

# Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services

API STANDARD 614  
FOURTH EDITION, APRIL 1999



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# **Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services**

**Downstream Segment**

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# CONTENTS

	Page
1 SCOPE .....	1-1
2 REFERENCED PUBLICATIONS .....	1-1
3 DEFINITION OF TERMS .....	1-1
4 GENERAL .....	1-3
4.1 Alternative Designs .....	1-3
4.2 Conflicting Requirements .....	1-3
4.3 System Selection .....	1-3
5 PIPING .....	1-3
5.1 General .....	1-3
5.2 Oil Piping .....	1-7
5.3 Instrument Piping .....	1-7
5.4 Process Piping .....	1-8
5.5 Intercoolers and Aftercoolers .....	1-8
6 INSTRUMENTATION, CONTROL, AND ELECTRICAL SYSTEMS .....	1-8
6.1 General .....	1-8
6.2 Instrument Installation .....	1-9
6.3 Alarms and Shutdowns .....	1-9
6.4 Instrumentation .....	1-10
6.5 Electrical Systems .....	1-11
7 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT .....	1-12
7.1 General .....	1-12
7.2 Inspection .....	1-12
7.3 Testing .....	1-13
7.4 Preparation for Shipment .....	1-14
8 VENDOR'S DATA .....	1-15
8.1 General .....	1-15
8.2 Proposals .....	1-15
8.3 Contract Data .....	1-16
APPENDIX A REFERENCE LIST OF U.S., ISO, AND INTERNATIONAL STANDARDS .....	1-19
APPENDIX B VENDOR DRAWING AND DATA REQUIREMENTS (INFORMATIVE) .....	1-39
APPENDIX C TYPICAL RESPONSIBILITY MATRIX WORKSHEET (INFORMATIVE) .....	1-45
APPENDIX D DATA SHEETS (INFORMATIVE) .....	1-49
APPENDIX E FILTER RATINGS AND CLEANLINESS STANDARDS (INFORMATIVE) .....	1-59
APPENDIX F PIPING SYMBOLS (INFORMATIVE) .....	1-67



# Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services

## Chapter 1—General Requirements

### 1 Scope

**1.1** This international standard covers the minimum requirements for lubrication systems, oil-type shaft-sealing systems, dry gas face-type shaft-sealing systems, and control-oil systems for general or special purpose applications. General purpose applications are limited to lubrication systems. These systems may serve equipment such as compressors, gears, pumps, and drivers. This standard does not apply to internal combustion engines.

This international standard is intended to be used for services in the petroleum, chemical, and gas industries as well as other industries by agreement. This standard is separated into four distinct chapters. Chapters 2, 3, and 4 are to be used separately in conjunction with Chapter 1.

Note: A bullet (•) at the beginning of a paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the data sheets (see Appendix D of Chapter 1, B of Chapters 2 and 3, and C of Chapter 4); otherwise, it should be stated in the quotation request or in the order.

**1.2** When the purchaser, on the purchase order or on the data sheets incorporated in the purchase order, specifies that oil or gas systems shall be supplied in accordance with this international standard, this standard shall take precedence over any other section of any other standard which covers the same subject.

### 2 Referenced Publications

**2.1** The purchaser and the vendor will mutually agree and indicate on the data sheets which set of national or international standards listed in Appendix A shall apply to the scope of supply.

Note: The listing presented in Appendix A does not imply each corresponding standard is equivalent to the USA standard. It is the responsibility of the purchaser and the vendor to verify that the specified standard meets or exceeds the requirements of the standard listed under USA.

**2.2** The purchaser and the vendor shall mutually determine the measures that must be taken to comply with any federal, state, or local codes, regulations, ordinances, or rules that are applicable to the equipment. This includes the use of Appendix A to determine the international standards.

### 3 Definition of Terms

Terms used in this standard are defined in 3.1 through 3.48.

**3.1 alarm point:** A preset value of a parameter at which an alarm warns of a condition requiring corrective action.

**3.2 block-in time:** The period required (after the driver is tripped) to isolate (valve in) a piece of equipment—such as a compressor—from its system and to de-pressurize it.

**3.3 booster pump:** An oil pump that takes suction from the discharge of another pump to provide oil at a higher pressure.

**3.4 coast-down time:** The period required (after the driver is tripped) for the equipment to come to rest.

**3.5 components:** Machinery and hardware items, such as reservoirs, pumps, coolers, filters, valves, and instruments, that are part of the oil system.

**3.6 console:** A total oil supply system whose components and controls are packaged as a single unit on a continuous or joined baseplate. This arrangement requires the purchaser to make only external connections.

**3.7 continuous-flow transfer valve:** A continuous-flow transfer valve can simultaneously divert both inlet and outlet flows from one component to its installed spare equipment without altering the continuity of full flow through the transfer valve to the equipment.

**3.8 control oil:** The oil required to operate such components as relays, servos, and power pistons on the main equipment.

**3.9 cool-off time:** The period when oil must be circulated through the equipment to prevent heat damage after the driver is tripped.

**3.10 design:** The use of the word “design” in any term (such as design power, design pressure, design temperature, or design speed) should be avoided in the purchaser’s specifications. This terminology should be used only by the equipment designer and the manufacturer.

**3.11 emergency oil pump:** A separate oil pump that provides adequate pressure and capacity to permit safe shut-down of the equipment when the main and standby pumps are inoperable.

**3.12 equipment:** The main machinery served by the oil or gas system.

**3.13 gas seal module:** The arrangement of piping, filters, and instrumentation used to control and monitor the pressure or flow of seal, buffer, or separation gas to the equipment shaft end seals.

**3.14 gauge board:** An unenclosed bracket or plate used to support and display gauges, switches, and other instruments.

**3.15 general purpose:** Refers to an application that is usually spared or is in noncritical service.

**3.16 local:** Refers to a device mounted on or near the equipment or console.

**3.17 main oil pump:** The oil pump that is normally in operation.

**3.18 maximum allowable temperature:** The maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure.

**3.19 maximum allowable working pressure:** The maximum continuous pressure for which the manufacturer has designed the console or components when handling the specified fluid at the maximum allowable temperature.

**3.20 maximum sealing pressure:** The highest pressure expected at the seals during any specified static or operating conditions and during start-up and shutdown. Considerations should include relief valve settings plus relief valve accumulation pressure.

**3.21 multiple-package arrangement:** A total oil supply system whose components are separated into individually packaged units. This arrangement requires only that the purchaser install the interconnections between the packages and the external connections.

**3.22 normal flow:** The total amount of oil required by equipment components, such as bearings, seals, couplings, and steady-state controls. It does not include transient flow for controls or oil bypassed directly back to the reservoir.

**3.23 normal operating point:** The point at which usual operation is expected and optimum efficiency is desired. This point is usually the point at which the vendor certifies that performance is within the tolerances stated in this standard.

**3.24 normal seal gas flow:** The total amount of flow required by equipment seals. It does not include transient gas flows, or bypass flows.

**3.25 normally open and normally closed:** Refer to on-the-shelf positions and designate the deenergized posi-

tions of devices, such as automatically-controlled electric switches and valves. During operation of the equipment, the positions of these devices are not necessarily the same as their on-the-shelf positions.

**3.26 package:** A total oil supply system whose components are mounted on a single baseplate. A package is complete in all respects, including controls and instrumentation.

**3.27 panel:** An enclosure used to mount, display, and protect gauges, switches, and other instruments.

**3.28 primary seal gas:** Dry, filtered gas supplied to the high pressure side of a self-acting gas seal.

**3.29 remote:** Located away from the equipment or the console, typically in a control house.

**3.30 seal barrier gas:** A clean gas supplied to the area between the seals of a dual seal arrangement at a pressure higher than the process pressure.

**3.31 seal buffer gas:** Clean gas supplied to the high pressure side of a seal.

Note: Seal gas is either supplied from the compressor discharge or from an external source. When supplied from an external source, it is referred to as seal buffer gas.

**3.32 seal gas leakage:** The gas which flows from the high pressure side of the seal to the low pressure side of the seal.

**3.33 secondary seal gas:** A clean purge gas supplied to the area between the seals of a tandem self-acting gas seal having an intermediate labyrinth. This gas is at a pressure lower than the process pressure (see Figure 4A-2).

**3.34 self-acting gas seal module:** The arrangement of components on a skid or a rack used to support the self-acting gas seal.

**3.35 self-acting gas seal system:** Includes the self-acting gas seal module and all other components necessary for operation of the self-acting gas seal.

**3.36 separation gas:** A supply of inert gas or air fed into the region between the seal and the shaft bearing.

**3.37 settling-out pressure:** The maximum pressure the system can come to under static conditions.

**3.38 shaft-driven pump:** An oil pump driven by the shaft of one of the main machines served by the oil system.

**3.39 shutdown point:** A pre-set value of a parameter at which automatic or manual shutdown of the system is required.

**3.40 special-purpose application:** An application for which the equipment is designed for uninterrupted, continuous operation in critical service and for which there is usually no spare equipment.

**3.41 standby pump:** An oil pump that is normally either stopped or running at idling speed, that is capable of either automatically or manually being immediately brought up to operating speed, and that is capable of operating continuously.

**3.42 standby service:** Refers to a normally idle or idling piece of equipment that is capable of immediate automatic or manual start-up and continuous operation.

**3.43 stilling tube:** A pipe extending into the reservoir from the connection to below pump suction loss level to prevent splashing and provide free release of foam and gas. Typically used for nonpressurized returns, the tube must have an open top or vent holes to equalize to reservoir pressure.

**3.44 unit responsibility:** Refers to the responsibility for coordinating the technical aspects of the equipment and all auxiliary systems included in the scope of the order. Responsibility for such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, and testing of components shall be reviewed.

**3.45 vendor:** The agency that manufactures, sells, and provides service support for the equipment.

**3.46 vent gas:** The seal gas leakage which is taken away by the vent system.

**3.47 vent system:** The arrangement of piping and valves used to take gas to a safe location.

**3.48** Terms relating to oil reservoir capacities and configurations are defined in Figure 2-1.

## 4 General

### 4.1 ALTERNATIVE DESIGNS

- The purchaser will specify whether systems supplied to this standard shall have metric dimensions and comply with applicable ISO standards or have U.S. Customary dimensions and comply with applicable U.S. standards. Appendix A provided in this chapter is a reference list of U.S., ISO, and International Standards to be used to specify the applicable standards.

### 4.2 CONFLICTING REQUIREMENTS

In case of conflict between this standard and the inquiry or order, the information included in the order shall govern.

### 4.3 SYSTEM SELECTION

- **4.3.1** Chapters 2, 3, and 4 appendices provide schematics and diagrams of typical complete lubrication, oil-type shaft-sealing, dry gas face-type shaft-sealing, and control-oil systems. These schematics and diagrams illustrate the general philosophy and requirements of this standard and are

included to assist the purchaser in the selection of an appropriate system. The purchaser and the vendor shall agree on a mutually acceptable system prior to releasing the order.

- **4.3.2** The purchaser will define the scope of supply, quality level or the brand of components, system type, general arrangement (including plan and elevation views of the console orientation), space available for the console, service (special purpose, or general purpose), and other requirements. Appendix C may be used to define scope of supply responsibility.

## 5 Piping

### 5.1 GENERAL

**5.1.1** Piping design and joint fabrication, examination, and inspection shall comply with ASME B31.3.

**5.1.2** Auxiliary systems are defined as piping systems that are in the following services:

- a. Group I: (see Table 1A)
  1. Sealing fluid.
  2. Gland and flushing fluid.
  3. Recirculation fluid.
  4. Balance gas.
  5. Buffer gas.
  6. Fuel gas or oil.
  7. Drains and vents.
  8. Starting gas.
  9. Separation gas.
- b. Group II: (see Table 1B)
  1. Sealing steam.
  2. Steam injection.
  3. Water injection.
  4. Starting air.
  5. Instrument and control air.
  6. Drains and vents.
- c. Group III: (see Table 1C)
  1. Cooling water.
  2. Liquid wash.
  3. Drains and vents.
- d. Group IV: (see Table 1D)
  1. Lubricating oil.
  2. Control oil.
  3. Seal oil (see 5.4 for seal oil contaminated with process fluid).
  4. Drains and vents.

Auxiliary systems shall comply with the requirements of Tables 1 and 2, except as modified in referencing standards, including references to Tables 1 and 2 in Chapters 2, 3, and 4 of this standard.

Table 1A—Minimum Requirements for Piping Materials: Auxiliary Process Fluid

Materials	Requirements
Pipe	ASTM A312 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel. Seamless, except Schedule 10S and 40S may be electric fusion welded. ASTM A106-B, A53-B or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel.
Pipe Fitting	ASTM A403 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel. Seamless, except Schedule 10S and 40S may be electric fusion welded. ASTM A182 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel, Class 3000. ASTM A234 or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel, Class 3000.
Flange	ASTM A181 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel weld neck or slip-on. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel slip-on. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, steel weld neck or slip-on.
Tubing	ASTM A269 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel.
Tube Fittings	Stainless steel type 304 or 316 (vendor's standard with purchasers approval).
Gaskets	For less than or equal to ANSI Class 300—flat nonasbestos type. For greater than or equal to ANSI Class 600—spiral wound with nonasbestos filler, 304 or 316 windings and external centering ring.
Flange Bolting	Refer to 5.1.23 in Chapter 1.
Valves	Refer to 5.1.18 in Chapter 1.

## Notes:

1. Piping to be butt-welded except DN20 (NPS 1) and smaller may be socket welded or threaded.
2. Threaded joints require seal welding; however, seal welding is not permitted on instruments or where disassembly is required for maintenance.
3. Minimum pipe wall thickness shall be in accordance with Table 2A.
4. Minimum tubing wall thickness shall be in accordance with Table 2B.

Table 1B—Minimum Requirements for Piping Materials: Steam and Air

Materials	Requirements
Pipe	ASTM A106-B, A53-B or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel.
Pipe Fitting	ASTM A234 or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel, Class 3000.
Flange	ASTM A105 or the equivalent code located in Appendix A in Chapter 1, steel weld neck or slip-on.
Tubing	ASTM A269 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel.
Tube Fittings	Stainless steel type 304 or 316 (vendor's standard).
Gaskets	For less than or equal to ANSI Class 300—flat nonasbestos type. For greater than or equal to ANSI Class 600—spiral wound with nonasbestos filler, 304 or 316 windings and external centering ring.
Flange Bolting	Refer to 5.1.23 in Chapter 1.
Valves	Refer to 5.1.18 in Chapter 1.

## Notes:

1. Piping to be butt-welded except DN20 (NPS 1) and smaller may be socket welded or threaded.
2. Threaded joints require seal welding; however, seal welding is not permitted on instruments or where disassembly is required for maintenance.
3. Minimum pipe wall thickness shall be in accordance with Table 2A.
4. Minimum tubing wall thickness shall be in accordance with Table 2B.



Table 1C—Minimum Requirements for Piping Materials: Cooling Water

Materials	Requirements
Pipe	ASTM A106-B and A53-B or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel.
Pipe Fitting	ASTM A234 or the equivalent code located in Appendix A in Chapter 1, seamless, carbon steel. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel, Class 3000.
Flange	ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel weld neck or slip-on.
Tubing	ASTM A269 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel.
Tube Fittings	Stainless steel type 304 or 316 (vendor's standard).
Gaskets	Flat nonasbestos type.
Flange Bolting	Refer to 5.1.23 in Chapter 1.
Valves	Refer to 5.1.18 in Chapter 1.

## Notes:

1. Piping to be butt-welded except DN20 (NPS 1) and smaller may be socket welded or threaded.
2. Threaded joints require seal welding; however, seal welding is not permitted on instruments or where disassembly is required for maintenance.
3. Minimum pipe wall thickness shall be in accordance with Table 2A.
4. Minimum tubing wall thickness shall be in accordance with Table 2B.

Table 1D—Minimum Requirements for Piping Materials: Lubricating, Control, and Seal Oil

Materials	Requirements
Pipe	ASTM A312 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel. Seamless, except Schedule 10S and 40S may be electric fusion welded.
Pipe Fitting	ASTM A403 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel. Seamless, except Schedule 10S and 40S may be electric fusion welded. ASTM A182 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel, Class 3000.
Flange	ASTM A181 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel weld neck or slip-on. ASTM A105 or the equivalent code located in Appendix A in Chapter 1, carbon steel slip-on.
Tubing	ASTM A269 or the equivalent code located in Appendix A in Chapter 1, type 304 or 316 stainless steel.
Tube Fittings	Stainless steel type 304 or 316 (vendor's standard with purchaser's approval).
Gaskets	For less than or equal to ANSI Class 300—flat nonasbestos type. For greater than or equal to ANSI Class 600—spiral wound with nonasbestos filler, 304 or 316 windings and external centering ring.
Flange Bolting	Refer to 5.1.23 in Chapter 1.
Valves	Refer to 5.1.18 in Chapter 1.

## Notes:

1. Piping to be butt-welded except DN20 (NPS 1) and smaller may be socket welded or threaded.
2. Threaded joints require seal welding; however, seal welding is not permitted on instruments or where disassembly is required for maintenance.
3. Minimum pipe wall thickness shall be in accordance with Table 2A.
4. Minimum tubing wall thickness shall be in accordance with Table 2B.

Table 2A—Minimum Pipe Wall Thicknesses

Materials	Nominal Pipe Size Minimum	(in.)	Schedule
Carbon Steel	DN40	( $\leq 1\frac{1}{2}$ )	80
Carbon Steel	DN50-200	(2 to 8)	40
Carbon Steel	DN200	( $\geq 8$ )	20
Stainless Steel	DN25	( $\leq 1$ )	80S
Stainless Steel	DN40-75	( $1\frac{1}{2}$ to 3)	40S
Stainless Steel	DN100	( $\geq 4$ )	10S

Table 2B—Minimum Tubing Wall Thicknesses

Minimum Wall Thickness	Nominal Tubing Size <sup>a</sup>	(in.)	(mm)
6 mm	( $\frac{1}{4}$ ) <sup>b</sup>	0.035	1.0
10 mm	( $\frac{3}{8}$ ) <sup>b</sup>	0.035	1.0
12 mm	( $\frac{1}{2}$ )	0.064	1.5
20 mm	( $\frac{3}{4}$ )	0.080	2.0
25 mm	(1)	0.104	2.6

## Notes:

<sup>a</sup>The tubing size is the outside diameter in inches.

<sup>b</sup>The sizes 6 mm ( $\frac{1}{4}$  in.) and 10 mm ( $\frac{3}{8}$  in.) are permitted for instrument and control air only.

**5.1.3** Piping systems shall include piping, isolating valves, control valves, relief valves, pressure reducers, orifices, temperature gauges and thermowells, pressure gauges, sight flow indicators, and related vents and drains.

- 5.1.4** The vendor shall furnish all piping systems, including mounted appurtenances, located within the confines of the main unit's base area, any oil console base area, or any auxiliary base area. The piping shall terminate with flanged connections at the edge of the base. When soleplates are specified for the equipment train, the extent of the piping system at the equipment train will be defined by the purchaser. The purchaser will furnish only interconnecting piping between equipment groupings and off-base facilities.

**5.1.5** The design of piping systems shall achieve the following:

- Proper support and protection to prevent damage from vibration or from shipment, operation, and maintenance.
- Proper flexibility and normal accessibility for operation, maintenance, and thorough cleaning.
- Installation in a neat and orderly arrangement adapted to the contour of the machine without obstructing access openings.

d. Elimination of air pockets by the use of valved vents or nonaccumulating piping arrangements.

e. Complete drainage through low points without disassembly of piping.

**5.1.6** Piping shall be fabricated by bending and welding to minimize the use of flanges and fittings where practical. Welded flanges are permitted only at equipment connections, at the edge of any base, and for ease of maintenance. The use of flanges at other points is permitted only with the purchaser's specific approval. Other than tees and reducers, welded fittings are permitted only to facilitate pipe layout in congested areas. Threaded connections shall be held to a minimum. Pipe bushings shall not be used.

**5.1.7** Pipe threads shall be taper threads in accordance with ASME B1.20.1. Alternately, pipe threads in accordance with ISO 228 part 1 are acceptable when required for compliance with local standards. Flanges shall be in accordance with ISO 7005 (ASME B16.5). Slip-on flanges are permitted only with the purchaser's specific approval. For socket-welded construction, a 1.5 mm ( $\frac{1}{16}$  in.) gap shall remain between the pipe end and the bottom of the socket.

**5.1.8** Connections, piping, valves, and fittings that are 30 mm ( $1\frac{1}{4}$  in.), 65 mm ( $2\frac{1}{2}$  in.), 90 mm ( $3\frac{1}{2}$  in.), 125 mm (5 in.), 175 mm (7 in.), or 225 mm (9 in.) in size shall not be used.

**5.1.9** Where space does not permit the use of DN12 (NPS  $\frac{1}{2}$  in.), DN20 (NPS  $\frac{3}{4}$  in.), or DN20 (NPS 1 in.) pipe, seamless tubing may be furnished in accordance with Table 1.

**5.1.10** The minimum size of any connection shall be NPS  $\frac{1}{2}$ .

**5.1.11** Piping systems furnished by the vendor shall be fabricated, installed in the shop, and properly supported. Bolt holes for flanged connections shall straddle lines parallel to the main horizontal or vertical centerline of the equipment.

**5.1.12** Welding shall be performed by operators and procedures qualified in accordance with Section IX of the ASME *Boiler and Pressure Vessel Code*.

**5.1.13** Tapped openings shall be plugged with solid, round-head steel plugs furnished in accordance with ASME B16.11. As a minimum, these plugs shall meet the material requirements of the piping system. Plugs that may later require removal shall be of corrosion-resistant material. A lubricant that meets the proper temperature specification shall be used on all threaded connections. Tape shall not be applied to threads of plugs inserted into oil passages. Plastic plugs are not permitted.

Note: This section refers to piping only. Plugs on equipment addressed in this standard, such as filters, coolers, etc. are covered in Chapters 2, 3, and 4. Plugs on other equipment are covered in their respective standards.

**5.1.14** The root pass of all butt-welds on stainless steel pipe shall be made by tungsten inert-gas arc welding. Filler passes may be made by tungsten inert-gas arc welding or by the shielded metal arc process.

- **5.1.15** Special requirements for piping, flanges, gaskets and O-rings, valves, and other appurtenances in special and/or hazardous service will be specified by the purchaser.

**5.1.16** All components—such as flanges, valves, control valve bodies or heads, and relief valves—that contain oil, special and/or hazardous fluids, or steam over 500 kPa (75 psig) shall be made of steel.

**5.1.17** Threaded joints for special and/or hazardous fluids or for steam pressures greater than 500 kPa (75 psig) shall be seal-welded; however, seal welding is not permitted on cast iron equipment, instruments, or locations that must be disassembled for maintenance. Seal-welded joints shall be made in accordance with ASME B31.3 or the equivalent code located in Appendix A.

**5.1.18** Valves shall have bolted bonnets and glands. For primary ANSI or the equivalent code located in Appendix A service ratings greater than or equal to Class 900, block valves may be of welded bonnet or no-bonnet construction with a bolted gland; these valves shall be suitable for repacking under pressure. Wafer check valves per API Standard 594 or the equivalent code located in Appendix A may be used in sizes NPS 2 and larger.

**5.1.19** Block valves shall be supplied with nominal 13Cr stainless steel trim.

**5.1.20** Instrument valves for oil and gas service located in sensing lines downstream of a primary service block valve may be bar-stock instrument valves, provided the instrument valves are protected against accidental disassembly. Valves shall be stainless steel or carbon steel with corrosion-resistant plating and stainless steel stems.

**5.1.21** Bleed valves provided at instruments may be the manufacturer's standard bleed fitting. Where test valves are provided according to 5.1.22, bleed valves may be omitted.

- **5.1.22** When specified, test valves shall be supplied adjacent to all of the instruments. Test valves shall terminate with a plugged  $\frac{1}{2}$ -inch NPT connection. When specified, test valves in oil lines shall be vented back to the reservoir. Test valves may be combined with instrument valves supplied according to 5.1.20.

**5.1.23** The bolting for pressure joints, valves, and piping shall be based on the actual bolting temperature as defined in ASME B31.3 or the equivalent code located in Appendix A. As a minimum, according to the requirements of ASME B1.1 or the equivalent code located in Appendix A, the pressure bolting shall be ASTM A193 Grade B7 or the equivalent mate-

rial located in Appendix A and shall use ASTM A194 Grade 2H nuts or the equivalent material located in Appendix A.

**5.1.24** Unless otherwise specified, through studs shall be used.

- **5.1.25** When specified, each utility such as air and inert gas supply, cooling water supply and return lines, and others as specified shall be manifolded to a common connection.

**5.1.25.1** The manifold shall be sized to handle the maximum flow through all components which may require simultaneous use of the specified utility.

## 5.2 OIL PIPING

**5.2.1** Oil drains shall be sized to run no more than half full when flowing at normal drain operating temperature at maximum flow conditions and shall be arranged to ensure good drainage (recognizing the possibility of foaming conditions). Horizontal runs shall slope continuously, at least 40 mm/m ( $\frac{1}{2}$  in./ft), toward the reservoir. If possible, laterals (not more than one in any transverse plane) should enter drain headers at 45° angles in the direction of the flow. The minimum size for most oil drains shall be DN40 (NPS  $1\frac{1}{2}$  in.); however, the minimum size for inner seal oil drains shall be DN25 (NPS 1 in.).

**5.2.2** Nonconsumable backup rings and sleeve-type joints shall not be used. Pressure piping downstream of oil filters shall be free from internal obstructions that could accumulate dirt. Socket-welded fittings shall not be used in pressure piping downstream of oil filters (see Table 1D).

**5.2.3** Unless otherwise specified, piping and tubing, including fittings (excluding slip-on flanges), shall be made of stainless steel (see Table 1D).

**5.2.4** Provision shall be made for bypassing the bearings (and seals if applicable) of equipment during oil system flushing operations.

## 5.3 INSTRUMENT PIPING

**5.3.1** The vendor shall supply all necessary piping, valves, and fittings for instruments and instrument panels. Panels shall be completely assembled, requiring only connection to the purchaser's external piping and wiring circuits.

**5.3.2** Connections on equipment and piping for pressure instruments and test points shall conform to 2.1.4. Beyond the initial  $\frac{3}{4}$  in. isolating valve, DN12 (NPS  $\frac{1}{2}$  in.) piping, valves, and fittings may be used. Where convenient, a common connection may be used for remotely mounted instruments that measure the same pressure. Separate secondary  $\frac{1}{2}$ -in. isolating valves are required for each instrument on a common connection. Where a pressure gauge is to be used for testing

pressure alarm or shutdown switches, common connections are required for the pressure gauge and switches.

**5.3.3** Tubing valves shall be the manufacturer's standard tube-end or instrument valve and shall be stainless steel, as approved by the purchaser.

## 5.4 PROCESS PIPING

- **5.4.1** The extent of and requirements for process piping to be supplied by the vendor will be specified.
- **5.4.2** The requirements of Section 7 shall apply to process piping supplied by the vendor.
- **5.4.3** When specified, the vendor shall review all piping, appurtenances (pulsation suppression devices, intercoolers, aftercoolers, separators, knockout drums, air intake filters, expansion joints), and vessels immediately upstream and downstream of the equipment and supports. The purchaser and the vendor shall mutually agree on the scope of this review.

## 5.5 INTERCOOLERS AND AFTERCOOLERS

- **5.5.1** When specified, the vendor shall furnish an intercooler between each compression stage. Intercoolers shall be air cooled or water cooled as specified.
- **5.5.2** The purchaser will specify whether aftercoolers shall be furnished by the vendor.
- **5.5.3** Water-cooled shell-and-tube intercoolers and aftercoolers shall be designed and constructed in accordance with TEMA Class C or R, as specified by the purchaser. Intercoolers and aftercoolers shall be furnished in accordance with Section VIII, Division 1, of the ASME Code. When TEMA Class R is specified, the heat exchanger shall be in accordance with API Standard 660.

Note: Caution should be exercised regarding the susceptibility of heat exchangers and their supporting structures to pulsation-induced vibration.

**5.5.4** Unless otherwise approved by the purchaser, intercoolers and aftercoolers shall be constructed and arranged to allow removal of tube bundles without dismantling piping or compressor components. Water shall be on the tube side.

**5.5.5** Fixed tube-sheet exchangers shall have inspection openings into their gas passages. Rupture disks on the shell side (to protect the shell in case of tube failures) shall be used only when specifically approved by the purchaser.

**5.5.6** When air coolers are specified, they shall be in accordance with API Std 661.

**5.5.7** Unless otherwise specified, air-cooled heat exchangers used for intercoolers shall have automatic temperature control. This control may be accomplished by means of louvers,

variable-speed fans, variable-pitch fans, bypass valves, or any combination of these. Proposed control systems will be approved by the purchaser.

**5.5.8** Unless otherwise specified, intercoolers and aftercoolers shall be of the shell-and-tube design. Double-pipe intercoolers and finned double-pipe designs may be furnished only when specifically approved by the purchaser.

- **5.5.9** Intercoolers shall be either machine mounted or separately mounted, as specified.

**5.5.10** Materials of construction shall be those specified.

**5.5.11** When condensate separation and collection facilities are furnished by the vendor, they shall include the following:

- a. An automatic drain trap with a manual bypass.
- b. An armored gauge glass with isolation valves and blow-down valves on the collection pot.
- c. Separate connections and level switches for high-level alarm and trip on the collection pot.
- d. Collection pots sized to provide an agreed-upon holding capacity and a 5-minute time span between high-level alarm and trip, based on the expected normal liquid condensate rate.
- e. Separate connections and level switches for the high-level alarm and trip on the collection pot.

- **5.5.12** When specified, the vendor shall furnish the fabricated piping between the compressor stages (or the nozzles of centrifugal compressor bodies) and the intercoolers and aftercoolers. Interstage piping shall conform to ASME B31.3.

## 6 Instrumentation, Control, and Electrical Systems

### 6.1 GENERAL

**6.1.1** The oil-and-gas seal system shall be suitably instrumented and controlled for orderly start-up, stable operation, warning of abnormal conditions, and shutdown of the main equipment in the event of impending damage.

**6.1.2** Unless otherwise specified, instrumentation and installation shall conform to this standard.

**6.1.3** Unless otherwise specified, all controls and instrumentation shall be suitable for outdoor installation.

**6.1.4** Where applicable, controls and instrumentation shall conform to API RP 550, Part I.

**6.1.5** All controls and instruments shall be located and arranged to permit easy visibility by the operators, as well as accessibility for tests, adjustments, and maintenance.

**6.1.6** Unless otherwise specified, all instruments and controls other than shut-down sensing devices shall be installed with sufficient valving to permit their replacement while the

system is in operation. When shut-off valves are specified for shut-down sensing devices, the vendor shall provide a means of locking the valves in the open position.

**6.1.7** Except for instrument air service, bleed valves are required between instruments and their isolation valves. Combination isolation/bleed valves may be used.

**6.1.8** When a failure or a malfunction of a pressure control valve may create a hazard or result in damage to equipment or components, an additional pressure-limiting valve discharging to the reservoir or drain header shall be furnished (see Figures 2A-8 and 2A-9 of Chapter 2 for typical arrangements). The design criteria for sizing this additional pressure-limiting valve depends only on the sizing of the pressure control valve in a fail-open mode; fail-open modes include oil starvation, overpressure, and flooding of bearing housings.

Note: Other methods for limiting pressure may be employed, e.g., short-stroke valve with a mechanical stop.

## 6.2 INSTRUMENT INSTALLATION

- **6.2.1** Instruments for the console, gas seal module, and equipment may be local or gauge-board mounted as specified.

**6.2.1.1** The gauge boards shall have individually labeled instruments and be located as mutually agreed on by the purchaser and the vendor.

- **6.2.2** When specified, a panel shall be provided and shall include all panel-mounted instruments for the driven equipment and driver. Such panels shall be designed and fabricated in accordance with the purchaser's description. The purchaser will specify whether the panel is to be freestanding, located on the base of the unit, or in another location. The instruments on the panel shall be clearly visible to the operator from the driver control point. A lamp test push button shall be provided. The instruments to be mounted on the panel shall be specified on the data sheets.

- **6.2.3** Panel instruments will be specified by the purchaser. (See Appendix D for an equipment instrumentation list.)

**6.2.4** Gauge boards and panels shall be completely piped and wired, requiring only connections to the purchaser's external piping and wiring circuits.

**6.2.4.1** When more than one wiring point is required on a unit for controls or instrumentation, wiring to each switch or instrument shall be provided from terminal posts in a single terminal box which is mounted on the unit (or its base, if any).

- **6.2.4.2** All wiring shall be installed in metal conduit, cable trays, or enclosures as specified.

**6.2.4.3** All leads and posts on terminal strips, switches, and instruments shall be tagged for identification.

- **6.2.5** Instrument connections shall terminate at locations specified. In accordance with 6.1.6, shut-off valves shall be provided within gauge boards.

## 6.3 ALARMS AND SHUTDOWNS

**6.3.1** As a minimum, the vendor shall furnish and mount the primary alarm and shutdown elements as specified in the appropriate chapter. The alarm setting shall precede the shut-down setting.

Note: Guidance for the use of various specified arrangements may be found in ISA S-84.01, "Application of Safety Instrumented Systems for the Process Industries."

- **6.3.2** Switches, transmitters, control devices, and annunciator display units shall be furnished and mounted by the vendor as specified.

**6.3.3** Alarm and trip switch settings shall not be adjustable from outside the housing. Alarm and trip switches shall be arranged to permit testing of the control circuit, including, when possible, the actuating element, without interfering with normal equipment operation. When trip bypass functions are furnished in a vendor-supplied panel, the vendor shall provide a clearly visible light on the panel to indicate when trip circuits are in a test bypass mode. Unless otherwise specified, shut-down systems shall be provided with key lock switches or another suitable means to permit testing without shutting down the unit.

**6.3.4** Each alarm switch and each shut-down switch shall be furnished in a separate enclosure to facilitate inspection and maintenance. Hermetically sealed, single-pole, double-throw switches with a minimum capacity of 5 amperes at 120 volts AC and 1/2 ampere at 120 volts DC shall be used. Mercury switches shall not be used.

**6.3.5** Pressure-sensing elements shall be made of AISI Standard Type 300 stainless steel. Low-pressure alarms and trips, which are activated by falling pressure, shall be equipped with a valved bleed or vent connection to allow controlled depressurizing so that the operator can note the alarm set pressure on the associated pressure gauge. High-pressure alarms and trips, which are activated by rising pressure, shall be equipped with valved test connections so that a portable test pump can be used to raise the pressure.

- **6.3.6** When specified, the vendor shall provide an annunciator.

**6.3.7** The vendor shall furnish a first-out annunciator when an annunciator system is specified. The annunciator shall contain approximately 25 percent spare points and, when specified, shall be arranged for purging. Connections shall be provided for actuation of a remote signal when any function alarms or trips. The sequence of operation shall be as specified in 6.3.7.1 through 6.3.7.3.

**6.3.7.1** Alarm indication shall consist of the flashing of a light and the sounding of an audible device.

**6.3.7.2** The alarm condition shall be acknowledged by operating an alarm-silencing button common to all alarm functions.

**6.3.7.3** When the alarm is acknowledged, the audible device shall be silenced, but the light shall remain steadily lit as long as the alarm condition exists. The annunciator shall be capable of indicating a new alarm (with a flashing light and the sounding horn) if another function reaches an alarm condition, even if the previous alarm condition has been acknowledged but still exists.

## 6.4 INSTRUMENTATION

### 6.4.1 Temperature Indicators (TI)

**6.4.1.1** Temperature-sensing elements shall be in the flowing fluid.

Note: This is particularly important for lines that may run partially full.

**6.4.1.2** Temperature-sensing elements may be located in oil-flow sight glasses.

### 6.4.2 Level Instruments

Direct-acting level instrument may be operated by displacers, floats, capacitance, ultrasonic, transmitter or other means as approved. Unless otherwise specified, sensing elements shall be made of Series 300 stainless steel.

### 6.4.3 Thermowells

Temperature indicators or sensing elements that are in contact with the process or are located in pressurized or flooded lines shall be furnished with NPS  $\frac{3}{4}$  in., Series 300 stainless steel separable solid-bar thermowells.

Note: Larger pipe sizes may be required to avoid restriction of flow by the thermowell.

### 6.4.4 Thermocouples and Resistance Temperature Detectors

Where practical, the design and location of thermocouples and resistance temperature detectors shall permit replacement while the unit is operating. The lead wires of the thermocouples or resistance temperature detectors shall terminate in the thermocouple or resistance detector head. The vendor shall install leads from the head to an on-base terminal box.

### 6.4.5 Pressure Indicators (PI)

- **6.4.5.1** Pressure indicators shall be located per the data sheets.

Note: This refers to local indication of pressure and can be accomplished by indicators or indicating pressure transmitters.

**6.4.5.2** Pressure gauges (not including built-in instrument air gauges) shall be furnished with AISI Standard Type 316 stainless steel bourdon tubes and stainless steel movements, 110 mm (4 $\frac{1}{2}$  in.) dials [150 mm (6 in.) dials for the range over 55 bar (800 psi)], and NPS  $\frac{1}{2}$  in. male stainless steel connections. Black printing on a white background is standard for gauges.

- **6.4.5.2.1** When specified, liquid-filled gauges shall be furnished in locations subject to vibration.

**6.4.5.2.2** Pressure indicator ranges shall preferably be selected so that the normal operating pressure is at the middle of the indicators range. In no case, however, shall the maximum reading on the dial be less than the applicable relief valve setting plus 10 percent.

**6.4.5.2.3** Each pressure indicator shall be provided with a device such as a disk insert or blowout back designed to relieve excess case pressure.

- **6.4.5.3** The vendor shall supply all pressure indicators and transmitters as defined by the purchaser on the data sheets. Transmitters which provide alarm/trip signals shall be purchased with the minimum response time setpoint available.

**6.4.5.4** Differential pressure indicators shall be located according to the data sheets.

### 6.4.6 Oil Sight Flow Indicators (FI)

**6.4.6.1** Flow indicators shall be furnished in the atmospheric oil-drain return line from each bearing, gear, and seal, and, unless otherwise specified, in the outlet piping of each continuously lubricated coupling.

Note: Flow indicators shall not be installed in pressurized lines except as indicated in 6.4.6.4.

**6.4.6.2** Unless otherwise specified, the flow indicator shall be flanged, shall be of the bull's-eye type, and shall have a steel body.

**6.4.6.3** To facilitate viewing of the oil flow through the line, each flow indicator should be installed with its bull's-eye glass in a vertical plane. The diameter of the bull's-eye shall be at least one-half the inside diameter of the oil pipe and shall clearly show the minimum oil-flowing level.

- **6.4.6.4** When specified, restrictive flow indicators shall be installed in the pressurized inlet line to each continuously lubricated coupling.

### 6.4.7 Solenoid Valves

**6.4.7.1** Direct solenoid-operated valves shall be used only in clean, dry instrument-air or control-oil service, shall have

Class F insulation or better and a continuous service rating. When required for other services, the solenoid shall act as a pilot valve to pneumatic valves, hydraulic valves, and the like.

**6.4.7.2** Solenoid valves shall not be used in continuous services that may affect normal operations; they may be used in intermittent instrument services.

- **6.4.7.3** When continuously energized solenoids are specified for trip circuits, the vendor shall provide the purchaser with the coil rating and estimated service life of each solenoid coil based on continuously energized operation. Dual-coil solenoids may be specified for any trip function. Each coil shall be capable of keeping the solenoid in its energized condition. Separate relays shall energize each coil.

### 6.4.8 Pressure-Limiting Valves

**6.4.8.1** The vendor shall furnish the pressure-limiting valves that are to be installed on components or in piping that is supplied by the vendor. Other pressure-limiting valves will be furnished by the purchaser. Only pressure-limiting valves for gas or steam service are required to meet the pressure-limiting requirements defined in API RP 520, Parts I and II, and in API RP 526.

**6.4.8.2** The vendor shall determine the size and set pressure of all pressure-limiting valves associated with the system components. Pressure-limiting settings, including not more than 10 percent accumulation, shall take into consideration all possible types of equipment and component failures and the protection of oil system or gas seal module components and piping.

- **6.4.8.3** When specified, thermal relief valves shall be provided for components that may be blocked in by isolation valves.

### 6.4.9 Control Valves

**6.4.9.1** Control valve(s) shall be installed to maintain system pressure, reduce pressure, regulate flow, or maintain a differential pressure.

**6.4.9.2** Control valve(s) shall have steel bodies with stainless steel trim. All air supply or pressure sensing tubing shall be made of stainless steel. The pressure rating of the body and head shall not be less than the maximum pressure the component can be exposed to in its failed position.

**6.4.9.3** Control valve(s) sizes shall be the same as the allowable pipe sizes.

Note: This may be swaged down from the pipe line size.

**6.4.9.4** Unless otherwise specified on the schematics, failure mode for control valves are:

- a. Backpressure—fail closed.
- b. Pressure reducing—fail open.

**6.4.9.5** Control valve(s) may be either direct-acting or pneumatically-operated.

a. Pneumatic control valves shall be sized to be not less than 10 percent open with the minimum flow through the valve and not more than 90 percent open with the maximum flow expected through the valve.

b. Pneumatic control valve(s) actuator and spring shall be sized to open or close against the maximum pressure (relief valve plus accumulation) expected in the system.

c. Direct acting valves shall be sized to limit proportional offset to 10 percent based on steady state and 25 percent for maximum transients.

d. Direct acting control valves shall have an external sensing line.

## 6.5 ELECTRICAL SYSTEMS

- **6.5.1** The characteristics of electrical power supplies for motors, heaters, and instrumentation will be specified.

**6.5.2** A pilot light shall be provided on the incoming side of each supply circuit to indicate that the circuit is energized. The pilot lights shall be installed on the control panel.

**6.5.3** Electrical equipment located on the unit or on any separate panel shall be suitable for the electrical area classification specified.

**6.5.4** Power, control, and instrument wiring within the confines of the baseplate or module shall be resistant to oil, heat, moisture, and abrasion.

**6.5.4.1** Stranded conductors shall be used within the confines of the baseplate and in other areas subject to vibration.

- **6.5.4.2** When specified, measurement and remote-control panel wiring may be solid conductors.

**6.5.4.3** Where rubber insulation is used, a neoprene rubber or high-temperature thermoplastic sheath shall be provided for insulation protection.

**6.5.4.4** Wiring shall be suitable for environmental temperatures.

**6.5.5** Unless otherwise specified, all leads on terminal strips, switches, and instruments shall be permanently tagged for identification. All terminal boards in junction boxes and control panels shall have at least 20 percent spare terminal points.

**6.5.6** To facilitate maintenance, liberal clearances shall be provided for all energized parts (such as terminal blocks and relays) on all components. The clearances required for 600-volt service shall also be provided for lower voltages. Enclosures shall be provided for all energized parts to guard against accidental contact.

- **6.5.7** Electrical materials including insulation, shall be corrosion resistant and nonhygroscopic insofar as is possible. When specified for tropical location, materials shall be given the treatments specified in 6.5.7.1 and 6.5.7.2.

**6.5.7.1** Parts (such as coils and windings) shall be protected from fungus attack.

**6.5.7.2** Unpainted surfaces shall be protected from corrosion by plating or another suitable coating.

**6.5.8** AC and DC circuits shall be clearly labeled, connected to separate terminal blocks, and isolated from each other.

- **6.5.9** Control, instrumentation, and power wiring (including temperature element leads) within the limits of the baseplate shall be installed in rigid metallic conduits, cable trays, or enclosures as specified, properly bracketed to minimize vibration and isolated or shielded to prevent interference between voltage levels.

**6.5.9.1** Conduits may terminate (and in the case of temperature element heads, shall terminate) with a flexible metallic conduit long enough to permit access to the unit for maintenance without removal of the conduit.

**6.5.9.2** If temperature element heads will be exposed to temperatures above 60°C (140°F), a 19 mm (NPS <sup>3</sup>/<sub>4</sub>) bronze hose with four-wall interlocking construction and joints with packed-on (heatproof) couplings shall be used.

**6.5.10** For Division 2 locations, flexible metallic conduits shall have a liquid tight thermosetting or thermoplastic outer jacket and approved fittings.

**6.5.10.1** For Division 1 locations, UL-approved flexible fittings shall be provided.

**6.5.11** All conduit shall be grouped and mounted above the baseplate to prevent the formation of a dam which can limit the free drainage of fluids. The conduit shall not be located in a maintenance access area.

- **6.5.12** The purchaser may provide a starting switch for the standby pump motor. This switch should contain manual-on and automatic-start positions only, with a separate manual reset button. The manual reset button allows the standby pump to be manually shut down while the switch is in the automatic-start position only if the primary pump is providing sufficient pressure [that is, if the pressure-rising limit relay of the low-pressure switch (PSL) (see Figures 2A-2, 2A-3) has been satisfied]. A separate electrical disconnect switch with a lockable off position should be provided, but this switch should be provided at a remote location and should be used only for pump maintenance or during the time the equipment is shut down.

## 7 Inspection, Testing, and Preparation for Shipment

### 7.1 GENERAL

- **7.1.1** The purchaser will specify the extent of participation in the inspection and testing and the amount of advance notification required.

**7.1.2** After advance notification of the vendor by the purchaser, the purchaser's representative shall have entry to all vendor and subvendor plants where manufacturing, testing, or inspection of the equipment is in progress.

**7.1.3** The vendor shall notify subvendors of the purchaser's inspection and testing requirements.

**7.1.4** The vendor shall provide sufficient advance notice to the purchaser before conducting any inspection or test that the purchaser has specified to be witnessed or observed.

**7.1.4.1** When shop inspection and testing have been specified by the purchaser, the purchaser and the vendor shall meet to coordinate manufacturing hold points and inspectors' visits.

**7.1.4.2** *Witnessed* means that a hold shall be applied to the production schedule and that the inspection or test shall be carried out with the purchaser or his representative in attendance. For mechanical running or operational tests, this requires written notification of a successful preliminary test.

**7.1.4.3** *Observed* means that the purchaser shall be notified of the timing of the inspection or test; however, the inspection or test shall be performed as scheduled, and if the purchaser or his representative is not present, the vendor shall proceed to the next step. (The purchaser should expect to be in the factory longer than for a witnessed test.)

**7.1.5** Equipment for the specified inspection and tests shall be provided by the vendor.

**7.1.6** The purchaser's representative shall have access to the vendor's quality program for review.

**7.1.7** The purchaser's representative shall have the right to reject any system or system components that do not conform to the purchase order.

### 7.2 INSPECTION

#### 7.2.1 General

**7.2.1.1** The vendor shall keep the following data available for at least 20 years for examination or reproduction by the purchaser or his representative upon request:

- Necessary certification of materials, such as mill test reports.
- Purchase specifications for all items on bills of material.



c. Test data to verify that the requirements of the specification have been met.

d. Results of documented tests and inspections, including fully identified records of all heat treatment and radiography.

**7.2.1.2** Pressure-containing parts shall not be painted until the specified inspection of the parts is completed.

- **7.2.1.3** In addition to the requirements of the governing piping, pressure vessel, and welding code or standard, the purchaser may specify the following:

a. Parts that shall be subjected to surface and subsurface examination.

b. The type of examination required, such as magnetic particle, liquid penetrant, radiographic, and ultrasonic examination.

## 7.2.2 Material Inspection

### • 7.2.2.1 General

When radiographic, ultrasonic, magnetic particle, or liquid penetrant inspection of welds or materials is required or specified, the criteria in 7.2.2.2 through 7.2.2.5 shall apply unless other criteria are specified by the purchaser. Cast iron may be inspected in accordance with 7.2.2.4 and 7.2.2.5. Welds, cast steel, and wrought material may be inspected in accordance with 7.2.2.2 through 7.2.2.5.

### 7.2.2.2 Radiography (7.2.2.1)

**7.2.2.2.1** Radiography shall be in accordance with ASTM E 94 and ASTM E 142.

**7.2.2.2.2** The acceptance standard used for welded fabrications shall be Section VIII, Division 1, UW-52, of the ASME Code. The acceptance standard used for castings shall be Section VIII, Division 1, Appendix 7, of the ASME Code.

### 7.2.2.3 Ultrasonic Inspection (7.2.2.1)

**7.2.2.3.1** Ultrasonic inspection shall be in accordance with Section V, Article 5, of the ASME Code.

**7.2.2.3.2** The acceptance standard used for welded fabrications shall be Section VIII, Division 1, Appendix 12, of the ASME Code. The acceptance standard used for castings shall be Section VIII, Division 1, Appendix 7, of the ASME Code.

### 7.2.2.4 Magnetic Particle Inspection (7.2.2.1)

**7.2.2.4.1** Both wet and dry methods of magnetic particle inspection shall be in accordance with ASTM E 709.

**7.2.2.4.2** The acceptance standard used for welded fabrications shall be Section VIII, Division 1, Appendix 6, of the ASME Code. The acceptability of defects in castings shall be based on a comparison with the photographs in ASTM E 125. For each type of defect, the degree of severity shall not exceed the limits specified in Table 3.

Table 3—Maximum Severity of Defects in Castings

Type	Defect	Maximum Severity Level
I	Linear discontinuities	1
II	Shrinkage	2
III	Inclusions	2
IV	Chills and chaplets	1
V	Porosity	1
VI	Welds	1

### 7.2.2.5 Liquid Penetrant Inspection (7.2.2.1)

**7.2.2.5.1** Liquid Penetrant inspection shall be in accordance with Section V, Article 6, of the ASME Code.

**7.2.2.5.2** The acceptance standard used for welded fabrications shall be Section VIII, Division 1, Appendix 8, of the ASME Code. The acceptance standard used for castings shall be Section VIII, Division 1, Appendix 7, of the ASME Code.

Note: Regardless of the generalized limits in 7.2.2, it shall be the vendor's responsibility to review the design limits of the equipment in the event that more stringent requirements are necessary. Defects that exceed the limits imposed in 7.2.2 shall be removed to meet the quality standards cited, as determined by the inspection method specified.

## 7.2.3 Mechanical Inspection

**7.2.3.1** During assembly of the system and before testing, each component (including cast-in passages of these components) and all piping and appurtenances shall be cleaned by appropriate methods to remove foreign materials, corrosion products, and mill scale.

Note: Purchased components shall be pre-cleaned.

- **7.2.3.2** When specified, the purchaser may inspect for cleanliness the equipment and all piping and appurtenances furnished by or through the vendor before heads are welded to vessels, openings in vessels or exchangers are closed, or piping is finally assembled.

- **7.2.3.3** When specified, the hardness of parts, welds, and heat-affected zones shall be verified as being within the allowable values by testing of the parts, welds, or heat-affected zones. The method, extent, documentation, and witnessing of the testing shall be mutually agreed on by the purchaser and the vendor.

## 7.3 TESTING

### 7.3.1 General

**7.3.1.1** At least 6 weeks prior to the first scheduled test, the vendor shall submit to the purchaser, for review and comment,

detailed procedures for all running tests, including acceptance criteria for all monitored parameters.

**7.3.1.2** The vendor shall notify the purchaser not less than 5 working days prior to the date the equipment will be ready for testing. If the testing is rescheduled, the vendor shall notify the purchaser not less than 5 working days prior to the new test date.

## 7.3.2 Hydrostatic Test

**7.3.2.1** Pressure-containing parts (including auxiliaries) shall be tested hydrostatically with liquid at a minimum of  $1\frac{1}{2}$  times the maximum allowable working pressure but not less than gauge pressure of 1.5 bar (20 psig). The test liquid shall be at a higher temperature than the nil-ductility transition temperature of the material being tested.

**7.3.2.1.1** The assembled piping system, or each package, shall be hydrostatically tested as per 7.3.2.1. Alternately, by prior agreement, the piping spools may be tested individually instead of an assembled hydrotest.

Note: Removal of spools, screens, or the loosening of flanges does not void the original hydrotest.

**7.3.2.2** If the part tested is to operate at a temperature at which the strength of a material is below the strength of that material at room temperature, the hydrostatic test pressure shall be multiplied by a factor obtained by dividing the allowable working stress for the material at room temperature by that at operating temperature. The stress values used shall conform to those given in ASME B31.3 for piping or in Section II, Part D, of the ASME Code for vessels. The pressure thus obtained shall then be the minimum pressure at which the hydrostatic test shall be performed. The data sheets shall list actual hydrostatic test pressures.

**7.3.2.3** Where applicable, tests shall be in accordance with the ASME Code. In the event that a discrepancy exists between the code test pressure and the test pressure in this standard, the higher pressure shall govern.

**7.3.2.4** The chloride content of liquids used to test austenitic stainless steel materials shall not exceed 50 parts per million. To prevent deposition of chlorides as a result of evaporative drying, all residual liquid shall be removed from tested parts at the conclusion of the test.

**7.3.2.5** Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactory when neither leaks nor seepage through the system and/or component joints are observed for a minimum of 30 minutes. Large, heavy castings may require a longer testing period to be agreed on by the purchaser and the vendor. Seepage beyond internal closures required for testing of segmented cases and operation of a test pump to maintain pressure are acceptable.

## 7.4 PREPARATION FOR SHIPMENT

**7.4.1** Equipment shall be suitably prepared for the type of shipment specified. The preparation shall make the equipment suitable for 6 months of outdoor storage from the time of shipment, with no disassembly required before operation, except for inspection of bearings and seals. If storage for a longer period is contemplated, the purchaser will consult with the vendor regarding the recommended procedures to be followed.

**7.4.2** The vendor shall provide the purchaser with the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and prior to start-up.

**7.4.3** The equipment shall be prepared for shipment after all testing and inspection has been completed and the equipment has been approved by the purchaser. The preparation shall include that specified in 7.4.3.1 through 7.4.3.12.

**7.4.3.1** Exterior carbon steel surfaces, except for machined surfaces, shall be given at least one coat of the manufacturer's standard paint. The paint shall not contain lead or chromates.

**7.4.3.2** Exterior machined surfaces except for corrosion-resistant material shall be coated with a suitable rust preventive.

**7.4.3.3** The interior of the equipment shall be clean; free from scale, welding spatter, and foreign objects and sprayed or flushed with a suitable rust preventive that can be removed with solvent.

**7.4.3.4** Internal steel areas of bearing housings and carbon steel oil systems' auxiliary equipment such as tanks, vessels, and piping shall be coated with an oil-soluble rust preventive.

**7.4.3.5** Flanged openings shall be provided with metal closures at least 5 mm ( $\frac{3}{16}$  in.) thick, with elastomer gaskets and at least four full-diameter bolts. For studed openings, all nuts needed for the intended service shall be used to secure closures.

**7.4.3.6** Threaded openings shall be provided with steel caps or round-head steel plugs in accordance with ANSI B16.11. The caps or plugs shall be of material equal to or better than that of the pressure casing. In no case shall nonmetallic (such as plastic) caps or plugs be used.

**7.4.3.7** Openings that have been beveled for welding shall be provided with closures designed to prevent entrance of foreign materials and damage to the bevel.

**7.4.3.8** Lifting points and lifting lugs shall be clearly identified.

**7.4.3.9** The equipment shall be identified with item and serial numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicat-

ing the item and serial number of the equipment for which it is intended. In addition, crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the shipping container.

**7.4.3.10** The base and all components and piping of a package or an assembled oil system shall be shipped as a single assembly and shall be temporarily braced as necessary to prevent damage during shipment. To minimize the entrance of contaminants, no component shall be disassembled for shipment except as required for protection against vibration or other damage during handling and shipment.

**7.4.3.11** Exposed shafts and shaft couplings shall be wrapped with waterproof, moldable waxed cloth or volatile-corrosion inhibitor paper. The seams shall be sealed with oil-proof adhesive tape.

**7.4.3.12** Each filter shall be shipped with clean elements installed and shall carry outside a securely affixed all-weather tag stating, "SHIPPED WITH CLEAN ELEMENTS INSTALLED."

**7.4.4** Turbine drivers shall be dried thoroughly and prepared for shipment in accordance with ISO 10436 (API Std 611).

**7.4.5** Auxiliary piping connections furnished on the purchased equipment shall be impression stamped or permanently tagged to agree with the vendor's connection table or general arrangement drawing. Service and connection designations shall be indicated.

**7.4.6** Assemblies and components 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, and bag locations shall be indicated by corrosion-resistant tags attached with stainless steel wire.

**7.4.7** One copy of the manufacturer's standard installation instructions shall be packed and shipped with the equipment.

**7.4.8** Connections on auxiliary piping removed for shipment shall be matchmarked for ease of assembly.

## 8 Vendor's Data

### 8.1 GENERAL

**8.1.1** The information to be furnished by the vendor is specified in 8.2 and 8.3. The vendor shall complete and forward the Vendor Drawing and Data Requirements form (see Appendix B) to the address or addresses noted on the inquiry or order. This form shall detail the schedule for transmission of drawings, curves, and data as agreed to at the time of the

order, as well as the number and type of copies required by the purchaser.

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

- a. The purchaser and user's corporate name.
- b. The job and project number.
- c. The equipment item number and service name.
- d. The inquiry or purchase order number.
- e. Any other identification specified in the inquiry or purchase order.
- f. The vendor's identifying proposal number, shop order number, or other reference required to identify return correspondence completely.

**8.1.3** Unless otherwise specified, a coordination meeting shall be held, preferably at the vendor's plant, within 4 to 6 weeks after the purchase commitment. Unless otherwise specified, the vendor will prepare and distribute an agenda prior to this meeting, which, as a minimum, shall include review of the following items:

- a. The purchase order, scope of supply, unit responsibility, and subvendor items.
- b. The data sheets.
- c. Applicable specifications and previously agreed-upon exceptions.
- d. Schedules for transmittal of data, production, and testing.
- e. The quality assurance program and procedures.
- f. Inspection, expediting, and testing.
- g. Schematics and bills of material.
- h. The physical orientation of the equipment and piping.
- i. Other technical items.

## 8.2 PROPOSALS

### 8.2.1 General

Unless otherwise specified, the vendor shall forward the original proposal and the specified number of copies to the addressee specified in the inquiry documents. As a minimum, the proposal shall include the data specified in 8.2.2 and 8.2.3, as well as a specific statement that the system and all its components are in strict accordance with this standard. If the system and components are not in strict accordance, the vendor shall include a list that details and explains each deviation. The vendor shall provide details to enable the purchaser to evaluate any proposed alternative designs. All correspondence shall be clearly identified in accordance with 8.1.2.

### 8.2.2 Drawings

**8.2.2.1** The drawings indicated on the Vendor Drawing and Data Requirements form (see Appendix B) shall be included

in the proposal. As a minimum, the following data shall be furnished:

- a. A general arrangement or outline drawing for each major skid or system, showing overall dimensions, maintenance clearance dimensions, overall weights, erection weights, and maximum maintenance weights (indicated for each piece). The size and location of major purchaser connections shall also be indicated.
- b. Cross-sectional drawings showing the details of the proposed equipment.
- c. Schematics of all auxiliary systems, including the fuel, lube-oil, control, and electrical systems. Bills of material shall be included.
- d. Sketches that show methods of lifting the assembled machine or machines and major components. (This information may be included on the drawings specified in item a, above.)

**8.2.2.2** If typical drawings, schematics, and bills of material are used, they shall be marked up to show the correct weight and dimension data and to reflect the actual equipment and scope proposed.

### 8.2.3 Technical Data

The following data shall be included in the proposal:

- a. The purchaser's data sheets, with complete vendor's information entered thereon and literature to fully describe details of the offering.
- b. The purchaser's noise data sheet.
- c. The Vendor Drawing and Data Requirements form (see Appendix B), indicating the schedule according to which the vendor agrees to transmit all the data specified as part of the contract.
- d. A schedule for shipment of the equipment, in weeks after receipt of the order.
- e. A list of spare parts recommended for start-up and normal maintenance purposes.
- f. A list of the special tools furnished for maintenance. The vendor shall identify any metric items included in the offering.
- g. A statement of any special weather protection and winterization required for start-up, operation, and periods of idleness under the site conditions specified on the data sheets. The list shall show the protection to be furnished by the purchaser, as well as that included in the vendor's scope of supply.
- h. A complete tabulation of utility requirements, such as those for steam, water, electricity, air and gas, and lube/control/seal oil required and the supply pressure, the heat load to be removed by the oil, and the nameplate power rating and operating power requirements of auxiliary drivers. (Approximate data shall be defined and clearly identified as such.)

- i. A description of any special requirements specified in the purchaser's inquiry.
- j. Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment.

- **8.2.3.1** When specified, procurement of components shall not proceed without the purchaser's review and acceptance of the selected components. When specified, manufacture of the console shall not proceed without the purchaser's review of the layout of components and piping.

### 8.2.4 Options

The vendor shall furnish a list of the procedures for any special or optional tests that have been specified by the purchaser or proposed by the vendor.

## 8.3 CONTRACT DATA

### 8.3.1 General

**8.3.1.1** The contract data to be furnished by the vendor is specified in Appendix B. Each drawing, bill of material, and data sheet shall have a title block in its lower right-hand corner that shows the date of certification, a reference to all identification data specified in 8.1.2, the revision number and date, and the title.

**8.3.1.2** The purchaser will promptly review the vendor's data when received; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed on in writing. After the data have been reviewed, the vendor shall furnish certified copies in the quantity specified.

**8.3.1.3** A complete list of vendor data shall be included with the first issue of the major drawings. This list shall contain titles, drawing numbers, and a schedule for transmission of all the data the vendor will furnish (see Appendix B).

### 8.3.2 Drawings

The drawings furnished shall contain sufficient information so that with the drawings and the manuals specified in 8.3.6, the purchaser can properly install, operate, and maintain the ordered equipment. Drawings shall be clearly legible, identified in accordance with 8.3.1.1, and in accordance with ASME Y14.2M. As a minimum, each drawing shall include the details for that drawing listed in Appendix B.

### 8.3.3 Technical Data

The data shall be submitted in accordance with Appendix B and identified in accordance with 8.3.1.1. Any comments on the drawings or revisions of specifications that necessitate a change in the data shall be noted by the vendor. These notations will result in the purchaser's issue of completed, corrected data sheets as part of the order specifications.

- **8.3.3.1** When specified, the vendor shall submit certified copies of the test data to the purchaser prior to shipment.

### **8.3.4 Progress Reports**

The vendor shall submit progress reports to the purchaser at the intervals specified on the Vendor Drawing and Data Requirements form (see Appendix B).

### **8.3.5 Parts Lists and Recommended Spares**

**8.3.5.1** The vendor shall submit complete parts lists for all equipment and accessories supplied. The lists shall include manufacturer's unique part numbers, construction materials, and delivery times. Each part shall be completely identified and shown on cross-sectional or assembly-type drawings so that the purchaser may determine the interchangeability of the part with other equipment. Parts that have been modified from standard dimensions and/or finish to satisfy specific performance requirements shall be uniquely identified by part number for interchangeability and future duplication purposes. Standard purchased items shall be identified by the original manufacturer's name and part number.

**8.3.5.2** On the above parts lists, the vendor shall identify recommended spares for start-up and parts that are recommended for normal maintenance (see item f of 8.2.3). The vendor shall forward the lists to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of the parts prior to field start-up. The transmittal letter shall be identified with the data specified in 8.1.2.

### **8.3.6 Instruction Manuals**

No more than 5 days after the actual shipment date, the vendor shall furnish the required number of instruction manuals for the equipment and any auxiliaries and instruments provided by the vendor. Methods of lifting the assembled system shall be completely described. The manuals shall include legible drawings of the specific equipment included (typical drawings are not acceptable), a parts list, and completed data sheets. They shall also include instructions covering installation, final tests and checks, start-up, shutdown, operating limits, and operating and maintenance procedures. The required amount, specifications, and supply temperature and pressure ranges for lubricating oils and seal fluids shall be stated.

