Dry Gas Sealing Systems for Axial, Centrifugal, and Rotary Screw Compressors and Expanders

API STANDARD 692

SECOND EDITION, XXXXXXXXX 202X

Part 1—General Requirements

1 Scope

1.1 General

This standard covers the minimum dry gas sealing system requirements in association with axial, centrifugal, and rotary screw compressors and expanders for use in the petroleum, chemical, and gas industry services as described in API 617 and API 619.

API 692 does not apply to other types of shaft seals such as clearance seals, restrictive ring seals, or oil seals.

1.2 Part 1—General Requirements

This part of API 692 contains information pertinent to all equipment covered by the other parts of API 692. It shall be used in conjunction with the following parts of API 692 as applicable.

— Part 2—Dry Gas Seals.

— Part 3—Dry Gas Seal Support Systems.

— Part 4—Installation and Commissioning.

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.

API Recommended Practice 520, *Sizing, Selection, and Installation of Pressure-relieving Devices—Part I: Sizing and Selection*

API Recommended Practice 520, *Sizing, Selection, and Installation of Pressure-relieving Devices—Part II: Installation*

API Standard 521, *Pressure-relieving and Depressuring Systems*

API Standard 526, *Flanged Steel Pressure-relief Valves*

API Recommended Practice 551, *Process Measurement*

API Recommended Practice 571, *Damage Mechanisms Affecting Fixed Equipment in the Refining Industry*

API Standard 594, *Check Valves: Flanged, Lug, Wafer, and Butt-welding*

API Standard 600, *Steel Gate Valves—Flanged and Butt-welding Ends, Bolted Bonnets*

API Standard 602, *Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries*

API Standard 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*

API Standard 608, *Metal Ball Valves— Flanged, Threaded, and Welding Ends*

API Standard 617, *Axial and Centrifugal Compressors and Expander-compressors*~~, Eighth Edition~~

API Standard 619, *Rotary-type Positive-displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries*~~, Fifth Edition~~

API Standard 660, *Shell-and-Tube Heat Exchangers*

API Standard 661, *Petroleum, Petrochemical, and Natural Gas Industries—Air-cooled Heat Exchangers*~~, Seventh Edition~~

API Recommended Practice 686, *Recommended Practice for Machinery Installation and Installation Design*~~, Second Edition~~

API Recommended Practice 691, *Risk-based Machinery Management*~~, First Edition~~

API Technical Report 21TR1, Materials Selection for Bolting

~~ANSI [1]/ASME [2] B31.3, *Process Piping*~~

ANSI/FCI 70-2, *Control Valve Seat Leakage*

ASME BPVC-VIII-1, *Section VIII Division 1 Rules For Construction Of Pressure Vessels*

ASME B1.1 ~~2~~, *Unified Inch Screw Threads (UN, UNR and UN~~R~~J Thread Forms)*

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard*

ASME B16.11, Forged Fittings, Socket-Welding and Threaded

ASME[2] B31.3, Process Piping

ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

ASTM A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

ASTM B 637-18 Standard Specification for Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service[1]

ASTM D5445~~-05~~ [3], *Standard Practice for Pictorial Markings for Handling of Goods*

ASTM E94/E94M, *Standard Guide for Radiographic Examination Using Industrial Radiographic Film*~~, 2010~~

ASTM E165/E165M, *Standard Practice for Liquid Penetrant Testing ~~Examination~~ for General Industry*

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[1] American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, New York 10036, www.ansi.org.
[2] ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.
[3] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E1417/E1417M, *Standard Practice for Liquid Penetrant Testing*

IEC 60079 [4] (all parts), *Electrical Apparatus for Explosive Gas Atmospheres*

IEC 60529, *Degrees of Protection Provided by Enclosures* (IP code)

ISA 18.1 [5], *Annunciator Sequences and Specifications*

ISO 8501, *Preparation of steel substrates before application of paints and related products*

ISO 10497, Testing of valves - fire-tight type testing

ISO 15649, *Petroleum and Natural Gas Industries—Piping*

ISO 21940-11~~1940-1~~ [6], *Mechanical vibration—Rotor Balancing- Part 11: Procedures and tolerances for rotors with rigid behavior ~~Balance quality requirements for rotors in a constant (rigid) state—Part 1: Specification and verification of balance tolerances~~*

ISPM Publication 15 (FAO) [7], *Regulation of wood packaging material in international trade*

NACE MR0103, *Petroleum, petrochemical and natural gas industries – Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments*

NACE MR0175, *Petroleum and natural gas industries – Materials for use in H_2S-containing environments in oil and gas production*

NEMA 250 [8], *Enclosures for Electrical Equipment (1000 Volts Maximum)*

NFPA 70 [9], *National Electrical Code (NEC)*

SAE J518-1, Hydraulic Flange Tube, Pipe, and Hose Connections Four-Screw Flange Connection - Part 1: 3.5 to 35 MPa (Code 61)

SSPC SP 6 [10],NACE No. 3, *Commercial Blast Cleaning*

TEMA [11], *Standards of the Tubular Exchanger Manufacturers Association*~~, Ninth Edition~~

[4] International Electrotechnical Commission, 3 rue de Varembe, 1st floor, P.O. Box 131, CH-1211 Geneva 20, Switzerland, www.iec.ch.

[5] International Society of Automation, 67 T.W. Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, www.isa.org.

[6] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org.

[7] Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00153 Rome, Italy.

[8] National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, Virginia, 22209, www.nema.org.

[9] National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts, 02169, www.nfpa.org.

[10] The Society for Protective Coatings, 800 Trumbull Drive, Pittsburgh, Pennsylvania, 15205, 222.sspc.org.

[11] Tubular Exchanger Manufacturers Association, 25 North Broadway, Tarrytown, New York 10591, www.tema.org.

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms, definitions, acronyms, and abbreviations apply.

3.1.1
alarm point
Preset value of a measured parameter at which an alarm is activated to warn of a condition that requires corrective action.

3.1.2
approve
Written documentation confirming an agreement.

3.1.3
booster
A device to increase the pressure and flow of gas.

3.1.4
buffer gas
Gas supplied to the process side of a double seal and used to keep untreated process gas away from the seal.

NOTE Buffer gas does not flow through the seal faces.

3.1.5
cartridge seal
Self-contained unit, typically including seal faces, sealing elements, housings, and sleeves, which is pre-assembled and preset before installation. The cartridge may also include the process side seal and separation seal.

3.1.6
certified point
Point to which the performance tolerances will be applied.

3.1.7
design
Manufacturer's calculated parameter.

NOTE A term used by the equipment manufacturer to describe various parameters, such as design pressure, design temperature, or design speed. It is not intended for the purchaser to use this term.

3.1.8
diamétre nominal
DN
Alphanumeric designation of size for components of a pipework system.

EXAMPLE DN 20

NOTE 1 Adapted from ISO 6708:1995.

NOTE 2 The letters DN are followed by a dimensionless whole number that is indirectly related to the physical size, in millimeters, of the bore or outside diameter of the end connection.

NOTE 3 The number following the letters DN does not represent a measurable value.

NOTE 4 In those standards which use the DN designation system, any relationship between DN and component dimensions should be given, e.g. DN/OD or DN/ID. [ISO 6708:1995 (E).]

3.1.9
dynamic pressure rating
Highest sealing pressure that the seal assembly can continuously be operated at the maximum allowable temperature while the shaft is rotating.

cf **static pressure rating** (3.1.53)

3.1.10
dynamic sealing element
Pressure-retaining component designed to seal a joint with relative axial movement.

cf **static sealing element** (3.1.54)

3.1.11
failsafe
System or component that will cause the equipment to revert to a permanently safe condition (shutdown and/or depressurized) in the event of a component failure or failure of the energy supply to the system.

3.1.12
informative
Information only.

cf **normative** (3.1.32)

NOTE An informative reference or annex provides advisory or explanatory information. It is intended to assist the understanding or use of the document.

3.1.13
local
<Position of devices> on or near the equipment or dry gas seal support system.

cf **remote** (3.1.40)

3.1.14
maximum allowable temperature
Maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred).

NOTE The maximum allowable temperature is usually set by material considerations.

3.1.15
maximum allowable working pressure
MAWP
Maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified gas at the specified maximum allowable temperature.

3.1.16
maximum continuous speed
MCS
Highest rotational speed [revolutions per minute (RPM)] at which the seal, as-built and tested, is capable of continuous operation.

3.1.17
maximum discharge pressure
Maximum suction pressure plus the maximum differential pressure the compressor is able to develop, when operating with the furnished impeller(s) and the fluid with the maximum density.

cf **maximum suction pressure** (3.1.20)

3.1.18
maximum flow
The highest flow that a system or component can pass under all conditions.

3.1.19
maximum operating temperature
Maximum temperature that the seal or system is expected to be subjected to.

NOTE 1 This is a process condition and is specified by the purchaser.

NOTE 2 Maximum operating temperature can be due to a process condition, a compressor discharge temperature, or a seal gas supply temperature.

3.1.20
maximum sealing pressure
Highest pressure the seals are required to seal during any specified operating conditions including start-up, shutdown, settle-out, and standby.

3.1.21
maximum suction pressure
Highest specified inlet pressure the equipment shall be subject to.

NOTE Relief valve setting on the suction system or settle-out pressure can affect the maximum suction pressure.

cf **maximum discharge pressure** (3.1.16)

3.1.22
minimum allowable speed
Lowest speed (RPM) at which the manufacturer's design will permit continuous operation.

3.1.23
minimum allowable temperature
Lowest temperature for which the manufacturer has designed the equipment (or any part to which the term is referred).

3.1.24
minimum design metal temperature
Lowest mean metal temperature (through the thickness) expected, including operation upsets, auto-refrigeration, and temperature of the surrounding environment.

3.1.25
national pipe thread taper
NPT
American National Standard Pipe Taper thread form designation for pipe threads.

EXAMPLE $^3/_4$-14 NPT

NOTE It is comprised of a number representing nominal pipe size followed by the number of threads per inch and the letters NPT representing the thread series.

3.1.26
nominal pipe size
NPS
Value approximately equal to a diameter in inches.

EXAMPLE NPS $^3/_4$.

NOTE 1 Refer to ASME B31.3.

NOTE 2 The letters NPS are followed by a value that is related to an approximate diameter of the bore, in inches, for piping up to and including 12 in. diameter. For piping over 12 in. (NPS 12), the NPS value is the nominal OD.

3.1.27
normal flow

3.1.26.1
buffer gas normal flow (double)
Flow to satisfy the velocity requirements across the process side seal at normal operating point.

3.1.26.2
primary vent normal flow (tandem)
Expected primary seal leakage plus secondary seal gas normal flow minus expected secondary seal leakage at normal operating point.

3.1.26.3
seal gas normal flow (single/tandem)
Flow to satisfy the velocity requirements across the process side seal including expected primary seal leakage at normal operating point.

3.1.26.4
secondary seal gas normal flow (tandem)
Flow to satisfy the velocity requirements across the intermediate labyrinth including expected secondary seal leakage at normal operating point.

3.1.26.5
secondary vent normal flow (tandem)
Expected secondary seal leakage plus separation seal gas flowing into the vent cavity at normal operating point.

3.1.26.6
separation seal normal flow
Flow to satisfy the velocity and/or pressure requirements across the separation seal (both sides when applicable) at normal operating point.

3.1.26.7
vent normal flow (double)
Expected secondary seal leakage plus separation seal gas flow into the vent cavity at normal operating point.

3.1.26.8
vent normal flow (single)
Expected primary seal leakage plus separation seal gas flow into the vent cavity at normal operating point.

3.1.28
normal operating point
Point at which usual operation is expected and optimum efficiency is desired.

~~NOTE Refer to API 617, Eighth Edition.~~

3.1.29
normal sealing pressure
Sealing pressure at the normal operating point.

3.1.30
normal speed
Rotational speed (RPM) at which the seal will operate at the normal operating point.

3.1.31
normal vent pressure
Primary vent pressure control set point.

3.1.32
normally open
normally closed
<Manual hand valve> state during normal operation.

3.1.33
normative
Required.

cf **informative** (3.1.11)

NOTE A normative reference or annex enumerates a requirement or mandate of the specification.

3.1.34
observed
Inspection or test where the purchaser is notified of the timing of the inspection or test and the inspection or test is performed as scheduled even if the purchaser or his/her representative is not present.

3.1.35
owner
Final recipient of the equipment, who may delegate another agent as the purchaser of the equipment.

3.1.36
panel
Open structure supporting dry gas seal support system components, typically in a single plane.

NOTE 1 A panel is not a skid.

NOTE 2 In this standard, the term panel refers to a seal system panel and not a control panel.

3.1.37
positive material identification
PMI
Any physical evaluation or test of a material to confirm that the material that has been or will be placed into service is consistent with the selected or specified alloy material designated by the purchaser. These evaluations or tests may provide either qualitative or quantitative information that is sufficient to verify the nominal alloy composition.

NOTE Adapted from API 578:2010.

3.1.38
primary seal
The set of dry gas seal faces closest to the process.

3.1.39
purchaser
Agency that issues the order and specifications to the vendor.

NOTE The purchaser can be the owner of the facility in which the equipment is installed, the owner's appointed agent, or the equipment manufacturer purchasing components.

3.1.40
relief valve set pressure
Pressure at which a relief valve starts to lift.

NOTE For information on relief valves, see API 520, Parts I and II.

3.1.41
remote
Position of a device when located away from the equipment or dry gas seal support system, typically in a control room.

cf **local** (3.1.12)

3.1.42
seal face velocity
A measure of the linear distance with respect to time based on the seal face outside diameter and the shaft rotational speed.

NOTE The units for seal face velocity are meters/second [International System (SI) units] or feet/second [U.S. customary (USC) units].

3.1.43
seal gas
Gas supplied to the high-pressure side of a primary seal, which flows through the primary seal faces and acts as a sealing medium.

3.1.44
secondary seal
The set of dry gas seal faces furthest from the process gas.

3.1.45
secondary seal gas
~~Gas~~ Nitrogen supplied between the primary and secondary seal of a tandem seal, which flows through the secondary seal faces, and through an intermediate labyrinth when one is present.

3.1.46
separation gas
~~Air or inert gas~~ Nitrogen or air supplied to a separation seal, providing a barrier between the atmospheric bearing housing and the dry gas seal.

3.1.47
settle-out pressure
Highest pressure that the machine experiences when the machine is not running and equilibrium has been reached.

NOTE Determination of settle-out pressure requires consideration of the trapped volume of gas throughout the machine and its associated piping system.

3.1.48
shutdown set point
Pre-set value of a measured parameter at which automatic or manual shutdown of the system or equipment is required.

3.1.49
skid
Baseplate-type structure supporting gas seal support system components.

NOTE 1 Panels can be mounted on skids.

NOTE 2 Skids can be grouted.

3.1.50
slow roll speed
~~Rotational speed (RPM) typically~~ Speed less than 5 % of the normal operating speed or the minimum speed permitted by speed control, which also achieves seal lift-off. ~~speed values for slow roll are about 500 RPM.~~

3.1.51
special tool
Tool that is not a commercially available catalog item.

3.1.52
standby
Service state in which a piece of equipment is normally idle or idling and is capable of immediate automatic or manual start-up for continuous operation.

3.1.53
standstill
Zero RPM.

3.1.54
static pressure rating
Highest sealing pressure that the seal assembly can continuously operate at the maximum allowable temperature while the shaft is not rotating.

cf **dynamic pressure rating** (3.1.8)

3.1.55
static sealing element
Pressure-retaining component designed to seal a joint with no relative axial movement.

cf **dynamic sealing element** (3.1.9)

3.1.56
steady state
Constant operating parameters.

3.1.57
total indicator reading
total indicated runout
TIR
Difference between the maximum and minimum readings of a dial indicator or similar device, monitoring a face or cylindrical surface during one complete revolution of the monitored surface.

NOTE For a cylindrical surface, the indicated runout implies an eccentricity equal to half the reading. For a flat face, the indicated runout implies an out-of-squareness equal to the reading. If the diameter in question is not cylindrical or flat, the interpretation of the meaning of TIR is more complex and can represent ovality or surface irregularities.

3.1.58
transient
Operation outside the defined conditions or transition from one operating state to another such as normal start-up to running or running to shutdown.

3.1.59
turning gear speed
ratcheting/barring
Temporary operating condition during start-up and shutdown. Typically 50 RPM or less.

3.1.60
unit responsibility
Obligation for coordinating the documentation, delivery, and technical aspects of all of the equipment and all auxiliary systems included in the scope of the order.

3.1.61
vendor
Manufacturer or manufacturer's agent that supplies the equipment.

3.1.62
vent gas
Gas flowing out of the seal through a designated vent connection.

3.1.63
witnessed
Inspection or test where the purchaser is notified of the timing of the inspection or test and a hold is placed on the inspection or test until the purchaser or the purchaser's representative is in attendance.

3.2 Acronyms and Abbreviations

ASME Code	ASME *Boiler and Pressure Vessel Code*
cf	(Latin conferre) confer or compare—cross-reference
DCS	distributed control system
DE	drive end

DGS	dry gas seal
DLC	diamond-like carbon
DN	diamétre nominal
FAT	factory acceptance test
FMEA	failure mode and effects analysis
HAZOP	hazard and operability study
HMI	human machine interface
ID	inside diameter
I/O	input/output
L, LL, H, HH	low, low low, high, high high
MAWP	maximum allowable working pressure
MCC	motor control center
MCS	maximum continuous speed
MRT	mechanical run test
NDE	non-drive end
NPS	nominal pipe size
NPT	national pipe thread taper
OD	outside diameter
PCD	polycrystalline diamond
PEEK	polyether ether keytone
P&ID	~~process~~ piping and instrumentation diagram
PLC	programmable logic controller
PMI	positive material identification
PTFE	polytetrafluoroethylene
RGD/ED	rapid gas decompression/explosive decompression
RPM	revolutions per minute
RTD	resistance temperature detector
SI	International System
SiC	silicon carbide

SiN	silicon nitride
TIR	total indicator reading/total indicated runout
USC	U.S. customary
VDDR	vendor drawing and data requirements
VFD	Variable Frequency Drive
VPI	vapor phase inhibitor
WC	tungsten carbide

4 General

4.1 Unit Responsibility

The vendor shall assume unit responsibility and shall assure that all subvendors comply with the requirements of this standard and all reference documents. The technical aspects to be considered by the vendor include, but are not limited to, such factors as the process conditions, power requirements, speed, rotation, general arrangement, couplings, dynamics, lubrication, sealing system, material test reports, instrumentation, piping, material compatibility, conformance to specifications, and testing of components.

Purchaser may specify a vendor responsible for each portion of the design, scope of supply, and installation of the dry gas sealing system.

4.2 Nomenclature

Dry gas seal nomenclature can be found in Annex C of Part 2.

5 Requirements

5.1 [●]Standard Fasteners and Units of Measure

5.1.1 Purchaser shall specify whether data, drawings, hardware (including fasteners), and equipment supplied to this standard shall use the SI or USC system of measurements.

5.1.2 Use of an SI datasheet indicates that SI units shall be used.

5.1.3 Use of an USC datasheet indicates that USC units shall be used.

NOTE 1 The factors in Chapter 15 of the API *Manual of Petroleum Measurement Standards*, formally API 2564, were used to convert from USC to SI units. The resulting exact SI units were then rounded off.

NOTE 2 Datasheets for SI and USC units are provided in Annex A in Parts 2 and 3.

5.2 Statutory Requirements

5.2.1 The purchaser and the vendor shall determine the measures to be taken to comply with any governmental codes, regulations, ordinances, directives, or rules that are applicable to the equipment its packaging and any preservatives used.

5.2.2 Equipment installed in the European Economic Area (EEA) shall comply with all applicable European Union Directives.

5.3 Alternative Designs

5.3.1 All designs shall comply with this standard, and any exceptions to the standard including alternate designs shall be clearly stated in the proposal.

5.3.2 Dry gas sealing systems shall be supplied by vendors qualified by experience in manufacturing the equipment proposed.

5.3.3 The vendor shall have manufactured, at the proposed point of manufacture, comparable speed, size, and pressure rating for a gas of comparable characteristics.

5.3.4 Proposed designs with less than 3 years of demonstrated successful operation shall be approved by the purchaser.

5.3.5 The extent of validation testing and design audits required shall be agreed.

5.4 [●] Documentation Requirements

The hierarchy of documents shall be specified by the purchaser.

NOTE Typical documents include the purchase order or inquiry, purchaser and industry specifications, meeting notes, and modifications to these documents.

5.5 Conflicting Requirements

In case of conflict between this standard and the inquiry, the inquiry shall govern. At the time of the order, the order shall govern.

6 Basic Design

6.1 General

Normative and informative annexes are provided as part of the document. These annexes are as follows.

— Annex A— Vent Study (normative).

— Annex B—Phase Maps (informative).

— Annex C—Dry Gas Sealing System Retrofit Checklist (informative).

— Annex D - Contract Documents and Engineering Design Data (informative)

6.1.1 Dry gas sealing systems shall be provided to contain process gas within the equipment and venting systems.

6.1.1.1 The "dry gas sealing system" includes the dry gas seals as defined in Part 2 and the dry gas seal support systems as defined in Part 3.

6.1.1.2 In the event of a dry gas seal failure, the separation seal shall be designed to maintain sealing integrity and limit the amount of process gas entering the bearing housing.

6.1.2 [●] The purchaser shall specify the period of uninterrupted continuous operation, during which time the equipment should not require shutdown to perform maintenance or inspection.

NOTE 1 It is realized there are some services where this objective is easily attainable and others where it is difficult.

NOTE 2 Auxiliary system design and conditions of the process in which the equipment is installed are very important in meeting this objective.

6.1.3 Vendor shall advise in the proposals any maintenance requirements or component replacements that may be required to achieve the continuous operation interval specified in 6.1.2, including maintenance performed in between intervals.

6.2 System Design

6.2.1 The dry gas sealing system shall be designed to operate under all defined transient and steady state operating conditions. These conditions may include but are not limited to the following:

a) all conditions defined on the compressor datasheets;

b) shop compressor tests;

c) field run tests;

d) slow roll;

e) turning gear—ratcheting/barring;

f) transient conditions (e.g. start-up, shutdown, defined failure modes, start-up from settle-out, operation at relief valve settings).

g) vent pressures and/or flare pressure for the above operating conditions.

6.2.2 [●] Purchaser shall specify maximum sealing pressure, settle-out pressures, and process relief valve settings. The maximum sealing pressure shall be at least equal to the settle-out pressure.

NOTE Maximum suction pressure, system relief valve settings, test conditions, external gas sources, or buffer gas or seal gas pressure can all affect the maximum sealing pressure.

6.2.3 Dry gas seal support systems shall be designed to prevent reverse pressurization during all conditions defined in 6.2.1. ~~outside the allowable limits defined in Part 2, Section 6.14 under all conditions defined in 6.2.1 of Part 1.~~

6.2.4 Vendor shall provide documentation defining system design and operation to prevent reverse pressurization.

6.2.5 Vendor shall supply a maximum depressurization rate to prevent explosive decompression damage.

6.2.6 The vendor shall identify the allowable range of gas supply temperatures for the dry gas seal and support system.

6.2.6.1 The maximum allowable temperature shall not be less than the maximum supply temperature of the seal gas and buffer gas, or any other temperatures associated with the conditions of 6.2.1.

6.2.6.2 The minimum allowable temperature shall not be greater than the minimum supply temperature of the seal gas and buffer gas, or any other temperatures associated with the conditions of 6.2.1.

6.2.6.3 ~~Unless approved by the purchaser, the maximum allowable temperature of the dry gas seal shall not be less than the maximum compressor discharge temperature.~~

6.2.7 [●] Purchaser shall specify the isolation and maintenance philosophy including the use and location of double block and bleed, car-sealed, or other valves for isolating a component and how they are arranged.

NOTE Double block valves are normally provided where there is safety or environmental issues associated with the reliability of a single block valve.

6.2.8 [●] If specified, a vent study shall be performed in accordance with Annex A.

6.3 Seal Gas, Buffer Gas, Secondary Seal Gas, and Separation Gas

6.3.1 [●] Purchaser shall specify all supply gas conditions (minimum, normal, and maximum) needed for the design of the dry gas sealing system. These conditions may include but are not limited to the following:

a) supply conditions (e.g. source, gas composition, gas pressure, and gas temperature);

b) alternate gas supply conditions (e.g. gas composition, gas pressure, and gas temperature).

6.3.2 Gas compositions shall fully define the components and saturation conditions. Heavy components shall be defined and not lumped as C6+.

6.3.3 [●] The purchaser shall specify the presence of any corrosive agents (including trace quantities) in the process fluids and in the site environment.

NOTE 1 Typical agents of concern are hydrogen, oxygen, hydrogen sulfide, amines, chlorides, carbon dioxide, cyanide, mercury, fluoride, naphthenic acid, and polythionic acid.

NOTE 2 If amines are present, refer to API RP 945 for information on amine cracking and its prevention.

NOTE 3 Guidelines to avoid caustic stress corrosion cracking can be found in NACE SP0403.

6.3.4 Buffer gas shall be used for double seals.

6.3.5 Seal gas for a double seal shall be nitrogen and supplied at the required differential pressure when the compressor is pressurized.

6.3.6 [●] If specified, alternative seal gas supply for double seals shall be used.

6.3.7 Nitrogen shall be used as separation and secondary seal gas.

6.3.8 [●] If specified, air shall be used as separation gas.

Caution—Air used as a separation gas can create an explosive mixture due to mixing with process hydrocarbons.

6.4 Site and Utility Conditions

6.4.1 [●] Purchaser shall specify all site and utility conditions needed for the design of the dry gas sealing system. These conditions may include but are not limited to the following:

a) ambient and environmental conditions;

b) area classification;

c) utility conditions (e.g. air, nitrogen, cooling water, electric power);

d) other external gas supply conditions (e.g. gas composition, gas pressure, and gas temperature);

e) minimum, normal, and maximum vent system pressure.

6.5 Gas Conditioning System

6.5.1 A seal gas conditioning system shall be supplied for all tandem seal systems.

NOTE Gas conditioning system requirements are defined in Part 3.

6.5.2 A gas conditioning system shall be supplied for single seal systems, double seal buffer gas, and/or seal gas that do not meet the cleanliness and dew point requirements for the application.

6.5.3 All seal gas and buffer gas streams (including alternate, backup, start-up sources) flowing into seal cavities shall be supplied at a temperature providing at least 20 °C (35 °F) margin from the dew point line in order to preclude the possibility of liquid entering or forming in the dry gas seal.

6.5.4 Vendor shall supply phase maps for all defined conditions.

NOTE 1 See Annex B for information on dew point margin.

NOTE 2 The discharge temperature of the compressor gas stream might not provide this dew point margin.

NOTE 3 The dew point margin is based on the temperatures and pressures in the seal and not just at the supply connections. The heater outlet temperature can be set higher in order to meet this requirement.

6.6 Gas Velocities

6.6.1 The dry gas seal support system shall be designed to provide no less than the minimum gas velocities listed in Table 1 for all labyrinths and clearance seals at 2 times maximum design clearance and expected eccentricity.

Table 1—Minimum Gas Velocities

	~~≤~~Standstill to Slow Roll	>Slow Roll
Process side seal	3 m/s (10 ft/s)	5 m/s (16 ft/s)
Intermediate labyrinth	3 m/s (10 ft/s)	3 m/s (10 ft/s)
Separation seal	5 m/s (16 ft/s)	5 m/s (16 ft/s)
NOTE During static conditions with external seal gas or buffer gas and a fixed or blocked in compressor volume, the compressor pressure can rise reducing the labyrinth velocity.		

6.6.1.1 The vendor shall supply supporting calculations for gas velocity compliance. The calculation shall define the total inlet flow and define any expected leakage across seal faces, continuous drain holes, or other leakage sources.

6.6.2 Seal gas for a single or tandem seal shall be supplied at or above the specified minimum velocity limits whenever the compressor is pressurized.

6.6.3 Buffer gas shall be supplied at or above the specified minimum velocity limits whenever the compressor is pressurized.

6.7 System Drain Connections

6.7.1 Dry gas seal support system and interconnecting piping shall be arranged with low point drains so the entire system can be drained prior to start-up to avoid the possibility of liquids entering the seals.

6.7.2 Drains shall be provided for all cavities (i.e. separation seal gas ~~supply~~, vent, primary vent, secondary vent, secondary seal gas, seal gas, buffer gas).

NOTE There can be insufficient space for small compressors to have dedicated drain lines.

6.7.3 ~~Separation seal gas~~ Supply and drain lines shall not be combined unless approved by the purchaser.

NOTE Gas velocity in supply lines do not allow for collection of liquid and can only be used for cavity draining prior to operation.

6.7.4 Vent and secondary vent lines shall not be combined with drains unless approved by the purchaser.

6.7.5 Drains shall be selected and designed per requirements listed in Part 3 and system diagrams as shown in Annex B of Part 3.

6.8 Alarms and Shutdowns

Alarms and shutdowns are listed in Part 3.

NOTE Alarms and shutdowns are typically reviewed during a failure mode and effects analysis (FMEA) or hazard and operability study (HAZOP).System Analysis Failures Modes

6.8.1 The vendor shall provide the minimum and maximum operating limits of the dry gas sealing systems.

6.8.2 [●] If specified, all potential failure modes and combinations that can occur within the entire seal system shall be identified by the vendor, including but not limited to:

a) dry gas seal failure combinations (e.g. primary only, secondary only, primary and secondary);

b) separation seal failure;

c) failure of seal gas, secondary seal gas, buffer gas, and separation gas supply system components;

d) single point of failure.

6.8.3 [●] If specified, mitigations addressing the identified failure modes to provide adequate response time, safe shutdown, and minimal outage time shall be agreed. The mitigations may include, but are not limited to:

a) adequately sized venting provisions to safe locations;

b) monitoring and alarming;

c) automatic shutdowns (if specified by the purchaser);

d) control valve bypasses;

e) sparing of seal assemblies, seal components, and seal gas system components.

6.8.4 [●] The purchaser shall specify any requirements for additional information or vendor participation in FMEA and/or HAZOP activities.

6.8.5 [●] If specified, API 691 shall be applied for the dry gas sealing system.

7 Special Tools

7.1 ~~If special tools or fixtures are required to disassemble, assemble, or maintain the equipment, they shall be included in the quotation and furnished as part of the initial supply of the equipment.~~ If special tools or fixtures are required to disassemble, assemble or maintain the equipment, they shall be included in the quotation and furnished as part of the initial supply of the equipment. For multiple-unit installations, the requirements for quantities of special tools and fixtures shall be agreed between purchaser and vendor. These special tools shall be used, and their use demonstrated, during shop assembly and posttest disassembly of the equipment.

7.2 ~~For multiple-unit installations, the requirements for quantities of special tools and fixtures shall be agreed between purchaser and vendor.~~ If special tools are provided, each tool shall be labeled using metal stamps or have a permanently attached stainless steel tag to indicate its intended use. Tools which do not exceed 1 meter in length, width or height and that weigh less than 40 kg shall be packaged in one or more rugged metal boxes and shall be marked “special tools for (tag/item number), box x of x”. Larger tools do not need to be boxed but shall have a stainless steel tag permanently attached to indicate both the intended use and the tag/item number of the equipment for which they are intended.

