INTERNATIONAL STANDARD

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Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries —

Part 2: Special-purpose oil systems

Industries du pétrole, de la pétrochimie et du gaz naturel — Systèmes de lubrification, systèmes d'étanchéité, systèmes d'huile de régulation et leurs auxiliaires —

Partie 2: Systèmes d'huile pour applications spéciales

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10438-2 was prepared by Technical Committee ISO/TC 67, *Materials equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

This second edition cancels and replaces the first edition (ISO 10438-2:2003), which has been technically revised.

ISO 10438 consists of the following parts, under the general title *Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries*:

— *Part 1: General requirements*

— *Part 2: Special-purpose oil systems*

— *Part 3: General-purpose oil systems*

— *Part 4: Self-acting gas seal support systems*

Introduction

This International Standard was developed jointly with API 614 5th edition. ISO 10438 is divided into four parts corresponding to the four chapters of API 614.

Users of this part of ISO 10438 should be aware that further or differing requirements can be needed for individual applications. This part of ISO 10438 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this part of ISO 10438 and provide details. This part of ISO 10438 is to be used in conjunction with 10438-1.

This part of ISO 10438 requires the purchaser to specify certain details and features.

A bullet (•) at the beginning of a clause or subclause indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on suitable data sheet(s); otherwise it should be stated in the quotation request (inquiry) or in the order.

In this International Standard, US Customary (USC) or other units are included in brackets for information.

Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries —

Part 2: Special-purpose oil systems

1 Scope

This part of ISO 10438, in conjunction with of ISO 10438-1, specifies requirements for oil systems for special-purpose applications. These oil systems can provide lubrication oil, seal oil or both. These systems can serve equipment such as compressors, gears, pumps and drivers.

NOTE The term “special-purpose application” is defined in ISO 10438-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10438-1:2007, *Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries — Part 1: General requirements*

ISO 13706:2005, *Petroleum, petrochemical and natural gas industries — Air-cooled heat exchangers*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 4572, *Hydraulic fluid power — Filters — Multipass method for evaluating filtration performance*

API STD 611, *General- Purpose Steam Turbines for Petroleum, Chemical and Gas Industry Services*

API RP 686-96, *Machinery RP Installation and Installation Design*

ASTM A240/A240M, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

3 Terms, abbreviated terms and definitions

For the purposes of this document, the terms, abbreviated terms and definitions given in ISO 10438-1 apply.

4 General requirements

4.1 General

4.1.1 The equipment (including auxiliaries) covered by this part of ISO 10438 shall be designed and constructed for a minimum service life of 20 years and at least 5 years of uninterrupted operation.

NOTE It is recognized that this is a design criterion.

4.1.2 The oil system shall be suitable for special-purpose applications as defined in ISO 10438-1. 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.

4.1.3 Unless otherwise specified, one oil system per equipment train shall be supplied.

NOTE If equipment trains share a common oil system, damage due to cross-contamination can affect all equipment served. Block valves can be needed in supply lines that, for maintenance reasons, have the potential to be accidentally closed. Equipment location can require unacceptably long runs of piping, equipment transients and other potentially detrimental factors that it is necessary to consider.

- **4.1.4** The purchaser shall specify the equipment's normal operating point and alternate operating points including transients.

NOTE Data sheets that can be used for specifying are included in Annex A.

- **4.1.5** Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort of the purchaser and the vendor having unit responsibility. The equipment furnished by the vendor shall conform to the maximum allowable sound pressure level specified. In order to determine compliance, the vendor shall provide both maximum sound pressure and sound power level data per octave band for the equipment.

- **4.1.6** The purchaser shall specify whether the seal-oil and lube-oil systems are to be separate or combined.

NOTE Annex B contains piping and instrument diagrams (P&IDs) for typical arrangements.

- **4.1.7** 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 shall be specified by the owner on the basis of mutual agreement with all vendors supplying equipment served by the common oil system.

NOTE Site conditions with extreme variations, such as desert or arctic applications, can also require special oil grade viscosity and increased oil supply temperatures.

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

4.1.9 The recycled oil shall originate upstream of the filters.

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

- **4.1.10** 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.

4.1.11 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 shaft end seal at atmospheric pressure.

4.1.12 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.

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

4.1.14 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.

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

- **4.1.16** The purchaser shall specify when and where double block and bleed valves are required for isolating a component and how they are arranged.