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Table A-1—International Standards and Referenced Publications

Application	USA	International ISO	Germany DIN	Great Britain BSI	France AFNOR	Japan JIS
Shaft and Housing Fits for Metric Radial and Ball Bearings	ABMA Std 7	2982, 2983 286-1, 286-2	5425	5446 5646 Part 1 5646 Part 2	NFE 22396	B0401, B1566
Load Ratings and Fatigue Life, Ball Bearings	ABMA Std 9	281, 76	662	5512 Part 1	NF ISO 281	B1518, B1519
Metric Bearings Boundary Dimensions	ABMA Std 20	5753, 15, 492		6107 Part 3	NF ISO5753	B1515, B1514, B1520
Gears	AGMA					
Classification of Electrical Areas in Petroleum Refineries	API RP 500A	IED-PUBL 49 IEC 79		5345 PART 2	NF-S	RIIS-TR-79-1 RIIS-TR-85-1
Sizing, Selection and Installation of Pressure Relieving Devices	API RP 520					
Quality Improvement Manual	API RP 683					
Flanged Steel Safety Relief Valves	API Std 526					
Form-Wound Squirrel Cage Induction Motors 250 HP and Larger	API Std 541					
Form-Wound Brushless Synchronous Motors	API Std 546					
Centrifugal Pumps	API Std 610	13709				
General Purpose Steam Turbines	API Std 611	10436	4312	132		
Special Purpose Steam Turbines	API Std 612					
Special Purpose Gears	API Std 613					
Special Purpose Oil Lubrication Systems	API Std 614	10438	24425	4807		
Shell and Tube Heat Exchangers	API Std 660					
Air-cooled Heat Exchangers	API Std 661					
Vibration, Axial Position and Bearing Temperature Monitoring Systems	API Std 670	ISO 2372 ISO 3945	VDI 2056 VDI 2059	4675	NFE 90300 NFE 90301	
Special Purpose Couplings	API Std 671					
Positive Displacement Pumps	API Std 676					
General Purpose Gears	API Std 677					
Screw Threads	ASME B 1.1					
Pipe Threads, General Purpose	ASME B 1.20.1					
Cast Iron Pipe Flanges and Flanged Fittings	ASME B 16.1					
Pipe Flanges and Flanged Fittings	ASME B 16.5					
Forged Fittings, Socket-Welding and Threaded	ASME B 16.11					
Ductile Iron Pipe Flanges and Flanged Fittings	ASME B 16.42					
Keys and Keyseats	ASME B 17.1					



Table A-1—International Standards and Referenced Publications

Application	USA	International ISO	Germany DIN	Great Britain BSI	France AFNOR	Japan JIS
Chemical Plant and Petroleum Refinery Piping	ASME B 31.3					
Nondestructive Examination	<i>ASME Boiler and Pressure Vessel Code, Section V</i>					
Pressure Vessels	<i>ASME Code, Section VIII Division 1 &amp; 2</i>					
Welding and Brazing Qualifications	<i>ASME Code, Section IX</i>					
Power Test Code for Displacement Compressors, Vacuum Pumps and Blowers	ASME PTC-9					
Line Conventions and Lettering	ASME Y 14.2M	31, 128, 129, 3098		308 Parts 2 & 3	NFE04202/203	
Method for Evaluating the Microstructure of Graphite in Iron Castings	ASTM A 247					
Recommended Practice for Ultrasonic Examination of Heavy Steel Forgings	ASTM A 388					
Guide for Radiographic Testing	ASTM E 94					
Reference Photographs for Magnetic Particle Indications on Ferrous Castings	ASTM E 125					
Method for Controlling Quality of Radiographic Testing	ASTM E 142					
Practice for Magnetic Particle Examination	ASTM E 709					
Structural Welding Code—Steel	AWS D 1.1			4780/1/2	NFP 22471	Code of Japan Welding Engineering Society
Severe Duty TEFC Squirrel-Cage Induction Motors up to 500 HP	IEEE 841					
Corrosion Resistant Material Requirements	NACE					
Steam Turbines for Mechanical Drive Service	NEMA SM23					
National Electrical Code	NFPA 70 Articles 500, 501, 502, 504	IEC 79			NFC 02-205U	JEA C8001
Balance Classification for Flexible Couplings		ISO 1940				
Tubular Heat Exchangers	TEMA					

Table A-2—International Materials Standards

Material	USA	France		Germany			Italy	United Kingdom		
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type	Material Number	Material Type	UNI Number	BS Number BS Grade	
Alloy-Steel Bolting for High-Temp. Service	ASTM A 193	Z 12C 13 Z6CN DT 17.12		17200	24CrMo 5	1.7258	42CrMo4	7874	1506-630	790
				17240	40CrMoV 4 7	1.7711			1506-630	790
				17245	X22CrMoV 12 1	1.4923			1506-410	S21
				17245	X6CrNiMoTi17 12 2	1.4571			1506-316	S31
Nuts for High-Pressure and High-Temp. Service	ASTM A 194	Z 12 C13 Z6CN DT 17.12		17440	CK 35	1.1181	42CrMo4	7874	1506-162	S21
				17200	24CrMo5	1.7258			1506-162	S31
				17245	X22CrMoV 12 1	1.4923			1506-410	
				17245	X6CrNiMoTi17 12 2	1.4571			1506-316	
Steel Bolts and Studs	ASTM A 307									
Alloy-Steel Bolting for Low-Temp. Service	ASTM A 320									
Ductile Iron	ASTM A 395	FGS400-12	A32-201	1693	GGG-40	0-0740	400/15	1083	2789	420/12
Ductile Iron Castings	ASTM A 536			1693	GGG40-3	0-0743	400/15	1083		
Cast Iron	ASTM A 48 OR 278 CLASS 30			1691	GG20	0-6020	G20	5007	1452	180
	ASTM A 278 CLASS 30	Ft 20 D	A32-101	1691	GG20	0-6020	G30	5007	1452	20
	ASTM A 278 CLASS 40	Ft 25D	A32-101	1691	GG25	0-6025			1452	26
Austenitic Cast Iron	ASTM A 436 TYPE 1b			1694	GGL-NiCuCr1563	0-6656				
	ASTM A 536 TYPE 2			1694	GGL-NiCuCr15631	0-6661				
	ASTM A571 TYPE D2M 1 CLASSES 1 & 2			1694	GGG-NiMo234	0-7673				
Steel	ASTM A 148									
	ASTM A 487 Gs4Q									
Cast Steel	ASTM A 216 GRADE WCA			1681	GS-38	1.0420				
	ASTM A 216 GRADE WCB	A43 C-M	A32-055	17245	GS-C25	1.0619			1504-161	480
	ASTM A 216 GRADE WCB	A48 C-M	A32-055	17245	GS-C25	1.0619			1504-161	480
	ASTM A 217 WC6			17245	GS-17CrMo55	1.7357	G15CrMo55	3608		
	ASTM A 217 WC9	15CD910-M	A32-055	17245	GS-18CrMo810	1.7379				



Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany			Italy		United Kingdom	
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type	Material Number	Material Type	UNI Number	BS Number	BS Grade
Stainless Steel (cont'd)	ASTM A 744 GRADE CF3	Z2CN18-18	A36-209	17440	G-X2CrNiN189	1.4306	X2CrNi1811	6901	970/1	304S11
	ASTM A 744 GRADE CF3M	Z2CN18-13	A36-209	17440	G-X2CrNiMoN1810	1.4404	X2CrNiN1712	8317	2056	316S42
	ASTM A 744 GRADE CF8	Z6CN19-10		17445	G-X6CrNi189	1.4308	X5CrNi1810	6900	1504-304	C15
	ASTM A 744 GRADE CF8M	Z6CND17-11	A35-586	17445	G-X6CrNiMo1810	1.4408	X5CrNiMo1712	6900	1504-316	C16
	ASTM A 747 TYPES CB7CU2									
Cast Stainless Steel	ASTM A 743 GRADE CA15	Z12C13	A35-586	17445	G-X8CrNi13	1.4008	X12Cr13	6900	1504-420	C29
	ASTM A 743 GRADE CF3	Z2CN18-10	A35-559	17440	G-X2CrNiN189	1.4306	X2CrNi1811	6901	1501	304S12
	ASTM A 743 GRADE CF3	Z2CN18-10	A36-559	17440	G-X2CrNiN189	1.4306	X2CrNi1811	6900	1501	304S512
	ASTM A 743 GRADE CF3M	Z2CN18-13	A36-209	17440	G-X2CrMoN1810	1.4404	X2CrNiMo1712	6901	1501	316S12
	ASTM A 743 GRADE CF3M	Z2CN18-13	A36-209	17440	G-X2CrMoN1810	1.4404	X2CrNiMo1713	6900	1501	316S512
	ASTM A 743 GRADE CF8	Z6CN19-10	A49-214	17445	G-X6CrNi189	1.4308	X5CrNi1810	6900	1504-304	C15
	ASTM A 743 GRADE CF8M	Z6CND17-11	A35-586	17445	G-X6CrNiMo1810	1.4408	X5CrNiMo1712	6900	1504-316	C16
	ASTM A 743 GRADE CF8M3	Z6CND17-11	A35-586	17445	G-X6CrNiMo1810	1.4408	X5CrNiMo1712	6900	1504-316	C16
	ASTM A 744 GRADE CF3	Z2CN18-09	A35-575	17440	C-X2CrNiN189	1.4306	X2CrNi1811	6901	1501	304S12
	ASTM A 744 GRADE CF3M	Z2CN18-13	A36-209	17440	G-X2CrNoN1810	1.4404	X2CrNiMo1712	6901	1501	316S12
	ASTM A 744 GRADE CF8	Z6CN19-10	A49-214	17445	G-X6CrNi189	1.4308	X6CrNi1810	6900	1504-304	C15
ASTM A 744 GRADE CF8M	Z6CND17-11	A35-586	17445	G-X6CrNiMo1810	1.4408	X5CrNiMo1712	6900	1504-316	C16	
Forged Steel	ASTM A 182 GR F22	12 D910		17155	12CrMo910	1.7380	12CrMo910	5462		
	ASTM A 182 GRADE F6NM	Z4CND13-4M		17445	X4CrNi134	1.4313	GX6CrNi1304	3161	1504-425	C11
	ASTM A 266 CLASS 1 OR 4	XC185	A35-534	17200	Ck22	1.1151	FeE585Ni36	EU129	970/1	050A20
	ASTM A 266 CLASS 1 OR 4	XC18S	A35-554	17200	Ck22	1.1151	FeE585Ni36	EU129	970/1	050A20
	ASTM A 322 GRADE 4137	35CD4	A35-551	17200	30CrMo4	1.7220	35CrMo4	5332	970/2	708A37
	ASTM A 322 GRADE 4340	30CND8	A35-552	17200	30CrNiMo8	1.6580	40NiCrMo7	7874		
	ASTM A 336 CLASS F1			17245	22Mo4	1.5419	C20	7874		
	ASTM A 350 GR LF2			17155	19Mn5	1.0482	20MnV4KT	7660		
	ASTM A 350 GR LF3	12Ni14		17173	10Ni14	1.5637	18Ni14KT	7660		
	ASTM A 350 GR LF5	16N6			14Ni6	1.5632	14Ni6KT	7660		

Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany			Italy		United Kingdom	
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type	Material Number	Material Type	UNI Number	BS Number	BS Grade
Forged Steel (cont'd)	ASTM A 414 GRADE B	A37-CP	A36-205	17155	M1	1.0345	Fe3601 KW;K6	5869	1501-151	360
	ASTM A 414 GRADE C	A42-CP	A36-205	17155	19MN6	1.0473	Fe3602 KW;K6	5869	1501-151	430
	ASTM A 414 GRADE D	A48-CP	A36-205	17155	HII	1.0425	Fe4101 KW;K6	5869	1501-151	400
	ASTM A 470 CLASS 1									
	ASTM A 470 CLASS 7				SEW 555	26NiCrMoV145	1.6957			
	ASTM A 473 TYPE 431	Z15Cn16-02	A35-574	17440	X20CrNi172	1.4057				
				17200	30CrNiMo8	1.6580				
	ASTM A 508 CLASS 3				20MnNi55	1.6310				
	ASTM A 508 CLASS 5A									
	ASTM A 522 TYPE 1			17173	X8Ni9	1.5662				
	AISI TYPE 1040			17200	Ck40	1.1186	C40	7874	970/1	080M40
	AISI TYPE 1042/1045	XC42	A35-551	17200	Ck45	1.1191	C45	7874	970/1	080M46
	AISI TYPE 1043	XC45	A35-551	17200	C45	1.0503	C45	7874	970/1	080M46
	AISI TYPE 1046									
	AISI TYPE 1049	XC48TS	A35-562	17200	Cm45	1.1201	C50	7874		
	AISI TYPE 1050			17201	Ck53	1.1210	C50	7874	970/1	070M55
	AISI TYPE 2320									
	AISI TYPE 4130							25CrMo4	7845	
	AISI TYPE 4130	25CD4	A35-551	SEW 555	25CrMo4	1.7218	25CrMo4	5332		
	AISI TYPE 4130	25CD4	A35-552	17200	25CrMo4	1.7218	25CrMo4	7875	970/1	708A25
			17173	26CrMo4	1.7219					
			17245	21CrMoV574	1.7709					
AISI TYPE 4135	35CD4	A35-551	17200	34CrMo4	1.7220	35CrMo4	5332	970/2	708A37	
AISI TYPE 4137	35CD4	A35-551	17200	34CrMo4	1.7220	35CrMo4	5332	970/2	708A37	
AISI TYPE 4140	42CD4	A35-551	17200	42CrMo4	1.7225	42CrMo4	7874	970/2	708M40	
AISI TYPE 4140	42CD4	A35-551	17200	42CrMo4	1.7220	42CrMo4	7845	970/2	708M40	
AISI TYPE 4140	42CD4	A35-551	17212	42CrMo4	1.7225	42CrMo4	7874	970/2	708M40	
AISI TYPE 4140	42CD4	A35-551	17200	42CrMo4	1.7225	42CrMo4	5332	970/2	708M40	
AISI TYPE 4142	42CD4TS	A35-563	17212	41CrMo4	1.7223	35CrMo4	7874	970/2	708M40	

Table A-2—International Materials Standards. (Continued)

Material	USA	France		Germany			Italy		United Kingdom	
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type	Material Number	Material Type	UNI Number	BS Number	BS Grade
Forged Steel (cont'd)	AISI TYPE 4145									
	AISI TYPE 4147			17200	50CrMo4	1.7228			970/1	708A25
	AISI TYPE 4150			17200	50CrMo4	1.7228			970/1	708A25
	AISI TYPE 4150			17200	50CrMo4	1.7228			970/1	708A47
	AISI TYPE 4320									
	AISI TYPE 4330	35NCD6	A35-551	17200	34CrNiMo6	1.6582	30NiCrMo12	7874	970/2	817M40
	AISI TYPE 4340	35NCD6	A35-551	17200	34CrNiMo6	1.6582	30NiCrMo12	5332	970/2	817M40
	AISI TYPE 4340	35NCD6	A35-551	17200	34CrNiMo6	1.6582	40NiCrMo7	7874	970/2	817M40
	AISI TYPE 4345									
Forged Stainless Steel	ASTM A 182 CLASS F6NM	Z4CND 13-4M		17445	X5CrNi134	1.4313	GX6CrNi1304	3161	1504-425	C11
	ASTM A 366 GRADE F6	Z12Cr13	A35-572	17440	X10Cr13	1.4006	X12Cr13	6901	970/4	410S21
	ASTM A 473 TYPE 410	Z12Cr13	A35-572	17440	X10Cr13	1.4006	X12Cr13	6901	970/4	410S21
	ASTM A 705 TYPE XM-12									
	AISI TYPE 403	Z6C13	A35-572	17440	X6Cr13	1.4000	X6Cr13	6901	970/4	403S17
	AISI TYPE 410	Z12C13	A35-572	17440	SEW 400 X4CrNiMo165	1.4418	X12Cr13	6901	970/4	410S21
Fabricated Casing Steel	ASTM A 203 GRADE A,D,E	35Ni		17173	10Ni14	1.5637	FEe285Ni14	EU129	1501-240	
	ASTM A 203 GRADE B			17173	14 NiMN6	1.5637				
	ASTM A 285 GRADE C	A42-FP	A36-205		H II	1-0456	Fe360-1KW	5869	1501-151	400
	ASTM A 353	9Ni-490	A36-208	17173	X8Ni9	1.5662	X12Ni09	5949		
	ASTM A 516 GRADE 55	A37-AP	A36-205	17153	St315	1.0425	Fe360-2KG	5869	1501-224	360
	ASTM A 516 GRADE 60	A42-AP	A36-205	17102	TstE315 TstE315	1.0505	Fe460-2KG	5869		
	ASTM A 516 GRADE 65	A48-AP	A36-205	17102	TstE315 TstE315	1.0508	Fe460-2KG	5869		
	ASTM A 516 GRADE 70	A52-AP	A36-205	17102	StE355	1.0562	Fe510-2KG	5869		
	ASTM A 537 CLASS 1	A52-FP	A36-205	17280	StE420	1.6228	Fe510-2KG	5869	1501-224	490
	ASTM A 537 CLASS 2	E420-1	A36-201	17102	StE420	1.8902				
	ASTM 553 TYPE I,II	Z8N09	A36-208	17173	X8Ni9	1.5662	FEe490Ni36	EU129		

Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany			Italy		United Kingdom	
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type	Material Number	Material Type	UNI Number	BS Number	BS Grade
Steel Plate	ASTM A 662 GRADE C			17102	TstE355	1.0566	FeE42OKG	7382		
					15NiCuMoNb5	1.6368				
	ASTM A 283 GRADE A	A33	A35-501	1615	St33	1.0035	Fe310-0	10025		
	ASTM A 283 GRADE B			1652	St37-2	1.0037	Fe360BFU	10025		
	ASTM A 283 GRADE C	E24-2	A35-501	1652	St44-2	1.0044	Fe360B	10025	4360	40B
	ASTM A 283 GRADE D	E28-2	A35-501	1652	St44-2	1.0044	Fe430B	10025	4360	43A
	ASTM A 284			17102	TStE285	1.0488	Fe360C	10025		
	ASTM A 285 GRADE A,B	A37-CP	A36-205	17155	H I	1.0345	Fe360-1KW	5869	1501-151	360
	ASTM A 285 GRADE C	A42-CP	A36-205	17155	H II	1.0425	Fe360-1KW	5869	1501-151	400
	ASTM A 516 GRADE 55	A37-AP	A36-205	17153	St315	1.0425	Fe360-2KG	5869	1501-224	360
	ASTM A 516 GRADE 60	A42-AP	A36-205	17102	TstE315 TstE315	1.0505	Fe460-2KG	5869		
	ASTM A 516 GRADE 65	A48-AP	A36-205	17102	TstE315 Tst E315	1.0508	Fe460-2KG	5869		
ASTM A 516 GRADE 70	A52-AP	A36-205	17102	StE355	1.0562	Fe510-2KG	5869			
ASTM A 543				22NiCrMoV145						
Stainless Plate	ASTM A 693 TYPE 630	Z6CNU17-04	A35-581		X5CrNiCuNb174	1.4542				
	ASTM A 693 TYPE XM-12									
Stainless Forge or Plate	ASTM A 182 CLASS F6NM	Z4CND13-4M		17445	X5CrNi134	1.4313	6X6CrNi1304	3161	504-42S	C11
	ASTM A 182 GR F22	12CD9,10		17155	10CrMo910	1.7380	12CrMo910	5462		622
	ASTM A 240 TYPE 304/304L	Z6N18-09	A35-572	17440	X5CrNi1810	1.4301	X5CrNi1810 X2CrNi1811	8317	1501	304S15
	ASTM A 240 TYPE 316	Z6CND17-12	A35-572	17440	X5CrNiMo17133	1.4436	X5CrNiMo1712	6900	1501	316S16
	ASTM A 240 TYPE 316L	Z2CND17-13	A35-577	17440	X2CrNiMo1843	1.4435	X2CrNiMo1712	6900	1501	316S12
	ASTM A 353/583 TYPE 1	9Ni-490	A36-208	17173	X8Ni9	1.5662	FeE190Ni35	EU129		
	ASTM A 470 CLASS 8				14CrMoV69	1.7735				
	ASTM A 473 TYPE 304	Z6CN18-09	A35-577	17440	X5CrNi1810	1.4301	X5CrNi1810	6901	970/4	304S15
ASTM A 473 TYPE 304L	Z6CN18-09	A35-577	17440	X5CrNi1810	1.4301	X2rNi1811	8517	970/4	304S15	

Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany		Material Number	Italy	United Kingdom		
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type		Material Type	UNI Number	BS Number	BS Grade
Stainless Forge or Plate (cont'd)	ASTM A 473 TYPE 316	Z6CND17-11	A35-572	17440	X5CrNiMo17122	1.4401	X5CrNiMo171203	6901		
	ASTM A 473 TYPE 410	Z12Cr13	A35-572	17440	X10Cr13	1.4006	X12CR13	6900	970	410S21
	ASTM A 522 TYPE I OR II	9Ni-490	A36-208	17173	X8Ni9	1.5662	X8Ni09,F2645	36087	509	1501/2
	ASTM A 543									
	ASTM A 705 TYPE 630	Z6CNU17-04	A35-581		X5CrNiCuNb174	1.4542				
	AISI TYPE 3140				40NiCr6	1.5711				
	AISI TYPE 4130	18CD4	A35-551	17200	25CrMo4	1.7218	25CrMo4	7845		
	AISI TYPE 4135	35CD4	A35-551	17200	34CrMo4	1.7220	35CrMo4	7845	970/2	708A37
	AISI TYPE 4137	35CD4	A35-551	17200	34CrMo4	1.7220	35CrMo4	7845	970/2	708A37
	AISI TYPE 4140	42CD4	A35-551	17200	42CrMo4	1.7220	42CrMo4	7845	970/2	708M40
	AISI TYPE 4315									
AISI TYPE 4320										
AISI TYPE 4340	35NCD6	A35-551	17200	30CrNiMo8	1.6580	42NiCrMo7	7874	970/2	817M40	
Forged Duplex Stainless Steel	ASTM A 182 GRADE F51			SEW 400	X2CrNiMoN 2253	1.4462				
Wrought Stainless	AISI TYPE 303	Z10CNF 18-09	A35-576	17440	X10CrNiS189	1.4305	X10CrNiS1809	6901	970/4	303S21
	AISI TYPE 304	Z6CN 18-09	A35-572	17440	X5CrNi189	1.4301	X5CrNi1810	6901	970/4	304S15
	AISI TYPE 316	Z2CND 17-12	A35-572	17440	X5CrNiMo17122	1.4401	X5CrNiMo1712	6901		
	AISI TYPE 403	Z8C13	A35-572	17440	X6Cr13	1.4000	X6Cr13	6901	970/4	403S17
	AISI TYPE 410	Z12C13	A35-572	17440	X10Cr13	1.4006	X12Cr13	6901	970/4	410S21
	AISI TYPE 416	Z12CF13	A35-576	SEW 410	X12CrS13	1.4005	X12CrS13	6901	9709/1	416S21
Cast Titanium	ASTM B 367 GRADE C3									
	ASTM B 367 GRADE C4			17864		3.7065				
Forged Titanium	ASTM B 381 GRADE F5			17864	TiAl16V4	3.7165				
	ASTM A 473 TYPE 316L	Z2CND19-15	A35-574	17440	X2CrNiMo18143	1.4438	X2CrNiMo1712	6900	1449/2	317S12



Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany		Material Number	Italy	United Kingdom	
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type		Material Type	UNI Number	BS Number
Cast Aluminium	ASTM B 26 ALLOY 335								
	ASTM B 26 ALLOY 355				G-AlSi6MgTi				
	ASTM B 26 ALLOY C355								
	ASTM B 26 ALLOY 443					AlSi5			3-2345
	ASTM B 26 ALLOY 850					AlSn6NiCu			
	A850					AlSn6NiCu			
	B850					AlSn6NiCu			
Aluminium Plate	6061-T6 OR ASTM 1100								
Precipitation Hardening	ASTM A 705 TYPE 630	Z6CNU17-04	A35-581		X5CrNiCuNb174				1.4542
	ASTM 747 TYPES CB7CU1								
Forged Ni-Cu Alloy	ASTM B 164			17443	NiCu30Fe				2.4360
	SAE AMS 4646			17743	NiCu30AI				2.4375
	SAE AMS 4670			17443	NiCu30AI				2.4375
	SAE AMS 4676			17443	NiCu30AI				2.4375
Ni-Cu Alloy Plate	ASTM B 127			17443	NiCu30Fe				2.4360
	QQ-N-286			17443	NiCu30AI				2.4375
Wrought Ni-Cu Alloy	ASTM B 164			17743	NiCu30Fe				2.4360
Wrought Alloy	ASTM B 462			17743	NiCr20CuMo				2.4660
Cast Ni-Mo-Cr Alloy	ASTM A 494 GRADE CW-12M 1								
Wrought Ni-Mo-Cr Alloy	ASTM B 574 ALLOY N10276			17744	NiMo16Cr15W				2.4819

Table A-2—International Materials Standards (Continued)

Material	USA	France		Germany		Material Number	Italy	United Kingdom		
	ASTM/AISI/SAE/ASME	AFNOR Type	NF	DIN No	DIN Type		Material Type	UNI Number	BS Number	BS Grade
Cast Babbitt	ASTM B 23				LgSn80	2-3770				
SS Plate Honey Comb	ASTM A 240 TYPE 304	Z6CN18-09	A35-572	17440	X5CrNi1810	1.4301	X5CrNi1810	8317	1501	304S15
	ASTM A 240 TYPE 304L	Z2CN18-09	A35-572	17440	X2CrNi1911	1.4306	X2CrNi1811	8317	1501	304S12
	ASTM A 240 TYPE 316	ZGCND17-12	A35-572	17440	X5CrNiMo17133	1.4436	X5CrNiMo1712	6900	1501	316S16
	ASTM A 240 TYPE 316L	Z2CND17-13	A35-577	17440	X2CrNiMo18143	1.4435	X2CrNiMo1712	6900	1501	316S12
Nonmetallic TFE										
Nonmetallic TFE carbon filled										
Nonmetallic TFE mica filled										
Cast Lead	ASTM B29									
Additional Materials					GGV30					
		A.S4G			AlSi5Mg	3.2341				
	A 380.0	A.S9U3			AlSi8Cu3	3.2161			LM24	
	AISI 3115	16NC6			15CrNiG	1.5919				
	AISI 1335	36M5/40M5			36Mn5	1.1167			150 M36	
	AISI 1035	AF55 C35			C35	1.0501			080 A35	
	65-45-12	FGS 500-7			GGG 50	0.7050			50017	
	AISI 430F	Z13 GF17			X12CrMoS17	1.4104				
	AISI 52100	100C6			100Cr6	1.3505			2S135-535A99	
	AISI 3310-3515	12NC15/14NG1			14NiCr14	1.5752			655H13	
AISI 2515-2517	Z18N5			14NiCr18	1.5860					

Table A-2—International Materials Standards—Extension

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Alloy-Steel Bolting for High-Temp. Service	ASTM A 193	G4107,CI SNB7 G4107,CI SNB16 G4303,Gr.SUS 403 or 420 G4303,Gr.1 SUS 316	2604-2-F31 683-1-21
Nuts for High-Pressure and High-Temp. Service	ASTM A 194	G4051,CI S45C G4051,CI S45C G4303,Gr.SUS 403 or 420 G4303,Gr.1 SUS 316	683-1-C35e 2604-2-F31 683-1-21
Steel Bolts and Studs	ASTM A 307		
Alloy-Steel Bolting for Low-Temp. Service	ASTM A 320		
Ductile Iron	ASTM A 395		
Ductile Iron Castings	ASTM A 536		
Cast Iron	ASTM A 48 OR 278 CLASS 30	G5501	185
	ASTM A 278 CLASS 30	G5501	185
	ASTM A 278 CLASS 40	G5501	185
Austenitic Cast Iron	ASTM A 436 TYPE 1b	G5510	
	ASTM A 536 TYPE 2		
	ASTM A571 TYPE D2M 1 CLASSES 1 & 2		
Steel	ASTM A 148		
	ASTM A 487 Gs4Q	G5121, G5151	
Cast Steel	ASTM A 216 GRADE WCA	G5151	
	ASTM A 216 GRADE WCB	G5151	
	ASTM A 217 WC6	G5151	
	ASTM A 217 WC9	G5151	
	ASTM A 352 GRADE LCB		
	ASTM A 352 GRADE LC2		
	ASTM A 352 GRADE LC3		
	ASTM A 352 GRADE LC4		
	ASTM A 352 GRADE LCC		
	ASTM A 389 C24		
ASTM A 757 GRADE E3N			

Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Stainless Steel	ASTM A 240 TYPE 304	G4304, G4305	
	ASTM A 240 TYPE 304L	G4304, G4305	
	ASTM A 240 TYPE 316	G4304, G4305	
	ASTM A 240 TYPE 316L	G4304, G4305	
	ASTM A 240 TYPE 321	G4304, G4305	
	ASTM A 351 GRADE CA 15		
	ASTM A 351 GRADE CA6NM	G5121	
	ASTM A 351 GRADE CF3	G5121	
	ASTM A 351 GRADE CF3M	G5121	
	ASTM A 351 GRADE CF8	G5121	
	ASTM A 351 GRADE CF8M	G5121	
	ASTM A 743 GRADE CA 15	G5121	
	ASTM A 743 GRADE CA6NM	G5121	
	ASTM A 743 GRADE CF3	G5121	
	ASTM A 743 GRADE CF3M	G5121	
	ASTM A 743 GRADE CF 8	G5121	
	ASTM A 743 GRADE CF8M	G5121	
	ASTM A 744 GRADE CA 15		
	ASTM A 744 GRADE CA 6NM		
	ASTM A 744 GRADE CF3		
ASTM A 744 GRADE CF3M			
ASTM A 744 GRADE CF8			
ASTM A 744 GRADE CF8M			
ASTM A 747 TYPES CB7CU2	G5121		
Cast Stainless Steel	ASTM A 743 GRADE CA15	G5121	
	ASTM A 743 GRADE CF3	G5121	
	ASTM A 743 GRADE CF3	G5121	
	ASTM A 743 GRADE CF3M	G5121	
	ASTM A 743 GRADE CF3M	G5121	
	ASTM A 743 GRADE CF8	G5121	
	ASTM A 743 GRADE CF8M	G5121	
	ASTM A 743 GRADE CF8M3	G5121	
	ASTM A 744 GRADE CF3		
	ASTM A 744 GRADE CF3M		
ASTM A 744 GRADE CF8			
ASTM A 744 GRADE CF8M			

Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Forged Steel	ASTM A 182 GR F22	G3203, G3214	
	ASTM A 182 GRADE F6NM	G3203, G3214	
	ASTM A 266 CLASS 1 OR 4		
	ASTM A 266 CLASS 1 OR 4		
	ASTM A 322 GRADE 4137		
	ASTM A 322 GRADE 4340		
	ASTM A 336 CLASS F1		
	ASTM A 350 GR LF2		
	ASTM A 350 GR LF3		
	ASTM A 350 GR LF5		
	ASTM A 414 GRADE B		
	ASTM A 414 GRADE C		
	ASTM A 414 GRADE D		
	ASTM A 470 CLASS 1		
	ASTM A 470 CLASS 7		
	ASTM A 473 TYPE 431		
	ASTM A 508 CLASS 3		
	ASTM A 508 CLASS 5A		
	ASTM A 522 TYPE 1		
	AISI TYPE 1040		
	AISI TYPE 1042/1045		
	AISI TYPE 1043		
	AISI TYPE 1046		
	AISI TYPE 1049		
	AISI TYPE 1050		
	AISI TYPE 2320		
	AISI TYPE 4130		
	AISI TYPE 4130		
	AISI TYPE 4130		
	AISI TYPE 4135		
AISI TYPE 4137			
AISI TYPE 4140			
AISI TYPE 4140			

Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Forged Steel (cont'd)	AISI TYPE 4140		
	AISI TYPE 4140		
	AISI TYPE 4142		
	AISI TYPE 4145		
	AISI TYPE 4147		
	AISI TYPE 4150		
	AISI TYPE 4150		
	AISI TYPE 4320		
	AISI TYPE 4330		
	AISI TYPE 4340		
	AISI TYPE 4340		
	AISI TYPE 4345		
Forged Stainless Steel	ASTM A 182 CLASS F6NM		
	ASTM A 366 GRADE F6	G3203, G3214	
	ASTM A 473 TYPE 410		
	ASTM A 705 TYPE XM-12		
	AISI TYPE 403		
	AISI TYPE 410		
Fabricated Casing Steel	ASTM A 203 GRADE A,D,E		
	ASTM A 203 GRADE B		
	ASTM A 285 GRADE C		
	ASTM A 353		
	ASTM A 516 GRADE 55	G3118	
	ASTM A 516 GRADE 60	G3118	
	ASTM A 516 GRADE 65	G3118	
	ASTM A 516 GRADE 70	G3118	
	ASTM A 537 CLASS 1		
	ASTM A 537 CLASS 2		
	ASTM 553 TYPE I, II		
	ASTM A 662 GRADE C		
Steel Plate	ASTM A 283 GRADE A	G3101	
	ASTM A 283 GRADE B	G3101	
	ASTM A 283 GRADE C	G3101	

Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Steel Plate (cont'd)	ASTM A 283 GRADE D	G3101	
	ASTM A 284		
	ASTM A 285 GRADE A,B		
	ASTM A 285 GRADE C		
	ASTM A 516 GRADE 55	G3118	
	ASTM A 516 GRADE 60	G3118	
	ASTM A 516 GRADE 65	G3118	
	ASTM A 516 GRADE 70	G3118	
	ASTM A 543		
Stainless Plate	ASTM A 693 TYPE 630		
	ASTM A 693 TYPE XM-12		
Stainless Forging or Plate	ASTM A 182 CLASS F6NM	G3203, G3214	
	ASTM A 182 GR F22	G3203, G3214	
	ASTM A 240 TYPE 304/304L	G3203, G3214	
	ASTM A 240 TYPE 316	G3203, G3214	
	ASTM A 240 TYPE 316L	G3203, G3214	
	ASTM A 353/583 TYPE 1		
	ASTM A 470 CLASS 8		
	ASTM A 473 TYPE 304		
	ASTM A 473 TYPE 304L		
	ASTM A 473 TYPE 316		
	ASTM A 473 TYPE 410		
	ASTM A 522 TYPE I OR II		
	ASTM A 543		
	ASTM A 705 TYPE 630		
	AISI TYPE 3140		
	AISI TYPE 4130		
	AISI TYPE 4135		
	AISI TYPE 4137		
	AISI TYPE 4140		
	AISI TYPE 4315		
AISI TYPE 4320			
AISI TYPE 4340			
Forged Duplex Stainless Steel	ASTM A 182 GRADE F51	G3203, G3214	

Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Wrought Stainless	AISI TYPE 303		
	AISI TYPE 304		
	AISI TYPE 316		
	AISI TYPE 403		
	AISI TYPE 410		
	AISI TYPE 416		
Cast Titanium	ASTM B 367 GRADE C3		
	ASTM B 367 GRADE C4		
Forged Titanium	ASTM B 381 GRADE F5		
	ASTM A 473 TYPE 316L		
Cast Aluminium	ASTM B 26 ALLOY 335		
	ASTM B 26 ALLOY 355		
	ASTM B 26 ALLOY C355		
	ASTM B 26 ALLOY 443		
	ASTM B 26 ALLOY 850		
	A850 B850		
Aluminium Plate	6061-T6 OR ASTM 1100		
Precipitation Hardening	ASTM A 705 TYPE 630		
	ASTM 747 TYPES CB7CU1	G5121	
Forged Ni-Cu Alloy	ASTM B 164		
	SAE AMS 4646		
	SAE AMS 4670		
	SAE AMS 4676		
Ni-Cu Alloy Plate	ASTM B 127		
	QQ-N-286		
Wrought Ni-Cu Alloy	ASTM B 164		



Table A-2—International Materials Standards—Extension (Continued)

Material	USA	Japan	International
	ASTM/AISI/SAE/ASME	JIS	ISO
Wrought Alloy	ASTM B 462		
Cast Ni-Mo-Cr Alloy	ASTM A 494 GRADE CW-12M 1		
Wrought Ni-Mo-Cr Alloy	ASTM B 574 ALLOY N10276		
Cast Babbitt	ASTM B 23		
SS Plate Honey Comb	ASTM A 240 TYPE 304 ASTM A 240 TYPE 304L ASTM A 240 TYPE 316 ASTM A 240 TYPE 316L		
Nonmetallic TFE			
Nonmetallic TFE carbon filled			
Nonmetallic TFE mica filled			
Cast Lead	ASTM B29		
Additional Materials	A 380.0 AISI 3115 AISI 1335 AISI 1035 65-45-12 AISI 430F AISI 52100 AISI 3310-3515 AISI 2515-2517		



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**CHAPTER 1**

**APPENDIX B—VENDOR DRAWING AND DATA  
REQUIREMENTS (INFORMATIVE)**

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**CHAPTER 1—APPENDIX B**

**Vendor Drawing and  
Data Requirements  
for General and Special Purpose  
Oil System Applications**

Job No. \_\_\_\_\_ Item No. \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_  
 Requisition No. \_\_\_\_\_ Date \_\_\_\_\_  
 Inquiry No. \_\_\_\_\_ Date \_\_\_\_\_  
 Revision \_\_\_\_\_ By \_\_\_\_\_ Console Manufacturer \_\_\_\_\_  
 For \_\_\_\_\_ Unit \_\_\_\_\_  
 Site \_\_\_\_\_ Service<sup>e</sup> \_\_\_\_\_

MINIMUM REQUIREMENTS FOR GENERAL PURPOSE SYSTEMS INDICATED BY "Req'd."<sup>d</sup>

PROPOSAL<sup>a</sup>—BIDDER SHALL FURNISH NUMBER OF COPIES/NUMBER OF TRANSPARENCIES OF DATA AS INDICATED

REVIEW—VENDOR SHALL FURNISH NUMBER OF COPIES/NUMBER OF TRANSPARENCIES OF DATA AS INDICATED

FINAL—VENDOR SHALL FURNISH NUMBER OF COPIES/NUMBER OF TRANSPARENCIES OF DATA AS INDICATED

				Description	Distribution Record				
					Review— Due from Vendor <sup>b,c</sup>	Review— Received from Vendor	Review— Returned to Vendor	Final— Due from Vendor <sup>c</sup>	Final— Received from Vendor
Req'd	/	/	/	1. Certified dimensional outline drawing and list of connection.					
	/	/	/	2. Component drawings and bills of materials.					
N/A	/	/	/	3. System schematic and bill of materials, including component sizing criteria.					
N/A	/	/	/	4. Component data sheets.					
Req'd	/	/	/	5. Electrical and instrumentation wiring diagram and bill of materials.					
	/	/	/	6. Electrical and instrumentation terminal box layout and list of connections.					
	/	/	/	7. Console test procedure.					
N/A	/	/	/	8. Weld procedures.					
	/	/	/	9. Hydrostatic test logs.					
	/	/	/	10. Operational test logs.					
N/A	/	/	/	11. As-built data sheets.					
Req'd	/	/	/	12. Installation, operating and maintenance manuals.					
N/A	/	/	/	13. Progress reports.					
	/	/	/	14. Spare parts recommendation and price list.					
	/	/	/	15. Pressure vessel certification data.					

<sup>a</sup>Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such.

<sup>b</sup>Purchaser may indicate in this column the desired time frame for submission of data.

<sup>c</sup>Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with his proposal.

<sup>d</sup>N/A signifies an item is generally not applicable to general purpose systems.

<sup>e</sup>Service may be GP lube (GPL), SP lube (SPL), SP seal (SPS), SP combined lube and seal (SPLS), or dry gas seal module (GM).

## DESCRIPTION

1. (Oil or Dry Gas support system) Certified dimensional outline drawing and list of connections, including the following:
  - Size, rating, and location of all customer connections.
  - Approximate overall handling weight.
  - Overall dimensions, maintenance clearances and dismantling clearances.
  - Dimensions of baseplates from a fixed control point complete with diameter, number, and locations of bolt holes; thickness of the metal through which the bolts must pass, and recommended clearance; centers of gravity; and details for foundation design.
2. (Oil or Dry Gas support system) Component drawings and bills of materials, including the following:
  - Filter outline drawings.
  - Cooler outline drawings (Oil systems).
  - Rundown tank and/or overhead seal tank outline drawings (Oil systems).
  - Instrumentation cut sheets with dimensions.
  - Oil pump outline drawings (Oil systems).
  - Oil pump coupling drawings (Oil systems).
3. (Oil or Dry Gas support) System schematic and bill of materials, including component sizing criteria including the following:
  - Steady state and transient flows and pressures at each use point.
  - Control, alarm, and trip settings (pressures, temperatures, and flows as applicable).
  - Supply temperatures and heat loads at each point at maximum load.
  - Utility requirements including electricity, steam, water, and air.
  - Pipe and valve sizes.
  - Instrumentation, safety devices, and control schemes.
4. Individual component data sheets as applicable on the following:
  - Pump data sheets.
  - Filter data sheets.
  - Cooler data sheets.
5. Electrical and Instrumentation wiring diagram and bill of materials. The schematics shall show all alarm and shutdown limits (set points).
6. Electrical and Instrumentation arrangement drawings, including terminal box layout and list of connections.
7. Console Test procedures including any special or optional tests to be performed.
8. Welding procedures for fabrication and repair.
9. Certified Hydrostatic Test logs.
10. Operational Test logs.
11. As-built data sheets.

12. Installation, operating and maintenance manuals describing the following:

- Start-up.
- Normal shut-down.
- Emergency shutdown.
- Operating limits (see item 5).
- Oil recommendations and specifications.
- Routine operational procedures.
- Instructions for maintenance of purchased mechanical components such as pumps, pump seals, etc.
- Performance data including flows, pressures, temperatures, and heat loads.
- As-built data including data sheets (see item 11) and test logs.

13. Progress reports and delivery schedule, including vendor buyouts and milestones. The reports shall include engineering, purchasing, manufacturing, and testing schedules for all major components. Planned and actual dates and the percentage completed shall be indicated for each milestone in the schedule.

14. Spare parts list with stocking level recommendations.

15. Pressure vessel certification data, including pressure vessel calculations, hydrotest reports, and material mill test reports for filters, coolers, and rundown tanks in the system.





## CHAPTER 1

### APPENDIX C—TYPICAL RESPONSIBILITY MATRIX WORKSHEET (INFORMATIVE)

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**APPENDIX C—TYPICAL RESPONSIBILITY MATRIX WORKSHEET**

Job No. \_\_\_\_\_ Item No. \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_  
 Requisition No. \_\_\_\_\_ Date \_\_\_\_\_  
 Inquiry No. \_\_\_\_\_ Date \_\_\_\_\_  
 Page \_\_\_\_\_ of \_\_\_\_\_ By \_\_\_\_\_  
 Revision \_\_\_\_\_  
 Unit \_\_\_\_\_  
 No. Required \_\_\_\_\_

For \_\_\_\_\_  
 Site \_\_\_\_\_  
 Service \_\_\_\_\_

Function	Manufacturer	Machinery Vendor	Construction Agency	End User	Other Specify: _____
Coordination					
Oil System Design					
Dry Gas Seal System Design					
Oil Console Purchase					
Gas Module Purchase					
Interconnecting Pipe and Wire					
Motor Control Centers					
Lube Oil Rundown Tank					
Overhead Seal Oil Tank					
Contaminated Seal Oil Drainers					
Installation					
Drawings per Appendix C					

-- 100 1 11 0000 0000 1 1100 11--





**API 614—Chapter 1 DATA SHEET  
SCOPE AND ATTACHMENTS  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 2 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 For \_\_\_\_\_ Site \_\_\_\_\_  
 Oil System for \_\_\_\_\_  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

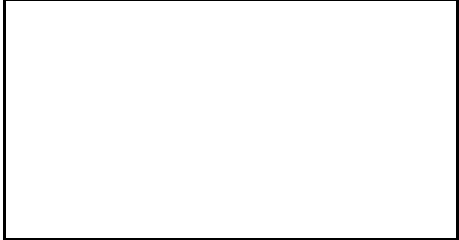
NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
 2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

**Applicable documents:**

- Local Instruments and Panel Items (Chapter 1)
- Instrument Suppliers (Chapter 1)
- Special Purpose Oil Systems (Chapter 2)
- General Purpose Oil Systems (Chapter 3)
- Dry Gas Seal Support Modules (Chapter 4)
- Additional documents \_\_\_\_\_
- Additional documents \_\_\_\_\_
- Additional documents \_\_\_\_\_
- Pumps
- Pump Drivers (Motor)
- Pump Drivers (Turbine)
- Referenced standards Table A-1 (4.1)
- Additional documents \_\_\_\_\_
- Additional documents \_\_\_\_\_

**Installation data:** (also see page 2)

- \* General site data included in specification
- \* Utility data included in specification  
 \* If blank, provide on page 2 of this specification
- Space available for oil system: L \_\_\_\_\_ W \_\_\_\_\_ H \_\_\_\_\_ (m)
- Plot plan showing console location in relation to main equipment: →
- Maximum allowable noise level not to exceed \_\_\_\_\_ dB or see \_\_\_\_\_  
 (Sketch the equipment plot plan with relation to the console location here)
- Winterize  Tropicalize
- Area classification: Class \_\_\_\_\_ Group \_\_\_\_\_ Division \_\_\_\_\_ or see \_\_\_\_\_



**Equipment oil required:**

Lube oil:	Normal	After trip	Seal oil:	Normal	After trip
kPa supply pressure	m <sup>3</sup> /hr	m <sup>3</sup> /hr		flow/pressure	flow/pressure
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Prime mover					
<input type="checkbox"/> Gears					
<input type="checkbox"/> Couplings					
<input type="checkbox"/> Total:				/	/
<input type="checkbox"/> Control oil (normal)			<input checked="" type="checkbox"/> Oil type and viscosity		
<input type="checkbox"/> Control oil (transient)			<input type="checkbox"/> Required heat load _____ (kW)		





**API 614—Chapter 1 DATA SHEET  
SCOPE AND ATTACHMENTS  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 2 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 For \_\_\_\_\_ Site \_\_\_\_\_  
 Oil System for \_\_\_\_\_  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

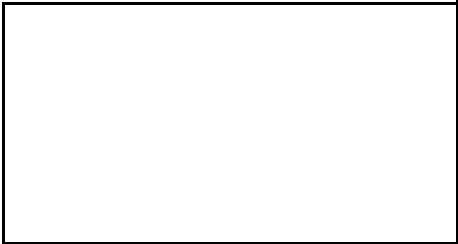
NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
 2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

**Applicable documents:**

<input type="radio"/> Local Instruments and Panel Items (Chapter 1)	<input type="radio"/> Pumps
<input type="radio"/> Instrument Suppliers (Chapter 1)	<input type="radio"/> Pump Drivers (Motor)
<input type="radio"/> Special Purpose Oil Systems (Chapter 2)	<input type="radio"/> Pump Drivers (Turbine)
<input type="radio"/> General Purpose Oil Systems (Chapter 3)	<input type="radio"/> Referenced standards Table A-1 (4.1)
<input type="radio"/> Dry Gas Seal Support Modules (Chapter 4)	<input type="radio"/> Additional documents _____
<input type="radio"/> Additional documents _____	<input type="radio"/> Additional documents _____
<input type="radio"/> Additional documents _____	

**Installation data:** (also see page 2)

\* General site data included in specification  
 \* Utility data included in specification  
 \* If blank, provide on page 2 of this specification

Space available for oil system: L \_\_\_\_\_ W \_\_\_\_\_ H \_\_\_\_\_ (ft)  
 Plot plan showing console location in relation to main equipment: →   
 Maximum allowable noise level not to exceed \_\_\_\_\_ dB or see \_\_\_\_\_  
 (Sketch the equipment plot plan with relation to the console location here)

Winterize  Tropicalize  
 Area classification: Class \_\_\_\_\_ Group \_\_\_\_\_ Division \_\_\_\_\_ or see \_\_\_\_\_

**Equipment oil required:**

Lube oil:	Normal	After trip	Seal oil:	Normal	After trip
PSIG supply pressure	gpm	gpm	flow/pressure	flow/pressure	flow/pressure
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Driven equipment			<input type="checkbox"/> Seal oil at:	/	/
<input type="checkbox"/> Prime mover					
<input type="checkbox"/> Gears					
<input type="checkbox"/> Couplings					
<input type="checkbox"/> Total:				/	/
<input type="checkbox"/> Control oil (normal)			<input checked="" type="checkbox"/> Oil type and viscosity		
<input type="checkbox"/> Control oil (transient)			<input type="checkbox"/> Required heat load _____ (Btu/hr)		

**API 614—Chapter 1 DATA SHEET  
SCOPE AND ATTACHMENTS  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 2 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

<p><b>* Site data:</b></p> <p><input type="radio"/> Ambient conditions</p> <p><input type="radio"/> Min/max temperature (°F) /</p> <p><input type="radio"/> Relative humidity</p> <p><input type="checkbox"/> Corrosive atmosphere</p> <p><input type="radio"/> Steam</p> <p style="margin-left: 40px;">Inlet min. Pressure</p> <p style="margin-left: 40px;">Normal Pressure</p> <p style="margin-left: 40px;">Maximum Pressure</p> <p style="margin-left: 40px;">Exhaust min. Pressure</p> <p style="margin-left: 40px;">Normal Pressure</p> <p style="margin-left: 40px;">Maximum Pressure</p>		<p><b>Utility data</b></p> <p><input type="radio"/> Electrical</p> <p>Volts</p> <p>Hertz</p> <p>Phase</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p>		<p><input type="radio"/> Cooling water: water source</p> <p>Inlet temperature (°F)</p> <p>Normal pressure (psig)</p> <p>Min. return (psig)</p> <p>Maximum return (°F)</p> <p>Design pressure (psig)</p> <p>Maximum Delta p (psi)</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p> <p style="margin-left: 40px;">Temperature</p>	
<p><b>Location:</b></p> <p><input type="radio"/> Indoor <input type="radio"/> Heated <input type="radio"/> Under roof</p> <p><input type="radio"/> Outdoor <input type="radio"/> Unheated</p>					
<p><b>Painting:</b></p> <p><input type="radio"/> Component supplier standard</p> <p><input type="radio"/> Unified per system supplier standard</p> <p><input type="radio"/> Purchaser standard per</p> <p><input type="radio"/> _____</p> <p><input type="radio"/> _____</p>			<p><input type="checkbox"/> Weights (lb.)</p> <p>Console _____</p> <p>Panel _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p><input type="checkbox"/> Dimensions L W H (ft)</p> <p>Console _____</p> <p>Panel _____</p> <p>_____</p> <p>_____</p> <p>_____</p>		
<p><b>Preparation for shipment</b></p> <p><input type="radio"/> Install new filter elements and tag</p> <p><input type="radio"/> Include _____ sets of extra filter elements</p> <p><input type="radio"/> Box extra sets with the _____ system</p> <p>Other spares</p> <p><input type="radio"/> _____</p> <p><input type="radio"/> _____</p> <p><input type="radio"/> _____</p> <p><input type="radio"/> _____</p>			<p><b>Miscellaneous documentation</b></p> <p><input type="radio"/> Spare parts quotation with proposal</p> <p><input type="radio"/> Spare parts quotation after contract</p> <p><input type="radio"/> Above based on normal supply for _____ months</p> <p><input type="radio"/> Complete inspector's checklist</p> <p><input type="radio"/> Progress reports</p> <p><input type="radio"/> Component selection review</p> <p><input type="radio"/> _____</p>		
<p><b>System and components</b></p> <p style="margin-left: 40px;">Vendor std.    Purch. spec.</p> <p><input type="radio"/> Domestic <input type="checkbox"/></p> <p><input type="radio"/> Export <input type="checkbox"/></p> <p><input type="radio"/> Extended storage _____ months <input type="checkbox"/></p>			<p><b>Spare parts</b></p> <p style="margin-left: 40px;">Vendor std.    Purch. spec.</p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>		
<p><b>Comments:</b></p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>					

# API 614—Chapter 1 DATA SHEET INSTRUMENT SUPPLIERS

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 1 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 For \_\_\_\_\_ Site \_\_\_\_\_  
 Oil System for \_\_\_\_\_  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

<input checked="" type="checkbox"/> Instrument suppliers:	Manufacturer	Description
Pressure gauges		
Temperature gauges		
Level gauges		
Differential pressure gauges		
Pressure switches		
Differential pressure switches		
Temperature switches		
Level switches		
Control valves		
Pressure relief valve		
Thermal relief valve		
Sight flow indicators		
Pressure transmitter		
Vibration equipment		
Tachometer		
Solenoid valves		
Annunciator		
Thermocouples		
RTDs		
Thermowells		

Alarm/Trip wiring per Arrangement 1  2  3  (Section 3, Chapters 2, 3, 4)

# API 614—Chapter 1 DATA SHEET

## LOCAL INSTRUMENTS AND PANEL

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 2 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

For \_\_\_\_\_ Site \_\_\_\_\_

Oil System for \_\_\_\_\_

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.

2. A dot \* indicates the standard specifies a requirement, value, or criterion.

3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

Service	Console gauge board	Local equipment panel	Remote equipment panel
<input type="radio"/> Panel identification			
<input type="radio"/> Supplied by			
<input type="radio"/> Type: free standing			
Mounted on			
<input type="radio"/> Open or fully enclosed			
<input type="radio"/> Weather tight			
<input type="radio"/> Purged or pressurized			
<input type="radio"/> Purge or pressure gas			
<input type="radio"/> Shutoff valves for shutdown sensing devices			
<input type="radio"/> Annunciator system			
<input type="radio"/> Rear access doors			
<input type="radio"/> Walk-in facility			
<input type="radio"/> Sun and weather roof extension			
<input type="radio"/> Light panel front/interior			
<input type="radio"/> Limits: max height above floor			
<input type="radio"/> Lowest item above floor			
<input type="radio"/> Spare terminals required			
<input type="radio"/> Minimum wire size			
<input checked="" type="checkbox"/> Material: front panel			
<input checked="" type="checkbox"/> Other panels and doors			
<input checked="" type="checkbox"/> Chassis			
<input type="radio"/> Vibration isolator			
<input type="radio"/> Electrical area classification			
<input type="radio"/> Panel power supply			
<input type="radio"/> Extra cutouts required			

# API 614—Chapter 1 DATA SHEET

## LOCAL INSTRUMENTS AND PANEL

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 2 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

### Panel mounted item details:

Use the following code letters to show details (refer to the general notes on page 1 of this appendix).

- |                             |   |  |
|-----------------------------|---|--|
| F - Flush mount on front    | H - Purchaser remote mount (control room) | CP - Cutout to purchaser item                  |
| S - Surface mount on front  | P - Purchaser supply and mount            | M - Mount by vendor of purchaser supplied item |
| R - Rear of panel mount     | V - Vendor supply and mount               |  |
| L - Locally mount on piping | B - Local equipment panel                 | C - Remote equipment panel                     |

### Equipment instrumentation

Panel identification	L	B	C	Panel identification	L	B	C
<b>Pressure gauges</b>				<b>Push button stations</b>			
<input type="radio"/> Main turbine inlet				<input type="radio"/> Main equipment start			
<input type="radio"/> Main turbine first stage				<input type="radio"/> Main equipment stop			
<input type="radio"/> Main turbine extraction				<input type="radio"/> Compressor block in			
<input type="radio"/> Main turbine exhaust				<input type="radio"/> Compressor unblock			
<input type="radio"/> Steam chest				<b>Miscellaneous</b>			
<input type="radio"/> First stage after extraction				<input type="radio"/> Equipment tachometer			
<input type="radio"/> Nozzle bowl				<input type="radio"/> Equipment speed control			
<input type="radio"/> Steam seal				<input type="radio"/> Equipment ammeter			
<input type="radio"/> Ejector/Eductor steam				<input type="radio"/> Compressor inlet controller			
<input type="radio"/> Compressor suction				<input type="radio"/> Annunciation system			
<input type="radio"/> Compressor discharge				<input type="radio"/> Equipment flow meter			
<input type="radio"/> Each compressor section				<input type="radio"/> Guide vane positioner			
<input type="radio"/> Balance chamber				<input type="radio"/> Suction throttle valve			
<b>Differential pressure gauges</b>				<input type="radio"/> Anti-surge equipment			
<input type="radio"/> Compressor air filter				<input type="radio"/> Capacity control equipment			
<input type="radio"/> Buffer gas				<input type="radio"/> Other			
<input type="radio"/> Balance chamber				<input type="radio"/> Other			
<input type="radio"/> Other				<input type="radio"/> Other			
<b>Temperature gauges</b>				<input type="radio"/> Other			
<input type="radio"/> Main turbine inlet steam				<input type="radio"/> Other			
<input type="radio"/> Main turbine exhaust				<input type="radio"/> Other			
<input type="radio"/> Main turbine extraction/induction				<input type="radio"/> Other			
<input type="radio"/> Compressor suction (each section)				<b>Monitors</b>			
<input type="radio"/> Compressor discharge (each section)				<input type="radio"/> Vibration			
<input type="radio"/> Other				<input type="radio"/> Axial position			
<input type="radio"/> Level indicators/controllers				<input type="radio"/> Thrust bearing metal temp			
<input type="radio"/> Suction separator				<input type="radio"/> Journal bearing metal temp			
<input type="radio"/> Interstage separator							
<input type="radio"/> Discharge separator							

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## CHAPTER 1

### APPENDIX E—FILTER RATINGS AND CLEANLINESS STANDARDS (INFORMATIVE)

#### E.1 Scope

This Appendix is intended to provide users of API Std 614 information relative to oil or gas filter performance and oil system cleanliness testing.

#### E.2 Filter Specifications

The primary requirement of filtration is to reliably remove contaminants in a different phase from a liquid or gas stream. In API Std 614 Chapter 2, the filters are required to remove particles in the oil that may be detrimental to special purpose machine bearings, gears or oil seals over an extended operating period. In API Std 614 Chapter 3, the General Purpose Lube Oil System filters are intended to remove sufficient solid particles from lubricating oil to provide an economical measure of protection for general purpose equipment bearings and gears. In Chapter 4, the filters must remove liquid phase contaminants from the seal gas as well as particles that may be detrimental to a dry gas seal.

##### E.2.1 FILTER ELEMENT RELIABILITY

The filters must be reliable and not fail or plug off during normal operation of the system and be able to retain contaminants during extreme upsets and even pulsating pressures. For this reason, filter elements for API Std 614 systems must be able to withstand differentials of more than 70 psi without collapse and release of trapped particles.

##### E.2.2 WATER CONTAMINATION

**E.2.2.1** In Chapters 2 and 3, to further assure filter element integrity a requirement for water resistance of filter elements has been added to cover up to 5 percent water content at elevated temperatures. Some elements in the presence of water contamination of the oil may start to deteriorate because of incompatibility of the filter media with water at operating temperatures.

**E.2.2.2** Elements also may absorb water and experience high differential pressures caused by swelling of the filter media. An optional requirement for nonhydroscopic media has been added with the criteria that, over an extended exposure period, clean elements do not double their pressure drop. Users of oil systems where water contamination can be a problem should consider nonhydroscopic filters. The user should keep in mind that water contamination cannot be present on a routine basis. If water contamination is experienced, the water source should be determined and corrected.

When correction is not feasible, a separate water removal system or a slip stream filter/coalescer should be considered to keep the water contamination under control.

**E.2.2.3** Water contamination can be a problem for an oil system serving a steam turbine. Other systems commonly exposed to water contamination include:

- Oil systems where make-up oil is provided from bulk storage or storage drums that are inadequately protected.
- Oil systems where the water pressure in the cooler(s) can exceed the oil pressure.
- Oil systems located at site locations with high humidity, especially if the equipment served is in intermittent service, can also experience problems with water contamination.

##### E.2.3 BETA RATIO

**E.2.3.1** Of primary importance in the selection of filters for API Std 614 systems is the filter element micron size rating. In previous editions, the requirement has been 10  $\mu\text{m}$  *nominal* rating. In a clarification note, nominal was implied to be 90 percent efficient for 10  $\mu\text{m}$  spherical particles and *absolute* was presumed for 15  $\mu\text{m}$  particles for a 10  $\mu\text{m}$  *nominal* rated element. The words nominal and absolute are not applied uniformly by vendors and there may be significant performance differences from one filter to another with 10 mm *nominal* filters. Filter elements are rated by the Beta ratio of the element for a given size particle and larger.

**E.2.3.2** The beta ratio requirement is displayed as  $\beta_x \geq y$ .

**E.2.3.3** Where  $x$  is the filter element rating in  $\mu\text{m}$  (microns); and  $y$  is the ratio of particles  $x$   $\mu\text{m}$  or larger entering a filter; divided by the number of particles  $x$   $\mu\text{m}$  or larger exiting a filter.

Example 1: Display a beta ratio of greater than or equal to ten for a ten-micron rated filter:  $x = 10 \mu\text{m}$ ;  
 $y \geq 10$

$$\beta_{10} \geq 10$$

Example 2: Display a beta ratio of greater than or equal to 200 for a 25-micron rated filter:  $x = 25 \mu\text{m}$ ;  
 $y \geq 200$

$$\beta_{25} \geq 200$$

**E.2.3.4** To determine the Particle Removal Efficiency (PRE) in percent for a filter with a known beta ratio, use the formula:

$$\text{PRE} = [1 - (1/y)] \times 100\%$$

Example 1:  $\beta_{10} \geq 10; \Rightarrow y \geq 10$  for 10  $\mu\text{m}$  and larger particles; the minimum PRE would be:

$$\text{PRE } 10 \mu\text{m} = [1 - (1/10)] \times 100$$

$$\text{PRE } 10 \mu\text{m} = 90\%$$

Example 2:  $\beta_{25} \geq 200; \Rightarrow y \geq 200$  for 25  $\mu\text{m}$  and larger particles; the minimum PRE would be:

$$\text{PRE } 25 \mu\text{m} = [1 - (1/200)] \times 100$$

$$\text{PRE } 25 \mu\text{m} = 99.5\%$$

**E.2.3.5** For every type of filter element a beta ratio vs. micron size can be developed. The position and shape of this curve is significantly affected by the construction features of the filter element. Some filter elements may have a very wide band of performance and others may have a narrow band. An example of a filter element (A) with a wide performance band would be one with a  $\beta_2 \geq 2$ ,  $\beta_{10} \geq 10$ ;  $\beta_{15} \geq 200$  and a  $\beta_{25} \geq 1000$ . Another filter element (B) could have a narrower band with a  $\beta_5 \geq 2$ ;  $\beta_{10} \geq 10$ ; and a  $\beta_{15} \geq 1000$ .

**E.2.3.6** In both examples, A and B, the filter element would be acceptable for special purpose systems. The main issue is that the manufacturer of both A and B may give a different nominal rating. It is not until the beta ratio for a given micron size is greater than or equal to the specified beta ratio that the filter is acceptable.

**E.2.3.7** There are many factors in determining the performance of a filter on a range of particles. Factors such as pressure; flow differential pressure; particle size and particle shape; fluid; and degree of loading can result in different beta ratios for the same type element. There is a widely used standard hydraulic filter test that is relatively similar to the conditions encountered in API Std 614, lube and seal systems. For the purpose of API Std 614, Chapters 2 and 3, ISO Standard 4572 or equal multi-pass method-type testing is required for passing the filter rating. A more detailed description of ISO Std 4572 testing is outlined in E.2.5.1. Filter vendors who supply type-tested elements have, and can make available, the test data for the elements being considered for API Std 614, Chapters 2 and 3 applications.

## E.2.4 RELATIVE SIZE OF PARTICLES

**E.2.4.1** To provide protection for equipment the filter must be able to remove particles that are in the range of the clearance of the component. For some insight into film thickness and particle sizes see Tables E-1 and E-2. For the majority of systems covered by API Std 614, Chapters 2, 3, and 4, the filter ratings will provide sufficient removal of the particles of concern as well as a reasonable installed life.

**E.2.4.2** Based on the data presented in Tables E-1 and E-2, it may be tempting to use a finer filtration specification. This may be inappropriate in many cases. Over-specification of the filter requirements can result in costly filter systems and frequent and expensive element changes.

**E.2.4.3** Users of API Std 614 filter specifications should be aware that the filters do remove particles smaller than the specified size. The filtration efficiency (PRE) or beta ratio for 1 mm to 10 mm particles may be low, but some will be captured by the element. It will only take more passes through the filter before the levels reach an equilibrium state where the filter removes the same number as ingress into the system. How small a particle is below the specified size that will be captured effectively is a function of the filter construction.

**E.2.4.4** There are some exceptions where fine filtration may be necessary. These may include, but are not limited to; control-oil systems with electrical-hydraulic pilot valves that have very close internal clearances and the oil supply systems for high speed gear-type couplings. In these applications it may be appropriate to install separate duplex filter(s) in the branch stream(s) just ahead of the sensitive component(s). The PRE for these filters should be mutually agreed on based on the requirements of the component.