~~**7.3** Use of special tools shall be demonstrated during shop assembly and post-test disassembly of the equipment~~

~~**7.4** When special tools are provided, they shall be packaged in a separate, rugged metal box or boxes and shall be marked “special tools for (tag/item number)”.~~

~~**7.5** Each tool shall be stamped or metal tagged to indicate its intended use.~~

8 Coatings, Insulation, and Heat Tracing

8.1 [●] If specified, surfaces shall be coated as defined by the purchaser.

8.2 All lines downstream of the separator shall be insulated.

8.3 Insulation and heat tracing to maintain gas temperature requirements provided in section 6.5.3 ~~It~~ shall be identified on the piping and instrument diagrams.

8.4 [●] Purchaser shall specify who is responsible for the design, supply, and installation of the heat tracing and insulation system.

8.5 Insulated lines and all components shall have a minimum of 50 mm (2 in.) clearance.

8.6 [●] Purchaser shall specify any special provisions for insulation or heat tracing.

8.7 [●] If specified, heat tracing and insulation of all panel mounted components and lines shall be completed by vendor after cleanliness and leak test of the panel, but prior to pre-shipping inspection.

9 Inspection, Testing, and Preparation for Shipment

9.1 General

9.1.1 [●] The purchaser shall specify the extent of participation in the inspection and testing.

9.1.2 [●] If specified, the purchaser's representative, the vendor's representative, or both shall indicate compliance in accordance with the inspector's checklist (Annex J for Part 2 and Annex C for Part 3) by initialing, dating, and submitting the completed checklist to the purchaser before shipment.

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

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

9.1.5 If shop inspection and testing have been specified, the purchaser and the vendor shall coordinate manufacturing hold points and inspectors' visits.

9.1.6 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 testing, including acceptance criteria for all monitored parameters.

9.1.7 The expected dates of testing shall be communicated at least 30 days in advance of testing and the actual dates confirmed as agreed.

9.1.8 The vendor shall give at least 5 working days advanced notification of a witnessed or observed inspection or test.

9.1.9 A witnessed test requires written confirmation of the successful completion of a preliminary test.

9.1.10 [●] If specified, an unwitnessed pre-test shall not be performed.

NOTE Some purchasers prefer to be present for initial preliminary tests prior to witnessed tests to understand any difficulties encountered during testing.

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

9.1.12 The vendor shall keep the following data available for at least 20 years:

a) necessary or specified certification of materials, such as mill test reports;

b) test data and results to verify the requirements of the specification have been met;

c) fully identified records of all heat treatments and radiography whether performed in the normal course of manufacture or as part of a repair procedure;

d) results of quality control tests and inspections;

e) details of all repairs;

f) final assembly, maintenance, and running clearances;

g) purchase specifications for all items on bills of material;

h) other data specified by purchaser or required by applicable codes and regulations.

9.1.13 Pressure-containing parts shall not be painted until the specified inspection and testing of the parts is complete.

9.1.14 [●] In addition to the industry material specifications, the purchaser shall identify: ~~identify~~:

a) parts to be subjected to surface and subsurface examination;

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

NOTE ASTM material specifications contain mandated and supplemental inspections.

9.2 Material Inspection

Radiographic, ultrasonic, magnetic particle, or liquid penetrant inspection of welds or materials shall be performed in accordance with 9.3 through 9.5.

9.3 Radiography

9.3.1 Radiography shall be in accordance with ASTM E94, ASME Code, and ASME B31.3.

9.3.2 [●] If specified, nondestructive examination maps shall be supplied.

9.4 Magnetic Particle Inspection

Both wet and dry methods of magnetic particle inspection shall be in accordance with ASTM E709.

9.5 Liquid Penetrant Inspection

Liquid penetrant inspection shall be based upon the procedures of ASTM E165/E165M and ASTM E1417/E1417M.

9.6 Positive Material Identification (PMI)

9.6.1 [●] If specified, PMI testing shall be in accordance with 9.6.2 through 9.6.7.

9.6.2 PMI shall be performed on completed components prior to shipment. PMI should also be completed on incoming material to verify compliance with specifications prior to fabrication and assembly.

9.6.3 Components not accessible for PMI verification at shipment shall be verified prior to assembly.

9.6.4 PMI techniques providing quantitative results shall be used.

NOTE Additional information on PMI testing can be found in API 578.

9.6.5 Mill test reports, material composite certificates, visual stamps, or markings shall not be considered as substitutes for PMI testing, or vice versa.

9.6.6 PMI results shall be within the material specification limits, allowing for the measurement uncertainty (inaccuracy) of the PMI device as specified by the device manufacturer.

9.6.7 PMI of piping shall include piping spool PMI record maps with unique identification of each sample point for correlation to the PMI data results.

9.7 Testing

Individual testing requirements are covered in Parts 2 and 3 of this standard.

9.8 Preparation for Shipment

9.8.1 [●] Equipment shall be prepared for the type of shipment specified.

9.8.1.1 The preparation shall make the equipment suitable for 6 months of outdoor storage from the time of shipment.

9.8.1.2 If storage for a longer period is contemplated, the purchaser shall consult with the vendor regarding the recommended procedures to be followed.

NOTE Individual requirements are listed in Part 2 and Part 3.

9.8.2 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 before start-up, as described in Part 4 of this standard and ~~Chapter 3 of~~ API 686.

9.8.3 The equipment shall be prepared for shipment after all testing and inspections have been completed and the purchaser has released the equipment.

9.8.4 The equipment shall be identified with item and serial numbers.

9.8.5 Crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the shipping container.

9.8.6 All spare parts shall be preserved and packaged per the purchase order requirements and the vendor recommended procedures.

9.8.7 Composition wood product such as particleboard, medium density fiberboard (MDF), and oriented strand board (OSB) shall not be used.

9.8.8 Wood used in export shipping shall comply with the requirements of ISPM Pub. No.15, ~~March 2002~~, ~~FAO, Rome~~.

9.9 Package Markings

9.9.1 [●] All markings shall be in English and additional other specified language.

9.9.2 Permanent identification labeling shall be provided on two opposite sides of the shipping box or container.

9.9.3 Shipping units shall be marked with industry standard cautionary symbols indicating center of gravity, sling or lifting points, top heavy packages, fragile and liquid contents, moisture sensitive contents, etc. per ASTM D5445~~-05~~.

9.9.4 Package markings shall include:

a) purchaser's purchase order number;

b) equipment tag number;

c) gross weight;

d) dimensions;

e) purchaser's project name.

10 Vendor's Data

10.1 General

10.1.1 The purchaser may specify the content of proposals, meeting frequency and vendor data content/format identified in Annex D. Annex D provides a general outline of information that potentially may be requested by the purchaser.

10.1.2 [●] If specified, the information in Annex D shall be provided.

10.1.3 ~~The information to be furnished by the vendor is specified in 10.2 and 10.3.~~

10.1.4 ~~The following information shall be included on transmittal (cover) letters, title pages, and in title blocks or other prominent position on drawings:~~

~~a) purchaser's/owner's corporate name;~~

~~b) job/project number;~~

~~c) equipment item number;~~

~~d) service name;~~

~~e) inquiry or purchase order number;~~

~~f) any other identification specified in the inquiry or purchase order;~~

~~g) vendor's identifying proposal number, shop order number, serial number, or other reference number required to identify for return correspondence.~~

10.1.5 ~~A coordination meeting shall be held, preferably at the vendor's plant, within 4 to 6 weeks after order commitment. The vendor shall prepare and distribute an agenda prior to this meeting, which as a minimum shall include a review of the following items.~~

~~a) Purchase order, scope of supply, unit responsibility, subvendor items, and lines of communications;~~

~~b) Datasheets;~~

~~c) Applicable specifications and previously agreed exceptions;~~

~~d) Schedules for the transmittal of data, production, and testing;~~

~~e) Quality assurance program and procedures;~~

~~f) Expediting;~~

~~g) Process and instrumentation diagrams (P&IDs) and bills of material;~~

~~h) Physical orientation of the equipment, piping, and auxiliary systems, including access for operation and maintenance;~~

~~i) Coupling selection with regard to seal installation and removal;~~

~~j) Seal operation and controls;~~

~~k) Rotordynamic lateral analysis;~~

~~l) Equipment performance, alternate operating conditions, start-up, shutdown, and any operating limitations;~~

~~m) Inspection, related acceptance criteria, and testing;~~

~~n) Bearing clearance and shaft centerline position(s);~~

~~o) Site utilities and conditions;~~

~~p) Gas sources and conditions, including alternate gas;~~

~~q) Flare/vent conditions.~~

~~10.2 Proposals~~

10.2.1 ~~General~~

10.2.1.1 ~~The vendor shall send the proposal to the addressee specified in the inquiry documents.~~

~~**10.2.1.1.1** The proposal shall include, as a minimum, the data specified in 10.2.2 through 10.2.4 and a specific statement that the equipment and all its components and auxiliaries are in strict accordance with this standard.~~

~~**10.2.1.1.2** If the equipment or any of its components or auxiliaries is not in strict accordance, the vendor shall include a list that details and explains each deviation.~~

~~**10.2.1.1.3** The vendor shall provide sufficient detail to enable the purchaser to evaluate any proposed alternative designs.~~

~~**10.2.1.1.4** All correspondence shall be clearly identified in accordance with 10.1.2.~~

10.2.1.2 ~~The materials of construction of all major components shall be clearly stated in the vendor's proposal.~~

~~**10.2.1.2.1** Materials shall be identified by reference to applicable international standards, including the material grade.~~

~~**10.2.1.2.2** If no such designation is available, the vendor's material specification, giving physical properties and chemical composition, and test requirements shall be included in the proposal.~~

~~**10.2.1.2.3** Where international standards are not available, internationally recognized national or other standards may be used.~~

10.2.1.3 ~~Vendor shall define the location of manufacturing and testing facilities that will be used.~~

10.2.1.4 ~~Vendor shall define the location of all repair facilities.~~

10.2.2 ~~**Proposal Drawings**~~

10.2.2.1 ~~The drawings indicated on the vendor drawing and data requirements (VDDR) form (see Part 2, Annex I for seals or Part 3, Annex E for systems) shall be included in the proposal. As a minimum, the following shall be included.~~

~~a) A general arrangement or outline drawing, showing overall dimensions, maintenance clearance dimensions, overall weights, erection weights, and the largest maintenance weight for each item. The direction of rotation and the size and location of major purchaser connections shall also be indicated.~~

~~b) Seal cross-sectional drawing including seal sleeve to shaft interface and the method for retaining and driving the seal sleeve with the rotor shaft.~~

~~c) Cross-sectional drawings of coolers, boosters, heaters, filters, and separators.~~

~~d) P&ID and bill of material of systems.~~

~~e) Sketches that show methods of lifting. [This information may be included on the drawings specified in Item a) above.]~~

~~f) Details of gas conditioning components sizing.~~

~~g) Separator separation method.~~

10.2.2.2 ~~If "typical" drawings, schematics, and bills of material are used, they shall be marked up to show the weight and dimension data to reflect the actual scope proposed.~~

10.2.3 ~~**Proposal Technical Data**~~

~~The following data shall be included in the proposal.~~

~~a) The purchaser's datasheets with complete vendor's information and literature to fully describe details of the offering.~~

~~b) The VDDR form (see Part 2, Annex I for seals or Part 3, Annex E for systems), indicating the schedule according to which the vendor agrees to transmit all the data specified.~~

~~c) A schedule for shipment in weeks after receipt of order.~~

~~d) A list of spare parts recommended for start-up and normal maintenance purposes, capital spares.~~

~~e) A list of the special tools furnished for maintenance.~~

~~f) Description of any special weather protection and winterization required for start-up, operation, and periods of idleness under the site conditions specified on the datasheets. This description shall clearly indicate the protection to be furnished by the purchaser, as well as that included in the vendor's scope of supply.~~

~~g) A complete tabulation of utility requirements (e.g. steam, water, electricity, air, and gas). Approximate data shall be clearly indicated.~~

~~h) A description of any inspection procedures for materials as required by 9.1 to 9.6.~~

~~i) Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment.~~

~~j) A list of any components that can be construed as being of alternative design, hence requiring purchaser's acceptance (5.3).~~

~~k) Guaranteed leakage rates (static and dynamic) for dry gas seal factory acceptance test.~~

~~l) All seal system normal flows, temperatures, pressures. Expected and maximum flows, temperatures, and pressures per the conditions defined in 6.2.1 and 6.2.2.~~

10.2.4 ~~Optional Tests~~

~~The vendor shall furnish an outline of the procedures to be used for each of the special or optional tests that have been specified by the purchaser or proposed by the vendor.~~

~~10.3 Contract Data~~

10.3.1 ~~General~~

10.3.1.1 ~~Contract data shall be furnished by the vendor in accordance with the agreed VDDR form.~~

10.3.1.2 ~~Each drawing shall have a title block in the lower right-hand corner with the date of certification, identification data specified in 10.1.2, revision number and date, and title. Similar information shall be provided on all other documents, including subvendor items.~~

10.3.1.3 ~~The purchaser shall promptly review the vendor's data upon receipt; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed upon in writing. After the data have been reviewed and accepted, the vendor shall furnish certified copies in the quantities specified.~~

10.3.1.4 ~~A complete list of vendor data shall be included with the first issue of major drawings. This list shall contain titles, drawing numbers, and a schedule for transmittal of each item listed. This list shall cross-reference data with respect to the VDDR form in Part 2, Annex I or Part 3, Annex E.~~

10.3.2 ~~Contract Drawings~~

~~The contract drawing and technical data requirements are found in Part 2 for seals and Part 3 for systems.~~

10.3.2.1 ~~The drawings and data furnished by the vendor shall contain sufficient information so that together with the manuals specified in 10.3.5, the purchaser can properly install, operate, and maintain the equipment covered by the purchase order.~~

10.3.2.2 ~~All contract drawings and data shall be clearly legible (8-point minimum font size even if reduced from a larger size drawing), shall cover the scope of the agreed VDDR form, and shall satisfy the applicable detailed descriptions in VDDR form in Part 2, Annex I or Part 3, Annex E.~~

10.3.3 ~~[●] Progress Reports~~

~~If specified, the vendor shall submit progress reports to the purchaser at the intervals specified.~~

10.3.4 ~~Parts Lists and Recommended Spares~~

10.3.4.1 ~~The vendor shall submit complete parts lists for all equipment and accessories supplied.~~

~~**10.3.4.1.1** These lists shall include part names, manufacturers' unique part numbers, and materials of construction (identified by applicable international standards).~~

~~**10.3.4.1.2** Each part shall be completely identified and shown on appropriate cross-sectional, assembly-type cutaway or exploded view isometric drawings.~~

~~**10.3.4.1.3** Interchangeable parts shall be identified as such.~~

~~**10.3.4.1.4** Part number shall uniquely identify parts that have been modified from standard dimensions or finished to satisfy specific performance requirements.~~

~~**10.3.4.1.5** The original manufacturer's name and part number shall identify standard purchased items.~~

10.3.4.2 ~~The vendor shall indicate on each of the above identified complete parts lists all parts recommended as start-up or maintenance spares and the recommended stocking quantities of each. These should include spare parts recommendations of subvendors that were not available for inclusion in the vendor's original proposal.~~

10.3.4.3 ~~The vendor shall provide recommended storage/preservation procedures.~~

10.3.5 ~~**Installation, Operation, Maintenance, and Technical Data Manuals**~~

10.3.5.1 ~~**General**~~

~~**10.3.5.1.1** The vendor shall provide sufficient written instructions and all necessary drawings to enable the purchaser to install, operate, and maintain all of the equipment covered by the purchase order.~~

~~**10.3.5.1.2** This information shall be compiled in a manual or manuals with a cover sheet showing the information listed in 10.1.2, an index sheet, and a complete list of the enclosed drawings by title and drawing number.~~

~~**10.3.5.1.3** The manual pages and drawings shall be numbered.~~

~~**10.3.5.1.4** The manual or manuals shall be prepared specifically for the equipment covered by the purchase order. "Typical" manuals are unacceptable.~~

~~**10.3.5.1.5** [●] If specified, a draft manual(s) shall be issued to purchaser 8 weeks prior to mechanical testing for review and comment.~~

~~**10.3.5.1.6** Refer to the VDDR form for number of copies. Hard copies as well as electronic copies shall be provided.~~

10.3.5.2 ~~**Installation Manual**~~

~~**10.3.5.2.1** All information required for the proper installation of the equipment shall be compiled in a manual that shall be issued no later than the time of issue of final certified drawings.~~

~~NOTE For this reason, it can be separate from the operating and maintenance instructions.~~

~~**10.3.5.2.2** This manual shall contain information on any grouting requirements, normal and maximum utility requirements, centers of mass, rigging provisions and procedures, and all other installation data.~~

~~**10.3.5.2.3** All drawings and data specified in 10.3.1 and 10.3.2 pertinent to proper installation shall be included as part of this manual.~~

~~NOTE Refer to Part 4 for installation data requirements.~~

10.3.5.3 **~~Operating and Maintenance Manual~~**

~~**10.3.5.3.1** A manual containing all required operating and maintenance instructions shall be supplied at shipment.~~

~~**10.3.5.3.2** In addition to covering operation at all specified process conditions, this manual shall also contain separate sections covering operation under any specified extreme environmental conditions.~~

10.3.5.4 **~~Technical Data Manual~~**

~~The vendor shall provide the purchaser with a technical data manual at shipment.~~

Annex A
(normative)

Vent Study

A.1 If specified by 6.2.7, a vent study shall be conducted to establish the venting system capacity during a seal failure to select and design a system to minimize potential damage and uncontrolled leakage to atmosphere. The study results define the pressure, flow, and temperature profile in the seal cavity and associated vents. The analysis shall consist of a steady state and dynamic modeling (considering the seal gas system control valves behavior). For the purpose of this annex, the scope is limited to the dry gas sealing systems as defined in Part 2 and Part 3. Effects of the process stream and venting system outside of the defined scope are not addressed here. The analysis will assist in establishing piping designs, components, and compressor porting requirements.

A.2 The vent study report shall contain as minimum the following data for each selected scenario shown on point A10:

- Mass flow to secondary and primary vent.
- Mass flow to lube oil system vent.
- Pressure and temperature on each seal cavity.
- Pressure and temperature on primary and secondary vent pipe.
- Pressure and temperature on lube oil system vent.

A.3 The study is coordinated between the purchaser and the vendor.

A.4 The typical data needed for this study are (where applicable) as follows.

1) Vent line P&IDs.

2) Vent line instrumentation datasheets.

3) Valve datasheets.

4) Seal gas and vent piping isometrics.

5) Vent line relief valve datasheet.

6) Dry gas seal (including seal retainer) information with porting and annulus dimensions to define flow area and restriction.

7) Separation seal information with porting and annulus dimensions to define flow area and restriction.

8) Compressor porting and cavity information with annulus dimensions to define flow area and restriction.

9) Process side seal drawing with defined maximum and 2 times maximum seal clearance.

10) Bearing housing venting details and expected operating pressure.

11) Compressor data sheet with operating suction pressure and settling out pressure and temperature.

A.5 The pressure and temperature coming from point 11 paragraph A.3 shall be imposed upstream the compressor laby seal, and the pressure in the primary and secondary cavities shall be iteratively calculated until mass continuity is met.

A.6 Calculation shall include reverse flow through separation seal if secondary chamber pressure is greater than normal separation seal gas supply.

A.7 Calculation should include pressure drop in primary and secondary vent line.

A.8 Calculation shall be completed using 2X labyrinth clearance on all seals.

A.9 Study shall include the ~~normal shutdown, emergency shutdown, and~~ settle-out conditions. Additional operational conditions to be provided shall be agreed.

A.10 Study shall include the following failure cases. Additional failure cases shall be agreed. In a seal failure event, the seal face or seal faces provide no restriction; the seal retainer shall be considered intact.

1) Failure of the primary seal to verify the primary vent and secondary seal gas injection rating.

2) Failure of the secondary seal to verify the effectiveness of protection.

3) Failure of the primary seal and the secondary seal to verify the venting system capability.

4) Failure of the primary seal and the secondary seal plus primary vent ~~restriction and/or~~ blockage (if specified by purchaser).

~~5) Failure of the primary seal and the secondary seal plus vent/secondary vent restriction and/or blockage.~~

6) Failure of the primary seal and the secondary seal plus blockage of both vents (if specified by purchaser).

NOTES:

a) The cases number 4 and 6 may result in an uncontrolled leakage to be assessed by purchaser considering the likelihood of the event.

b) the case number 4 shall consider the blockage of the primary vent system only downstream the safety devices (if installed) if the vendor provides the evidence that the primary vent blockage is not a credible scenario; this means that the effective area starting from primary seal gas cartridge cavities and porting, through compressor porting and primary vent line up to safety devices is always increasing without any restriction.

c) the case number 6 will be not included in the vent study if the vendor provides the evidence that the secondary vent blockage is not credible scenario; this means that the effective area starting from secondary seal gas cartridge cavities and porting, through compressor porting and secondary vent line up to atmosphere is always increasing without any restriction.

Annex B
(informative)

Phase Maps

B.1 General

Seal gas has to maintain its gaseous state throughout the dry gas seal including the vent system to prevent seal damage due to liquids. Gas flowing through the seal gas system undergoes pressure and temperature changes, which can cause gas to condense.

The phase map is a graphical representation of the condition or state (liquid and vapor) of a gas mixture at any pressure and temperature (see Figure B.1). The phase diagram contains the following regions:

a) region encompassed by bubble and dew point lines (also known as a dome) that contains fluid in a two-phase state;

b) region to the left of the bubble line that contains fluid in a liquid state;

c) region to the right of the dew point line that contains a superheated gas state;

d) region above that contains dense phase where the fluid is in a gaseous form but starts to behave more like a liquid.

Gas conditions at various pressure and temperature points are calculated by empirical equations of state. The equations provide a range of results based on the gas mixture and should be selected based on experience or industry recommendations. Typically, for oil and gas industry applications, modified Peng Robinson equation of state is used.

To prevent liquid condensation within the seal gas system, a safety margin/superheat of 20 °C (35 °F) to the right of the dew point line has to be maintained.

B.2 Terms and Definitions (Related to Phase Maps)

B.2.1
bubble point line
The bubble point line is the curve on the phase map where the gas mixture changes state from vapor and liquid to liquid with changing pressure and temperature**.**

B.2.2
critical point
The critical point (Cp) is located at the junction of the dew point line and the bubble point line**.**

B.2.3
depressurization curve
When no heat is added to the gas (e.g. static condition), the depressurization of the gas inside the gas seal interface is isenthalpic and there is a single depressurization curve, which is tangent to the dew point line.

B.2.4
dew point line
The dew point line is the curve on a phase map where the gas mixture changes state from vapor to vapor and liquid with changing pressure and temperature.

B.2.5

supercritical region

The gas is supercritical when it is in a vapor condition and when its behavior becomes similar to that of a liquid: its density is high and its viscosity is decreasing as the temperature increases; the region of the phase map where the vapor meets these conditions is called the supercritical region (or the dense phase region).

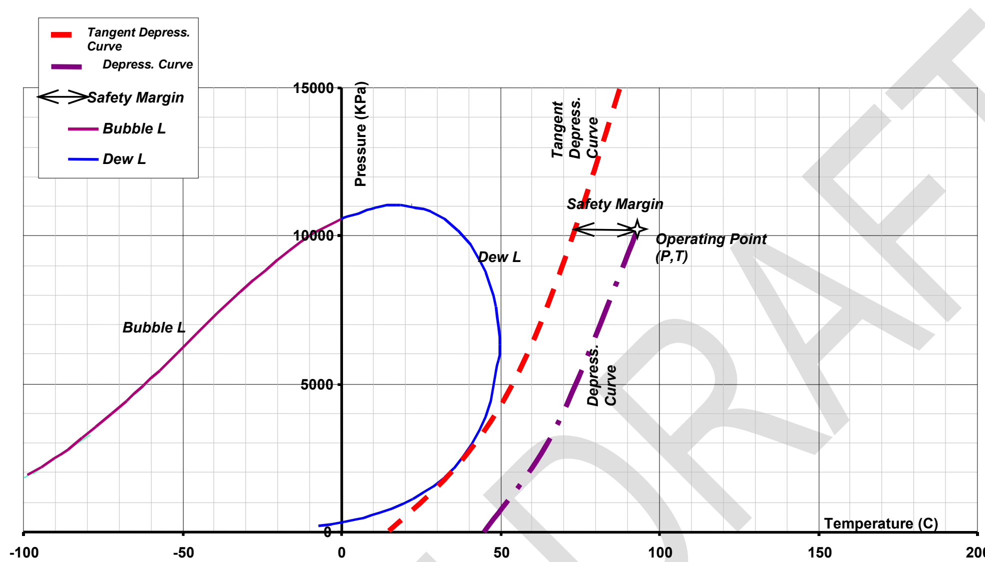

Figure B.1—Typical Phase Diagram

Annex C
(informative)

Dry Gas Sealing System Retrofit Checklist

This annex provides information for retrofitting an oil seal system to a dry gas sealing system.

Dry gas seal technology has been adopted as a standard and default choice for new centrifugal compressors. However, there are many older centrifugal compressors still operating with oil lubricated mechanical seals or labyrinth seals. There are many factors that play a role in making the decision to proceed with a retrofit. Some of the main factors to consider when retrofitting a machine to dry gas seals are reliability, economics, operability, safety, execution timeline and environmental considerations.

Heritage equipment may not allow compliance due to physical limitations requiring the purchaser to approve exceptions and deviations. Detailed design work may be required to confirm the retrofit is acceptable for a given service or equipment. This detailed design work may identify that a conversion is not feasible because of the compressor design and/or operational requirements.

Table C.1 should be used when considering a retrofit to confirm a conversion is possible.

Table C.1—Dry Gas Sealing System Retrofit Checklist

Evaluation Areas	Recommended Actions
Dimensional Accurate dimensional analysis and features for seal design, to understand modifications (if any) to the rotor ~~shaft~~ and seal cavity. ~~to shaft attachment.~~	i. Verify existing seal cavity has sufficient axial and radial space for the gas seal including the process side seal and separation seal or if modifications are required. ii. Verify if the rotor has sufficient axial and radial space to fit the seal or if modifications are required. iii. Check for appropriate surface finish on stepped bores and shaft ODs. iv. Check for proper and smooth chamfers on stepped bores and shaft ODs. v. Sufficient area for seal maintenance, installation, and removal. Verify the distance between shaft ends of the involved unit and connected units. vi. Verify consistent dimensions on all rotors [in-service and spare(s)] and between drive end (DE) and NDE seal cavities. vii. Verify the retention method of the seal to the compressor shaft.
Rotordynamic Oil seals act as dampers and removal of existing oil seals will result in reduced rotor dampening, which can have an adverse effect on the rotordynamic characteristics of the compressor.	A full rotordynamic analysis (RDA) to be performed for each compressor casing comparing rotor stability and running characteristics prior to retrofitting to and after retrofitting to dry gas seals. Requirements set out in API 617 and API 619 for comparing critical speed separation margins, amplification factors, and expected shaft vibration levels. If the outcome of the RDA is unsatisfactory modifications may be necessary.
Seal Gas Suitability/selection of seal gas.	Checked for its suitability for the application. Dew point analysis completed to identify if any conditioning equipment is required to ensure the seal gas is clean and stays dry as it flows through the dry gas seal system.

Evaluation Areas	Recommended Actions
Process or external gas composition, which will be used as sealing gas.	
Compressor Connections The availability and sizing of ports to support gas seal operation.	Are there sufficient drain, supply, and vent connections? ~~Can any additional connections be added?~~ If additional connections are required, confirm if they can be added or have components replaced. Check rating, sizing, and position of all supply, vent, and drain ports for the specific type seal selected.
Available Utility	Adequate air and/or nitrogen. Adequate cooling water. Electrical power/MCC.
Availability of Plant Process Connections	Seal gas supply. ~~External~~ Alternate seal gas supply. Vent connections. Drain connections. Pipe routing
Removal of Seal Oil System	Is it a combined system? Is the seal oil reservoir integral to the base or lube oil system? Verify impact on lube/control oil system, e.g. a) ensure adequate lube oil/control oil supply flow/pressure; b) coolers, pumps, control, and relief valve sizing; c) seal oil/lube oil pump start-up/trip logics/permissive.
Extent of Modification/Additions for Instrumentation and Control	I/O capacity. Control system modifications for alarm/trip, start-up sequence, permissive/interlocks. Field wiring/junction boxes.
Civil	Plot space and location of skid/panel close to compressor. Space for maintenance NOTE Gas conditioning system and panel size can exceed legacy plot space.
Environmental	Impact of inert gas in gas collection systems.
Testing	Determine minimum testing requirements on any of the modified/replaced components. Can they be tested in place or other location?

Annex D
(informative)

Contract Documents and Engineering Design Data

D.1 If specified by the purchaser in 10.1.2, the contract documents and engineering design data shall be supplied by the vendor, as listed in this annex.

D.1.1 The information to be furnished by the vendor is specified in D.2 and D.3.

D.1.2 The following information shall be included on transmittal (cover) letters, title pages, and in title blocks or other prominent position on drawings:

a) purchaser's/owner's corporate name;

b) job/project number;

c) equipment item number;

d) service name;

e) inquiry or purchase order number;

f) any other identification specified in the inquiry or purchase order;

g) vendor's identifying proposal number, shop order number, serial number, or other reference number required to identify for return correspondence.

D.1.3 A coordination meeting shall be held, preferably at the vendor's plant, within 4 to 6 weeks after order commitment. The vendor shall prepare and distribute an agenda prior to this meeting, which as a minimum shall include a review of the following items.

a) Purchase order, scope of supply, unit responsibility, sub-vendor items, and lines of communications;

b) Datasheets;

c) Applicable specifications and previously agreed exceptions;

d) Schedules for the transmittal of data, production, and testing;

e) Quality assurance program and procedures and documents

f) Expediting;

g) Process and instrumentation diagrams (P&IDs) and bills of material;

h) Physical orientation of the equipment, piping, and auxiliary systems, including access for operation and maintenance;

i) Coupling selection with regard to seal installation and removal;

j) Seal operation and controls;

k) Rotordynamic lateral analysis;

l) Equipment performance, alternate operating conditions, start-up, shutdown, and any operating limitations;

m) Inspection, related acceptance criteria, and testing; (Inspection Test Plan)

n) Bearing clearance and shaft centerline position(s);

o) Site utilities and conditions;

p) Gas sources and conditions, including alternate gas;

q) Flare/vent conditions.

D.2 Proposals

D.2.1 General

D.2.1.1 The vendor shall send the proposal to the addressee specified in the inquiry documents.

D.2.1.1.1 The proposal shall include, as a minimum, the data specified in D.2.2 through D.2.4 and a specific statement that the equipment and all its components and auxiliaries are in strict accordance with this standard.

D.2.1.1.2 If the equipment or any of its components or auxiliaries is not in strict accordance, the vendor shall include a list that details and explains each deviation.

D.2.1.1.3 The vendor shall provide sufficient detail to enable the purchaser to evaluate any proposed alternative designs.

D.2.1.1.4 All correspondence shall be clearly identified in accordance with D.1.2.

D.2.1.2 The materials of construction of all major components shall be clearly stated in the vendor's proposal.