- **4.1.17** Coolers, filters, overhead oil tanks, drain traps, accumulators and other pressure vessels shall be in accordance with the specified pressure design code (Refer to ISO 10438-1:2007, 4.4). If specified by the purchaser, vessels shall be code stamped.

NOTE 1 Code stamping might not be applicable for pressure design codes other than ASME.

NOTE 2 Refer to ISO 10438-1:2007, 4.5.7. Local jurisdictions can require a code stamp and conformity assessment markings.

4.1.18 The console shall perform on the test stand and on its permanent foundation within the specified acceptance criteria. After installation, the performance of the oil system, including piping, console and associated auxiliaries, shall be the joint responsibility of the purchaser and the vendor who has unit responsibility for the equipment train served.

NOTE Certain auxiliaries, such as overhead seal-oil tanks, rundown tanks, interconnecting piping, etc., might not be installed on test.

- **4.1.19** The vendor shall advise the purchaser of, and both parties shall mutually agree upon, any special provisions that are necessary to ensure that an adequate supply of backup lube or seal oil or both is maintained in the event of complete failure of the primary lube- 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 upon the system and its components.

4.1.20 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.

4.2 Baseplates

- **4.2.1** The system shall be designed as a single console, in multiple packages or in any other arrangement as specified. Each package shall have a structural steel baseplate with all system components and related valves and manifolds mounted on the baseplate. The major component supports (pumps, filters, coolers, reservoir, etc.) shall be mounted directly on structural steel.

4.2.2 Unless otherwise specified, package baseplates shall be of the drain-gutter type with one or more drain connections at least DN 40 (NPS 1 1/2) in size. Baseplates, mounted components and decking shall be arranged and installed to ensure drainage and to avoid the retention of liquid by sloping of the decking and gutters.

● **4.2.3** If specified, flat decking may be furnished.

NOTE Minor puddling of fluid can occur.

4.2.4 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.

NOTE Spreader bars can be required.

4.2.5 Unless otherwise specified, non-skid metal decking covering all walk and work areas shall be provided on the top of the baseplate.

NOTE Examples of other options are grating or phenolic material to reduce mass for off-shore applications, or deletion of decking and a grout poured to create a walking surface.

4.2.6 Baseplates shall be suitable for installation in accordance with API RP 686. 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^2 (20 in^2) 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 into which the grout is poured shall be accessible: no component or piping shall be disturbed and no tripping hazards in the walk and work areas shall be created. Vent holes at least 13 mm (1/2 in) in diameter shall be provided for each bulkhead compartment. Each grout hole shall also be provided with steel curbing 13 mm (1/2 in) high to prevent accumulated oil or water from entering the grout. Vent holes shall be provided without curbing.

NOTE The 13 mm (1/2 in) curb required for grout holes is not considered a tripping hazard.

● **4.2.7** 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 instructions for field preparation of the epoxy primer to the purchaser.

4.2.8 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.

● **4.2.9** If specified, the baseplate shall be designed 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 upon between the purchaser and the vendor.

4.2.10 Levelling screws shall be provided in the proximity of each hold-down bolt.

4.3 Oil reservoirs

4.3.1 General

Unless otherwise specified, reservoirs shall be separate from the baseplate for the equipment train served by the oil console and shall 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. If reinforcing ribs are required, they shall be installed externally to avoid deposit accumulation.

NOTE For special features, see 4.3.12.

4.3.2 Protection from dirt and water

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

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

NOTE It is possible that this can be a user consideration for offshore or other installations where available space is limited.

4.3.2.3 The tops of reservoirs shall slope at least 10 mm/m (1/8 in/ft).

NOTE It might not be possible to implement this requirement for reservoirs integrated with the main equipment baseplate.

4.3.3 Oil connections and internal piping

4.3.3.1 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 it is possible to direct return flow streams by internal piping or baffling to avoid disturbing the oil flow at pump inlets. This internal piping or baffling can be used in lieu of external connections physically located such a distance from the pump suctions that they avoid disturbing the oil flow at the pump inlets.

4.3.3.2 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 B.24. Stilling tubes shall have bottom baffles.

4.3.3.3 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 B.24. Pressurized oil shall not be returned to vented stilling tubes or degassing trays. Internal piping shall have bottom baffles.