Table E-1—Relative Size Comparison of Some Common Materials

Relative Size ( $\mu\text{m}$ )	Material
159	100-mesh screen opening
100	Table salt
74	200-mesh screen opening
60	Pollen
40	Human lower limit of visibility
2	Bacteria

Table E-2—Typical Dynamic Film Thickness for Equipment

Component	Thickness, $\mu\text{m}$	
Roller bearings	0.40 – 1.00	
Ball bearings	0.10 – 0.70	
Journal bearings	0.50 – 25.00	
Gears	0.10 – 1.00	
Seals	0.05 – 0.50	
Servo valves	Orifice	130.00 – 450.00
	Flapper to wall	18.00 – 63.00
	Spool to Sleeve	1.00 – 4.00
Hydraulic Actuators	25.00 – 250.00	



## E.2.5 STANDARDS

A brief description of applicable filtration standards is outlined to provide the API Std 614 users some background on the basis for use of these standards. For more information, the actual standard should be reviewed.

### E.2.5.1 ISO-4572

**E.2.5.1.1** Title: *Hydraulic Fluid Power—Filters—Multi-pass Method for Evaluating Filtration Performance of a Filter Element.*

**E.2.5.1.2** This is a rigorous method of type testing of filter elements in a recirculating loop with the injection rate of a standard test dust into the upstream side of the loop. Reporting of the results of the tests is in a standard format, and beta ratio for each of several micron sizes is averaged over the range from clean to maximum element differential pressure. This averaging is done over ten equal time frames. Typically, test data is taken for five particle size increments. The test is valid for 1  $\mu\text{m}$  to at least 30  $\mu\text{m}$  ratings and at flow rates in the test loop of from 4 to 600 l/min (160 gals/min). In addition to the filter element average beta rating for five or more particle sizes, a contaminant-loading capability for a filter element is established.

**E.2.5.1.3** The following items are controlled during the test of a filter to assure consistent results.

- The type of oil must meet a given specification.
- The temperature of the test fluid is controlled within a specific range.
- The test contaminate is restricted to a known particle distribution and is standardized (ISO Medium Test Dust).
- An automatic particle counter is used and calibrated to a standard.
- The automatic particle counter is used on-line and is validated to be correct in the system by means of a validation procedure.
- A system volume to flow ratio is established.
- Testing condition variations are limited for flow, upstream contamination level by weight, viscosity, temperature, and system volume.
- Instrument accuracy are established for the test circuit.
- The injection system is validated to assure constant rates of contaminate injection.

**E.2.5.1.4** The ISO-4572 test procedure provides a method to type test filter elements for lube oil, control oil, and seal oil systems in a loop that simulates as close as possible conditions the element will encounter in service. Filters used in Chapters 2 and 3 of this standard should have elements that have been type-tested to this standard or equal. The ISO-4572 test differential pressure should also be in the range of the expected operational differential pressure because some type

of elements may have significantly different beta ratios depending on the differential pressure range selected.

### E.2.5.2 ISO-4066

**E.2.5.2.1** Title: *Hydraulic Fluid Power—Fluids—Code for Defining the Level of Contamination of Solid Particles.*

**E.2.5.2.2** This standard provides a means of defining the quantity of solid particle contaminates in oil or hydraulic fluid. The code is composed of two scale numbers or grades based on the number of particles greater than or equal to 5  $\mu\text{m}$  and 15  $\mu\text{m}$  per milliliter of fluid. In recent years, many groups have expanded on the standard system to cover a third range for particle counts of 2  $\mu\text{m}$  or larger. Particle counts are made via microscope or by means of automatic particle counters. The results are reported as two or three grade numbers (see Table E-3 for a partial list of grade numbers). Each number is separated by a slash, “/”. The number for the smallest size range particles is presented first.

Table E-3—ISO-4066  
(Grade Numbers from 24 to 1 Only)

Number of Particles per Milliliter		Scale Number
More Than	Up To and Including	
80,000.00	160,000.00	24
40,000.00	80,000.00	23
20,000.00	40,000.00	22
10,000.00	20,000.00	21
5,000.00	10,000.00	20
2,500.00	5,000.00	19
1,300.00	2,500.00	18
640.00	1,300.00	17
320.00	640.00	16
160.00	320.00	15
80.00	160.00	14
40.00	80.00	13
20.00	40.00	12
10.00	20.00	11
5.00	10.00	10
2.50	5.00	9
1.30	2.50	8
0.64	1.30	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1

Example 1: Display the ISO-4066 grade of a 1 ml sample with the following data:

58,000 particles  $\geq 2 \mu\text{m}$ ;  $\Rightarrow$  (23)

4,100 particles  $\geq 5 \mu\text{m}$ ;  $\Rightarrow$  (19)

210 particles  $\geq 15 \mu\text{m}$ ;  $\Rightarrow$  (15)

ISO Grade 23/19/15

Example 2: Display the ISO-4066 grade of a 10 ml sample with the following data:

4,100 particles  $\geq 5 \mu\text{m}$ ;

210 particles  $\geq 15 \mu\text{m}$ ;

$4,100/10 = 410$ ;  $\Rightarrow$  (16);  $210/10 = 21$ ;  $\Rightarrow$  (12)

ISO Grade 16/12

### E.2.5.3 National Aerospace Standard 1638

**E.2.5.3.1** National Aerospace Standard (NAS) NAS-1638 is another frequently used standard for assigning cleanliness. NAS-1638 defines 14 different cleanliness classes. The particle count basis is 100 ml of fluid. Each class specifies a given number of particles in each of five size groups: 5 to 15  $\mu\text{m}$ , 15 to 25  $\mu\text{m}$ , 25 to 50  $\mu\text{m}$ , 50 to 100  $\mu\text{m}$  and  $>100 \mu\text{m}$ . Table E-4 of the NAS 1638 classifications is provided.

**E.2.5.3.2** Of the NAS-1638 and ISO-4066 standards, the ISO is more frequently used. The reason the NAS-1638 class is referenced is that it can be estimated by filtering a measured sample of fluid through filter disc in a standard apparatus and a

comparison is made to standard comparator discs. This may be much more applicable in a field situation.

### E.2.5.4 Comparison of NAS-1638 and ISO-4066

Table E-5 provides the approximate ISO grades for each NAS class. It is not possible to provide an equivalent three number ISO grade because the NAS 1638 does not count particles smaller than 5  $\mu\text{m}$ . Conversion from ISO grade to NAS class can only be approximated and may indicate a better grade quality than if the actual particle count is taken.

### E.2.6 DRY GAS SEAL FILTRATION

**E.2.6.1** In most cases, the seal gas filtration system for a compressor dry gas seal must perform two functions. The first is to remove debris and small particles that can cause excessive wear of the seal faces and silt up the seal cartridge. The second is to prevent liquids from entering the seal and causing sudden failure of the seal.

**E.2.6.2** The gas filtration for dry gas seals will not be effective unless the characteristics of the gas supply is provided to the vendor for all conditions. Seal gas supplies can vary from dry inert gas with dew points below 100°C to a complex hydrocarbon mixture at the dew point with droplets or aerosols of hydrocarbon liquid in equilibrium. The characteristics of the seal gas may vary considerably with the operating conditions of the compressor.

**E.2.6.3** For the vendor to supply appropriate seal gas filter/separators, the characteristics and gas composition of the sup-

Table E-4—NAS-1638

Class	Number of Particles per 100 Milliliters				
	5 to 15 $\mu\text{m}$	15 to 25 $\mu\text{m}$	25 to 50 $\mu\text{m}$	50 to 100 $\mu\text{m}$	$>100 \mu\text{m}$
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	506	90	16
7	32,000	5,700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,440	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,400	32,400	5,760	1,024

Table E-5—NAS-1638 to ISO Approximation

NAS-1638 Class	Number of Particles per 1 Milliliter		ISO-4066 Grade
	>5 $\mu\text{m}$	>15 $\mu\text{m}$	
00	1.52	0.27	8/5
0	3.00	0.54	9/6
1	6.10	1.10	10/7
2	12.20	2.20	11/8
3	24.30	4.30	12/9
4	48.60	8.60	13/10
5	97.30	17.30	14/11
6	195.00	35.00	15/12
7	389.00	69.00	16/13
8	779.00	139.00	17/14
9	1551.00	277.00	18/15
10	3114.00	554.00	19/16
11	6228.00	1108.00	20/17
12	12456.00	2216.00	21/18

ply must be fully identified to the vendor at all operating conditions from start-up to settle-out. When the seal gas supply is taken from the compressor discharge, the gas composition may be identified from the API 617 compressor data sheet number 2 of 6. The purchaser, vendor, dry gas seal supplier, and dry gas seal console supplier must work together to identify the applicable conditions such as testing, off-design operation, start-up and settle-out where the presence of liquids are possible. For all possible conditions, special attention should be made to the gas supply dew point, pressure, supply temperature, and ambient temperature. Special attention is also required to assure the seal gas is compatible with the filters, filter elements, and elastomers over the possible operating conditions.

**E.2.6.4** On most dry gas seal systems there are two sets of gas filters; one for the separation gas and one for the seal gas. The separation gas is generally an inert dry gas, such as nitrogen. Unless there are special circumstances identified to the vendor, the filters for separation gas do not require coalescing capability.

**E.2.6.5** Unless the seal gas has a dew point at least 28°K (50°F) below operating temperature (including any Joules/Thompson effect at the control valve) downstream of the controlling device and 60°K (10°F) below minimum ambient, a seal gas filter/separator should be supplied with elements that are a combined filter/coalescer or with two separate elements, one for filtering and one for coalescing.

**E.2.6.6** Because the seal gas and separation gas filters are not part of a recycling system, the filter beta ratings or particle removal efficiency should be identified on a one-time through basis at conditions similar to the seal support oper-

ating conditions. The multipass test method ISO-4572 is not to be applied to gas filters.

**E.2.6.7** Two factors for dry gas seal systems that must be addressed are the coalescing capacity and the dirt-holding capacity of the filter/separator. Dry gas seals require fine filtration ( $\beta_3 \geq 75$ ) along with the ability to remove liquid aerosols with droplets as fine as one micron. When this is combined with the single-pass nature of the service filter/separator, in the presence of significant liquid, the filter elements can overload quickly. If the liquid rate to the filter/separator exceeds 50 percent of the vendor's published capacity, a mechanical centrifugal separator ahead of the filter/separator is necessary to handle the liquid. The vendor's published separator capacity is based on steady state liquid flow and new clean elements. Excess capacity is necessary to prevent overload of the separator as the element service life increases as well as handle intermittent small liquid slugs that can develop in horizontal pipe runs.

**E.2.6.8** It is critical, in services where seal gas dew points are close to seal gas flowing temperatures, to trap any low points or slope all piping to a location where the liquids can be removed. This applies to both on- and off-skid seal gas piping.

**E.2.6.9** The fine filter/separator elements can quickly plug off if the gas stream is contaminated with solid particles or sediments. If dirty gas is a problem, a guard filter with a large holding capacity may be necessary to obtain acceptable filter/separator element life. Where practical the element's dirt holding capacity for a dry gas seal filter or filter/separator should be on the order of 6 months. For some "dirty" systems, the vendor and purchaser should review and agree on an acceptable filter holding capacity requirement based on what change-out frequency is possible and cost effective.

## E.2.7 FILTER HOLDING CAPACITY

In most systems covered by Chapters 2 and 3, the ingress of contamination is insignificant after the system is initially flushed. In general, filters that have sufficient flow capability to meet the requirements of 1.6.5 in Chapter 2 or 1.7.7 in Chapter 3, have an acceptable service life. The service life of filter elements in a system after flushing should be more than 6 months unless there is some problem external to the filters that is causing a significant degree of contamination.

## E.3 System Cleanliness Testing

### E.3.1 GENERAL

The intent of the 100-mesh screen test for special purpose lube and seal system consoles is to confirm that when shipped, there is no debris remaining in the console or vendor-supplied piping or components that could contaminate the remainder of the system and extend system flushing time at the site. When applied by other API standards to vendor testing of equipment or by users at machinery installation, it is intended to confirm there is no debris remaining in the system downstream of the filters that can be immediately detrimental to the machinery components served by the system(s).

### E.3.2 SPECIAL PURPOSE SYSTEMS

**E.3.2.1** The method of determining when a Special Purpose Oil or Seal Oil System is clean enough to deliver or when a vendor oil system is clean enough for factory run testing of special purpose machinery is covered by 4.3.3.7.1 and 4.3.3.7.2 in Chapter 2. This requirement may also be extended to a site evaluation of installed oil and seal oil systems.

**E.3.2.2** To comply with 4.3.3.7.1 of Chapter 2, systems that have been circulated for 1 hour through the 100-mesh test screens shall have no more than the maximum particle counts shown on Table E-6.

**E.3.2.3** The use of test screens has been a reliable indicator of when an oil system with an adequate filter system will support start-up and/or testing of API special machinery. The advantage of this testing is that a large representative volume of fluid is circulated through the test screens, and the harmful debris that is introduced during fabrication and assembly of a special purpose system is removed. When this test is done to an appropriate procedure and the test screens located where there is downward flow through the screens in supply lines, the system will be free of damaging debris downstream of the screens.

**E.3.2.4** There is some concern that 100-mesh screens do not pick up the small particles that may have undesirable long-term effects on the equipment serviced by the lube and seal oil system. The test in 4.3.3.7.1 of Chapter 2 is not intended to define how well a system will perform in the long

Table E-6—Maximum Number of Particles

Nominal Pipe size (in.)	Schedule 40 or less	Schedule 80	Schedule 160	Double Extra-Strong
< 1	6	5	4	—
1 to 1.5	15	10	10	5
2	20	20	15	10
3	45	40	35	25
4	80	70	60	50
6	180	160	130	115

term. Long-term reliability of components served by a special-purpose system is more a function of the system design and filter specification. Other factors, such as control of the ingress of damaging size particles and the type of particle contamination, are important factors contributing to long-term reliability of machinery.

**E.3.2.5** Some API Std 614 users have started to add a criteria from ISO-4066 or NAS-1638 to make sure the system is clean enough for long-term operation. An ISO-4066 grade specification often used is 20/15/12, (15/12) when only 5  $\mu\text{m}$  and larger particles are counted. The approximate equivalent NAS-1638 requirement is Class 6. For some very critical or sensitive special purpose machines, the ISO criteria may be as tight as 18/14/11 (14/11 when particles smaller than 5  $\mu\text{m}$  are not counted) downstream of the filters. This is approximately equivalent to NAS Class 5. (See Table E-5).

**E.3.2.6** In the context of factory testing large consoles with large residence capacity, the use of a low-particle count requirement such as 14/11 may result in extensive circulation through the filters before a sufficient number of passes through the filters have been completed to remove enough particles in the 5  $\mu\text{m}$  to 10  $\mu\text{m}$  range. This testing can only be valid after the screens have shown that the system is free of damaging debris at the equipment supply connections. It is highly likely that the act of inspection of a console for debris of the console per Chapter 2, 4.3.3.7.1, and 4.3.3.7.2 will introduce enough dust to exceed the particle count criteria. If not, the particle count criteria will almost certainly be exceeded due to even minor contamination that is inevitable in the course of a special purpose console and system preservation, shipping, storage, and construction.

**E.3.2.7** Caution should be used if only a particle count criteria is specified for special purpose systems/consoles in any context (console vendor, machinery test floor, at site operation). Because small volumes are sampled, the use of only particle count criteria can easily miss damaging debris that may be released intermittently from piping and components.

**E.3.2.8** Particle-counting criteria can be useful in the course of flushing an entire system at the installation site when used in conjunction with testing the supply lines with 100-mesh screens. An ISO 15/12 criteria (NAS Class 6) is

acceptable for start-up of most special-purpose equipment and even a 16/13 criteria should not be a problem for start-up so long as particle counts are trending downward. In general, unless there is an equipment malfunction or a deficiency in the system filters, the system should be able to reach a 14/11 NAS Class 5 level or better within a week or two of continuous service.

**E.3.2.9** In general, special-purpose Lube Oil and Seal Oil Systems users who have tracked their systems by means of qualitative testing (such as, ISO-4066 or NAS-1638) from installation through operation have noted at least one grade or class improvement from start-up of the system until a steady-state particle level is reached.

### E.3.3 GENERAL PURPOSE

**E.3.3.1** In Chapter 3, 4.3.3.6.2 requires 100-mesh screen testing of general purpose oil consoles. This test is justified for relatively large, general-purpose systems. The percent of the cost added for 100-mesh screen testing of large general-purpose systems is not large. For small general-purpose systems in terms of percent, this testing can add a significant cost to the console. An option exists in 4.3.3.6.2 to select a mutually agreed alternate test.

**E.3.3.2** The alternate test specifies an ISO-4066 grade 17/14 or NAS-1638 Class Eight be obtained as a method to verify if the oil console is clean enough. A circulation time needs to be selected to assure there is mixing to suspend any sediments. Prior to taking a sample, it is suggested that the minimum circulation time be five times the reservoir capacity divided by the pump normal flow.

**E.3.3.3** Some larger debris in the general purpose oil console may be missed by checking only particle count. If the oil is clean enough to pass ISO 17/14 grade, then the quantity of debris left in the system should not require additional flushing effort at the site. At the site, prior to placing the system in service, it is still recommended that the entire system be flushed. A 100-mesh screen evaluation based on Table E-5 at the

equipment oil supply header should be done prior to commissioning the general-purpose equipment.

### E.3.4 DRY GAS SEAL CONSOLE TESTING

**E.3.4.1** Dry gas seal console cleanliness testing is covered by 4.3.1 in Chapter 4. This test is also based on inspection of a 100-mesh screen after the console is blown for a set period of time with 100 psig dry and filtered air. The particle counting methods of NAS-1638 and ISO-4066 are not applicable to seal gas module testing because they are hydraulic tests. The use of a particle count criteria is very difficult to set-up in the context of a 10-minute flow or blow test and not normally required.

**E.3.4.2** The cleanliness test procedure should be reviewed with the console fabricator. Whenever possible, the test screen should be located so that flow through the screen is down. The flow path through the console of the oil should be reviewed and flow restrictions, such as orifice plates and control valve trim, may need to be removed for the test.

**E.3.4.3** The console filter/separator elements must be removed if there is any possibility of reaching the collapse differential for the element or if the element could present a significant restriction to the flow of air. Removal of the console filter/separator elements should only occur after the upstream console piping and components are confirmed to be clean.

**E.3.4.4** The location of the air source pressure gauge (100 psig minimum) should be reviewed and it should always be downstream of the air supply filter. An agreement on if and how far the pressure may drop at the flowing condition should comply with the vendor. It is also suggested that only one supply connection be checked at a time.

**E.3.4.5** In the context of Chapter 4, this test is applicable to factory tests of consoles. With agreement of all parties, the use of this test can be expanded to include vendor test stand dry gas seal support consoles and the testing of the assembled dry gas seal support system in the field to determine if the system is clean enough to allow factory testing or field start-up.

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# CHAPTER 1

## APPENDIX F—PIPING SYMBOLS (INFORMATIVE)

### F.1 General Notes

**F.1.1** The schematics presented in this appendix illustrate the general philosophy and requirements of this standard and typify commonly used systems. The systems illustrated may be modified as necessary, as mutually agreed on by the purchaser and the vendor, to achieve a system or systems adequate for a particular application.

**F.1.2** Instrument piping and valving details are not shown on most of the schematics; however, these details are illustrated in Figures 2A-17a through 2A-17i and shall apply unless otherwise specified.

**F.1.3** When specified by the purchaser or when necessary for the conditions and functions involved, equivalent transmitters (pilot operators) with suitable separate control valves shall be substituted for the direct-acting control valves shown on the schematics. The transmitter-controller schemes illustrated show pneumatic transmission; actual transmission shall be pneumatic, hydraulic, or electric as specified by the purchaser.

**F.1.4** External control connections are shown on the control valves to illustrate more clearly the intended function of the system. Where applicable and when permitted by the purchaser, these control valves may be of the self-contained type without external connections.

**F.1.5** Relief valves are illustrated as angle-type valves, the most common pattern. A straight-through pattern may be used if it is adequate for the required service conditions.

**F.1.6** A typical arrangement for a modulating-flow-type relief valve to protect a low pressure-system (see 6.1.8) is illustrated in Figures 2A-7 and 2A-8.

**F.1.7** Relief valves whose sole purpose is to protect blocked-in equipment (for example, coolers or filters) from thermal expansion are not shown but shall be supplied when specified by the purchaser. The purchaser shall mark "THERM" outside the relief valve symbol on the schematic when the relief valve is for protection from thermal expansion only.

**F.1.8** Figures 2A-17b, 2A-17c, and 2A-17d represent designs which permit alarm and trip switches to be isolated for testing while the system is in operation.

**F.1.9** The purchaser's connections shown are based on a console arrangement. When a multiple-package arrangement is used, the purchaser must make additional connections among the separate groups.













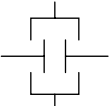

























### F.2 Legend for Schematics

The following legend is provided to facilitate interpretations and understanding of the schematics presented in this appendix. Some of the abbreviations and symbols listed are from ISA S5.1.

AS	air supply
ES	electric supply
FCV	flow control valve
FG	flow gas
FO	flow restriction orifice
H-P	high pressure
LC	level controller
LG	level glass
LI	level indicator
LIC	level-indicating controller
L-P	low pressure
LSH	high-level switch
LSHH	very high-level switch
LSL	low-level switch
LSLL	very low-level switch
LT	level transmitter
LV	loop-actuated level control valve
LY	relay in level control loop
PCV	direct-acting pressure control valve
PDCV	direct-acting differential-pressure control valve
PDI	pressure differential indicator
PDSH	high-differential-pressure switch
PDSL	low-differential-pressure switch
PDSLL	very low differential-pressure switch
PI	pressure indicator
PRV	pressure-regulating (relief) valve
PSH	high-pressure switch
PSL	low-pressure switch
PSV	pressure safety (relief) valve
PV	loop-actuated pressure control valve
PY	relay in pressure control loop
SS	steam supply
TC	temperature controller
TCV	direct-acting temperature control valve
TI	temperature indicator

### F.3 Symbols

Typical symbols for the schematics are shown on the following page.

	Actuator, diaphragm		Piping, oil and gas
	Actuator, diaphragm, with hand jack		Reducer or swage nipple
	Actuator, differential-pressure diaphragm		Spectacle blind
	Actuator, solenoid		Trap
	Connections by purchaser		Tubing, capillary (filled system)
	Control switch, manual, with hand/off/automatic positions		Valve, atmospheric breather
	Coupling, continuously lubricated		Valve, check
	Device, purging		Valve, gate or valve, two-way actuator-operated
	Flange, blind, or plug		Valve, globe
	Flow indicator, rotameter type		Valve, needle
	*Instrument, combined arrangement		Valve, pressure control
	*Instrument, externally connected		Valve, pressure limiting
	*Instrument, locally mounted	<b>FC</b>	Ports failing closed
	*Instrument, pad-mounted (flush)	<b>FI</b>	Ports failing indeterminately
	*Instrument, panel-mounted	<b>FL</b>	Ports failing locked in position
	*Instrument, single, with two functions	<b>FO</b>	Ports failing open
	Line, electrical	<b>NO</b>	Normally open
	Line, hydraulic	<b>NC</b>	Normally closed
	Line, pneumatic		Valve, two-port
	Line, strainer, Y-type		Valve, three-port manual
	Manual-reset feature		Valve, three-port, for actuator
	Orifice, flow restriction		Valve, six-port continuous-flow transfer, manually operated

\*Letters inside the balloon indicate the instrument's function.



**Lubrication, Shaft-Sealing, and Control-Oil Systems  
and Auxiliaries for Petroleum, Chemical and  
Gas Industry Services**

**CHAPTER 2—SPECIAL-PURPOSE OIL SYSTEMS**



# CONTENTS

	Page
1 BASIC DESIGN . . . . .	2-1
1.1 General . . . . .	2-1
1.2 Baseplates . . . . .	2-2
1.3 Oil Reservoirs . . . . .	2-3
1.4 Pumps and Drivers . . . . .	2-6
1.5 Coolers . . . . .	2-9
1.6 Filters . . . . .	2-10
1.7 Transfer Valves . . . . .	2-12
1.8 Accumulators . . . . .	2-12
1.9 Overhead Tanks . . . . .	2-13
1.10 Seal-Oil Drain Traps . . . . .	2-14
1.11 Degassing Drum . . . . .	2-14
2 PIPING . . . . .	2-15
2.1 General . . . . .	2-15
2.2 Oil Piping . . . . .	2-15
2.3 Instrument Piping . . . . .	2-15
2.4 Process Piping . . . . .	2-15
2.5 Water Piping . . . . .	2-15
3 INSTRUMENTATION, CONTROL, AND ELECTRICAL SYSTEMS . . . . .	2-15
3.1 General . . . . .	2-15
3.2 Instrumentation . . . . .	2-16
3.3 Electrical Systems . . . . .	2-17
4 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT . . . . .	2-18
4.1 General . . . . .	2-18
4.2 Inspection . . . . .	2-18
4.3 Testing . . . . .	2-18
4.4 Preparation for Shipment . . . . .	2-19
5 VENDOR'S DATA . . . . .	2-19
5.1 General . . . . .	2-19
5.2 Proposals . . . . .	2-19
APPENDIX A SPECIAL-PURPOSE OIL SYSTEM SCHEMATICS (INFORMATIVE) . . . . .	2-21
APPENDIX B DATA SHEETS (INFORMATIVE) . . . . .	2-47
APPENDIX C INSPECTOR'S CHECKLIST (INFORMATIVE) . . . . .	2-63
APPENDIX D COST ESTIMATE WORKSHEET FOR SPECIAL-PURPOSE OIL SYSTEM (INFORMATIVE) . . . . .	2-69
Figures	
2-1 Reservoir Levels and Oil Level Glass Details . . . . .	2-4
2-2 Overhead Seal-Oil Tank . . . . .	2-13
2-3 Blowdown Connection . . . . .	2-13
2-4 Typical Degassing Drum Arrangement . . . . .	2-15



# Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services

## Chapter 2—Special-Purpose Oil Systems

### 1 Basic Design

#### 1.1 GENERAL

**1.1.1** The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a 20-year minimum service life and at least 3 years of uninterrupted operation. It is recognized that this is a design criterion.

**1.1.2** The oil system shall be suitable for special-purpose applications as defined in 3.40 of Chapter 1 of this standard. The system shall be designed as a separate console, or if approved by the purchaser, it may be designed to be integral with the baseplate of the equipment it serves. The design shall allow for transfer between and shutdown of the main and spare components of the system for maintenance without interrupting the operation of the system or the equipment the system serves.

**1.1.3** The vendor shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of the order.

**1.1.4** Materials shall be identified in the proposal with their applicable ASTM, AISI, ASME, or SAE numbers or equivalent standards per Appendix A of Chapter 1, including the material grade. When no such designation is available, the vendor's material specification, giving physical properties, chemical composition, and test requirements, shall be included in the proposal.

- **1.1.5** The purchaser will specify the equipment's normal operating point on the data sheets.
- **1.1.6** Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort of the purchaser and the vendor. The equipment furnished by the vendor shall conform to the maximum allowable SPL specified by the purchaser.
- **1.1.7** The purchaser will specify whether the seal-oil and lube-oil systems are to be separate or combined. If separate systems are specified, the means of preventing interchange of oil between the two systems shall be described in the vendor's proposal.
- **1.1.8** Where oil is supplied from a common system to two or more machines (such as a compressor, a gear, and a motor), the oil's characteristics will be specified by the purchaser on the basis of mutual agreement with all vendors supplying equipment served by the common oil system.

Note: The usual lubricant employed in a common oil system is a hydrocarbon oil that corresponds to ISO Grade 32, as specified in ISO 3448.

- **1.1.9** The system shall be designed to supply oil to all equipment specified.

**1.1.10** The recycled oil shall originate upstream of the filters.

Note: This is to minimize the potential for generating static electricity (or a static charge) that may result when filtered oil bypasses the equipment and is recycled directly to the reservoir. This is very important, especially if explosive gas may also be present in the reservoir.

- **1.1.11** The seal-oil system shall be designed to serve the full range of equipment operating conditions specified. These conditions may include but are not limited to the following:

- a. Settling-out pressures.
- b. Process relief valve settings.
- c. Shop test and field run-ins.
- d. Start-up conditions.

**1.1.12** In addition to the above requirements, seal-oil systems shall be designed to operate safely prior to process start-up or any other idling condition specified, with the system in total automatic control and with the compressor at atmospheric pressure.

- **1.1.13** The purchaser will specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof) as well as the weather and environmental conditions in which the equipment must operate (including maximum and minimum temperatures and unusual humidity, dust, or corrosion conditions).

**1.1.14** The arrangement of the equipment, including piping and auxiliaries, shall be developed jointly by the purchaser and the vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance.

- **1.1.15** If applicable, the purchaser will specify minimum requirements for clearance around and access to components (especially clearance around and access to coolers, filters, and hand valves).

- **1.1.16** Motors, electrical components, and electrical installations shall be suitable for the area classification (class, group, and division or zone) specified by the purchaser; and shall meet the requirements of NFPA 70, Articles 500, 501, 502, and 504, or equivalent standards per Appendix A of

Chapter 1; as well as local codes specified and furnished by the purchaser.

**1.1.17** Pumps, filters, strainers, coolers, traps, valves, and all other components that retain oil under pressure and are external to the reservoir shall be made of steel.

**1.1.18** Valved vents, drains, and piping shall be furnished to permit draining, cleaning, and refilling of idle components while the equipment is in operation.

- **1.1.19** The purchaser will specify when and where double block and bleed valves are required for isolating a component and how they are to be arranged (see Figure 2A-22f).

- **1.1.20** Coolers, filters, overhead oil tanks, drain traps, accumulators, and other pressure vessels within the scope of Section VIII of the ASME Code shall conform to the code or equivalent code per Appendix A of Chapter 1 and, if specified by the purchaser, shall be code-stamped (see 1.9 for overhead tank requirements).

**1.1.21** The console shall perform on the test stand and on its permanent foundation within the specified acceptance criteria. After installation, the performance of the console shall be the joint responsibility of the purchaser and the vendor.

- **1.1.22** The vendor shall advise the purchaser of, and both parties shall mutually agree on, any special provisions that are necessary to ensure that an adequate supply of lube or seal oil or both is maintained in the event of complete failure of the lube-oil or seal-oil supply system. These provisions may include emergency pumps, accumulators, rundown tanks, and special arrangements for equipment safety and protection when the equipment decelerates. Provisions shall be adequate for coast-down time, cool-off time, and block-in time as applicable; the purchaser shall specify the required block-in time. The purchaser and the vendor shall mutually agree on the system and its components.

**1.1.23** Block valves that interrupt the oil flow to the equipment shall not be installed in oil supply lines downstream of the filters unless the block valves are part of a component block and bypass arrangement.

**1.1.24** Welding of piping and pressure-containing parts, as well as any dissimilar-metal welds and weld repairs, shall be performed and inspected by operators and procedures qualified in accordance with Section VIII, Division 1, and Section IX of the ASME Code or equivalent code per Appendix A of Chapter 1.

- **1.1.25** In addition to the requirements of 1.1.24, the purchaser may specify that 100-percent radiography, magnetic particle inspection, or liquid-penetrant inspection of welds is required.

**1.1.26** Unless otherwise specified, all welding other than that covered by Section VIII, Division 1, of the ASME Code

and ASME B31.3, such as welding on baseplates, nonpressure ducting, lagging, and control panels, shall be performed in accordance with AWS D1.1 or equivalent code per Appendix A, Chapter 1.

## 1.2 BASEPLATES

- **1.2.1** The system shall be designed as a console, a single or multiple package, or another arrangement as specified by the purchaser. Each package shall have a structural steel baseplate with all system components and related valves and manifolds mounted on the baseplate. The major components (pumps, filters, coolers, and reservoir) shall be mounted directly on structural steel.

**1.2.2** Unless otherwise specified, package baseplates shall be drain-gutter type with one or more drain connections at least DN 40 (1½ in.) in size. Baseplates, mounted components, and decking shall be arranged and installed to ensure drainage and avoid the retention of liquid.

**1.2.3** The baseplate shall be provided with lifting lugs for at least a four-point lift. The baseplate shall be designed so that after the components and all piping mounted on it are drained of oil, the package can be lifted without permanently distorting or otherwise damaging either the baseplate or any component mounted on it.

**1.2.4** Unless otherwise specified, nonskid metal decking covering all walk and work areas shall be provided on the top of the baseplate.

**1.2.5** Unless otherwise specified, all baseplates shall be provided with at least one opening or hole in each bulkhead section through which grout can be poured and vented. Each opening shall have a clear area of no less than 125 cm<sup>2</sup> (20 in.<sup>2</sup>) and no dimension less than 100 mm (4 in.), and each shall permit filling and venting of the entire cavity with grout under the baseplate without creating air pockets. Each hole that the grout is to be poured in shall be accessible: no component or piping shall be disturbed, and no tripping hazards in walk and work areas shall be created. Each hole shall also be provided with steel curbing 13 mm (½ in.) high to prevent accumulated oil or water from entering the grout. Vent holes at least 13 mm (½ in.) in diameter shall be provided for each bulkhead compartment.

- **1.2.6** When specified, the baseplate shall be suitable for column mounting (that is, of sufficient rigidity to be supported at specified points) without continuous grouting under structural members. The baseplate design shall be mutually agreed on by the purchaser and the vendor.

- **1.2.7** When epoxy grout is specified, the vendor shall pre-coat all the grouting surfaces of the mounting plates with a catalyzed epoxy primer applied to degreased white metal. The epoxy primer shall be compatible with epoxy grout. The

vendor shall submit to the purchaser instructions for field preparation of the epoxy primer.

**1.2.8** The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation, accessibility for grouting under all load-carrying structural members shall be provided.

## 1.3 OIL RESERVOIRS

### 1.3.1 General

**1.3.1.1** Unless otherwise specified, reservoirs shall be separate from the equipment baseplate and be rigid enough to prevent sagging and vibration. Components bolted to the reservoir shall be mounted on pads; no bolt holes shall extend into the reservoir. To prevent deposit accumulations, reinforcing ribs on the walls of the reservoir shall be external.

Note: See 1.3.12 for special features.

### 1.3.2 Protection From Dirt and Water

**1.3.2.1** Reservoirs shall be sealed to prevent dirt and water from entering. Top-surface openings shall be raised at least 25 mm (1 in.) and have a gasket.

**1.3.2.1.1** Unless otherwise approved, pumps, coolers, or filters shall not be mounted on top of the reservoir.

Note: This may be a user consideration for offshore or other installations where available space is limited.

**1.3.2.2** The tops of reservoirs shall be sloped at least 1:100 ( $1/8$  in./ft).

Note: This may not be possible for reservoirs integrated with main equipment baseplate.

### 1.3.3 Oil Connections and Internal Piping

**1.3.3.1** All oil return flow streams shall be hydraulically located as far away from the pump suction connections as possible.

Note: The use of the term, "hydraulically located as far away," is intended to convey the concept that return flow streams may be directed by internal piping or baffling to avoid disturbing the oil flow at pump inlets. This internal piping or baffling could be used in lieu of external connections physically located such a distance from the pump suction connections that they avoid disturbing the oil flow at the pump inlets.

**1.3.3.2** All atmospheric oil return connections (including fill connections) shall be located above the maximum operating level and shall transport oil (via open-top stilling tubes or degassing trays) as shown in Figure 2A-21. Stilling tubes shall have bottom baffles.

**1.3.3.3** Control back-pressure valve and return stream control valve connections shall be separate and shall discharge oil via internal piping below the pump suction-loss level as

shown in Figure 2A-21. Pressurized oil shall not be returned to stilling tubes or degassing trays. Internal piping shall have bottom baffles.

**1.3.3.4** Pump suction connections shall be located near the high end of the sloped reservoir bottom and at least 50 mm (2 in.) above it.

**1.3.3.5** Except as specified in 1.3.9, reservoir pipe connections shall be flanged.

### 1.3.4 Manways and Drains

To ensure complete drainage, the bottom of each reservoir shall slope continuously, at least 1:50 ( $1/4$  in./ft), to a low point. A flanged drain connection (with a valve and a blind flange) at least 50 mm (2 in.) in size shall be provided. Manway openings shall be provided which will permit unobstructed entry for inspection and cleaning of all interior compartments. If entry is required for cleaning and unless otherwise specified, manways shall be located on top of the reservoir and each manway shall be at least 60 cm x 60 cm or 45 cm in diameter (24 in. x 24 in. or 18 in. in diameter). Internal manways are not acceptable.

### 1.3.5 Features and Appendages

**1.3.5.1** The oil reservoir shall have the features and appendages described in paragraphs 1.3.5.1.1 through 1.3.5.1.9:

**1.3.5.1.1** The capacity to settle moisture and foreign matter adequately and to provide allowance for rundown from the entire system.

**1.3.5.1.2** Provisions to eliminate air and minimize migration of foreign matter to each pump suction.

**1.3.5.1.3** A reflex-type, welding-pad oil level glass (with stainless steel weld pad and carbon steel cover) arranged to cover the span from at least 25 mm (1 in.) above the rundown level to 50 mm (2 in.) below the pump suction-loss level. The oil level glass shall be located as far away as possible from the oil return lines and be visible from the perimeter of the unit (see 1.3.3.1). The maximum and minimum operating levels, rundown level, and suction-loss level shall be indicated on the level glass. If more than one level glass is provided, they shall be offset.

**1.3.5.1.4** A fill opening at least 50 mm (2 in.) in size that automatically closes (normally held shut by a spring) and is equipped with a stainless steel fine-mesh strainer basket that has an open area equal to 200 percent of the internal pipe area.

**1.3.5.1.5** A blind-flanged vent connection at least 50 mm (2 in.) in size.

**1.3.5.1.6** A weatherproof, corrosion-resistant filter-breather cap at least 50 mm (2 in.) in size. (For reservoirs containing seal oil, see 1.3.5.2.)

**1.3.5.1.7** Internal baffles that are not gas tight.

- **1.3.5.1.8** If the train is driven by a gas or steam turbine and the oil reservoir contains the seal oil, a separate connection shall be provided on the reservoir for the compressor seal oil return line.

Note: This line will prevent pressurization of the steam turbine lube oil drain header if the compressor seals fail.

**1.3.5.1.9** Individual nonpressurized reservoir return lines shall enter the reservoir above the rundown level. (See 1.3.6.1.1.)

- **1.3.5.2** On reservoirs containing seal oil, a specially sized vent is required to handle the total flow of gas coming from the failed seal(s) through the oil drain lines. The vendor shall provide the purchaser with the vent size and the sizing criteria.

Note: Vents routed to flare systems or vapor recovery systems shall be provided with an overpressure protection device. The sizing of this device shall be jointly developed by the purchaser and the vendor.

### 1.3.6 Capacity and Configurations

Note: Sizing criteria is covered in 1.3.6.2.

#### 1.3.6.1 Definitions of Levels

**1.3.6.1.1** The rundown level (Level A in Figure 2-1) is the highest level that oil in the reservoir may reach when the entire system is shut down.

**1.3.6.1.2** The maximum operating level (Level B) is the highest level that oil will reach during normal operation of the equipment.

**1.3.6.1.3** The minimum operating level (Level C) is the lowest level that oil will reach during normal operation of the equipment.

**1.3.6.1.4** The suction-loss level (Level D) is the level above the pump section level (Level E) at which the pump begins to lose prime. The pump suction level is defined by the pump suction vortex and net positive suction head requirements.

**1.3.6.1.5** The charge capacity is the total volume below the rundown level.

**1.3.6.1.6** The normal operating range is any level between the maximum and minimum operating levels.

**1.3.6.1.7** The retention capacity is the total volume below the minimum operating level.

**1.3.6.1.8** Retention time is the time allowed for disengagement of entrained air or gas.

**1.3.6.1.9** The rundown capacity is the volume between the rundown level and the maximum operating level.

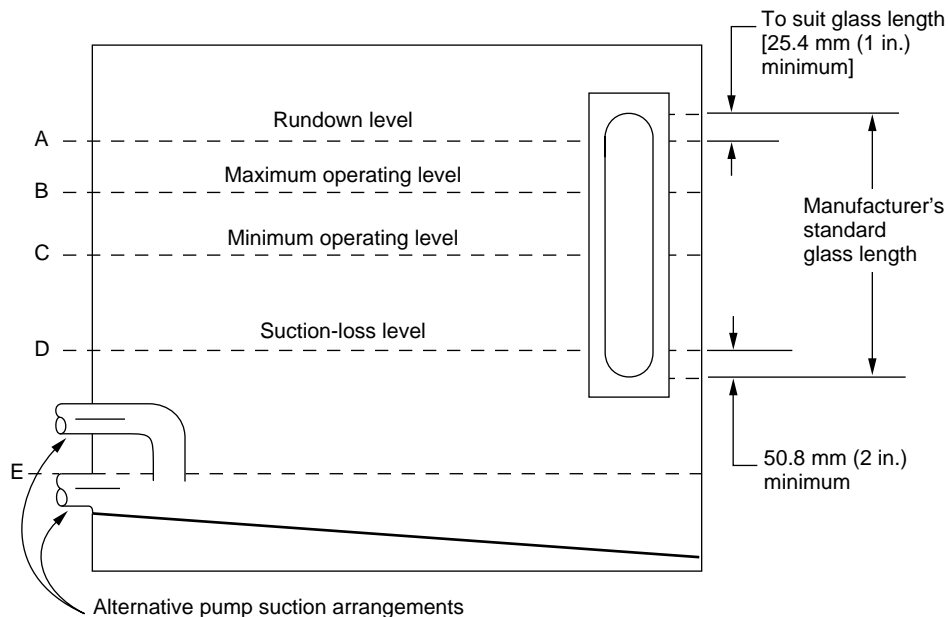


Figure 2-1—Reservoir Levels and Oil Level Glass Details



**1.3.6.1.10** The working capacity is the volume between the minimum operating level and the suction-loss level.

**1.3.6.1.11** A low-level alarm shall actuate at the minimum operating level.

### 1.3.6.2 Criteria for Sizing

The criteria for sizing a reservoir are shown in 1.3.6.2.1 through 1.3.6.2.6.

**1.3.6.2.1** The working capacity between Level C and Level D shall be sufficient for at least 5 minutes of normal flow.

**1.3.6.2.2** The minimum retention capacity shall be calculated based on 8 minutes of normal oil flow.

**1.3.6.2.3** The rundown capacity shall allow for all of the oil contained in all of the components, such as bearings and seal housings, overhead seal tanks, rundown tanks, accumulators, control elements, and vendor-furnished piping that drain back to the reservoir. The rundown capacity shall also allow for at least an additional 10 percent of these volumes for the purchaser's interconnecting piping.

Note: Rundown may cause some backup in the drain lines entering the reservoir.

**1.3.6.2.4** Where sour oil is present in a seal-oil system, the capacity between the minimum and maximum operating levels shall be at least 50 mm (2 in.) of reservoir height, and, based on the manufacturer's estimated seal-oil usage rate when the seals have worn to two times their maximum design clearance, the capacity shall be sufficient to permit at least 3 days of operation without requiring that oil be added to the reservoir.

Note: The usage rate shall be provided by the seal manufacturer. This is of special concern when the sour oil is not returned to the reservoir.

**1.3.6.2.5** In a lube-oil system, the capacity between the minimum and maximum operating levels shall be at least 50 mm (2 in.) of reservoir height.

**1.3.6.2.6** The free surface of the oil in the reservoir shall be a minimum of 60 cm<sup>2</sup> for each liter per minute (0.25 ft<sup>2</sup> for each gallon per minute) of normal flow.

### 1.3.7 Heating

**1.3.7.1** Heaters shall be provided if the minimum site temperature on the data sheet is less than the minimum oil start-up temperature.

Note: Users may specify special provisions to lube oil coolers to allow steam to be introduced to the water side and act as a heater prior to startup. Details of alternate arrangements such as this must be mutually discussed.

**1.3.7.2** Purchaser will specify if heaters are to be steam or electric.

**1.3.7.2.1** When a steam heater is specified, a removable element external to the oil reservoir shall be provided for heating the charge capacity of oil prior to start-up in cold weather. The device shall have the capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required minimum oil start-up temperature within 12 hours. Unless otherwise specified, the reservoir heat loss during heating shall be determined based on an uninsulated reservoir, the minimum site ambient temperature, and a 16 kmph (10 mph) wind. The vendor shall provide data to support this.

**1.3.7.2.2** When an electric heater is specified, a thermostatically-controlled, removable electric immersion heating element shall be provided for heating the charge capacity of oil prior to start-up in cold weather. It shall have a sheath of AISI Standard Type 300 stainless steel. The device shall have the capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required start-up temperature within 12 hours. It shall have a maximum watt density of 2 W/cm<sup>2</sup> (15 W/in.<sup>2</sup>). Heater elements in contact with the oil shall be sheathed in austenitic stainless steel; copper or copper-bearing materials shall not contact the oil. Unless otherwise specified, the reservoir heat loss during heating shall be determined based on an uninsulated reservoir, the minimum site ambient temperature, and a 16 kmph (10 mph) wind. The vendor shall provide data to support this.

Note: Electric immersion heaters should be interlocked by the purchaser to be de-energized when the oil level drops below the minimum operating level.

**1.3.7.2.2.1** Electric immersion heaters shall be installed in a manner which allows the heaters to be removed during operation. They shall be top- or side-mounted and installed vertically, on an angle, or horizontally. If oil-filled tubes with vented expansion chambers are used, the oil inside the tubes shall be the same as in the reservoir and its temperature maintained at a minimum of 10°K (18°F) below its flash point.

Note: In all installations, but especially if top-mounted vertical or angle heaters are used, the heater element shall be located below the pump suction loss level.

### • 1.3.8 Provision for Insulation

When specified by the purchaser, reservoirs shall be fitted with insulation clips. The purchaser will furnish and install the insulation.

### 1.3.9 Plugged Connections

Above the rundown oil level, each reservoir shall be provided with two threaded and plugged connections that are at least 25 mm (1 in.) in size. These two connections may be used for such services as purge gas, makeup oil supply, and oil conditioner return. One connection shall be located to ensure an effective sweep of purge gas toward the vents.

### 1.3.10 Provision for Oil Conditioner

**1.3.10.1** Unless otherwise specified, the vendor shall provide below the minimum operating level a 25 mm (1 in.) flanged, valved, and blinded connection (see Figure 2A-21) that will be used to supply an oil conditioner.

**1.3.10.2** The vendor shall also provide inside the reservoir a pipe loop with a siphon breaker hole at the top which has a maximum diameter of 6 mm ( $1/4$  in.). This pipe loop shall prevent the oil level from falling more than 50 mm (2 in.) below the minimum operating level due to the action of the conditioner.

### 1.3.11 Welds

Joints, pads, and connections shall be both internally and externally welded to eliminate cavities, potential sources of corrosion, and contamination. The reservoir's wall-to-top junctions may be welded from the outside if a full-penetration weld is used. All welds shall be continuous. Internal joints shall be made smooth by grinding or other suitable means as necessary to eliminate pockets and provide an unbroken finish.

### 1.3.12 Special Features

Reservoir tops shall be provided with the following:

- **1.3.12.1** When specified, an accessible ladder with extended handrails.
- **1.3.12.2** When specified, handrails around the perimeter of the reservoir top.
- **1.3.12.3** When specified, nonskid surfaces decking (checker or diamond plate or hot-dipped galvanized steel grating).
- **1.3.12.4** For equipment mounted on the reservoir, the reservoir shall provide sufficient structural stiffness to properly support the equipment (see 1.3.2.1.1).

### 1.3.13 Materials

Unless otherwise specified, reservoirs and all appendages welded to reservoirs shall be fabricated from Series 300 stainless steel in accordance with ASTM A 240. Pipe connections shall be as specified in 2.1.

Note: Carbon steel appendages such as ladders and handrails may be bolted to clips welded to the reservoir.

### 1.3.14 Grounding

Two grounding clips or pads diagonally opposed to each other (see Figure 2A-21) shall be welded to the reservoir. The pads shall accommodate a 13 mm ( $1/2$  in. UNC) bolt.

## 1.4 PUMPS AND DRIVERS

- **1.4.1** The oil system shall include a main oil pump and a standby oil pump. The main and standby pumps shall be identical and suitable for continuous operation. The purchaser will specify whether horizontal centrifugal or rotary pumps shall be used. Except as modified in this standard, pumps shall conform to API Std 610 or 676, respectively.

**1.4.2** Unless otherwise specified, pumps shall be external to the reservoir.

Note: Chapter 3 provides guidance on material and structural requirements in cases where the purchaser allows the use of submerged pumps.

- **1.4.3** When specified, an emergency oil pump shall be furnished to allow safe shutdown without damage to the equipment in the event that both the main and standby pumps fail. The purchaser will define the requirements for safe shutdown.

**1.4.4** Unless otherwise specified, oil pumps not submerged inside the reservoir shall be equipped with mechanical seals that have carbon rings with mating tungsten or silicon carbide rings; Viton gaskets and O-rings; and end plates with throttle bushings as outlined in API Std 610.

- **1.4.5** The purchaser will specify if the main oil pump will be turbine or motor driven.

Note: It is recommended that the purchaser supply electric feeds from independent sources when two motor driven pumps are used.

Note: Standby pumps are always motor-driven because of relatively long start-up times for turbine-driven pumps.

**1.4.6** Each pump shall have its own driver.

**1.4.7** Shaft-driven pumps may be provided only if approved by the purchaser.

**1.4.8** Motors shall comply with IEEE 841-1994.

**1.4.9** Steam turbines shall conform to API Std 611.

**1.4.10** The minimum criteria provided in 1.4.10.1 through 1.4.10.4 shall be used when sizing pumps.

**1.4.10.1** In all cases, pumps shall be sized to deliver the required capacity when pumping lube oil at the highest temperature and the corresponding minimum viscosity.

**1.4.10.2** Each pump shall be capable of:

- a. Supplying the normal oil flow required by the equipment plus the greater of 20 percent of the normal oil flow or 40 l/min (10 gal/min).
- b. Transient oil requirements.
- c. The equipment vendor's allowance for normal wear.

Accumulators may be provided to meet transient control oil requirements, if approved by the purchaser. Accumulators

shall be sized according to 1.8.1. Equipment supplier shall define all transient conditions.

**1.4.10.3** In booster systems, the capacity of the main pump as established in 1.4.10.1 shall be increased by the amount required to supply both the main and stand-by booster oil pumps simultaneously.

**1.4.10.4** Rotary pumps shall be capable of passing the total flow, as established in 1.4.10.1 and 1.4.10.2, at the relief valve set pressure while not exceeding 90 percent of the pump manufacturer's maximum differential pressure rating at the minimum operating viscosity. The pump must also be capable of operating continuously at the normal flow, relief valve set pressure, and minimum operating viscosity.

Note: This selection criterion is required to avoid pump rotor contact during operation under extreme conditions.

**1.4.11** The normal operating capacity of the centrifugal pumps shall be within 50 to 110 percent of their best efficiency point. From their normal operating point to shutoff, centrifugal pumps shall have a continuous rise in head of at least 5 percent and, with the installation of a new impeller, shall be capable of a future increase in head of at least 10 percent.

**1.4.12** Pump drivers shall be sized according to which of the following requires the larger driver:

- a. The applicable API pump standard.
- b. The conditions shown in 1.4.12.1 and 1.4.12.2.

Motor drivers for centrifugal pumps shall have a power rating which covers the "end-of-curve" requirements of the supplied impeller with a minimum nameplate rating of 1.0 kW (1.0 HP).

**1.4.12.1** Centrifugal pumps shall deliver the specified system pressure over the pump's stable flow range when the temperature of the pumped oil is 10°C (50°F).

**1.4.12.2** Rotary pumps shall be capable of operating at the specified pump relief valve setting (including accumulation) when the temperature of the pumped oil is 10°C (50°F).

- **1.4.12.3** Purchaser will specify the minimum inlet steam temperature and pressure and the highest exhaust pressure under which the turbine is expected to operate.

**1.4.13** Check valves shall be provided on each pump discharge to prevent the flow of oil backwards through a stand-by or idling pump.

**1.4.14** For rotary pump systems, the vendor shall furnish external oil-pressure limiting valves that shall be installed on the components or in the piping supplied by the vendor. Oil-pressure limiting valve settings, including an allowance for no more than 10 percent accumulation, shall be determined after all of the possible equipment and component failures are

considered. The settings shall protect the oil system components and piping. Fully accumulated pressure shall not exceed 110 percent of the design pressure.

**1.4.15** Oil-pressure limiting valves shall be pressure-modulating devices (as opposed to snap-acting or pop-type safety relief valves) with a pressure increase proportional to flow above the valve cracking pressure (i.e., the pressure at which the valve begins to open). These devices shall be mounted external to the reservoir and shall operate smoothly, without chattering and without causing a drop in supply pressure to the equipment. Pressure limiting valve piping shall be sized for the full flow of each pump; the valves shall not chatter, and the piping shall not vibrate. The minimum-pressure limiting valve cracking pressure shall be 10 percent or 1.7 bar (25 psi) higher than the highest required operating pressure, whichever is greater. To avoid unnecessary delay in opening, pressure limiting valves shall be located as close to the oil pump discharge as possible at an elevation as near to or below the minimum operating level as possible. Pressure limiting valves shall not be used for continuous pressure regulation.

Note: For high-pressure applications (typically above 55 bar or 800 psig), where pressure modulating valves cannot be provided, provisions for venting or otherwise relieving pumps may be required.

**1.4.16** The oil system shall be provided with pressure-regulating devices that prevent fluctuation of the oil pressure to the equipment when both the main and the standby pump are in operation or when either the main or the standby pump is in operation and the other pump is started, brought up to operating speed, or stopped. Each device shall have an adequate response time and shall operate smoothly in a stable manner without chattering, or producing pressure or flow transients that can cause the equipment to shut down (see 4.3.3.5). These pressure-regulating devices shall be located so that an excessive rise in oil temperature resulting from a recirculation of uncooled oil is avoided (e.g., see Figure 2A-10, Note 7).

Note: Bypass pressure regulating valves shall be sized to cover a range from the maximum usage of one pump to the minimum usage of two pumps.

**1.4.16.1** System back-pressure regulating valves shall be sized to pass the excess flow when one and/or both pumps are in operation.

**1.4.17** All pumps (except booster pumps) shall be installed with flooded suctions to ensure self-priming; and shall be installed with suction block valves and discharge block and check valves. Vertically-mounted pumps shall be continuously vented to assure the entire pump remains flooded. Suction piping shall be continuously vented or arranged to avoid pockets where air can accumulate or become trapped. Each pump shall have a separate suction line from the reservoir. The pump suction lines shall be designed to avoid excessive piping loads on the pump casing flanges (see API RP 686,

Chapter 6). Designs for suction piping, suction block valves, pump casings, and all other components (particularly those for booster pump arrangements) shall avoid the possibility of overpressure caused by leaking discharge check valves.

**1.4.18** For the protection of centrifugal pumps during flushing and for the initial operation of new oil systems, a removable strainer that is made from ASTM Series 300 stainless steel and has an open flow area equal to 150 percent of the cross-sectional area of the suction pipe shall be installed in the suction piping of each pump between the pump suction flange and the block valve. The temporary strainer shall be identified by a protruding tab and shall have a mesh size adequate to stop all objects that would be injurious to the pump. The piping arrangement shall permit the removal of the strainer without disturbing the alignment of the pump.

Note: Strainer can be cone, basket, or Y-type.

**1.4.19** Unless otherwise specified, for rotary pumps, a permanent Y-type strainer with an ASTM Series 300 stainless steel basket that has an open flow area equal to 150 percent of the cross-sectional area of the suction pipe shall be installed in the suction piping of each pump. The strainer shall have a mesh size capable of stopping all objects that would be injurious to the pump.

- **1.4.19.1** When specified, a basket-type strainer shall be provided.

**1.4.20** Strainers are not required for booster pumps that are located downstream of primary filters.

**1.4.21** Unless otherwise specified, when a permanent strainer is being used, a compound-type pressure gauge shall be installed between it and the pump suction. The gauge shall be scaled properly to detect a fouled strainer.

**1.4.22** To maintain satisfactory system operation when the main pump fails to meet system requirements, the vendor shall furnish the primary element for the purchaser's start-up control for the standby oil pump. The start-up control of the standby pump shall be actuated by devices that sense low supply pressure to the equipment or low oil levels in the overhead seal oil tanks. Motor control centers will be provided by the purchaser. The control system shall have a manual reset. (See 6.1.6 and 6.1.7, Chapter 1, for instrumentation that allows the operation of the standby oil pump controls to be checked while the main pump is in operation; see Table 1 for a description of the start switch for the standby oil pump motor.)

**1.4.23** For each system requiring booster pumps, the supply of low-pressure oil shall be sufficient for simultaneous operation of both the main and the standby high-pressure booster pumps. The vendor shall provide a device to alarm or to trip the booster pumps on low pressure.

**1.4.24** Removable coupling guards shall be furnished.

**1.4.24.1** Unless otherwise specified, flexible-element couplings shall be used. Coupling hubs shall be made of steel. Metallic flexible element types shall have elements of corrosion-resistant material. A spacer coupling shall be used unless otherwise specified. The spacer shall have a nominal length of at least 125 mm (5 in.) minimum or as required to remove coupling, bearings, seal, and rotor as applicable, without disturbing the driver or the suction and discharge piping.

**1.4.24.2** Couplings shall be keyed in place. Information on shafts, keyway dimensions, and shaft end movements because of end play and thermal effects shall be furnished to the vendor supplying the coupling.

**1.4.24.3** Couplings and coupling-to-shaft junctures shall be rated for at least the maximum driver power (including any motor service factor).

**1.4.24.4** To assure that the connected machinery is accurately aligned, the total indicator reading of coupling registration and alignment surfaces shall be controlled within specific limits. For all pumps, the coupling surfaces normally used for checking alignment shall be concentric with the axis of coupling hub rotation within the following limits: 13  $\mu\text{m}$  (0.0005 in.) total diameter, with a minimum applicable tolerance of 25  $\mu\text{m}$  (0.001 in.) total indicator reading and a maximum of 75  $\mu\text{m}$  (0.003 in.) total indicator reading. All other diameters not used for location, registration, or alignment shall be to the coupling manufacturer's standard, provided balance requirements are met.

**1.4.25** Mounting plates shall be provided as specified in 1.4.25.1 through 1.4.25.6.

**1.4.25.1** Mounting pads shall be provided for each pump and its driver. Pads shall be larger than the feet of the mounted equipment to allow for leveling of the console or package 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  $\mu\text{m}/\text{m}$  (0.002 in./ft) of distance between the pads.

Note: 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. This tolerance shall be met at the time of assembly at the vendor's shop between coupled rotating pieces of equipment. The coupled pieces shall be capable of being aligned in the field when properly installed per API RP 686.

**1.4.25.2** Pumps and drivers shall be mounted on a machined surface. All pads for oil pumps and drivers shall be machined to allow for the installation of stainless steel shims; shims packs, at least 3 mm ( $1/8$  in.) thick, shall be placed under the feet of each component.

**1.4.25.3** To minimize misalignment of the pump and driver shafts due to piping load effects, the pump and its baseplate shall be constructed with sufficient structural stiffness to limit total misalignment to the values specified in 1.4.24.4.

**1.4.25.4** When the pump and driver are mounted on the console without a separate sub-base, the pump and driver shall be mounted to a structural support.

- **1.4.25.5** When specified, the vendor, by bolting and unbolting piping, shall demonstrate that the pump on its baseplate is in compliance with 1.4.24.4.

**1.4.25.6** Transverse alignment positioning jackscrews shall be provided for each driver that weighs more than 200 kg (450 lb). Axial alignment positioning jackscrews shall be provided for each driver weighing more than 400 kg (900 lb). 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. Alignment positioning screws shall be at least the same size as the jackscrews furnished with each component.

## 1.5 COOLERS

**1.5.1** Twin coolers shall be provided and shall be piped in a parallel arrangement using a continuous-flow transfer valve (see 1.7).

**1.5.1.1** Unless otherwise specified coolers shall be shell and tube type and shall be in accordance with the requirements of paragraphs 1.5.3.1 through 1.5.3.4.

- **1.5.1.2** When specified, a plate frame or fin fan cooler shall be supplied. The vendor shall include in the proposal complete details of any proposed air-cooled or plate frame cooler. (See 1.5.3.5.)
- **1.5.1.3** When specified, the vendor shall supply connections for installation of the purchaser's fin fan oil cooler(s) off the oil console. (See 1.5.3.6.)
  - 1.5.1.3.1** The vendor shall supply all relevant data such as heat load and oil flow.
  - 1.5.1.3.2** Pressure-drop criteria for the oil side shall be mutually agreed on between the vendor and purchaser.
  - 1.5.1.4** For twin cooler arrangements where the coolers are in accordance with paragraph 1.1.18, the vendor shall provide provision for thermal over-pressure protection of the oil side of the coolers (see 3.2.8.3).
  - **1.5.1.5** The purchaser may specify the equalization/fill valve be locked or car sealed in the open position with the equalization/fill line orifice sized by the vendor for thermal expansion.

**1.5.2** A cooling water system or systems shall be designed for the following conditions:

- Velocity over heat exchange surfaces: 1.5 to 2.5 m/s (5 to 8 ft/s).
- Maximum allowable working pressure:  $\geq 6.9$  barg ( $\geq 100$  psig).
- Test pressure:  $\geq 1.5 \times$  MAWP, 10.4 barg ( $\geq 150$  psig).
- Maximum pressure drop: 1 bar (15 psi).
- Maximum inlet temperature: 30°C (90°F).
- Maximum outlet temperature: 50°C (120°F).
- Maximum temperature rise: 20K (30°F).
- Minimum temperature rise: 10K (20°F).
- Fouling factor on water side:  $0.35 \text{ m}^2 \cdot \text{K}/\text{kW}$  ( $0.002 \text{ hr-ft}^2 \cdot \text{°F}/\text{Btu}$ ).
- Shell corrosion allowance: 3 mm (0.125 in.).

Provision shall be made for complete venting and draining of the system or systems.

Note: The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchange surfaces result in a conflict. The criterion for velocity over heat exchange surfaces is intended to minimize water-side fouling; the criterion for minimum temperature rise is intended to minimize the use of cooling water. The purchaser will approve the final selection.

**1.5.3** Oil coolers shall have the following characteristics as outlined in 1.5.3.1 through 1.5.3.5.

**1.5.3.1** Each oil cooler shall maintain the lube-oil supply temperature at or below 50°C (120°F).

**1.5.3.2** Each cooler shall be sized to accommodate the total cooling load.

**1.5.3.3** Oil coolers shall not be located inside the reservoir.

**1.5.3.4** In addition to the requirements of 1.5.3.1 through 1.5.3.3, shell-and-tube coolers shall be in accordance with 1.5.3.4.1 through 1.5.3.4.7.

**1.5.3.4.1** Unless otherwise specified, a removable-bundle design is required for shell-and-tube coolers with more than  $0.5 \text{ m}^2$  ( $5 \text{ ft}^2$ ).

**1.5.3.4.2** Removable-bundle coolers shall comply with the applicable heat exchanger code in Appendix A, Chapter 1.

**1.5.3.4.3** Coolers shall be constructed with a removable channel cover.

**1.5.3.4.4** Tubes shall have an outside diameter of at least 16 mm ( $\frac{5}{8}$  in.) and the tube wall thickness shall be at least 1.22 mm [18 Birmingham wire gage (BWG) 0.048 in.].

**1.5.3.4.5** Water shall be on the tube side of the coolers. Alternative designs may be offered for high-pressure oil coolers [pressures greater than 30 bar (500 psig)].

**1.5.3.4.6** The oil-side operating pressure shall be higher than the water-side operating pressure.

Note: This is to prevent the oil from being contaminated if a cooler fails.

**1.5.3.4.7** Unless otherwise specified, fin tubes or extended surface tubes shall not be used.

**1.5.3.5** When specified, and in addition to the requirements of 1.5.3.1 through 1.5.3.3, multiplate type coolers shall be in accordance with 1.5.3.5.1 and 1.5.3.5.2.

**1.5.3.5.1** Unless otherwise specified, multiplate coolers shall have plates of austenitic stainless steel for fresh water cooling or titanium for brackish or salt water.

**1.5.3.5.2** The oil-side operating pressure shall be higher than the water-side operating pressure.

Note: This is to prevent the oil from being contaminated if a cooler fails.

**1.5.3.6** When specified, and in addition to the requirements of 1.5.3.1 through 1.5.3.3, air-to-oil heat exchangers (fin fan type) shall be comply with 1.5.3.6.1 and 1.5.3.6.6.