D.2.1.2.1 Materials shall be identified by reference to applicable international standards, including the material grade.

D.2.1.2.2 If no such designation is available, the vendor's material specification, giving physical properties and chemical composition, and test requirements shall be included in the proposal.

D.2.1.2.3 Where international standards are not available, internationally recognized national or other standards may be used.

D.2.1.3 Vendor shall define the location of manufacturing and testing facilities that will be used.

D.2.1.4 Vendor shall define the location of all repair facilities.

D.2.2 Proposal Drawings

D.2.2.1 The drawings indicated on the vendor drawing and data requirements (VDDR) form (see Part 2, Annex I for seals or Part 3, Annex E for systems) shall be included in the proposal. As a minimum, the following shall be included.

a) A general arrangement or outline drawing, showing overall dimensions, maintenance clearance dimensions, overall weights, erection weights, and the largest maintenance weight for each item. The direction of rotation and the size and location of major purchaser connections shall also be indicated.

b) Seal cross-sectional drawing including seal sleeve to shaft interface and the method for retaining and driving the seal sleeve with the rotor shaft.

c) Cross-sectional drawings of coolers, boosters, heaters, filters, and separators.

d) P&ID and bill of material of systems.

e) Sketches that show methods of lifting. [This information may be included on the drawings specified in Item a) above.]

f) Details of gas conditioning components sizing.

g) Separator separation method.

D.2.2.2 If “typical” drawings, schematics, and bills of material are used, they shall be marked up to show the weight and dimension data to reflect the actual scope proposed.

D.2.3 Proposal Technical Data

The following data shall be included in the proposal.

a) The purchaser’s datasheets with complete vendor’s information and literature to fully describe details of the offering.

b) The VDDR form (see Part 2, Annex I for seals or Part 3, Annex E for systems), indicating the schedule according to which the vendor agrees to transmit all the data specified.

c) A schedule for shipment in weeks after receipt of order.

d) A list of spare parts recommended for start-up and normal maintenance purposes, capital spares.

e) A list of the special tools furnished for maintenance.

f) Description of any special weather protection and winterization required for start-up, operation, and periods of idleness under the site conditions specified on the datasheets. This description shall clearly indicate the protection to be furnished by the purchaser, as well as that included in the vendor’s scope of supply.

g) A complete tabulation of utility requirements (e.g. steam, water, electricity, air, and gas). Approximate data shall be clearly indicated.

h) A description of any inspection procedures for materials as required by 9.1 to 9.6.

i) Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment.

j) A list of any components that can be construed as being of alternative design, hence requiring purchaser's acceptance (5.3).

k) Guaranteed leakage rates (static and dynamic) for dry gas seal factory acceptance test.

l) All seal system normal flows, temperatures, pressures. Expected and maximum flows, temperatures, and pressures per the conditions defined in 6.2.1 and 6.2.2.

D.2.4 Optional Tests

The vendor shall furnish an outline of the procedures to be used for each of the special or optional tests that have been specified by the purchaser or proposed by the vendor.

D.3 Contract Data

D.3.1 General

D.3.1.1 Contract data shall be furnished by the vendor in accordance with the agreed VDDR form.

D.3.1.2 Each drawing shall have a title block in the lower right-hand corner with the date of certification, identification data specified in D.1.2, revision number and date, and title. Similar information shall be provided on all other documents, including sub-vendor items.

D.3.1.3 The purchaser shall promptly review the vendor's data upon receipt; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed upon in writing. After the data have been reviewed and accepted, the vendor shall furnish certified copies in the quantities specified.

D.3.1.4 A complete list of vendor data shall be included with the first issue of major drawings. This list shall contain titles, drawing numbers, and a schedule for transmittal of each item listed. This list shall cross-reference data with respect to the VDDR form in Part 2, Annex I or Part 3, Annex E.

D.3.2 Contract Drawings

The contract drawing and technical data requirements are found in Part 2 for seals and Part 3 for systems.

D.3.2.1 The drawings and data furnished by the vendor shall contain sufficient information so that together with the manuals specified in 10.3.5, the purchaser can properly install, operate, and maintain the equipment covered by the purchase order.

D.3.2.2 All contract drawings and data shall be clearly legible (8-point minimum font size even if reduced from a larger size drawing), shall cover the scope of the agreed VDDR form, and shall satisfy the applicable detailed descriptions in VDDR form in Part 2, Annex I or Part 3, Annex E.

D.3.3 [●] Progress Reports

If specified, the vendor shall submit progress reports to the purchaser at the intervals specified.

D.3.4 Parts Lists and Recommended Spares

D.3.4.1 The vendor shall submit complete parts lists for all equipment and accessories supplied.

D.3.4.1.1 These lists shall include part names, manufacturers' unique part numbers, and materials of construction (identified by applicable international standards).

D.3.4.1.2 Each part shall be completely identified and shown on appropriate cross-sectional, assembly-type cutaway or exploded view isometric drawings.

D.3.4.1.3 Interchangeable parts shall be identified as such.

D.3.4.1.4 Part number shall uniquely identify parts that have been modified from standard dimensions or finished to satisfy specific performance requirements.

D.3.4.1.5 The original manufacturer's name and part number shall identify standard purchased items.

D.3.4.2 The vendor shall indicate on each of the above identified complete parts lists all parts recommended as start-up or maintenance spares and the recommended stocking quantities of each. These should include spare parts recommendations of subvendors that were not available for inclusion in the vendor's original proposal.

D.3.4.3 The vendor shall provide recommended storage/preservation procedures.

D.3.5 Installation, Operation, Maintenance, and Technical Data Manuals

D.3.5.1 General

D.3.5.1.1 The vendor shall provide sufficient written instructions and all necessary drawings to enable the purchaser to install, operate, and maintain all of the equipment covered by the purchase order.

D.3.5.1.2 This information shall be compiled in a manual or manuals with a cover sheet showing the information listed in 10.1.2, an index sheet, and a complete list of the enclosed drawings by title and drawing number.

D.3.5.1.3 The manual pages and drawings shall be numbered.

D.3.5.1.4 The manual or manuals shall be prepared specifically for the equipment covered by the purchase order. "Typical" manuals are unacceptable.

D.3.5.1.5 [●] If specified, a draft manual(s) shall be issued to purchaser 8 weeks prior to mechanical testing for review and comment.

D.3.5.1.6 Refer to the VDDR form for number of copies. Hard copies as well as electronic copies shall be provided.

D.3.5.2 Installation Manual

D.3.5.2.1 All information required for the proper installation of the equipment shall be compiled in a manual that shall be issued no later than the time of issue of final certified drawings.

NOTE For this reason, it can be separate from the operating and maintenance instructions.

D.3.5.2.2 This manual shall contain information on any grouting requirements, normal and maximum utility requirements, centers of mass, rigging provisions and procedures, and all other installation data.

D.3.5.2.3 All drawings and data specified in D.3.1 and D.3.2 pertinent to proper installation shall be included as part of this manual.

NOTE Refer to Part 4 for installation data requirements.

D.3.5.3 Operating and Maintenance Manual

D3.5.3.1 A manual containing all required operating and maintenance instructions shall be supplied at shipment.

D.3.5.3.2 In addition to covering operation at all specified process conditions, this manual shall also contain separate sections covering operation under any specified extreme environmental conditions.

D.3.5.4 Technical Data Manual

The vendor shall provide the purchaser with a technical data manual at shipment.

Part 2—Dry Gas Seals

1 Scope

This part of API 692, in conjunction with API 692, Part 1, specifies requirements for compressor dry gas seals for axial, centrifugal, expander, and rotary screw compressors for use in the petroleum, chemical, and gas industry services as described in API 617 and API 619.

2 Normative References

For the purposes of this document, normative references are listed in Part 1.

3 Terms, Definitions, Acronyms, and Abbreviations

For the purposes of this document, the terms, definitions, acronyms, and abbreviations given in Part 1 apply.

4 General

For the purposes of this document, unit responsibility given in Part 1 applies.

5 Requirements

5.1 Standard Fasteners and Units of Measure

For the purposes of this document, standard fasteners and units of measure given in Part 1 apply.

5.2 Statutory Requirements

For the purposes of this document, statutory requirements given in Part 1 apply.

5.3 Alternative Designs

For the purposes of this document, alternative design requirements given in Part 1 apply.

5.4 Documentation Requirements

For the purposes of this document, documentation requirements given in Part 1 apply.

6 Basic Design

6.1 General

Normative and informative annexes are provided in the document. The annexes are as follows.

— Annex A—Datasheets (informative).

— Annex B—Dry Gas Seal Test Procedures (normative).

— Annex C—Seal Nomenclature (informative).

— Annex D— Dry Gas Seal Selection Guide (informative).

— Annex E—Separation Seals (informative).

— Annex F—Process Side Seal (informative).

— Annex G—Hysteresis Test (informative).

— Annex H—Dry Gas Seal Materials (informative).

— Annex I—Vendor Drawing and Data Requirements (VDDR) (normative).

— Annex J—Inspector’s Checklist (informative).

— Annex K— Post-test Dry Gas Seal Visual Inspection (normative).

— Annex L - Contract Documents and Engineering Design Data (informative).

6.2 Seal Types

The dry gas seal is a pressure-balanced, gas-lubricated end face seal in which the sealing mechanism is comprised of two faces, one stationary and one rotating. One seal face is etched with grooves partially across the face. These grooves in conjunction with the seal balance create face separation by both hydrostatic (pressure) and hydrodynamic (shear) forces. Face separation is typically a 3 to 5 micron gap. Leakage across the faces is a function of pressure differential, temperature, physical properties of the gas, seal size, seal geometry, and rotational speed for a given seal design.

NOTE Annex C provides dry gas seal nomenclature.

6.3 Tandem Seal with Intermediate Labyrinth

A tandem seal with intermediate labyrinth consists of two single seals arranged in series separated by a labyrinth. Tandem seals with intermediate labyrinth are suitable for medium- and high-pressure applications where leakage of process/seal gas to the atmosphere is unacceptable. Seal gas is injected between the process side seal and the primary seal faces. The majority of the seal gas flows into the compressor and a slight amount flows across the primary seal faces. The seal gas pressure is reduced across the primary seal to primary vent pressure. The intermediate labyrinth provides a restriction between the primary and secondary seal. Secondary seal gas is supplied between the intermediate labyrinth and secondary seal to provide a barrier and prevent primary seal leakage from reaching the secondary seal. Leakage from the primary seal is diluted with secondary seal gas and routed to a vent system. Secondary seal leakage is reduced across the secondary seal to atmospheric pressure and typically routed to the atmosphere. In case of primary seal failure, the secondary seal is designed to operate at primary seal conditions, which prevents uncontrolled leakage to the atmosphere and achieves a safe shutdown of the compressor. An example of a tandem seal with intermediate labyrinth configuration with a process side seal and a non-contacting bushing separation seal is shown in Figure 1.

6.4 Tandem Seal

A tandem seal consists of two single seals arranged in series. Tandem seals are suitable for medium- and high-pressure applications where some leakage of process/seal gas to the atmosphere is acceptable. This configuration is used where axial space constraints do not allow the installation of an intermediate labyrinth. Seal gas is injected between the process side seal and the primary seal faces. The majority of the seal gas flows into the compressor and a slight amount flows across the primary seal faces. The seal gas pressure is reduced across the primary seal to vent pressure. Primary seal leakage is reduced from vent pressure across the secondary seal to atmospheric pressure. In case of primary seal failure, the secondary seal is designed to operate at primary seal conditions, which prevents uncontrolled leakage to the atmosphere and achieves a safe shutdown of the compressor. Leakage from the primary seal is routed to a vent system, and leakage from the secondary seal is typically routed to the atmosphere. An example of a tandem seal configuration with a process side seal and a non-contacting bushing separation seal is shown in Figure 2.

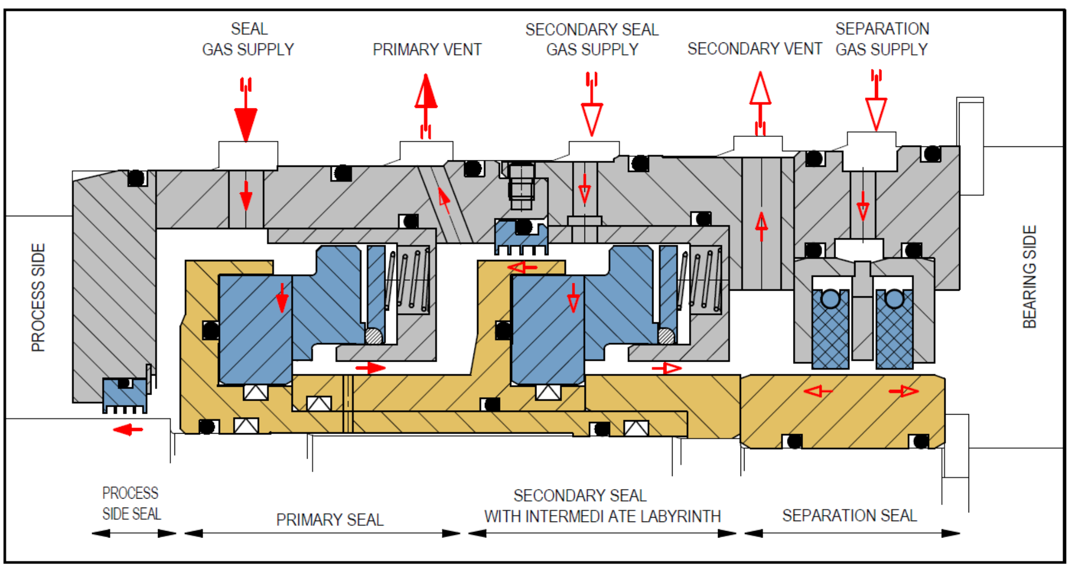

Figure 1—Tandem Seal with Intermediate Labyrinth Schematic

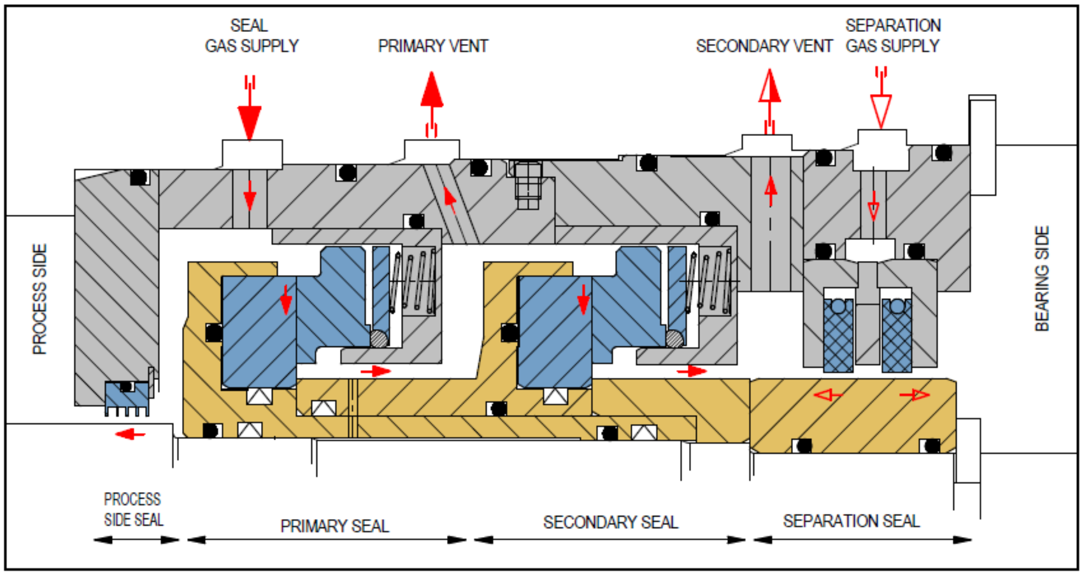

Figure 2—Tandem Seal Schematic

6.5 Double Seal

A double seal consists of two sets of single seals arranged in an opposed configuration. Double seals are suitable for low-pressure applications and where leakage of process gas to the atmosphere is unacceptable. Seal gas at a pressure higher than the process gas is supplied between the opposed seals. Seal gas leakage across the primary seal, along with any buffer gas, is introduced into the compressor/process. Seal gas leakage across the secondary seal is typically routed to the atmosphere. In case of primary seal failure, the secondary seal is designed to operate at primary seal conditions, which prevents uncontrolled leakage to the atmosphere. An example of a double seal configuration with a process side seal and a non-contacting bushing separation seal is shown in Figure 3.

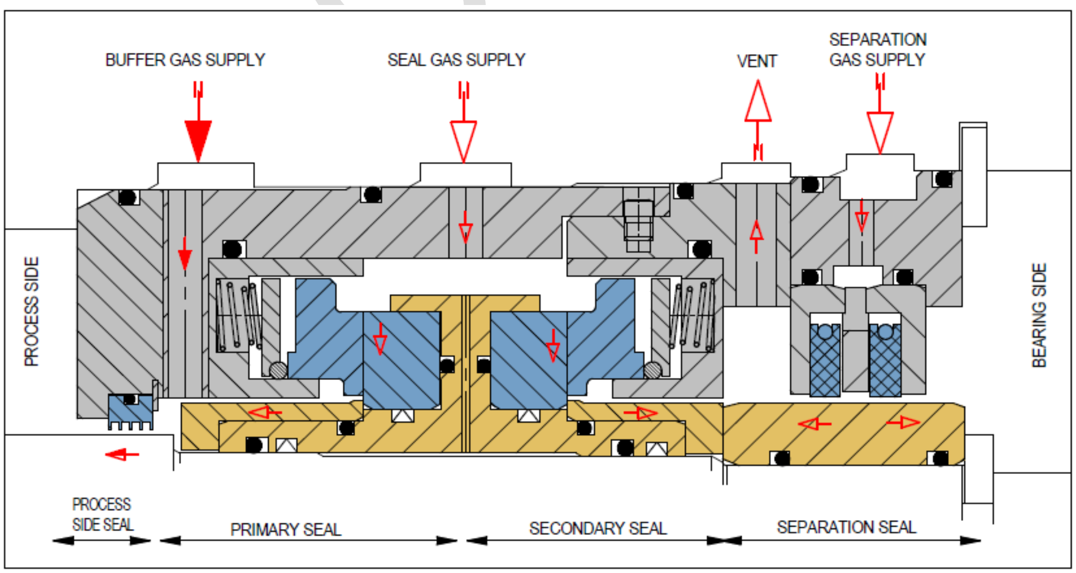

Figure 3—Double Seal Schematic

6.6 Single Seal

A single seal consists of a single set of seal faces separating process gas from the atmosphere. Single seals are suitable for applications where the gas sealed, such as air or nitrogen, is neither flammable nor harmful to the environment. Seal gas is injected between the process side seal and the primary seal faces. The majority of the seal gas flows into the compressor and a slight amount flows across the primary seal faces. The seal gas pressure is reduced across the seal faces to vent pressure. Seal leakage is typically vented to the atmosphere. An example of a single seal configuration with a process side seal and a non-contacting bushing separation seal is shown in Figure 4.

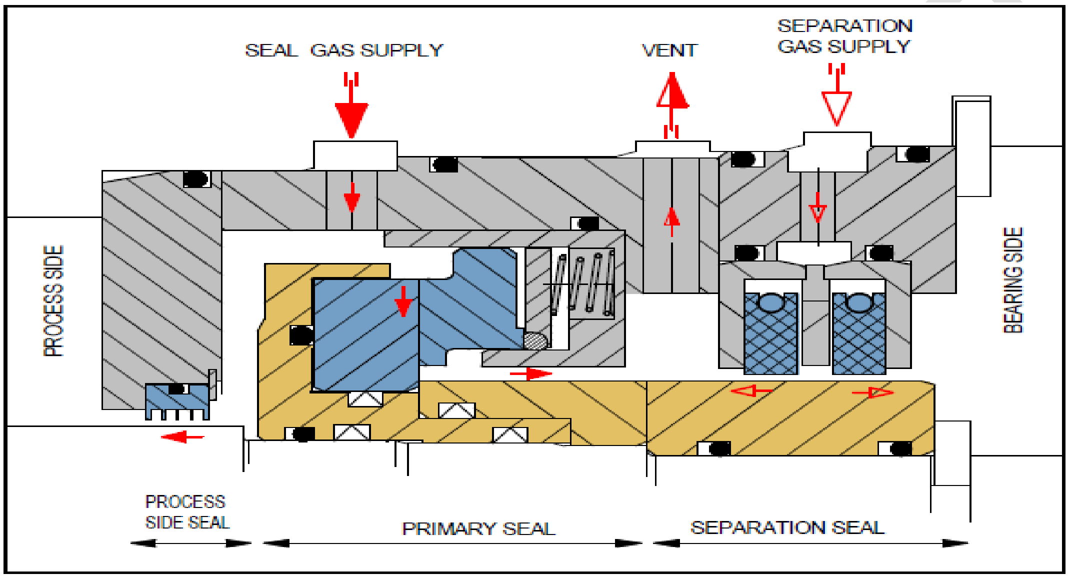

Figure 4—Single Seal Schematic

6.7 Separation Seals

6.7.1 General

The separation seal is located between the dry gas seal and bearing cavity and supplied with separation gas to prevent bearing oil migration to the seal cavity and seal leakage to the bearing cavity.

6.7.2 Non-contacting Bushing Seal

Non-contacting bushings consist of two sets of segmented rings (typically made of carbon) with a garter spring around the OD of the ring to hold the segments together. These segmented rings are positioned un-constrained within the stationary housing to allow for radial movement. ~~The segmented rings typically have an anti-rotation device.~~ As the segmented rings are able to float radially, the ID of the segmented ring is de-signed to achieve a minimal clearance above the rotating sleeve during normal operation. ~~A separation gas is supplied to the central tap at a pressure greater than the downstream bearing housing and seal vent cavity pressures. The separation gas flows through the annulus created between the segmented rings and rotating surface.~~ An example of a non-contacting bushing separation seal is shown in Figure 5.

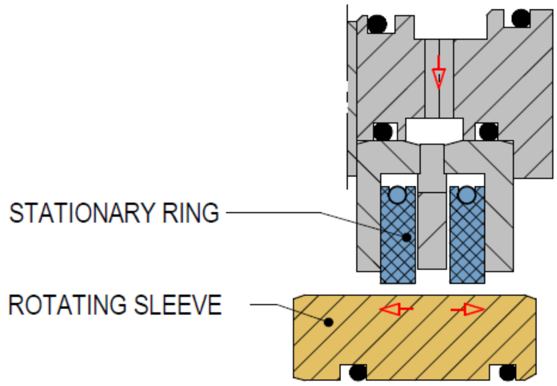

Figure 5—Non-contacting Bushing Seal Schematic

6.7.3 Labyrinth Seal

The separation labyrinth consists of two sections of teeth divided by a central tap to accommodate the introduction of separation gas. ~~Typically, the separation labyrinth teeth are stationary, rigidly mounted with a fixed clearance (non-contacting) to the rotating sleeve. A separation gas is supplied to the central tap at a pressure greater than the downstream bearing housing and seal vent cavity pressures. The separation gas flows through the annulus created between the teeth and rotating surface.~~ An example of a separation labyrinth seal is shown in Figure 6.

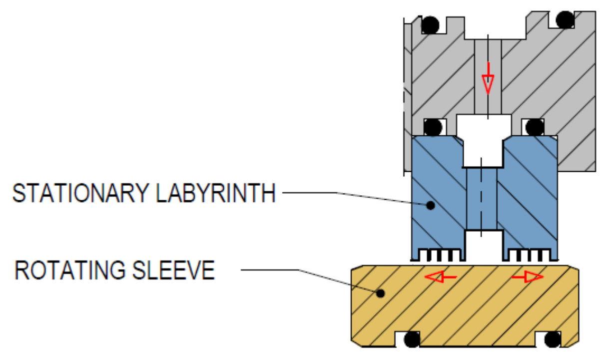

Figure 6—Separation Labyrinth Seal Schematic

6.7.4 Contacting Bushing Seal

Contacting bushings consist of two sets of segmented rings (typically made of carbon) with a garter spring around the OD of the ring to hold the segments together. These segmented rings are positioned unconstrained within the stationary housing and to allow for radial movement. ~~The segmented rings typically have an anti-rotation device.~~ As the segmented rings are able to float radially, the ID of the segmented ring is designed to be in constant contact with the rotating sleeve during normal operation. ~~A separation gas is supplied to the central tap at a pressure greater than the downstream bearing housing and seal vent cavity pressures. It is the pressure of the separation gas that prevents oil from migrating to the seal cavity and seal leakage from entering the bearing cavity.~~ An example of a contacting bushing separation seal is shown in Figure 7.

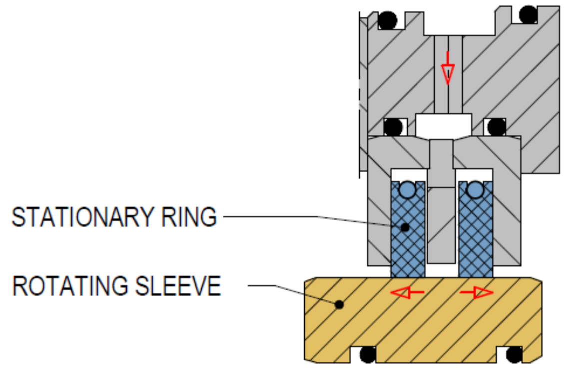

Figure 7—Contacting Bushing Seal Schematic

6.7.5 Non-Contacting Lift-off Bushing Seal

Lift-off bushings consist of two segmented rings (typically made of carbon) with a garter spring around the OD of the ring to hold the segments together. These segmented rings are positioned unconstrained within the stationary housing and to allow for radial movement. As the segmented rings are pressure-balanced, the ID of the segmented rings is designed to allow for lifting and maintain a minimal clearance above rotating sleeve during the normal operation. An example of a lift-off bushing separation seal is shown in Figure 8.

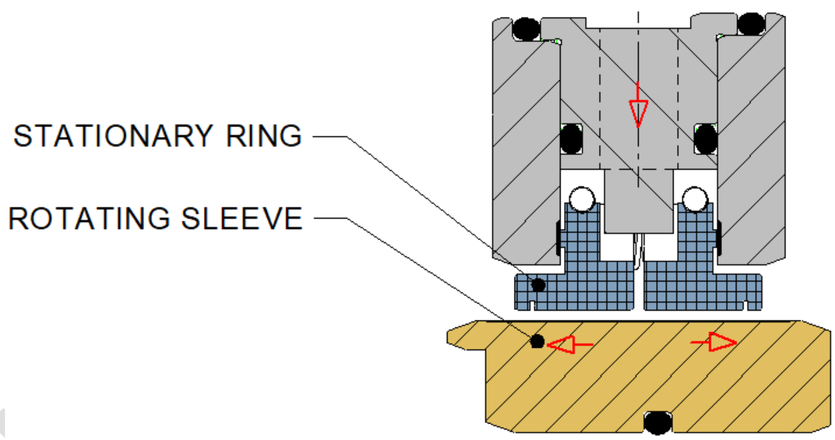

Figure 8 – Non-contacting Lift-off Bushing Seal Schematic

6.7.6 Coaxial Separation Seal

The coaxial separation seal functions like a double dry gas seal injecting separation gas through the stationary seal face between two sets of etched grooves. An example of a Coaxial separation seal is shown in Figure 9.

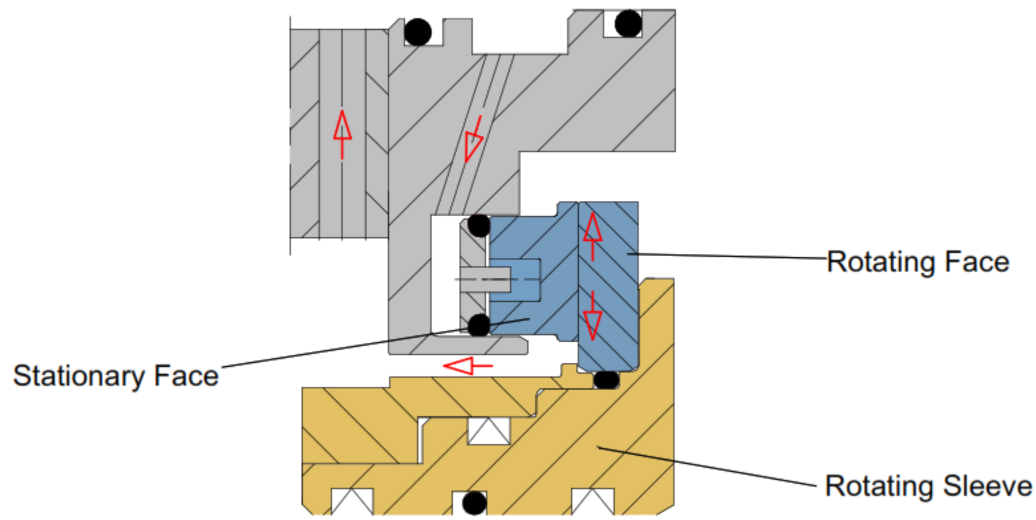

Figure 9 – Coaxial Separation Seal Schematic

6.8 Process Side Seals

6.8.1 General

The process side seal is located between the dry gas seal and the compressor internals. When seal gas or buffer gas (for double seals) is supplied, it prevents flow of unconditioned process gas to the dry gas seal.

6.8.2 Labyrinth Seal

A process labyrinth consists of a section of teeth, which can be stationary or rotating. Stationary labyrinth teeth are typically made from aluminum or engineered thermoplastics and are designed with a clearance between the rotating surface and labyrinth teeth. Rotating labyrinth teeth are typically made from alloy steel and are designed with a reduced clearance between the labyrinth teeth and a replaceable stationary compliant material. Design clearance between stationary and rotating components typically exceeds bearing clearance and calculated shaft deflections to avoid contact during normal operation. An example of a labyrinth process side seal is shown in Figure 10 ~~8~~.

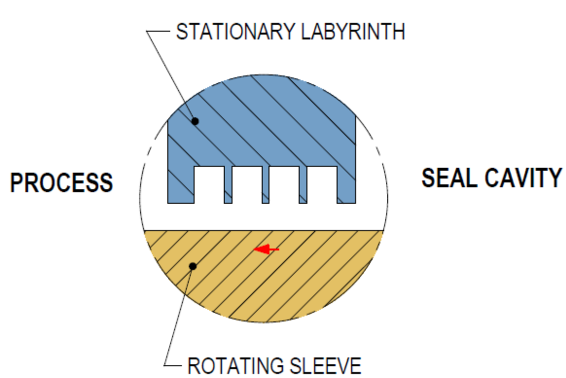

Figure 10~~8~~—Labyrinth Seal Schematic

6.8.3 Abradable Seal

The abradable process side seal consists of a rotating labyrinth running against a compliant stationary material. Rotating labyrinth teeth are typically made from alloy steel. The stationary compliant material may be a polytetrafluoroethylene (PTFE) or other material compatible with the process.

Design clearance between stationary and rotating components may be less than a traditional labyrinth but typically exceed bearing clearance and calculated shaft deflections to avoid contact during normal operation. The compliant material is designed to allow minor contact during abnormal operation without damage to the rotating component and minimize clearance changes that could impact the gas velocity. An example of an abradable process side seal is shown in Figure 11~~9~~.