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

4.3.3.5 Except as specified in 4.3.9, reservoir pipe connections shall be flanged.

4.3.4 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 diameter shall be provided. The manway openings provided shall permit unobstructed entry for inspection and cleaning of all interior compartments. Manways, where entry is required for cleaning, unless otherwise specified, shall be located on top of the reservoir and each manway shall be at least 600 mm × 600 mm or 450 mm in diameter (24 in × 24 in or 18 in in diameter). Internal manways are not acceptable.

4.3.5 Features and appendages

4.3.5.1 The oil reservoir shall have the following features and appendages:

a) capacity to settle moisture and foreign matter adequately and to provide allowance for rundown from the entire system;

b) provisions to eliminate air and minimize migration of foreign matter to each pump suction;

c) 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 4.3.3.1). 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;

d) unless otherwise specified, a fill opening at least 50 mm (2 in) in diameter, which 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 % of the internal pipe area;

NOTE Some users pipe up fill connections using the connections provided in 4.3.9. If manual fill is used, the connection described above is required.

e) blind-flanged vent connection at least 50 mm (2 in) in diameter;

f) for lube-oil reservoirs, a weatherproof, corrosion-resistant filter-breather cap at least 50 mm (2 in) in diameter with filtration rating of 10 µm beta 10 or better. (For reservoirs containing seal oil, see 4.3.5.2.);

g) internal baffles that do not trap gas;

h) if the driver of the train is lubricated by the same system as the compressor 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 1 This line prevents pressurization of the drivers lube-oil drain header if the compressor seals fail.

NOTE 2 If this option is incorporated, it requires separate bearing and seal-oil drains from the compressor.

4.3.5.2 On reservoirs containing seal oil, a flanged vent sized to handle the total flow of gas coming from the failed seal(s) through the oil drain lines shall be furnished. The vendor shall provide the purchaser with the vent size and the sizing criteria.

4.3.6 Capacity and configurations

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

4.3.6.2 The criteria for sizing a reservoir are given in 4.3.6.3 through 4.3.6.8.

NOTE All level references refer to ISO 10438-1:2007, Figure F.1.

4.3.6.3 The working capacity between 3 and 4 in ISO 10438-1:2007, Figure F.1 shall be sufficient for at least 5 min of normal flow.

4.3.6.4 The minimum retention capacity shall be calculated based on 8 min of normal oil flow.

4.3.6.5 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 % of these volumes for the purchaser's interconnecting piping.

NOTE Rundown can cause some backup in the drain lines entering the reservoir.

4.3.6.6 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.

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.

4.3.6.7 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.

4.3.6.8 The free surface of the oil in the reservoir shall be a minimum of 60 cm^2 for each litre per minute (0.25 ft^2 for each gallon per minute) of normal flow.

4.3.7 Heating

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

Users may elect to use tempered water in the lube-oil cooler for the cooler to operate as a lube-oil heater prior to start-up. Details of this alternate operation shall be discussed and mutually agreed upon (see 4.5.1.15).

NOTE There are many factors to consider when heating the lube oil to minimum starting temperature, including lube pump start-up minimum oil temperature, equipment minimum oil temperature, circulating heat loss, etc. Many of these factors are the responsibility of the installing contractor in coordination with the console designer. Insulation, location and heat tracing requirements are considerations of the installation.

● **4.3.7.2** Purchaser shall specify whether the heaters are steam or electric.

4.3.7.3 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 km/h (10 mi/h) wind. The vendor shall provide data to support this.

4.3.7.4 When a steam heater is specified, a removable element external to the oil reservoir shall be provided for heating the charge capacity of oil before 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 minimum oil start-up temperature required by the equipment being served within 12 h while circulating oil through the system. If minimum site temperatures are lower than 10 °C (50 °F), it is necessary that the oil in the reservoir be heated to 10 °C (50 °F) before starting the pump.

NOTE Lube-oil pumps and drivers are sized for 10 °C (50 °F) oil.

4.3.7.5 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. 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 h while circulating oil through the system. If minimum site temperatures are lower than 10 °C (50 °F), it is necessary that the oil in the reservoir be heated to 10 °C (50 °F) before starting the pump. It shall have a maximum watt density of 2 W/cm^2 (15 W/in^2). Heater elements shall be sheathed in austenitic stainless steel or Incoloy[1)]; copper or copper-bearing materials shall not contact the oil.

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

NOTE Lube-oil pumps and drivers are sized for 10 °C (50 °F) oil.