**1.5.3.6.1** The cooler shall be provided with two fans. Each fan shall be capable of 100 percent of the duty requirement.

**1.5.3.6.2** When specified, the cooler tubes shall be Series 300 stainless steel. The header boxes shall be made of hardened stainless steel plate, The header plug material shall be selected to prevent galling.

**1.5.3.6.3** Two separate headers shall be provided for each cooler.

**1.5.3.6.4** Electronic vibration switches shall be provided for each fan and shall alarm on high vibration.

**1.5.3.6.5** High Torque Drive (HTD) drive belts are required, and shall be static conducting.

**1.5.3.6.6** Turbulence promoters may only be used with purchaser approval. When supplied, turbulence promoters shall be Series 300 stainless steel.

**1.5.4** U-bend tubes are permitted only when approved by the purchaser.

**1.5.5** Unless otherwise specified, cooler shells, channels, and covers shall be made of steel; tube sheets shall be made of naval brass; and tubes shall be made of inhibited admiralty.

Note: High-pressure oil coolers may require steel tubes and tubesheets.

**1.5.6** Unless otherwise specified, an oil bypass line around the cooler with a temperature control valve shall be included to regulate the oil supply temperature. This includes oil systems where the purchaser supplies the cooler. In no case,

however, shall oil bypass the filter. The control valve shall comply with 1.5.6.1 through 1.5.6.4.

Note: When fouling or freezing of the water side of a cooler is a factor, and oil temperature is regulated by adjusting water flow through the cooler, it is possible for the cooler water side to silt up or freeze and break at low water flow rates.

**1.5.6.1** Unless otherwise specified, the oil bypass valve shall be a flanged and pneumatically operated (air-to-open fail-close), two-port or three-port temperature control valve. Failure of the control valve shall cause all the oil to pass through the cooler.

- **1.5.6.2** When specified, the temperature control valve shall be an internal thermostat operated three-port valve.

**1.5.6.3** The temperature control valve shall be provided with a manual override that permits operation independent of temperature conditions.

**1.5.6.4** The temperature control valve shall be sized to handle all oil flow passing through the cooler with a pressure drop equal to or less than the pressure drop through the cooler.

**1.5.7** The maximum allowable working pressure for coolers shall not be less than the maximum operating pressure of the system, less than the pressure limiting valve setting for the positive displacement pumps, or less than the maximum discharge pressure (at the trip speed for the turbine drive) for the centrifugal pumps.

- **1.5.7.1** When specified by the purchaser, shell-and-tube or plate frame coolers shall be suitable for use of a 150°C (300°F) heating medium, such as steam or a mixture of steam and water.

**1.5.8** Both the water side and the oil side of the cooler shall be self-venting and self-draining or shall be completely drainable (provided with valved vent/drain connections).

- **1.5.8.1** When specified, duplex cooler oil drains shall be manifolded together with duplex filter clean side oil drains.
- **1.5.8.2** When specified, vents on the oil side shall be piped back to the reservoir through flow indicators.
- **1.5.8.3** When specified, the coolers shall be fabricated with flanged vent and drain nozzles. Screwed and seal-welded, or socket-welded pipe and flange additions to coolers after cooler certification is not acceptable.

## 1.6 FILTERS

**1.6.1** Twin full-flow filters with replaceable elements or cartridges shall be provided. Filters shall provide a minimum particle removal efficiency (PRE) of 90 percent for 10 micron particles ( $\beta_{10} \geq 10$ ) and a minimum PRE of 99.5 percent for 15 micron particles ( $\beta_{15} \geq 200$ ), both per ISO 4572 when

tested to a minimum terminal (end of test run) differential pressure of 3.5 bar (50 PSID). Filter installations shall comply with 1.6.1.1 through 1.6.1.7.

Note: See Appendix E of Chapter 1 for additional information concerning filter ratings.

**1.6.1.1** The filters shall be located downstream of the coolers.

**1.6.1.2** The filters shall be piped in a parallel arrangement using a continuous-flow transfer valve (see 1.7).

**1.6.1.3** Filter cases and heads shall be suitable for operation at the maximum discharge pressure (at the trip speed for turbine drives) of centrifugal pumps or at a pressure not less than the pressure limiting device setting of positive displacement pumps.

**1.6.1.4** Filters that have covers weighing more than 15 kg (35 lb) shall have cover lifters.

**1.6.1.5** The filters shall not be equipped with differential pressure limiting valves or other valves, which can cause bypass of unfiltered (dirty) oil around the filter elements.

**1.6.1.6** The filters shall be equipped with valved vents and clean- and dirty-side valved drain connections. The dirty-side connections shall be located lower in the housing than the filter elements or cartridge support bases.

**1.6.1.7** For duplex filter arrangements where the filters are in accordance with 1.1.18, the vendor shall provide provision for thermal overpressure protection of the off-line filter (see 3.2.8.3).

- **1.6.1.8** The purchaser may specify the equalization/fill valve be locked or car sealed in the open position with the equalization/fill line orifice thermal sized by the vendor.
- **1.6.1.9** When specified, duplex oil filter clean side oil drains shall be manifolded together with duplex cooler drains.
- **1.6.1.10** When specified, the filter vents shall be piped back to the oil reservoir through flow indicators.

**1.6.2** Oil filter design shall incorporate the features listed in 1.6.2.1 through 1.6.2.9.

**1.6.2.1** Oil flow from the outside inward toward the center of the filter element.

**1.6.2.2** Adequate support of the filter elements to prevent them from rupturing or to prevent unfiltered (dirty) oil from bypassing the elements and reaching the equipment.

**1.6.2.3** Center posts and other removable hardware in contact with filtered oil shall be made of stainless steel.

**1.6.2.4** The maximum number of filter cartridges in one stack is 2.

**1.6.2.5** If the cartridge-to-cartridge joint is not self-aligning, a collar shall be used between the stacked cartridges to ensure alignment.

**1.6.2.6** The maximum length of a filter or filters in one stack is 1 m (3 ft).

**1.6.2.7** Stacked cartridges shall have adequate support and maintainable alignment.

**1.6.2.8** The ability to completely drain oil from the filter housing while avoiding contamination of the downstream (clean) side with unfiltered (dirty) oil during replacement of the filter elements.

**1.6.2.9** Consideration of the use of guard elements to capture debris (such as filter element fibers) if filter element deterioration or failure occurs.

**1.6.3** Alternate designs (for example, those incorporating the flow of oil from the center towards the outside of the filter element) may be used if specifically approved.

**1.6.4** Filter cartridge materials shall be water and corrosion resistant.

**1.6.4.1** Water-resistant filter cartridges shall not deteriorate if water contamination in the oil reaches 5% by volume and an operating temperature as high as 70°C (160°F).

- **1.6.4.2** When specified, filter element media shall be non-hygroscopic. If water contamination in the oil reaches 5% for extended time periods (up to 3 months), clean filter cartridges shall not have more than two times the clean filter pressure drop at rated oil viscosity, flow, and temperature.
- **1.6.4.3** When a specific filter element or cartridge is required, the purchaser will completely specify the make, model number, and type of construction.

**1.6.4.4** Metal mesh or stainless metal filter elements are not acceptable.

**1.6.5** The pressure drop for clean filter elements or cartridges shall not exceed 30 kPa (5 psi) at an operating temperature of 40°C (100°F) and normal flow.

Note: Pressure drop across the total filter system may exceed these values by the amount of pressure drop across the transfer valve and other filter system components.

Note: The 30 kPa drop (5 psi) mentioned above is the difference between the drop across the filter housing with no elements installed, and the drop across the filter housing with clean elements installed.

**1.6.6** Elements or cartridges shall have a minimum collapsing differential pressure of 500 kPa (70 psi).

**1.6.7** When the tops of filter housing covers are more than 1.2 m (4 ft) above the console base, the vendor shall provide a step to facilitate their maintenance.

**1.6.8** Systems with booster pumps shall be provided with twin filters rated at 10 microns or finer filters shall be 90 percent ( $\beta_{10} = 10$ ) or better efficient at the micron rating.

**1.6.8.1** Filters shall be piped in a parallel arrangement using a continuous-flow transfer valve.

**1.6.8.2** Filters shall be located downstream of the booster pumps to protect the equipment from damage caused by products of pump deterioration.

**1.6.9** Control oil filtration requirements are listed in 1.6.9.1 through 1.6.9.3.

**1.6.9.1** Unless otherwise specified, control oil shall be filtered to 10 microns or finer. Filters shall be 90 percent ( $\beta_{10} = 10$ ) or better efficient at the micron rating.

**1.6.9.2** When control oil is filtered separately from the main oil stream, twin filters with replaceable elements or cartridges shall be provided and shall be piped in a parallel arrangement using a continuous-flow transfer valve.

**1.6.9.3** The filter shall not be equipped with differential pressure limiting valves or other valves that can cause bypass of unfiltered (dirty) oil around the filter elements.

## 1.7 TRANSFER VALVES

**1.7.1** Unless otherwise specified, the vendor shall supply individual transfer valves independently serving each cooler and filter set.

- **1.7.1.1** The purchaser may specify when the flow will be switched between coolers and filters via a single transfer valve serving coolers and filters (see Figure 2A-18).

**1.7.2** Transfer valves shall be two-way, six-ported continuous-flow valves. A single-body, six-port taper or a straight-plug valve may be used, or two three-way plug or ball valves permanently aligned and joined with a single operating lever may be used.

**1.7.2.1** Tapered plug-type valves shall have provisions for plug lifting.

**1.7.2.2** Valves shall be designed so that if the internal valve mechanisms fail, both flow paths will not be blocked.

**1.7.2.3** Valves and assemblies shall be designed to prevent incorrect assembly.

**1.7.3** Transfer valves shall have steel bodies. Valve stems and valve plugs or balls shall be made of stainless steel.

**1.7.4** When approved, transfer valves with positively retained resilient seats may be used.

- **1.7.5** Spectacle blinds shall be provided if specified or if required to assure tight shutoff.

Note: Transfer valves are not intended to be used as tight shut-off devices for the maintenance of filters and coolers (see 4.3.3.6).

## 1.8 ACCUMULATORS

**1.8.1** An accumulator shall be provided if it is needed to maintain the turbine control-oil pressure during servo-control transients or to maintain lube- or seal-oil pressure while the stand-by pump accelerates from an idle condition to operating speed. The control pressure shall be maintained above the equipment manufacturer's minimum specified, supply pressure at all operating conditions (including transients). Typically, this will be within 10 percent of the normal system pressure when a servomotor makes a full stroke in 1 second.

**1.8.2** The system delivery pressure shall be maintained above the shut-down switch settings during standby pump acceleration or for at least 4 seconds for motor-driven pumps (see 4.3.3.5.5).

**1.8.3** Unless otherwise specified, accumulator vessels shall be made of Series 300 stainless steel.

- **1.8.4** A manual precharge valve or a constant-pressure regulating system shall be furnished as specified by the purchaser (see Figures 2A-16).

**1.8.5** If a direct-contact-type accumulator is used, it shall be equipped with an armored reflex-type gauge glass that extends from 25 mm (1 in.) above the maximum operating level to not less than 25 mm (1 in.) below the minimum operating level. The glass shall show the oil level when the vessel is precharged at the controlled normal operating pressure.

Note: Purchaser may want to give consideration to a nonglass level-indicating device.

**1.8.6** A connection for a pressure gauge shall be provided for checking the precharge pressure in the accumulator.

**1.8.7** The physical location and piping arrangement of the accumulator shall avoid pockets in which foreign materials or air could accumulate.

- **1.8.8** When specified by the purchaser, the accumulator shall be equipped to maintain the contained oil at the required system oil temperature. The purchaser shall provide the details of the required temperature control system.

**1.8.9** Unless otherwise specified, accumulators provided with a constant-pressure regulating system for pump switch-over or other purposes shall automatically vent and automatically reset.

**1.8.10** Accumulator designs shall not allow precharge gas to be delivered with the oil to the equipment or to impair the oil flow to the equipment.



**1.8.11** Accumulators shall be isolated (e.g., by a check valve; see Figure 2A-10) from the standby oil pump start controls to eliminate delay in the actuation of the starting signal.

## 1.9 OVERHEAD TANKS

### 1.9.1 Seal-Oil Tanks

**1.9.1.1** Separately mounted or equipment-mounted overhead tanks shall be provided when they are required by the designs of the seals and the seal-oil control systems. Unless otherwise specified, the tanks shall be made of Series 300 stainless steel.

- **1.9.1.2** Each overhead seal-oil tank (see Figure 2-2) shall be sized so that the oil capacity above the low-level alarm setting is equal to a 2-minute flow at normal seal-oil rates, and each tank shall have the capacity for a 10-minute flow from low-level alarm to low-low-level shutdown, plus sufficient time (as specified by the purchaser but not less than 3 minutes at normal flow rates after shut down) for coast-down, block-in, and depressurization of the equipment. Larger tanks may be required for special operating conditions, such as rapid depressurization of high-pressure equipment. The vapor column above the high-level alarm setting shall be no less than 1 minute of normal flow.

Note: The purchaser and the manufacturer together must determine the required capacity after trip based on the compressor block-in and blowdown and the seal-oil flow rate at various conditions.

**1.9.1.3** Overhead seal-oil tanks shall be designed in accordance with Section VIII of the ASME Code or the equivalent code per Appendix A of Chapter 1, and shall be code-stamped.

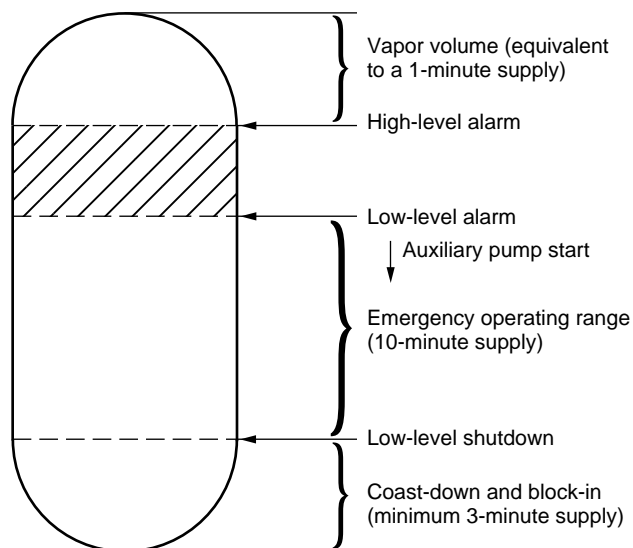


Figure 2-2—Overhead Seal-Oil Tank

**1.9.1.4** Overhead seal-oil tanks shall be provided in accordance with 1.9.1.4.1 through 1.9.1.4.6

**1.9.1.4.1** One bottom outlet nozzle at least DN 150 (6 in.) in size which shall not extend inside the vessel. This nozzle shall be used for internal access and inspection.

**1.9.1.4.2** One reference gas connection at least DN 25 (1 in.) in size.

**1.9.1.4.3** A full-length reflex-type level glass that extends from 25 mm (1 in.) above the high-level alarm to 25 mm (1 in.) below the low-level shutdown.

**1.9.1.4.4** One DN 150 by DN 50 (6 in. x 2 in.) in size flanged reducing spacer that is 450 mm (18 in.) long and is fitted to the bottom outlet connection.

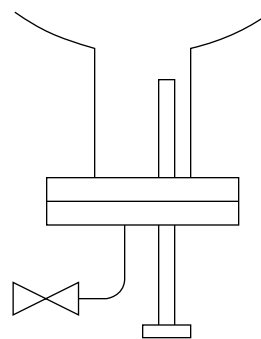
- **1.9.1.4.5** When specified by the purchaser, e.g., for dirty, sludge building gas service, the reducing spacer shall project into the bottom nozzle, and a valved blow-down connection shall be provided (see Figure 2-3). The nozzle shall be at least 200 mm (8 in.) long.

**1.9.1.4.6** A level transmitter externally mounted to the tank and provided with isolation valves, a vent connection, and a valved drain.

**1.9.1.5** When specified, the reference gas shall be isolated from the seal oil by a bladder of material suitable for the service (see Figure 2A-14).

### 1.9.2 Lube-Oil Rundown Tanks

- **1.9.2.1** When specified, a separately mounted emergency lube-oil rundown tank (either atmospheric or pressurized)



Note: The presence of free water, dirt, and dissolved gases in lubrication, control, and seal oil can contribute to accelerated wear, corrosion, sludge formation, and sticking of hydraulic controls. Dilution or contamination of compressor seal oil by hydrocarbons, hydrogen sulfide, and other contaminants also causes a reduction in viscosity and flashpoint. Oil condition maintenance procedures and equipment should be considered during project planning.

Figure 2-3—Blowdown Connection

shall provide oil for the coast-down period specified by the purchaser, but this coast-down period shall not be less than 3 minutes of normal lube-oil flow (see Figures 2A-13a and 2A-13b). Unless otherwise specified, the tank shall be made of Series 300 stainless steel.

Note: Coast-down time to be provided by the purchaser.

**1.9.2.2** A rundown tank shall be provided with a sight flow glass in the tank overflow line. DN 150 (6 in.) in size nozzle for accessing and inspecting the interior of the rundown tank shall be provided. The vendor shall specify the allowable minimum and maximum height of the bottom outlet nozzle above the machine centerline; the maximum static head shall be less than the lube-oil trip pressure but not less than 30 kPa (5 psig) at the beginning of coast-down.

**1.9.2.3** When an atmospheric rundown tank is provided per Figure 2A-13a, it shall be provided with a low-level alarm device and a high-level permissive start device.

**1.9.2.4** A pressurized tank shall be designed in accordance with Section VIII of the ASME Code or the equivalent code per Appendix A of Chapter 1 of this standard and shall be code-stamped.

## 1.10 SEAL-OIL DRAIN TRAPS

**1.10.1** One drain trap per seal shall be provided. An emergency line and valve shall be provided to cross-connect trap inlets and permit trap maintenance where seals operate at the same oil-sealing pressure (see Figure 2A-12).

**1.10.1.1** Drainer bypass orifices shall be a minimum of 1½ mm (1/16 in.).

**1.10.1.2** Automatic seal traps are required. For gas pressures less than or equal to 50 bar (725 psig), mechanical float-type traps are permitted. The float and trim shall be the single-lever, stainless steel design and arranged so that the gas flow does not impinge on the float or float mechanisms.

Note: Level transmitter control-type traps should be used when gas fouling would interfere with the operation of mechanical float-type traps.

**1.10.1.3** For pressures greater than 50 bar (725 psig), snap-acting level transmitter/controllers and separate control valves shall be used.

**1.10.1.4** Drain traps shall be pre-piped and mounted in a package arrangement. All appurtenances shall be located within the confines of the package base. Manually-operated drain valves shall be provided on each trap.

**1.10.2** Traps shall be furnished with reflex-type gauge glasses. The inlet piping shall enter the seal traps above the oil level of the traps.

Note: Special consideration to level device should be considered at higher pressure applications.

- **1.10.3** When specified, seal-trap vents shall be equipped with mist eliminators (with appropriate connections) to agglomerate the residual oil before the vent gas is recycled to the compressor suction or vented to other disposal outlets. Mist eliminators shall be self-draining or be provided with separate, automatic drain traps.

- **1.10.4** The seal gas vent piping arrangement shall be jointly developed by the purchaser and the vendor.

Note: The arrangement of seal-gas vent piping is important to the proper function of the compressor shaft seals.

- **1.10.5** As specified by the purchaser, the drain line for each trap shall be piped separately to the sewer, degassing drain, or reservoir.

Note: Separate piping of the drain lines allows the leakage from each seal to be monitored.

## 1.11 DEGASSING DRUM

Refer to 1.11.2 for definition.

- **1.11.1** When specified by the purchaser, seal-oil degassing facilities shall be provided. Unless otherwise specified, the tank and internals shall be made of Series 300 stainless steel.

**1.11.2** The degassing drum shall be a single-chamber tank (see Figure 2-4) provided with the following features:

a. A sloped inlet tray, extending below the operating level, which ensures that the oil enters the tank in a thin layer.

Note: Having the oil enter in a thin layer facilitates degassing.

b. An oversized gas vent connection to handle the gas flow from the seals through the oil drains. The size of the connection shall be at least DN 50 (NPS 2) and flanged. The purchaser will pipe the vented gas to a safe location.

c. A purge connection with a minimum size of DN 25 (NPS 1).

d. A clean-out opening and a valved low-point drain.

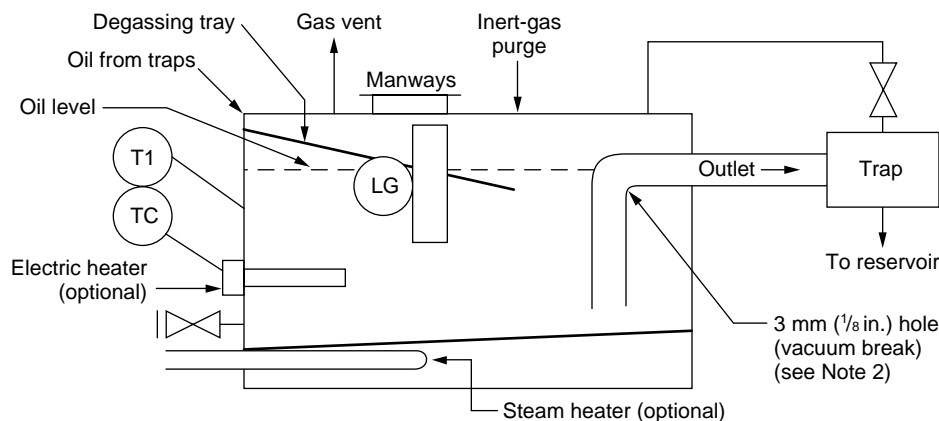
e. A weld-pad reflex level glass extending a minimum of 50 mm (2 in.) above and 50 mm (2 in.) below the operating level.

f. A temperature indicator with a thermowell.

g. A level device with high alarm.

- **1.11.3** When specified by the purchaser, an electric immersion heater, steam heater, or some other method of heating shall be provided to assist in degassing the oil. If a steam heater is used, it shall be external to the drum and shall be removable. If an electric immersion heater is used, its heat flow (power) density shall not exceed 2 W/cm<sup>2</sup> (15 W/in.<sup>2</sup>). Electric heater elements shall be sheathed in austenitic stainless steel; copper or copper-bearing materials shall not contact the oil. The vendor shall provide temperature element and controls for the heater as mutually agreed to with the purchaser.

Note: Electric immersion heaters should be interlocked by the purchaser to be de-energized when the oil level drops below the heater.



## Notes:

1. Refer to 2.12 for design details.
2. Provide a 3 mm ( $\frac{1}{8}$  in.) hole inside the degassing tank. The trap prevents the gas from entering the reservoir via the 3 mm ( $\frac{1}{8}$  in.) hole.

Figure 2-4—Typical Degassing Drum Arrangement

**1.11.4** A level device shall be provided where electric immersion heaters are used

**1.11.5** The drum shall have a 4-hour minimum retention time, based on the guaranteed total inner-seal oil leakage rate or a minimum liquid volumetric capacity of 60 l (15 gal) per compressor body.

Note: The drum shall be sized to handle the contaminated oil flow coming out of the seal-trap. The vendor shall provide sizing criteria.

- **1.11.6** When specified by the purchaser, the degassing drum shall be designed and constructed for pressurized service in accordance with the appropriate recognized pressure vessel codes. The degassing drum shall permit discharge of the gas to the compressor suction or to a disposal outlet.

## 2 Piping

### 2.1 GENERAL

**2.1.1** All piping shall be in accordance with Section 5, Chapter 1, unless otherwise specified in this section.

### 2.2 OIL PIPING

**2.2.1** Piping shall be in accordance with Tables 1D and 2A, Chapter 1.

### 2.3 INSTRUMENT PIPING

**2.3.1** Piping shall be in accordance with Tables 1D and 2A, Chapter 1.

### 2.4 PROCESS PIPING

**2.4.1** Piping shall be in accordance with Tables 1A and 2A, Chapter 1.

## 2.5 WATER PIPING

**2.5.1** Piping shall be in accordance with Tables 1C and 2A, Chapter 1.

## 3 Instrumentation, Control, and Electrical Systems

### 3.1 GENERAL

**3.1.1** As a minimum, the vendor shall furnish and mount the alarm and shutdown contacts specified in Table 1. The alarm setting shall precede the shutdown setting.

**3.1.2** Instrumentation shall comply with Section 6, Chapter 1, except as modified in the following paragraphs.

- **3.1.3 Arrangement 1**

**3.1.3.1** When specified, both shut-down and alarm switches shall be connected through normally energized, fail-safe circuits. The shut-down circuits wiring shall be completely independent from the alarm circuit wiring and shall be mechanically protected.

- **3.1.4 Arrangement 2**

**3.1.4.1** Shut-down functions shall be initiated by local direct-acting switches connected in normally de-energized circuits.

**3.1.4.2** Alarm functions shall comprise locally mounted transmitters (electronic or pneumatic as specified) connected to either separate panel mounted switches or to a multi-pointed scanning-type instrument.

Table 1—Conditions Requiring Alarms and Shutdowns<sup>a</sup>

Condition	Alarm	Shutdown
Low control oil pressure	X	
High oil temperature leaving cooler	X	
Low pressure for each lube-oil pressure level	X	X
Low level for each oil reservoir	X	
Low level for each seal-oil overhead tank or low seal-oil differential pressure for each seal-oil level	X	X
High level for each overhead seal tank	X	
Low level for each lube-oil rundown tank	X	
High level for each lube-oil rundown tank (permissive)	X	
Pump running for each stand-by and emergency pump	X <sup>b</sup>	
High differential pressure for each oil-filter set	X <sup>c</sup>	
Starting of standby oil pump	X <sup>d</sup>	

Notes:

<sup>a</sup>If applicable.

<sup>b</sup>Not required if the purchaser's alarms are from the motor starter.

<sup>c</sup>The differential pressure indicator shall span the filter-cooler set when a single continuous-flow transfer valve is used (see Figure 2A-15).

<sup>d</sup>Switch needed to start standby pump.

**3.1.4.3** Where multipoint, scanning-type instruments are used, the alarm setting for each function shall be separately and independently adjustable.

### • 3.1.5 Arrangement 3

**3.1.5.1** Each function, for which both an alarm and a shutdown have been specified, shall be provided with three separate and independent transmitters (electronic unless agreed to otherwise).

**3.1.5.2** Each transmitter shall be independently connected to one of three multipoint, electronic, scanning-type instruments for each transmitter's input.

**3.1.5.3** Each multipoint instrument shall provide both alarm and shutdown settings, separately and independently adjustable, for each transmitted input.

**3.1.5.4** The shut-down and alarm function outputs from the three multipoint instruments shall be connected through "two out of three" voting logic. The arrangement shall allow operation of any one alarm or shut-down function that will initiate an alarm; operation of two shut-down functions monitoring the same parameter that will initiate a separate alarm and shall cause the served equipment to shutdown.

**3.1.5.5** Alarm functions not associated with a shut-down function shall be provided with one single transmitter. These alarm transmitters may be connected to one of the three alarm/shut-down multipoint instruments or to a separate multipoint instrument.

Note: Arrangement 3 has the following advantages.

- Any shutdown or alarm function can be tested at any time with the equipment in service without the need to disarm any part of the system.
- Failure of any one component will initiate an alarm but will not result in equipment shutdown.
- The use of modern, digital-instrument technology is facilitated.

The detail arrangement should be jointly developed between the purchaser and the vendor or vendors of the oil system and the served equipment.

Note: If the circuit is normally energized, this shall be a fail-safe arrangement to avoid spurious trips. Example 2 out of 3 voting, DC power supply, UPS.

## 3.2 INSTRUMENTATION

### 3.2.1 Temperatures Indicators (TI)

- 3.2.1.1** Dial-type temperature indicators shall be heavy-duty and corrosion-resistant. They should be at least 125 mm (5 in.) in diameter and bimetallic-type or fluid-filled. Black printing on a white background is standard for gauges. Temperature indicators shall be located per the data sheets.

**3.2.1.2** Temperature-sensing elements shall be in the flowing fluid.

Note: This is particularly important for lines that may run partially full.

**3.2.1.3** Temperature-sensing elements may be located at oil-flow sight glasses.

**3.2.2** Direct-acting level instrument may be operated by displacers, floats, capacitance, ultrasonic, transmitter, or other means as approved by the purchaser. Sensing elements unless otherwise specified shall be made of Series 300 stainless steel.

**3.2.3** Temperature indicators or sensing elements that are in contact with the process or are located in pressurized or flooded lines shall be furnished with NPS  $\frac{3}{4}$  in. NPT, 300 stainless steel separable solid-bar thermowells.

Note: Larger pipe sizes may be required to avoid restriction of flow by the thermowell.

### 3.2.4 Thermocouples and Resistance Temperature Detectors

Where practical, the design and location of thermocouples and resistance temperature detectors shall permit replacement while the unit is operating. The lead wires of the thermocouples or resistance temperature detectors shall terminate in the thermocouple or resistance detector head. The vendor shall install leads from the head to an on-base terminal box.

### 3.2.5 Pressure Indicators (PI)

**3.2.5.1** Differential pressure indicators shall be furnished with carbon or stainless steel pressure containing housings and stainless steel movements. Dial size shall be 112 mm ( $4\frac{1}{2}$  in.) minimum with black printing on a white background. Differential pressure indicators shall be protected against over ranging.

### 3.2.6 Oil Sight Flow Indicators

**3.2.6.1** Flow indicators shall be furnished in the atmospheric oil-drain return line from each bearing, gear, and seal, and, unless otherwise specified, in the outlet piping of each continuously lubricated coupling.

Note: Flow indicators may not be installed in pressurized lines except as indicated in 6.4.6.4, Chapter 1.

**3.2.6.2** Unless otherwise specified, the flow indicator shall be flanged, be of the bull's-eye type, and have a steel body.

**3.2.6.3** To facilitate viewing of the oil flow through the line, each flow indicator should be installed with its bull's-eye glass in a vertical plane. The diameter of the bull's eye shall be at least one-half the inside diameter of the oil pipe and shall clearly show the minimum oil-flowing level.

**3.2.6.4** When specified by the purchaser, restrictive flow indicators shall be installed in the pressurized inlet line to each continuously-lubricated coupling.

### 3.2.7 Solenoid Valves

**3.2.7.1** Direct solenoid-operated valves shall be used only in clean, dry instrument-air or control-oil service, have Class F insulation or better, and have a continuous service rating.

When required for other services, the solenoid shall act as a pilot valve to pneumatic valves, hydraulic valves, or equivalent alternate valve arrangement.

- **3.2.7.2** When continuously energized solenoids are specified for trip circuits, the vendor shall provide the purchaser with the coil rating and estimated service life of each solenoid coil based on continuous energized operation. Dual coil solenoids may be specified for any trip function. Each coil shall be capable of keeping the solenoid in its energized condition. Separate relays shall energize each coil.

### 3.2.8 Pressure Limiting Valves

**3.2.8.1** The vendor shall furnish the pressure limiting valves that are to be installed on components or in piping that the vendor is supplying. Other relief valves will be furnished by the purchaser. Only relief valves for gas service are required to meet the limiting relief valve requirements defined in API RP 520, Parts I and II, and in API RP 526.

**3.2.8.2** The vendor shall determine the size and set pressure of all pressure limiting valves associated with the system components. Pressure limiting valve settings, including not more than 10 percent accumulation, shall take into consideration all possible types of equipment and component failures and the protection of oil system components and piping.

- **3.2.8.3** When specified, thermal relief valves shall be provided for components that may be blocked in by isolation valves.

### 3.2.9 Control Valves

**3.2.9.1** Control valve(s) shall be installed to maintain system pressure, reduce pressure, regulate flow, or maintain a differential pressure.

**3.2.9.2** Control valve(s) shall have steel bodies with stainless steel trim. All air supply or pressure-sensing tubing shall be made of stainless steel. The pressure rating of the body and head shall not be less than the maximum pressure the component can be exposed to in its failed position.

**3.2.9.3** Control valve(s) sizes shall conform to the allowable pipe sizes.

Note: This may be swagged down from the pipe line size.

**3.2.9.4** Unless otherwise specified on the schematics, failure mode for control valves are:

- a. Backpressure—fail close.
- b. Pressure reducing—fail open.

## 3.3 ELECTRICAL SYSTEMS

Electrical systems shall be in accordance with 6.5, Chapter 1.

## 4 Inspection, Testing, and Preparation for Shipment

### 4.1 GENERAL

Inspection, testing, and preparation for shipment shall be in accordance with Section 7, Chapter 1, unless otherwise specified in this section.

- **4.1.1** When specified, the purchaser's or the vendor's representative will indicate compliance in accordance with the inspector's checklist (Appendix C) by initialing, dating, and submitting the completed checklist to the purchaser prior to shipment.

### 4.2 INSPECTION

**4.2.1** The oil system furnished shall meet the cleanliness requirements of 4.3.3.7.1 and 4.3.3.7.2.

### 4.3 TESTING

#### 4.3.1 General

**4.3.1.1** Equipment shall be tested in accordance with 4.3.2 and 4.3.3. Other tests may be specified and shall be jointly developed by the purchaser and the vendor.

- **4.3.1.2** The purchaser will specify whether the purchased oil system shall be used during the shop testing of the equipment.
- **4.3.1.3** Complete-unit tests or other tests of the oil system and the equipment it serves shall be performed in place of or in addition to separate tests of the oil system as specified by the purchaser. Details of these tests shall be developed jointly by the purchaser and the vendor.

#### 4.3.2 Hydrostatic Test

**4.3.2.1** The hydrostatic test shall be performed per 7.3.2, Chapter 1.

#### 4.3.3 Operational Tests

**4.3.3.1** The complete oil system shall be run in the vendor's shop to test its operation, sound level, and cleanliness. The oil used shall be as specified and shall be compatible with the system oil (see 1.1.8).

**4.3.3.1.1** At least 6 weeks prior to testing, the vendor shall submit to the purchaser for approval a complete, detailed description of the proposed test program. The test program is to be purchase-order specific.

**4.3.3.1.2** System cleanliness shall be demonstrated by the vendor after the operational and sound-level tests.

**4.3.3.1.3** The running tests shall be conducted under normal system operating conditions for at least 4 hours. The operational tests may be done concurrently within the 4 hours.

**4.3.3.2** If console mounted, the low-oil-pressure alarm, the standby-pump start, and the shut-down switches purchased for the project shall be used for the operational tests. Otherwise, the vendor shall provide shop devices for test.

**4.3.3.3** All oil pressures, viscosities, and temperatures shall be within the range of operating values recommended in the vendor's operating instructions for the specific unit being tested.

**4.3.3.3.1** All filter elements shall be installed prior to all operational tests.

**4.3.3.4** If the steam turbine pump driver has not been mechanically tested, it shall be run during the operational tests. If steam is not available for the operational tests, turbine drivers shall be tested with compressed air or gas of sufficient capacity and pressure to develop normal system operating pressures.

Note: The vendor is responsible for verifying that the turbine is mechanically suited for the test fluid. If the turbine has been previously tested, a test motor may be considered to replace the turbine during the operational tests.

**4.3.3.5** The operational testing of the oil system shall be conducted in the sequence shown in 4.3.3.5.1 through 4.3.3.5.7.

**4.3.3.5.1** The oil system shall be thoroughly checked for leaks; all leaks shall be corrected prior to testing.

**4.3.3.5.2** The limiting pressures shall be determined so that the subsequent proper operation of each pressure limiting valve may be verified.

**4.3.3.5.3** A filter-cooler changeover shall be accomplished without the system delivery pressure dropping to the automatic-start setting of the standby pump.

**4.3.3.5.4** If applicable, it shall be demonstrated that the control valve or valves can handle a governor-transient step change on the main equipment drive turbine without the pressure limiting valves lifting and without the delivery pressure dropping to the automatic-start setting of the standby pump.

**4.3.3.5.5** It shall be demonstrated that, after a failure or trip of the main oil pump, the standby pump will start automatically and return the system to normal operating pressure without the delivery pressure dropping as follows:

- In a single-level oil pressure system, below the midpoint between the standby pump's automatic-start setting and the equipment's shut-down pressure.
- In a multilevel oil pressure system, below the midpoint between the equipment's normal operating and shutdown pressures.

Note: Verification of this criteria requires test instrumentation such as a switch or other device with response time adequate to record the transient pressures during pump switchover. (Switches are typically under 25 m/sec response time.)

**4.3.3.5.6** It shall be demonstrated that the control valve or valves are capable of controlling the oil pressure when only one pump, either the main or the standby pump, is operating at minimum oil requirements, defined as the sum of the normal bearing and seal oil requirements and the steady-state control-oil requirements. The test shall be considered satisfactory when no abnormal conditions occur during the operational test. Some abnormal conditions are system instability, an excessive drop in delivery pressure, alarm or shutdown signals, or other conditions that would require operator attention.

**4.3.3.5.7** All warning, protective, and control devices shall be checked, and adjustments shall be made as required.

**4.3.3.6** While the system is at maximum operating pressure, the internal side-to-side leakage around the plugs of continuous-flow transfer valves shall be demonstrated to be less than the drainage capability of the inactive filter housings. Leakage shall not exceed the expected or specified rates.

**4.3.3.7** Conformity to the criteria for system cleanliness shown in 4.3.3.7.1 and 4.3.3.7.2 shall be demonstrated.

**4.3.3.7.1** After 1 hour of oil circulation at the design flow rate and a temperature of 66°C to 71°C (150°F to 160°F) or lower, as component design dictates, screens placed at all discharge terminations from the console or the packages and at other strategic points mutually agreed on by the purchaser and the vendor shall be within the particle count limits listed in Table E-6, Appendix E, Chapter 1. The screen mesh shall be No. 100 plain-weave, stainless steel wire with a diameter of 0.1 mm (0.004 in.) and a 0.15-mm (0.006 in.) opening. The particles' greatest dimension shall not exceed 0.25 mm (0.010 in.), and the particles shall be randomly distributed on the screen. Piping, coolers, and valves shall be hammered frequently during the test.

Note: Typically, screens are mounted such that the flow is entering the screen in a vertical downward direction to prevent debris from escaping the screen.

**4.3.3.7.2** To further verify cleanliness, the system shall be visually inspected at two to six points selected by the inspector. The system shall be considered clean when such foreign matter such as scale, rust, metal shavings, and sand are not visible to the eye and grittiness is not detectable to the touch. This verification shall not constitute the need to rehydrotest nor necessitate the installation of screens.

**4.3.3.8** If dismantling of the oil system is required to make modifications to improve operation, the initial running test shall not be acceptable, and final tests shall be run after corrections are made. In any event, the demonstration of cleanliness shall be conducted only after the final assembly.

- **4.3.3.9** When specified, the vendor, by unbolting and rebolting pump inlet and discharge piping, shall demonstrate that the pump on its baseplate is in compliance with 1.4.24.4.

## 4.4 PREPARATION FOR SHIPMENT

**4.4.1** The oil system shall be prepared for shipment per 7.4, Chapter 1.

## 5 Vendor's Data

### 5.1 GENERAL

**5.1.1** Unless otherwise specified, a coordination meeting shall be held, preferably at the vendor's plant, within 4 to 6 weeks after the purchase commitment. Unless otherwise specified, the vendor will prepare and distribute an agenda prior to this meeting, which, as a minimum, shall include review of the following items:

- a. The purchase order, scope of supply, unit responsibility, and subvendor items.
- b. The data sheets.
- c. Applicable specifications and previously agreed-on exceptions.
- d. Schedules for transmittal of data, production, and testing.
- e. The quality assurance program and procedures.
- f. Inspection, expediting, and testing.
- g. Schematics and bills of material.
- h. The physical orientation of the components, piping, in the auxiliary systems.
- i. Other technical items.

Note: For SP oil systems, the coordination meeting is typically held in conjunction with the coordination meeting for the main equipment. This is typically held at the plant of the vendor having prime responsibility for the equipment.

### 5.2 PROPOSALS

#### 5.2.1 General

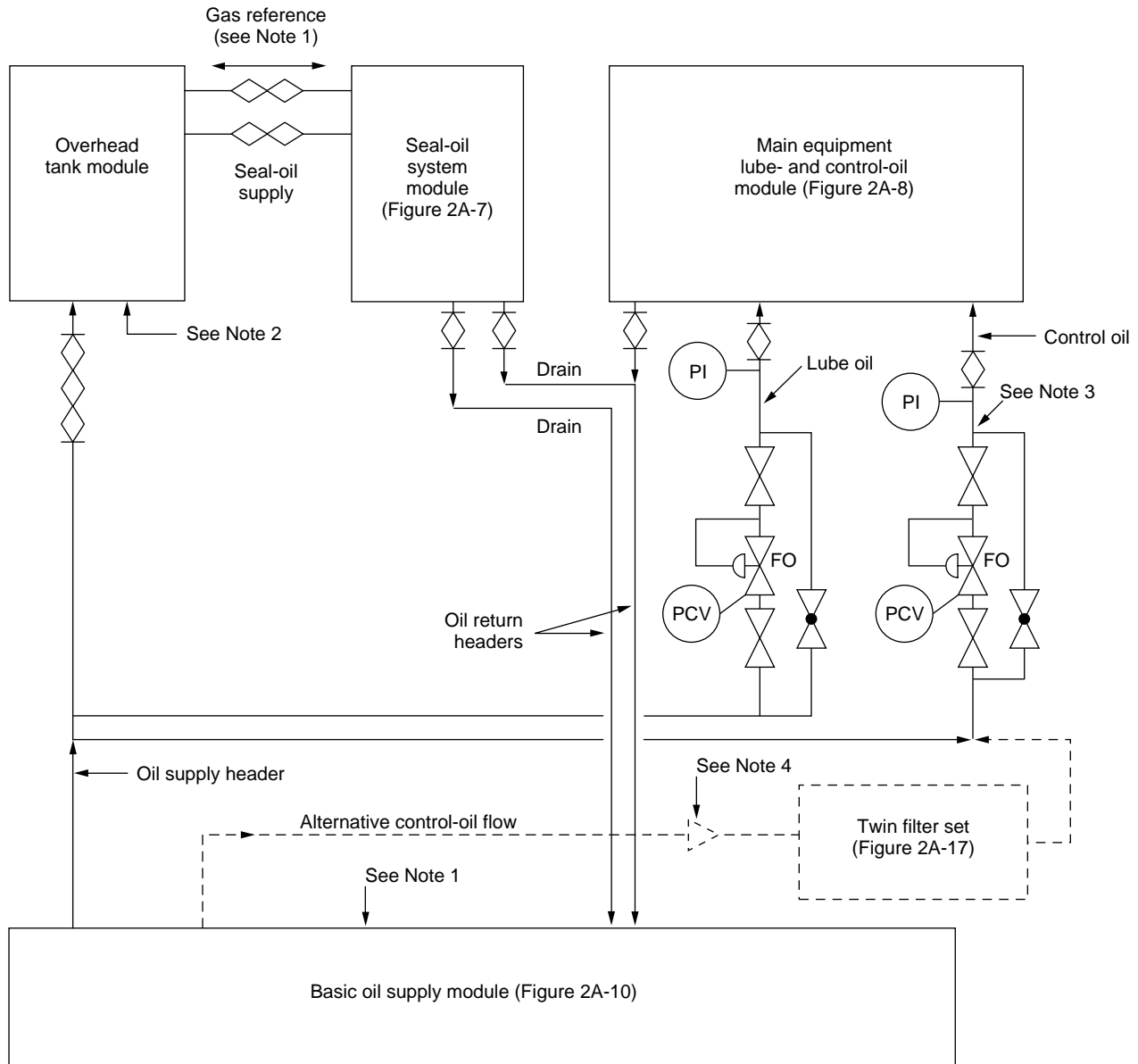
Proposal shall be prepared per 8.2, Chapter 1.

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**CHAPTER 2**  
**APPENDIX A—SPECIAL-PURPOSE OIL SYSTEM**  
**SCHEMATICS (INFORMATIVE)**

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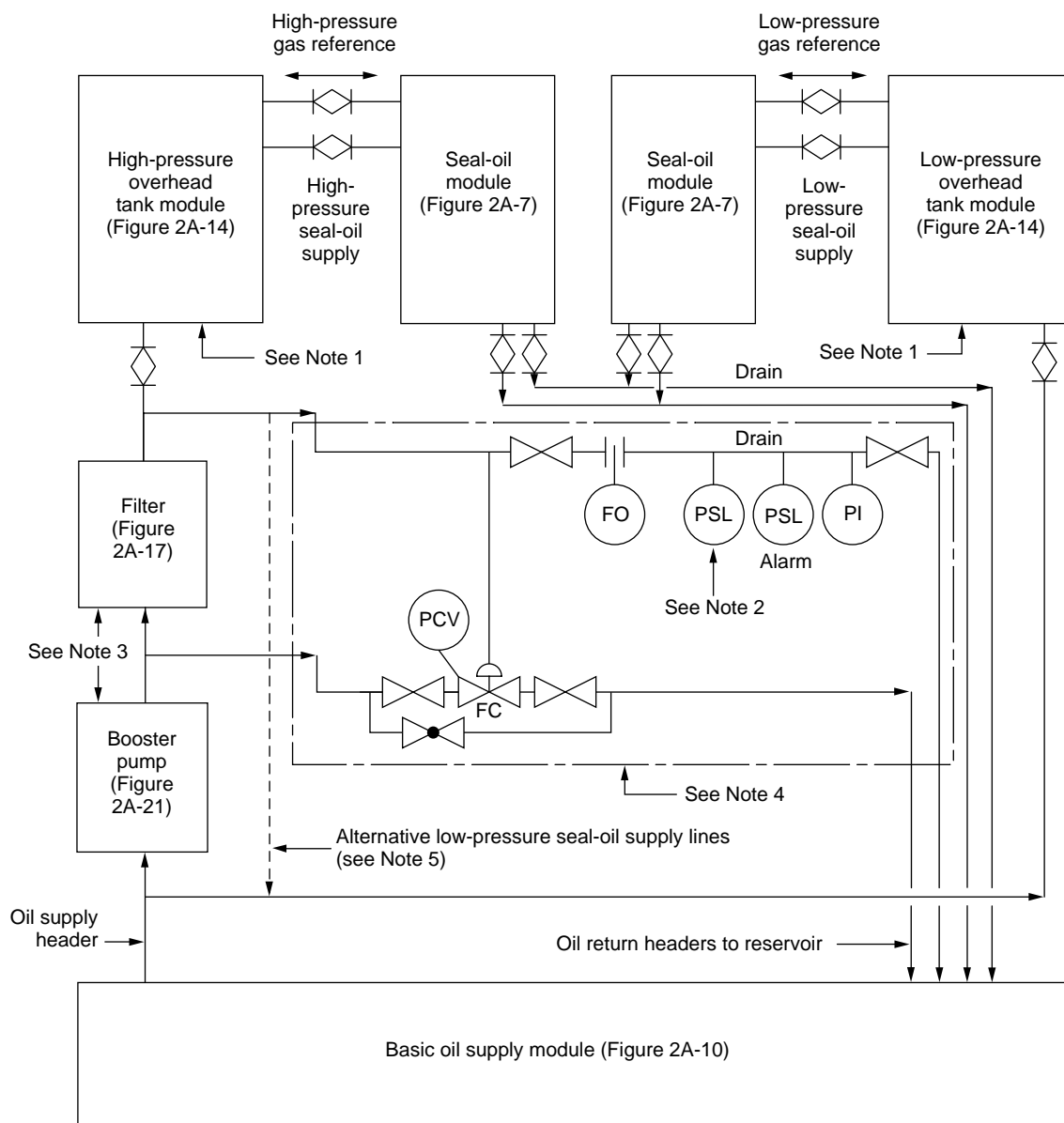


Notes:

- 1. Option 2A-1a: For systems without overhead seal-oil tanks, the gas reference is connected to a direct-acting differential-pressure control valve according to the alternative arrangement shown in Figure 2A-10.
- 2. The overhead tank module may be either upstream (see Figure 2A-4A) or downstream (see Figure 2A-4B) of the seal-oil system module.

- 3. This arrangement is valid only when the minimum seal-oil supply pressure is higher than the control-oil pressure.
- 4. The check valve is omitted if an accumulator is not used.

Figure 2A-1—Combined Seal-Oil, Lube-Oil, and Control-Oil Systems

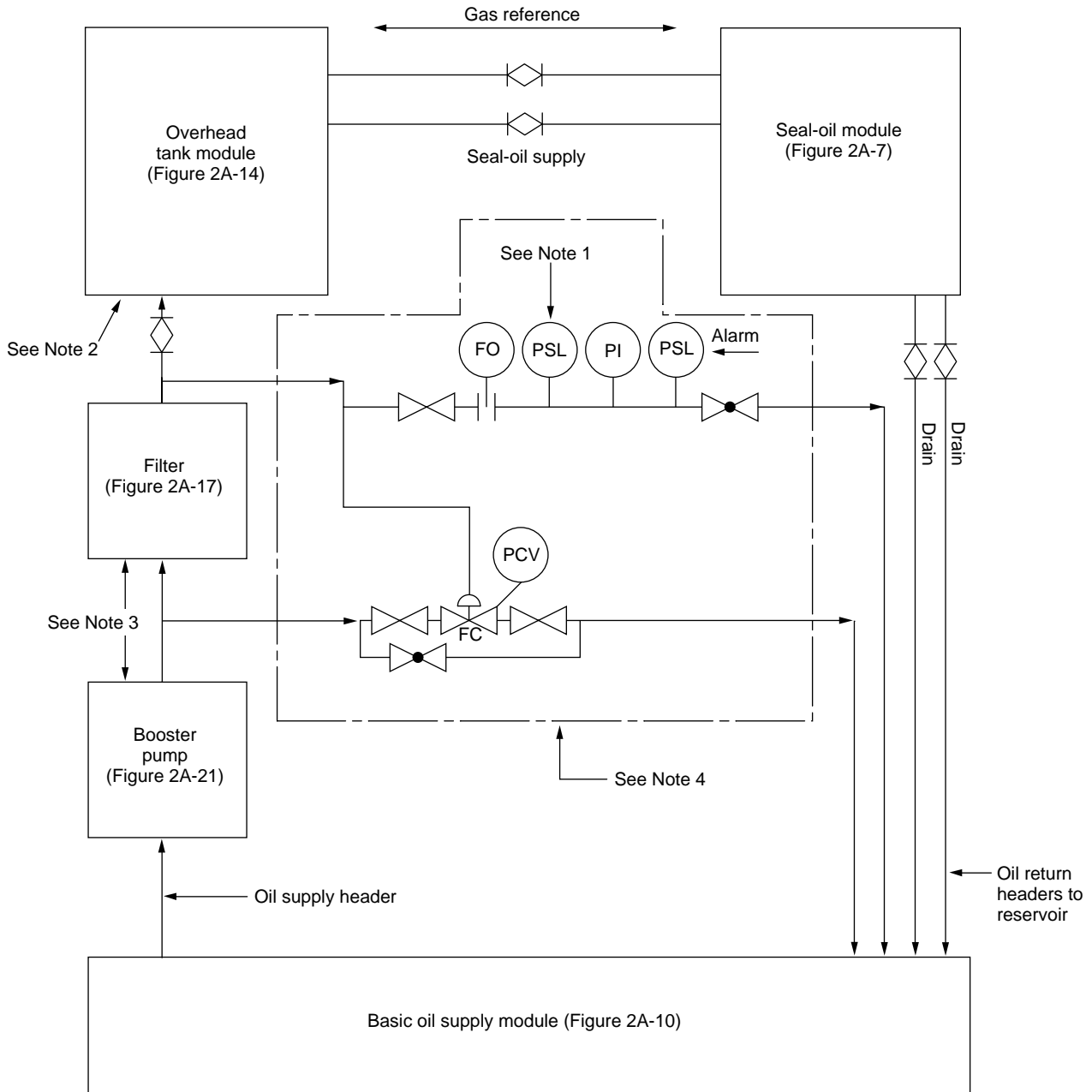


Notes:

1. The overhead tank module may be either upstream (see Figure 2A-4A) or downstream (see Figure 2A-4B) of the seal-oil system module.
2. Option 2A-2a: A switch to start the standby booster pump.
3. Option 2A-2b: The booster pump and filter are omitted if the basic oil supply system is specified to provide the required pressure.

4. Option 2A-2c: The pressure control valve and associated switches and pressure indicator may be deleted when the equipment has seals which take the total flow of oil from the pumps without the need for back-pressure regulation.
5. The source for low-pressure seal oil depends on the required pressure.

Figure 2A-2—Seal-Oil System Only, With Overhead Tanks for Equipment With More Than One Pressure Level



Notes:

- 1. Option 2A-3a: A switch to start the standby booster pump.
- 2. The overhead tank module may be either upstream (see Figure 2A-4A) or downstream (see Figure 2A-4B) of the seal-oil module.
- 3. Option 2A-3b: The booster pump and filter are omitted if the basic oil supply system is specified to provide the required pressure.

- 4. Option 2A-3c: The pressure control valve and associated switches and pressure indicator may be deleted if the equipment seals utilize the total flow of oil from the pumps (e.g., for cooling purposes).

Figure 2A-3—Seal-Oil System Only, With Overhead Tank for Equipment With One Pressure Level

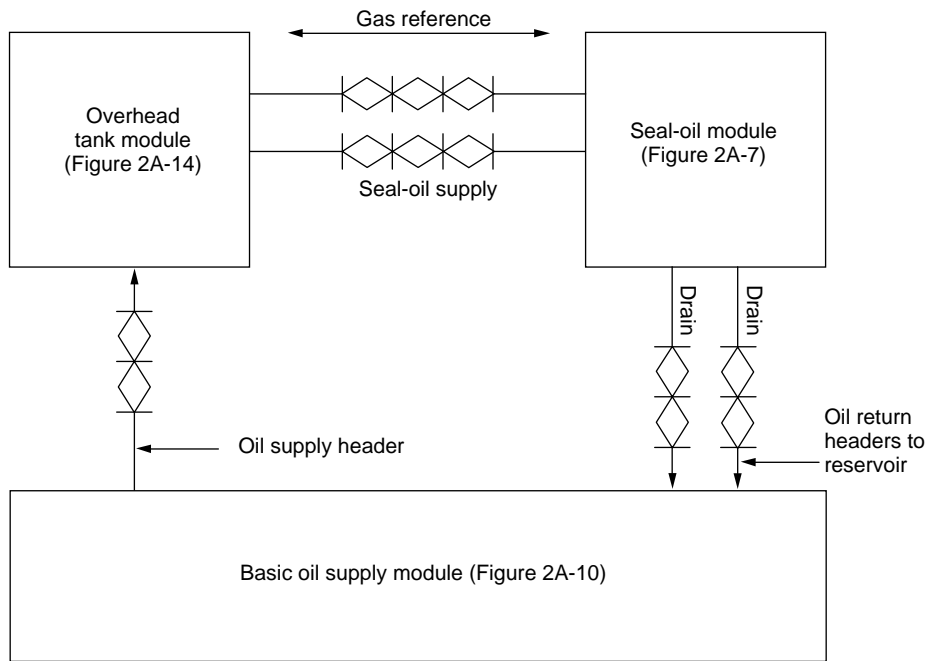
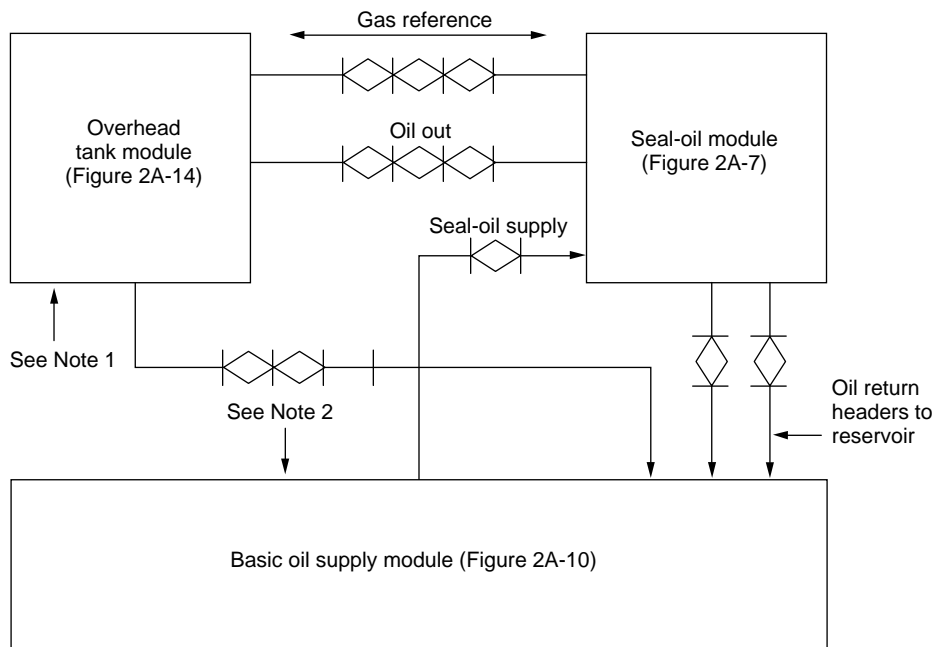


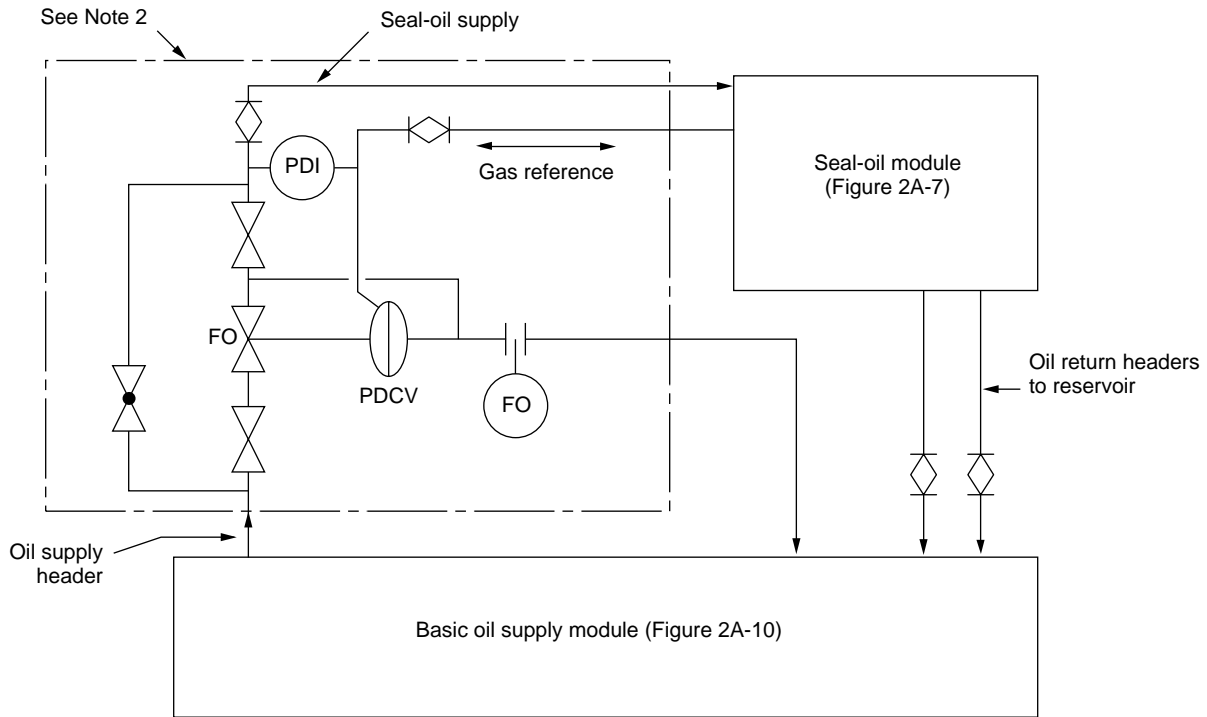
Figure 2A-4A—Seal-Oil System Only, for Equipment With Film-Type Seals:  
Overhead Tank Upstream of Seals



Notes:

1. The check valve shown in Figure 2A-14 is omitted from the overhead tank module.
2. The direct-acting pressure control valve circuit shown in Figure 2A-10 is omitted.

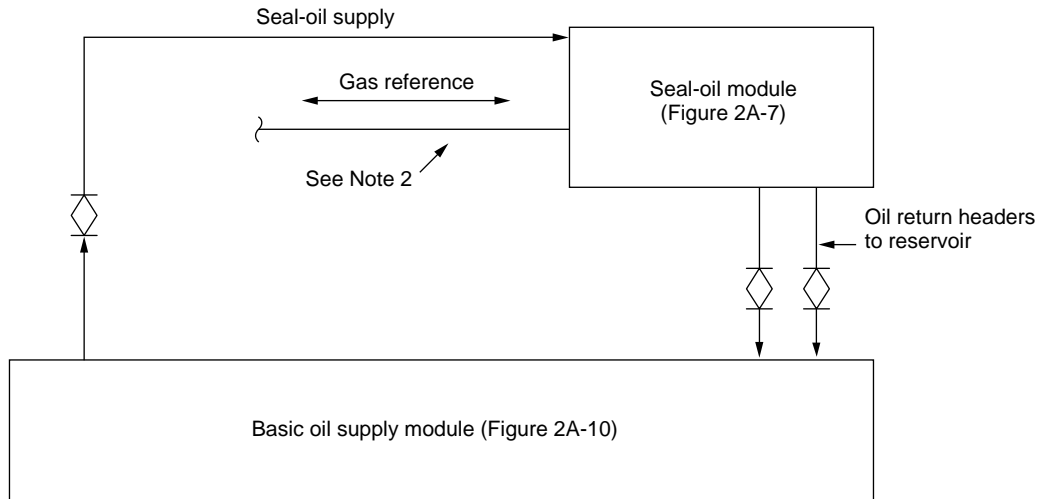
Figure 2A-4B—Seal-Oil System Only, for Equipment With Film-Type Seals:  
Overhead Tank Downstream of Seals



Notes:

1. This arrangement is valid only when the pressure of the seal-oil supply at the compressor is lower than the pressure of the cooling water. If the pressure of the cooling water is lower, refer to Figure 2A-5B.
2. The purchaser and vendor may agree upon an alternative arrangement.

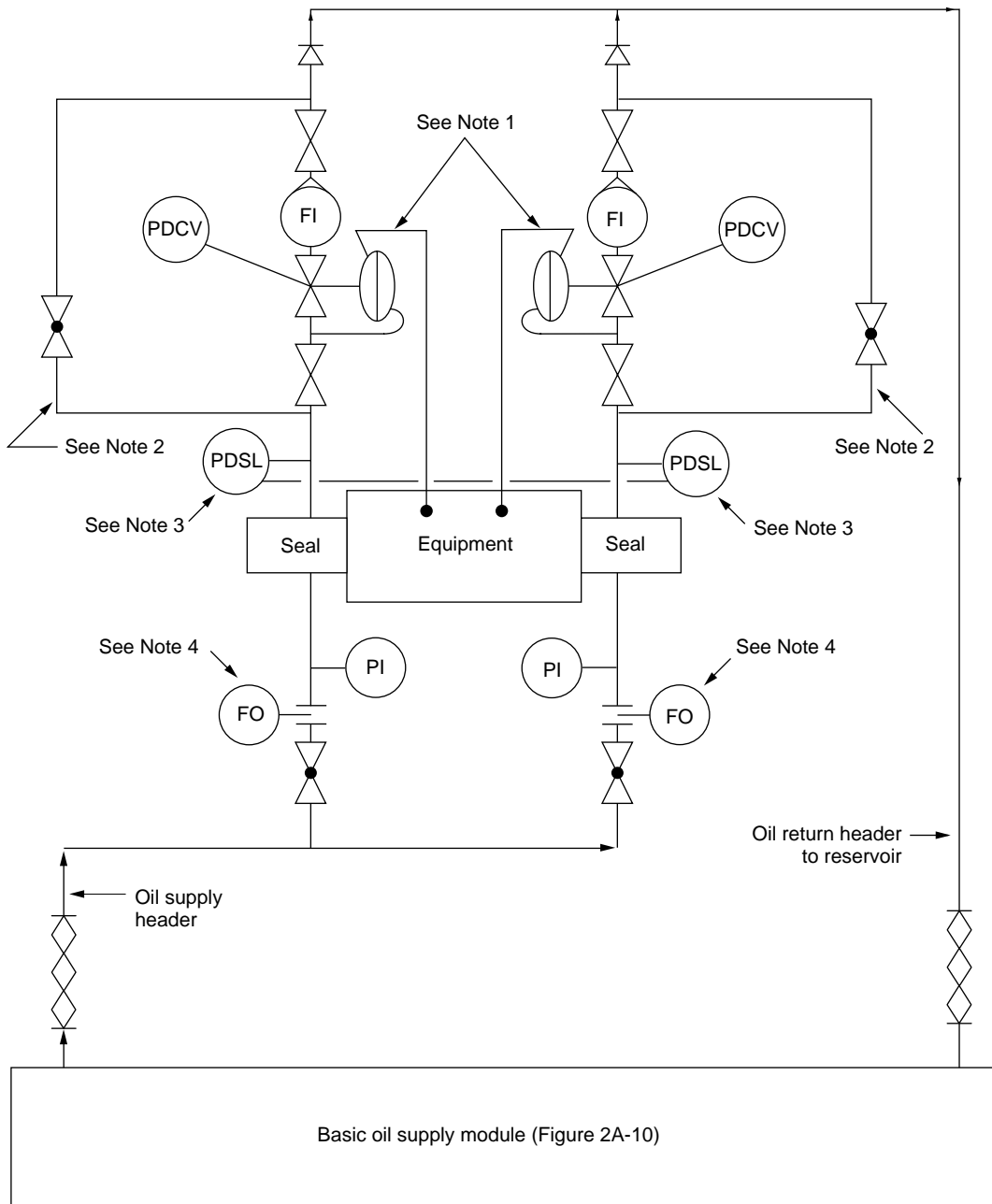
Figure 2A-5A—Seal-Oil System With Oil Pressure Lower Than Cooling Water Pressure



Notes:

1. This arrangement is valid only when the pressure of the seal-oil supply is higher than the pressure of the cooling water. If the pressure of the cooling water is higher, refer to Figure 2A-5A.
2. A direct-acting differential-pressure control valve is used according to the alternative arrangement shown in Figure 2A-10.