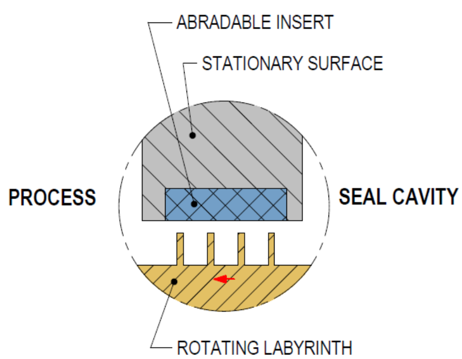

Figure 11 ~~9~~—Abradable Process Side Seal Schematic

6.8.4 Non-contacting Bushing Seal

The non-contacting bushing seal consists of one or two carbon rings. The rings float radially within their housing, allowing reduced clearance and contain an anti-rotation device. The rings and rotating surface may have different thermal expansion properties and therefore the clearance can vary between cold/static and hot/dynamic conditions. The required gas velocity across the stationary rings is sized on the cold/static conditions. This will result in lower sealing gas flow during normal operating conditions compared with labyrinth designs with larger clearances. An example of a non-contacting bushing process side seal is shown in Figure 12 ~~10~~.

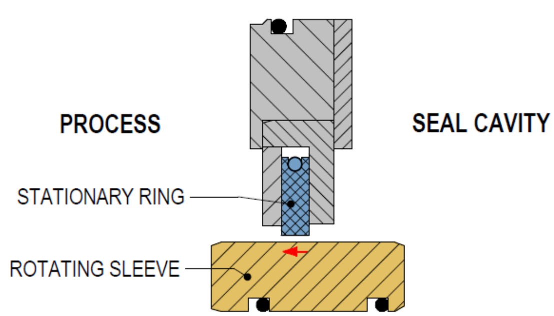

Figure 12~~10~~—Non-contacting Bushing Seal Schematic

6.9 Seal Requirements

6.9.1 General

6.9.1.1 [●] Purchaser will specify the dry gas seal type. If the dry gas seal is not specified, the default shall be a tandem seal with intermediate labyrinth.

NOTE Guidance on dry gas seal selection is in Annex D.

6.9.1.2 [●] Purchaser will specify the separation seal type. ~~S~~If the separation seal is not specified, the default ~~separation seal~~ shall be a non-contacting bushing seal.

6.9.1.3 [●] If specified, separation seal shall be a labyrinth seal, a contacting bushing seal, lift-off non-contacting or coaxial separation seal.

NOTE Attributes of separation seal types are provided in Annex E

6.9.1.4 [●] Purchaser will specify the process side seal type. ~~S~~If the process side seal is not specified, the default ~~Process side seal~~ shall be a labyrinth seal.

6.9.1.5 [●] If specified, process side seal shall be a non-contacting bushing seal or abradable seal.

6.9.1.6 Purchaser shall specify either bidirectional or unidirectional dry gas seals.

NOTE Bidirectional seals are typically used when the compressor has the potential for reverse rotation.

6.9.1.7 The seal sleeve shall be retained by a split ring.

6.9.1.8 The face of split ring groove shall be perpendicular within 0.01mm (0.0004 in).

6.9.1.9 The faces of the split ring shall be parallel within 0.005 mm (0.0002 in).

6.9.1.10 ~~Retaining components of the gas seal sleeve shall have an assembled perpendicularity in conformance with the requirements listed in Table 1.~~ The seal sleeve and rotating face axial runouts shall conform to the limits listed in Table 1 at the locations shown in Figure 13 and Figure 14.

6.9.1.10.1 The rotating face runouts may be measured with removed secondary sealing element behind rotating face and rotating face centering elements.

6.9.1.10.2 If specified, the vendor specific runout limits shall be supplied.

NOTE The sleeve and rotating face runout limits are determined to reduce the amount of wobble or “swash” of the stationary face leading to premature wear of the dynamic sealing element.

~~Table 1— Perpendicularity Limits~~

~~Perpendicularity Limit (Peak to Peak)~~	~~Primary Seal Face Outer Diameter~~
~~0.005 mm (0.0002 in.)~~	~~125 mm (4.9 in.) or less~~
~~0.0075 mm (0.0003 in.)~~	~~>125 mm (4.9 in.) to <175 mm (6.9 in.)~~
~~0.01 mm (0.0004 in.)~~	~~175 mm (6.9 in.) and up~~

~~NOTE This is commonly referred to as swash or wobble.~~

Table 1 – Swash Runout Limits

End of Sleeve Runout Limit X	Rotating Face Runout Limit Y
0.01 mm (0.0004 in)	0.03 mm (0.0012 in)
NOTE Rotating face runout limits measured within 2 mm (0.079 in.) at ID of gas grooves (alternative hydraulic diameter).	

6.9.1.11 ~~Stack up tolerance diagram shall be supplied to validate the design meets the perpendicularity limits.~~ The vendor shall supply the final manufactured seal sleeve X and rotating face Y runouts per the locations in Figures 13 and 14.

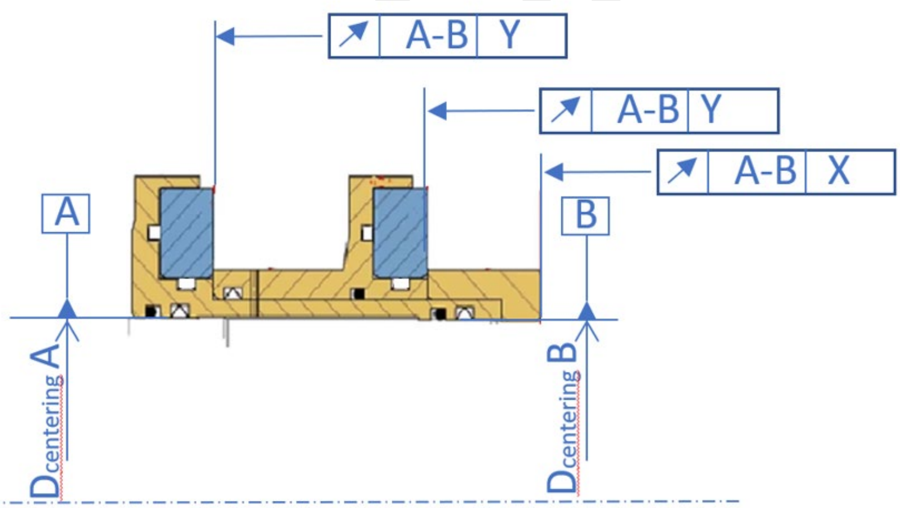

Figure 13 – Tandem Seal

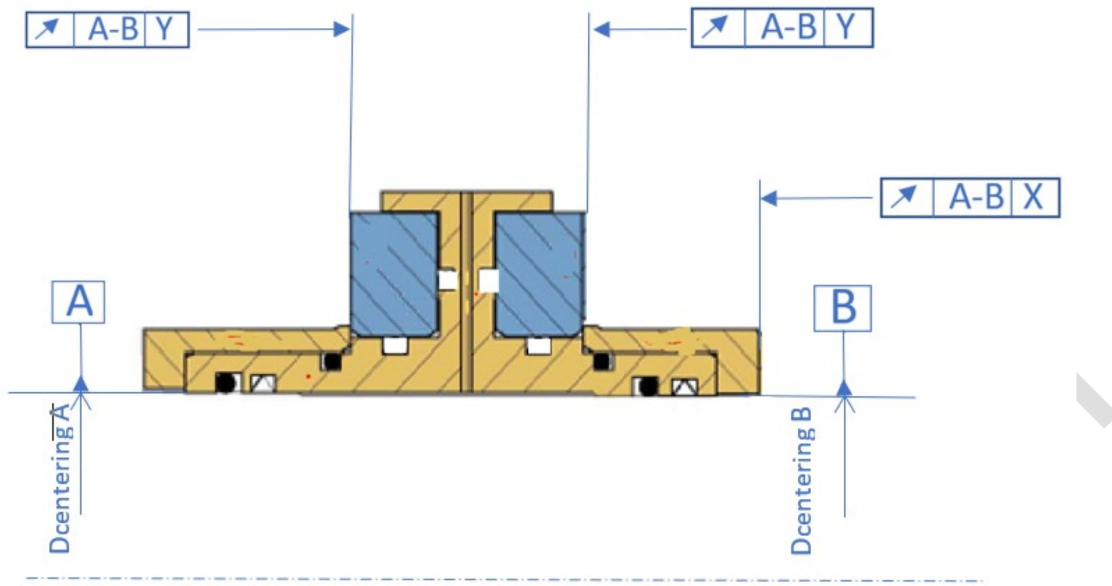

Figure 14 – Double Seal

6.9.1.12 Seal design shall accommodate axial shaft movement during installation and operation.

NOTE See Part 4 for details on seal installation.

6.9.1.13 The maximum continuous speed (MCS) of the seal shall be equal to or greater than the maximum continuous ~~or allowable~~ speed of the compressor.

6.9.1.14 Equipment shall be designed to operate simultaneously at the maximum allowable working pressure (MAWP) and trip speed without damage.

6.9.1.15 The purchaser will specify the maximum sealing pressure.

6.9.1.16 The dynamic and static pressure rating of the dry gas seal shall be equal to or greater than the maximum sealing pressure or the compressor casing maximum allowable working pressure (MAWP). If the static and dynamic seal rating is less than the MAWP of the compressor casing, the purchaser and vendor shall agree on the seal rating and mitigation plan.

NOTE Rating the dry gas seal for the compressor MAWP can result in seal material and/or design changes or, in extreme cases, be outside of a vendor current design limits.

6.9.1.17 Vendor shall specify minimum and normal secondary seal differential pressures. The secondary seal shall be capable of continuous operation at the minimum differential pressure.

6.9.1.18 Vendor shall specify the maximum and minimum temperature rating for the dry gas, separation, and process side seals.

6.9.1.19 Maximum dry gas seal temperature rating shall be equal to or exceed the maximum temperature expected at the dry gas seal.

NOTE The maximum temperature expected at the dry gas seal considers: compressor operating temperatures, gas conditioning system heating, heat generation in the seal, utility conditions, alternative gas sources, and special conditions such as compressor steam out.

6.9.1.20 Minimum dry gas seal temperature rating shall be less than or equal to the minimum ambient temperature, minimum process temperature, or minimum temperature expected at the seal, whichever is lower.

NOTE 1 Minimum process temperature includes auto-refrigeration during depressurization.

NOTE 2 Cold services, typically below −29 °C (−20 °F), can require alternate materials.

6.9.1.21 Non-ductile ~~r~~rotating seal faces shall be shrouded on the OD.

6.9.1.22 A separation seal shall be used between the dry gas seal and the bearing and meet the following requirements.

Prevent oil migration into the dry gas seal cavity from the bearing housing.

Prevent dry gas seal leakage from entering bearing housing.

Minimize dry gas seal leakage from entering bearing housing in the event of dry gas seal failure.

Have a maintenance interval equal to or in excess of that of the dry gas seal cartridge.

6.9.1.23 Labyrinth seals shall have a minimum of three teeth in the direction of flow.

6.9.1.24 Normal flow rates and leakage values shall be provided for primary seals, secondary seals, intermediate labyrinth, and separation seals at standstill conditions and the normal speed.

6.9.1.25 The vendor shall specify all static and dynamic sealing elements supplied with the dry gas seal.

6.10 Seal Cartridges

6.10.1 All seals shall be cartridge seal design.

6.10.2 If the separation seal is integral to the gas seal cartridge, it shall be designed such that it can be removed without disassembling the entire cartridge.

6.10.3 Unidirectional seals shall incorporate design features to prevent incorrect installation.

NOTE This is coordinated with the compressor supplier.

6.10.4 The seal cartridge shall be provided with anti-rotation and drive devices.

6.10.5 Dry gas seal cartridge anti-rotation and drive devices shall be visible during installation or installed after the dry gas seal cartridge is installed. Blind pins or keys shall not be used.

6.10.6 The seal cartridge shall be designed with centering devices to allow for proper running position of the rotating components and allow for installation and removal without damaging the compressor shaft or seal components.

6.10.6.1 Centering of seal rotating components and shaft may be achieved by use of O-rings, centering strips, PTFE seal rings, or other equivalent.

6.10.6.2 The vendor, as part of the proposal, shall provide centering device details.

6.10.6.3 Centering devices should be designed not to yield under any operating conditions including dynamic and static heat cycling.

6.10.7 Shaft sleeves for tandem and double seals shall have two static sealing elements sealing to the compressor shaft.

6.10.7.1 The area between the static sealing elements on a tandem seal shall be vented to the primary vent cavity to prevent pressure buildup if the primary side element fails.

6.10.7.2 The area between the static sealing elements on a double seal shall be vented to the seal gas cavity to prevent pressure buildup if the primary side element fails.

6.10.8 Seal cartridge shall have an installation plate to lock rotating and stationary components during installation and removal. Installation plates should be two-piece design to allow for angular misalignment during assembly and removal.

6.10.9 Single piece plates shall be designed to allow installation of the plate for seal removal without rotating the compressor shaft.

6.10.10 Installation plates shall have additional threaded holes to retain the assembly bolting after the plates are removed from the seal.

NOTE Assembly bolting are typically small socket head cap screws and can get lost during handling.

6.11 Balance and Overspeed

6.11.1 Seal rotating assemblies shall be balanced to ISO ~~1940-1~~ 21940-11, Grade 2.5 or better. Modifications or replacement of any rotating component require a rebalance of the entire assembly.

6.11.2 [●] If specified, the seal rotating assembly shall be disassembled and reassembled to assure the assembly balance can be repeated.

6.11.2.1 The seal shall be disassembled to the same extent required for component replacement and remounted on the balance fixture or fixtures.

6.11.2.2 The unbalance of the reassembled seal shall not exceed ISO ~~1940-1~~ 21940-11, Grade ~~10~~ 16 or better.

6.11.3 Balance mandrel diameters shall be the same as the compressor shaft diameter including tolerances and exhibit no measurable eccentricity using an indicator graduated in 2.5 μm (0.0001 in.) increments.

6.11.4 Rotating seal faces shall be designed for a minimum of 122 % of the MCS.

NOTE 122 % is a value used by seal vendors and represents approximately 50 % increase over the MCS stress level. This also provides a margin over driver trip speed (including steam turbine overshoot).

6.12 Labyrinth Seal Clearances

6.12.1 Minimum labyrinth seal clearances shall be equal to or greater than bearing clearances to prevent contact during operation.

6.12.2 Vendor shall provide labyrinth clearance, mating surface details and material type, location, and method of retention.

NOTE Required labyrinth clearance can be affected by eccentricity tolerances, thermal growth, vibration, surge conditions, and shaft bending that might occur when passing through critical speeds.

6.12.3 Gas flow shall be provided to maintain the minimum gas velocity listed in Part 1, Table 1.

6.13 Minimum Speed/Slow Roll/Turning Gear/Ratcheting

6.13.1 [●] Purchaser will specify if the compressor will be operating on turning gear or ratcheted.

6.13.2 [●] Purchaser will specify conditions for all operating points during slow roll, turning gear, and ratcheting, including speed, case pressures, gas compositions, gas temperatures, dew points, and vent pressures.

6.13.3 Vendor shall provide the following dry gas seal limits based on the defined conditions:

a) lift-off speed for slow roll operation,

b) acceptable speed range and duration for turning gear,

c) maximum operating speed (for possible overspeed conditions).

~~NOTE Typical values are below 50 RPM for turning gear and ratcheting and 500 RPM for slow roll.~~

6.13.4 The dry gas seal shall be suitable for coast down.

6.13.5 Purchaser will specify coast down time, rate of decay of speed, frequency, and gas conditions.

6.13.6 Vendor shall define any restrictions or requirements needed to operate at each of the conditions defined on the datasheet.

6.14 Reverse Pressurization

6.14.1 Dry gas seal shall be designed for reverse differential pressure up to 3 bar (50 psid) at standstill.

NOTE 1 During the reverse pressure condition, unfiltered gas can flow in reverse across the seal faces and through the adjacent secondary sealing elements, which can compromise seal performance.

NOTE 2 If reverse pressurization occurs while rotating, the seal can be damaged.

6.14.2 ~~Dry gas seal system design, including primary vent back pressure controls defined in Part 3, should minimize the potential of reverse pressurization.~~

6.15 Marking and Rotation Arrows

6.15.1 Dry gas seal cartridges and installation plates shall be etched with direction of rotation arrow(s), vendor serial number(s), part number(s), and top dead center (TDC).

6.15.2 All rotating seal components, housings~~,~~ and retainers shall be permanently match-marked.

6.16 Materials

6.16.1 Vendor shall specify materials to be used in the dry gas seal. All materials shall be suitable for all process conditions as specified in Part 1, Sections 6.2.1 and 6.2.2.

6.16.2 Materials of construction, except for non-ductile dry gas seal faces, shall conform to the requirements of Part 3, Section 8.

NOTE For additional information for dry gas seal materials, see Annex H.

7 Accessories—Special Tools

7.1 The vendor shall provide special tools required for removal and installation of the dry gas seal cartridge.

7.2 Special tool drawings shall be provided defining space requirements in all directions to avoid interference during seal handling.

7.3 Lifting provisions, fixtures, or devices shall be supplied for dry gas seals exceeding 10 kg (25 lb).

7.4 Lifting fixtures shall allow the seal to be oriented for proper installation without interfering with surrounding equipment.

7.5 Jackscrews, guide rods, and/or other appropriate devices shall be provided to facilitate disassembly and reassembly.

7.6 Seal installation sleeves shall not interfere with rotor lifting or positioning devices.

8 Inspection, Testing, and Preparation for Shipment

8.1 General

General requirements for inspection, testing, and preparation for shipment in Part 1, Section 9.1 shall apply.

8.2 Inspection

8.2.1 Residual magnetism shall not exceed ± 2 gauss for all seal assemblies and components as measured with a Hall-Effect type probe.

NOTE The free air gauss level is measured while suspending the component from a non-conductive strap with no influence from stray magnetic fields.

8.2.2 [●] If specified, PMI shall be completed on all pressure-retaining alloy components.

8.3 Testing

8.3.1 [●] If Specified, Vendor shall perform hysteresis test on each stationary face subassembly prior to factory acceptance testing.

8.3.2 Rotating seal faces shall be overspeed spin tested at a minimum of 122 % of the MCS for a minimum of 1 minute.

8.3.3 Test results shall be in accordance with the vendor's acceptance criteria.

NOTE See Annex G for information on hysteresis testing.

8.3.4 Dry gas seals shall be tested in accordance with Annex B.

8.3.5 [●] If specified, seals shall be tested in accordance with Annex B Refurbished Test Section

8.3.6 Dry gas seals shall be tested as a complete assembled cartridge. Removal of components is not allowed.

8.3.7 Post-test visual inspection shall be performed in accordance with Annex K.

8.4 Preparation for Shipment

8.4.1 Each dry gas seal assembly shall be placed in a padded box.

8.4.2 Package markings shall include the items listed in Part 1, Section 9.9.4 and the following items:

a) dry gas seal serial number,

b) dry gas seal drawing number and/or part number,

c) special storage requirements.

8.4.3 [●] If specified, spare seals shall be shipped in a container capable of nitrogen pressurization and suitable for long-term storage.

8.4.4 [●] If specified, spare dry gas seals shall be shipped in weather resistant flight boxes.

8.4.5 Each component shall be placed in plastic bags with desiccant.

8.4.6 Desiccant packets shall be strong enough to prevent desiccant from leaking out of the package and placed so they cannot be damaged by the seal.

8.4.7 Spare static sealing elements and centering devices that interface with the compressor shall be provided.

8.4.8 Spare static sealing elements shall be individually packaged for long-term storage in sealed opaque packages to prevent light exposure and labeled with the following: vendor part number, compound, cure date and batch details, and any shelf life or special storage requirements.

8.4.9 Static sealing element lubricant compatible with the process gas shall be provided with seal in box.

8.4.10 One copy of the manufacturer's installation instructions and seal drawing shall be packed and shipped with the seal in a weatherproof envelope.

8.4.11 [●] If specified, the vendor shall submit certified copies of the test data to the purchaser before shipment.

8.4.12 [●] If specified, a copy of the test report shall be packed and shipped with the seal in a weatherproof envelope.

9 Vendor's Data

9.1 General

Vendor data shall be in accordance with Section 10 of Part 1.

9.1.1 [●] If specified, the information in Annex L shall be provided.

9.1.2 ~~The vendor shall provide all documents listed in the VDDR form (Annex I).~~

9.1.3 ~~Vendor shall complete and supply the agreed VDDR form (see Annex I for an example).~~

~~9.2 Proposals~~

~~Proposal data shall be in accordance with Section 10.2 of Part 1.~~

~~9.3 Contract Data~~

9.3.1 ~~Contract data shall be in accordance with Section 10.3 of Part 1.~~

9.3.2 ~~Vendor shall provide the weight of the rotating assembly, polar and transverse moments of inertia, and center of gravity.~~

9.3.3 ~~Vendor shall provide normal and maximum flows, temperatures, and pressures per the conditions defined in Part 1, Sections 6.2.1 and 6.2.2.~~

9.3.4 ~~Vendor shall provide a certified test report prior to shipment of the dry gas seals.~~

~~9.4 Drawings~~

9.4.1 ~~Seal drawing shall define:~~

~~h) seal mounting details on the compressor shaft and seal cavity;~~

~~i) shaft and housing surface finish requirements;~~

~~j) installation plate details to indicate proper assembly;~~

~~k) bill of materials including materials of construction;~~

~~l) dry gas seal axial and radial travel limits;~~

~~m) the weight of the rotating assembly, polar and transverse moments of inertia, and center of gravity;~~

~~n) gas seal installation/assembly reference dimension.~~

Annex A
(informative)

Datasheets

A representation of the datasheets is enclosed in this annex; however, MS Excel format datasheets have been developed and are available, for purchase from API publications distributors, with this standard. The MS Excel electronic datasheets have additional functionality over printed hard copies.

The following changes were made to the datasheets, this text box is for the ballot only and will be deleted prior to publication

- New datasheets have been developed

Annex A-1 - US Customary

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS **DATASHEET (API 692-2nd, Part 2)** **U.S. CUSTOMARY Units**	Job No.: ____ Page: 1 of XX Date: ____ Customer doc number: ____	Item No.: ____ By: ____ Revision: ____ Vendor doc number: ____	Rev

No.		Rev
1	**APPLICABLE TO:** ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT	
2	For ____ Compressor Manufacturer ____	
3	Site ____ Unit Model / Serial No. ____	
4	Service ____ Dry Gas Seal Manufacturer ____	
5	Unit ____ Seal Gas System Manufacturer ____	
6	Inquiry No. ____ Requisition No. ____	
7		
8	**Explanations:** 1. The party to complete the information is indicated as follows:	
9	○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.	
10	2. An asterisk * specifies a requirement, value, or criterion.	
11	3. Designations in parenthesis ( ) are explained in the cited standard; numbers without a prefix are subclause	
12	numbers; those prefixed "T" are text figure numbers; those prefixed "B" are Annex "B" Figure numbers.	
13	○ Per API 692-2nd Edition ○ Governing Specification (If Different) ____	
14	**Referenced documents/standards**	
15	○ * API 614 (Site and Utility Datasheet) ○ Additional documents ____	
16	○ * API 617 (Datasheet for Unit Operating Conditions) ○ Additional documents ____	
17	○ * API 692 Annex 3A (Datasheet for DGS Support System) ○ Additional documents ____	
18		
19	**Application and Site information:** (See reference documents/standards for additional information)	
20	Service - Number of compressor units: ____ Other: ____	
21	Quantity of Dry Gas Seals per unit: ____ Spares (Y/N): ____	
22	○ Two seals per unit (beam compressor) ○ Multiple seals per unit (geared compressor)	
23	▽ Equilized Seals (Y/N): ____ Is each dry gas seal sealing against the same or different pressures. (e.g. balance line used)	
24	○ One seal per unit (overhung compressor)	
25	○ New Installation ○ Retrofit	
26	**Location:** ○ Onshore ○ Offshore ○ Indoor ○ Outdoor	
27		
28	**Scope of supply:**	
29	**Type of dry gas seal:** | **Type of separation seal:** | **Type of process side seal:**	
30	○ Tandem Seal with Intermediate Labyrinth | ▽ Non-contacting Bushing Seal | ▽ Standard Labyrinth	
31	○ Tandem Seal | ▽ Labyrinth Seal | ▽ Abradable Labyrinth	
32	○ Double Seal | ▽ Contacting Bushing Seal | ▽ Non-Contacting Bushing	
33	○ Single Seal | ▽ Non-Contacting Lift-off Bushing Seal | ▽ Other: ____	
34	**Dry gas seal direction of rotation:** | ▽ Coaxial Separation Seal	
35	○ Uni-Directional ○ Bi-Directional | ▽ Other: ____	
36		
37	**Special tools and fixtures:** **Dry gas seal packaging:**	
38	▽ Dry gas seal installation/removal tooling and fixtures ○ Wood storage container ○ Flight Box	
39	▽ Other: ____ ○ Metal storage container ○ N2 Purge	
40	**Special tool packaging:** ○ Other: ____	
41	▽ Wood storage container **Shipment (Dry gas seal):**	
42	▽ Metal storage container ○ Domestic ○ Export ○ Export boxing req'd	
43	▽ Other: ____ **Shipment (Spare dry gas seal):**	
44	**Shipment (Tooling):** ○ Domestic ○ Export ○ Export boxing req'd	
45	▽ Domestic ▽ Export ▽ Export boxing req'd	
46	**Manuals:** (Part 1 – 10.3.5)	
47	● Draft manual for review ● Technical data manual	
48	**Remarks:** ____	
49		
50		
51		

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS **DATASHEET (API 692-2nd, Part 2)** **U.S. CUSTOMARY Units**	Job No.: ______ Page: 2 of XX Date: ______	Item No.: ______ By: ______ Revision: ______

Rev

Dry gas seal design and rating requirements

☐ Maximum allowable pressure (static)	(psig)	______	☐ Minimum allowable speed	(rpm)	______
☐ Maximum allowable pressure (dynamic)	(psig)	______	☐ Minimum slow roll speed	(rpm)	______
☐ Minimum allowable temperature	(°F)	______	☐ Maximum turning gear speed	(rpm)	______
☐ Maximum allowable temperature	(°F)	______	☐ Turning gear maximum duration	(hr)	______
☐ Maximum depressurization rate	(psi/min)	______	☐ Axial movement (+/-)	(in)	______
☐ Maximum/Minimum labyrinth clearance	(in)	______	☐ Radial movement (+/-)	(in)	______

Remarks:

Materials of Construction

○ Materials to NACE ○ MR0103 ○ MR0175		☐ Rotating seal face	______
▽ Compressor seal housing	______	☐ Stationary seal face	______
▽ Compressor shaft	______	☐ Rotating sleeves	______
▽ Separation seal	______	☐ Stationary housings	______
▽ Process side seal	______	☐ Centering elements	______
☐ Intermediate seal labyrinth	______	☐ Fasteners	______
☐ Static sealing elements	______	☐ Springs	______
☐ Dynamic sealing elements	______	☐ Dowels	______
☐ Stationary thrust element	______	☐ Shims	______
☐ Rotating thrust element	______	☐ Pins	______
Coatings:		☐	______
☐ Rotating components	______		
☐ Stationary components	______		

Remarks:

Unit and dry gas seal design parameters

○ Minimum continuous speed	(rpm)	______	○ Journal bearing diameter	(in)	______
○ Maximum continuous speed	(rpm)	______	○ Journal bearing maximum diametral clearance	(in)	______
○ Trip speed	(rpm)	______	○ Bearing chamber pressure	(psig)	______
○ Turning gear speed	(rpm)	______	○ Mimimum allowable temperature	(°F)	______
○ Turning gear duration	(hr)	______	○ Maximum allowable temperature	(°F)	______
○ Settleout pressure	(psig)	______	○ Maximum allowable working pressure	(psig)	______
○ Distance between shaft ends	(in)	______			

○ Primary vent back pressure:	Normal (psig) ______	Minimum (psig) ______	Maximum (psig) ______
○ Secondary vent/Vent pressure:	Normal (psig) ______	Minimum (psig) ______	Maximum (psig) ______
○ Site flare conditions:	Normal (psig) ______	Minimum (psig) ______	Maximum (psig) ______

○ **Seal gas source:**	○ **Secondary seal gas source:**	○ **Separation seal gas source:**	○ **Buffer gas source:**
○ Unit Discharge	○ Nitrogen	○ Nitrogen	○ Unit Discharge
○ External supply	○ Other	○ Other	○ External supply

Note: See API 614 (Site and Utility Datasheet) and/or API 617 (Datasheet for Unit Operating Conditions) for gas source conditions and gas composition.