4.3.7.6 Electric immersion heaters shall be installed in a manner that allows the heaters to be removed during operation. Top or angle-mounted direct immersion elements are preferred. 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 °R) below its flash point. If dry tube heating elements are used, the cold section of the element shall extend at least 30,5 cm (12 in) beyond the reservoir wall, and the thermostat shall be located external to the dry well. The hot section of the heater element shall be located a minimum of 50 mm (2 in) below the reservoir minimum operating level.

● **4.3.7.7** If specified, the vendor having train responsibility shall conduct an analysis of the complete system, including lube-oil console, interconnecting piping, rundown tanks, equipment heat loss and other system components, to verify that the complete system heats up to the minimum equipment starting temperature in 12 h when ambient temperature is at the minimum specified value.

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1) Incoloy is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 10438 and does not constitute an endorsement by ISO of this product.

This requires that the installing contractor provide details of the interconnecting piping arrangements and can result in the need for additional heating.

Consideration of a lighter-viscosity oil compatible with the entire train can allow the permissive starting temperature to be lowered.

4.3.8 Provision for insulation

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

4.3.9 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 diameter. 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.

4.3.10 Provision for oil conditioner

- **4.3.10.1** If specified, the vendor shall provide a 25 mm (1 in) flanged, valved and blinded connection (see Figure B.24, Footnote i), located below the minimum operating level for use as an oil supply connection for an oil conditioner.

4.3.10.2 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 recirculation.

4.3.11 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.

4.3.12 Special features

4.3.12.1 Reservoir tops shall be provided with the following:

- a) if specified, an accessible ladder with extended handrails;
- b) if specified, handrails around the perimeter of the reservoir top;
- c) if specified, non-skid surfaces decking (checker or diamond plate or hot-dipped galvanized steel grating).

4.3.12.2 For equipment mounted on the reservoir, the reservoir shall provide sufficient structural stiffness to properly support the equipment (see 4.3.2.2).

4.3.12.3 If the reservoir top is to be used as a personnel access area, it shall be designed to withstand a live load of 1 100 N (250 lbf) without permanent distortion.

4.3.13 Materials

Unless otherwise specified, reservoirs and all appendages welded to reservoirs shall be fabricated from austenitic stainless steel in accordance with ASTM A240/A240M. Pipe connections shall be as specified in 5.1.

NOTE Carbon steel appendages, such as ladders and handrails, can be bolted to clips welded to the reservoir.

4.3.14 Grounding

Two grounding clips or pads diagonally opposed to each other (see Figure B.24) shall be welded to the reservoir. The pads shall accommodate a 13 mm (1/2 in UNC) bolt.

4.4 Pumps and pump drivers

- **4.4.1** The oil system shall include a main oil pump and a standby oil pump both suitable for continuous operation. For non shaft-driven pumps, the main and standby pumps shall be identical. The purchaser shall specify whether horizontal centrifugal or rotary pumps shall be used. Except as modified in this part of ISO 10438, pumps shall conform to ISO 13709.

NOTE For the purpose of this provision, API STD 610 is equivalent to ISO 13709.

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

- **4.4.3** If specified by the purchaser, 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 and driven-equipment suppliers shall define the requirements for safe shutdown.

NOTE A lube-oil rundown tank can provide bearing oil for rundown. Sometimes an emergency oil pump with separate power source is supplied in order to allow cool-down oil after coast-down or seal oil.

4.4.4 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; Buna or Viton gaskets[2)] and O-rings; and end plates with throttle bushings as outlined in ISO 13709.

NOTE For the purpose of this provision, API STD 610 is equivalent to ISO 13709.

- **4.4.5** Purchaser shall specify if the main oil pump shall be turbine or motor driven. Standby pumps shall be motor driven.

NOTE 1 Standby pumps are motor driven due to relatively long start-up times for turbine driven pumps.

NOTE 2 Typically, installations for two motor driven pumps have electric feeds from independent sources.

4.4.6 Each pump shall be driven separately.

4.4.7 A shaft-driven pump may be provided when approved by the purchaser. The pump shall be positive-displacement type.

NOTE 1 If the shaft-driven pump fails, on-line maintenance of the pump is not possible and requires an outage for maintenance of the pump.

NOTE 2 When a shaft-driven pump is provided, consideration for a lube-oil rundown tank might not be required.

4.4.8 When a shaft-driven pump is provided, the following pump design considerations shall be taken into consideration as a minimum:

a) NPSH;

b) priming;

c) maintenance accessibility;

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2) Buna and Viton gaskets are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 10438 and does not constitute an endorsement by ISO of this product.