Figure 2A-5B—Seal-Oil System With Oil Pressure Higher Than Cooling Water Pressure



Notes:

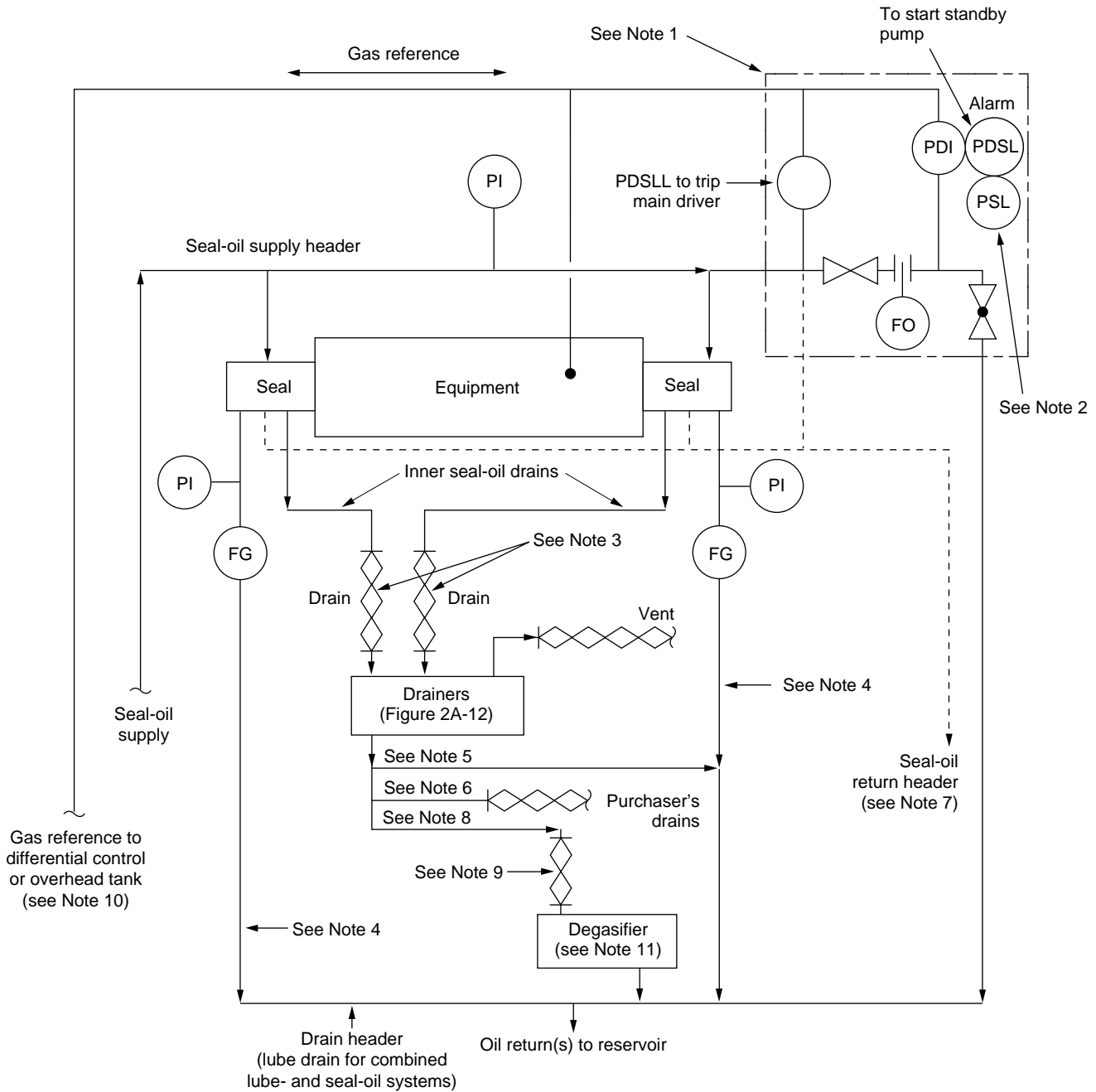
1. Each direct-acting differential-pressure control valve must be referenced to sense the working fluid pressure acting at the corresponding mechanical seal.

2. Block and bypass valves may be omitted if the equipment is spared.

3. Option 2A-6a: switch to alarm or trip or both.

4. Option 2A-6b: flow restriction orifice.

Figure 2A-6—Seal-Oil Circulation System for Equipment With Double Mechanical Seals or Multiple Sealing Pressure Levels



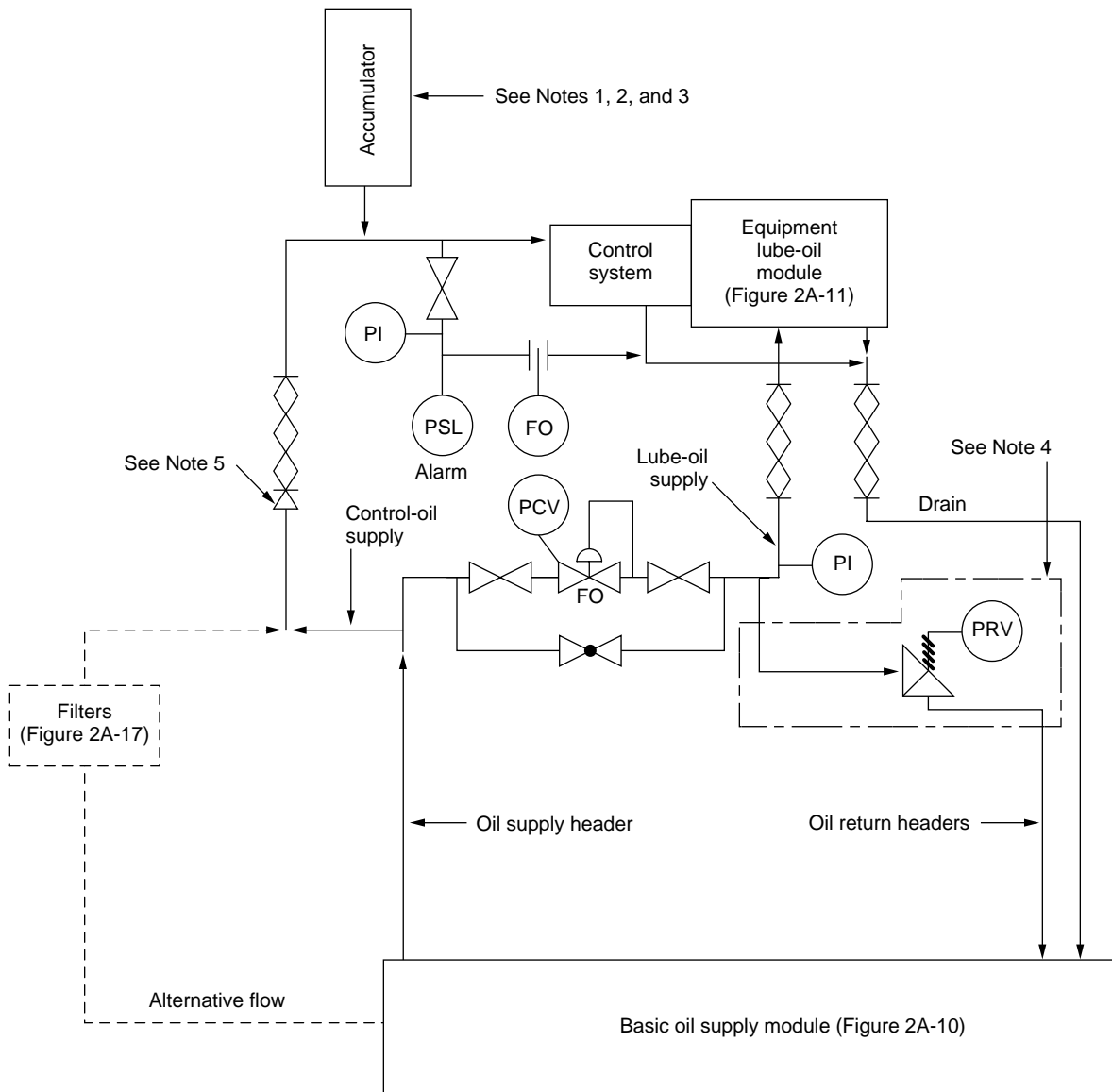
Notes:

1. The indicated components are omitted if they are furnished separately on the overhead tank.
2. The low-pressure switch is not required if the module is supplied with a back-pressure regulator circuit (see Figure 2A-10).
3. This piping is furnished by the vendor when the drainers are mounted on a compressor baseplate (sloped as specified in 5.2.1, Chapter 1).
4. On combined lube- and seal-oil systems, the outer seal drain may be combined with the lube-oil drain inside the compressor.
5. Option 2A-7a: drain to reservoir.

6. Option 2A-7b: drain to purchaser's drains.
7. Alternative seal-oil sensing point: the indicating points are referenced to a pressure-controlled header, either upstream or downstream of the seals, as agreed to by the purchaser and the vendor.
8. Option 2A-7c: drain to degassing drum.
9. This piping is furnished by the vendor if the degassifier is mounted on a compressor baseplate supplied by the vendor.
10. Each direct-acting differential-pressure control valve must be referenced to sense the working fluid pressure acting at the corresponding seal.
11. Option 2A-7d: degassing drum (see Figure 2-4).

Figure 2A-7—Seal-Oil Module at Equipment



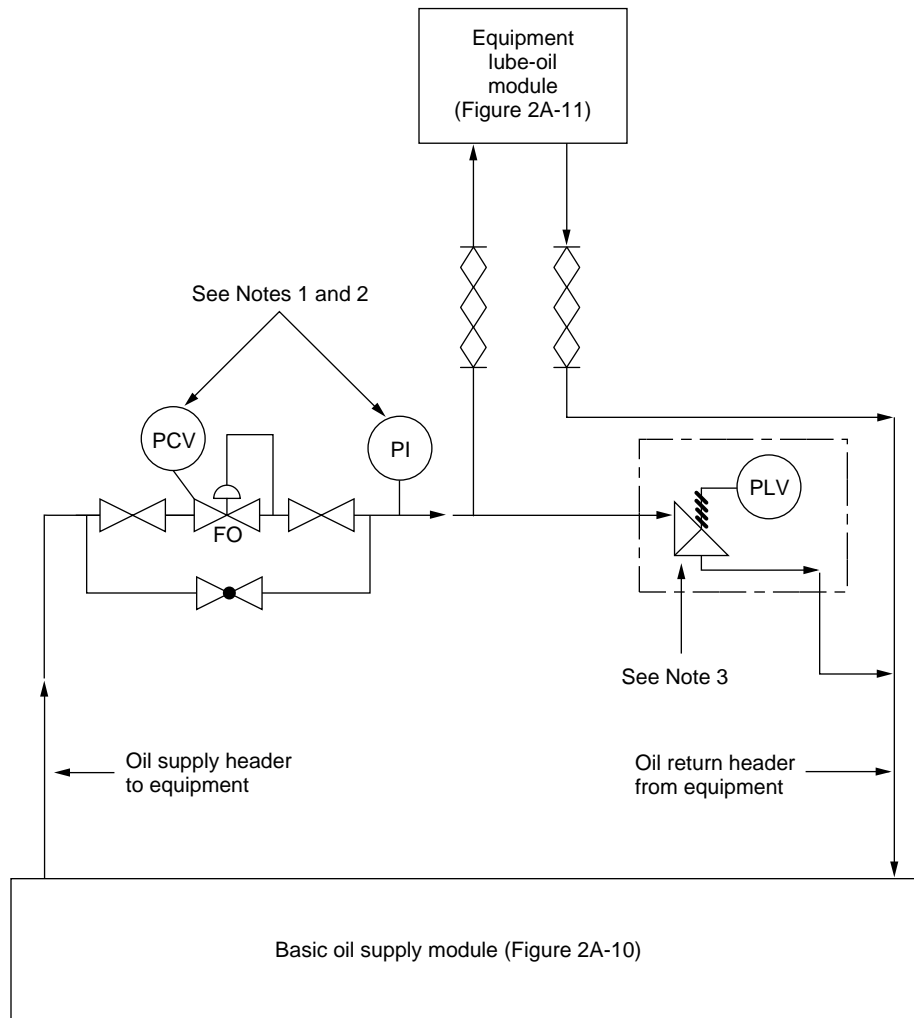


Notes:

1. A control-oil accumulator shall be supplied if one is required to maintain the control-oil pressure.
2. The accumulator shall be mounted as close as possible to the main equipment.
3. When required, the accumulator shall be of the bladder (Figure 2A-15) or direct-contact (Figure 2A-16) type.

4. This represents a typical arrangement that includes an additional pressure-regulating (relief) valve (PRV) for any system in which failure of a control valve can jeopardize or damage a low-pressure system.
5. The check valve is omitted if an accumulator is not used.

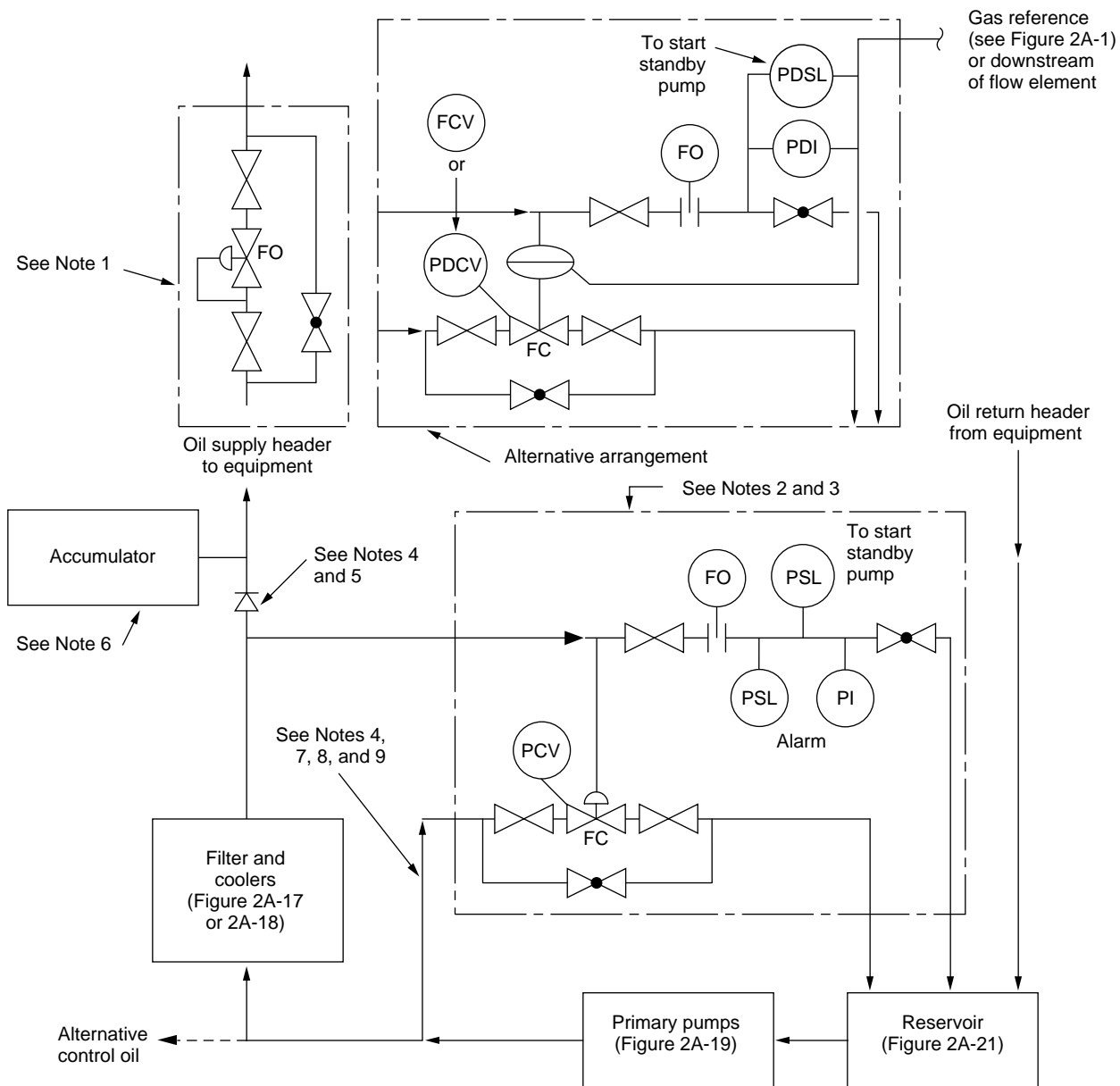
Figure 2A-8—Lube-Oil and Control-Oil Systems Only



## Notes:

1. The direct-acting pressure control valve and the pressure indicator are omitted when the pressure of the lube-oil supply is higher than the pressure of the cooling water.
2. A direct-acting pressure control valve is required if centrifugal pumps are used.
3. This represents a typical arrangement that includes an additional pressure-limiting valve (PLV) for any system in which failure of a control valve can jeopardize or damage a low-pressure system.

Figure 2A-9—Equipment Lube-Oil System Only

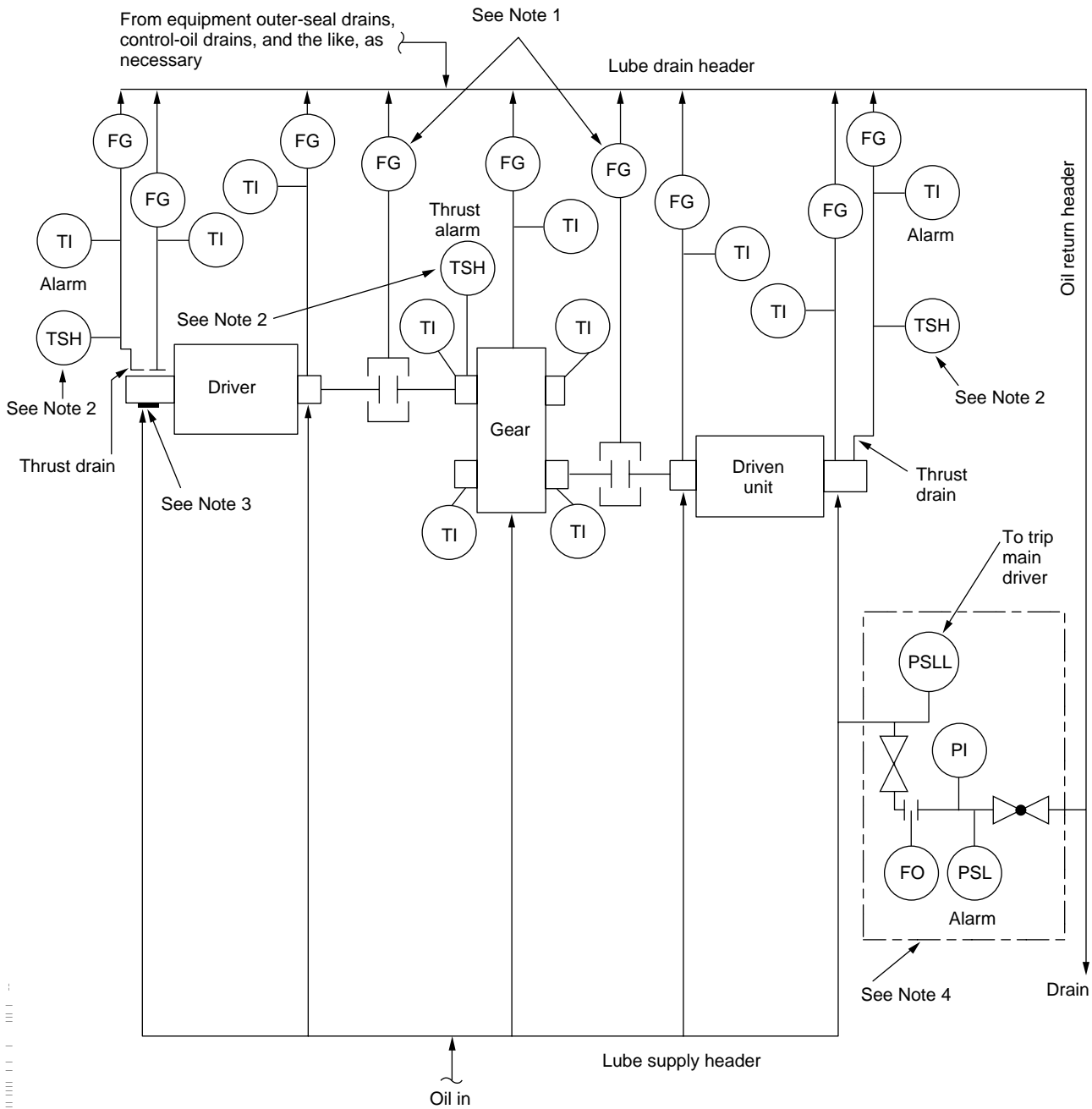


Notes:

1. Provision may be required to ensure adequate lube- and/or control-oil pressure when the seal-oil supply pressure is low relative to the lube- and/or control-oil pressure or to maintain the required oil-pressure differential above the cooling-water pressure.
2. When the module is specified for seal-oil applications, a direct-acting differential-pressure control valve or regulator shall be used.
3. The bypass valve may be deleted for a separate seal-oil system which utilizes the total oil flow from the pumps.
4. The check valve is omitted if: a) an accumulator is not used, b) a direct-acting pressure control valve circuit is used, or c) an emergency rundown tank is not used.

5. The check valve is omitted if a rotary primary pump or an accumulator is not used.
6. When required, the accumulator shall be of the bladder (Figure 2A-15) or direct-contact (Figure 2A-16) type.
7. The heat load may require the supply to the direct-acting pressure control valve to be downstream of the coolers.
8. The direct-acting pressure control valve circuit is omitted when the module is specified for seal-oil systems (see Figures 2A-4A and 2A-4B).
9. The bypass direct-acting pressure control valve circuit is omitted if centrifugal pumps are used.

Figure 2A-10—Basic Oil Supply Module

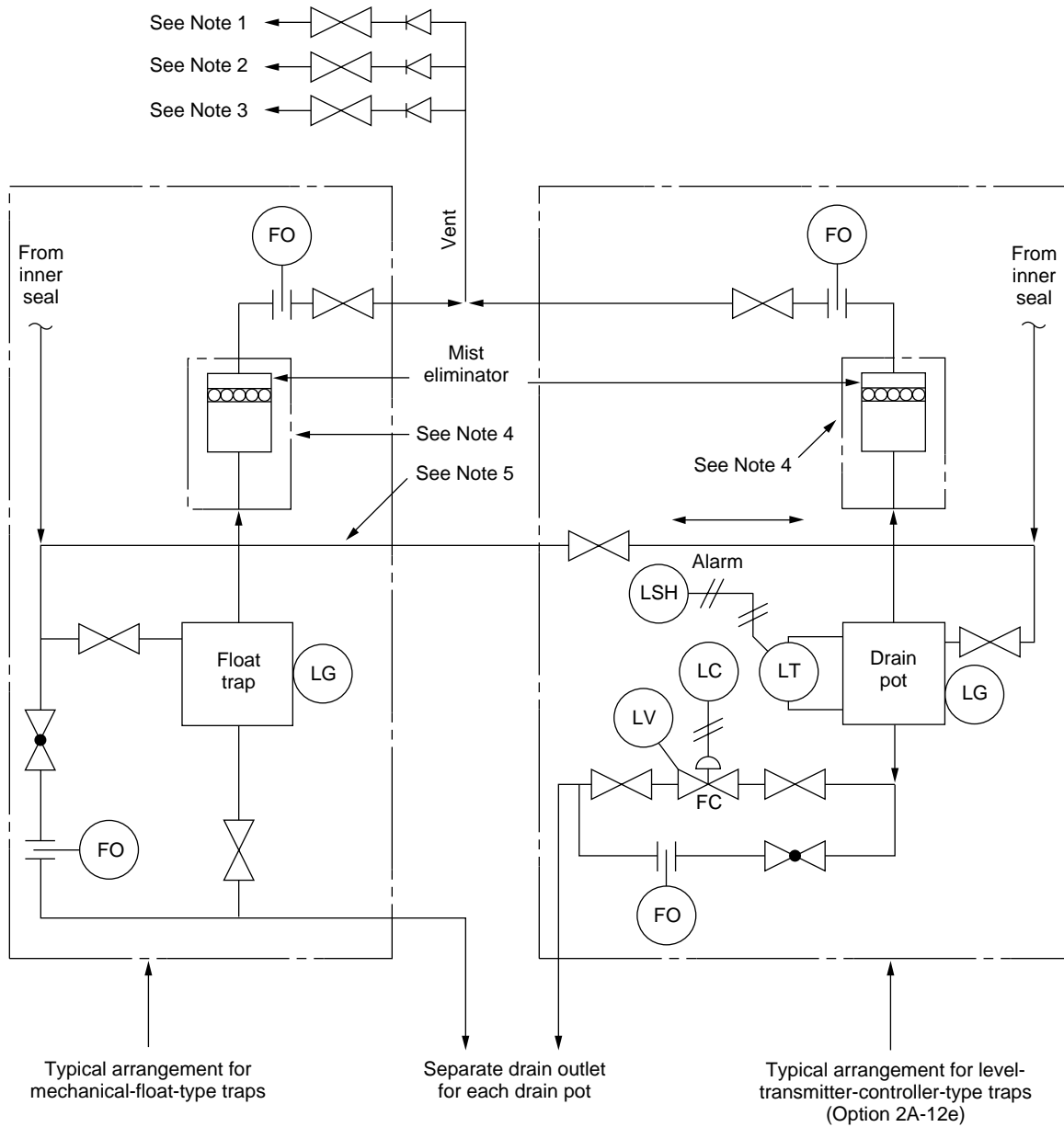


Notes:

1. Flow glasses are required for continuous lubricated couplings; they shall be located in the drain lines.
2. An oil drain high-temperature switch is not required if a thrust-bearing metal temperature detector is specified.

3. If required by the motor design, all connections shall be electrically insulated.
4. These components may be located on the gauge board.

Figure 2A-11—Lube-Oil Module at Equipment

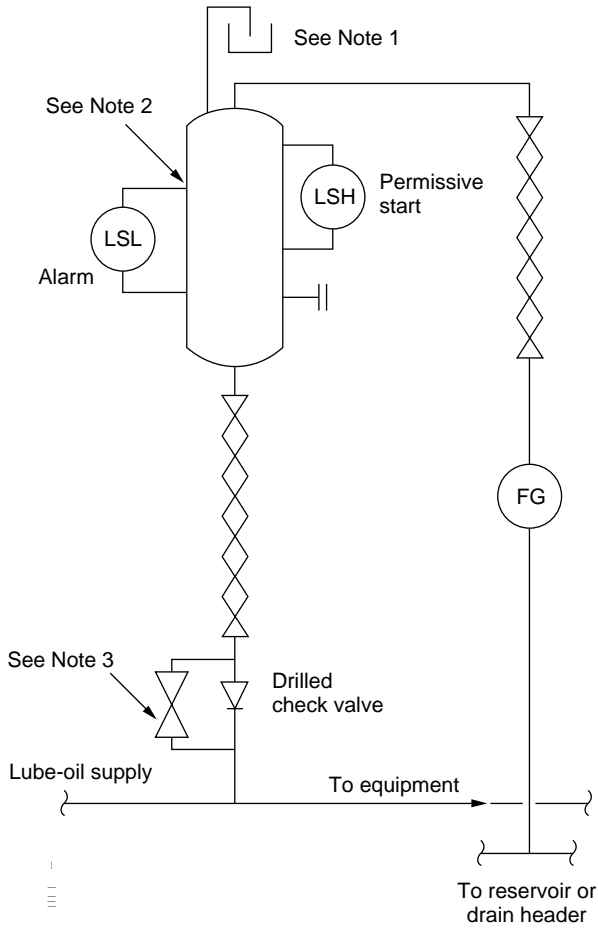


Notes:

1. Option 2A-12a: The purchaser may specify a vent to the flare.
2. Option 2A-12b: The purchaser may specify a vent to the gas system.
3. Option 2A-12c: The purchaser may specify a vent to the suction of a lower pressure casing.

4. Option 2A-12d: The purchaser may specify mist eliminators.
5. This line is omitted if the seals are not at the same pressure.

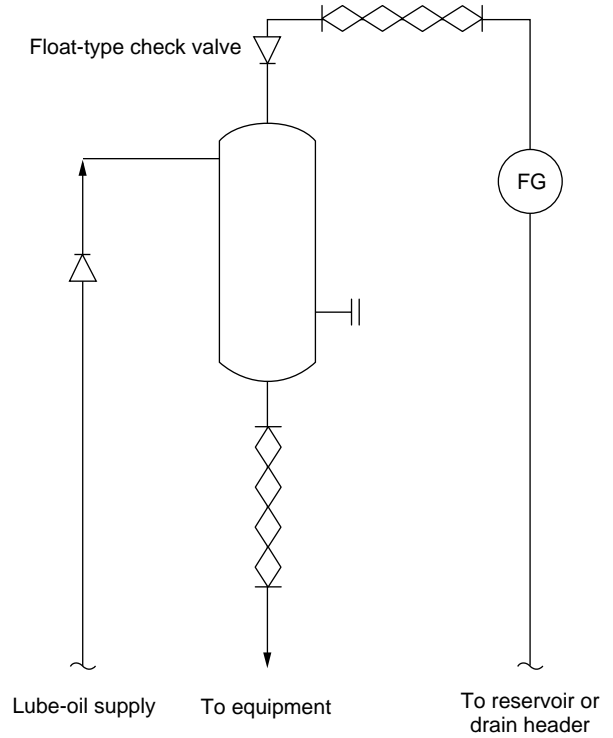
Figure 2A-12—Inner Seal Drain Traps



Notes:

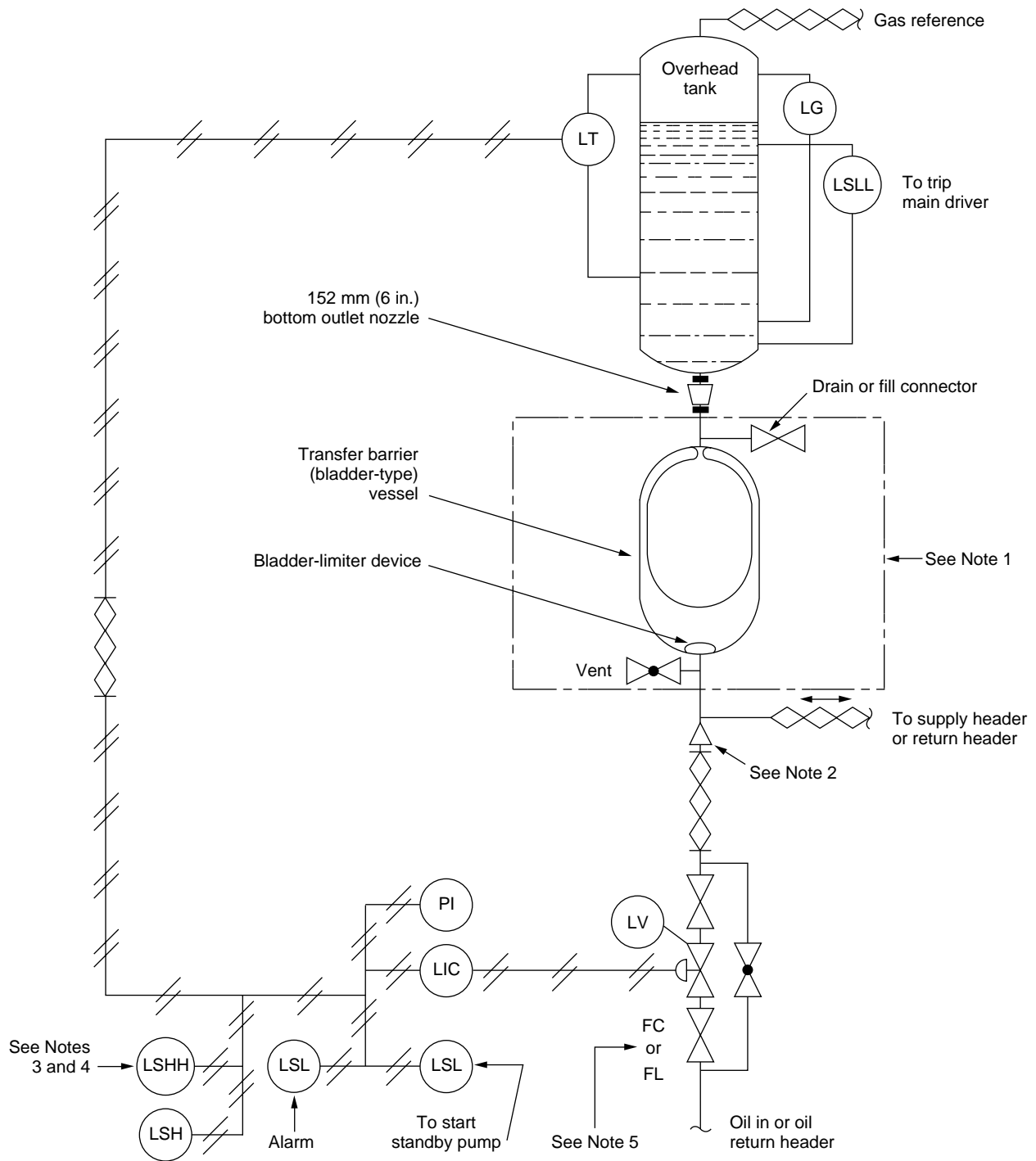
1. Option 2A-13a: the purchaser may specify an atmospheric breather valve.
2. This tank shall be located at an elevation such that the static head is less than the equipment lube-oil trip pressure.
3. This valve is normally closed; it is opened only to fill the tank before the equipment is started.

Figure 2A-13A—Emergency Lube-Oil Atmospheric Rundown Tank



Note: This tank shall be located at an elevation such that the static head is less than the equipment lube-oil trip pressure.

Figure 2A-13B—Emergency Lube-Oil Pressurized Rundown Tank

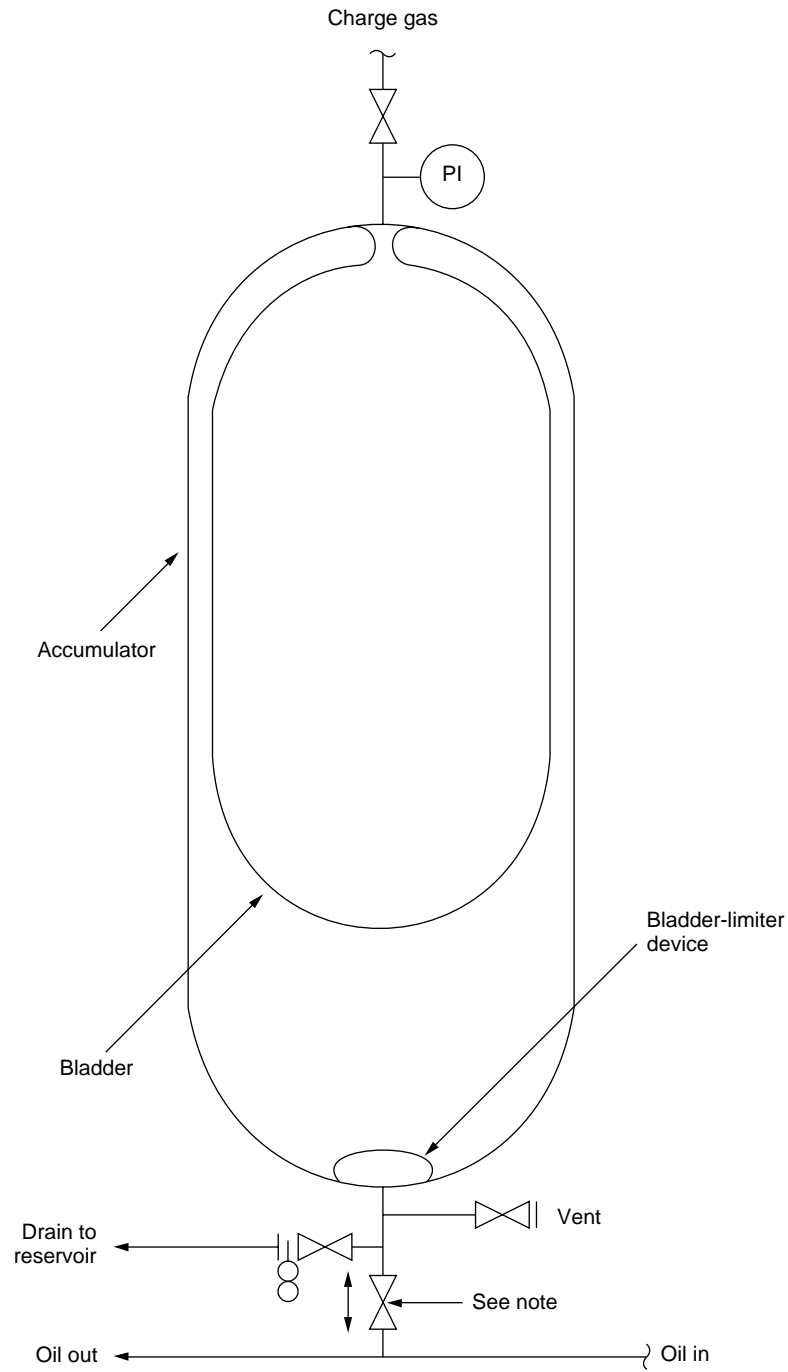


Notes:

1. Option 2A-14a: The purchaser may specify an accumulator with an isolation bladder.
2. The check valve is omitted when the overhead tank module is downstream of the seals.
3. Option 2A-14b: If the pump is for seal oil only, the purchaser may specify a switch to stop the pump.

4. Option 2A-14c: If the pump is for a combined lube- and seal-oil system, the purchaser may specify an alarm switch.
5. Option 2A-14d: The following are the failure actions for the loop-actuated control valve; FO in the supply header and FC in the return header.

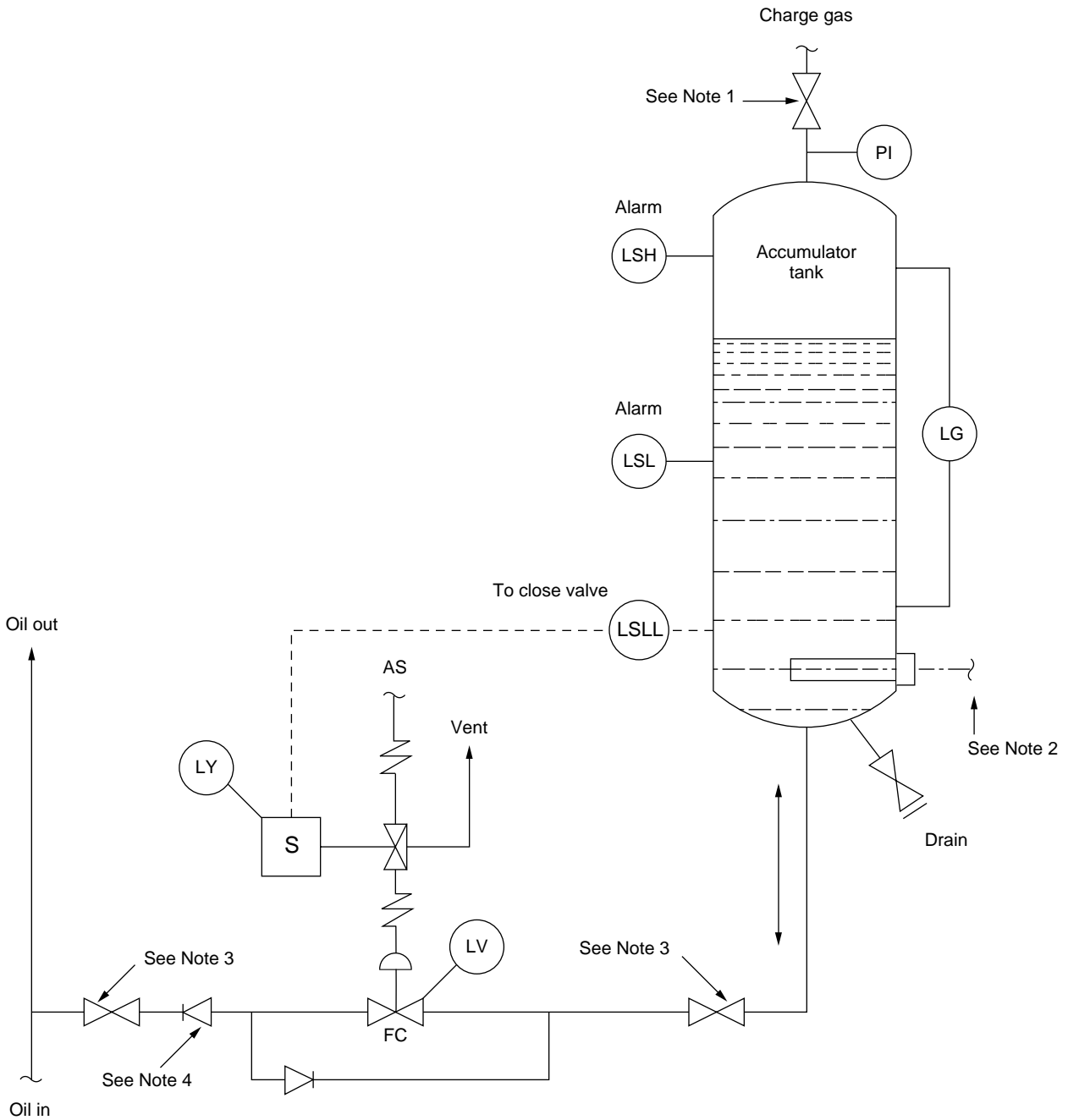
Figure 2A-14—Direct-Contact-Type Overhead Tank Module for Seal-Oil System, Including Optional Transfer Barrier (Bladder-Type) Vessel



Note: The block valve may be locked open.

Figure 2A-15—Accumulator (Manual Precharge Bladder Type)



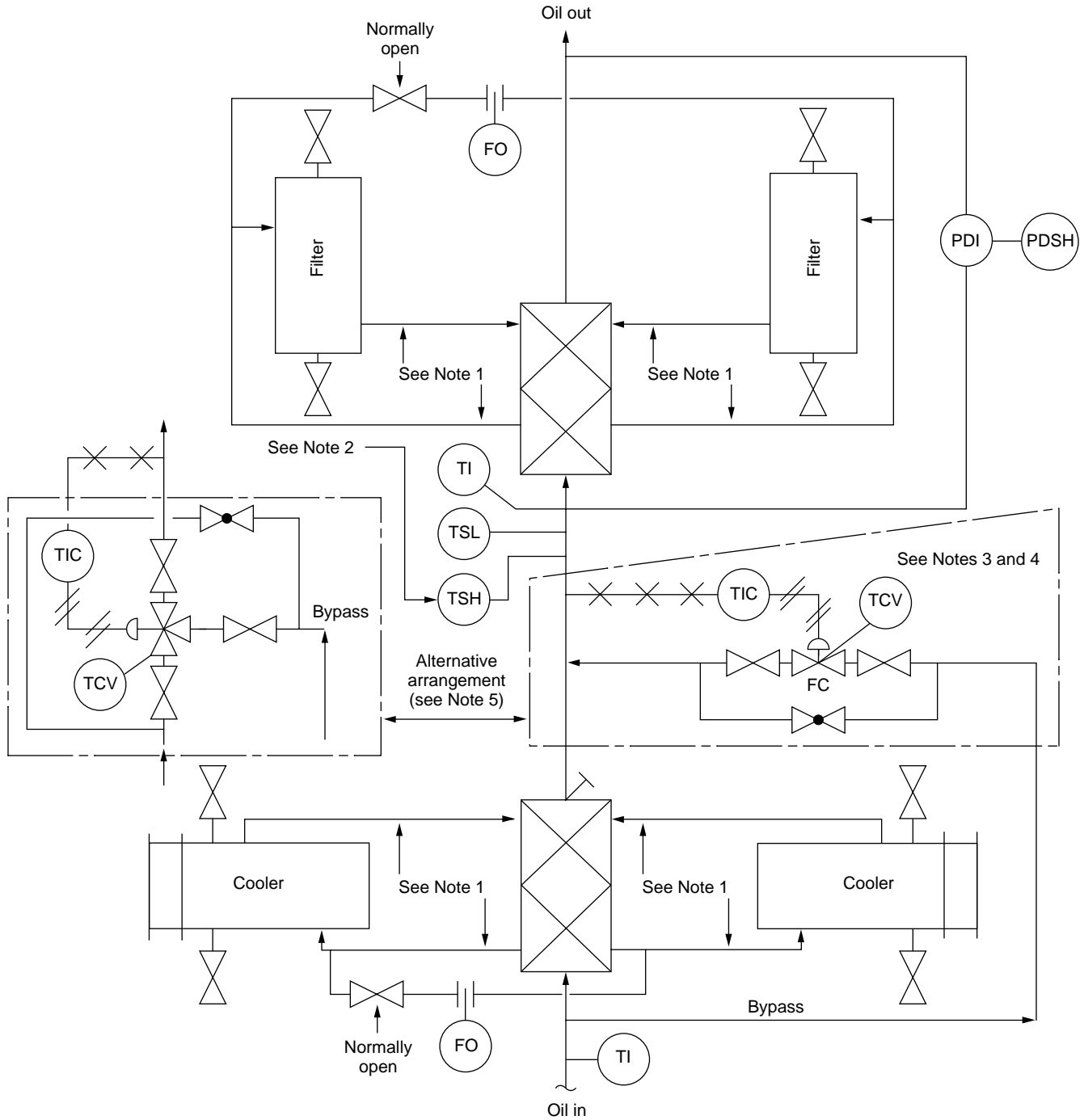


Notes:

1. Option 2A-16a: The purchaser may specify a constant-pressure regulating system.
2. Option 2A-16b: The purchaser may specify an electric heater.
3. The block valve may be locked open.

4. Option 2A-16c: A check valve with its seat or disk drilled reduces the recharging rate after an upset of the oil system. The purchaser should recognize that this may reduce the attentuation of pressure pulsations during system recovery.

Figure 2A-16—Accumulator (Direct-Contact Manual Precharge Type)

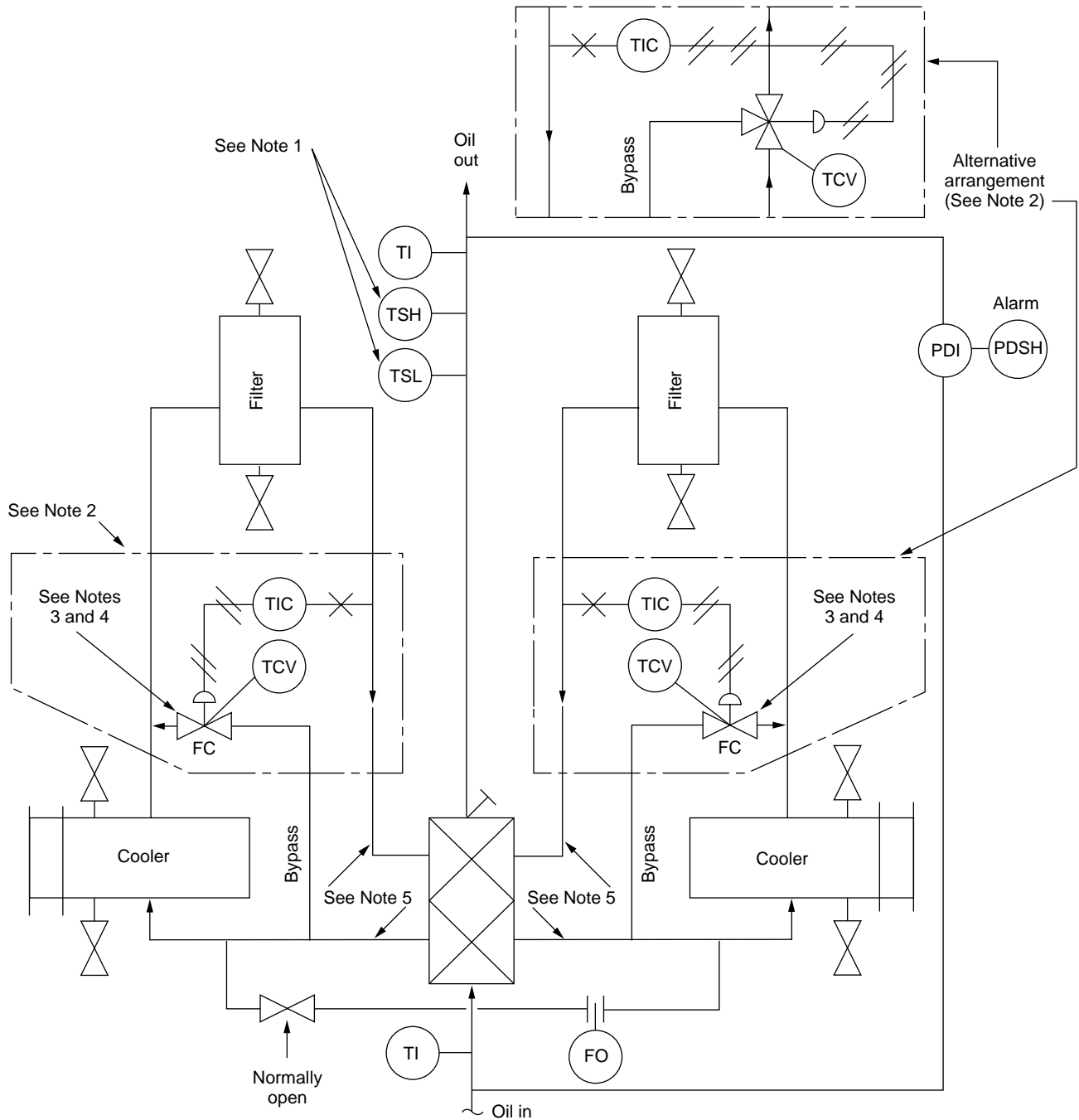


Notes:

- 1. Option 2A-17a: The purchaser may specify tight shutoff requiring spectacle blinds.
- 2. Option 2A-17b: The purchaser may specify a high-temperature switch (TSH) and/or a low-temperature switch (TSL).
- 3. Option 2A-17c: The purchaser may specify a bypass oil line and a constant-temperature control valve.

- 4. Option 2A-17d: If the fail-closed (FC) feature of the directing temperature control valve is not acceptable, the purchaser may specify a valve with a fail-locked (FL) feature.
- 5. Option 2A-17e: The purchaser may specify a constant-temperature three-way control valve as an alternative.

Figure 2A-17—Twin Oil Coolers and Filters With Separate Continuous-Flow Transfer Valves

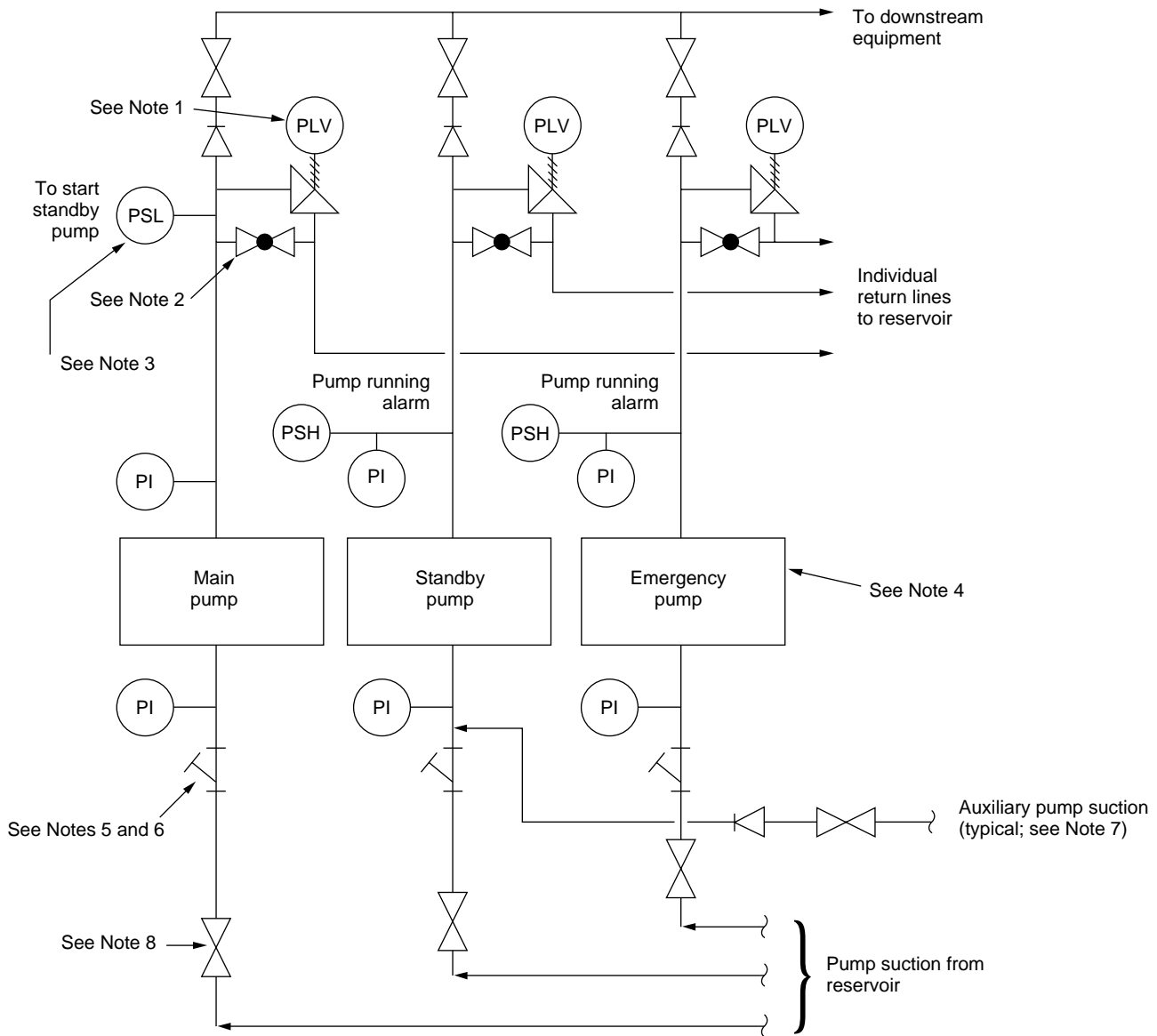


Notes:

- 1. Option 2A-18a: The purchaser may specify a high-temperature switch (TSH) and/or a low-temperature switch (TSL).
- 2. Option 2A-18b: The purchaser may specify a constant-temperature three-way control valve as an alternative.
- 3. Option 2A-18c: The purchaser may specify a bypass oil line and a constant-temperature two-way control valve.

- 4. Option 2A-18d: If the fail-closed (FC) feature of the direct-acting temperature control valve is not acceptable, the purchaser may specify a valve with a fail-locked (FL) feature.
- 5. Option 2A-18e: The purchaser may specify tight shutoff requiring spectacle blinds.

Figure 2A-18—Twin Oil Coolers and Filters With a Single Continuous-Flow Transfer Valve

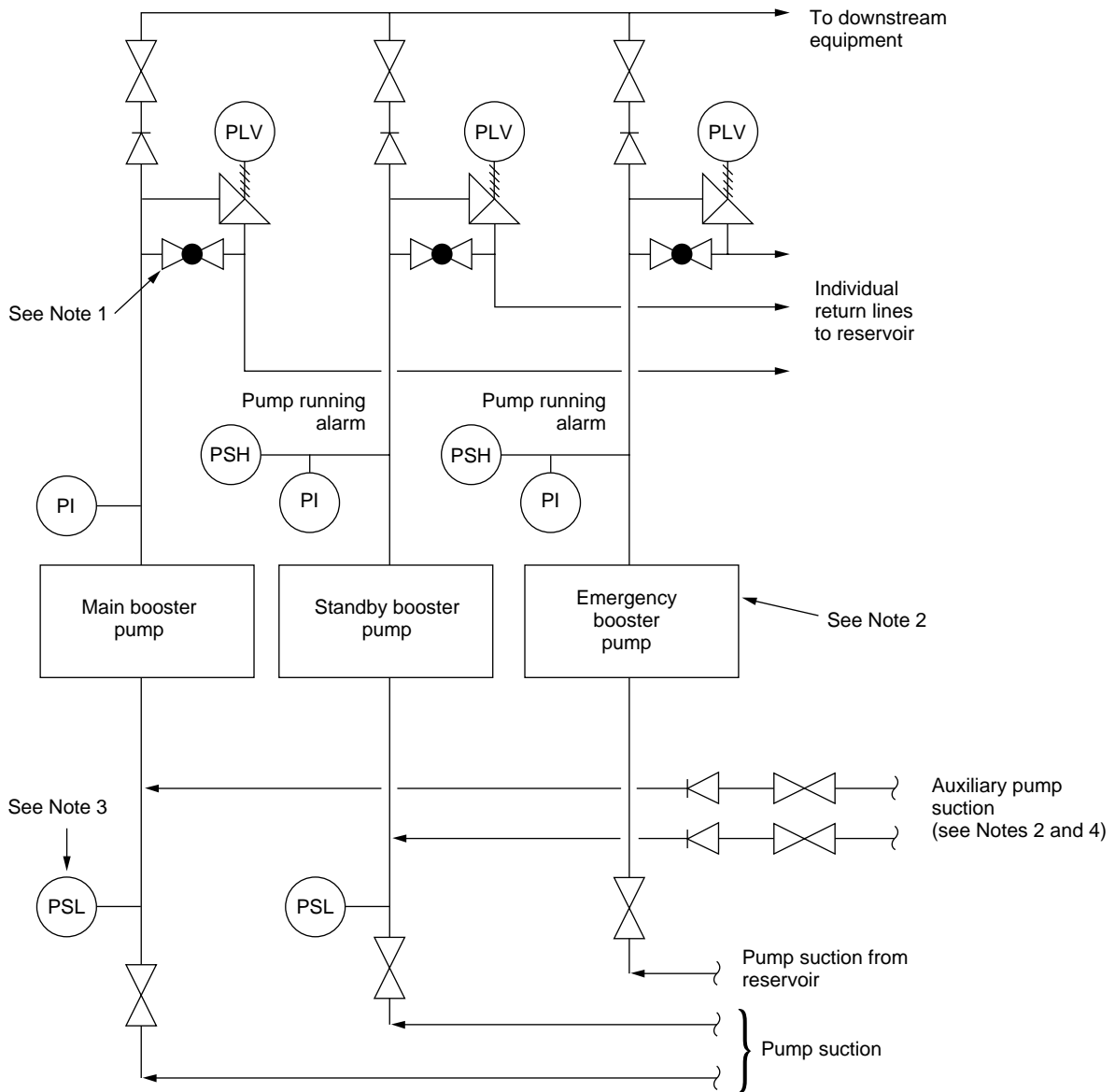


Notes:

1. The pressure-limiting valves (PLV) are omitted for centrifugal pumps.
2. Option 2A-19a: The purchaser may specify a bypass valve to start.
3. Option 2A-19b: The purchaser may specify an additional switch to start the standby pump (see Figure 2A-10).
4. Option 2A-19c: The purchaser may specify an emergency pump.
5. For centrifugal pumps, the line strainers are omitted and temporary screens are provided.

6. A basket-type screen shall be used instead of a line strainer for the suction of pumps submerged in the reservoir.
7. Option 2A-19d: For positive displacement pumps, the purchaser may specify an auxiliary emergency suction line from the reservoir to the main, standby, or emergency pump.
8. Suction valves are omitted for pumps submerged in the reservoir.

Figure 2A-19—Primary (Centrifugal or Rotary) Pump Arrangement



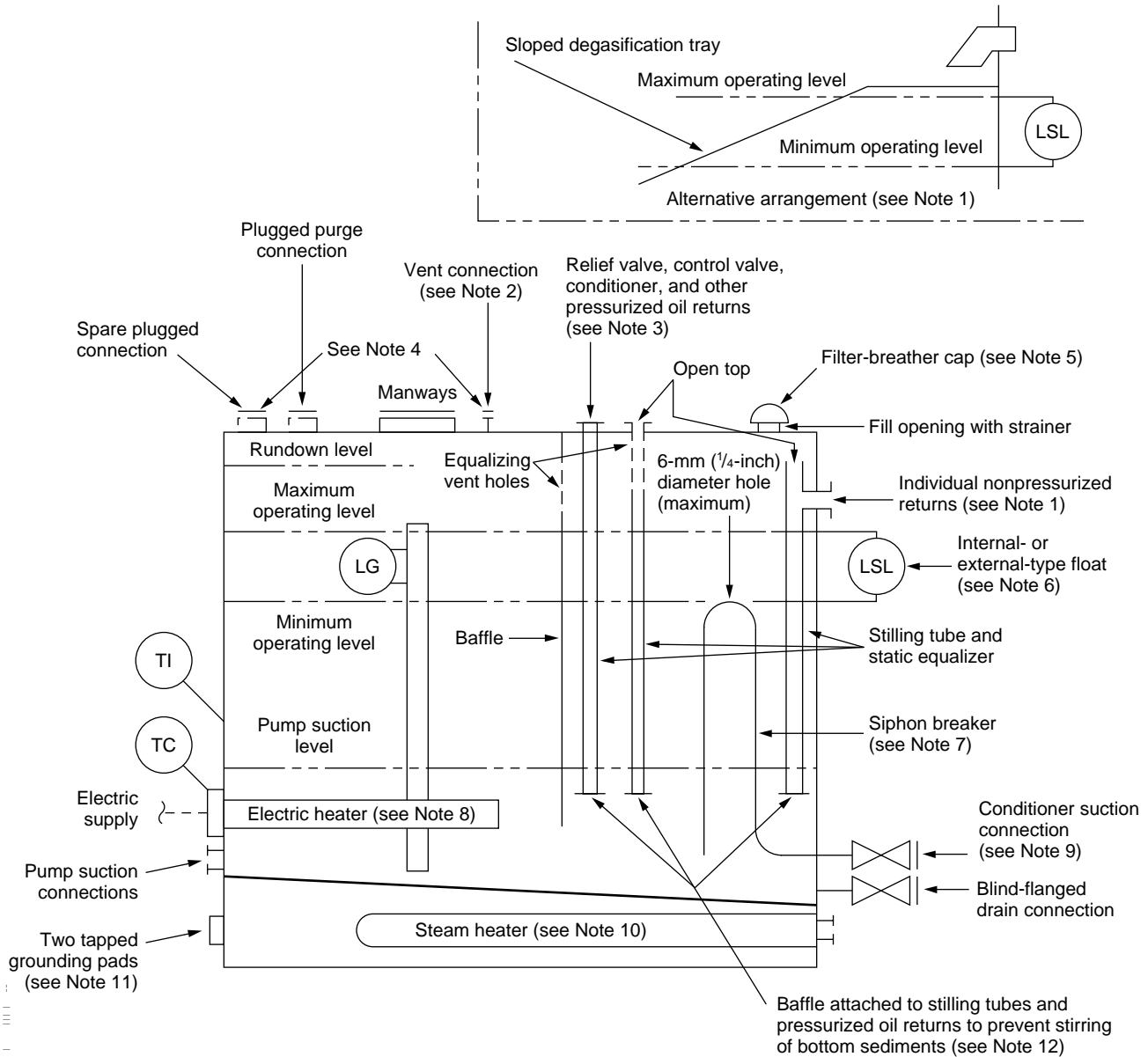
Notes:

1. Option 2A-20a: The purchaser may specify a bypass valve to start.
2. Option 2A-20b: The purchaser may specify an emergency pump that will take suction only from the reservoir.
3. Option 2A-20c: The purchaser may specify an alarm and/or a permissive start switch for the booster pumps or a low-pressure trip switch.