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
U.S. CUSTOMARY Units

Job No.: ______ Item No.: ______
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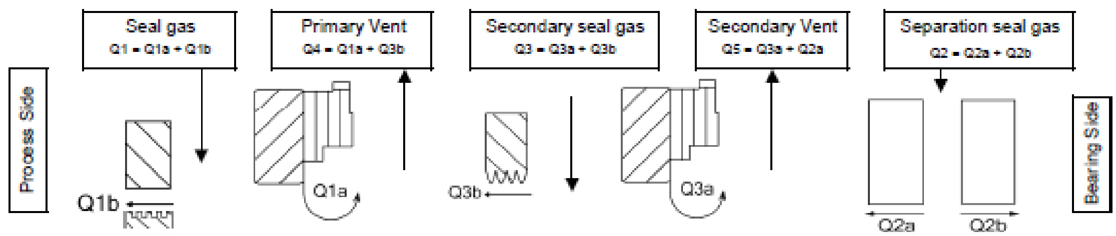
Date: ______ Revision: ______

									Rev
1	Remarks:								
2									
3									
4									
5	**Typical flow schematic diagram for a tandem with intermediate labyrinth dry gas seal**								



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

			Unit Operating Cases - Values in this chart are for only dry gas seal						Rev
17			Normal	Start-up				Settleout	
18	Unit speed	(rpm)							
19	Seal gas pressure	(psig)							
20	Seal gas temperature	(°F)							
21	Seal gas MW	MW							
22	Process side labyrinth radial clearance	(in)							
23	Process side seal leakage (Q1b)	scfm							
24	Expected primary seal leakage (Q1a)	scfm							
25	Guaranteed primary seal leakage (Q1a)	scfm							
26	Primary vent back pressure	(psig)							
27	Secondary seal gas pressure	(psig)							
28	Secondary seal gas temperature	(°F)							
29	Secondary seal gas MW	MW							
30	Intermediate labyrinth radial clearance	(in)							
31	Intermediate labyrinth leakage (Q3b)	scfm							
32	Expected secondary seal leakage (Q3a)	scfm							
33	Guaranteed secondary seal leakage (Q3a)	scfm							
34	Secondary vent pressure	(psig)							
35	Separation seal gas pressure	(psig)							
36	Separation seal gas temperature	(°F)							
37	Separation seal gas MW	MW							
38	Separation seal radial clearance	(in)							
39	Expected separation seal leakage (Q2a)	scfm							
40	Guaranteed separation seal leakage (Q2a)	scfm							
41	Expected separation seal leakage (Q2b)	scfm							
42	Guaranteed separation seal leakage (Q2b)	scfm							
43									
44	Seal gas flow (Q1)	scfm							
45	Primary vent leakage (Q4)	scfm							
46	Secondary seal gas flow (Q3)	scfm							
47	Secondary vent leakage (Q5)	scfm							
48	Separation seal gas flow (Q2)	scfm							
49									

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
U.S. CUSTOMARY Units

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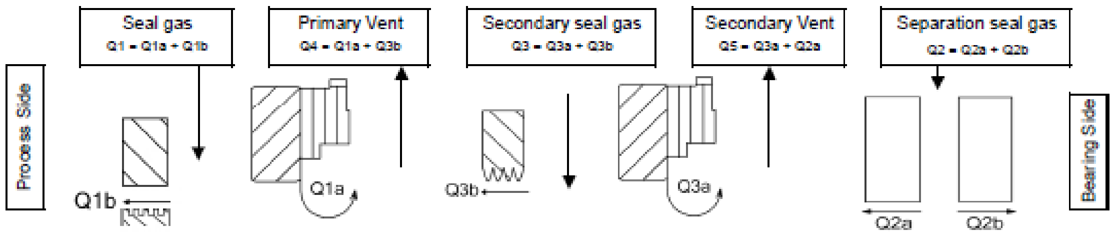
Date: ______ Revision: ______

Rev

1 Remarks:
2
3
4

5 **Typical flow schematic diagram for a tandem with intermediate labyrinth dry gas seal**



15 Note: See gas velocity requirements listed in
16 Part 1 for labyrinths and clearance seals

Unit Operating Cases - Values in this chart are for only dry gas seal

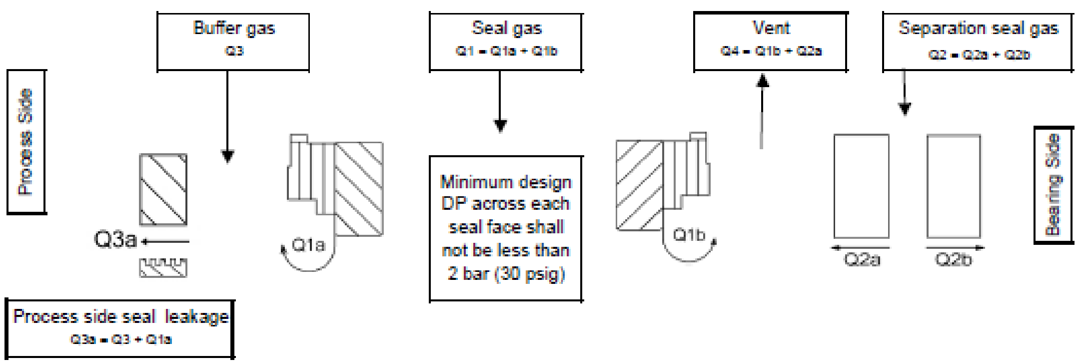
17								
18	Unit speed	(rpm)						
19	Seal gas pressure	(psig)						
20	Seal gas temperature	(°F)						
21	Seal gas MW	MW						
22	Process side labyrinth radial clearance	(in)						
23	Process side seal leakage (Q1b)	scfm						
24	Expected primary seal leakage (Q1a)	scfm						
25	Guaranteed primary seal leakage (Q1a)	scfm						
26	Primary vent back pressure	(psig)						
27	Secondary seal gas pressure	(psig)						
28	Secondary seal gas temperature	(°F)						
29	Secondary seal gas MW	MW						
30	Intermediate labyrinth radial clearance	(in)						
31	Intermediate labyrinth leakage (Q3b)	scfm						
32	Expected secondary seal leakage (Q3a)	scfm						
33	Guaranteed secondary seal leakage (Q3a)	scfm						
34	Secondary vent pressure	(psig)						
35	Separation seal gas pressure	(psig)						
36	Separation seal gas temperature	(°F)						
37	Separation seal gas MW	MW						
38	Separation seal radial clearance	(in)						
39	Expected separation seal leakage (Q2a)	scfm						
40	Guaranteed separation seal leakage (Q2a)	scfm						
41	Expected separation seal leakage (Q2b)	scfm						
42	Guaranteed separation seal leakage (Q2b)	scfm						
43								
44	Seal gas flow (Q1)	scfm						
45	Primary vent leakage (Q4)	scfm						
46	Secondary seal gas flow (Q3)	scfm						
47	Secondary vent leakage (Q5)	scfm						
48	Separation seal gas flow (Q2)	scfm						
49								

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
U.S. CUSTOMARY Units

Job No.: ______ Item No.: ______
Page: 4 of XX By: ______
Date: ______ Revision: ______

Rev

1 Remarks:
2
3
4
5 **Typical flow schematic diagram for a double dry gas seal**



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

			Unit Operating Cases - Values in this chart are for only dry gas seal					
22			Normal	Start-up				Settleout
23	Unit speed	(rpm)						
24	Seal gas pressure	(psig)						
25	Seal gas differential pressure	(psi)						
26	Seal gas temperature	(°F)						
27	Seal gas MW	MW						
28	Expected primary seal leakage (Q1a)	scfm						
29	Guaranteed primary seal leakage (Q1a)	scfm						
30	Expected secondary seal leakage (Q1b)	scfm						
31	Guaranteed secondary seal leakage (Q1b)	scfm						
32	Buffer gas pressure	(psig)						
32	Buffer gas temperature	(°F)						
33	Buffer gas MW	MW						
32	Process side seal radial clearance	(in)						
33	Process side seal leakage (Q3a)	scfm						
34	Vent pressure	(psig)						
35	Separation seal gas pressure	(psig)						
36	Separation seal gas temperature	(°F)						
37	Separation seal gas MW	MW						
38	Separation seal radial clearance	(in)						
39	Expected separation seal leakage (Q2a)	scfm						
40	Guaranteed separation seal leakage (Q2a)	scfm						
41	Expected separation seal leakage (Q2b)	scfm						
42	Guaranteed separation seal leakage (Q2b)	scfm						
43								
44	Seal gas flow (Q1)	scfm						
45	Buffer gas flow (Q3)	scfm						
46	Vent leakage (Q4)	scfm						
47	Separation seal gas flow (Q2)	scfm						
48								
49								

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
U.S. CUSTOMARY Units

Job No.: ______ Item No.: ______
Page: 4a of XX By: ______
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Rev

1 Remarks:
2
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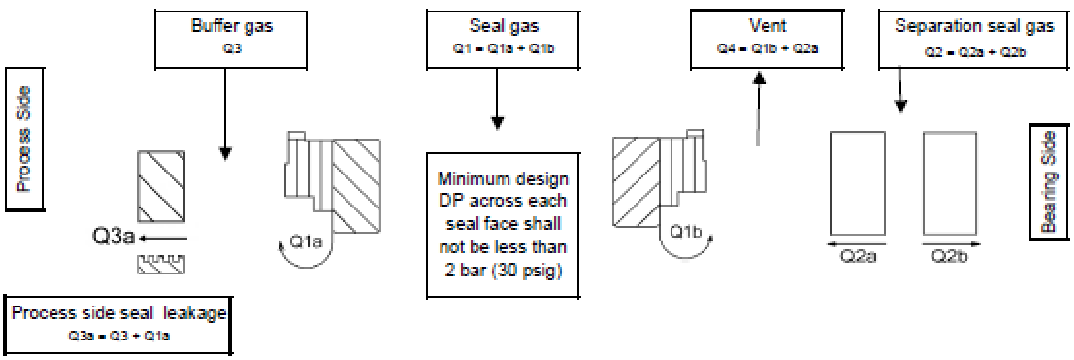
5 **Typical flow schematic diagram for a double dry gas seal**



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

No.		Units	Unit Operating Cases - Values in this chart are for only dry gas seal					
22								
23	Unit speed	(rpm)						
24	Seal gas pressure	(psig)						
25	Seal gas differential pressure	(psi)						
26	Seal gas temperature	(°F)						
27	Seal gas MW	MW						
28	Expected primary seal leakage (Q1a)	scfm						
29	Guaranteed primary seal leakage (Q1a)	scfm						
30	Expected secondary seal leakage (Q1b)	scfm						
31	Guaranteed secondary seal leakage (Q1b)	scfm						
32	Buffer gas pressure	(psig)						
32	Buffer gas temperature	(°F)						
33	Buffer gas MW	MW						
32	Process side seal radial clearance	(in)						
33	Process side seal leakage (Q3a)	scfm						
34	Vent pressure	(psig)						
35	Separation seal gas pressure	(psig)						
36	Separation seal gas temperature	(°F)						
37	Separation seal gas MW	MW						
38	Separation seal radial clearance	(in)						
39	Expected separation seal leakage (Q2a)	scfm						
40	Guaranteed separation seal leakage (Q2a)	scfm						
41	Expected separation seal leakage (Q2b)	scfm						
42	Guaranteed separation seal leakage (Q2b)	scfm						
43								
44	Seal gas flow (Q1)	scfm						
45	Buffer gas flow (Q3)	scfm						
46	Vent leakage (Q4)	scfm						
47	Separation seal gas flow (Q2)	scfm						
48								
49								

DRY GAS SEALS DATASHEET (API 692-2nd, Part 2) U.S. CUSTOMARY Units	Job No.:		Item No.:	
	Page:	5 of XX	By:	
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Remarks:

Unit and dry gas seal operating conditions (Cont.)

Seal gas method of control:

- ○ Pressure Control (Differential) (psi) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Separation seal gas method of control:

- ○ Pressure Control (Differential) (psi) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Secondary seal gas method of control:

- ○ Pressure Control (Differential) (psi) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Buffer gas method of control:

- ○ Pressure Control (Differential) (psi) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Notes: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals.
See filtration level requirements listed in Part 3 for for gas supplies.

Shop Inspections, Tests, and Reports

Inspection Records:

- ○ See inspectors checklist
- ○ Overspeed testing of rotating dry gas seal faces
- ○ Hysteresis testing of the stationary sub-assembly
- ○ Balance record of the rotating seal assembly
- ○ Seal rotating assembly balance (Part 2: 6.11.2)
- ○ Materials of construction for materials exposed to H2S
- ○ Visual inspection of faces after dynamic testing

Material inspections:

- ○ Certification of materials, such as mill test reports
- ○ PMI (Positive Material Identification) testing reports

Static and dynamic testing of dry gas seal assemblies:

- ○ Per API 692, Annex B
- ○ Other specified test
- ○ ________________

- ○ Inspectors checklist compliance

Reports:

- ○ Rotordynamic lateral analysis report

Remarks:

Annex A-2 - SI Units

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS DATASHEET (API 692-2nd, Part 2) SI UNITS (bar)	Job No.: ______ Page: 1 of XX Date: ______	Item No.: ______ By: ______ Revision: ______	
	Customer doc number: ______	Vendor doc number: ______	Rev

No.				
1	APPLICABLE TO:	☐ PROPOSAL	☐ PURCHASE	☐ AS BUILT
2	For ______		Compressor Manufacturer ______	
3	Site ______		Unit Model / Serial No. ______	
4	Service ______		Dry Gas Seal Manufacturer ______	
5	Unit ______		Seal Gas System Manufacturer ______	
6	Inquiry No. ______		Requisition No. ______	
7				
8	Explanations:	1. The party to complete the information is indicated as follows:		
9		○ Purchaser	☐ Vendor	▽ Either, but by vendor if not by purchaser.
10		2. An asterisk * specifies a requirement, value, or criterion.		
11		3. Designations in parenthesis ( ) are explained in the cited standard; numbers without a prefix are subclause		
12		numbers; those prefixed "T" are text figure numbers; those prefixed "B" are Annex "B" Figure numbers.		
13	○ Per API 692-2nd Edition		○ Governing Specification (If Different) ______	
14	Referenced documents/standards			
15	○ * API 614 (Site and Utility Datasheet)		○ Additional documents ______	
16	○ * API 617 (Datasheet for Unit Operating Conditions)		○ Additional documents ______	
17	○ * API 692 Annex 3A (Datasheet for DGS Support System)		○ Additional documents ______	
18				
19	Application and Site information:	(See reference documents/standards for additional information)		
20	Service - Number of compressor units: ______		Other: ______	
21	Quantity of Dry Gas Seals per unit: ______		Spares (Y/N): ______	
22	○ Two seals per unit (beam compressor)	○ Multiple seals per unit (geared compressor)		
23	▽ Equilized Seals (Y/N): ______	Is each dry gas seal sealing against the same or different pressures. (e.g. balance line used)		
24	○ One seal per unit (overhung compressor)			
25	○ New Installation	○ Retrofit		
26	Location: ○ Onshore	○ Offshore	○ Indoor	○ Outdoor
27				
28	Scope of supply:			
29	Type of dry gas seal:	Type of separation seal:	Type of process side seal:	
30	○ Tandem Seal with Intermediate Labyrinth	▽ Non-contacting Bushing Seal	▽ Standard Labyrinth	
31	○ Tandem Seal	▽ Labyrinth Seal	▽ Abradable Labyrinth	
32	○ Double Seal	▽ Contacting Bushing Seal	▽ Non-Contacting Bushing	
33	○ Single Seal	▽ Non-Contacting Lift-off Bushing Seal	▽ Other: ______	
34	Dry gas seal direction of rotation:	▽ Coaxial Separation Seal		
35	○ Uni-Directional ○ Bi-Directional	▽ Other: ______		
36				
37	Special tools and fixtures:		Dry gas seal packaging:	
38	▽ Dry gas seal installation/removal tooling and fixtures		○ Wood storage container	○ Flight Box
39	▽ Other: ______		○ Metal storage container	○ N2 Purge
40	Special tool packaging:		○ Other: ______	
41	▽ Wood storage container		Shipment (Dry gas seal):	
42	▽ Metal storage container		○ Domestic ○ Export	○ Export boxing req'd
43	▽ Other: ______		Shipment (Spare dry gas seal):	
44	Shipment (Tooling):		○ Domestic ○ Export	○ Export boxing req'd
45	▽ Domestic ▽ Export ▽ Export boxing req'd			
46			Manuals: (Part 1 – 10.3.5)	
47			○ Draft manual for review	○ Technical data manual
48	Remarks: ______			
49				
50				
51				

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS **DATASHEET (API 692-2nd, Part 2)** **SI UNITS (bar)**	Job No.: ____ Page: 2 of XX Date: ____	Item No.: ____ By: ____ Revision: ____

Line							Rev
1	**Dry gas seal design and rating requirements**						
2	☐ Maximum allowable pressure (static)	(barG)	____	☐ Minimum allowable speed	(rpm)	____	
3	☐ Maximum allowable pressure (dynamic)	(barG)	____	☐ Minimum slow roll speed	(rpm)	____	
4	☐ Minimum allowable temperature	(°C)	____	☐ Maximum turning gear speed	(rpm)	____	
5	☐ Maximum allowable temperature	(°C)	____	☐ Turning gear maximum duration	(hr)	____	
6	☐ Maximum depressurization rate	(bar/min)	____	☐ Axial movement (+/-)	(mm)	____	
7	☐ Maximum/Minimum labyrinth clearance	(mm)	____	☐ Radial movement (+/-)	(mm)	____	
8							
9	Remarks:						
10							
11							
12							
13	**Materials of Construction**						
14	○ Materials to NACE ○ MR0103 ○ MR0175			☐ Rotating seal face		____	
15	▽ Compressor seal housing		____	☐ Stationary seal face		____	
16	▽ Compressor shaft		____	☐ Rotating sleeves		____	
17	▽ Separation seal		____	☐ Stationary housings		____	
18	▽ Process side seal		____	☐ Centering elements		____	
19	☐ Intermediate seal labyrinth		____	☐ Fasteners		____	
20	☐ Static sealing elements		____	☐ Springs		____	
21	☐ Dynamic sealing elements		____	☐ Dowels		____	
22	☐ Stationary thrust element		____	☐ Shims		____	
23	☐ Rotating thrust element		____	☐ Pins		____	
24	Coatings:			☐		____	
25	☐ Rotating components		____				
26	☐ Stationary components		____				
27	Remarks:						
28							
29							
30	**Unit and dry gas seal design parameters**						
31	○ Minimum continuous speed	(rpm)	____	○ Journal bearing diameter	(mm)	____	
32	○ Maximum continuous speed	(rpm)	____	○ Journal bearing maximum diametral clearance	(mm)	____	
33	○ Trip speed	(rpm)	____	○ Bearing chamber pressure	(barG)	____	
34	○ Turning gear speed	(rpm)	____	○ Mimimum allowable temperature	(°C)	____	
35	○ Turning gear duration	(hr)	____	○ Maximum allowable temperature	(°C)	____	
36	○ Settleout pressure	(barG)	____	○ Maximum allowable working pressure	(barG)	____	
37	○ Distance between shaft ends	(mm)	____				
38							
39	○ Primary vent back pressure:	Normal (barG)	____	Minimum (barG) ____	Maximum (barG)	____	
40	○ Secondary vent/Vent pressure:	Normal (barG)	____	Minimum (barG) ____	Maximum (barG)	____	
41	○ Site flare conditions:	Normal (barG)	____	Minimum (barG) ____	Maximum (barG)	____	
42							
43							
44	○ **Seal gas source:**	○ **Secondary seal gas source:**		○ **Separation seal gas source:**	○ **Buffer gas source:**		
45	○ Unit Discharge	○ Nitrogen		○ Nitrogen	○ Unit Discharge		
46	○ External supply	○ Other		○ Other	○ External supply		
47							
48	**Note:** See API 614 (Site and Utility Datasheet) and/or API 617 (Datasheet for Unit Operating Conditions) for gas source conditions						
49	and gas composition.						
50							

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
SI UNITS (bar)

Job No.:
Page: 3 of XX
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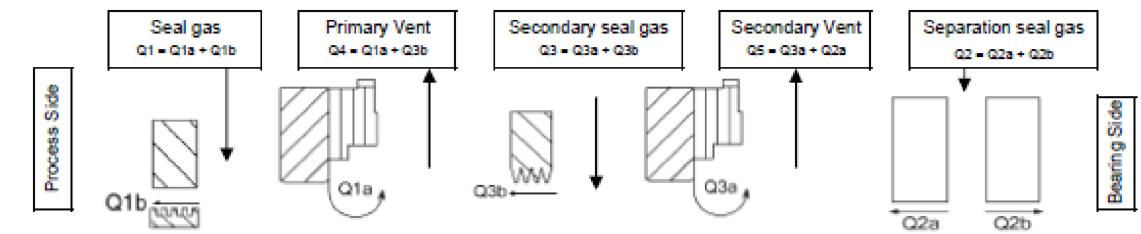
By:
Revision:

									Rev
1	Remarks:								
2									
3									
4									
5	**Typical flow schematic diagram for a tandem with intermediate labyrinth dry gas seal**								



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

			Unit Operating Cases - Values in this chart are for only dry gas seal						Rev
17			Normal	Start-up				Settleout	
18	Unit speed	(rpm)							
19	Seal gas pressure	(barG)							
20	Seal gas temperature	(°C)							
21	Seal gas MW	MW							
22	Process side labyrinth radial clearance	(mm)							
23	Process side seal leakage (Q1b)	Nm³/h							
24	Expected primary seal leakage (Q1a)	Nm³/h							
25	Guaranteed primary seal leakage (Q1a)	Nm³/h							
26	Primary vent back pressure	(barG)							
27	Secondary seal gas pressure	(barG)							
28	Secondary seal gas temperature	(°C)							
29	Secondary seal gas MW	MW							
30	Intermediate labyrinth radial clearance	(mm)							
31	Intermediate labyrinth leakage (Q3b)	Nm³/h							
32	Expected secondary seal leakage (Q3a)	Nm³/h							
33	Guaranteed secondary seal leakage (Q3a)	Nm³/h							
34	Secondary vent pressure	(barG)							
35	Separation seal gas pressure	(barG)							
36	Separation seal gas temperature	(°C)							
37	Separation seal gas MW	MW							
38	Separation seal radial clearance	(mm)							
39	Expected separation seal leakage (Q2a)	Nm³/h							
40	Guaranteed separation seal leakage (Q2a)	Nm³/h							
41	Expected separation seal leakage (Q2b)	Nm³/h							
42	Guaranteed separation seal leakage (Q2b)	Nm³/h							
43									
44	Seal gas flow (Q1)	Nm³/h							
45	Primary vent leakage (Q4)	Nm³/h							
46	Secondary seal gas flow (Q3)	Nm³/h							
47	Secondary vent leakage (Q5)	Nm³/h							
48	Separation seal gas flow (Q2)	Nm³/h							
49									

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
SI UNITS (bar)

Job No.: ______ Item No.: ______
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Date: ______ Revision: ______

		Rev
1	Remarks:	
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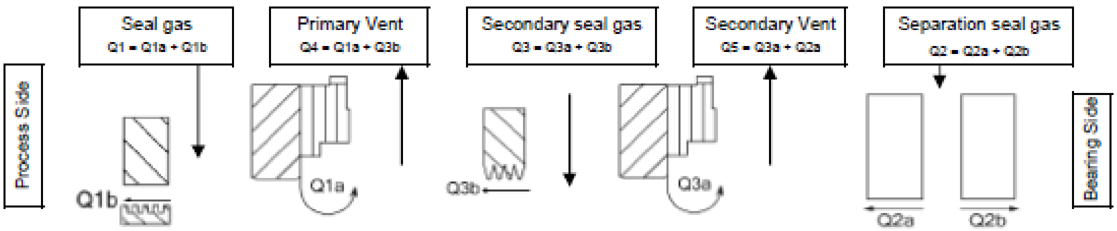
5	**Typical flow schematic diagram for a tandem with intermediate labyrinth dry gas seal**	



									Rev
6									
7									
8									
9									
10									
11									
12									
13									
14									
15	Note: See gas velocity requirements listed in								
16	Part 1 for labyrinths and clearance seals		Unit Operating Cases - Values in this chart are for only dry gas seal						
17									
18	Unit speed	(rpm)							
19	Seal gas pressure	(barG)							
20	Seal gas temperature	(°C)							
21	Seal gas MW	MW							
22	Process side labyrinth radial clearance	(mm)							
23	Process side seal leakage (Q1b)	Nm³/h							
24	Expected primary seal leakage (Q1a)	Nm³/h							
25	Guaranteed primary seal leakage (Q1a)	Nm³/h							
26	Primary vent back pressure	(barG)							
27	Secondary seal gas pressure	(barG)							
28	Secondary seal gas temperature	(°C)							
29	Secondary seal gas MW	MW							
30	Intermediate labyrinth radial clearance	(mm)							
31	Intermediate labyrinth leakage (Q3b)	Nm³/h							
32	Expected secondary seal leakage (Q3a)	Nm³/h							
33	Guaranteed secondary seal leakage (Q3a)	Nm³/h							
34	Secondary vent pressure	(barG)							
35	Separation seal gas pressure	(barG)							
36	Separation seal gas temperature	(°C)							
37	Separation seal gas MW	MW							
38	Separation seal radial clearance	(mm)							
39	Expected separation seal leakage (Q2a)	Nm³/h							
40	Guaranteed separation seal leakage (Q2a)	Nm³/h							
41	Expected separation seal leakage (Q2b)	Nm³/h							
42	Guaranteed separation seal leakage (Q2b)	Nm³/h							
43									
44	Seal gas flow (Q1)	Nm³/h							
45	Primary vent leakage (Q4)	Nm³/h							
46	Secondary seal gas flow (Q3)	Nm³/h							
47	Secondary vent leakage (Q5)	Nm³/h							
48	Separation seal gas flow (Q2)	Nm³/h							
49									

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
SI UNITS (bar)

Job No.: ______ Item No.: ______
Page: 4 of XX By: ______
Date: ______ Revision: ______

Rev

1 Remarks:
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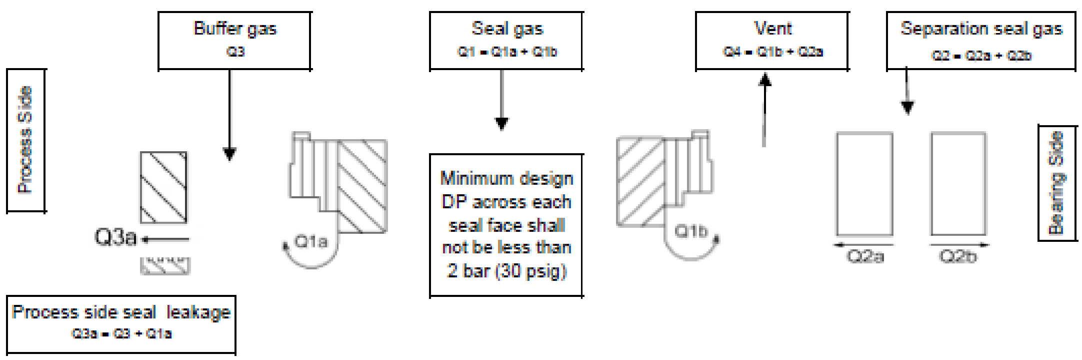
5 **Typical flow schematic diagram for a double dry gas seal**



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

			Unit Operating Cases - Values in this chart are for only dry gas seal					
22			Normal	Start-up				Settleout
23	Unit speed	(rpm)						
24	Seal gas pressure	(barG)						
25	Seal gas differential pressure	(bar)						
26	Seal gas temperature	(°C)						
27	Seal gas MW	MW						
28	Expected primary seal leakage (Q1a)	Nm³/h						
29	Guaranteed primary seal leakage (Q1a)	Nm³/h						
30	Expected secondary seal leakage (Q1b)	Nm³/h						
31	Guaranteed secondary seal leakage (Q1b)	Nm³/h						
32	Buffer gas pressure	(barG)						
32	Buffer gas temperature	(°C)						
33	Buffer gas MW	MW						
32	Process side seal radial clearance	(mm)						
33	Process side seal leakage (Q3a)	Nm³/h						
34	Vent pressure	(barG)						
35	Separation seal gas pressure	(barG)						
36	Separation seal gas temperature	(°C)						
37	Separation seal gas MW	MW						
38	Separation seal radial clearance	(mm)						
39	Expected separation seal leakage (Q2a)	Nm³/h						
40	Guaranteed separation seal leakage (Q2a)	Nm³/h						
41	Expected separation seal leakage (Q2b)	Nm³/h						
42	Guaranteed separation seal leakage (Q2b)	Nm³/h						
43								
44	Seal gas flow (Q1)	Nm³/h						
45	Buffer gas flow (Q3)	Nm³/h						
46	Vent leakage (Q4)	Nm³/h						
47	Separation seal gas flow (Q2)	Nm³/h						
48								
49								

DRY GAS SEALS
DATASHEET (API 692-2nd, Part 2)
SI UNITS (bar)

Job No.: ____ Item No.: ____
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			Rev
1	Remarks:		
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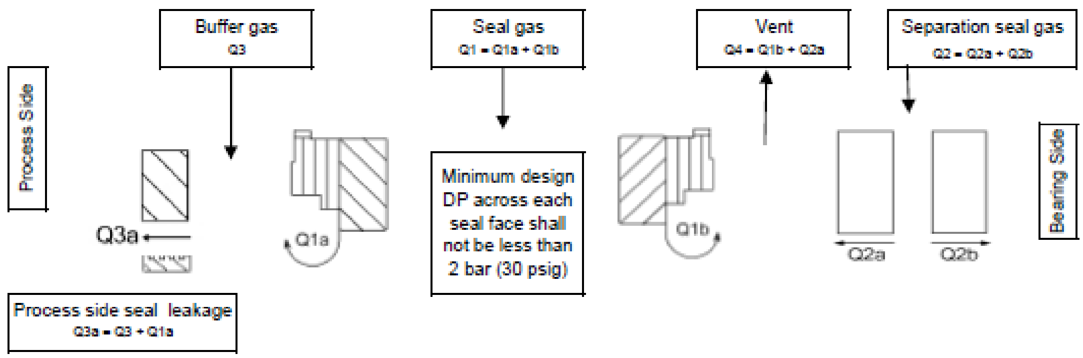
4			
5	**Typical flow schematic diagram for a double dry gas seal**		



Note: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals

			Unit Operating Cases - Values in this chart are for only dry gas seal						Rev
22									
23	Unit speed	(rpm)							
24	Seal gas pressure	(barG)							
25	Seal gas differential pressure	(bar)							
26	Seal gas temperature	(°C)							
27	Seal gas MW	MW							
28	Expected primary seal leakage (Q1a)	Nm³/h							
29	Guaranteed primary seal leakage (Q1a)	Nm³/h							
30	Expected secondary seal leakage (Q1b)	Nm³/h							
31	Guaranteed secondary seal leakage (Q1b)	Nm³/h							
32	Buffer gas pressure	(barG)							
32	Buffer gas temperature	(°C)							
33	Buffer gas MW	MW							
32	Process side seal radial clearance	(mm)							
33	Process side seal leakage (Q3a)	Nm³/h							
34	Vent pressure	(barG)							
35	Separation seal gas pressure	(barG)							
36	Separation seal gas temperature	(°C)							
37	Separation seal gas MW	MW							
38	Separation seal radial clearance	(mm)							
39	Expected separation seal leakage (Q2a)	Nm³/h							
40	Guaranteed separation seal leakage (Q2a)	Nm³/h							
41	Expected separation seal leakage (Q2b)	Nm³/h							
42	Guaranteed separation seal leakage (Q2b)	Nm³/h							
43									
44	Seal gas flow (Q1)	Nm³/h							
45	Buffer gas flow (Q3)	Nm³/h							
46	Vent leakage (Q4)	Nm³/h							
47	Separation seal gas flow (Q2)	Nm³/h							
48									
49									

API 692 Annex 2A — Datasheets for Dry Gas Seals

DRY GAS SEALS DATASHEET (API 692-2nd, Part 2) SI UNITS (bar)	Job No.:		Item No.:	
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Rev

Remarks:

Unit and dry gas seal operating conditions (Cont.)

Seal gas method of control:
- ○ Pressure Control (Differential) (bar) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Separation seal gas method of control:
- ○ Pressure Control (Differential) (bar) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Secondary seal gas method of control:
- ○ Pressure Control (Differential) (bar) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Buffer gas method of control:
- ○ Pressure Control (Differential) (bar) ________
- ○ Flow Control
- ○ Gas filtration level (µm) ________

Notes: See gas velocity requirements listed in Part 1 for labyrinths and clearance seals.
See filtration level requirements listed in Part 3 for for gas supplies.

Shop Inspections, Tests, and Reports

Inspection Records:
- ○ See inspectors checklist
- ○ Overspeed testing of rotating dry gas seal faces
- ○ Hysteresis testing of the stationary sub-assembly
- ○ Balance record of the rotating seal assembly
- ○ Seal rotating assembly balance (Part 2: 6.11.2)
- ○ Materials of construction for materials exposed to H2S
- ○ Visual inspection of faces after dynamic testing

Material inspections:
- ○ Certification of materials, such as mill test reports
- ○ PMI (Positive Material Identification) testing reports

Static and dynamic testing of dry gas seal assemblies:
- ○ Per API 692, Annex B
- ○ Other specified test
- ○ ________

- ○ Inspectors checklist compliance

Reports:
- ○ Rotordynamic lateral analysis report

Remarks:

Annex B
(normative)

Dry Gas Seal Test Procedures

This annex contains test procedures for the following dry gas seal configurations.

— B.1—Tandem Seal with or Without an Intermediate Labyrinth Test Procedure.

— B.2—Double Seal Test Procedure.

— B.3—Single Seal Test Procedure.

— B.4—Refurbished Tandem Seal with or Without an Intermediate Labyrinth Test Procedure.

— B.5—Refurbished Double Seal Test Procedure.

— B.6—Refurbished Single Seal Test Procedure.

B.1 Tandem Seal with or Without an Intermediate Labyrinth Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Normal vent pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
Primary MRT sealing pressure (psig or barg)	
Secondary MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Primary Seal Gas Pressure	Secondary Seal Gas Pressure	Speed	Leakage Acceptance (scfm or slpm)		Test Step
			Primary	Secondary	
Maximum sealing pressure	0	0			5
≥Maximum sealing pressure	Maximum sealing pressure	0			13
Normal sealing pressure	Normal vent pressure	Normal speed			25~~28~~

>Normal sealing pressure	Normal sealing pressure	Normal speed	[redacted]		52~~55~~

3. Testing

Test Step	Primary Seal Gas Pressure (psig or barg)	Secondary Seal Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
Primary Cold Static Test					
1	25 % Maximum sealing pressure	0	0	1	
2	50 % Maximum sealing pressure	0	0	1	
3	75 % Maximum sealing pressure	0	0	1	
4	Static pressure rating	0	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure	0	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure	0	0	1	
7	50 % Maximum sealing pressure	0	0	1	
8	25 % Maximum sealing pressure	0	0	1	
Secondary Cold Static Test					
9	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	
10	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
11	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
12	≥Static pressure rating	Static pressure rating	0	6	Record every 2 minutes
13	≥100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	6	Acceptance point Record every 2 minutes
14	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
15	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
16	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	

Test Step	**Primary Seal Gas Pressure** (psig or barg)	**Secondary Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
		~~**MRT**~~			
~~17~~	~~Primary MRT sealing pressure~~	~~Secondary MRT sealing pressure~~	~~10% MCS~~	~~15~~	~~Record every 5 minutes~~
~~18~~	~~Primary MRT sealing pressure~~	~~Secondary MRT sealing pressure~~	~~Trip speed~~	~~15~~	~~Record every 5 minutes~~
		~~**Minimum Pressure Test**~~			
~~19~~	~~25 % Dynamic pressure rating~~	~~Normal vent pressure~~	~~Trip speed~~	~~5~~	
		Primary Dynamic Test			
17~~20~~	25 % Normal sealing pressure	Normal vent pressure	0	1	
18~~21~~	25 % Normal sealing pressure	Normal vent pressure	MCS	2	
19~~22~~	50 % Normal sealing pressure	Normal vent pressure	MCS	2	
20~~23~~	75 % Normal sealing pressure	Normal vent pressure	MCS	2	
21~~24~~	100 % Maximum sealing pressure	Normal vent pressure	MCS	15	Record every 5 minutes
22~~25~~	100 % Maximum sealing pressure	Normal vent pressure	Trip speed	15	Record every 5 minutes
23~~26~~	100 % Maximum sealing pressure	Normal vent pressure	Normal speed	2	
24~~27~~	Dynamic pressure rating	Normal vent pressure	Normal speed	15	Record every 5 minutes
25~~28~~	100 % Normal sealing pressure	Normal vent pressure	Normal speed	60	Acceptance point Record every 5 minutes
26~~29~~	100 % Normal sealing pressure	Maximum vent pressure	Normal speed	2	
27~~30~~	100 % Normal sealing pressure	Maximum vent pressure	MCS	2	
28~~31~~	100 % Normal sealing pressure	Normal vent pressure	MCS	2	
29~~32~~	75 % Normal sealing pressure	Normal vent pressure	MCS	2	
30~~33~~	50 % Normal sealing pressure	Normal vent pressure	MCS	2	

Test Step	Primary Seal Gas Pressure (psig or barg)	Secondary Seal Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
31~~34~~	25 % Normal sealing pressure	Normal vent pressure	MCS	2	
Primary Hot Static Test					
32~~35~~	25 % Maximum sealing pressure	0	0	1	
33~~36~~	50 % Maximum sealing pressure	0	0	1	
34~~37~~	75 % Maximum sealing pressure	0	0	1	
35~~38~~	100 % Maximum sealing pressure	0	0	1	
36~~39~~	75 % Maximum sealing pressure	0	0	1	
37~~40~~	50 % Maximum sealing pressure	0	0	1	
38~~41~~	25 % Maximum sealing pressure	0	0	1	
Primary Start-up/Shutdown Test					
39~~42~~	100 % Maximum sealing pressure	Minimum vent pressure	0	1	
40~~43~~	100 % Maximum sealing pressure	Minimum vent pressure	Trip speed	1	
41~~44~~	100 % Maximum sealing pressure	Minimum vent pressure	MCS	1	
42~~45~~	100 % Maximum sealing pressure	Minimum vent pressure	0	1	
43~~46~~	100 % Maximum sealing pressure	Minimum vent pressure	Trip speed	1	
44~~47~~	100 % Maximum sealing pressure	Minimum vent pressure	MCS	1	
45~~48~~	100 % Maximum sealing pressure	Minimum vent pressure	0	1	
Secondary Dynamic Test					
46~~49~~	>50 % Normal sealing pressure	50 % Normal sealing pressure	0	1	
47~~50~~	>50 % Normal sealing pressure	50 % Normal sealing pressure	Normal speed	2	

Test Step	**Primary Seal Gas Pressure** (psig or barg)	**Secondary Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
48~~51~~	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	Normal speed	2	
49~~52~~	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	MCS	2	
Secondary Dynamic Test (Continued)					
50~~53~~	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	Normal speed	2	
51~~54~~	>Dynamic pressure rating	Dynamic pressure rating	Normal speed	6	Record every 2 minutes
52~~55~~	>100 % Normal sealing pressure	100 % Normal sealing pressure	Normal speed	15	Acceptance point Record every 5 minutes
53~~56~~	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	Normal speed	6	Record every 2 minutes
54~~57~~	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	1	
MRT					
55	Primary MRT sealing pressure	Secondary MRT sealing pressure	10% MCS	15	Record every 5 minutes
56	Primary MRT sealing pressure	Secondary MRT sealing pressure	Trip speed	15	Record every 5 minutes
Minimum Pressure Test					
57	25 % Dynamic pressure rating	Normal vent pressure	Trip speed	5	
Secondary Hot Static Test					
58	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	
59	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
60	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
61	≥100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	1	
62	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
63	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
64	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	

Test Step	Primary Seal Gas Pressure (psig or barg)	Secondary Seal Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
Slow Roll					
65	The slow roll test conditions (primary pressure, secondary pressure, speed, and time) can be specified by purchaser				
66	Visual inspection				
67	Static test (Steps 1 to 16) ~~may be required by purchaser~~				
68	Shipment				

B.2 Double Seal Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Minimum design differential pressure (psig or barg)	
Differential pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Process Pressure	Seal Pressure	Speed	Guaranteed Leakage (scfm or slpm)		Test Step
			~~Inboard~~ Primary	~~Outboard~~ Secondary	
0	Maximum sealing pressure	0			5
Normal sealing pressure	>Normal sealing pressure	Normal speed			17~~20~~

3. Testing

Test Step	Seal Gas Pressure (psig or barg)	Process Side Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
Cold Static Test					
1	25 % Maximum sealing pressure + differential pressure	≥0	0	1	
2	50 % Maximum sealing pressure + differential pressure	≥0	0	1	
3	75 % Maximum sealing pressure + differential pressure	≥0	0	1	
4	Static pressure rating	≥0	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure + differential pressure	≥0	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure + differential pressure	≥0	0	1	
7	50 % Maximum sealing pressure + differential pressure	≥0	0	1	
8	25 % Maximum sealing pressure + differential pressure	≥0	0	1	
~~**MRT**~~					
~~9~~	~~MRT sealing pressure + differential pressure~~	~~0~~	~~10 % MCS~~	~~15~~	~~Record every 5 minutes~~

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
~~10~~	~~MRT sealing pressure + differential pressure~~	~~0~~	~~Trip speed~~	~~15~~	~~Record every 5 minutes~~
		~~**Minimum Pressure Test**~~			
~~11~~	~~Minimum design differential pressure~~	~~0~~	~~Trip speed~~	~~5~~	
		Dynamic Test			
9~~12~~	25 % Normal sealing pressure + differential pressure	≥0	0	1	
10~~13~~	25 % Normal sealing pressure + differential pressure	≥0	MCS	2	
11~~14~~	50 % Normal sealing pressure + differential pressure	≥0	MCS	2	
12~~15~~	75 % Normal sealing pressure + differential pressure	≥0	MCS	2	
13~~16~~	100 % Maximum sealing pressure + differential pressure	≥0	MCS	15	Record every 5 minutes
14~~17~~	100 % Maximum sealing pressure + differential pressure	≥0	Trip speed	15	Record every 5 minutes
		Dynamic Test (Continued)			
15~~18~~	100 % Maximum sealing pressure + differential pressure	≥0	Normal speed	2	
16~~19~~	Dynamic pressure rating	≥0	Normal speed	15	Record every 5 minutes
17~~20~~	100 % Normal sealing pressure + differential pressure	100 % Normal sealing pressure	Normal speed	60	Acceptance point Record every 5 minutes
18~~21~~	100 % Normal sealing pressure + differential pressure	≥0	Normal speed	2	
19~~22~~	100 % Normal sealing pressure + differential pressure	≥0	MCS	2	
20~~23~~	75 % Normal sealing pressure + differential pressure	≥0	MCS	2	
21~~24~~	50 % Normal sealing pressure + differential pressure	≥0	MCS	2	
22~~25~~	25 % Normal sealing pressure + differential pressure	≥0	MCS	2	
		MRT			
23	MRT sealing pressure + differential pressure	≥0	10 % MCS	15	Record every 5 minutes

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
24	MRT sealing pressure + differential pressure	≥0	Trip speed	15	Record every 5 minutes
Minimum Pressure Test					
25	Minimum design differential pressure	≥0	Trip speed	5	
Hot Static Test					
26	25 % Maximum sealing pressure + differential pressure	≥0	0	1	
27	50 % Maximum sealing pressure + differential pressure	≥0	0	1	
28	75 % Maximum sealing pressure + differential pressure	≥0	0	1	
29	100 % Maximum sealing pressure + differential pressure	≥0	0	1	
30	75 % Maximum sealing pressure + differential pressure	≥0	0	1	
31	50 % Maximum sealing pressure + differential pressure	≥0	0	1	
32	25 % Maximum sealing pressure + differential pressure	≥0	0	1	
Start-up/Shutdown Test					
33	100 % Maximum sealing pressure + differential pressure	≥0	0	1	
34	100 % Maximum sealing pressure + differential pressure	≥0	Trip speed	1	
35	100 % Maximum sealing pressure + differential pressure	≥0	MCS	1	
Start-up/Shutdown Test (Continued)					
36	100 % Maximum sealing pressure + differential pressure	0	0	1	
37	100 % Maximum sealing pressure + differential pressure	≥0	Trip speed	1	
38	100 % Maximum sealing pressure + differential pressure	≥0	MCS	1	
39	100 % Maximum sealing pressure + differential pressure	≥0	0	1	
Slow Roll					
40	The slow roll test conditions (sealing pressure, speed, and time) may be specified by purchaser				

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
41	Visual inspection				
42	Static test (Steps 1 to 8) ~~may be required by purchaser~~				
43	Shipment				

B.3 Single Seal Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Seal Gas Pressure	Speed	Leakage Acceptance (scfm or slpm)	Test Step
Maximum sealing pressure	0		5
Normal sealing pressure	Normal speed		17~~20~~

3. Testing

Test Step	**Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
Cold Static Test				
1	25 % Maximum sealing pressure	0	1	
2	50 % Maximum sealing pressure	0	1	
3	75 % Maximum sealing pressure	0	1	
4	Static pressure rating	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure	0	1	
7	50 % Maximum sealing pressure	0	1	
8	25 % Maximum sealing pressure	0	1	
~~MRT~~				
~~9~~	~~MRT sealing pressure~~	~~10 % MCS~~	~~15~~	~~Record every 5 minutes~~
~~10~~	~~MRT sealing pressure~~	~~Trip speed~~	~~15~~	~~Record every 5 minutes~~
~~Minimum Pressure Test~~				
~~11~~	~~25 % Dynamic pressure rating~~	~~Trip speed~~	~~5~~	
Dynamic Test				
9~~12~~	25 % Normal sealing pressure	0	1	
10~~13~~	25 % Normal sealing pressure	MCS	2	
11~~14~~	50 % Normal sealing pressure	MCS	2	
12~~15~~	75 % Normal sealing pressure	MCS	2	
13~~16~~	100 % Maximum sealing pressure	MCS	15	Record every 5 minutes
14~~17~~	100 % Maximum sealing pressure	Trip speed	15	Record every 5 minutes
15~~18~~	100 % Maximum sealing pressure	Normal speed	2	
16~~19~~	Dynamic pressure rating	Normal speed	15	Record every 5 minutes
17~~20~~	100 % Normal sealing pressure	Normal speed	60	Acceptance point Record every 5 minutes
18~~21~~	100 % Normal sealing pressure	MCS	2	
19~~22~~	75 % Normal sealing pressure	MCS	2	
19~~22~~				
20~~23~~	50 % Normal sealing pressure	MCS	2	
21~~24~~	25 % Normal sealing pressure	MCS	2	

Test Step	**Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
MRT				
22	MRT sealing pressure	10 % MCS	15	Record every 5 minutes
23	MRT sealing pressure	Trip speed	15	Record every 5 minutes
Minimum Pressure Test				
24	25 % Dynamic pressure rating	Trip speed	5	
Hot Static Test				
25	25 % Maximum sealing pressure	0	1	
26	50 % Maximum sealing pressure	0	1	
27	75 % Maximum sealing pressure	0	1	
28	100 % Maximum sealing pressure	0	1	
29	75 % Maximum sealing pressure	0	1	
30	50 % Maximum sealing pressure	0	1	
31	25 % Maximum sealing pressure	0	1	
Start-up/Shutdown Test				
32	100 % Maximum sealing pressure	0	1	
33	100 % Maximum sealing pressure	Trip speed	1	
34	100 % Maximum sealing pressure	MCS	1	
35	100 % Maximum sealing pressure	0	1	
36	100 % Maximum sealing pressure	Trip speed	1	
37	100 % Maximum sealing pressure	MCS	1	
38	100 % Maximum sealing pressure	0	1	
Slow Roll				
39	The slow roll test conditions (sealing pressure, speed and time) may be specified by purchaser			
40	Visual inspection			
41	Static test (Steps 1 to 8) ~~may be required by purchaser~~			
42	Shipment			

B.4 Refurbished Tandem Seal with or Without an Intermediate Labyrinth Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Normal vent pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
Primary MRT sealing pressure (psig or barg)	
Secondary MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Primary Seal Gas Pressure	Secondary Seal Gas Pressure	Speed	Leakage Acceptance (scfm or slpm)		Test Step
			Primary	**Secondary**	
Maximum sealing pressure	0	0			5
≥Maximum sealing pressure	Maximum sealing pressure	0			13
Normal sealing pressure	Normal vent pressure	Normal speed			26

> Normal sealing pressure	Normal sealing pressure	Normal speed	[redacted]		50

3. Testing

Test Step	Primary Seal Gas Pressure (psig or barg)	Secondary Seal Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
Primary Cold Static Test					
1	25 % Maximum sealing pressure	0	0	1	
2	50 % Maximum sealing pressure	0	0	1	
3	75 % Maximum sealing pressure	0	0	1	
4	Static pressure rating	0	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure	0	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure	0	0	1	
7	50 % Maximum sealing pressure	0	0	1	
~~**Primary Cold Static Test (Continued)**~~					
8	25 % Maximum sealing pressure	0	0	1	
Secondary Cold Static Test					
9	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	
10	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
11	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
12	≥Static pressure rating	Static pressure rating	0	6	Record every 2 minutes
13	≥100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	6	Acceptance point Record every 2 minutes

Test Step	Primary Seal Gas Pressure (psig or barg)	Secondary Seal Gas Pressure (psig or barg)	Speed (RPM)	Hold Time (min)	Remarks
14	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
15	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
16	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	
~~Minimum Pressure Test~~					
~~17~~	~~25 % Dynamic pressure rating~~	~~Normal vent pressure~~	~~Trip speed~~	~~5~~	
Primary Dynamic Test					
17	25 % Normal sealing pressure	Normal vent pressure	0	1	
18	25 % Normal sealing pressure	Normal vent pressure	MCS	2	
~~20~~	~~50 % Normal sealing pressure~~	~~Normal vent pressure~~	~~MCS~~	~~2~~	
~~21~~	~~75 % Normal sealing pressure~~	~~Normal vent pressure~~	~~MCS~~	~~2~~	
19	100 % Maximum sealing pressure	Normal vent pressure	MCS	15	Record every 5 minutes
20	100 % Maximum sealing pressure	Normal vent pressure	Trip speed	15	Record every 5 minutes
~~24~~	~~100 % Maximum sealing pressure~~	~~Normal vent pressure~~	~~Normal speed~~	~~2~~	
~~Primary Dynamic Test (Continued)~~					
~~25~~	~~Dynamic pressure rating~~	~~Normal vent pressure~~	~~Normal speed~~	~~6~~	~~Record every 2 minutes~~
21	100 % Normal sealing pressure	Normal vent pressure	Normal speed	10	Acceptance point Record every 5 minutes
~~27~~	~~100 % Normal sealing pressure~~	~~Maximum vent pressure~~	~~Normal speed~~	~~2~~	
~~28~~	~~100 % Normal sealing pressure~~	~~Maximum vent pressure~~	~~MCS~~	~~2~~	
22	100 % Normal sealing pressure	Normal vent pressure	0	1	

Test Step	**Primary Seal Gas Pressure** (psig or barg)	**Secondary Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
~~30~~	~~75 % Normal sealing pressure~~	~~Normal vent pressure~~	~~MCS~~	~~2~~	
~~31~~	~~50 % Normal sealing pressure~~	~~Normal vent pressure~~	~~MCS~~	~~2~~	
~~32~~	~~25 % Normal sealing pressure~~	~~Normal vent pressure~~	~~MCS~~	~~2~~	

Primary Hot Static Test					
23	25 % Maximum sealing pressure	0	0	1	
24	50 % Maximum sealing pressure	0	0	1	
25	75 % Maximum sealing pressure	0	0	1	
26	100 % Maximum sealing pressure	0	0	1	
Primary Start-up/Shutdown Test					
27	100 % Maximum sealing pressure	Minimum vent pressure	0	1	
28	100 % Maximum sealing pressure	Minimum vent pressure	Trip speed	1	
29	100 % Maximum sealing pressure	Minimum vent pressure	MCS	1	
30	100 % Maximum sealing pressure	Minimum vent pressure	0	1	
31	100 % Maximum sealing pressure	Minimum vent pressure	Trip speed	1	
~~**Primary Start-up/Shutdown Test (Continued)**~~					
32	100 % Maximum sealing pressure	Minimum vent pressure	MCS	1	
43	~~100 % Maximum sealing pressure~~	~~Minimum vent pressure~~	~~0~~	~~1~~	
Secondary Dynamic Test					
~~44~~	~~>50 % Normal sealing pressure~~	~~50 % Normal sealing pressure~~	~~0~~	~~1~~	

Test Step	**Primary Seal Gas Pressure** (psig or barg)	**Secondary Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
~~45~~	~~>50 % Normal sealing pressure~~	~~50 % Normal sealing pressure~~	~~Normal speed~~	~~2~~	
33	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	Normal speed	2	
34	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	MCS	2	
~~48~~	~~>100 % Maximum sealing pressure~~	~~100 % Maximum sealing pressure~~	~~Normal speed~~	~~2~~	
~~49~~	~~>Dynamic pressure rating~~	~~Dynamic pressure rating~~	~~Normal speed~~	~~6~~	~~Record every 2 minutes~~
35	>100 % Normal sealing pressure	100 % Normal sealing pressure	Normal speed	3	Acceptance point ~~Record every 2 minutes~~
~~51~~	~~>100 % Maximum sealing pressure~~	~~100 % Maximum sealing pressure~~	~~Normal speed~~	~~6~~	~~Record every 2 minutes~~
36	>100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	1	
Secondary Hot Static Test					
37	≥100 % Maximum sealing pressure	100 % Maximum sealing pressure	0	1	
38	≥75 % Maximum sealing pressure	75 % Maximum sealing pressure	0	1	
39	≥50 % Maximum sealing pressure	50 % Maximum sealing pressure	0	1	
40	≥25 % Maximum sealing pressure	25 % Maximum sealing pressure	0	1	
Visual Inspection					
41	Visual inspection				
42	Static test (Steps 1 to 16) ~~may be required by purchaser~~				
43	Shipment				

B.5 Refurbished Double Seal Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Minimum design differential pressure (psig or barg)	
Differential pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Process Pressure	**Seal Pressure**	**Speed**	**Guaranteed Leakage** (scfm or slpm)		**Test Step**
			~~**Inboard**~~ **Primary**	~~**Outboard**~~ **Secondary**	

0	Maximum sealing pressure	0			5
Normal sealing pressure	>Normal sealing pressure	Normal speed			18

3. Testing

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
		Cold Static Test			
1	25 % Maximum sealing pressure + differential pressure	0	0	1	
2	50 % Maximum sealing pressure + differential pressure	0	0	1	
3	75 % Maximum sealing pressure + differential pressure	0	0	1	
4	Static pressure rating	0	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure + differential pressure	0	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure + differential pressure	0	0	1	
7	50 % Maximum sealing pressure + differential pressure	0	0	1	
8	25 % Maximum sealing pressure + differential pressure	0	0	1	
		~~**Minimum Pressure Test**~~			
~~9~~	~~Minimum design differential pressure~~	~~0~~	~~Trip speed~~	~~5~~	
		Dynamic Test			
9	25 % Normal sealing pressure + differential pressure	0	0	1	
10	25 % Normal sealing pressure + differential pressure	0	MCS	2	
~~12~~	~~50 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
~~13~~	~~75 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
11	100 % Maximum sealing pressure + differential pressure	0	MCS	6	Record every 2 minutes.

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
12	100 % Maximum sealing pressure + differential pressure	0	Trip speed	6	Record every 2 minutes
~~16~~	~~100 % Maximum sealing pressure + differential pressure~~	~~0~~	~~Normal speed~~	~~2~~	
~~17~~	~~Dynamic pressure rating~~	~~0~~	~~Normal speed~~	~~6~~	~~Record every 2 minutes~~
13	100 % Normal sealing pressure + differential pressure	100 % Normal sealing pressure	Normal speed	15	Acceptance point Record every 5 minutes. Speed adjustment as needed to manage heat generation.
Dynamic Test (Continued)					
14	100 % Normal sealing pressure + differential pressure	0	Normal speed	2	
~~20~~	~~100 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
~~21~~	~~75 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
~~22~~	~~50 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
~~23~~	~~25 % Normal sealing pressure + differential pressure~~	~~0~~	~~MCS~~	~~2~~	
Hot Static Test					
15	100 % Maximum sealing pressure + differential pressure	0	0	1	
16	75 % Maximum sealing pressure + differential pressure	0	0	1	
17	50 % Maximum sealing pressure + differential pressure	0	0	1	
18	25 % Maximum sealing pressure + differential pressure	0	0	1	
Start-up/Shutdown Test					
~~28~~	~~100 % Maximum sealing pressure + differential pressure~~	~~0~~	~~0~~	~~1~~	

Test Step	**Seal Gas Pressure** (psig or barg)	**Process Side Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
~~19~~	100 % Maximum sealing pressure + differential pressure	0	Trip speed	1	
~~20~~	100 % Maximum sealing pressure + differential pressure	0	MCS	1	
~~21~~	100 % Maximum sealing pressure + differential pressure	0	0	1	
~~22~~	100 % Maximum sealing pressure + differential pressure	0	Trip speed	1	
23	100 % Maximum sealing pressure + differential pressure	0	MCS	1	
24	100 % Maximum sealing pressure + differential pressure	0	0	1	
Visual Inspection					
25	Visual inspection				
26	Static test (Steps 1 to 8) ~~may be required by purchaser~~				
27	Shipment				

B.6 Refurbished Single Seal Test Procedure

1. Test Parameters

Parameter (units)	
Normal sealing pressure (psig or barg)	
Maximum sealing pressure (psig or barg)	
Static pressure rating (psig or barg)	
Dynamic pressure rating (psig or barg)	
MRT sealing pressure (psig or barg)	
Normal speed (RPM)	
MCS (RPM)	
Trip speed (RPM)	
Test Gas	

The following data will be obtained throughout the test.

— Time at which data is recorded.

— Seal gas temperature at seal inlet (°F or °C).

— Seal pressures (psig or barg).

— Test speed (RPM).

— Leakage flow (scfm or slpm).

— Static Torque (lbft or Nm).

2. Acceptance Criteria

Seal Gas Pressure	**Speed**	**Leakage Acceptance** (scfm or slpm)	**Test Step**
Maximum sealing pressure	0		5
Normal sealing pressure	Normal speed		18

3. Testing

Test Step	**Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
	Cold Static Test			
1	25 % Maximum sealing pressure	0	1	
2	50 % Maximum sealing pressure	0	1	
3	75 % Maximum sealing pressure	0	1	
4	Static pressure rating	0	6	Record every 2 minutes
5	100 % Maximum sealing pressure	0	6	Acceptance point Record every 2 minutes
6	75 % Maximum sealing pressure	0	1	
7	50 % Maximum sealing pressure	0	1	
8	25 % Maximum sealing pressure	0	1	
	~~**Minimum Pressure Test**~~			
~~9~~	~~25 % Dynamic pressure rating~~	~~Trip speed~~	~~5~~	
	Dynamic Test			
~~10~~	~~25 % Normal sealing pressure~~	~~0~~	~~1~~	
9	25 % Maximum sealing pressure	MCS	2	
~~12~~	~~50 % Normal sealing pressure~~	~~MCS~~	~~2~~	
~~13~~	~~75 % Normal sealing pressure~~	~~MCS~~	~~2~~	
10	100 % Maximum sealing pressure	MCS	6	Record every 2 minutes
11	100 % Maximum sealing pressure	Trip speed	6	Record every 2 minutes

Test Step	**Seal Gas Pressure** (psig or barg)	**Speed** (RPM)	**Hold Time** (min)	**Remarks**
~~16~~	~~100 % Maximum sealing pressure~~	~~Normal speed~~	~~2~~	
~~17~~	~~Dynamic pressure rating~~	~~Normal speed~~	~~6~~	~~Record every 2 minutes~~
11	100 % Normal sealing pressure	Normal speed	15	Acceptance point Record every 5 minutes
12	100 % Normal sealing pressure	0	0	
~~20~~	~~75 % Normal sealing pressure~~	~~MCS~~	~~2~~	
~~21~~	~~50 % Normal sealing pressure~~	~~MCS~~	~~2~~	
~~22~~	~~25 % Normal sealing pressure~~	~~MCS~~	~~2~~	
Hot Static Test				
13	25 % Maximum sealing pressure	0	1	
14	50 % Maximum sealing pressure	0	1	
15	75 % Maximum sealing pressure	0	1	
16	100 % Maximum sealing pressure	0	1	
Start-up/Shutdown Test				
17	100 % Maximum sealing pressure	0	1	
18	100 % Maximum sealing pressure	Trip speed	1	
19	100 % Maximum sealing pressure	MCS	1	
20	100 % Maximum sealing pressure	0	1	
21	100 % Maximum sealing pressure	Trip speed	1	
22	100 % Maximum sealing pressure	MCS	1	
23	100 % Maximum sealing pressure	0	1	
Visual Inspection				
24	Visual Inspection			
25	Static test (Steps 1 to 8) ~~may be required by purchaser~~			
26	Shipment			

Annex C
(informative)

Seal Nomenclature

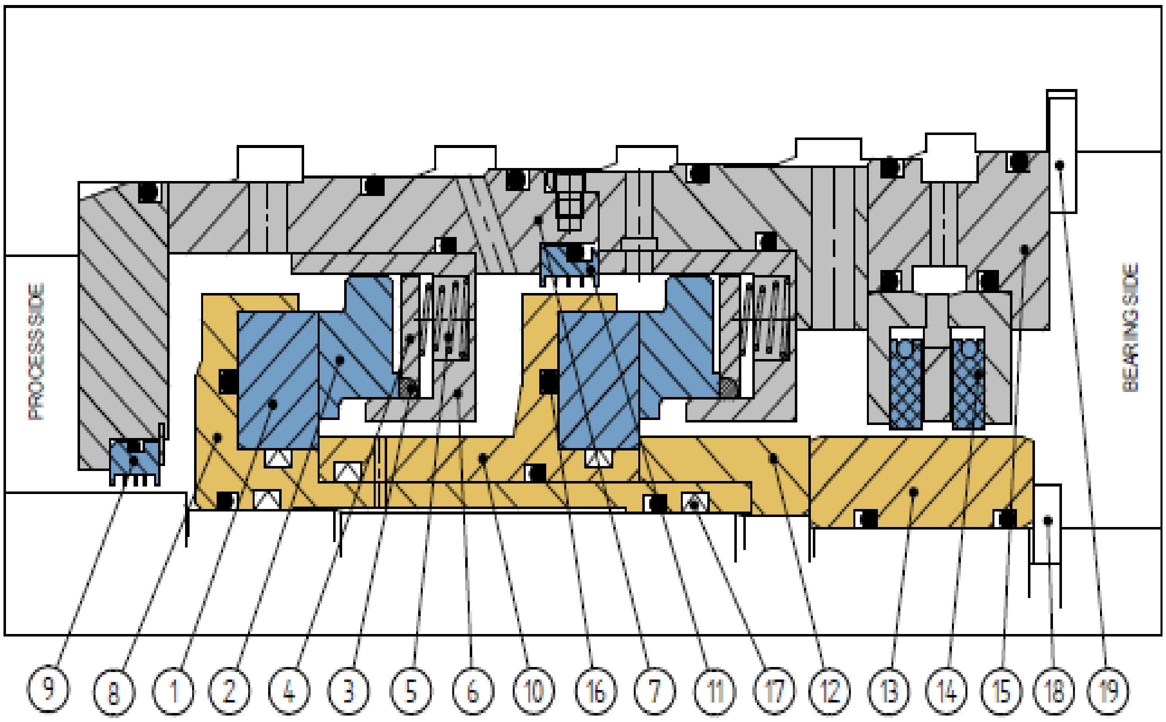
This annex contains the common nomenclature used for dry gas seals. Figure and nomenclature are provided for the following.

— Figure C.1—Tandem Seal with an Intermediate Labyrinth.

— Figure C.2—Tandem Seal.

— Figure C.3—Double Seal.

— Figure C.4—Single Seal.