CAUTION: Trip switches are not recommended if auxiliary pump suction lines are used.

4. Option 2A-20d: The purchaser may specify an auxiliary emergency suction line from the reservoir to the main, standby, or emergency pump.

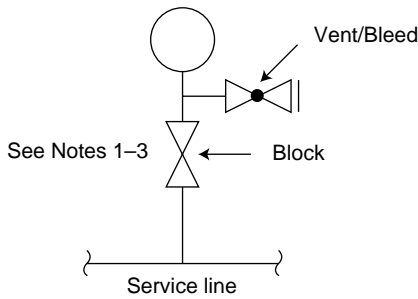
Figure 2A-20—Booster (Rotary) Pump Arrangement



**Notes:**

1. For nonpressurized gravity oil return lines and fill openings, a stilling tube or sloped degasification tray arranged to prevent splashing and provide free release of foam and gas is required for every return inlet and spare connection.
2. A blind flange shall be provided for venting the reservoir. For seal-oil reservoirs, this vent shall be piped to a safe location by the purchaser.
3. Option 2A-21a: the purchaser may specify a particular oil conditioner and other pressurized oil returns in addition to the spare top connection.
4. Purge and vent connections shall enter the top of the reservoir. No extension tubes or seals are permitted.
5. A filter-breather cap is not permitted on a reservoir containing seal-oil.
6. An internal-type float shall be protected by a static-conducting shield.
7. Option 2A-21b: the purchaser may specify a siphon breaker when an oil conditioner suction connection is specified.
8. Option 2A-21c: the purchaser may specify an electric heater.
9. Option 2A-21d: the purchaser may specify an oil conditioner suction connection.
10. Option 2A-21e: The purchaser may specify a steam heater.
11. Option 2A-21f: When specified, two tapped grounding pads positioned diagonally to each other shall be provided.
12. Individual oil returns shall be located away from the pump suction and arranged to provide the maximum residence time.

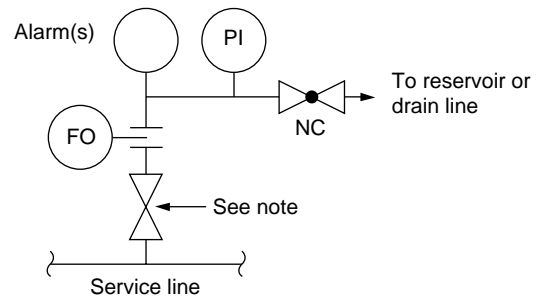
Figure 2A-21—Oil Reservoir



Notes:

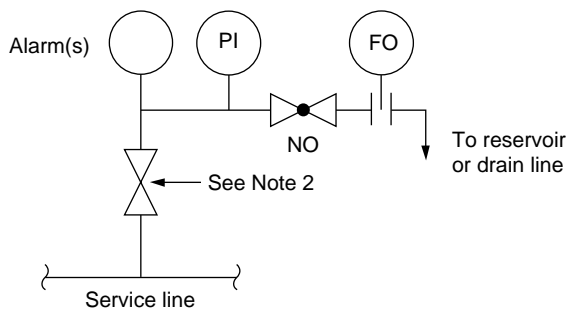
1. Option 2A-22a: If approved by the purchaser, a combination block and bleed gauge valve may be substituted for individual block and vent-bleed valves, except as specified in Note 2.
2. Option 2A-22Aa: Unless otherwise specified by the purchaser, block and vent-bleed valves shall be omitted for all instruments in trip service.
3. For services of less than or equal to 14 bar effective (200 psig), bleed valves may be omitted, except for arrangements shown in Figures 2A-22b and 2A-22c or when Note 2 applies.

Figure 2A-22A—Local Instrument Piping Details: Pressure Gauges, Switches, and Transmitters



Note: The block valve may be locked open.

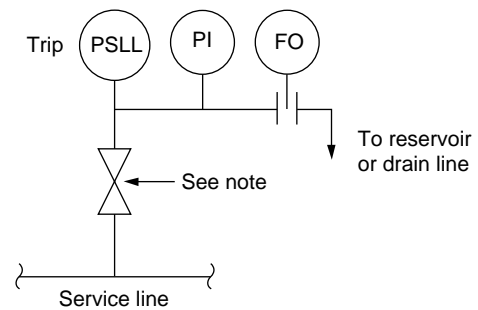
Figure 2A-22B—Local Instrument Piping Details: Combined Instrument System for Low-Pressure Alarms and Pump-Start Switches (Typical Design)



Notes:

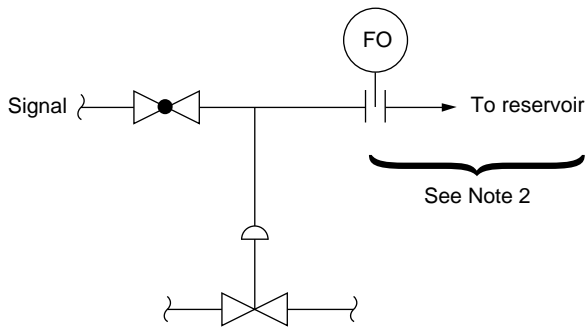
1. Option 2A-22c: This design is intended for cold climates and for pump-running alarm switches (high-pressure switches).
2. Option 2A-22Ca: The purchaser may specify a block valve. The block valve may be locked open.

Figure 2A-22C—Local Instrument Piping Details: Combined Instrument System for Low-Pressure Alarms and Pump-Start Switches (Alternative Design)



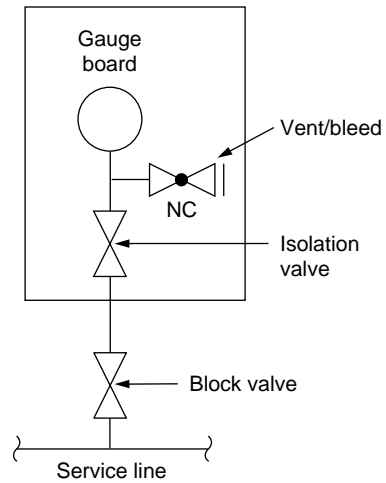
Note: The block valve may be locked open.

Figure 2A-22D—Local Instrument Piping Details: Low-Pressure Trip Switch (Alternative Design)



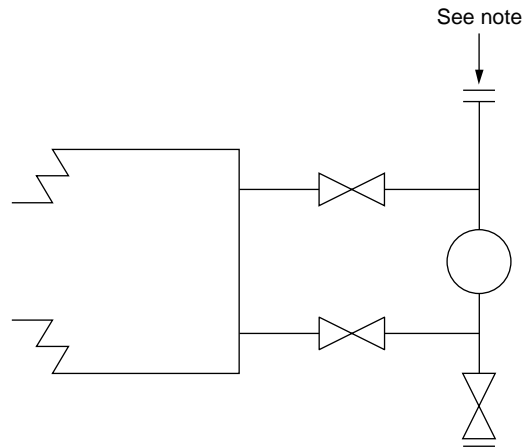
- Notes:
1. A diaphragm actuator is not required for air signals unless other devices are receiving the same signals.
  2. The reservoir and flow restriction orifice are for oil service.

Figure 2A-22E—Instrument Piping Details: Diaphragm Actuator



- Notes:
1. Combination isolation/bleed valve may be used.
  2. Unless otherwise specified by the purchaser, block, isolation, and vent-bleed valves shall be omitted for all instruments in trip service.
  3. For services of less than or equal to 14 bar effective (200 psig), bleed valves may be omitted, except for arrangements shown in Figures 2A-22B and 2A-22C or when Note 2 applies.

Figure 2A-22F—Remote Instrument Piping Details: Panel- and Board-Mounted Gauges, Switches, and Transmitters



Note: This connection may be added to facilitate cleaning of the level indicator.

Figure 2A-22G—Instrument Piping Details: Externally Connected Level Instruments





-- 111 1 11 11111 11111 1 1111 1---



-- 111 1 1 11111 11111 1 1111 1---

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 For \_\_\_\_\_ Site \_\_\_\_\_  
 Oil System for \_\_\_\_\_  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
 2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

Overall system typical schematics	Figure No.	Option Nos.	Comment
<input type="radio"/> Combined lube, seal, and control system			
<input type="radio"/> Separate seal-oil system			
<input type="radio"/> Seal module at equipment			
<input type="radio"/> Lube/control system			
<input type="radio"/> Basic oil supply module			
<input type="radio"/> Lube module at equipment			
<input type="radio"/> Drawing requirements		<input type="radio"/> Component review	

**Oil Requirements: See Chapter 1 data sheet (1.1.5, 1.1.6, 1.1.8, 1.1.9, and 1.1.13)**

<b>Supply arrangement:</b>	Lube Oil	Seal Oil	Combined	<b>Baseplates:</b>
<input type="radio"/> Separate console	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/> Point support
<input type="radio"/> Multiple package	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/> Grout hole/vent holes
<input type="radio"/> Package no. 1				<input type="radio"/> Epoxy grout/precoat
<input type="radio"/> Package no. 2				
<input type="radio"/> Package no. 3				

**Basic system details:**

Compressor block-in time \_\_\_\_\_ minutes  Process relief valve setting \_\_\_\_\_ (barg)  
 Equipment coast-down time \_\_\_\_\_ minutes  Shop test conditions  
**Equipment cool-off time:**  Field start-up/run-in conditions  
 Driver \_\_\_\_\_ minutes  Other special conditions  
 \_\_\_\_\_ other \_\_\_\_\_ minutes  Welding and special fabrication requirements  
 Minimum start-up oil temperature \_\_\_\_\_ °C  100% radiography  
**Other:**  Magnetic particle  
 Settling out pressures \_\_\_\_\_ (barg) (1.11.1)  Liquid penetrant

**Components:**

**Piping and Tubing:**

Material  Special requirements  
 Double blocks and bleeds  Utilities manifolded to common connections  
 Tight shutoff  Air  
 Tubing fittings—Mfg. \_\_\_\_\_ Model \_\_\_\_\_  Cooling water  
 Carbon steel slip-on flanges  Other  
 Through studs required  Instrument test valves required  
 Heat tracing required by  Purch.  Vendor  Valve heads vented to reservoir

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

<p><b>Oil Conditioners:</b></p> <p><input type="radio"/> Purchaser's item no.</p> <p><input type="radio"/> Service used in</p> <p><input type="radio"/> Type</p> <p><input type="radio"/> Portable or mounted on</p> <p><input checked="" type="radio"/> Rated flow of oil (m<sup>3</sup>/hr)</p> <p><input checked="" type="radio"/> Manufacture</p> <p><input checked="" type="radio"/> Model</p> <p><input type="checkbox"/> Driver for</p> <p><input checked="" type="radio"/> HP and enclosure</p> <p><input checked="" type="radio"/> Volts/PH/Hz</p> <p><input checked="" type="radio"/> ____/____/____</p> <p><input type="checkbox"/> Water removal rate</p> <p><input checked="" type="radio"/> Material of construction</p>	<p><b>Degassing Drum:</b></p> <p><input type="radio"/> Purchaser's item no.</p> <p><input type="radio"/> Type per Figure 2A-4 or other spec</p> <p>Operating temp. ____ °C</p> <p>m<sup>3</sup>/hr normal/max. ____ / ____</p> <p>Normal retention ____ minutes</p> <p>Norm/max. capacity ____ / ____</p> <p><input type="radio"/> Purge gas type</p> <p><input type="checkbox"/> SCFM required</p> <p><input type="radio"/> Type heating device</p> <p><input type="radio"/> Corrosion allowance</p> <p><input type="radio"/> Design/test barg ____ / ____</p> <p><input type="radio"/> Other</p> <p><input type="radio"/> Other</p>	<p><input type="radio"/> Service used in</p> <p><input type="radio"/> Flow control</p> <p><input type="radio"/> Thermostat control</p> <p><input checked="" type="radio"/> Material</p> <p><input checked="" type="radio"/> Interior coating</p> <p><input checked="" type="radio"/> Oversized vent</p> <p><input type="radio"/> Vent relief device</p> <p><input type="radio"/> Omit breather</p> <p><input type="radio"/> Code construction</p> <p><input type="radio"/> Code stamp</p> <p><input type="radio"/> Other</p> <p><input type="radio"/> Other</p> <p><input type="radio"/> Other</p>
--	---	--

**Reservoir**

Service application  Separate lube  Lube/seal combined  Separate seal

Purchaser's item no.

Figures no.

Include options no.

Heater steam/electric (S/E)

Heater in sealed tube

Material

Normal flow m<sup>3</sup>/hr

Free surface—m<sup>2</sup>

Working capacity (min/liter)

Retention capacity (min/liter)

Rundown capacity

Normal operating range

Charge capacity

Insulation clips

Ladder with handrail

Handrails on top

Non-skid decking

Flanged vent

Oversized flanged vent

Pressure relief device type

Siphon breaker

Top mounted components permitted

Top mounted components are:

Submerged components and materials

Dimensions of tank L x W x H (m) / / / /

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 3 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Pumps and drivers:	Lube		Lube/seal		Separate seal oil	Booster seal
	main/ standby	emergency	main/ standby	emergency	main/standby	emergency
<input type="radio"/> Service application						
<input type="radio"/> Figure nos.						
<input type="radio"/> Include option nos.						
<input type="radio"/> Emergency pump system	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<b>Pump service</b>						
<input type="radio"/> Pump item no.						
<input type="radio"/> Pump type						
<input type="radio"/> Pump data sheet						
<input type="radio"/> Horizontal or vertical (H/V)						
<input type="radio"/> Driver item no.						
<input type="radio"/> Turbine driver for						
<input type="radio"/> Turbine data sheet						
<input type="radio"/> Electric motor for						
<input type="radio"/> Electric motor data sheet						
<input type="radio"/> Other driver						
<input type="radio"/> Other driver data sheet						
<input type="radio"/> Coupling type						
<input type="radio"/> Booster pumps required						
<input type="radio"/> Booster suction protection						
<input type="radio"/> Solenoid trip valve						
<input type="radio"/> Rotary pump relief valve by purchaser/vendor						

**Filters:**

Service application:	<input type="radio"/> Lube oil, <input type="radio"/> Seal oil & <input checked="" type="radio"/> Control oil	<input checked="" type="radio"/> Separate control oil	<input type="radio"/> Separate seal oil	<input type="radio"/> Booster pump discharge oil	<input type="radio"/> Separate coupling oil
<input type="radio"/> Purchase item no.					
<input type="radio"/> Twin	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Second filter for control oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.					
<input type="radio"/> Filtration level					
<input checked="" type="radio"/> Manufacturer					
<input checked="" type="radio"/> Model					
<input checked="" type="radio"/> Design/test psig	/	/	/	/	/
Code const/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
Material: case and top					
Cartridges:					

Furnish \_\_\_\_\_ extra sets of cartridges.  per service  per filter (extra over other spares).

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 4 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

**Coolers:**

Service application	<input type="radio"/> Lube	<input type="radio"/> Lube/seal	<input type="radio"/> Separate seal oil
<input type="radio"/> Purchaser item nos.			
<input type="radio"/> Twin units	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.			
<input type="radio"/> Water side for steam heating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Details on data sheet			
<input type="checkbox"/> Water side corrosion allowance			
<input type="checkbox"/> Manufacturer			
<input type="checkbox"/> Model			
<input type="radio"/> TEMA class			
<input type="checkbox"/> Fouling factor water/oil-side			
Duty: Btu/hr			
<input type="checkbox"/> Tube: L/OD/BWG			
<input type="checkbox"/> Design/test shell side (barg)			
<input type="checkbox"/> Design/test tube side (barg)			
<input type="radio"/> Code construction/stamp	<input type="radio"/> / <input type="radio"/>	<input type="radio"/> / <input type="radio"/>	<input type="radio"/> / <input type="radio"/>
<input type="checkbox"/> Tube water vel. and cap. (mps/m <sup>3</sup> /hr)	/	/	/
<input type="checkbox"/> Material: shell			
<input type="checkbox"/> Channels and covers			
<input type="checkbox"/> Tube sheets and tubes			
<input type="radio"/> Removable tube bundle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> U-bend tubes permitted	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Oil temperature control valve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Continuous Flow Transfer Valves:**

Service application:	<input type="radio"/> Lube oil, <input type="radio"/> Seal oil and <input type="checkbox"/> Control oil	<input type="checkbox"/> Separate control oil	<input type="radio"/> Separate seal oil	<input type="radio"/> Booster pump discharge oil	<input type="radio"/> Separate coupling oil
<input type="radio"/> Common for coolers and filters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Tight shutoff required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Type					
<input type="checkbox"/> Manufacturer					
<input type="checkbox"/> Model					
<input type="checkbox"/> With lifting jack	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rating: barg					
<input type="checkbox"/> Materials: Body					
<input type="checkbox"/> Plug or ball					
<input type="checkbox"/> Trim					



**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 5 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

<b>Accumulators:</b>				
Service application	Lube oil	Control oil	Seal oil	Seal oil booster
<input type="radio"/> Purchaser's item no.				
<input checked="" type="checkbox"/> Required, yes or no, and quantity				
<input checked="" type="checkbox"/> Service combined with				
<input checked="" type="checkbox"/> Direct contact type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Bladder type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.				
<input type="radio"/> Rundown (min.)				
<input type="radio"/> Oil temperature control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Constant pressure regulator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Manufacturer				
<input checked="" type="checkbox"/> Model				
<input checked="" type="checkbox"/> Nominal/usable capacity (liters)				
<input type="radio"/> Material: Shell				
<input type="radio"/> Bladder				
<input type="radio"/> Design/test (barg)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<input type="radio"/> Include: charge pressure gauge plus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Manual charge valve or	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Gas supply regulator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Overhead tanks (Figs. 2A-12, 2A-13)</b>				
Service application	Rundown lube	Low pressure seal	Medium pressure seal	High pressure seal
<input type="radio"/> Required, yes or no				
<input checked="" type="checkbox"/> Service combined with				
<input type="radio"/> Direct contact tank	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Bladder type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include options no.				
<input type="checkbox"/> Capacity (mins)				
<input type="checkbox"/> Capacity (liters)				
<input type="radio"/> Blowdown connection				
<b>Rundown tanks (Figs. 2A-12a, 2A-12b)</b>				
<b>Overhead tank (Figs. 2A-12, 2A-13)</b>				
<input type="radio"/> Corrosion allowance				
<input checked="" type="checkbox"/> Material				
<input checked="" type="checkbox"/> Total capacity (liters)				
<input checked="" type="checkbox"/> Design/test (barg)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 6 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built				
Supplier _____		Manufacturer _____		
Purchase Order No. _____		Date _____	Inquiry no. _____ Requisition No. _____	
<b>Accumulator unit (Figure 2A-13)</b>	Rundown lube	Low pressure seal	Medium pressure seal	High pressure seal
<input type="radio"/> Purchaser item no.				
<input type="radio"/> Corrosion allow.				
<input checked="" type="checkbox"/> Manufacture and quantity				
<input checked="" type="checkbox"/> Model				
<input checked="" type="checkbox"/> Material: Shell				
<input checked="" type="checkbox"/> Bladder				
<input type="checkbox"/> Nominal/usable capacity (m <sup>3</sup> )				
<input checked="" type="checkbox"/> Design/test (barg)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<b>Traps for inner seal oil: (oil seals)</b>				
<input type="radio"/> Service application				
<input type="radio"/> Purchaser's item no.				
<input type="radio"/> Seal-gas vent piping arrangement				
<input type="radio"/> float controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> transmitter controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> pots only, for manual drain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> with: valving	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Flush level glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> High level switch	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.				
Retention: hours/liter				
<b>Float trap</b>				
<input checked="" type="checkbox"/> Manufacturer/model				
<input checked="" type="checkbox"/> Pressure rating (barg)				
<input checked="" type="checkbox"/> Materials: body				
<input checked="" type="checkbox"/> Float/trim				
<input type="radio"/> Drain line piped to:				
<b>Drain pot</b>				
<input type="radio"/> Corrosion allowance				
<input checked="" type="checkbox"/> Material				
<input checked="" type="checkbox"/> Design/test (barg)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<b>Mist eliminator</b>				
<input type="radio"/> Corrosion allowance				
<input checked="" type="checkbox"/> Material: shell				
<input checked="" type="checkbox"/> Demisting mesh				
<input checked="" type="checkbox"/> Design/test (barg)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 7 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Shop inspection		Shop test	
<input type="checkbox"/>		Required	Witness
<input type="checkbox"/>	Compliance with inspector's checklist		
<input type="checkbox"/>	Required for system assemblies	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Cleanliness prior to closure	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Required for major components	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Material certifications to be furnished	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Special examinations	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Code construction/stamp	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Certified copies of all test logs and data	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>			
<input type="checkbox"/>			

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 For \_\_\_\_\_ Site \_\_\_\_\_  
 Oil System for \_\_\_\_\_  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
 2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

Overall system typical schematics	Figure No.	Option Nos.	Comment
<input type="radio"/> Combined lube, seal, and control system			
<input type="radio"/> Separate seal-oil system			
<input type="radio"/> Seal module at equipment			
<input type="radio"/> Lube/control system			
<input type="radio"/> Basic oil supply module			
<input type="radio"/> Lube module at equipment			
<input type="radio"/> Drawing requirements		<input type="radio"/> Component review	

**Oil Requirements: See Chapter 1 data sheet (1.1.5, 1.1.6, 1.1.8, 1.1.9, and 1.1.13)**

<b>Supply arrangement:</b>	Lube Oil	Seal Oil	Combined	<b>Baseplates:</b>
<input type="radio"/> Separate console	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/> Point support
<input type="radio"/> Multiple package	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/> Grout hole/vent holes
<input type="radio"/> Package no. 1				<input type="radio"/> Epoxy grout/precoat
<input type="radio"/> Package no. 2				
<input type="radio"/> Package no. 3				

**Basic system details:**

Compressor block-in time \_\_\_\_\_ minutes  Process relief valve setting \_\_\_\_\_ (psig)  
 Equipment coast-down time \_\_\_\_\_ minutes  Shop test conditions  
**Equipment cool-off time:**  Field start-up/run-in conditions  
 Driver \_\_\_\_\_ minutes  Other special conditions  
 \_\_\_\_\_ other \_\_\_\_\_ minutes  Welding and special fabrication requirements  
 Minimum start-up oil temperature \_\_\_\_\_ °F  100% radiography  
**Other:**  Magnetic particle  
 Settling out pressures \_\_\_\_\_ (psig) (1.11.1)  Liquid penetrant

**Components:**

**Piping and Tubing:**

Material  Special requirements  
 Double blocks and bleeds  Utilities manifolded to common connections  
 Tight shutoff  Air  
 Tubing fittings—Mfg. \_\_\_\_\_ Model \_\_\_\_\_  Cooling water  
 Carbon steel slip-on flanges  Other  
 Through studs required  Instrument test valves required  
 Heat tracing required by  Purch.  Vendor  Valve heads vented to reservoir

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

**Oil Conditioners:**

- Purchaser's item no.
- Service used in
- Type
- Portable or mounted on
- Rated GPM of oil
- Manufacture
- Model
- Driver for
  - HP and enclosure
  - Volts/PH/Hz
  - \_\_\_\_/\_\_\_\_/\_\_\_\_
- Water removal rate
- Material of construction

**Degassing Drum:**

- Purchaser's item no.
- Type per Figure 2A-4 or other spec
- Operating temp. \_\_\_\_°F
- GPM normal/max. \_\_\_\_/\_\_\_\_
- Normal retention \_\_\_\_ minutes
- Norm/max. capacity \_\_\_\_/\_\_\_\_
- Purge gas type
- SCFM required
- Type heating device
- Corrosion allowance
- Design/test psig \_\_\_\_/\_\_\_\_
- Other
- Other
- Other

- Service used in
- Flow control
- Thermostat control
- Material
  - Interior coating
  - Oversized vent
- Vent relief device
- Omit breather
- Code construction
- Code stamp
- Other
- Other
- Other

**Reservoir**

Service application  Separate lube  Lube/seal combined  Separate seal

- Purchaser's item no.
- Figures no.
- Include options no.
- Heater steam/electric (S/E)
- Heater in sealed tube
- Material
- Normal flow GPM
- Free surface—ft<sup>2</sup>
- Working capacity (min/gal)
- Retention capacity (min/gal)
- Rundown capacity
- Normal operating range
- Charge capacity
- Insulation clips
- Ladder with handrail
- Handrails on top
- Non-skid decking
- Flanged vent
- Oversized flanged vent
- Pressure relief device type
- Siphon breaker
- Top mounted components permitted
- Top mounted components are:
- Submerged components and materials
- Dimensions of tank L x W x H (ft) / / / /

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 3 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built						
Supplier _____		Manufacturer _____				
Purchase Order No. _____		Date _____		Inquiry no. _____		Requisition No. _____
Pumps and drivers:	Lube		Lube/seal		Separate seal oil	Booster seal
<input type="checkbox"/> Service application						
<input type="checkbox"/> Figure nos.						
<input type="checkbox"/> Include option nos.						
<input type="checkbox"/> Emergency pump system	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
<i>Pump service</i>	main/ standby	emergency	main/ standby	emergency	main/standby	emergency
<input type="checkbox"/> Pump item no.						
<input type="checkbox"/> Pump type						
<input type="checkbox"/> Pump data sheet						
<input type="checkbox"/> Horizontal or vertical (H/V)						
<input type="checkbox"/> Driver item no.						
<input type="checkbox"/> Turbine driver for						
<input type="checkbox"/> Turbine data sheet						
<input type="checkbox"/> Electric motor for						
<input type="checkbox"/> Electric motor data sheet						
<input type="checkbox"/> Other driver						
<input type="checkbox"/> Other driver data sheet						
<input type="checkbox"/> Coupling type						
<input type="checkbox"/> Booster pumps required						
<input type="checkbox"/> Booster suction protection						
<input type="checkbox"/> Solenoid trip valve						
<input type="checkbox"/> Rotary pump relief valve by purchaser/vendor						
Filters:						
Service application:	<input type="checkbox"/> Lube oil, <input type="checkbox"/> Seal oil & <input checked="" type="checkbox"/> Control oil	<input checked="" type="checkbox"/> Separate control oil	<input type="checkbox"/> Separate seal oil	<input type="checkbox"/> Booster pump discharge oil	<input type="checkbox"/> Separate coupling oil	
<input type="checkbox"/> Purchase item no.						
<input type="checkbox"/> Twin	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Second filter for control oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Include option nos.						
<input type="checkbox"/> Filtration level						
<input checked="" type="checkbox"/> Manufacturer						
<input checked="" type="checkbox"/> Model						
<input checked="" type="checkbox"/> Design/test psig	/	/	/	/	/	/
Code const/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
Material: case and top						
Cartridges:						
Furnish _____ extra sets of cartridges. <input type="checkbox"/> per service <input type="checkbox"/> per filter (extra over other spares).						

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 4 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

<b>Coolers:</b>			
Service application	<input type="radio"/> Lube	<input type="radio"/> Lube/seal	<input type="radio"/> Separate seal oil
<input type="radio"/> Purchaser item nos.			
<input type="radio"/> Twin units	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.			
<input type="radio"/> Water side for steam heating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Details on data sheet			
<input checked="" type="checkbox"/> Water side corrosion allowance			
<input checked="" type="checkbox"/> Manufacturer			
<input checked="" type="checkbox"/> Model			
<input type="radio"/> TEMA class			
<input checked="" type="checkbox"/> Fouling factor water/oil-side			
Duty: Btu/hr			
<input checked="" type="checkbox"/> Tube: L/OD/BWG			
<input checked="" type="checkbox"/> Design/test shell side (psig)			
<input checked="" type="checkbox"/> Design/test tube side (psig)			
<input type="radio"/> Code construction/stamp	<input type="radio"/> / <input type="radio"/>	<input type="radio"/> / <input type="radio"/>	<input type="radio"/> / <input type="radio"/>
<input checked="" type="checkbox"/> Tube water vel. and cap. (fps/gpm)	/	/	/
<input checked="" type="checkbox"/> Material: shell			
<input checked="" type="checkbox"/> Channels and covers			
<input checked="" type="checkbox"/> Tube sheets and tubes			
<input type="radio"/> Removable tube bundle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> U-bend tubes permitted	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Oil temperature control valve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Continuous Flow Transfer Valves:</b>					
<input type="radio"/> Service application:	<input type="radio"/> Lube oil, <input type="radio"/> Seal oil and <input checked="" type="checkbox"/> Control oil	<input checked="" type="checkbox"/> Separate control oil	<input type="radio"/> Separate seal oil	<input type="radio"/> Booster pump discharge oil	<input type="radio"/> Separate coupling oil
<input type="radio"/> Common for coolers and filters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Tight shutoff required	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Type					
<input checked="" type="checkbox"/> Manufacturer					
<input checked="" type="checkbox"/> Model					
<input checked="" type="checkbox"/> With lifting jack	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rating: psig					
<input checked="" type="checkbox"/> Materials: Body					
<input checked="" type="checkbox"/> Plug or ball					
<input checked="" type="checkbox"/> Trim					

**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 5 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

<b>Accumulators:</b>				
Service application	Lube oil	Control oil	Seal oil	Seal oil booster
<input type="radio"/> Purchaser's item no.				
<input type="checkbox"/> Required, yes or no, and quantity				
<input type="checkbox"/> Service combined with				
<input type="checkbox"/> Direct contact type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Bladder type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.				
<input type="radio"/> Rundown (min.)				
<input type="radio"/> Oil temperature control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Constant pressure regulator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Manufacturer				
<input type="checkbox"/> Model				
<input type="checkbox"/> Nominal/usable capacity (gal.)				
<input type="radio"/> Material: Shell				
<input type="radio"/> Bladder				
<input type="radio"/> Design/test (psig)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<input type="radio"/> Include: charge pressure gauge plus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Manual charge valve or	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Gas supply regulator	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Overhead tanks (Figs. 2A-12, 2A-13)</b>				
Service application	Rundown lube	Low pressure seal	Medium pressure seal	High pressure seal
<input type="checkbox"/> Required, yes or no				
<input type="checkbox"/> Service combined with				
<input type="radio"/> Direct contact tank	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Bladder type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include options no.				
<input type="checkbox"/> Capacity (mins)				
<input type="checkbox"/> Capacity (gal.)				
<input type="radio"/> Blowdown connection				
<b>Rundown tanks (Figs. 2A-12a, 2A-12b)</b>				
<b>Overhead tank (Figs. 2A-12, 2A-13)</b>				
<input type="radio"/> Corrosion allowance				
<input type="checkbox"/> Material				
<input type="checkbox"/> Total capacity (gal.)				
<input type="checkbox"/> Design/test (psig)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>



**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 6 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built				
Supplier _____		Manufacturer _____		
Purchase Order No. _____		Date _____	Inquiry no. _____ Requisition No. _____	
<b>Accumulator unit (Figure 2A-13)</b>	<b>Rundown lube</b>	<b>Low pressure seal</b>	<b>Medium pressure seal</b>	<b>High pressure seal</b>
<input type="radio"/> Purchaser item no.				
<input type="radio"/> Corrosion allow.				
<input checked="" type="checkbox"/> Manufacture and quantity				
<input checked="" type="checkbox"/> Model				
<input checked="" type="checkbox"/> Material: Shell				
<input checked="" type="checkbox"/> Bladder				
<input type="checkbox"/> Nominal/usable capacity				
<input checked="" type="checkbox"/> Design/test psig				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<b>Traps for inner seal oil: (oil seals)</b>				
<input type="radio"/> Service application				
<input type="radio"/> Purchaser's item no.				
<input type="radio"/> Seal-gas vent piping arrangement				
<input type="radio"/> float controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> transmitter controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> pots only, for manual drain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> with: valving	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Flush level glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> High level switch	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Include option nos.				
Retention: hours/gal.				
<b>Float trap</b>				
<input checked="" type="checkbox"/> Manufacturer/model				
<input checked="" type="checkbox"/> Pressure rating (psig)				
<input checked="" type="checkbox"/> Materials: body				
<input checked="" type="checkbox"/> Float/trim				
<input type="radio"/> Drain line piped to:				
<b>Drain pot</b>				
<input type="radio"/> Corrosion allowance				
<input checked="" type="checkbox"/> Material				
<input checked="" type="checkbox"/> Design/test (psig)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>
<b>Mist eliminator</b>				
<input type="radio"/> Corrosion allowance				
<input checked="" type="checkbox"/> Material: shell				
<input checked="" type="checkbox"/> Demisting mesh				
<input checked="" type="checkbox"/> Design/test (psig)				
<input type="radio"/> Code construction/stamp	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>	<input type="checkbox"/> / <input type="checkbox"/>

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**API 614—Chapter 2 DATA SHEET  
SPECIAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 7 of 7 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Shop inspection	Shop test		
		Required	Witness
<input type="checkbox"/> Compliance with inspector's checklist			
<input type="checkbox"/> Required for system assemblies	<input type="checkbox"/> Cleanliness	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Cleanliness prior to closure	<input type="checkbox"/> Four hour run	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Required for major components	<input type="checkbox"/> Check controls	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Material certifications to be furnished	<input type="checkbox"/> Changeover filters/coolers	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Special examinations	<input type="checkbox"/> One and two pump operation	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Code construction/stamp	<input type="checkbox"/> Sound level	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Certified copies of all test logs and data	<input type="checkbox"/> Hydro test assembled system	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/> Use for complete unit system test	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/> Certified copies of all test logs and data	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>		
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**CHAPTER 2**  
**APPENDIX C—INSPECTOR’S CHECKLIST (INFORMATIVE)**





## Chapter 2—Inspector’s Checklist

Item	Date Inspected	Inspected By	Status
1. Sound pressure level requirements met (1.1.6).			
2. Oil characteristics.			
a. Per specification (1.1.8).			
b. Hydrotest compatible (7.3.2.4) in Chapter 1.			
c. Run-test compatible (4.3.3.3).			
3. Compatible rust preventatives used (7.4.3.3, 7.4.3.4) in Chapter 1.			
4. Lube-oil/seal-oil separation demonstrated (if applicable) (1.1.7).			
5. System arrangement (1.1.14).			
a. Per drawings (1.2.1).			
b. Providing adequate clearances.			
c. Providing safe access.			
d. Adequate for maintenance (1.1.14, 1.1.15).			
6. ASME Code stamp (if applicable) (1.1.20).			
a. Coolers.			
b. Filters.			
c. Accumulators.			
d. Lube-oil rundown tanks (1.9.2.4).			
e. Drain traps.			
f. Other pressure vessels.			
g. Overhead seal-oil tanks (1.9.1.3).			
h. Degassing drum (1.11.6).			
7. Welding operators and procedures qualified per Section IX of ASME Code.			
a. Welding of pressure vessels (1.1.24).			
(1) Coolers.			
(2) Filters.			
(3) Accumulators			
(4) Lube-oil rundown tanks.			
(5) Seal-oil tanks.			
(6) Degassing drum.			
(7) Other pressure vessels.			
(8) Oil conditioner.			
b. Welding of oil piping (2.1.1).			
c. Welding of oil reservoir (if specified) ( <i>1.3.II</i> ).			
d. Dissimilar-metal welding and weld repairs (1.1.24).			
e. Verification of welds (4.2.3.3) in Chapter 1.			

Item	Date Inspected	Inspected By	Status
8. Welding procedures (other than above) (1.2.7).			
a. Baseplates			
b. Panels.			
c. Nonpressure ducting.			
d. Other.			
9. Baseplates			
a. Major components mounted directly on structural steel (1.2.1).			
b. Adequate drain gutter (1.2.2).			
c. Adequate lifting lug (distortion, damage) (1.2.3).			
d. Metal decking (1.2.4).			
e. Precoat for epoxy grout (1.2.8).			
10. Reservoir top sealed and sloped properly (1.3.2.1, 1.3.2.2).			
11. Manway openings adequate (1.3.4).			
12. Reservoir heaters adequate for the application (1.3.7.2.1).			
13. Clips provided.			
a. Insulation clips (1.3.8).			
b. Grounding clips (1.3.14).			
14. Pumps.			
a. Piping vented or arranged to avoid air pockets (1.4.16).			
b. Strainers installed and tabbed (1.4.17).			
c. Alignment checked (1.4.23.4).			
d. Mounting surfaces flat and parallel (1.4.24.1).			
e. Shims installed (1.4.24.2).			
f. Bolting and unbolting of piping demonstrated (1.4.24.5).			
g. Jackscrews adequate (1.4.24.6)			
15. Oil Filters.			
a. Drainability demonstrated (1.6.2.8).			
16. Oil conditioner siphon breaker installed and demonstrated (1.3.10.1).			
17. Piping.			
a. Examined and inspected per ASME B31.3 (2.1.1, 2.1.12) in chapter 1.			
b. Fabricated per specification (2.1.6).			
18. Oil drains shown to run not more than half full (2.2.1).			
19. Electrical systems/panels.			
a. Wiring suitable (3.5.3).			
b. Spare terminal points adequate (3.5.4).			

Item	Date Inspected	Inspected By	Status
c. Clearances adequate for maintenance (3.5.5).			
d. Fungus/corrosion protection provided (3.5.6.1, 3.5.6.2).			
e. Wiring clearly labeled and isolated (3.5.7, 3.5.8).			
20. Material inspected as specified (list each component) (7.2.2) in Chapter 1.			
21. Components inspected for cleanliness (list each) (7.2.3.2) in Chapter 1.			
22. Hydrostatic tests.			
a. Hydrotests certified (list each component) (7.3.2.1) in Chapter 1.			
b. Assembled oil system hydrostatic test performed (7.3.2.1) in Chapter 1.			
c. Chlorides in hydrotest liquid addressed adequately (7.3.2.4) in Chapter 1.			
d. Test pressures verified (7.3.2.2, 7.3.2.3) in Chapter 1.			
23. Operational tests.			
a. System cleanliness verified after operational tests (4.3.3.1.2).			
b. All leaks corrected before starting (4.3.3.5.1).			
c. Limiting pressures verified (4.3.3.5.2).			
d. Filter-cooler changeover performed (4.3.3.5.3).			
e. Control valve response and stability demonstrated (4.3.3.5.4, 4.3.3.5.5, 4.3.3.5.7).			
f. Pressure drop on pump trip checked/demonstrated (4.3.3.5.6).			
g. Transfer valve leakage demonstrated (4.3.3.6).			
h. System cleanliness after test demonstrated (4.3.3.7.1, 4.3.3.7.2).			
24. Painting (7.4.3.1) in Chapter 1.			
25. Preparation for shipment.			
a. Equipment cleaned and prepared properly (7.4.3) in Chapter 1.			
b. Items properly tagged (7.4.3.9) in Chapter 1.			
c. Storage/handling/installation instructions received (7.4.2, 7.4.8) in Chapter 1.			
d. Piping and components adequately braced (7.4.3.10) in Chapter 1.			
e. Connections properly tagged (7.4.6) in Chapter 1.			
f. Shipping documents included (7.4.3.9) in Chapter 1.			

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**CHAPTER 2**  
**APPENDIX D—COST ESTIMATE WORKSHEET FOR SPECIAL-  
PURPOSE OIL SYSTEM (INFORMATIVE)**

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**API 614, 4th Edition—Cost Estimating Worksheet for  
Special Purpose Oil System**

(\*Indicates that customer is to enter data.)

<u>System Type</u>		<u>Maximum Gas Pressure</u>	<u>kPa</u>	<u>(psig)</u>
Lube oil only	( )	Suction	___	___
Seal oil only (no boost)	( )	Discharge	___	___
Seal oil only (w/boost)	( )	Settle-out	___	___
Combined lube and seal oil (no boost)	( )	* Process relief	___	___
Combined lube and seal oil (w/boost)	( )			
Lube and control oil	( )			
Lube, seal, and control oil (no boost)	( )			
Lube, seal, and control oil (w/boost)	( )			

Equipment Oil Requirements

<u>Lube Oil</u>	<u>m<sup>3</sup>/h</u>	<u>kPa</u>	<u>(gpm)</u>	<u>(psig)</u>
Compressor #1	___	___	___	___
Compressor #2	___	___	___	___
Compressor #3	___	___	___	___
Prime mover	___	___	___	___
Gear	___	___	___	___
other: _____	___	___	___	___
other: _____	___	___	___	___
Total	___	___	___	___

<u>Control Oil</u>		<u>Normal</u>			<u>Transient</u>	
	<u>m<sup>3</sup>/h</u>	<u>kPa</u>	<u>(gpm)</u>	<u>(psig)</u>	<u>m<sup>3</sup>/h</u>	<u>(gpm)</u>
Steam turbine	___	___	___	___	___	___

<u>Seal Oil</u>		<u>Normal</u>		<u>Maximum</u>				
	<u>m<sup>3</sup>/h</u>	<u>kPa</u>	<u>(gpm)</u>	<u>(psig)</u>	<u>m<sup>3</sup>/h</u>	<u>kPa</u>	<u>(gpm)</u>	<u>(psig)</u>
Compressor #1	___	___	___	___	___	___	___	___
Compressor #2	___	___	___	___	___	___	___	___
Compressor #3	___	___	___	___	___	___	___	___
Total	___	___	___	___	___	___	___	___

<u>Total Heat Load</u>	<u>Lube oil (+ control oil)</u>	<u>Lube and seal oil (+ control oil)</u>	<u>Separate seal oil</u>
kcal/h	___	___	___
(Btu/h)	___	___	___

\* Reservoir

Material: ( ) CS ( ) SS - type \_\_\_\_\_  
 Heater: ( ) None ( ) Steam ( ) Electric

\* Pumps

Type: ( ) Positive displacement ( ) Centrifugal  
 PD pump mounting: ( ) Horizontal ( ) Vertical

\* Drivers

	<u>Main</u>	<u>Auxiliary</u>	<u>Emergency</u>	<u>Other (_____)</u>
Motor (AC)	( )	( )	( )	( )
Steam turbine	( )			
Motor (DC)			( )	( )

Accumulator

Service: ( ) Pump transfer ( ) Control oil transient ( ) other: \_\_\_\_\_  
Type: ( ) Bladder ( ) Direct contact ( ) other: \_\_\_\_\_  
\* Shell material: ( ) CS ( ) SS - type \_\_\_\_\_  
Volume #1 - \_\_\_ m<sup>3</sup> (\_\_\_ gal)  
Volume #2 - \_\_\_ m<sup>3</sup> (\_\_\_ gal)  
Volume #3 - \_\_\_ m<sup>3</sup> (\_\_\_ gal)

\* Lube Oil Rundown Tank

Type: ( ) Atmospheric ( ) Pressurized  
Material: ( ) CS ( ) SS - type \_\_\_\_\_

\* Coolers

Type: ( ) Shell and tube ( ) Fin fan ( ) Plate frame  
Shell material: ( ) CS ( ) SS - type \_\_\_\_\_  
Tube material: ( ) Inhibited admiralty ( ) other: \_\_\_\_\_  
Tube sheet material: ( ) Naval brass ( ) other: \_\_\_\_\_  
Coolant: ( ) Water T in \_\_\_ deg C (\_\_\_ deg F) P in \_\_\_ kPa (\_\_\_ psig)  
T out max \_\_\_ deg C (\_\_\_ deg F) P out \_\_\_ kPa (\_\_\_ psig)  
( ) Air T max \_\_\_ deg C (\_\_\_ deg F) T min \_\_\_ deg C (\_\_\_ deg F)  
( ) other: \_\_\_\_\_  
Shell and tube type: ( ) AEW ( ) AES ( ) AEU ( ) other: \_\_\_\_\_  
TEMA: ( ) C ( ) R

\* Filters

Shell material: ( ) CS ( ) SS - type \_\_\_\_\_

\* Piping

Material: SS - type \_\_\_\_\_  
Flanges: ( ) CS slip-on ( ) SS slip-on ( ) SS weld neck

\* Degassing Tank

Material: ( ) CS ( ) SS - type \_\_\_\_\_  
Type: ( ) Atmospheric ( ) Pressurized - \_\_\_ kPa (\_\_\_ psig)  
Heater: ( ) Steam ( ) Electric  
Volume - \_\_\_ m<sup>3</sup> (\_\_\_ gal)

\* Instrumentation

( ) Switches ( ) Transmitters

\* Junction Boxes

( ) Explosion proof ( ) NEMA 4 ( ) NEMA 4X  
Material: ( ) CS ( ) Feraloy ( ) Copper-free aluminum ( ) SS - type \_\_\_\_\_

\* Special Requirements

( ) Material certifications  
( ) Winterization  
( ) Tropicalization  
Third party approval: ( ) CSA ( ) UL ( ) FM ( ) CENELEC  
( ) BASEEFA ( ) other: \_\_\_\_\_ ( ) Certificates required  
Units: ( ) SI ( ) Customary  
Painting: ( ) Vendor's standard ( ) other: \_\_\_\_\_  
Preparation for shipment: ( ) Domestic ( ) Export box

\* Utilities

Electrical (motors): \_\_\_ Phase \_\_\_ Hertz \_\_\_ Volts  
Electrical (controls): \_\_\_ Phase \_\_\_ Hertz \_\_\_ Volts  
Electrical classification: ( ) Class \_\_\_ Group \_\_\_ Division \_\_\_  
( ) Zone \_\_\_ Group \_\_\_ Temperature class \_\_\_  
Steam: P in \_\_\_ kPa (\_\_\_ psig) T in \_\_\_ deg C (\_\_\_ deg F)  
max P exhaust \_\_\_ kPa (\_\_\_ psig)

**Lubrication, Shaft-Sealing, and Control-Oil Systems  
and Auxiliaries for Petroleum, Chemical and  
Gas Industry Services**

**CHAPTER 3—GENERAL PURPOSE OIL SYSTEMS**

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# CONTENTS

	Page
1 BASIC DESIGN . . . . .	3-1
1.1 Minimum Components . . . . .	3-1
1.2 General . . . . .	3-1
1.3 Baseplates . . . . .	3-2
1.4 Oil Reservoirs . . . . .	3-2
1.5 Pumps and Drivers . . . . .	3-5
1.6 Coolers . . . . .	3-7
1.7 Filters . . . . .	3-8
1.8 Transfer Valves . . . . .	3-9
1.9 Lube-Oil Rundown Tanks . . . . .	3-9
2 PIPING . . . . .	3-10
2.1 Piping . . . . .	3-10
2.2 Oil Piping . . . . .	3-10
2.3 Instrument Piping . . . . .	3-10
2.4 Water Piping . . . . .	3-10
3 INSTRUMENTATION AND ELECTRICAL SYSTEMS . . . . .	3-10
4 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT . . . . .	3-10
4.1 General . . . . .	3-10
4.2 Inspection . . . . .	3-10
4.3 Testing . . . . .	3-10
4.4 Preparation for Shipment . . . . .	3-11
5 VENDOR'S DATA . . . . .	3-11
5.1 General . . . . .	3-11
5.2 Proposals . . . . .	3-12
APPENDIX A TYPICAL SCHEMATICS (NORMATIVE) . . . . .	3-13
APPENDIX B DATA SHEETS (INFORMATIVE) . . . . .	3-21
APPENDIX C INSPECTOR'S CHECKLIST(INFORMATIVE). . . . .	3-31
APPENDIX D COST ESTIMATE WORKSHEET FOR GENERAL-PURPOSE OIL SYSTEM (INFORMATIVE) . . . . .	3-37
Figures	
3A-1 Minimum Requirements for General Purpose Oil System . . . . .	3-15
3A-2 Reservoir . . . . .	3-16
3A-3 Pumps . . . . .	3-17
3A-4 Pumps and Coolers . . . . .	3-18
3A-5 Pressure Control . . . . .	3-19





# Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services

## Chapter 3—General Purpose Oil Systems

### 1 Basic Design

#### 1.1 MINIMUM COMPONENTS

This section covers the basic general purpose oil system. The bill of material addressed in the following paragraph describes the minimum specified system. Manufacturers may substitute any of the options covered in this section as upgrades to the basic system if required or if offered as standard for the equipment serviced. The oil system supplied shall be capable of supplying sufficient quantities of clean, filtered oil at proper temperature and pressure for startup and all operating conditions of the serviced rotating equipment.

**1.1.1** The basic oil system shall contain as a minimum the following components:

- a. Single pump—(cast iron or steel casing) which may be shaft-driven or motor driven.
- b. Motor driven start-up pump (if required).
- c. Valves—carbon steel with stainless steel trim.
- d. Oil piping—stainless steel with carbon steel slip-on flanges, conforming to ASME B-31.3; or stainless steel tubing and fittings.
- e. Reservoir—stainless steel with minimum 3-minute retention time, or combined with equipment base.
- f. Single cooler.
- g. Single filter—25 micron nominal.
- h. Single regulator for control of delivered oil pressure.
- i. The following instruments:
  1. Two PI (pressure indicator).
  2. One TI (temperature indicator).
  3. One visual LI (level indicator).
  4. One PSL (pressure switch low-low).

#### 1.2 GENERAL

**1.2.1** The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a 20-year minimum service life. It is recognized that this is a design criterion.

**1.2.2** The oil system shall be suitable for general purpose applications as defined in 3.15, Chapter 1. The system shall be designed as a separate console or may be designed to be integral with the baseplate of the equipment it serves. If components are spared, the design shall allow for transfer between and shutdown of the main and spared components of the system for maintenance without interrupting the operation of the system or the equipment the system serves. Gen-

eral purpose systems supply lubricating oil only (i.e., no seal oil), and do not require an accumulator to cover transient conditions.

**1.2.3** The vendor shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of the order.

**1.2.4** Materials shall be identified in the proposal with their applicable ASTM, AISI, ASME, or SAE numbers or equivalent standards per Appendix A, Chapter 1, including the material grade. When no such designation is available, the vendor's material specification, giving physical properties, chemical composition, and test requirements, shall be included in the proposal.

- **1.2.5** The purchaser will specify the equipment's normal operating point on the data sheets.
- **1.2.6** Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort by the purchaser and the vendor. The equipment furnished by the vendor shall conform to the maximum allowable SPL specified by the purchaser.
- **1.2.7** Where oil is supplied from a common system to two or more machines (such as a compressor, a gear, and a motor), the oil's characteristics will be specified on the data sheets on the basis of mutual agreement with all vendors supplying equipment served by the common oil system.

Note: The usual lubricant employed in a common oil system is a hydrocarbon oil that corresponds to ISO Grade 32, as specified in ISO 3448.

- **1.2.8** The system shall be designed to supply oil to all equipment specified by the purchaser.

**1.2.9** Where practical, the bypass oil shall originate upstream of the filters.

Note: This is to minimize the potential for generation of static electricity (or a static charge) that may result when filtered oil bypasses the equipment and is recycled directly to the reservoir.

- **1.2.10** The purchaser will specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof) as well as the weather and environmental conditions in which the equipment must operate (including maximum and minimum temperatures and unusual humidity, dust, or corrosion conditions).

- **1.2.11** When specified, the arrangement of the equipment, including piping and auxiliaries, shall be developed jointly by the purchaser and the vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance.

Note: For some pre-engineered general purpose oil systems, purchaser input may be impractical.

- **1.2.12** If applicable, the purchaser will specify minimum requirements for clearance around and access to components (especially clearance around and access to coolers, filters, and hand valves).
- **1.2.13** Motors, electrical components, and electrical installations shall be suitable for the area classification (class, group, and division or zone) specified on the data sheets and shall meet the requirements of NFPA 70, Articles 500, 501, 502, and 504, or equivalent standards per Appendix A, Chapter 1, as well as local codes specified and furnished by the purchaser. (See 6.5.1, Chapter 1.)
- **1.2.14** When specified, pumps, filters, strainers, coolers, traps, valves, and all other components that retain oil under pressure and are external to the reservoir shall be made of steel.
- **1.2.15** Unless otherwise specified, components may be submerged in the reservoir, and these may be made of cast iron.
- **1.2.16** When specified, valved vents, drains, and piping shall be furnished to permit draining, cleaning, and refilling of idle components while the equipment is in operation.
- **1.2.17** Coolers, filters, overhead rundown tanks, and other pressure vessels within the scope of Section VIII of the ASME Code shall conform to the code or equivalent code per Appendix A, Chapter 1, and, if specified, shall be code-stamped. (See 1.9 for lube oil rundown tank requirements.)
- **1.2.18** The vendor shall advise the purchaser of, and both parties shall mutually agree on, any special provisions that are necessary to ensure that an adequate supply of lube oil is maintained in the event of complete failure of the lube-oil supply system. These provisions may include standby pumps, rundown tanks, and special arrangements for equipment safety and protection when the equipment decelerates. Provisions shall be adequate for coast-down time and cool-off time as applicable. The purchaser and the vendor shall mutually agree on the system and its components.
- **1.2.19** Block valves that interrupt the oil flow to the equipment shall not be installed in oil supply lines downstream of the filters unless the block valves are part of a component block and bypass arrangement.
- **1.2.20** Welding of piping and pressure-containing parts, as well as any dissimilar-metal welds and weld repairs, shall be performed and inspected by operators and procedures qualified

in accordance with Section VIII, Division 1, and Section IX of the ASME Code or equivalent code per Appendix A, Chapter 1.

- **1.2.21** When components that may require later removal for maintenance are installed using screwed connections, the connecting piping shall be provided with flanges such that the component may be removed without requiring cutting pipe or major disassembly of the unit.

## 1.3 BASEPLATES

- **1.3.1** The major components (pumps, filters, coolers, and reservoir) shall be mounted directly on structural steel as a separate console or integrated with the equipment base.

- **1.3.2** Unless otherwise specified, package baseplates shall be of the drip-rim type with one or more drain connections at least DN 40 (1½ in.) in size. Baseplates, mounted components, and decking shall be arranged and installed to ensure drainage and avoid the retention of liquid.

- **1.3.3** The baseplate shall be provided with lifting lugs for at least a four-point lift. The baseplate shall be designed so that after the components and all piping mounted on it are drained of oil, the package can be lifted without permanently distorting or otherwise damaging either the baseplate or any component mounted on it.

- **1.3.4** When specified, metal decking covering all walk and work areas shall be provided on the top of the baseplate. If furnished, metal decking shall be nonskid.

- **1.3.5** When specified, console shall be suitable for grouting.
- **1.3.6** When specified, the baseplate shall be suitable for column mounting (that is, of sufficient rigidity to be supported at specified points) without continuous grouting under structural members. The baseplate design shall be mutually agreed on by the purchaser and the vendor.
- **1.3.7** When specified, all welding other than that covered by Section VIII, Division 1, of the ASME Code and ASME B31.3, such as welding on baseplates, nonpressure ducting, lagging, and control panels, shall be performed in accordance with AWS D1.1 or equivalent code per Appendix A, Chapter 1.

- **1.3.8** The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation and grouted as specified in 1.3.5, accessibility for grouting under all load-carrying structural members shall be provided.

## 1.4 OIL RESERVOIRS

### 1.4.1 General

Reservoirs shall be separate or combined with the equipment baseplate and be rigid enough to prevent sagging and vibration.

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is defined by the pump suction vortex and net positive suction head requirements.

**1.4.6.1.5** The charge capacity is the total volume below the rundown level.

**1.4.6.1.6** The normal operating range is any level between the maximum and minimum operating levels.

**1.4.6.1.7** The retention capacity is the total volume below the minimum operating level.

**1.4.6.1.8** Retention time is the time allowed for disengagement of entrained air or gas.

**1.4.6.1.9** The rundown capacity is the volume between the rundown level and the maximum operating level.

**1.4.6.1.10** The working capacity is the volume between the minimum operating level and the suction-loss level.

- **1.4.6.1.11** When specified, a low-level alarm which actuates at the minimum operating level shall be provided.

#### 1.4.6.2 Criteria for Sizing

The criteria for sizing a reservoir are shown in 1.4.6.2.1 through 1.4.6.2.3.

**1.4.6.2.1** The working capacity between Level C and Level D shall be sufficient for at least 3 minutes of normal flow.

**1.4.6.2.2** The minimum retention capacity shall be defined as 3 minutes of normal oil flow.

**1.4.6.2.3** The rundown capacity shall allow for all of the oil contained in all of the components, bearings housings, rundown tanks, control elements, and vendor-furnished piping that drain back to the reservoir. The rundown capacity shall also allow for at least an additional 10 percent of these volumes for the purchaser's interconnecting piping.

Note: Rundown may cause some backup in the drain lines entering the reservoir.

#### 1.4.7 Heating

- **1.4.7.1** Purchaser shall specify if an electric heater shall be furnished.

**1.4.7.1.1** When an electric heater is specified, a thermostatically-controlled removable electric immersion heating element shall be provided for heating the charge capacity of oil before start-up in cold weather. It shall have a sheath of AISI Standard Type 300 stainless steel. The device shall have the capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required start-up temperature within 12 hours. Heater elements in contact with the oil shall be sheathed in austenitic

stainless steel; copper or copper-bearing materials shall not contact the oil.

Note: Electric immersion heaters should be interlocked by the purchaser to be deenergized when the oil level drops below the minimum operating level.

- **1.4.7.1.2** When specified, electric heaters shall have a maximum watt density of 2.32 W/cm<sup>2</sup> (15 W/in.<sup>2</sup>).

**1.4.7.1.2.1** Electric heaters may be in direct contact with the reservoir oil when sized according to 1.4.7.1.2

**1.4.7.1.3** In all installations, but especially if top-mounted vertical or angle heaters are used, the heater element shall be located below the pump suction loss level.

#### • 1.4.8 Provision for Insulation

When specified by the purchaser, reservoirs shall be fitted with insulation clips. The purchaser will furnish and install the insulation.

#### • 1.4.9 Plugged Connections

When specified, each reservoir shall be provided with one threaded and plugged connection at least 25 mm (1 in.) in size above the run-down oil level. This connection may be used for such services as purge gas, makeup oil supply, and oil conditioner return.

#### 1.4.10 Special Features

- **1.4.10.1** When specified, a clearly accessible ladder with extended handrails and nonskid working surface shall be provided.

- **1.4.10.2** When specified, handrails around the perimeter of the reservoir top shall be provided.

- **1.4.10.3** When specified, nonskid surface decking shall be provided.

**1.4.10.4** For equipment mounted on the reservoir, the reservoir shall provide sufficient structural stiffness to properly support the equipment.

#### 1.4.11 Materials

**1.4.11.1** Unless otherwise specified, reservoirs and all appendages (except ladders and handrails) welded to reservoirs shall be fabricated from Series 300 stainless steel in accordance with ASTM A 240, as agreed on by the purchaser and the vendor. Pipe connections shall be as specified in Section 2.

**1.4.11.2** Where reservoirs are integral with equipment or equipment baseplates and where stainless steel inserts or cladding is not practical, coated carbon steel is acceptable upon purchaser approval.

### 1.4.12 Grounding

Reservoir shall be grounded either by grounding clips attached to the reservoir (for free-standing reservoirs) or through the attached base structure. In either case, two grounding clips or pads diagonally opposed to each other are required. The pads shall accommodate a 13 mm ( $1/2$  in. UNC) bolt.

## 1.5 PUMPS AND DRIVERS

- **1.5.1** As a minimum, the oil system shall include an oil pump suitable for continuous operation. An ASME B73.1 horizontal centrifugal or vertical centrifugal (submerged or ASME B73.2 inline), rotary positive displacement, or API pump shall be used.

**1.5.2** Each pump shall have its own driver.

**1.5.3** Unless otherwise specified, the main oil pump (unless it is shaft-driven) shall be motor-driven.

Note: When primary and standby pumps are motor-driven, it is recommended that the purchaser shall supply electric feeds from independent sources.

Note: Stand-by pumps are always motor driven because of relatively long start-up times for turbine-driven pumps.

- **1.5.4** When specified, a turbine-driven pump shall be supplied as the main oil pump.
- **1.5.4.1** When specified, and when a shaft-driven pump is supplied, an electric-driven standby pump shall be provided for start-up and main pump failure backup.

**1.5.5** Motors shall comply with NEMA MG 1 or the equivalent per Appendix A, Chapter 1.

**1.5.5.1** "C-flanged" motors may be used for motors below 7.5kW (10 HP).

**1.5.6** The minimum criteria in 1.5.6.1 through 1.5.6.3 shall be used when sizing pumps.

**1.5.6.1** In all cases, pumps shall be sized to deliver the required capacity when pumping lube oil at the highest temperature and the corresponding minimum viscosity (see 1.5.8).

**1.5.6.2** Each pump (main or standby) shall be capable of supplying the normal oil flow required by the equipment plus 20 percent of the normal oil flow and supplying transient oil requirements.

**1.5.6.3** Rotary pumps shall be capable of passing the total flow, as established in 1.5.8.2, at the pressure limiting valve set pressure while not exceeding 90 percent of the pump manufacturer's maximum differential pressure rating at the minimum operating viscosity. The pump must also be capable of operating continuously at the normal flow, relief valve set pressure, and minimum operating viscosity.

Note: This selection criterion is required to avoid pump rotor contact during operation under extreme conditions.

**1.5.7** The normal operating capacity of the centrifugal pumps shall be within 50 to 110 percent of their best efficiency point. From their normal operating point to shutoff, centrifugal pumps shall have a continuous rise in head of at least 5 percent and, with the installation of a new impeller, shall be capable of a future increase in head of at least 10 percent.

**1.5.8** Pump drivers shall be sized according to 1.5.8.1 or 1.5.8.2 as applicable.

**1.5.8.1** Centrifugal pumps shall deliver the specified system pressure across the pump's stable flow range when the temperature of the pumped oil is 10°C (50°F).

**1.5.8.2** Rotary pumps shall be capable of operating at the specified pump pressure limiting valve setting (including accumulation) when the temperature of the pumped oil is 10°C (50°F).

**1.5.9** Check valves shall be provided on each pump discharge to prevent the flow of oil backwards through a standby or idling pump.

**1.5.10** For rotary pump systems, the vendor shall furnish external pressure limiting valves that shall be installed on the pump or in the piping supplied by the vendor. This valve shall not be used for pressure control. Pressure limiting valve settings, including an allowance for no more than 10 percent accumulation, shall be determined after all of the possible equipment and component failures are considered. The settings shall protect the oil system components and piping. Fully accumulated pressure cannot exceed 110 percent of the design pressure.

**1.5.11** Pressure limiting valves, when provided, shall be pressure-modulating devices (as opposed to snap-acting or pop-type safety relief valves) with a pressure increase proportional to flow above the valve cracking pressure (i.e., the pressure at which the valve begins to open). These devices shall be mounted external to the reservoir and shall operate smoothly, without chattering and without causing a drop in supply pressure to the equipment. Pressure limiting valve piping shall be sized for the full flow of each pump; the valves shall not chatter, and the piping shall not vibrate. The minimum pressure limiting valve cracking pressure shall be 10 percent or 1.7 bar (25 psi) higher than the highest required operating pressure, whichever is greater. To avoid unnecessary delay in opening, pressure limiting valves shall be located as close to the oil pump discharge as possible at an elevation as near to or below the minimum operating level as possible.

**1.5.12** The oil system shall be provided with pressure-regulating devices that prevent fluctuation of the oil pressure to

the equipment when both the main and the standby pump are in operation or when either the main or the standby pump is in operation and the other pump is started, brought up to operating speed, or stopped. Each device shall have an adequate response time and shall operate smoothly without hunting, chattering, or producing pressure or flow transients that can cause the equipment to shut down (see 4.3.3.5.5). These pressure-regulating devices shall be located so that an excessive rise in oil temperature resulting from a recirculation of uncooled oil is avoided (e.g., see Figure 3A-3).