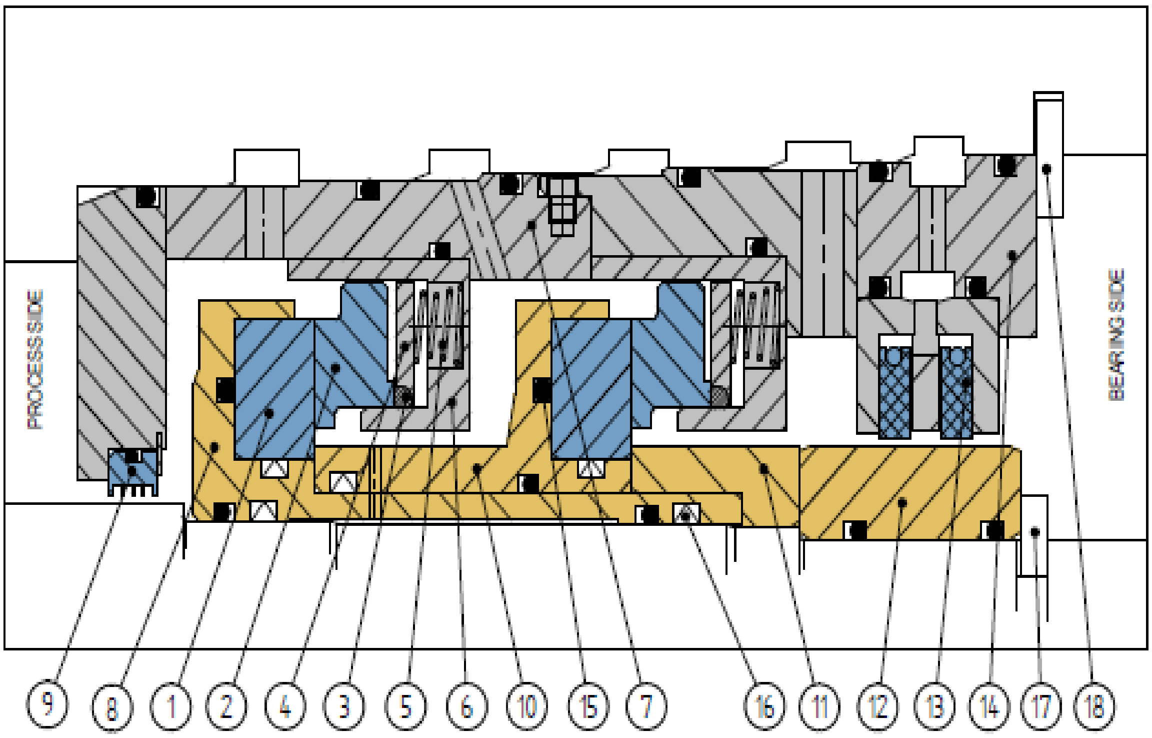
1 ROTATING SEAL FACE
2 STATIONARY SEAL FACE
3 DYNAMIC SEALING ELEMENT
4 DISK
5 SPRING
6 RETAINER
7 HOUSING
8 SHAFT SLEEVE
9 PROCESS SIDE SEAL
10 SPACER SLEEVE
11 INTERMEDIATE LABYRINTH
12 RETAINING SLEEVE
13 SEPARATION SEAL SLEEVE
14 SEPARATION SEAL
15 SEPARATION SEAL HOUSING
16 STATIC SEALING ELEMENT
17 CENTERING ELEMENT
18 ROTATING THRUST ELEMENT
19 STATIONARY THRUST ELEMENT

STATIONARY PARTS

CORE SEALING ELEMENTS

ROTATING PARTS

Figure C.1—Tandem Seal with an Intermediate Labyrinth



1 ROTATING SEAL FACE
2 STATIONARY SEAL FACE
3 DYNAMIC SEALING ELEMENT
4 DISK
5 SPRING
6 RETAINER
7 HOUSING
8 SHAFT SLEEVE
9 PROCESS SIDE SEAL
10 SPACER SLEEVE
11 RETAINING SLEEVE
12 SEPARATION SEAL SLEEVE
13 SEPARATION SEAL
14 SEPARATION SEAL HOUSING
15 STATIC SEALING ELEMENT
16 CENTERING ELEMENT
17 ROTATING THRUST ELEMENT
18 STATIONARY THRUST ELEMENT

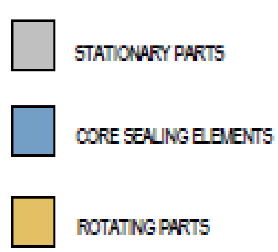
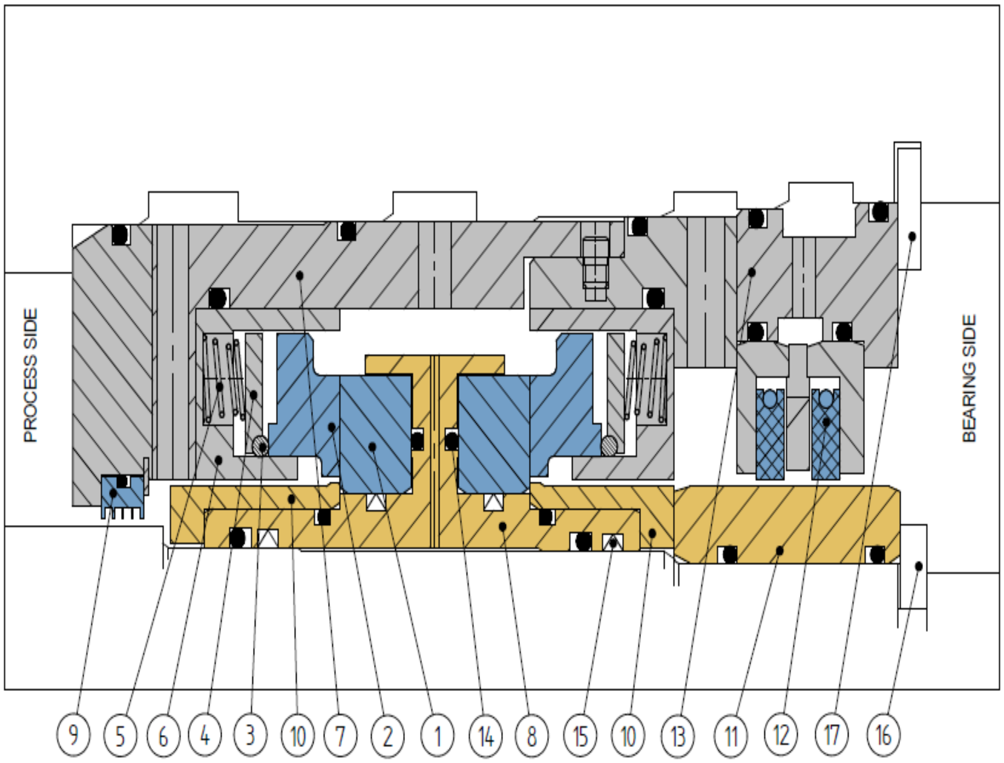


Figure C.2—Tandem Seal



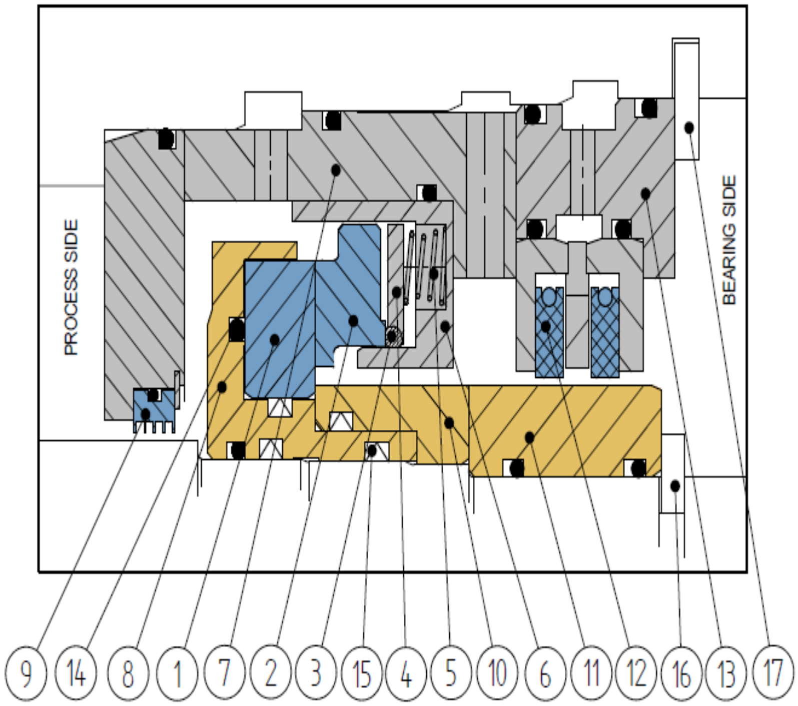
1	ROTATING SEAL FACE	10	RETAINING SLEEVE
2	STATIONARY SEAL FACE	11	SEPARATION SEAL SLEEVE
3	DYNAMIC SEALING ELEMENT	12	SEPARATION SEAL
4	DISK	13	SEPARATION SEAL HOUSING
5	SPRING	14	STATIC SEALING ELEMENT
6	RETAINER	15	CENTERING ELEMENT
7	HOUSING	16	ROTATING THRUST ELEMENT
8	SHAFT SLEEVE	17	STATIONARY THRUST ELEMENT
9	PROCESS SIDE SEAL		

STATIONARY PARTS

CORE SEALING ELEMENTS

ROTATING PARTS

Figure C.3—Double Seal



1 ROTATING SEAL FACE
2 STATIONARY SEAL FACE
3 DYNAMIC SEALING ELEMENT
4 DISK
5 SPRING
6 RETAINER
7 HOUSING
8 SHAFT SLEEVE
9 PROCESS SIDE SEAL
10 SPACER SLEEVE
11 SEPARATION SEAL SLEEVE
12 SEPARATION SEAL
13 SEPARATION SEAL HOUSING
14 STATIC SEALING ELEMENT
15 CENTERING ELEMENT
16 ROTATING THRUST ELEMENT
17 STATIONARY THRUST ELEMENT

STATIONARY PARTS

CORE SEALING ELEMENTS

ROTATING PARTS

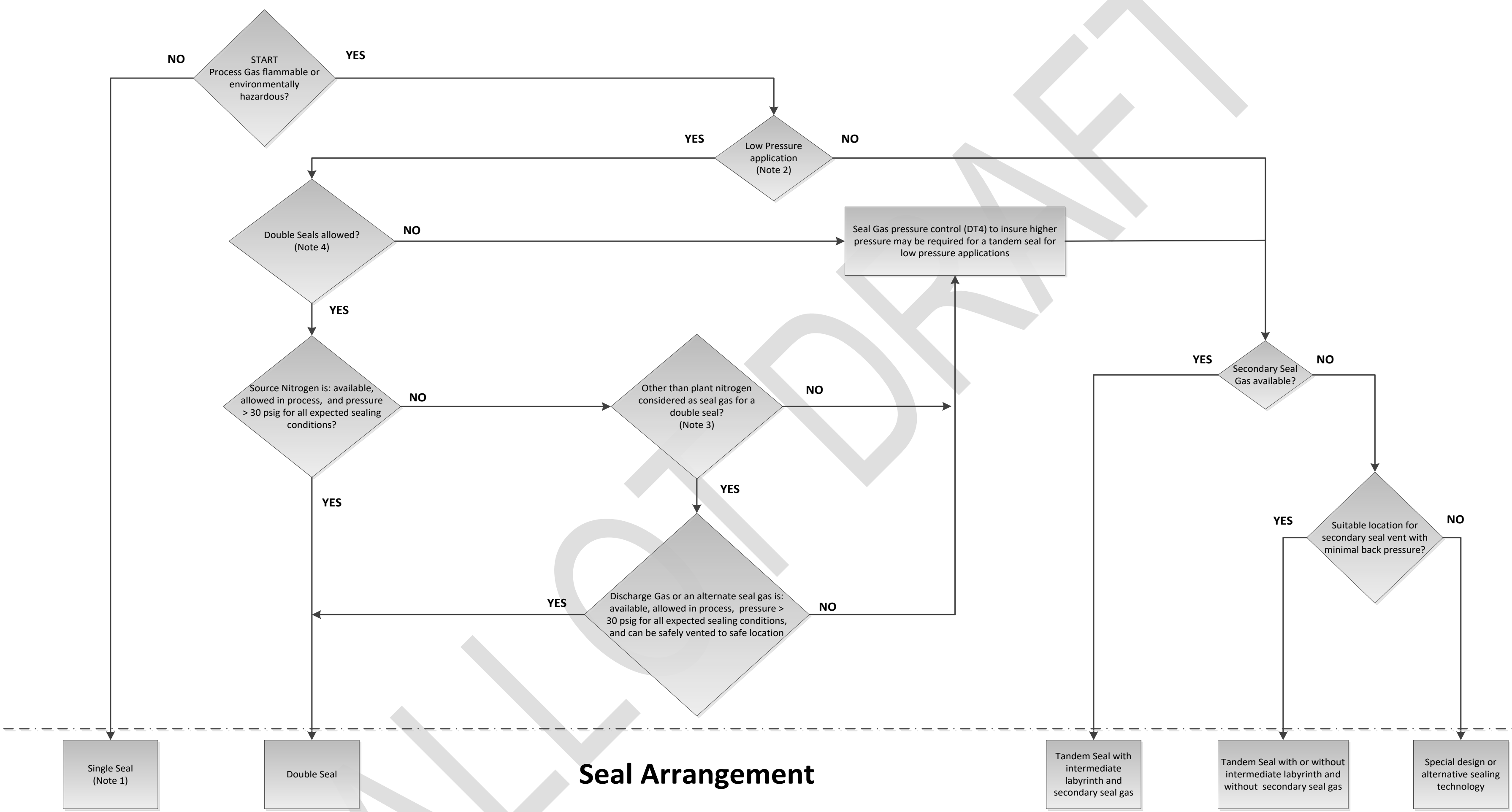
Figure C.4—Single Seal

Annex D
(informative)

Dry Gas Seal Selection Guide

This annex contains an informative flowchart that can be used to select the dry gas seals for specific applications.

Dry Gas Seal Selection Guide



General Note: Limited Axial installation space or rotordynamic requirements may require a different selection. Individual system design is required

Note 1: Alternatively all other seal types are possible if selection criteria are fulfilled.
Note 2: Minimum pressure being sealed is below maximum primary vent back pressure plus 30 psig.
Note 3: Discharge gas or an alternate process compatible seal gas can be used as seal gas for a double seal with suitable pressure for start up and low differential pressure or a back-up.. Because of limited amount of leakage into the process during this time.
Note 4: Individual selection criteria might be: Reliability of seal gas supply system, failure mode considerations.

Annex E
(informative)

Separation Seals

E.1 Introduction

A separation seal is a device located between the dry gas seal and the bearing housing used to restrict migration of oil from the bearing housing toward the dry gas seal and restrict dry gas seal leakage from entering the bearing housing (Figure E.1). In the event of a dry gas seal failure, the separation seal will minimize the flow of process gas to the bearing housing. Adequate separation gas for all conditions is required for the seal to properly function.

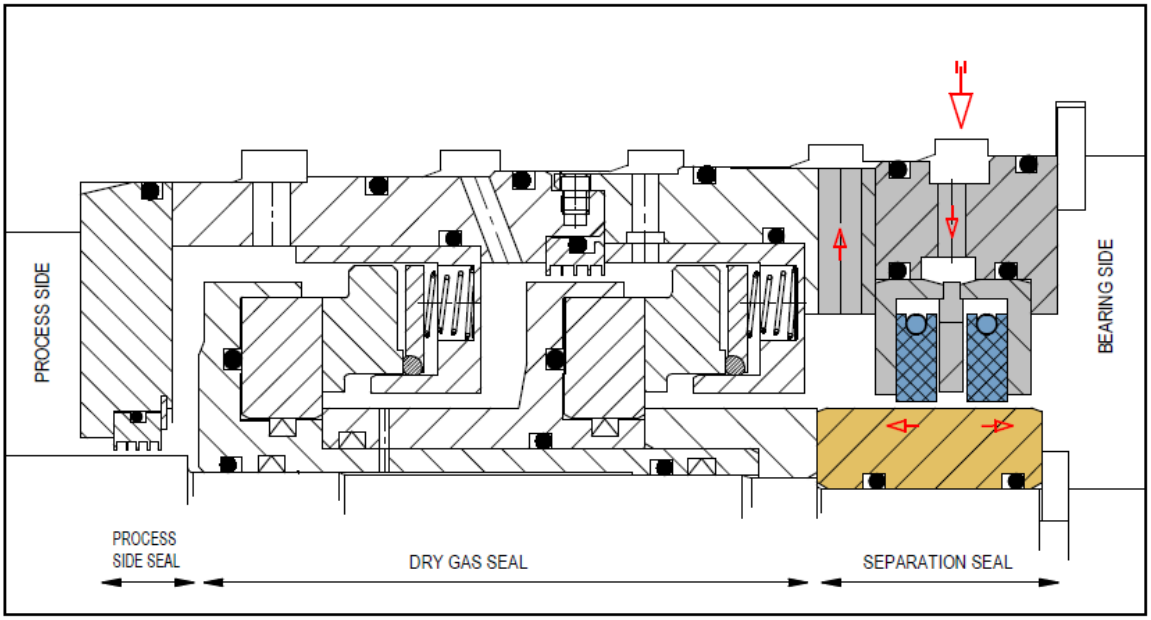


Figure E.1—Cross-section Showing a Separation Seal

Separation seals consist of a stationary and rotating pair of components, having a clearance between them through which separation gas passes. ~~The rotating component is a driven shaft sleeve. Stationary components have anti-rotation provisions.~~

Separation gas is supplied to a central port at a pressure greater than the downstream bearing housing and outboard seal vent cavity pressures. The separation gas flows toward both the bearing housing and the outboard seal vent cavity, through the clearance between the stationary and rotating surfaces as shown in Figure E.1. It is the velocity of the separation gas through these clearances that restricts oil from migrating to the seal cavity and seal leakage from entering the bearing housing.

Separation gas is supplied prior to activating the lube oil system and not interrupted until after the lube oil system is shut down to restrict oil migration to the dry gas seal.

Separation seal types have different clearances, which affect the separation gas consumption.

There are five ~~three~~ common types of separation seals, as follows:

1) non-contacting bushing,

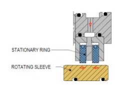
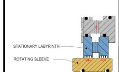
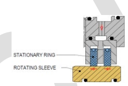
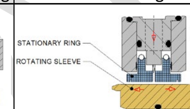
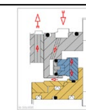
2) labyrinth,

3) contacting bushing.

4) Lift-off bushing,

5) Coaxial.

The above types of separation seals have different characteristics. A comparison table is shown in Figure E2.~~Labyrinths have the highest separation gas consumption but are the simplest design. Non-contacting bushings offer opportunities for lower separation gas consumption. Contacting bushings offer opportunities for the lowest separation gas consumption but will wear.~~

	Separation Seal Type		Non-Contacting Bushing	Labyrinth	Contacting Bushing	Lift-off Bushing	Coaxial
	Figure						
Attribute Comparison	Consumption / Clearance	Cold/static	medium	high	low	low	low
	Note: Control System Method may impact consumption.	Hot/dynamic	low	high	low	low	low
	Typical Control System Method		flow, differential pressure (dP)	flow, differential pressure (dP)	differential pressure (dP)	flow, differential pressure (dP)	differential pressure (dP)
	Potential for Wear during normal operation (result from constant contact)		low	low	high	low	low
	Potential to Flow Process Gas to Bearing Housing (vent/secondary vent cavity pressure **BELOW** separation seal gas supply pressure)		low	medium	low	low	low
	Potential to Flow Process Gas to Bearing Housing (vent/secondary vent cavity pressure **ABOVE** separation seal gas supply pressure)		low	high	low	low	low
	Supply Gas Filtration Requirement (need for higher filtration)		medium	low	medium	medium	medium
	Complexity		medium	low	medium	medium	high

E.2 Separation Seal—Non-contacting Bushing

E.2.1 Overview

Non-contacting bushing seals consist of two segmented rings, typically made of carbon, separated by a central port, and each held together by a garter spring. The segmented rings typically have an anti-rotation device but are designed to be non-contacting float for radial movement. ~~The rings are designed to be non-contacting and float to allow for radial movement~~. A separation gas is supplied to the central port at a pressure greater than the downstream bearing housing and seal vent cavity pressures. The separation gas flows through the annulus created between the segmented rings and rotating surface (Figure ~~E.2~~ E.3).

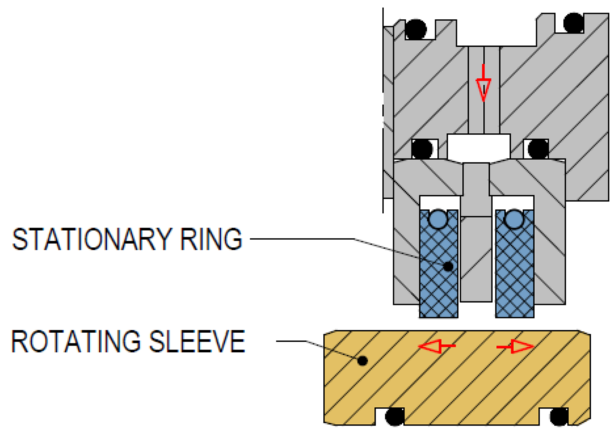


Figure E.3~~E.2~~—Separation Seal Non-contacting Bushing Schematic

E.2.2 Considerations

This design has multiple components.

Non-contacting bushing seals have smaller clearances than the labyrinth seal and therefore less separation gas consumption.

Clearance at cold/static conditions will be different than at hot/dynamic conditions, which will affect leakage and velocity (Figure E.4 ~~E.3~~). The clearance is larger during cold/static conditions and is smaller during hot/dynamic conditions. Therefore, the required velocity should be sized on the cold/static conditions.

For this separation seal type, the typical control methods are flow control or differential pressure (see Part 3, Annex B—Modules M and M2).

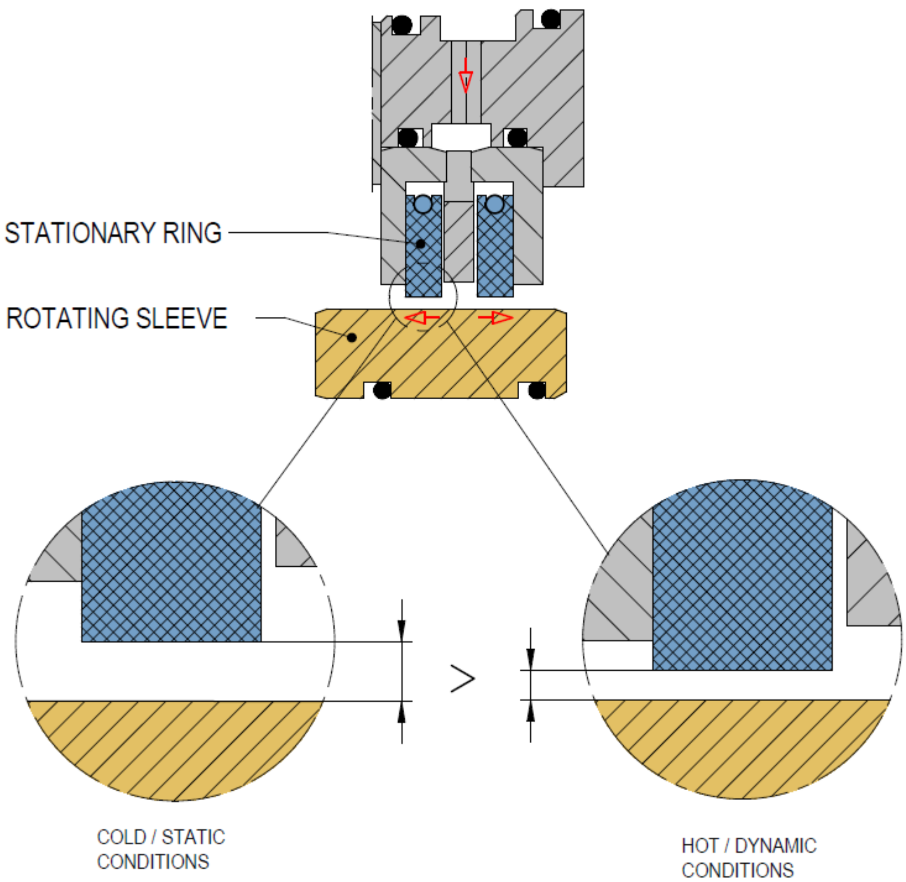


Figure E.4 ~~E.3~~—Showing Separation Seal Non-contacting Bushing Clearance at Cold/Static and Hot/Dynamic Conditions

E.3 Separation Seal—Labyrinth

E.3.1 Overview

The labyrinth teeth are usually on the stationary component, made of aluminum, and consist of two sections divided by a central port (Figure E.5~~E.4~~). The design is non-contacting, fixed radially, and operates at a clearance greater than maximum bearing clearance plus possible radial shaft movements (e.g. rotor sag, shaft position, and deflections). A separation gas is supplied to the central tap at a pressure greater than the downstream bearing housing and seal vent cavity pressures. The separation gas flows through the annulus created between the teeth and rotating surface.

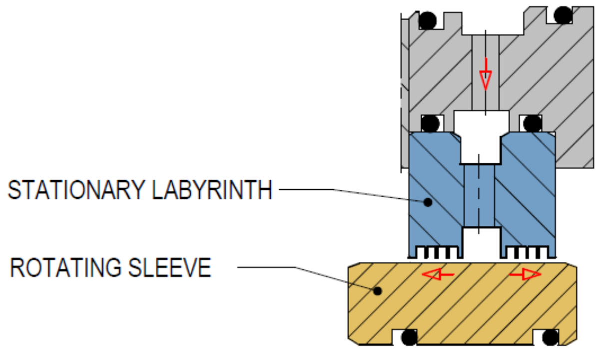


Figure E.5~~E.4~~—Separation Seal Labyrinth Schematic

E.3.2 Considerations

This design contains few components.

Compared to other separation seal types, the labyrinth seal has the largest clearance and therefore increased separation gas consumption.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged, due to the large clearance (Figure E.6~~E.5~~). This results in a minimal change in leakage and velocity.

For this separation seal type, the typical control method is flow control (see Part 3, Annex B—Module M).

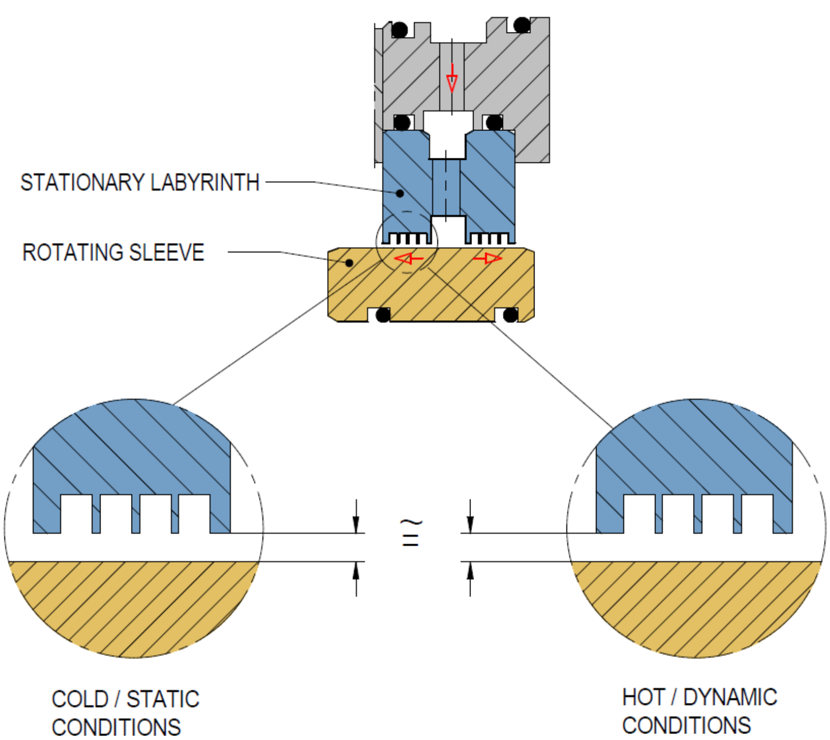


Figure E.6 ~~E.5~~—Showing Separation Seal Labyrinth Clearance at Cold/Static and Hot/Dynamic Conditions

E.4 Separation Seal—Contacting Bushing

E.4.1 Overview

Contacting bushing seals consist of two segmented rings, typically made of carbon, separated by a central port, and each held together by a garter spring. The rings are pressure balanced to minimize the closing forces and joints are designed to expand and contract as the operating temperature varies from cold/static to hot/dynamic conditions. The segmented rings typically have an anti-rotation device but ~~The rings~~ float to allow for radial movement (Figure ~~E.7~~ E.7). The net result is a minimal clearance during all operating conditions with design features to reduce wear. A separation gas is supplied to the central port at a pressure greater than the downstream bearing housing and seal vent cavity pressures. It is the pressure of the separation gas that prevents oil from migrating to the seal cavity and seal leakage from entering the bearing cavity.

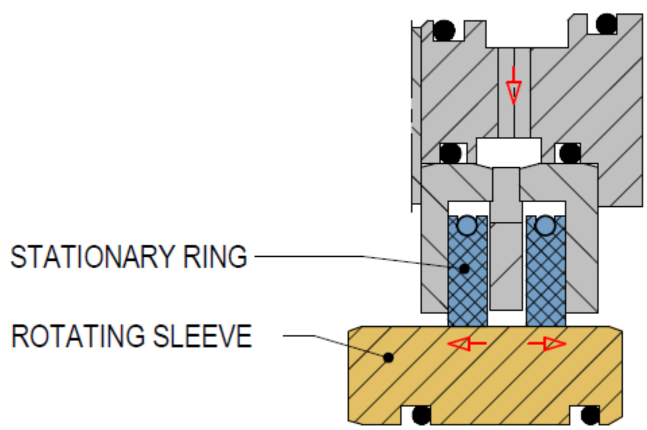


Figure E.7 ~~E.6~~—Separation Seal Contacting Bushing Schematic

E.4.2 Considerations

This design has multiple components.

Contacting bushing seals have the least clearance of the separation seals and therefore less separation gas consumption.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged, due to the contacting nature of the design (Figure E.8~~E.7~~). This results in minimal changes in leakage and velocity.

For this separation seal type, the typical control method is differential pressure control (see Part 3, Annex B—Module M). Due to the contacting design, the seal will wear and improper separation gas pressure can accelerate the wear rate.