**1.5.12.1** System pressure regulating valve(s) shall be sized to pass the excess flow when one and/or both pumps are in operation.

**1.5.13** All pumps (except shaft-driven pumps) shall be installed with flooded suctions to ensure self-priming and shall be installed with suction block valves (unless the pumps are inside the reservoir) and with discharge block and check valves. Vertically-mounted pumps shall be continuously vented to assure the entire pump remains flooded. Shaft-driven pumps shall have adequate provision for priming and be of positive displacement design. Suction piping shall be continuously vented or arranged to avoid pockets in which air can accumulate or become trapped. Each pump shall have a separate suction line from the reservoir. The pump suction lines shall be designed to avoid excessive piping loads on the pump casing flanges. Designs for suction piping, suction block valves, pump casings, and all other components shall avoid the possibility of overpressure caused by leaking discharge check valves.

- **1.5.14** When specified, for the protection of externally-mounted centrifugal pumps during flushing and for the initial operation of new oil systems, a removable strainer that is made from ASTM Series 300 stainless steel and has an open flow area equal to 150 percent of the cross-sectional area of the suction pipe shall be installed in the suction piping of each pump between the pump suction flange and the block valve. The temporary strainer shall be identified by a protruding tab and shall have a mesh size adequate to stop all objects that would be injurious to the pump. The piping arrangement shall permit the removal of the strainer without disturbing the alignment of the pump.

Note: Strainer can be cone, basket, or Y-type.

**1.5.15** Unless otherwise specified, for externally mounted rotary pumps, a permanent Y-type strainer with an ASTM Series 300 stainless steel basket that has an open flow area equal to 150 percent of the cross-sectional area of the suction pipe shall be installed in the suction piping of each pump. The strainer shall have a mesh size capable of stopping all objects that would be injurious to the pump.

**1.5.16** If a standby pump is furnished (1.5.4.1), in order to maintain satisfactory system operation when the main pump

fails to meet system requirements, the vendor shall furnish an automatic start-up control for the standby oil pump. The start-up control of the standby pump shall be actuated by low oil supply pressure. Motor control centers will be provided by the purchaser. The control system shall have a manual reset.

**1.5.17** Removable coupling guards shall be furnished.

**1.5.18** A nonspacer elastomeric coupling is acceptable for power ratings up to 22 kW (30 hp).

**1.5.18.1** Couplings and coupling-to-shaft junctures shall be rated for at least the maximum driver power (including any motor service factor).

**1.5.18.2** To assure that the connected machinery is accurately aligned, the total indicator reading of coupling registration and alignment surfaces shall be controlled within specific limits. For all pumps, the coupling surfaces normally used for checking alignment shall be concentric with the axis of coupling hub rotation within the following limits: 13  $\mu\text{m}$  (0.0005 in.) total diameter, with a minimum applicable tolerance of 25  $\mu\text{m}$  (0.001 in.) total indicator reading and a maximum of 75  $\mu\text{m}$  (0.003 in.) total indicator reading. All other diameters not used for location, registration, or alignment shall be to the coupling manufacturer's standard, provided balance requirements are met.

**1.5.19** For drivers larger than 7.5 kW (10 hp), mounting plates shall be provided as specified in 1.5.19.1 through 1.5.19.5.

Note: See paragraph 1.5.5.1.

- **1.5.19.1** When specified, mounting pads shall be provided for each pump and its driver. Pads shall be larger than the feet of the mounted equipment to allow for leveling of the console or package 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  $\mu\text{m}/\text{m}$  (0.002 in./ft) of distance between the pads.

**1.5.19.2** Pumps and drivers shall be mounted on a machined surface. All pads for drivers shall be machined to allow for the installation of shims; shims, at least 3 mm ( $1/8$  in.) thick, shall be placed under the feet of each component. When the vendor mounts the components, a set of stainless steel shims at least 3 mm ( $1/8$  in.) thick shall be furnished.

**1.5.19.3** To minimize misalignment of the pump and driver shafts due to piping load effects, the pump and its baseplate shall be constructed with sufficient structural stiffness to limit total misalignment to the values specified in 1.5.18.2.

**1.5.19.4** When mounted on the console without a baseplate, the pump shall be mounted on a structural support.

**1.5.19.5** Transverse alignment positioning jackscrews shall be provided for each driver that weighs more than

200 kg (450 lb). Axial alignment positioning jackscrews shall be provided for each driver weighing more than 400 kg (900 lb). 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. Alignment-positioning screws shall be at least the same size as the 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 pads has been completed.

## 1.6 COOLERS

**1.6.1** A single oil cooler shall be provided if required to maintain oil-supply temperature at 50°C (120°F).

**1.6.1.1** Coolers (if required by 1.6.1) shall comply with the requirements of 1.6.1.4 through 1.6.1.5., and unless otherwise specified shall be shell-and-tube type.

- **1.6.1.2** When specified, a plate frame or fin fan cooler shall be supplied. The vendor shall include in the proposal complete details of any proposed air-cooled or plate frame cooler.

- **1.6.1.3** When specified, the vendor shall supply connections for installation of the purchaser's fin fan oil cooler(s) off the oil console.

**1.6.1.4** The vendor shall supply all relevant data such as heat load and oil flow.

**1.6.1.5** Pressure drop criteria for the oil side shall be mutually agreed on by the vendor and purchaser.

**1.6.1.6** Unless otherwise specified for duplex cooler arrangements, the equalization/fill valve shall be locked or car sealed in the open position with the equalization/fill line orifice thermal sized by the vendor to provide thermal overprotection.

- **1.6.1.7** When specified, for duplex cooler arrangements, the vendor shall provide thermal overpressure protection of the oil side of the coolers by providing separate thermal relief valves. (See 1.6.1.6.)

- **1.6.2** When specified, a cooling water system or systems shall be designed for the following conditions:

a. Velocity over heat exchange surfaces: 1.5 to 2.5 m/s (5 to 8 ft/s).

b. Maximum allowable working pressure:  $\geq 6.9$  barg ( $\geq 100$  psig).

c. Test pressure:  $\geq 1.5$  X MAWP, 10.4 barg ( $\geq 150$  psig).

d. Maximum pressure drop: 1 bar (15 psi).

e. Maximum inlet temperature: 30°C (90°F).

f. Maximum outlet temperature: 50°C (120°F).

g. Maximum temperature rise: 20 K (30°F).

h. Minimum temperature rise: 10 K (20°F).

i. Fouling factor on water side: 0.35 m<sup>2</sup> • K/kW (0.002 hr-ft<sup>2</sup>-°F/Btu).

Provision shall be made for complete venting and draining of the system or systems.

Note: The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchange surfaces result in a conflict. The criterion for velocity over heat exchange surfaces is intended to minimize water-side fouling; the criterion for minimum temperature rise is intended to minimize the use of cooling water. The purchaser will approve the final selection.

**1.6.3** Oil coolers shall have the following characteristics as outlined in 1.6.3.1 through 1.6.3.4.

**1.6.3.1** Each oil cooler shall maintain the lube-oil supply temperature at or below 50°C (120°F).

**1.6.3.2** Each cooler shall be sized to accommodate the total cooling load.

**1.6.3.3** Oil coolers shall not be located inside the reservoir.

**1.6.3.4** In addition to the requirements of 1.6.3.1 through 1.6.3.3, shell-and-tube coolers shall be in accordance with 1.6.3.4.1 through 1.6.3.4.7.

- **1.6.3.4.1** When specified, a removable-bundle design is required for shell-and-tube coolers with more than 0.5 m<sup>2</sup> (5 ft<sup>2</sup>).

**1.6.3.4.2** Removable-bundle coolers shall comply with the applicable heat exchanger code in Appendix A, Chapter 1.

**1.6.3.4.3** Coolers shall be constructed with a removable channel cover.

**1.6.3.4.4** Unless otherwise specified, tubes shall be standard wall thickness and shall have an outside diameter of at least 9 mm ( $\frac{3}{8}$  in.).

Note: For oil systems that are cooled by open cooling tower circulation that is likely to have large particle contamination of the cooling water the purchaser may wish to require 16 mm ( $\frac{5}{8}$  in.) minimum tube size to prevent rapid fouling of the tubes.

**1.6.3.4.5** Water shall be on the tube side of the cooler.

- **1.6.3.4.6** When specified, the oil-side operating pressure shall be higher than the water-side operating pressure.

Note: If selected for general-purpose oil system, this requirement may mandate the oil-pump discharge pressure be well above the lubricated equipment required oil pressure.

**1.6.3.4.7** Unless otherwise specified, fin tubes or extended surface tubes are allowed.

- **1.6.3.5** When specified, and in addition to the requirements of 1.6.3.1 through 1.6.3.3, multiplate type coolers shall have plates of austenitic stainless steel, or as specified by the purchaser.

- **1.6.3.6** When specified, and in addition to the requirements of 1.6.3.1 through 1.6.3.3, fin fan type coolers shall comply with 1.6.3.6.1 through 1.6.3.6.2.

**1.6.3.6.1** Multi-V or toothed drive belts are required (not multiple belts).

- **1.6.3.6.2** When specified, two separate headers shall be provided for each cooler.
- **1.6.4** When specified, cooler shells, channels, and covers shall be made of steel.
- **1.6.5** When specified, an oil bypass line around the cooler with a temperature control valve shall be included to regulate the oil supply temperature. This includes oil systems where the purchaser supplies the cooler. In no case, however, shall oil bypass the filter. The control valve shall comply with 1.6.5.1 through 1.6.5.4.

Note: When fouling or freezing of the water side of a cooler is a factor, and oil temperature is regulated by adjusting water flow through the cooler, it is possible for the cooler water side to silt up or freeze and break at low water flow rates.

- **1.6.5.1** When specified, the oil bypass valve shall be a thermostatically operated three-port valve.
- **1.6.5.2** When specified, the temperature control valve shall be provided with a manual override that permits operation independent of temperature conditions.

**1.6.5.3** The temperature control valve shall be sized to handle all oil flow passing through the cooler with a pressure drop equal to or less than the pressure drop through the cooler.

- **1.6.5.4** When specified, the temperature control valve body shall be stainless steel.

**1.6.6** The maximum allowable working pressure for coolers shall not be less than the maximum operating pressure of the system, less than the pressure limiting valve setting for the positive displacement pumps, or less than the maximum discharge pressure (at the trip speed for the turbine drive) for the centrifugal pumps.

- **1.6.6.1** When specified by the purchaser, shell and tube or plate frame coolers shall be suitable for use of a 150°C (300°F) heating medium, such as steam or a mixture of steam and water.
- **1.6.7** When specified, both the water side and the oil side of the cooler shall be provided with NPS plugged or flanged and blinded drains and vents.

## 1.7 FILTERS

**1.7.1** A minimum of one replaceable oil filter shall be provided. Filter shall provide a minimum particle removal efficiency (PRE) of 99.5 percent for 25 micron particles (B25 ≥

200) per ISO 4572 when tested to a minimum terminal (end of test run) differential pressure of 3.5 bar (50 psid). Filter installation shall comply with 1.7.3.1 through 1.7.3.7.

Note: See Appendix E of Chapter 1 for additional information concerning filter ratings.

- **1.7.2** When specified, replaceable filter shall provide a minimum particle removal efficiency (PRE) for 10 micron particles of 90 percent ( $\beta_{10} \geq 10$ ) and a minimum PRE of 99.5 percent for 15 micron particles ( $\beta_{15} \geq 200$ ), both per ISO 4572 when tested to a minimum terminal differential pressure of 3.5 bar (50 psid). Filter installation shall comply with 1.7.3.1 through 1.7.3.7.

Note: See Appendix E of Chapter 1, for additional information concerning filter ratings.

- **1.7.3** When specified, duplex filters shall be provided.

**1.7.3.1** The filters shall be located downstream of the coolers.

**1.7.3.2** Unless otherwise specified, the filters shall be piped in a parallel arrangement using a continuous-flow transfer valve (see 1.8).

**1.7.3.3** Filter cases and heads shall be suitable for operation at the maximum discharge pressure (at the trip speed for turbine drives) of centrifugal pumps or at a pressure not less than the pressure limiting device setting of positive displacement pumps.

**1.7.3.4** Filters that have covers weighing more than 15 kg (35 lb) shall have cover lifters.

**1.7.3.5** The filters shall not be equipped with differential pressure limiting valves or other valves, which can cause bypass of unfiltered (dirty) oil around the filter elements.

**1.7.3.6** The filters shall be equipped with NPS pipe size plugged or blind flanged vent and drain connections.

**1.7.3.7** For duplex filter arrangements (see 1.7.3), the vendor shall provide for the equalization/fill valve to be locked or car sealed in the open position with the equalization/fill line orifice thermal sized by the vendor.

- **1.7.3.8** For duplex filter arrangements (see 1.7.3), the purchaser may specify thermal overpressure protection of the off-line filter.

**1.7.4** Oil filter design shall incorporate the features listed in 1.7.4.1 through 1.7.4.9.

**1.7.4.1** Oil flow from the outside inward toward the center of the filter element.

**1.7.4.2** Adequate support of the filter elements to prevent them from rupturing or to prevent unfiltered (dirty) oil from bypassing the elements and reaching the equipment.



**1.7.4.3** Center posts and other removable hardware in contact with filtered oil shall be made of stainless steel.

**1.7.4.4** The maximum number of filter cartridges in one stack is two.

**1.7.4.5** If the cartridge to cartridge joint is not self-aligning a collar shall be used between the stacked cartridges to ensure alignment.

**1.7.4.6** The maximum length of a filter or filters in one stack is 1 m (3 ft).

**1.7.4.7** Stacked cartridges shall have adequate support and maintainable alignment.

**1.7.4.8** The ability to completely drain oil from the filter housing while avoiding contamination of the downstream (clean) side with unfiltered (dirty) oil during replacement of the filter elements.

**1.7.4.9** Consideration of the use of guard elements to capture debris (such as filter element fibers) in case of filter element deterioration or failure.

**1.7.5** Alternate designs (e.g., those incorporating the flow of oil from the center towards the outside of the filter element) may be used if specifically approved.

**1.7.6** Filter cartridge materials shall be water and corrosion resistant.

**1.7.6.1** Water-resistant filter cartridges shall not deteriorate if water contamination in the oil reaches 5% by volume and an operating temperature as high as 70°C (160°F).

- **1.7.6.2** When specified, filter element media shall be non-hygroscopic. If water contamination in the oil reaches 5% for extended time periods (up to 3 months), clean filter cartridges shall not have more than two times the clean filter pressure drop at rated oil viscosity, flow, and temperature.

- **1.7.6.3** When a specific filter element or cartridge is required, the purchaser will completely specify the make, model number, and type of construction.

**1.7.6.4** Metal mesh or stainless metal filter elements are not acceptable.

**1.7.7** The pressure drop for clean filter elements or cartridges shall not exceed 15 percent of the total allowable dirty pressure drop at an operating temperature of 40°C (100°F) and normal flow. Elements or cartridges shall have a minimum collapsing differential pressure of 300 kPa (45 psi).

Note: Pressure drop across the total filter system may exceed these values by the amount of pressure drop across the transfer valve and other filter system components.

**1.7.8** When the tops of filters housing covers are more than 1.2 m (4 ft) above the console base, the vendor shall provide an elevated step to facilitate their maintenance.

## 1.8 TRANSFER VALVES

**1.8.1** Unless otherwise specified, and when duplex coolers are specified as an exception to 1.6.1, the flow will be switched between coolers and filters via a single transfer valve serving coolers and filters. (see Figure 2A-18).

- **1.8.1.1** The purchaser may specify individual transfer valves independently serving each cooler and filter set (see Figure 2A-17).

**1.8.2** Transfer valves shall be two-way, six-ported continuous-flow valves. A single-body, six-port taper or a straight plug valve may be used; or two three-way plug or ball valves permanently aligned and joined with a single operating lever may be used.

**1.8.2.1** Tapered plug-type valves shall have provisions for plug lifting.

**1.8.2.2** Valves shall be designed so that if the internal valve mechanisms fail, both flow paths will not be blocked.

**1.8.2.3** Valves and assemblies shall be designed to prevent incorrect assembly.

**1.8.3** Transfer valves shall have steel bodies. Valve stems and valve plugs or balls shall be made of stainless steel.

**1.8.4** When approved, transfer valves with positively retained resilient seats may be used.

- **1.8.5** Spectacle blinds shall be provided if specified or if required to assure tight shutoff.

Note: Transfer valves are not intended to be used as tight shut-off devices for the maintenance of filters and coolers (see 4.3.3.5.7).

## 1.9 LUBE-OIL RUNDOWN TANKS

- **1.9.1** When specified, a separately mounted emergency lube-oil rundown tank (either atmospheric or pressurized) shall provide oil for the coast-down period specified by the purchaser, but this coast-down period shall not be less than 3 minutes of normal lube-oil flow (see Figures 2A-13a and 2A-13b). Unless otherwise specified, the tank shall be made of Series 300 stainless steel.

Note: Coast-down time is to be provided by the purchaser. (This is normally furnished by the supplier of the equipment served by the oil system, i.e., the rotating equipment supplier.)

**1.9.2** A rundown tank shall be provided with a sight flow glass in the tank overflow line. DN 150 (6 in.) in size nozzle for accessing and inspecting the interior of the run-down tank shall be provided. The vendor shall specify the allowable minimum and maximum height of the bottom outlet nozzle above the machine centerline; the maximum static head shall be less than the lube-oil trip pressure but not less than 30 kPa (5 psig) at the beginning of coast-down.

**1.9.3** When an atmospheric rundown tank is provided per Figure 2A-12a, it shall be provided with a low-level alarm device and a high-level permissive start device.

**1.9.4** A pressurized tank shall be designed to comply with Section VIII of the ASME Code or the equivalent code per Appendix A, Chapter 1, and shall be code-stamped.

## 2 Piping

### 2.1 PIPING

#### 2.1.1 General

**2.1.2** All piping shall comply with Section 5, Chapter 1, unless otherwise specified in this section.

**2.1.2.1** The radiographic requirements associated with pipe fabrication per ASME B31.3 or the equivalent code per Appendix A, Chapter 1, are not required (see 5.1.1, Chapter 1).

- **2.1.2.2** When specified. Radiographic requirements associated with pipe fabrication shall be per ASME B31.3 or the equivalent code per Appendix A, Chapter 1.

### 2.2 OIL PIPING

**2.2.1** Piping shall comply with Tables 1D and 2A, Chapter 1, and shall be stainless steel unless otherwise specified.

### 2.3 INSTRUMENT PIPING

**2.3.1** Piping shall comply with Tables 1D and 2A, Chapter 1, and shall be stainless steel unless otherwise specified.

### 2.4 WATER PIPING

**2.4.1** Piping shall comply with Tables 1C and 2A, Chapter 1, and shall be carbon steel unless otherwise specified.

## 3 Instrumentation and Electrical Systems

**3.1** Instrumentation shall comply with Section 6, Chapter 1, except as modified in the following paragraphs.

- **3.1.1** As a minimum, the vendor shall furnish and mount the alarm and shut-down contacts specified. The alarm setting shall precede the shut-down setting. Recommended alarms and shutdowns are shown in Table 1, Chapter 2.

**3.2** Flow indicators may have screwed connections and shall be of the bull's-eye type.

**3.3** The requirements of 6.1.6, 6.1.7, and 6.4.6.2, Chapter 1, are not applicable.

## 4 Inspection, Testing, and Preparation for Shipment

### 4.1 GENERAL

Inspection, testing, and preparation for shipment shall be per Section 7, Chapter 1, unless otherwise specified in this section.

- **4.1.1** When specified, the purchaser's or the vendor's representative shall indicate compliance in accordance with the inspector's checklist (Appendix C) by initialing, dating, and submitting the completed checklist to the purchaser prior to shipment.

### 4.2 INSPECTION

#### 4.2.1 General

**4.2.1.1** The oil system furnished shall meet the cleanliness requirements of 4.3.3.6.2 and 4.3.3.6.3.

### 4.3 TESTING

#### 4.3.1 General

**4.3.1.1** Equipment shall be tested in accordance with 4.3.2 and 4.3.3. Other tests may be specified and shall be jointly developed by the purchaser and the vendor.

- **4.3.1.2** The purchaser will specify whether the purchased oil system shall be used during the shop testing of the equipment.
- **4.3.1.3** Complete-unit tests or other tests of the oil system and the equipment it serves shall be performed in place of or in addition to separate tests of the oil system as specified by the purchaser. Details of these tests shall be developed jointly by the purchaser and the vendor.
- **4.3.1.4** When specified, the vendor, by bolting and unbolting piping, shall demonstrate that the pump on its baseplate is in compliance with 1.5.18.2.

#### 4.3.2 Hydrostatic Test

The hydrostatic test is to be performed per 7.3.2, Chapter 1.

#### 4.3.3 Operational Tests

**4.3.3.1** Unless otherwise specified, the complete oil system shall be run in the vendor's shop to test its operation, sound level, and cleanliness. The oil used shall be as specified and shall be compatible with the system oil (see 1.2.7).

**4.3.3.1.1** At least 6 weeks prior to testing, the vendor shall submit a complete description of the proposed test program.

**4.3.3.1.2** The running tests shall be conducted under normal system operating conditions for at least 2 hours. The

operational tests may be done concurrently within the 2 hours.

**4.3.3.1.3** All filter elements shall be installed prior to the operational tests.

**4.3.3.2** If console-mounted, the low-oil-pressure alarm, the standby-pump start, and the shut-down switches purchased for the project shall be used for the operational tests.

**4.3.3.3** All oil pressures, viscosities, and temperatures shall occur within the range of operating values recommended in the vendor's operating instructions for the specific unit being tested.

**4.3.3.4** If the steam turbine pump driver has not been mechanically tested, it shall be run during the operational tests. If steam is not available for the operational tests, turbine drivers shall be tested with compressed air or gas of sufficient capacity and pressure to develop normal system operating pressures.

Note: The vendor is responsible for verifying the turbine is mechanically suited for the test fluid. If the turbine driver has been previously tested, a test motor may be considered to replace the turbine during operational tests.

**4.3.3.5** The operational testing of the oil system shall be conducted in the sequence given in 4.3.3.5.1 through 4.3.3.5.7.

**4.3.3.5.1** The oil system shall be thoroughly checked for leaks; all leaks shall be corrected prior to testing.

**4.3.3.5.2** The relieving pressures shall be determined so that the subsequent proper operation of each pressure limiting valve may be verified.

**4.3.3.5.3** A filter-cooler changeover shall be accomplished without the system delivery pressure dropping to the automatic-start setting of the standby pump.

**4.3.3.5.4** It shall be demonstrated that after a failure or trip of the main oil pump, the standby pump will start automatically and return the system to normal operating pressure without the delivery pressure dropping below the standby pump's automatic-start setting and the equipment's shutdown pressure.

**4.3.3.5.5** It shall be demonstrated that the control valve or valves are capable of controlling the oil pressure when only one pump, either the main or the stand-by pump, is operating at the normal bearing oil requirements. The test shall be considered satisfactory when no abnormal conditions occur during the operational test. Some abnormal conditions are system instability; an excessive drop in delivery pressure; alarm or shutdown signals; or other conditions that would require operator attention.

**4.3.3.5.6** All warning, protective, and control devices shall be checked, and adjustments shall be made as required.

**4.3.3.5.7** While the system is at maximum operating pressure, the internal side-to-side leakage around the plugs of continuous-flow transfer valves shall be demonstrated to be less than the drainage capability of the inactive filter housings. Leakage shall not exceed the expected or specified rates.

**4.3.3.6** Conformity to the criteria for system cleanliness in 4.3.3.6.2 and 4.3.3.6.3 shall be demonstrated.

**4.3.3.6.1** System cleanliness shall be demonstrated by the vendor after the operational and sound-level tests.

**4.3.3.6.2** After 1 hour of oil circulation at the design flow rate and a temperature of 66°C to 71°C (150°F to 160°F) or lower, as component design dictates, screens placed at all discharge terminations from the console or the packages and at other strategic points mutually agreed on by the purchaser and the vendor shall be within the particle count limits listed in Table E-6, Appendix E, Chapter 1. The screen mesh shall be No. 100 plain-weave, stainless steel wire with a diameter of 0.1 mm (0.004 in.) and a 0.15 mm (0.006 in.) opening. The particles' greatest dimension shall not exceed 0.25 mm (0.010 in.), and the particles shall be randomly distributed on the screen. Piping, coolers, and valves shall be hammered frequently during the test.

Note: Refer to Appendix E in Chapter 1 for a discussion of alternate methods of measuring oil cleanliness.

**4.3.3.6.3** If dismantling of the oil system is required to modify the system to improve operation, the initial running test shall not be acceptable, and final tests shall be run after corrections are made. In any event, the demonstration of cleanliness shall be conducted only after the final assembly.

## 4.4 PREPARATION FOR SHIPMENT

**4.4.1** The oil system shall be prepared for shipment according to 7.4, Chapter 1.

## 5 Vendor's Data

### 5.1 GENERAL

- **5.1.1** When specified, a coordination meeting shall be held, within 4 to 6 weeks after the purchase commitment. Unless otherwise specified, the vendor will prepare and distribute an agenda prior to this meeting, which, as a minimum, shall include review of the following items:
  - a. The purchase order, scope of supply, unit responsibility, and subvendor items.
  - b. The data sheets.
  - c. Applicable specifications and previously agreed-on exceptions.
  - d. Schedules for transmittal of data, production, and testing.

- e. The quality assurance program and procedures.
- f. Inspection, expediting, and testing.
- g. Schematics and bills of material.
- h. The physical orientation of the components, piping, in the auxiliary systems.
- i. Other technical items.

## 5.2 PROPOSALS

### 5.2.1 General

Proposal shall be prepared according to 8.2, Chapter 1.

**5.2.1.1** Where equipment bases are used as reservoirs, the vendor shall include in the proposal retention time and working capacity as well as an experience list of similar systems with similar retention time and working capacity.





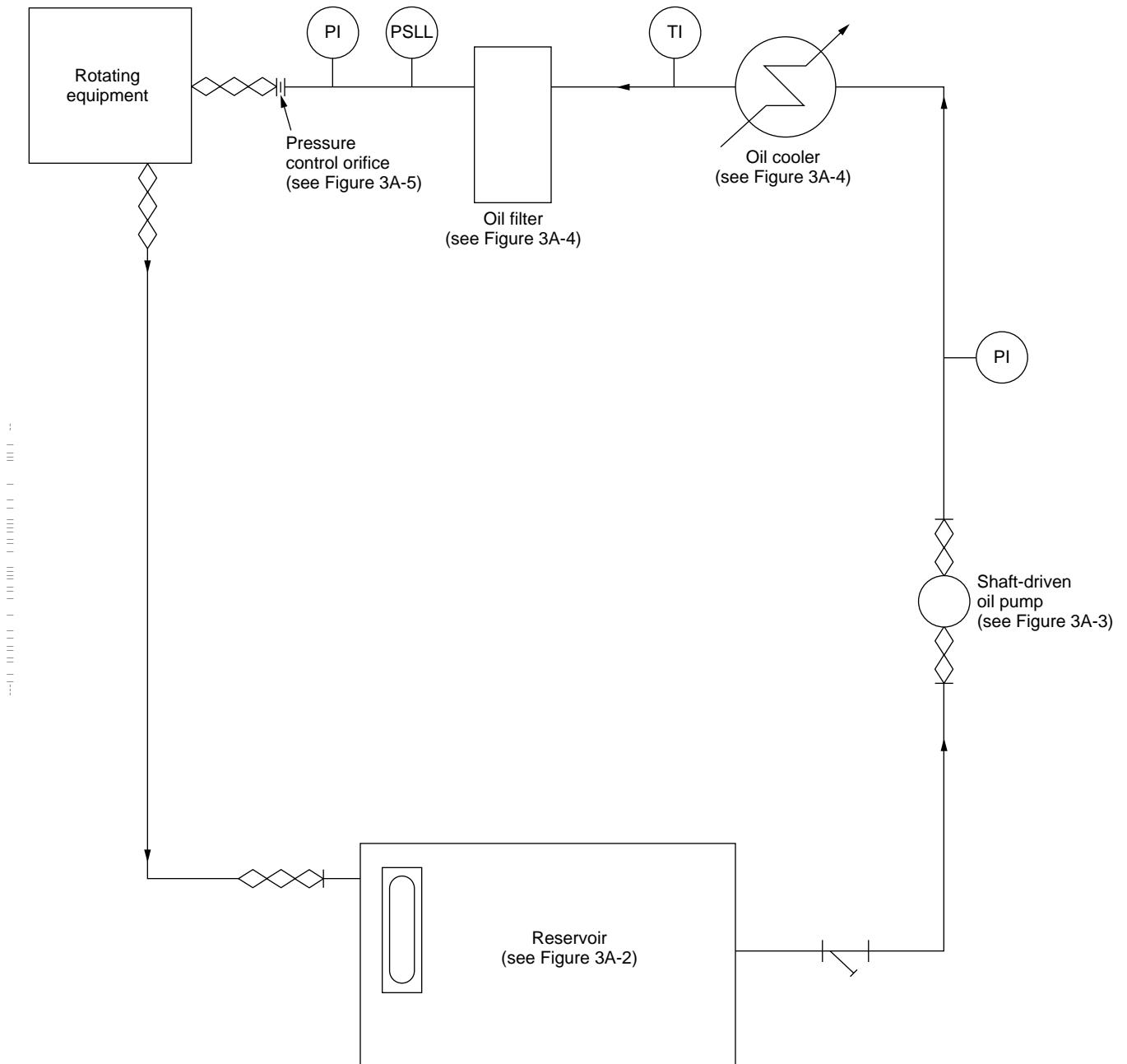
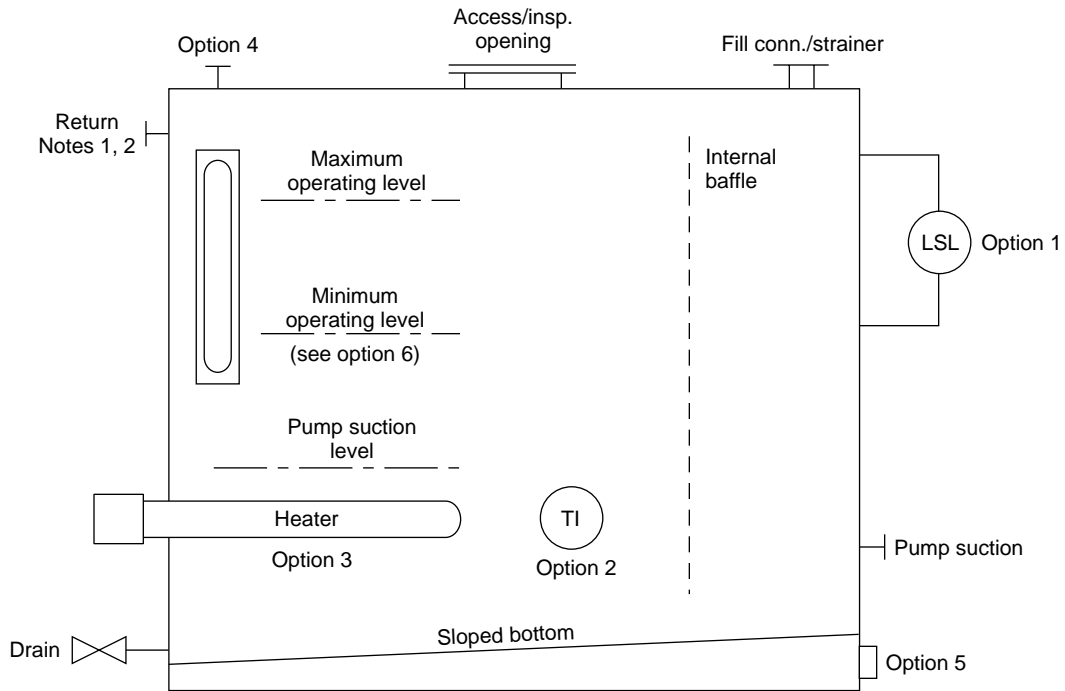


Figure 3A-1—Minimum Requirements for General Purpose Oil System



Notes:

1. All oil return lines require a stilling tube or sloped tray to prevent splashing.
2. Individual oil return lines shall be located away from the pump section.

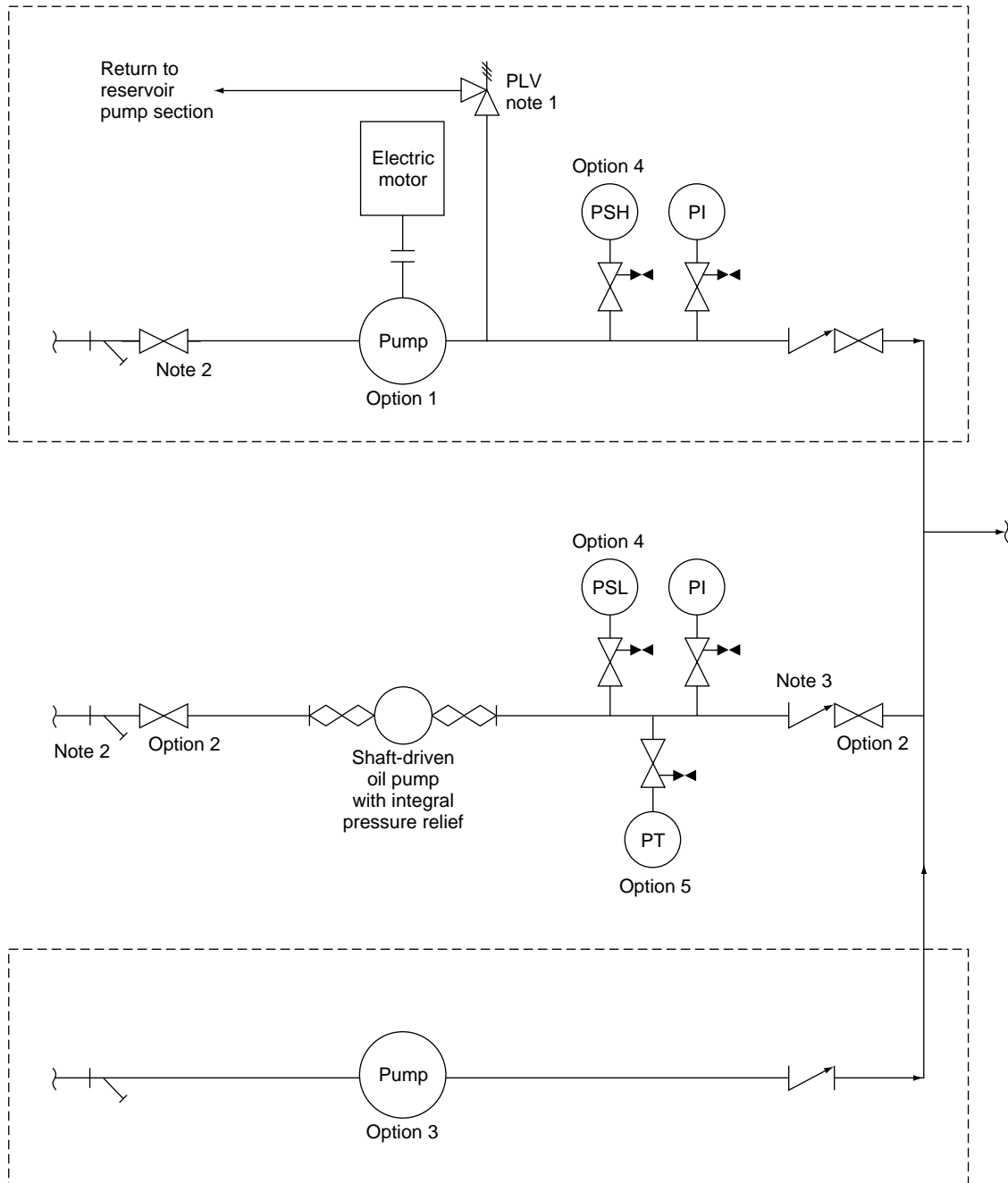
Options:

1. External or internal level switch.
2. Temperature indicator with thermowell.
3. Electric immersion or steam heater.
4. Additional connections.
5. Tapped grounding lugs.
6. Gauge glass may be armored and extended.

Figure 3A-2—Reservoir

--- 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 |---

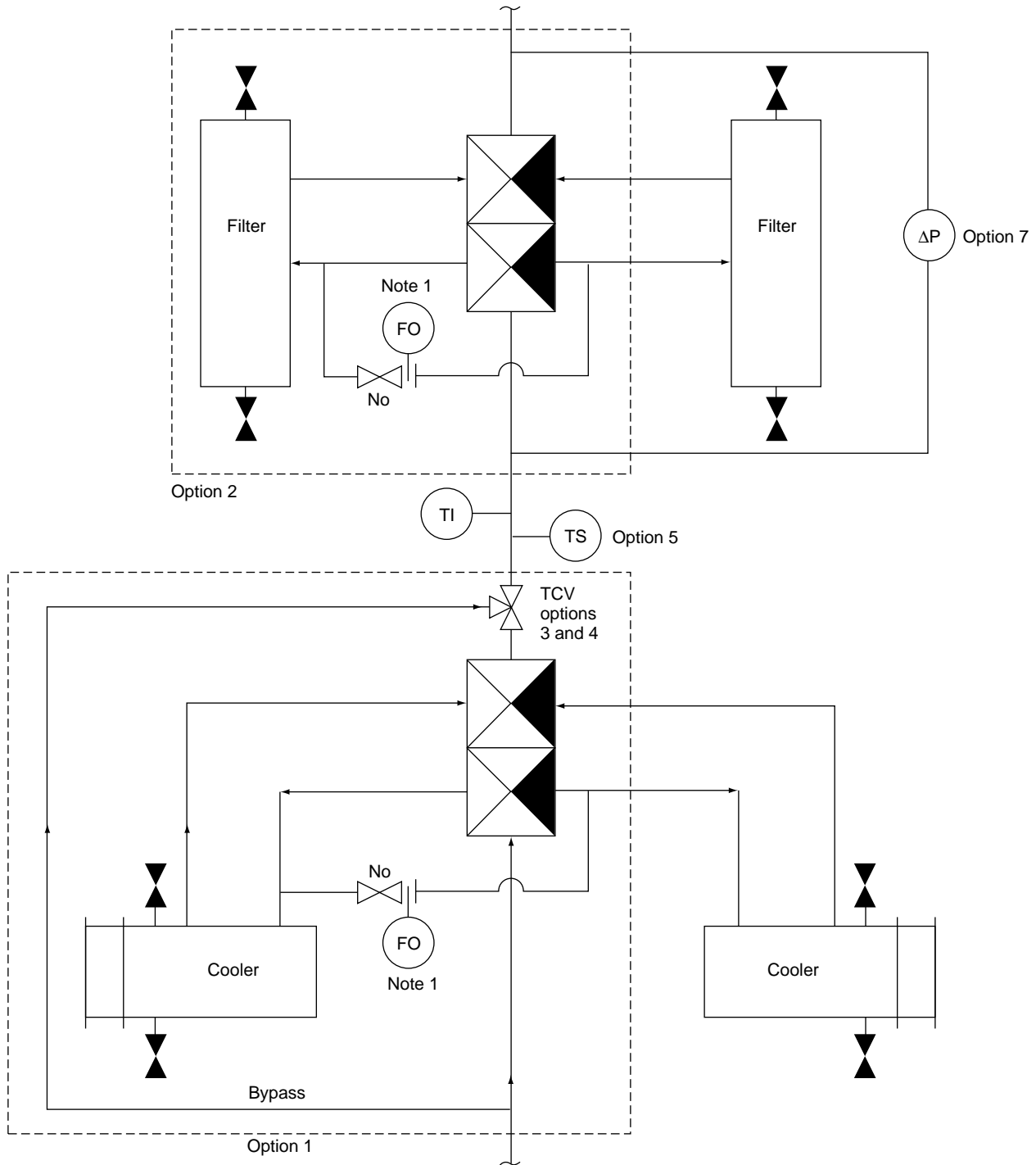




Notes:  
 1. PLV may be omitted for centrifugal pumps.  
 2. Suction strainer may be omitted for submerged oil pumps.  
 3. Check valves should be used on pump discharge if more than one pump is used.

Options:  
 1. 100% capacity auxiliary oil pump.  
 2. Block valves.  
 3. Pre/post lube oil pump (electric motor or hand operated) if required by rotating equipment manufacturer.  
 4. Pressure switch.  
 5. Pressure transmitter.

Figure 3A-3—Pumps



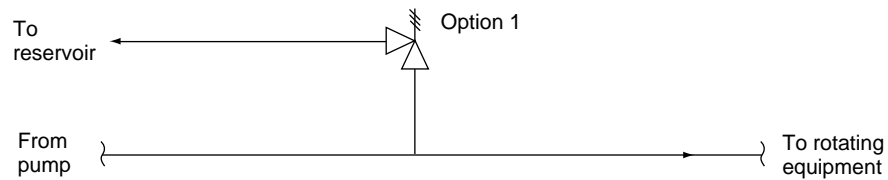
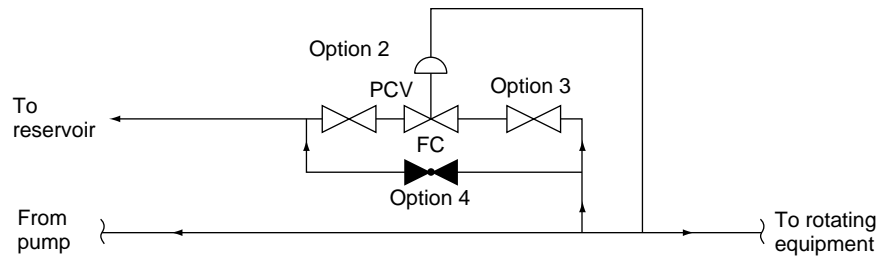
Notes:

1. When dual components are used, a normally open equalization line with orifice is required.

Options:

1. Dual coolers.
2. Dual filters.
3. Three-way constant temperature control valve with bypass line.
4. Two- or three-way variable temperature control valve with bypass line.
5. Temperature switch.
6. A single transfer valve with cooler and filter in parallel with separate TCV.
7. Differential pressure indicator, switch, combination, or separate.

Figure 3A-4—Pumps and Coolers



- Options:
1. Pressure-relieving valve.
  2. Back-pressure control valve—direct acting.
  3. Block valves around PCV.
  4. Globe bypass valve.

Figure 3A-5—Pressure Control



**CHAPTER 3**  
**APPENDIX B—DATA SHEETS**  
**(INFORMATIVE)**

1  
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**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
Page: 1 of 4 By: \_\_\_\_\_  
Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

For \_\_\_\_\_ Site \_\_\_\_\_

Oil System for \_\_\_\_\_

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
 2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

NOTE: For definition of General Purpose basic system, see 1.1.1.

Overall system typical schematics:	Figure No.	Option Nos.	Comment
<input type="radio"/> Basic oil supply module			
<input type="radio"/> Lube module at equipment			
<input type="radio"/> Drawing requirements		<input type="radio"/> Component review	

**Oil Requirements: See Chapter 1 data sheet (1.2.5, 1.2.7, 1.2.8, 1.2.10, 1.2.11, and 1.2.13)**

**Baseplate/layout:**

Grout hole/vent holes (1.3.5)

Epoxy grout/primer pre-coat (1.3.5)

Combined with equipment base (1.4.11.2)

Point support (1.3.6)

\_\_\_\_\_ m min. clearance for components (1.2.12)

**Basic system details:**

Equipment coast-down time \_\_\_\_\_ minutes

Minimum start-up oil temperature \_\_\_\_\_ °C

Sound level \_\_\_\_\_ Db max. (1.2.6)

Shop test conditions

Field start-up/run-in conditions

Welding and special fabrication requirements

**Components:**  All steel external components (1.2.14)

**Piping and Tubing:**

Tubing fittings—Mfg. \_\_\_\_\_ Model \_\_\_\_\_

Carbon steel slip-on flanges not allowed (Table 1D)

Through studs required

Heat tracing required by  Purch.  Vendor

Valve heads vented to reservoir

Radiographic examination (2.1.2.2)

Additional special requirements, see \_\_\_\_\_

Utilities manifolded to common connections

Air

Cooling water

Instrument test valves required

**Continuous flow transfer valves**

Separate for coolers and filters

Tight shutoff required

Type \_\_\_\_\_

Manufacturer \_\_\_\_\_

Model \_\_\_\_\_

with lifting jack

Rating: barg

Materials: body

Plug or ball

Trim

**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

**Oil conditioners:** (if required)

Purchaser's item no.  Driver for  
 Type  HP and enclosure  
 Portable or mounted on  Volts/PH/Hz  
 Rated m<sup>3</sup>/hr of oil \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_  
 Manufacturer  Water removal rate  
 Model  Material of construction

**Reservoir (1.4)**

Figures no.  
 Include options no.  
 Electric heater (1.4.7.1)  
 Special heater sizing (1.4.7.1.2)  
 Oil level glass (1.4.5.1.4)  
 Low level alarm (1.4.6.2)  
 50-mm fill opening (1.4.5.1.6)  
 Sloped bottom (1.4.4.3)  
 Free surface—m<sup>2</sup>  
 Working capacity (min/liter)  
 Retention capacity (min/liter)  
 Rundown capacity  
 Normal operating range  
 Charge capacity  
 Insulation clips (1.4.8)  
 Ladder with handrail (1.4.10.1)  
 Handrails on top (1.4.10.2)  
 Non-skid decking (1.4.10.3)  
 Flanged vent  
 Flanged drain (1.4.4.4)  
 Extra connection (1.4.9)  
 Siphon breaker  
 Top mounted components permitted  
 Top mounted components are:  
 Submerged components and materials  
 Dimensions of tank L x W x H \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_ (m)

**Pumps and drivers (1.5):**

Purchaser item nos.  
 Full details on data sheet  
**Pump type and material (1.5.1)**  
 Supplier standard  
 ANSI/ASME B73.1 horizontal  
 ANSI/ASME B73.2 vertical  
 Rotary positive displacement  
 In-line  
 Submerged  
 Steel casing (1.2.14)  
 API 610  
**Pump quantity and driver(s)**  
 Single-shaft driven  
 Single-motor driven  
 Motor driven start-up w/shaft drive main (1.5.4.1)  
 Full-sized motor-driven start-up to double  
 as auxiliary pump (1.5.4)  
 Dual motor drive  
 Dual steam turbine main/motor aux. (1.5.4)  
**Pump installation**  
 Removable strainer (1.5.14)  
 Mounting pads (1.5.19.1)



**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
Page: 3 of 4 By: \_\_\_\_\_  
Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built			
Supplier _____		Manufacturer _____	
Purchase Order No. _____ Date _____		Inquiry no. _____ Requisition No. _____	
<b>Filters:</b> <input type="radio"/> Purchaser item no. <input type="radio"/> Duplex (1.7.3) <input type="checkbox"/> <input type="radio"/> 10 Micron filtration level (1.7.2) <input checked="" type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Model <input checked="" type="checkbox"/> Design/test (psig) / <input type="radio"/> Code construction/stamp <input type="checkbox"/> / <input type="checkbox"/> <input checked="" type="checkbox"/> Material: case and top <input checked="" type="checkbox"/> Cartridges: (1.7.6.3) <input type="radio"/> Thermal relief valves (1.7.3.8) <input type="checkbox"/> <input type="radio"/> Nonhydroscopic elements (1.7.6.2) <input type="checkbox"/>		<b>Lube oil rundown tanks</b> <input type="radio"/> Required, yes or no (1.9.1) <input checked="" type="checkbox"/> Per Figure 2A-13a or 2A-13b (1.9.1) <input type="radio"/> Purchaser item no. Capacity (mins) <input type="checkbox"/> Capacity (liters) Material (1.9.1) Design/test (barg) <input type="radio"/> Code construction/stamp for <input type="checkbox"/> / <input type="checkbox"/> 2A-13a (1.2.17, 1.9.4)	
Furnish _____ extra sets of cartridges. <input type="radio"/> Per filter (extra over other spares).			
<b>Coolers:</b> <input type="checkbox"/> None required (1.6.1)		<input checked="" type="checkbox"/> Single	<input checked="" type="checkbox"/> Connections only for off-base cooler (1.6.1.3)
<b>Type:</b> <input type="radio"/> Shell and tube		<input type="radio"/> Fin fan	<input type="radio"/> Plate frame (1.6.1.3)
<input type="radio"/> Refer to specification		<input type="radio"/> Supplier std.	
<input type="radio"/> Purchaser item no(s)		<input type="checkbox"/> Duty: (Btu/hr) (KW)	
<input type="radio"/> Twin units (1.6.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Manufacturer	
<input type="radio"/> Details on data sheet		<input checked="" type="checkbox"/> Model	
<b>Shell and tube:</b>			
<input type="radio"/> Water side for steam heating	<input type="checkbox"/>	<input checked="" type="checkbox"/> Design/test shell side (psig)	
<input checked="" type="checkbox"/> Water side corrosion allowance		<input checked="" type="checkbox"/> Design/test tube side (psig)	
<input type="radio"/> TEMA class		<input type="radio"/> Code construction/stamp (1.2.17)	<input type="radio"/> / <input type="radio"/>
<input checked="" type="checkbox"/> Fouling factor water/oil side		<input checked="" type="checkbox"/> Tube water velocity and capacity (mps/m <sup>3</sup> /liter)	
<input checked="" type="checkbox"/> Tube: L/OD/BWG		<input checked="" type="checkbox"/> Material: shell	
<input type="radio"/> Removable bundle (1.6.3.4.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Channels and covers	
<input type="radio"/> Oil temperature control valve	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tube sheets and tubes	
<input type="radio"/> Thermal relief valve (1.6.1.7)	<input type="checkbox"/>	<input type="radio"/> Removable tube bundle	<input type="checkbox"/>
<b>Continuous flow transfer valves (1.8)</b>			
<input type="radio"/> Separate for coolers and filters (1.8.1.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Rating: _____ psig	
<input type="radio"/> Type		<input checked="" type="checkbox"/> Materials: body	
<input checked="" type="checkbox"/> Manufacturer		<input checked="" type="checkbox"/> Plug or ball	
<input checked="" type="checkbox"/> Model		<input checked="" type="checkbox"/> Trim	
		<input type="radio"/> Spectacle blinds (1.8.5)	



**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
Page: 1 of 4 By: \_\_\_\_\_  
Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
For \_\_\_\_\_ Site \_\_\_\_\_  
Oil System for \_\_\_\_\_  
Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

NOTES: 1. The party to complete the information is indicated as follows:  
 Purchaser  Vendor  Either, but by vendor if not by purchaser.  
2. A dot \* indicates the standard specifies a requirement, value, or criterion.  
3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.

NOTE: For definition of General Purpose basic system, see 1.1.1.

Overall system typical schematics:	Figure No.	Option Nos.	Comment
<input type="radio"/> Basic oil supply module			
<input type="radio"/> Lube module at equipment			
<input type="radio"/> Drawing requirements		<input type="radio"/> Component review	

**Oil Requirements: See Chapter 1 data sheet** (1.2.5, 1.2.7, 1.2.8, 1.2.10, 1.2.11, and 1.2.13)

**Baseplate/layout:**

Grout hole/vent holes (1.3.5)  Combined with equipment base (1.4.11.2)  
 Epoxy grout/primer pre-coat (1.3.5)  Point support (1.3.6)  
 \_\_\_\_\_ ft min. clearance for components (1.2.12)

**Basic system details:**

Equipment coast-down time \_\_\_\_\_ minutes  Shop test conditions  
 Minimum start-up oil temperature \_\_\_\_\_ °F  Field start-up/run-in conditions  
 Sound level \_\_\_\_\_ Db max. (1.2.6)  Welding and special fabrication requirements

**Components:**  All steel external components (1.2.14)

**Piping and Tubing:**

Tubing fittings—Mfg. \_\_\_\_\_ Model \_\_\_\_\_  Additional special requirements, see  
 Carbon steel slip-on flanges not allowed (Table 1D)  Utilities manifolded to common connections  
 Through studs required  Air  
 Heat tracing required by  Purch.  Vendor  Cooling water  
 Valve heads vented to reservoir  Instrument test valves required  
 Radiographic examination (2.1.2.2)

**Continuous flow transfer valves**

Separate for coolers and filters   with lifting jack   
 Tight shutoff required  Rating: psig  
 Type  Materials: body  
 Manufacturer  Plug or ball  
 Model  Trim

**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
Page: 2 of 4 By: \_\_\_\_\_  
Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built Supplier _____ Manufacturer _____ Purchase Order No. _____ Date _____ Inquiry no. _____ Requisition No. _____	
<b>Oil conditioners: (if required)</b>	
<input type="radio"/> Purchaser's item no. <input type="radio"/> Type <input type="radio"/> Portable or mounted on <input checked="" type="radio"/> Rated GPM of oil <input checked="" type="radio"/> Manufacturer <input checked="" type="radio"/> Model	<input type="checkbox"/> Driver for <input checked="" type="radio"/> HP and enclosure <input checked="" type="radio"/> Volts/PH/Hz ____/____/____ <input type="checkbox"/> Water removal rate <input checked="" type="radio"/> Material of construction
<b>Reservoir (1.4)</b> <input type="radio"/> Figures no. <input type="radio"/> Include options no. <input type="radio"/> Electric heater (1.4.7.1) <input type="radio"/> Special heater sizing (1.4.7.1.2) <input type="radio"/> Oil level glass (1.4.5.1.4) <input type="radio"/> Low level alarm (1.4.6.2) <input type="radio"/> 2-inch fill opening (1.4.5.1.6) <input type="radio"/> Sloped bottom (1.4.4.3) <input type="radio"/> Free surface—ft <sup>2</sup> <input checked="" type="radio"/> Working capacity (min/gal) <input checked="" type="radio"/> Retention capacity (min/gal) <input type="checkbox"/> Rundown capacity <input type="checkbox"/> Normal operating range <input type="checkbox"/> Charge capacity <input type="radio"/> Insulation clips (1.4.8) <input type="radio"/> Ladder with handrail (1.4.10.1)  <input type="radio"/> Handrails on top (1.4.10.2) <input type="radio"/> Non-skid decking (1.4.10.3) <input type="radio"/> Flanged vent <input type="radio"/> Flanged drain (1.4.4.4) <input type="radio"/> Extra connection (1.4.9) <input type="radio"/> Siphon breaker <input type="radio"/> Top mounted components permitted <input type="checkbox"/> Top mounted components are:  <input type="checkbox"/> Submerged components and materials <input type="checkbox"/> Dimensions of tank L x W x H ____/____/____ (ft)	<b>Pumps and drivers (1.5):</b> <input type="radio"/> Purchaser item nos. <input type="radio"/> Full details on data sheet <b>Pump type and material (1.5.1)</b> Supplier standard <input type="radio"/> ANSI/ASME B73.1 horizontal <input type="radio"/> ANSI/ASME B73.2 vertical <input type="radio"/> Rotary positive displacement <input type="radio"/> In-line <input type="radio"/> Submerged <input type="radio"/> Steel casing (1.2.14) <input type="radio"/> API 610 <b>Pump quantity and driver(s)</b> Single-shaft driven <input type="radio"/> Single-motor driven <input checked="" type="radio"/> Motor driven start-up w/shaft drive main (1.5.4.1) <input type="radio"/> Full-sized motor-driven start-up to double as auxiliary pump (1.5.4) <input type="radio"/> Dual motor drive <input type="radio"/> Dual steam turbine main/motor aux. (1.5.4) <b>Pump installation</b> <input type="radio"/> Removable strainer (1.5.14) <input type="radio"/> Mounting pads (1.5.19.1)

**API 614—Chapter 3 DATA SHEET  
GENERAL PURPOSE OIL SYSTEM  
U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
Page: 3 of 4 By: \_\_\_\_\_  
Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built			
Supplier _____		Manufacturer _____	
Purchase Order No. _____		Date _____	
Inquiry no. _____		Requisition No. _____	
<b>Filters:</b> <input type="radio"/> Purchaser item no. <input type="radio"/> Duplex (1.7.3) <input type="checkbox"/> <input type="radio"/> 10 Micron filtration level (1.7.2) <input checked="" type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Model <input checked="" type="checkbox"/> Design/test (psig) / <input type="radio"/> Code construction/stamp <input type="checkbox"/> / <input type="checkbox"/> <input checked="" type="checkbox"/> Material: case and top <input checked="" type="checkbox"/> Cartridges: (1.7.6.3) <input type="radio"/> Thermal relief valves (1.7.3.8) <input type="checkbox"/> <input type="radio"/> Nonhydroscopic elements (1.7.6.2) <input type="checkbox"/>		<b>Lube oil rundown tanks</b> <input type="radio"/> Required, yes or no (1.9.1) <input checked="" type="checkbox"/> Per Figure 2A-13a or 2A-13b (1.9.1) <input type="radio"/> Purchaser item no. Capacity (mins) <input type="checkbox"/> Capacity (gal.) Material (1.9.1) Design/test (psig) <input type="radio"/> Code construction/stamp for <input type="checkbox"/> / <input type="checkbox"/> 2A-13a (1.2.17, 1.9.4)	
Furnish _____ extra sets of cartridges. <input type="radio"/> Per filter (extra over other spares).			
<b>Coolers:</b> <input type="checkbox"/> None required (1.6.1)		<input checked="" type="checkbox"/> Single	
<input checked="" type="checkbox"/> Connections only for off-base cooler (1.6.1.3)			
<b>Type:</b> <input type="radio"/> Shell and tube		<input type="radio"/> Fin fan	
<input type="radio"/> Refer to specification		<input type="radio"/> Plate frame (1.6.1.3)	
<input type="radio"/> Supplier std.			
<input type="radio"/> Purchaser item no(s)		<input type="checkbox"/> Duty: (Btu/hr) (KW)	
<input type="radio"/> Twin units (1.6.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Manufacturer	
<input type="radio"/> Details on data sheet		<input checked="" type="checkbox"/> Model	
<b>Shell and tube:</b>			
<input type="radio"/> Water side for steam heating	<input type="checkbox"/>	<input checked="" type="checkbox"/> Design/test shell side (psig)	
<input checked="" type="checkbox"/> Water side corrosion allowance		<input checked="" type="checkbox"/> Design/test tube side (psig)	
<input type="radio"/> TEMA class		<input type="radio"/> Code construction/stamp (1.2.17)	<input type="radio"/> / <input type="radio"/>
<input checked="" type="checkbox"/> Fouling factor water/oil side		<input checked="" type="checkbox"/> Tube water velocity and capacity (fps/gpm)	
<input checked="" type="checkbox"/> Tube: L/OD/BWG		<input checked="" type="checkbox"/> Material: shell	
<input type="radio"/> Removable bundle (1.6.3.4.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Channels and covers	
<input type="radio"/> Oil temperature control valve	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tube sheets and tubes	
<input type="radio"/> Thermal relief valve (1.6.1.7)	<input type="checkbox"/>	<input type="radio"/> Removable tube bundle	<input type="checkbox"/>
<b>Continuous flow transfer valves (1.8)</b>			
<input type="radio"/> Separate for coolers and filters (1.8.1.1)	<input type="checkbox"/>	<input checked="" type="checkbox"/> Rating: _____ psig	
<input type="radio"/> Type		<input checked="" type="checkbox"/> Materials: body	
<input checked="" type="checkbox"/> Manufacturer		<input checked="" type="checkbox"/> Plug or ball	
<input checked="" type="checkbox"/> Model		<input checked="" type="checkbox"/> Trim	
		<input type="radio"/> Spectacle blinds (1.8.5)	



**CHAPTER 3**  
**APPENDIX C—INSPECTOR’S CHECKLIST**  
**(INFORMATIVE)**

.....



### Chapter 3—Inspector’s Checklist

Item	Date Inspected	Inspected By	Status
1. Sound pressure level requirements met <i>(I.1.6)</i> .			
2. Oil characteristics.			
a. Per specification <i>(I.1.8)</i> .			
b. Hydrotest compatible <i>(7.3.2.1)</i> in Chapter 1.			
c. Run-test compatible <i>(4.3.3.I)</i> in Chapter 1.			
3. Compatible rust preventatives used <i>(7.4.3.3, 7.4.3.4)</i> in Chapter 1.			
4. Lube-oil/seal-oil separation demonstrated (if applicable) <i>(I.1.7)</i> .			
5. System arrangement <i>(I.1.13)</i> .			
a. Per drawings <i>(I.2.1)</i> .			
b. Providing adequate clearances.			
c. Providing safe access.			
6. ASME Code stamp (if applicable) <i>(I.1.18)</i> .			
a. Coolers.			
b. Filters.			
c. Accumulators.			
d. Other pressure vessels.			
7. Welding operators and procedures qualified per Section IX of ASME Code.			
a. Welding of pressure vessels <i>(I.1.22)</i> .			
(1) Coolers.			
(2) Filters.			
(3) Accumulators			
(4) Other pressure vessels.			
b. Welding of oil piping <i>(2.1.1)</i> .			
c. Dissimilar-metal welding and weld repairs <i>(I.1.22)</i> .			
d. Verification of welds <i>(7.2.3.3)</i> in Chapter 1.			
8. Welding procedures (other than above) <i>(I.2.7)</i> .			
a. Baseplates			
b. Panels.			
c. Nonpressure ducting.			
d. Other.			
9. Baseplates			
a. Major components mounted directly on structural steel <i>(I.2.1)</i> .			
b. Adequate drip rim <i>(1.2.2)</i> .			

Item	Date Inspected	Inspected By	Status
c. Adequate lifting lug (distortion, damage) (1.2.3).			
d. Metal decking (1.2.4).			
10. Reservoir top sealed properly (1.3.2.1).			
11. Manway openings adequate (1.3.4).			
12. Reservoir heaters adequate for the application (1.3.7.2).			
13. Clips provided.			
a. Insulation clips (1.3.8).			
b. Grounding clips (1.3.14).			
14. Pumps.			
a. Piping vented or arranged to avoid air pockets (1.4.14).			
b. Strainers installed and tabbed (1.4.15).			
c. Alignment checked (1.4.19.4).			
d. Mounting surfaces flat and parallel (1.4.20.1).			
e. Shims installed (1.4.20.2).			
f. Bolting and unbolting of piping demonstrated (1.4.24.5).			
g. Jackscrews adequate (1.4.20.6)			
15. Oil Filters.			
a. Drainability demonstrated (1.6.2.8).			
16. Piping.			
a. Examined and inspected per ASME B31.3 (5.1.1, 5.1.12) in Chapter 1.			
b. Fabricated per specification (2.1.6).			
17. Oil drains shown to run not more than half full (5.2.1) in Chapter 1.			
18. Electrical systems/panels.			
a. Wiring suitable (6.5.3) in Chapter 1.			
b. Spare terminal points adequate (6.5.4) in Chapter 1.			
c. Clearances adequate for maintenance (6.5.5) in Chapter 1.			
d. Fungus/corrosion protection provided (6.5.6.1, 6.5.6.2) in Chapter 1.			
e. Warning clearly labeled and isolated (6.5.7, 6.5.8) in Chapter 1.			
19. Material inspected as specified (list each component) (7.2.2) in Chapter 1.			
20. Components inspected for cleanliness (list each) (7.2.3.2) in Chapter 1.			
21. Hydrostatic tests.			
a. Hydrotest certified (list each component) (7.3.2.1) in Chapter 1.			
b. Assembled oil system hydrostatic test performed (7.3.2.1) in Chapter 1.			
c. Chlorides in hydrotest liquid address adequately (7.3.2.4) in Chapter 1.			
d. Test pressures verified (7.3.2.2, 7.3.2.3) in Chapter 1.			

Item	Date Inspected	Inspected By	Status
22. Operational tests.			
a. System cleanliness verified after operational tests (4.3.3.1.2).			
b. All leaks corrected before starting (4.3.3.5.1).			
c. Limiting pressures verified (4.3.3.5.2).			
d. Filter-code changeover performed (4.3.3.5.3).			
e. Control valve response and stability demonstrated (4.3.3.5.4, 4.3.3.5.5, 4.3.3.5.6).			
f. Pressure drop on pump trip checked/demonstrated (4.3.3.5.6).			
g. Transfer valve leakage demonstrated (4.3.3.6).			
h. System cleanliness after test demonstrated ( <b>4.3.3.7.I</b> ).			
24. Painting (7.4.3.1) in Chapter 1.			
25. Preparation for shipment.			
a. Equipment cleaned and prepared properly (7.4.3) in Chapter 1.			
b. Items properly tagged (7.4.3.9) in Chapter 1.			
c. Storage/handling/installation instructions received (7.4.2, 7.4.8) in Chapter 1.			
d. Piping and components adequately braced ( <b>4.4.3.10</b> ) in Chapter 1.			
e. Connections properly tagged (7.4.6) in Chapter 1.			
f. Shipping documents included (7.4.3.9) in Chapter 1.			



**CHAPTER 3**  
**APPENDIX D—COST ESTIMATE WORKSHEET FOR**  
**GENERAL-PURPOSE OIL SYSTEM (INFORMATIVE)**



### API 614, 4th Edition—Cost Estimating Worksheet for General Purpose Oil System

(\* Indicates that customer is to enter data.)

Equipment Oil Requirements

<u>Lube Oil</u>	m <sup>3</sup> /h	kPa	(gpm)	(psig)
Unit #1	_____	_____	_____	_____
Unit #2	_____	_____	_____	_____
Unit #3	_____	_____	_____	_____
Prime mover	_____	_____	_____	_____
Gear	_____	_____	_____	_____
other: _____	_____	_____	_____	_____
other: _____	_____	_____	_____	_____
Total	_____	_____	_____	_____

<u>Total Heat Load</u>	kcal/h	(Btu/h)
Lube oil	_____	_____

(

\* Reservoir

Material:	( ) CS	( ) SS - type _____
Heater:	( ) None	( ) Steam ( ) Electric

\* Pumps

Type:	( ) Positive displacement	( ) Centrifugal
PD pump mounting:	( ) Horizontal	( ) Vertical
	( ) External to reservoir	( ) Internal to reservoir

\* Drivers

	<u>Main</u>	<u>Auxiliary</u>	<u>Emergency</u>	<u>Other ( _____ )</u>
Shaft driven	( )			
Motor (AC)	( )	( )	( )	( )
Steam turbine	( )			
Motor (DC)			( )	( )

\* Lube Oil Rundown Tank

Type:	( ) Atmospheric	( ) Pressurized
Material:	( ) CS	( ) SS - type _____

\* Coolers

Arrangement	( ) Single	( ) Duplex
Type:	( ) Shell and tube	( ) Fin fan ( ) Plate frame
Shell material:	( ) CS	( ) SS - type _____
Tube material:	( ) Inhibited admiralty	( ) other: _____
Tube sheet material:	( ) Naval brass	( ) other: _____
Coolant:	( ) Water	T in ___ deg C ( ___ deg F) P in ___ kPa ( ___ psig)
		T out max ___ deg C ( ___ deg F) P out ___ kPa ( ___ psig)
	( ) Air	T max ___ deg C ( ___ deg F) T min ___ deg C ( ___ deg F)
	( ) other: _____	
Shell and tube type:	( ) AEW	( ) AES ( ) AEU ( ) other: _____
TEMA:	( ) C	( ) R

\* Filters

Shell material:	( ) CS	( ) SS - type _____
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# CONTENTS

	Page
1 GENERAL . . . . .	4-1
1.1 Scope . . . . .	4-1
1.2 Definition of Terms . . . . .	4-1
1.3 System Selection . . . . .	4-1
2 BASIC DESIGN . . . . .	4-1
2.1 General . . . . .	4-1
2.2 Piping and Tubing . . . . .	4-2
2.3 Gas Filters . . . . .	4-2
2.4 Transfer Valves . . . . .	4-2
2.5 Condensate Traps . . . . .	4-2
3 INSTRUMENTATION, CONTROL, AND ELECTRICAL SYSTEMS . . . . .	4-3
3.1 Instruments—Specific to Module . . . . .	4-3
3.2 Alarms and Shutdowns . . . . .	4-3
3.3 Instrumentation . . . . .	4-3
4 INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT . . . . .	4-4
4.1 General . . . . .	4-4
4.2 Inspection . . . . .	4-4
4.3 Testing . . . . .	4-4
4.4 Preparation for shipment . . . . .	4-4
5 VENDOR'S DATA . . . . .	4-4
5.1 Proposal . . . . .	4-4
5.2 Spare Parts . . . . .	4-4
APPENDIX A DRY GAS SEAL SYSTEM SCHEMATICS (INFORMATIVE) . . . . .	4-5
APPENDIX B DATA SHEETS (INFORMATIVE) . . . . .	4-17
APPENDIX C INSPECTOR'S CHECKLIST (INFORMATIVE) . . . . .	4-29

## Figures

4A-1	Double Opposed Dry Gas Seal Schematic . . . . .	4-7
4A-2	Tandem Dry Gas Seal Schematic With Intermediate Labyrinth Seal . . . . .	4-8
4A-3	Tandem Dry Gas Seal Schematic . . . . .	4-9
4A-4	Single Dry Gas Seal Schematic . . . . .	4-10
4A-5a	Seal Gas Filter Module . . . . .	4-11
4A-5b	Optimal Automatic Liquid Drainer System for Coalescing Gas Filters . . . . .	4-11
4A-5c	Separation Gas Filter Module . . . . .	4-11
4A-6a	Differential Pressure Control . . . . .	4-12
4A-6b	Flow Control (1) . . . . .	4-12
4A-6c	Flow Control (2) . . . . .	4-12
4A-6d	Flow Control (3) . . . . .	4-12
4A-7a	Differential Pressure Control . . . . .	4-13
4A-7b	Flow Control (Option 1) . . . . .	4-13
4A-7c	Flow Control (Option 2) . . . . .	4-13

4A-8a	Flow Measuring by Differential Pressure . . . . .	4-14
4A-8b	Flow Monitoring by Back Pressure. . . . .	4-14
4A-8c	Flow Measuring . . . . .	4-14
4A-9a	Separation Gas Modules (Option 1) . . . . .	4-15
4A-9b	Separation Gas Modules (Option 2) . . . . .	4-15
4A-9c	Separation Gas Modules (Option 3) . . . . .	4-15

Tables

1	Conditions Requiring Alarms and Shutdowns for Each Shaft End . . . . .	4-3
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**2.1.12** Block valves which interrupt the gas flow to the equipment shall not be installed in gas supply lines downstream of the filters unless the blockvalves are part of a component block and bypass arrangement.

## 2.2 PIPING AND TUBING

**2.2.1** The vendor shall furnish the dry gas seal module, including mounted appurtenances, located within the confines of the base area. All connections on the module for interconnecting piping to the equipment, shall be flanged.

Note: This is to keep work areas and walkways as free as possible from obstructions. The intent is to use tubing within the limits of the module such that the module will protect the tubing from external loads. The interconnecting system between the module and equipment should be rigid pipe. The interconnecting system is provided by the vendor defined in Appendix B.

**2.2.2** Unless otherwise specified, the piping for each utility, such as for instrument air and nitrogen supply, and others as specified, shall be manifolded to a common connection.

**2.2.3** Unless otherwise specified, self-acting gas seal module designed for working pressures below 6200 kPa (900 psig) shall have the gas flow lines manufactured from stainless steel tubing, or stainless steel piping.

**2.2.4** Unless otherwise specified, self-acting gas seal module with working pressures greater than 6200 kPa (900 psig) shall have gas flow lines manufactured from stainless steel piping.

**2.2.5** Instrument valves within the self-acting gas seal module on tubing lines, shall be tubing valves.

**2.2.6** Control valves shall have steel bodies, and stainless steel trim. Valves shall be removable without removing piping or tubing.

## 2.3 GAS FILTERS

**2.3.1** The filter element material shall be designed for the maximum process gas temperature and shall be compatible with the process gas.

**2.3.2** Unless otherwise specified, filters in flammable or toxic services shall have bolted covers.

**2.3.3** Unless otherwise specified, the filter housings shall be stainless steel.

### 2.3.4 Particulate Filter Sizing

**2.3.4.1** For differential pressure control systems, filters shall be sized for a clean pressure drop of 21 kPa (3 psig) at twice the gas flow calculated at maximum labyrinth design clearance and at the design differential pressure.

**2.3.4.2** For flow control systems, filters shall be sized for a clean pressure drop of 1 kPa (4 in. of water) at 10 times the

normal flow. They shall function to a differential of 25 kPa (100 in. of water).

## 2.3.5 Coalescing Filter Sizing

**2.3.5.1** When the gas contains liquids or moisture, coalescing filters shall be provided. The coalescing filter shall have an efficiency of 98.7 percent on particles less than or equal to 3 microns ( $\beta_3 \geq 75$ ). If the knockout rates exceed 50 percent of the coalescing capacity of the element, a mechanical separator shall be installed ahead of the filter assembly.

Note: It may be advantageous to use filter designs that use the same cartridge to avoid having different type cartridges as spare parts. The cost of a possible oversized filter cost and operation should be weighed against the benefit of standardization.

## 2.4 TRANSFER VALVES

**2.4.1** For flammable or toxic service there shall be no leakage into the isolated system (such as the standby filter). When an isolation system is designed such that total shutoff of flow will adversely affect the seal, the vendor shall provide cautionary warning signs of such on the dry gas seal module.

Note: Four individual block valves or a combination of block valves and transfer valves may be required for positive isolation to transfer filters.

**2.4.2** Transfer valves shall have steel bodies. Valve stems, plugs, or balls shall be made of stainless steel.

- **2.4.3** When specified, provide a strainer with 100-mesh screen when zero leakage (bubble tight) transfer valves are supplied.

Note: This will prevent particulate damage to the valve seat and help to maintain performance.

## 2.5 CONDENSATE TRAPS

**2.5.1** One condensate drain trap per coalescing filter shall be provided when condensate may be present at the coldest operating temperature in seal gas and or seal buffer gas. Gas downstream of the filter and trap shall be kept liquid-free.

Note: For some services, heat tracing and/or drain traps at supply piping low points downstream of the control valve may be required.

**2.5.1.1** Nonrepairable float traps are acceptable for services below 31 bar (450 psig) when approved by the purchaser.

**2.5.1.2** A mechanical float-type trap is permitted for gas pressures less than or equal to 68 bar (1000 psig).

Note: Level transmitter control-type traps should be used when gas fouling would interfere with the operation of mechanical float-type traps.

**2.5.1.3** For pressures greater than 68 bar (1000 psig), snap-acting level transmitter/controllers and separate control valves shall be used.

**2.5.2** All low points upstream of filters shall have drain valves.

**2.5.3** Traps of 2.5.1.2 and 2.5.1.3 configuration shall be furnished with reflex-type gauge glasses. The inlet piping shall enter the seal traps above the condensate level of the traps.

**2.5.4** Unless otherwise specified drain lines for traps on the module shall be manifolded and a flange connection supplied at the edge of the module.

### 3 Instrumentation, Control, and Electrical Systems

Instrumentation shall be in accordance with Section 6, Chapter 1, except as modified in the following paragraphs.

#### 3.1 INSTRUMENTS—SPECIFIC TO MODULE

**3.1.1** Unless otherwise specified, the support structure of the dry gas seal module shall be fabricated from carbon steel and painted.

**3.1.2** Vents shall be sized to prevent overpressurization of the bearing housings in the event of a failure of the seal.

#### 3.2 ALARMS AND SHUTDOWNS

**3.2.1** As a minimum, the vendor shall furnish and mount the primary alarm and shutdown contacts specified in Table 1.

##### • 3.2.2 Arrangement 1

**3.2.2.1** When specified, both shut-down and alarm switches shall be connected through normally energized, fail-safe circuits. The shut-down circuits wiring shall be completely independent from the alarm circuit wiring and shall be mechanically protected.

##### • 3.2.3 Arrangement 2

**3.2.3.1** Shut-down functions shall be initiated by local direct-acting switches connected in a normally de-energized, circuit.

Table 1—Conditions Requiring Alarms and Shutdowns for Each Shaft End

Condition	Alarm	Shutdown
Low seal gas, seal buffer gas or separation gas differential pressure or flow	X	
High primary vent pressure or flow	X	X
High differential pressure for each filter set	X	

**3.2.3.2** Alarm functions shall comprise locally mounted transmitters (electronic or pneumatic as specified) connected to either separate panel mounted switches or to a multipointed scanning-type instrument.

**3.2.3.3** Where multipoint, scanning-type instruments are used, the alarm setting for each function shall be separately and independently adjustable.

##### • 3.2.4 Arrangement 3

**3.2.4.1** Each function for which both an alarm and a shut-down have been specified, shall be provided with three separate and independent transmitters (electronic unless agreed to otherwise).

**3.2.4.2** Each transmitter shall be independently connected to one of three independent multipoint, electronic, scanning-type instruments for each transmitter input.

**3.2.4.3** The shut-down and alarm function outputs from the three multipoint instruments shall be connected through “two out of three” voting logic and shall allow the operation of any one alarm or shut-down function to initiate an alarm. Operation of two shut-down functions monitoring the same parameter will initiate a separate alarm and shall cause the served equipment to shutdown.

**3.2.4.4** Alarm functions not associated with a shut-down function shall be provided with one single transmitter. These alarm transmitters may be connected to one of three alarm/shut-down multipoint instruments or to a separate multipoint instrument.

Note: This arrangement (Arrangement 3) has the following advantages.

- Any shut-down or alarm function can be tested at any time with the equipment in service without the need to disarm any part of the system.
- Failure of any one component will initiate an alarm but will not result in equipment shutdown.
- The use of modern, digital instrument technology is facilitated.
- The detail arrangement should be jointly developed between the purchaser and the vendor or vendors of the system and the served equipment.

Note: If the circuit is normally energized this shall be a fail safe arrangement to avoid spurious trips. Example 2 out of 3 voting, DC power supply, UPS.

### 3.3 INSTRUMENTATION

#### 3.3.1 Flow Indicators

**3.3.1.1** Unless otherwise specified for flow control systems, the flow indicators shall be the armored type and have an internal magnetic float or rotameter design. When specified, turbine flow transmitters shall be supplied.

**3.3.1.2** Unless otherwise specified for differential pressure control systems, an orifice flowmeter shall be supplied.

**3.3.1.3** Unless otherwise specified, flow meters in inert separation gas services may be the plastic rotameter design.

- **3.3.1.4** When specified, seal gas flow measurement shall be by an electronic device such as a linear mass flow meter, venturi, or turbine type. The purchaser will specify whether the readout device is to be supplied by module manufacturer or by the purchaser.

### 3.3.2 Relief Valves

**3.3.2.1** The vendor shall furnish the relief valves that are to be installed on components or in piping that the vendor is supplying. Other relief valves will be furnished by the purchaser. Only relief valves for gas service are required to meet the limiting relief valve requirements defined in API RP 520, Parts I and II, and in API RP 526.

**3.3.2.2** The vendor shall determine the size and set pressure of all relief valves associated with the system components.

**3.3.2.3** Relief valve settings shall take into consideration all possible types of equipment and component failures and the protection of the self-acting gas seal module components and piping.

**3.3.2.4** Unless otherwise specified, relief valves shall have steel bodies.

## 4 Inspection, Testing, and Preparation for Shipment

### 4.1 GENERAL

Inspection, testing, and preparation for shipment shall occur according to Section 7, Chapter 1, unless otherwise specified in this section.

- **4.1.1** When specified, the purchaser's or the vendor's representative or both shall indicate compliance in accordance with the inspector's checklist (Appendix C) by initialing, dating, and submitting the completed checklist to the purchaser prior to shipment.

### 4.2 INSPECTION

Inspection shall occur per 7.2, Chapter 1.

### 4.3 TESTING

#### 4.3.1 General

**4.3.1.1** Equipment shall be tested in accordance with 7.3, Chapter 1, and the requirements of 4.3.2 and 4.3.3. Other

tests may be specified and shall be jointly developed by the purchaser and the vendor.

- **4.3.1.2** When specified, the self-acting gas seal module shall be used during the main equipment's mechanical run test.

**4.3.2** The hydrostatic test shall be performed per 7.3.2, Chapter 1.

### 4.3.3 Operational Tests

**4.3.3.1** A cleanliness test of the dry gas seal module shall be conducted at the vendor's shop with the job filter or new test filter (of equal filtration capability) elements installed. A 100-mesh screen shall be fastened to the outlet of the module flange for each gas line from the module. The module shall be blown for a 5-minute period with a nominal 100 psig dry filtered (dew point not greater than 20°F and filtered to  $\beta_2 \geq 10$  gas. The screen shall be inspected for discoloration and cleanliness. Any hard particles or discoloration shall be grounds for rejection. If the dry gas seal module does not meet the cleanliness criteria, then disassembly and mechanical cleaning may be required and a repeat of the cleanliness test shall be done.

**4.3.3.2** A gas leak test at 110 percent of maximum design pressure shall be performed of the system using a gas mutually agreed to by the purchaser and vendor.

**4.3.3.3** Unless otherwise specified, test gas shall be helium for seal gas MW 12 or less, and air or nitrogen for seal gas MW greater than 12.

- **4.3.3.4** When specified, a functional test proposed by the vendor and agreed to by the purchaser of the self-acting seal gas module shall be performed at the vendor's shop.

### 4.4 PREPARATION FOR SHIPMENT

The dry gas module shall be prepared for shipment according to 7.4, Chapter 1.

## 5 Vendor's Data

### 5.1 PROPOSAL

**5.1.1** The seal vendor's proposals shall incorporate requirements for the self-acting gas seal module to allow successful operation of the seal.

### 5.2 SPARE PARTS

The vendor shall ship the unit with clean filter elements installed.





.....

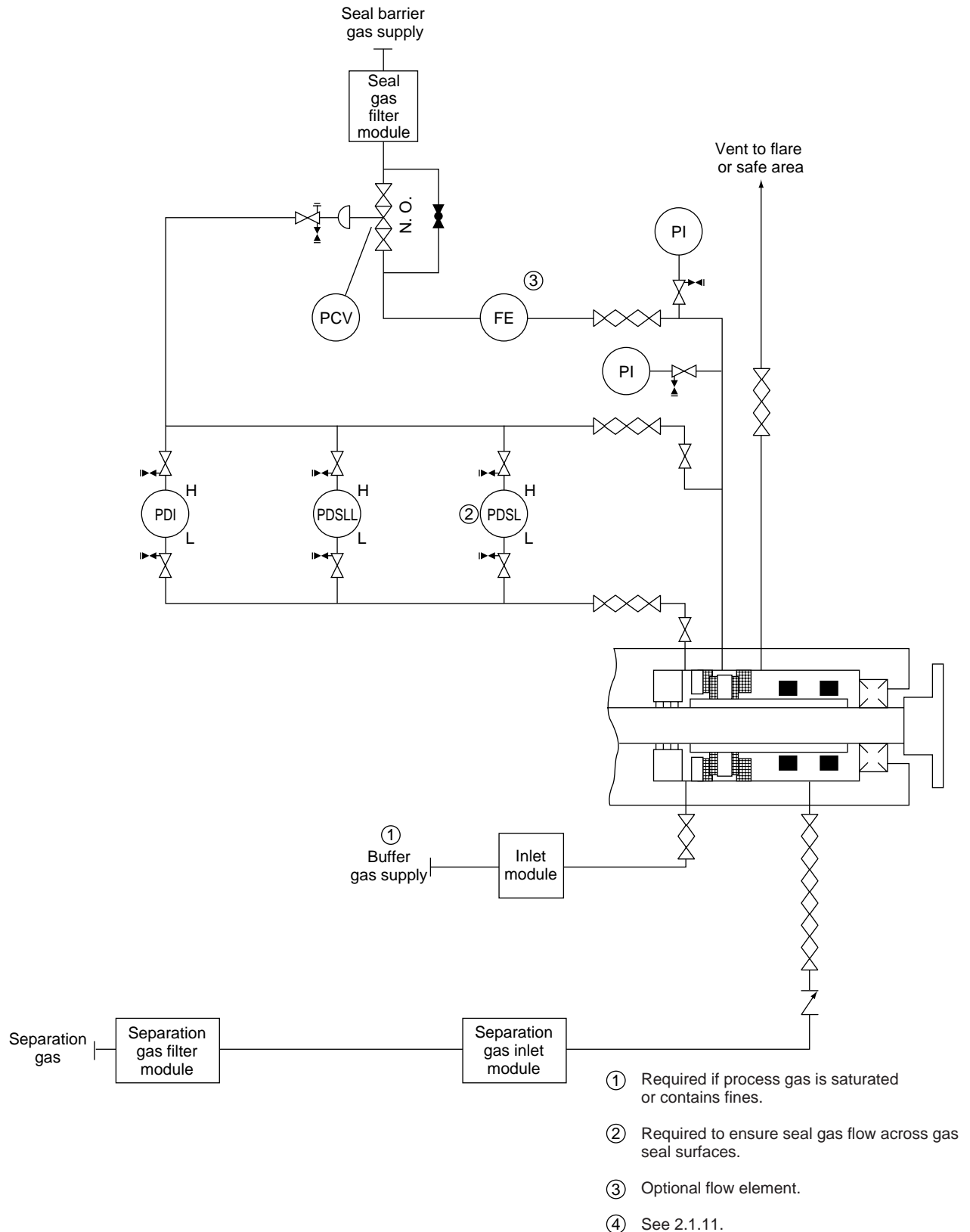


Figure 4A-1—Double Opposed Dry Gas Seal Schematic

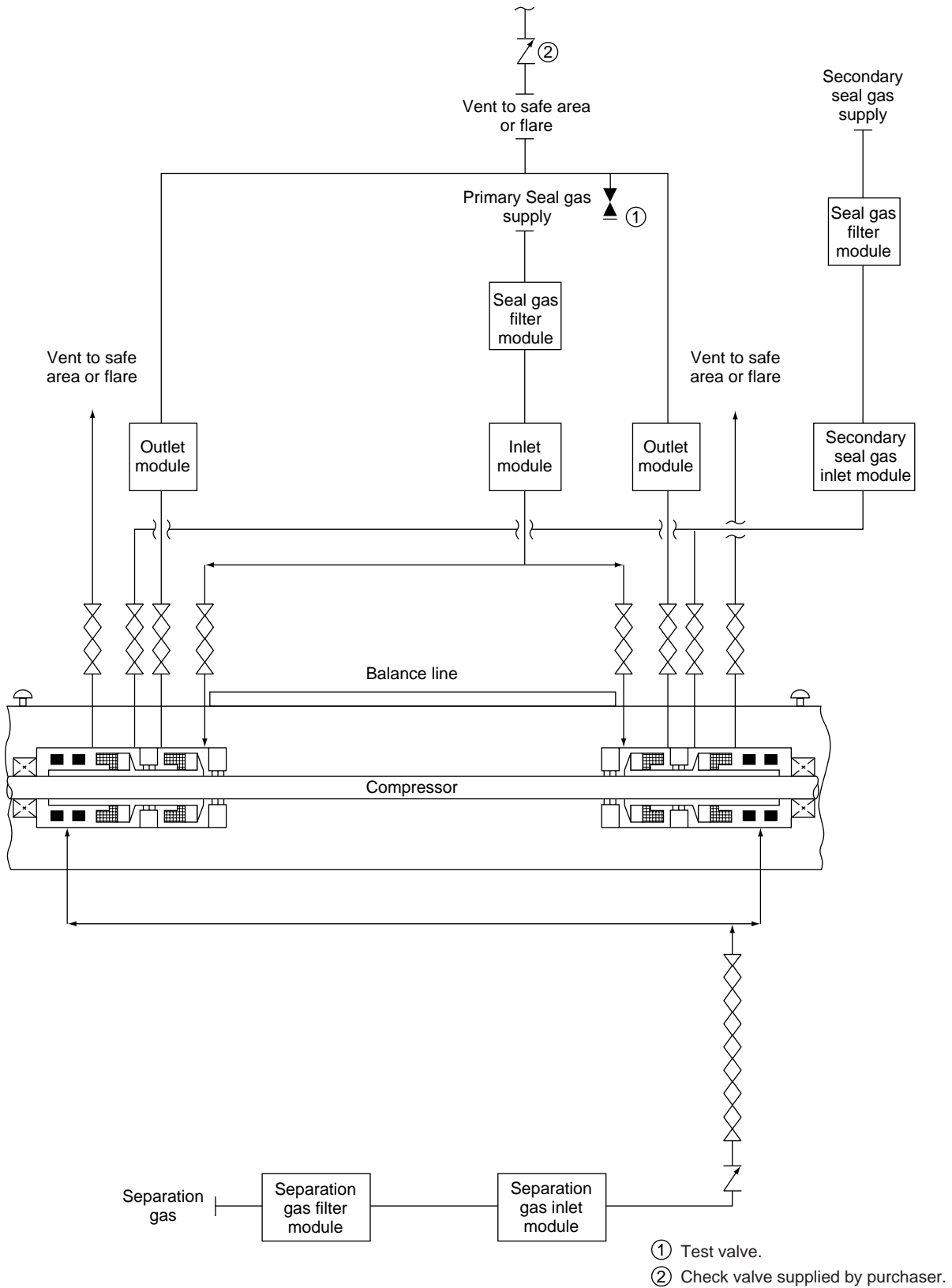


Figure 4A-2—Tandem Dry Gas Seal Schematic With Intermediate Labyrinth Seal

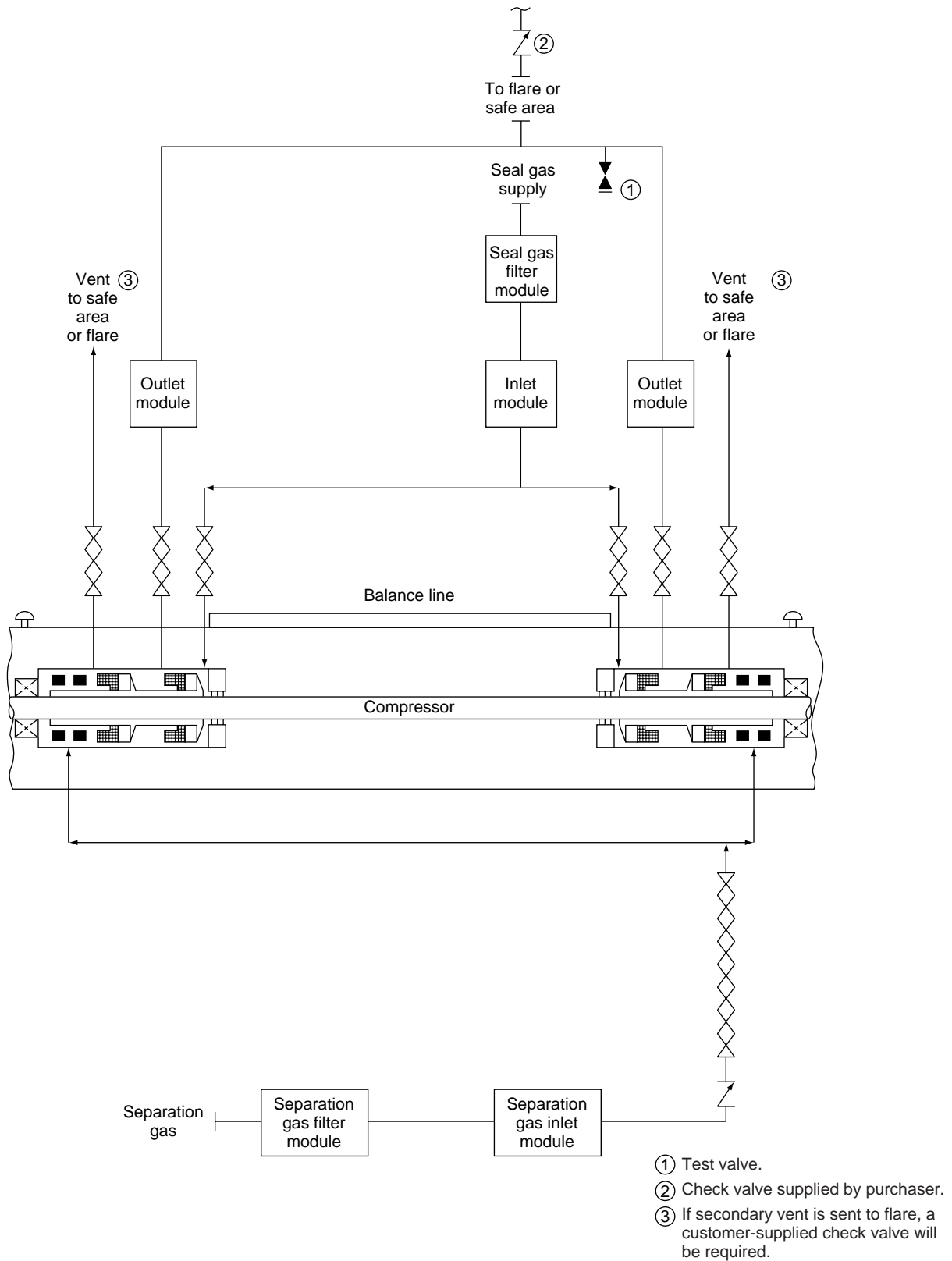


Figure 4A-3—Tandem Dry Gas Seal Schematic

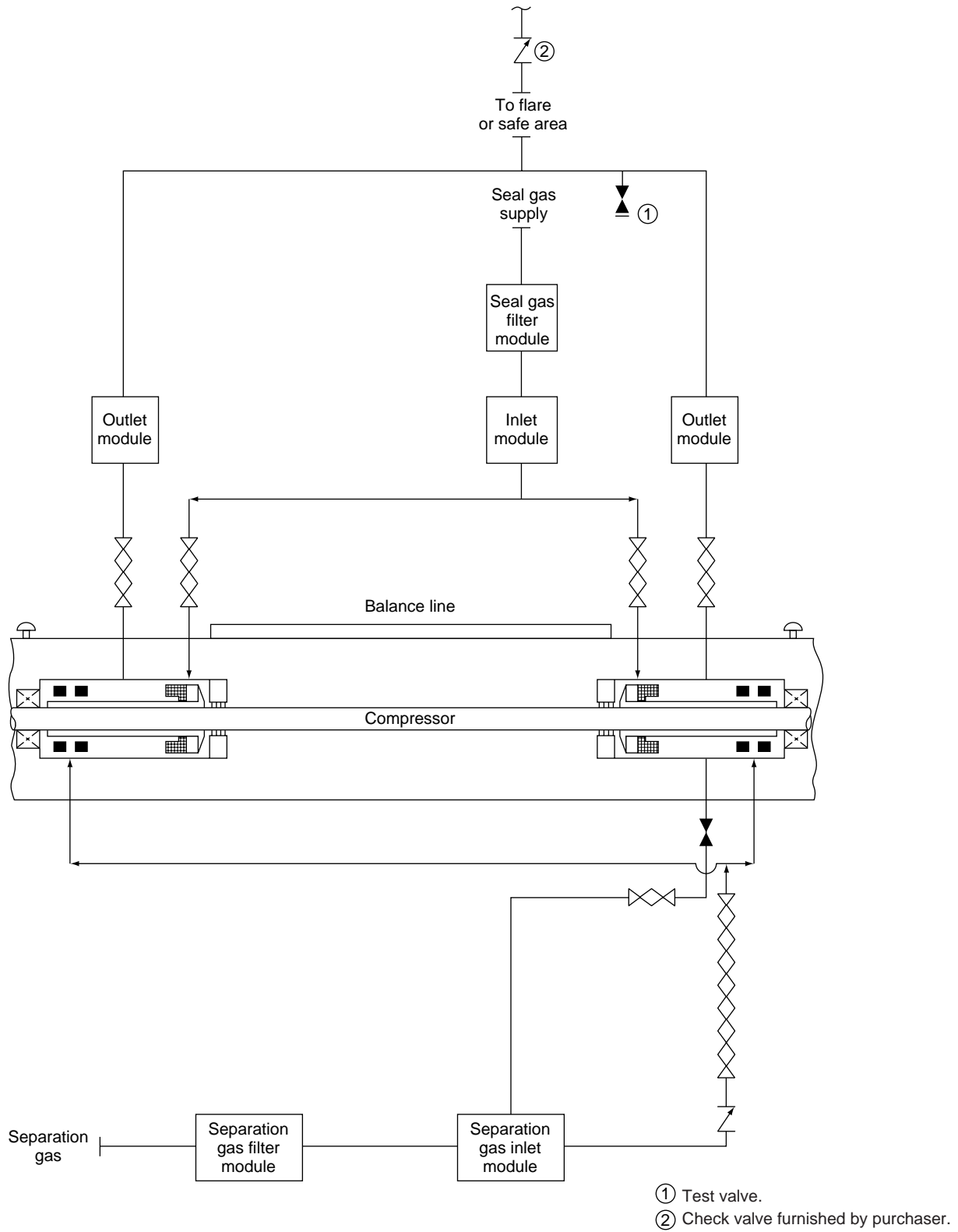
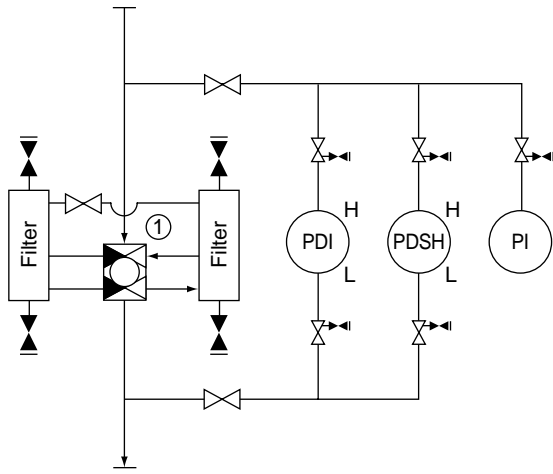


Figure 4A-4—Single Dry Gas Seal Schematic



① Individual block valves may be substituted for transfer valve.

Figure 4A-5a—Seal Gas Filter Module

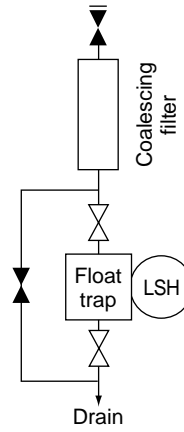


Figure 4A-5b—Optimal Automatic Liquid Drainer System for Coalescing Gas Filters

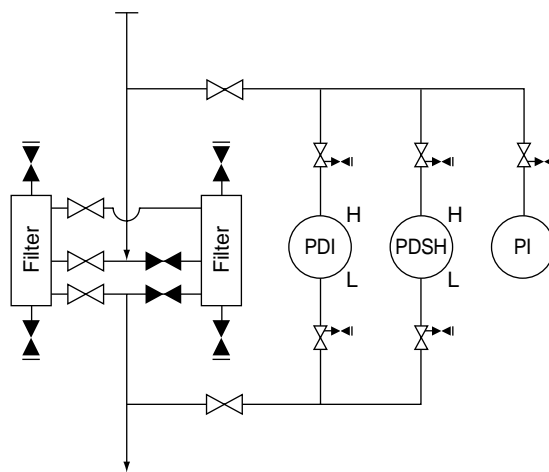


Figure 4A-5c—Separation Gas Filter Module

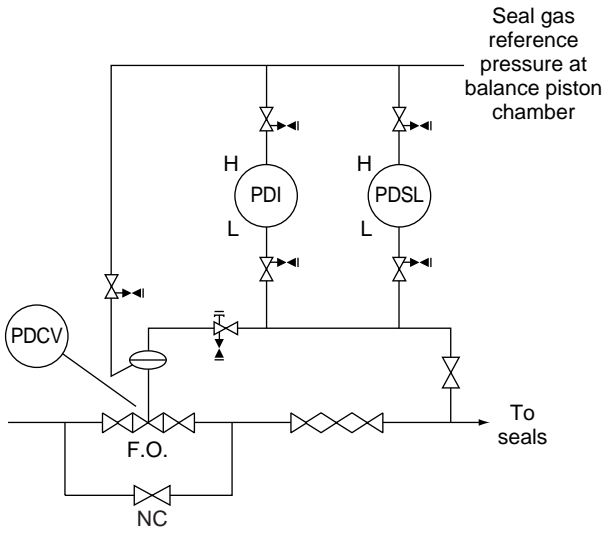


Figure 4A-6a—Differential Pressure Control

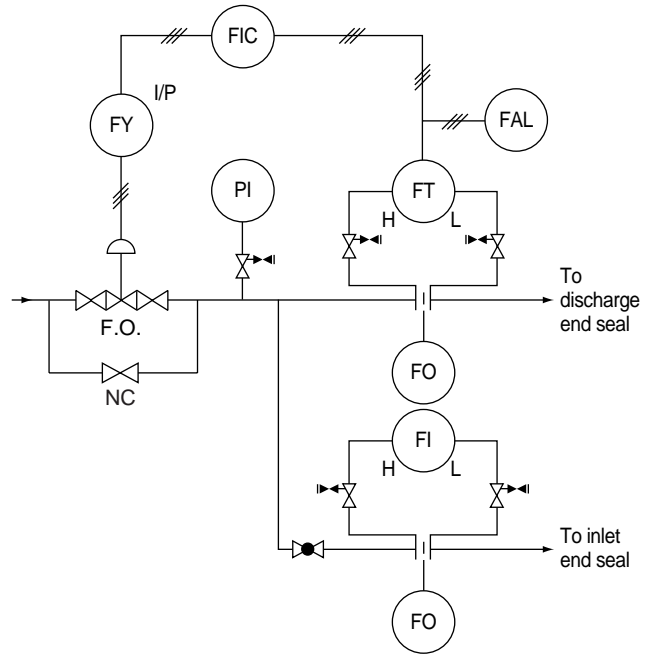


Figure 4A-6b—Flow Control (1)

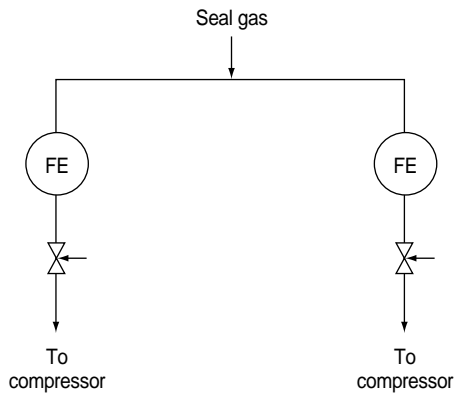
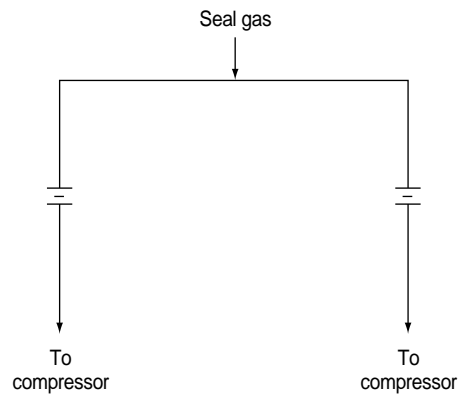


Figure 4A-6c—Flow Control (2)



Note: Only to be used if seal gas is from compressor discharge or internal stages.

Figure 4A-6d—Flow Control (3)



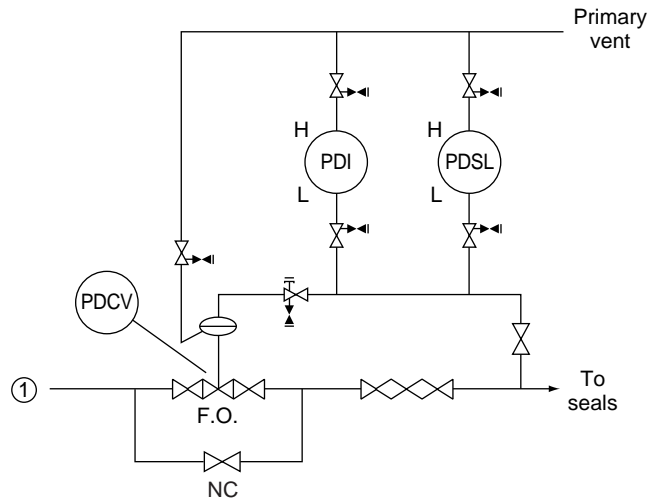


Figure 4A-7a—Differential Pressure Control

- ① Seal gas supply.
- ② Low seal gas pressure alarm.

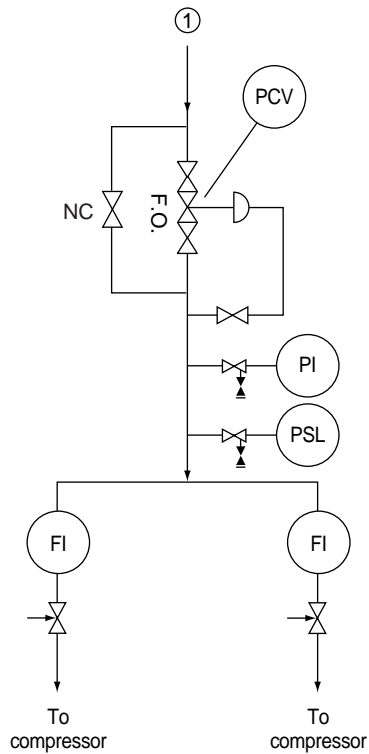


Figure 4A-7b—Flow Control (Option 1)

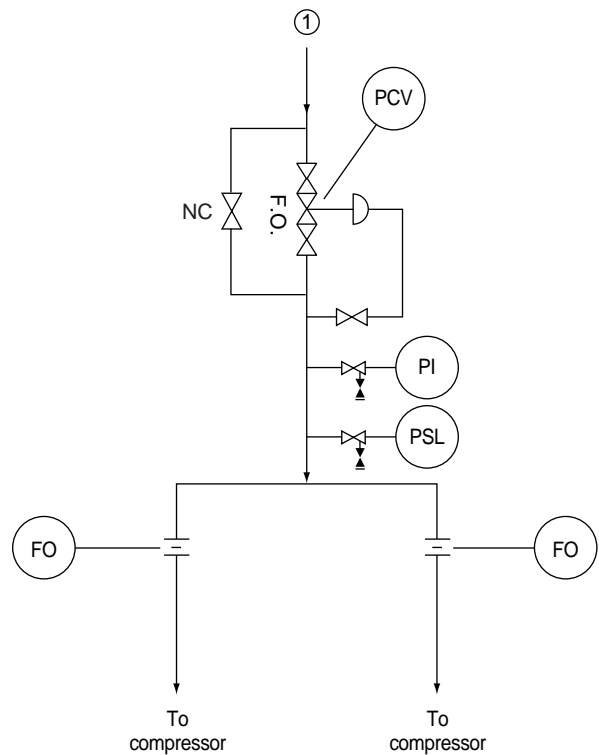


Figure 4A-7c—Flow Control (Option 2)

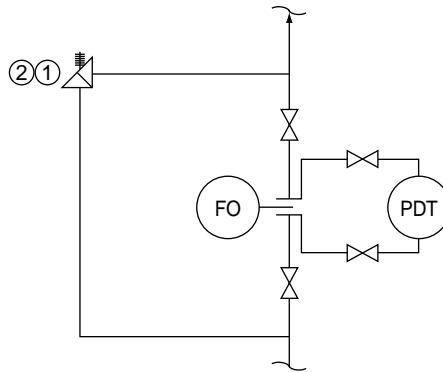


Figure 4A-8a—Flow Measuring by Differential Pressure

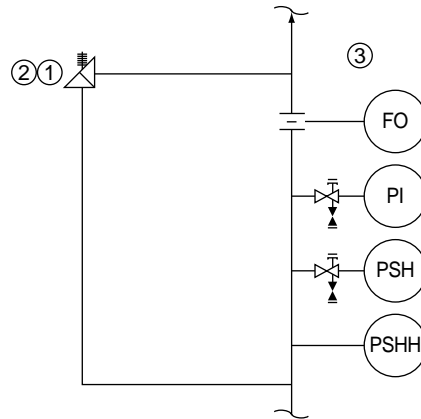
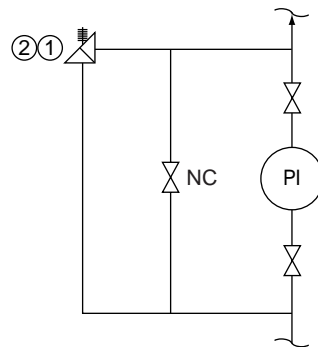
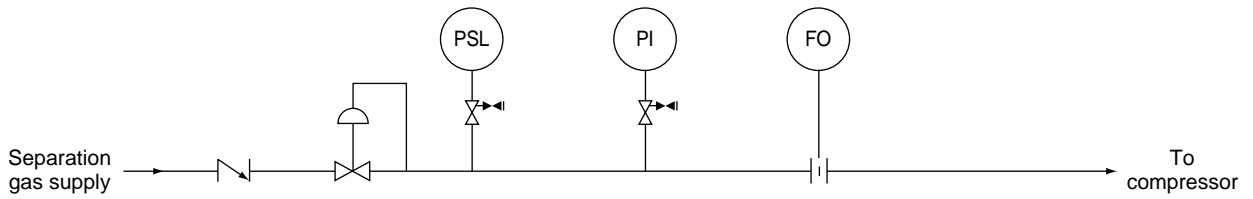


Figure 4A-8b—Flow Monitoring by Back Pressure



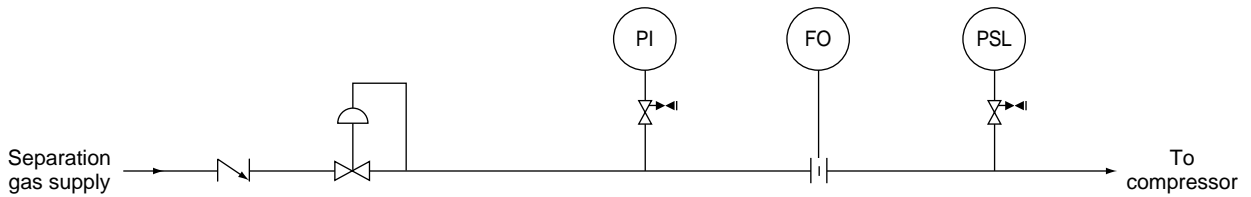
- ① When over pressure protection is required for the system, a relief device shall be provided.
- ② Relief valve shown. Rupture disk may be substituted.
- ③ Not to be used when high back pressure could cause false shutdowns.

Figure 4A-8c—Flow Measuring



Note: FO is reasonably sized to regulate flow through the seal.

Figure 4A-9a—Separation Gas Modules (Option 1)  
(Buffered Labyrinth with a Remote Vent)



Note: Flow is regulated by the relatively “tight” circumferential seal. PSL is arranged to sense plugging of FO as well as loss of separation gas.

Figure 4A-9b—Separation Gas Modules (Option 2)  
(Buffered Circumferential Seal with a Remote Vent)

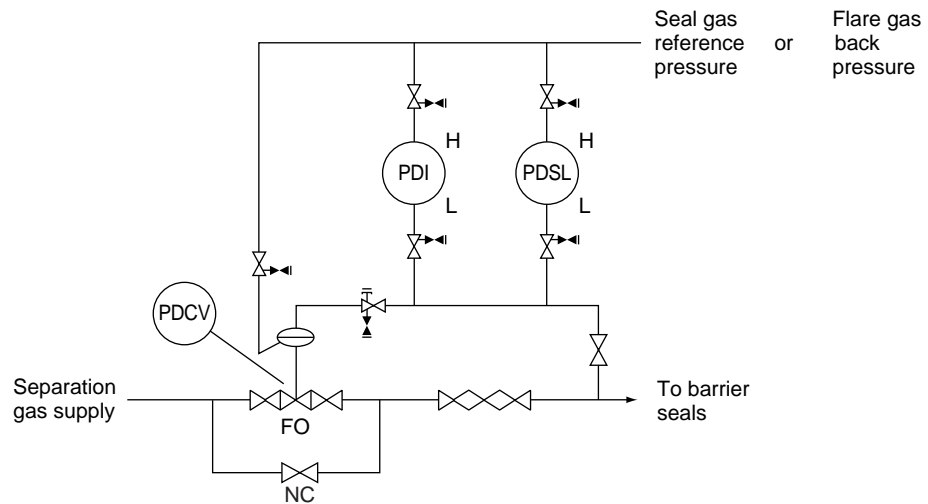


Figure 4A-9c—Separation Gas Modules (Option 3)









**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_

Page: 2 of 4 By: \_\_\_\_\_

Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

**Components:**

**Piping and tubing:**

- Tight shutoff  Carbon steel slip-on flanges
- Tubing fittings—mfg. \_\_\_\_\_ model \_\_\_\_\_  Through studs required
- Heat tracing required by  purchaser  vendor

**Continuous flow transfer valves**

Service application <input type="radio"/> Common for coolers and filters <input type="radio"/> Tight shutoff required <input type="radio"/> Type <input checked="" type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Model	Gas     <input type="checkbox"/> <input type="checkbox"/>	Strainer reg'd (2.4.3) <input checked="" type="checkbox"/> With lifting jack Rating: barg <input checked="" type="checkbox"/> Materials: body <input checked="" type="checkbox"/> Plug or ball <input checked="" type="checkbox"/> Trim
--	---	--

**Filters:**

Service application: <input type="radio"/> Purchaser item no. <input type="radio"/> Twin <input type="radio"/> Include option nos. <input type="radio"/> Filtration level <input checked="" type="checkbox"/> Manufacturer <input checked="" type="checkbox"/> Model	Separation gas     <input type="checkbox"/>	<input checked="" type="checkbox"/> Design/test (barg) / <input type="radio"/> Code construction/stamp (2.1.9) <input type="checkbox"/> / <input type="checkbox"/> <input checked="" type="checkbox"/> Material: case and top <input checked="" type="checkbox"/> Cartridges: <input type="checkbox"/> Filter body diameter (mm)
--	--	--

**Testing:**

- Functional test (4.3.3.4)



**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 3 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built

Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_

Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Furnish \_\_\_\_\_ extra sets of cartridges.  Per filter (extra over other spares).

<b>Coolers:</b>	Lube	<input checked="" type="checkbox"/> Design/test shell side (barg)	
Service application		<input checked="" type="checkbox"/> Design/test tube side (barg)	
<input type="radio"/> Purchaser item nos.		<input type="radio"/> Code construction/stamp (2.1.9)	<input type="radio"/> / <input type="radio"/>
<input type="radio"/> Twin units	<input type="checkbox"/>	<input checked="" type="checkbox"/> Tube water velocity and capacity (mps/m <sup>3</sup> /hr)	/
<input type="radio"/> Include option nos.		<input checked="" type="checkbox"/> Material: shell	
<input type="radio"/> Water side for steam heating		<input checked="" type="checkbox"/> Channels and covers	
<input type="radio"/> Details on data sheet		<input checked="" type="checkbox"/> Tube sheets and tubes	
<input checked="" type="checkbox"/> Water side corrosion allowance	<input type="checkbox"/>	<input type="radio"/> Removable tube bundle	<input type="checkbox"/>
<input checked="" type="checkbox"/> Manufacturer		<input type="radio"/> U-bend tubes permitted	<input type="checkbox"/>
<input checked="" type="checkbox"/> Model		<input type="radio"/> Oil temperature control valve	<input type="checkbox"/>
<input type="radio"/> TEMA class			
<input checked="" type="checkbox"/> Fouling factor water/oil side			
<input type="checkbox"/> Duty: Btu/hr			
<input checked="" type="checkbox"/> Tube: L/OD/BWG			

**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 SI UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 4 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Shop inspection		Shop test	
<input type="checkbox"/> Compliance with inspector's checklist		Required	Witness
<input type="checkbox"/> Required for system assemblies	<input type="checkbox"/> Cleanliness	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Cleanliness prior to closure	<input type="checkbox"/> Four hour run	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Required for major components	<input type="checkbox"/> Check controls	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Material certifications to be furnished	<input type="checkbox"/> Changeover filters/coolers	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Special examinations	<input type="checkbox"/> One and two pump operation	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Code construction/stamp	<input type="checkbox"/> Sound level	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Certified copies of all test logs and data	<input type="checkbox"/> Hydro test assembled system	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/> Use for complete unit system test	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/> Certified copies of all test logs and data	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>		
<input type="checkbox"/>	<input type="checkbox"/>		

**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL  
 SI UNITS**

Job No.: \_\_\_\_\_ Seals for Item No.: \_\_\_\_\_  
 Page: 1 of 1 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_ By: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built	
<input type="radio"/> Gas seal supplier _____	<input type="radio"/> Equipment manufacturer _____
Purchase Order No. _____ Date _____	Inquiry no. _____ Requisition No. _____
<b>Dry gas seal design:</b>	
Rotational speed _____ max. rpm	<input type="radio"/> Vent pressure—normal/max _____ / _____ barg
<input type="radio"/> Application <input type="checkbox"/> new <input type="checkbox"/> retrofit	Vendor drawing no. _____
<input checked="" type="checkbox"/> Rotation viewed from driver end <input type="checkbox"/> CW <input type="checkbox"/> CCW	<input type="radio"/> Equipment suction pressure (min/max) _____ / _____ barg
<input type="radio"/> Maximum sealing pressure: _____ barg (2.1.6)	<input type="radio"/> Equipment discharge temperature _____ °C
<input type="radio"/> Settle out pressure _____ barg	<input type="radio"/> Process relief valve setting _____ barg
Seal maximum design pressure: _____ barg	
<b>Leakage rates:</b>	
<i>normal operation                      static</i>	
Primary vent	
Secondary vent	
Secondary vent for intermediate laby.	
<b>Comments:</b>	

**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 1 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built	
For _____	Site _____
Gas seal module for _____	
Module supplier _____	Module manufacturer _____
Purchase Order No. _____ Date _____	Inquiry no. _____ Requisition No. _____
NOTES: 1. The party to complete the information is indicated as follows: <input type="radio"/> Purchaser <input type="checkbox"/> Vendor <input checked="" type="checkbox"/> Either, but by vendor if not by purchaser. 2. A dot * indicates the standard specifies a requirement, value, or criterion. 3. Designations in ( ) are applicable portions of the standard; numbers without a prefix are paragraph numbers; those prefixed "T" are text figure numbers; those prefixed "A" are Appendix "A" Figure numbers.	
<input type="radio"/> Drawing requirements	<input type="radio"/> Component review
<b>System responsibility: (2.1.2)</b>	
<input type="radio"/> Vendor responsible for system design	<input type="radio"/> Vendor responsible for installation
	<input type="radio"/> Vendor responsible for scope of supply
<b>Supply arrangement:</b>	
<input type="radio"/> Separate modules for	
<input type="radio"/> Multiple package for	
<b>Basic system details:</b> (see referenced Figures 4A-1 through 4A-4)	
<b>Dry gas seal type:</b>	
<input type="radio"/> Double (4A-1)	<input type="radio"/> Tandem with internal laby (4A-2)
<input type="radio"/> Tandem (4A-3)	<input type="radio"/> Single (4A-4)
<b>Dry gas seal specifics:</b>	
<input type="radio"/> Seal manufacturer	<input type="radio"/> Seal model no.
<input type="radio"/> Seal gas hazardous (yes/no)	<input type="radio"/> Seal gas composition below or refer to _____
<input type="radio"/> Seal gas composition: _____	Gas _____ Mole pct. _____
MW = _____	
<b>Gas supply:</b> <input type="radio"/> Pressure <input type="radio"/> Temperature <input type="radio"/> Flow <input type="radio"/> Description of gas	
<input type="radio"/> Seal gas supply (2.1.11)	
<input type="radio"/> Buffer gas	
<input type="radio"/> Intermediate gas	
<b>Options</b>	
<b>Basics</b>	
<input checked="" type="checkbox"/> Seal gas filter module (4A-5a, 4A-5b)	
<input checked="" type="checkbox"/> Separation gas filter module (4A-5c)	<input type="checkbox"/>
<input checked="" type="checkbox"/> Differential pressure control (4A-6a)	<input type="checkbox"/>
<input checked="" type="checkbox"/> Flow control (4A-6b, 4A-6c, 4A-6d)	
<b>For option 4A2 (tandem with internal laby)</b>	
<input checked="" type="checkbox"/> Differential pressure control (4A-7a)	<input type="checkbox"/>
<input checked="" type="checkbox"/> Flow control (4A-7b, 4A-7c)	
<input type="checkbox"/> Material	
<input type="checkbox"/> Double blocks and bleeds (2.1.8)	
<b>Outlet modules</b>	
<input checked="" type="checkbox"/> Flow monitoring—diff. pressure (4A-8a)	
<input checked="" type="checkbox"/> Flow monitoring—backpressure (4A-8b)	
<input checked="" type="checkbox"/> Flow measuring (4A-8c)	
<b>Separation gas modules</b>	
<input checked="" type="checkbox"/> Option (4A-9a, 4A-9b, 4A-9c)	
<input type="checkbox"/> Special requirements	
<input type="checkbox"/> Instrument test valves required	

**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 2 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built Supplier _____ Manufacturer _____ Purchase Order No. _____ Date _____ Inquiry no. _____ Requisition No. _____													
<b>Components:</b>													
<b>Piping and tubing:</b>													
<input type="radio"/> Tight shutoff <input checked="" type="radio"/> Tubing fittings—mfg. _____ model _____ <input type="radio"/> Heat tracing required by <input type="checkbox"/> purchaser <input type="checkbox"/> vendor	<input type="radio"/> Carbon steel slip-on flanges <input type="radio"/> Through studs required												
<b>Continuous flow transfer valves</b>													
Service application <input type="radio"/> Common for coolers and filters <input type="radio"/> Tight shutoff required <input type="radio"/> Type <input checked="" type="radio"/> Manufacturer <input checked="" type="radio"/> Model	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%; text-align: center;">Gas</td> <td style="width:50%; text-align: center;">Strainer reg'd (2.4.3)</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="radio"/> With lifting jack <input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">Rating: psig</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="radio"/> Materials: body</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="radio"/> Plug or ball</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="radio"/> Trim</td> </tr> </table>	Gas	Strainer reg'd (2.4.3)	<input type="checkbox"/>	<input checked="" type="radio"/> With lifting jack <input type="checkbox"/>	<input type="checkbox"/>	Rating: psig	<input type="checkbox"/>	<input checked="" type="radio"/> Materials: body	<input type="checkbox"/>	<input checked="" type="radio"/> Plug or ball	<input type="checkbox"/>	<input checked="" type="radio"/> Trim
Gas	Strainer reg'd (2.4.3)												
<input type="checkbox"/>	<input checked="" type="radio"/> With lifting jack <input type="checkbox"/>												
<input type="checkbox"/>	Rating: psig												
<input type="checkbox"/>	<input checked="" type="radio"/> Materials: body												
<input type="checkbox"/>	<input checked="" type="radio"/> Plug or ball												
<input type="checkbox"/>	<input checked="" type="radio"/> Trim												
<b>Filters:</b> Service application: Separation gas <input type="radio"/> Purchaser item no. <input type="radio"/> Twin <input type="checkbox"/> <input type="radio"/> Include option nos. <input type="radio"/> Filtration level <input checked="" type="radio"/> Manufacturer <input checked="" type="radio"/> Model	<input checked="" type="radio"/> Design/test (psig) / <input type="radio"/> Code construction/stamp (2.1.9) <input type="checkbox"/> / <input type="checkbox"/> <input checked="" type="radio"/> Material: case and top <input checked="" type="radio"/> Cartridges: <input type="checkbox"/> Filter body diameter (in)												
<b>Testing:</b> <input type="radio"/> Functional test (4.3.3.4)													



**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL MODULE  
 U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Item No.: \_\_\_\_\_  
 Page: 4 of 4 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_

Applicable to  Proposal  Purchase  As built  
 Supplier \_\_\_\_\_ Manufacturer \_\_\_\_\_  
 Purchase Order No. \_\_\_\_\_ Date \_\_\_\_\_ Inquiry no. \_\_\_\_\_ Requisition No. \_\_\_\_\_

Shop inspection	Shop test		
		Required	Witness
<input type="radio"/> Compliance with inspector's checklist			
<input type="radio"/> Required for system assemblies	<input type="radio"/> Cleanliness	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Cleanliness prior to closure	<input type="radio"/> Four hour run	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Required for major components	<input type="radio"/> Check controls	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Material certifications to be furnished	<input type="radio"/> Changeover filters/coolers	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Special examinations	<input type="radio"/> One and two pump operation	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Code construction/stamp	<input type="radio"/> Sound level	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/> Certified copies of all test logs and data	<input type="radio"/> Hydro test assembled system	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	<input type="radio"/> Use for complete unit system test	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	<input type="radio"/> Certified copies of all test logs and data	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	<input type="radio"/>		
<input type="radio"/>	<input type="radio"/>		

**API 614—Chapter 4 DATA SHEET  
 DRY GAS SEAL  
 U.S. CUSTOMARY UNITS**

Job No.: \_\_\_\_\_ Seals for Item No.: \_\_\_\_\_  
 Page: 1 of 1 By: \_\_\_\_\_  
 Date: \_\_\_\_\_ Revision: \_\_\_\_\_ By: \_\_\_\_\_

Applicable to <input type="checkbox"/> Proposal <input type="checkbox"/> Purchase <input type="checkbox"/> As built	
<input type="radio"/> Gas seal supplier _____	<input type="radio"/> Equipment manufacturer _____
Purchase Order No. _____ Date _____	Inquiry no. _____ Requisition No. _____
<b>Dry gas seal design:</b>	
Rotational speed _____ max. rpm	<input type="radio"/> Vent pressure—normal/max _____ / _____ psig
<input type="radio"/> Application <input type="checkbox"/> new <input type="checkbox"/> retrofit	Vendor drawing no. _____
<input checked="" type="checkbox"/> Rotation viewed from driver end <input type="checkbox"/> CW <input type="checkbox"/> CCW	<input type="radio"/> Equipment suction pressure (min/max) _____ / _____ psia
<input type="radio"/> Maximum sealing pressure: _____ psig (2.1.6)	<input type="radio"/> Equipment discharge temperature _____ °F
<input type="radio"/> Settle out pressure _____ psig	<input type="radio"/> Process relief valve setting _____ psig
Seal maximum design pressure: _____ psig	
<b>Leakage rates:</b> _____ <i>normal operation</i> _____ <i>static</i>	
Primary vent _____	
Secondary vent _____	
Secondary vent for intermediate laby. _____	
<b>Comments:</b>	



**CHAPTER 4**  
**APPENDIX C—INSPECTOR’S CHECKLIST**  
**(INFORMATIVE)**



## Chapter 4—Inspector’s Checklist

Item	Date Inspected	Inspected By	Status
1. System arrangement (1.3).			
a. Per drawings (2.1.4).			
b. Providing adequate clearances.			
c. Providing safe access.			
d. Adequate for maintenance (2.1.7, 2.1.8, 2.2.6).			
2. ASME code stamp (if applicable) (2.1.9).			
a. Filters.			
b. Traps.			
c. Other pressure vessels.			
3. Welding operators and procedures qualified per Section IX of ASME Code.			
a. Filters.			
b. Traps.			
c. Piping (5.1.1) in Chapter 1.			
d. Verification of welds (7.2.3.3) in Chapter 1.			
4. Welding procedures (other than above).			
a. Baseplates			
b. Panels.			
d. Other.			
5. Piping.			
a. Examined per ASME B31.3 (5.1.1, 5.1.12) in Chapter 1.			
b. Fabricated per specification (2.2.3, 2.2.4).			
6. Electrical systems/panels.			
a. Wiring suitable (6.5.2) in Chapter 1.			
b. Spare terminal points adequate (6.5.4) in Chapter 1.			
c. Clearances adequate for maintenance (6.5.5) in Chapter 1.			
d. Fungus/corrosion protection provided (6.5.6) in Chapter 1.			
e. Warning clearly labeled and isolated (6.5.7, 6.5.8) in Chapter 1.			
7. Material inspected as specified (list each component) (7.2.2) in Chapter 1.			
8. Components inspected for cleanliness (list each) (7.2.3.2) in Chapter 1.			
9. Hydro test.			
a. Hydrotest certified (list each component) (7.2.2) in Chapter 1.			
b. Assembled oil system hydrostatic test performed (7.3.2.1) in Chapter 1.			
c. Chlorides in hydrotest liquid addressed adequately (7.3.2.4) in Chapter 1.			
d. Test pressures verified (7.3.2.2, 7.3.2.3) in Chapter 1.			

Item	Date Inspected	Inspected By	Status
10. Operational tests.			
a. System cleanliness verified (4.3.1).			
b. Gas leak test (4.3.2).			
c. Operational test (4.3.3).			
11. Painting ( <b>4.3.3.1</b> ) in Chapter 1.			
12. Preparation for shipment.			
a. Equipment cleaned and prepared properly (7.4.3) in Chapter 1.			
b. Items properly tagged (7.4.3.9) in Chapter 1.			
c. Storage/handling/installation instructions received (7.4.2, 7.4.8) in Chapter 1.			
d. Piping and components adequately braced ( <b>4.4.3.10</b> ) in Chapter 1.			
e. Connections properly tagged (7.4.6) in Chapter 1.			
f. Shipping documents included (7.4.3.9) in Chapter 1.			

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