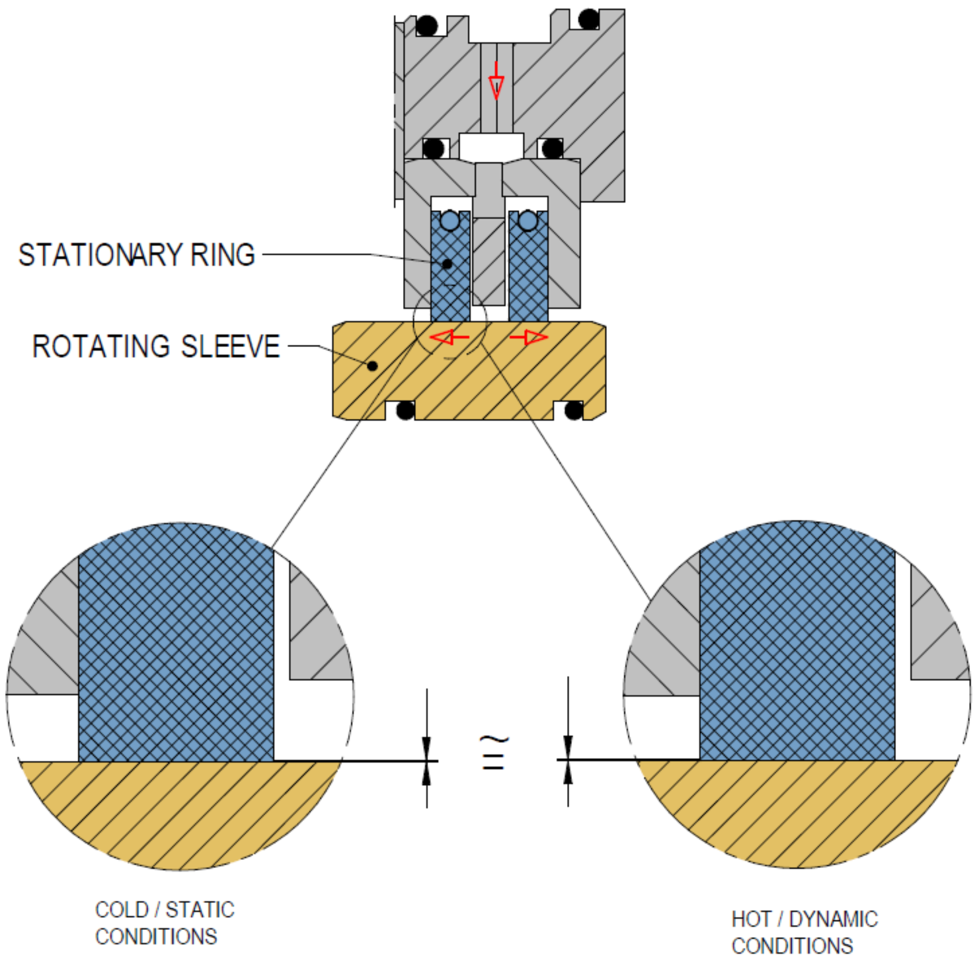


Figure E.8~~E.7~~—Show Expansions of the Separation Seal Contacting Bushing and Rotating Surface

E5 Separation Seal – Non-Contacting Lift-off Bushing

E.5.1 Overview

Lift-Off bushing seals consist of two segmented rings, typically made of carbon, separated by a central port, and each held together by a garter spring. The segmented rings typically have an anti-rotation device but are allowed to float for radial movement. The rings are pressure-balanced to provide lift off when separation gas is supplied between the rings. Ring segments are designed to expand and contract to accommodate pressure variances and fluctuations in operating temperature, ensuring a similar gap between the rings and rotating sleeve during both cold/static and hot/dynamic conditions (Figure E.9).

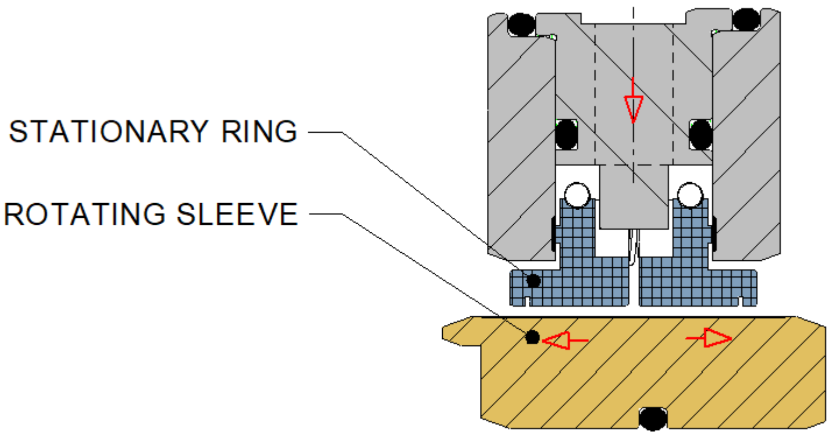


Figure E.9 – Lift-Off Bushing Seal Schematic

E.5.2. Considerations

This design has multiple components.

Lift-off bushing seals contact the rotating surface without the separation gas (Figure E.10).

Lift-off bushing seals have smaller clearance than the non-contacting bushing seal at cold/static condition, and therefore low separation gas consumption.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged (Figure E.11).

For this separation seal type, the typical control method is differential pressure (see Part 3, Annex B- Module M2).

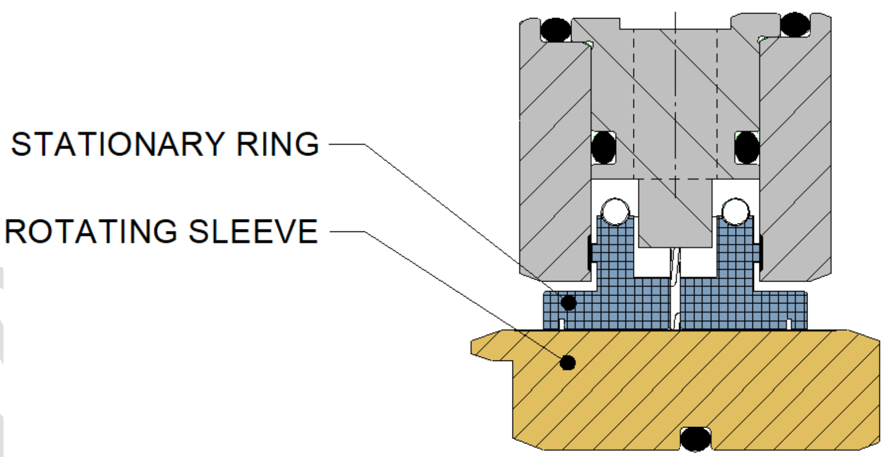


Figure E.10 – Showing Separation Seal Lift-off Bushing contacts at the rotating surface without the separation gas

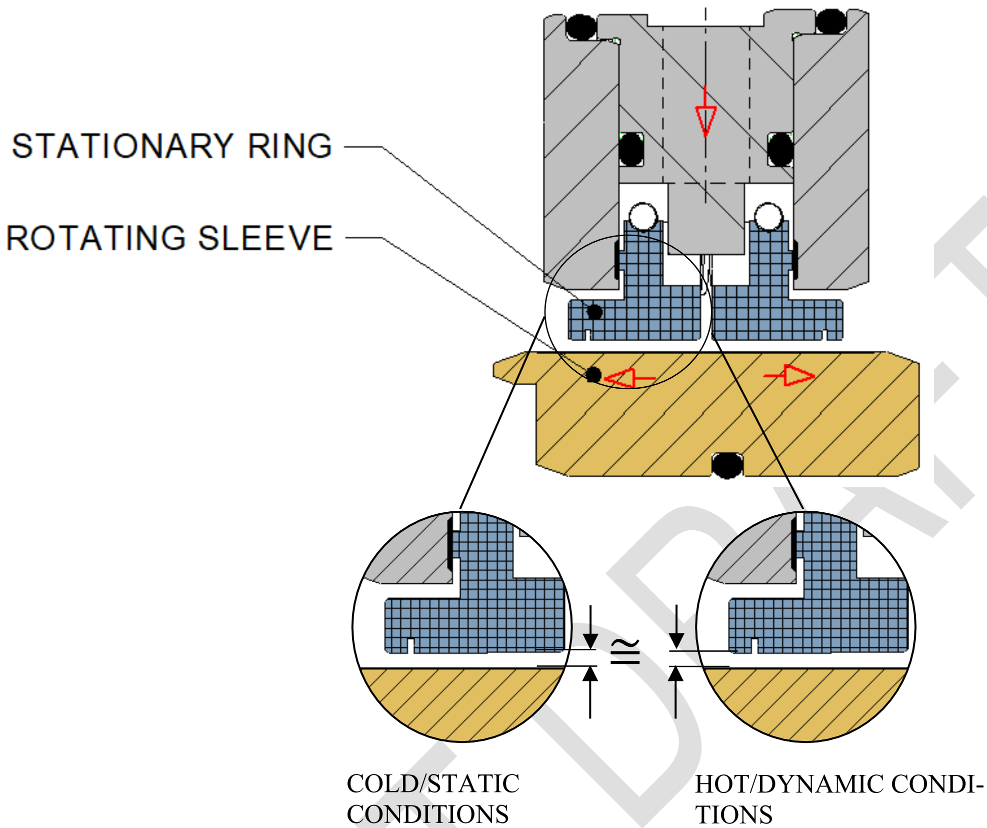


Figure E.11 – Showing Separation Seal Lift-off Bushing Clearance at Cold/static and Hot/Dynamic Conditions

E6 Separation Seal -Coaxial Separation Seal

E.6.1 Overview

Coaxial Separation Seals consist of a single set of seal faces forming an axial gap similar to a Dry Gas Seal. The rotating ring is assembled in a shaft sleeve. The stationary ring is assembled in a housing including an anti-rotation device and axial springs pushing the rings together. Separation gas is injected through the stationary seal faces between two sets of etched grooves sealing in both radial directions enabling contact-free start and stop.

Separation gas flow A exiting toward the bearing side prevents oil migration from the bearing cavity and separation gas flow B exiting the ID of the seal faces is directed toward the vent/secondary vent (Figure E.12).

Clearance during cold/static conditions will be different than at hot/dynamic conditions. During operation, the faces will separate and allow a small leakage. During cold/static conditions, the faces remain closed. (Figure E.13).

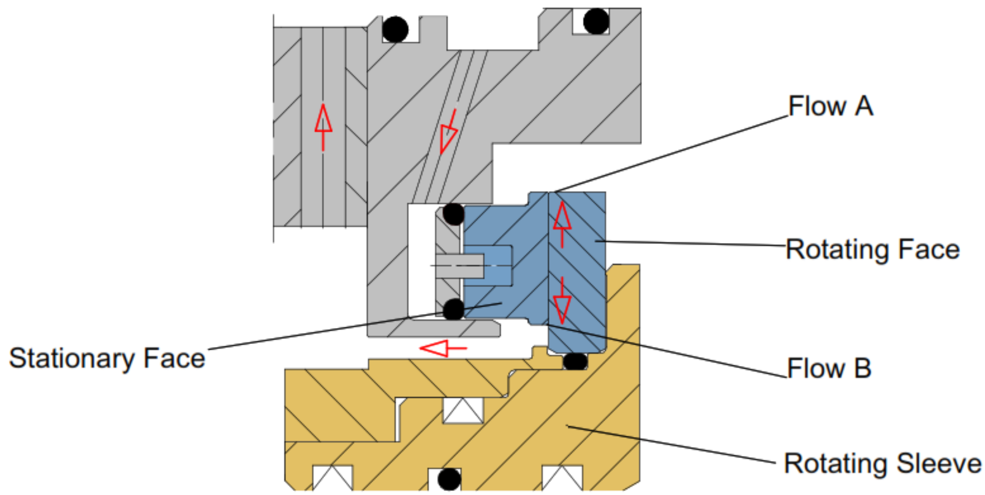


Figure E.12 – Coaxial Separation Seal Schematic showing flow direction of separation gas

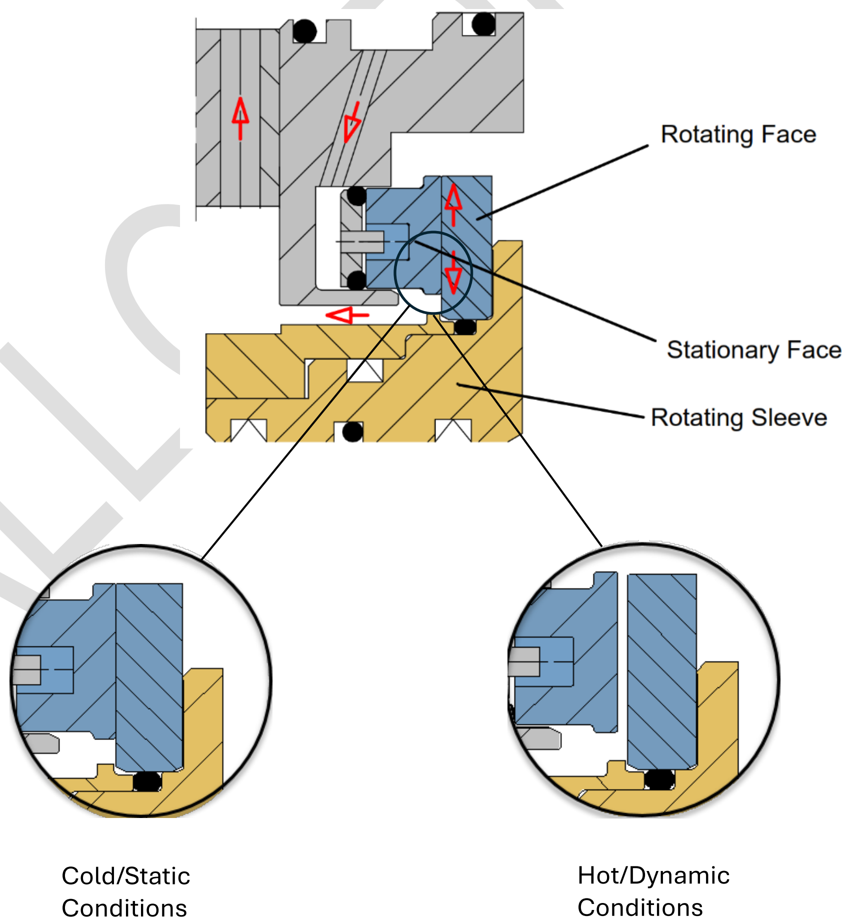


Figure E.13 – Showing Coaxial Separation Seal Clearance at Cold/static and Hot/Dynamic Conditions

E.6.2. Considerations

This design has multiple components.

Coaxial seal faces contact without the separation gas in standstill. A minimum differential pressure is required for static lift-off and to ensure contact free start up and shut down.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged. When pressurized Coaxial seals have small static clearance similar to that of DGS and therefore low separation gas consumption. In dynamic operation separation gas consumption will increase slightly with increasing RPM.

For this separation seal type, the typical control method is differential pressure control to the secondary vent/vent.

Annex F
(informative)

Process Side Seal

F.1 Introduction

The process side seal is a device located between the dry gas seal and the compressor internals. Together with an adequate gas supply, it creates the necessary gas velocity to prevent the flow of unconditioned process gas, debris, or liquids from reaching the dry gas seal (Figure F.1). In the event of a seal failure, the process side seal can act as a restriction limiting the release of process gas.

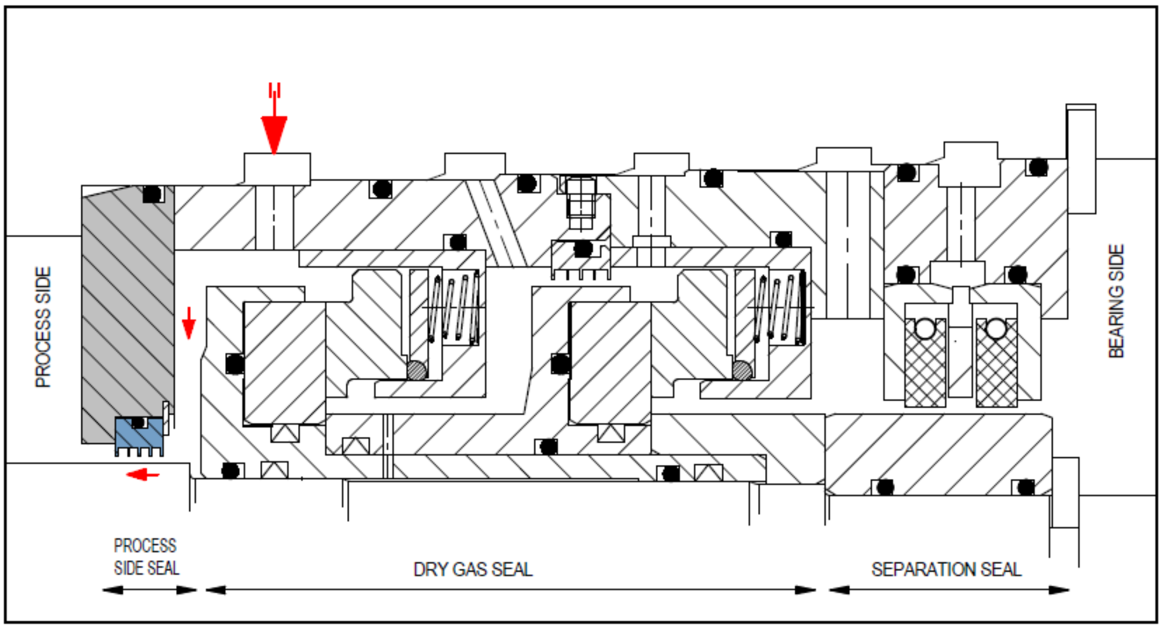


Figure F.1—Cross-section Showing a Process Side Seal

Process side seals consist of a stationary and rotating pair of components, having a clearance between them through which seal or buffer gas passes. The rotating component is a driven shaft sleeve. Stationary components have anti-rotation provisions.

Seal or buffer gas is supplied into the cavity between the dry gas seal and the process side seal at a pressure or flow sufficient to maintain a positive differential across the process side seal, directing the flow into the machine internals (Figure F.1). It is the velocity of the seal or buffer gas through the process side seal that prevents unconditioned process gas from reaching the dry gas seal.

Gas is supplied prior to pressurization of the compressor casing and maintained whenever the compressor casing is pressurized to prevent contamination of the dry gas seal.

Process side seal types have different clearances, which affects the seal or buffer gas consumption.

Process side seals are in direct contact with process gas. Material compatibility is an important consideration based on gas composition, pressure, and temperature.

There are three common types of process side seals, as follows:

1) standard labyrinths,

2) abradable labyrinths,

3) non-contacting bushings.

The above types of process side seals have different characteristics. Standard labyrinths have the highest gas consumption but are the simplest design. Abradable labyrinths and non-contacting bushings offer opportunities for lower seal and buffer gas consumption, with non-contacting bushings typically having the lowest consumption.

F.2 Process Side Seal—Standard Labyrinth

F.2.1 Overview

The labyrinth teeth are usually on the stationary component and are made with materials compatible with the process. They can be made of engineered thermoplastics (Figure F.2). The design is non-contacting, fixed radially, and operates at a clearance greater than maximum bearing clearance plus possible radial shaft movements (e.g. rotor sag, shaft position, and deflections).

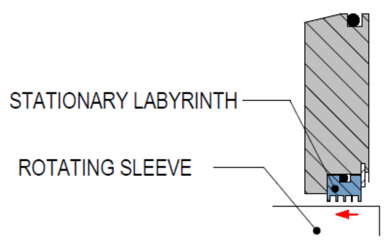


Figure F.2—Process Side Seal Standard Labyrinth Schematic

F.2.2 Considerations

This design contains few components.

Compared to other process side seal types, the labyrinth seal has the largest clearance and therefore increased gas consumption.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged, due to the large clearance (Figure F.3). This results in a minimal change in leakage and velocity.

For this process side seal, the typical control method is flow control (see Part 3, Annex B—Modules DT and T).

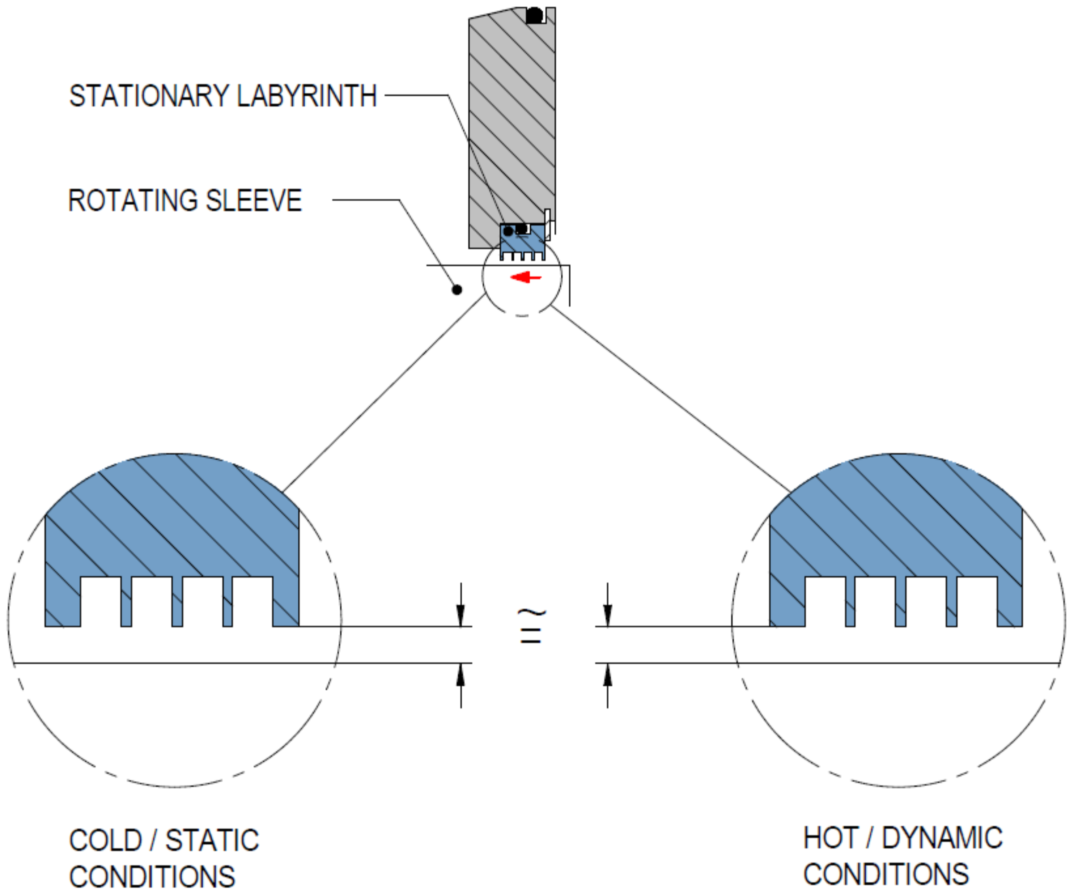


Figure F.3—Showing Process Labyrinth Clearance at Cold/Static and Hot/Dynamic Conditions

F.3 Process Side Seal—Abradable Labyrinth

F.3.1 Overview

The teeth of the abradable labyrinth can be located either on the stationary or rotating component. The abradable material is typically made from enhanced PTFE or engineered thermoplastics. The design is fixed radially and non-contacting; however, misalignment and shaft deflections can produce contact. Due to the nature of the abradable material, minor contact may not be detrimental to the seal. This seal operates at a clearance value slightly greater than or equal to maximum bearing clearance plus possible radial shaft movements (e.g. rotor sag, shaft position, and deflections). The clearances are designed such that contact is a possibility, whereas the standard labyrinth clearances are designed to ensure contact does not occur during operation (Figure F.4).

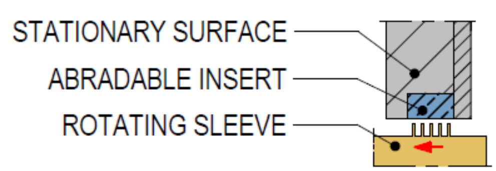


Figure F.4—Process Side Seal Abradable Labyrinth Schematic

F.3.2 Considerations

This design contains few components.

Abradable labyrinth seals have smaller clearances than the standard labyrinth seal and therefore less gas consumption.

Clearance at cold/static conditions vs hot/dynamic conditions remains relatively unchanged, due to the nature of the abradable material and its associated clearance (Figure F.5). This results in a minimal effect on leakage and velocity.

For this process side seal type, the typical control methods are flow control or differential pressure (see Part 3, Annex B—Modules DT and T for flow and Modules DT1 and T2 for pressure).

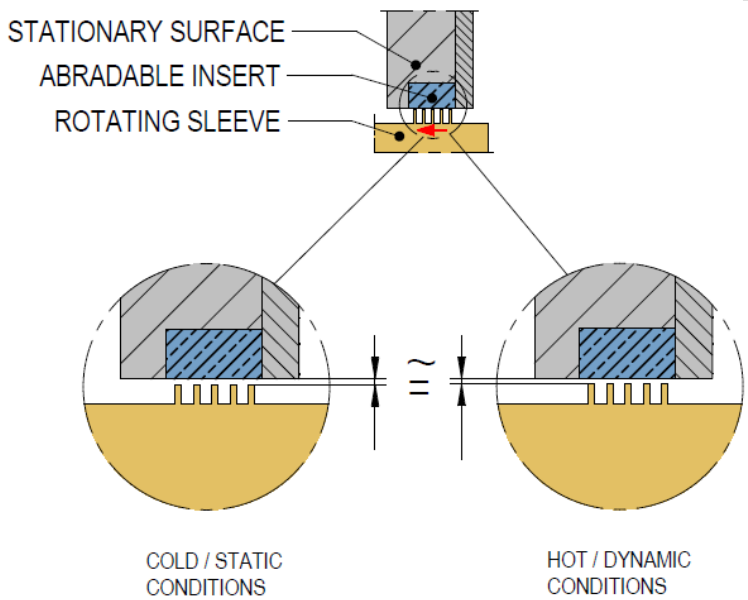


Figure F.5—Showing Process Abradable Labyrinth Clearance at Cold/Static and Hot/Dynamic Conditions

F.4 Process Side Seal—Non-contacting Bushing

F.4.1 Overview

Non-contacting bushing seals consist of one segmented ring, typically made of carbon, and held together by a garter spring. The ring is designed to remain non-contacting during hot/dynamic operation and floats to allow for radial movement (Figure F.6).

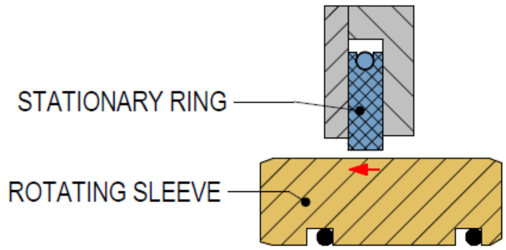


Figure F.6—Process Side Seal Non-contacting Bushing Schematic

F.4.2 Considerations

This design has multiple parts and can be provided integral to the dry gas seal cartridge or as a separate cartridge assembly.

Non-contacting bushing seals have smaller clearances than the standard labyrinth seal and therefore less seal or buffer gas consumption.

Clearance at cold/static conditions will be different than at hot/dynamic conditions, which will affect leakage and velocity (Figure F.7). The clearance is larger during cold/static conditions and is smaller during hot/dynamic conditions. Therefore, the required velocity should be sized on the cold/static conditions.

For this process side seal, the typical control methods are flow control or differential pressure (see Part 3, Annex B—Modules DT and T for flow and Modules DT1 and T2 for pressure).

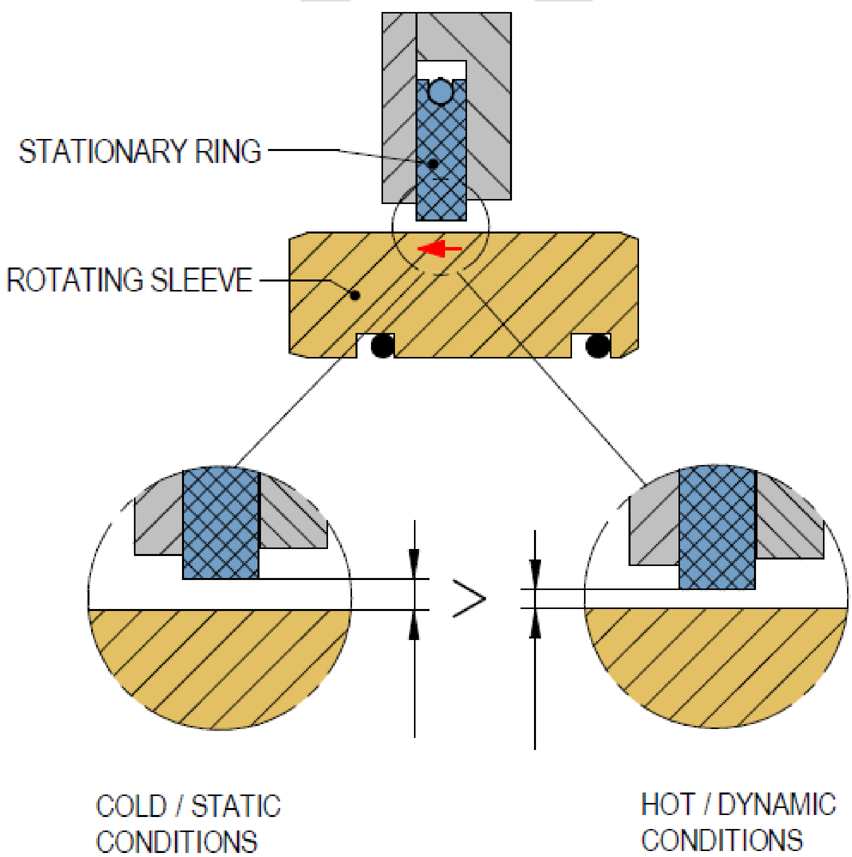


Figure F.7—Showing Process Non-contacting Bushing Clearance at Cold/Static and Hot/Dynamic Conditions

Annex G
(informative)

Hysteresis Test

G.1 General

A hysteresis test is a measurement of the force difference between compression and decompression force of the stationary subassembly. The measured force difference (hysteresis) is representing the friction characteristic of the dynamic seal element sliding along the balance diameter over the displacement range (see Figure G.1).

G.2 The purpose of this test is to verify functionality of the following:

a) surface roughness of the balance diameter,

b) spring-load,

c) pre-load of the dynamic sealing element.

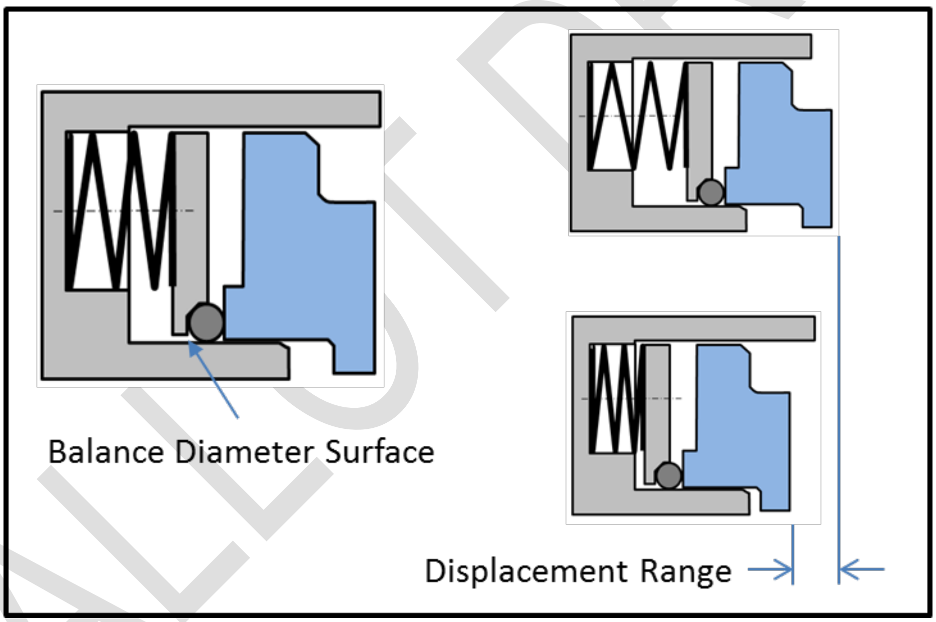
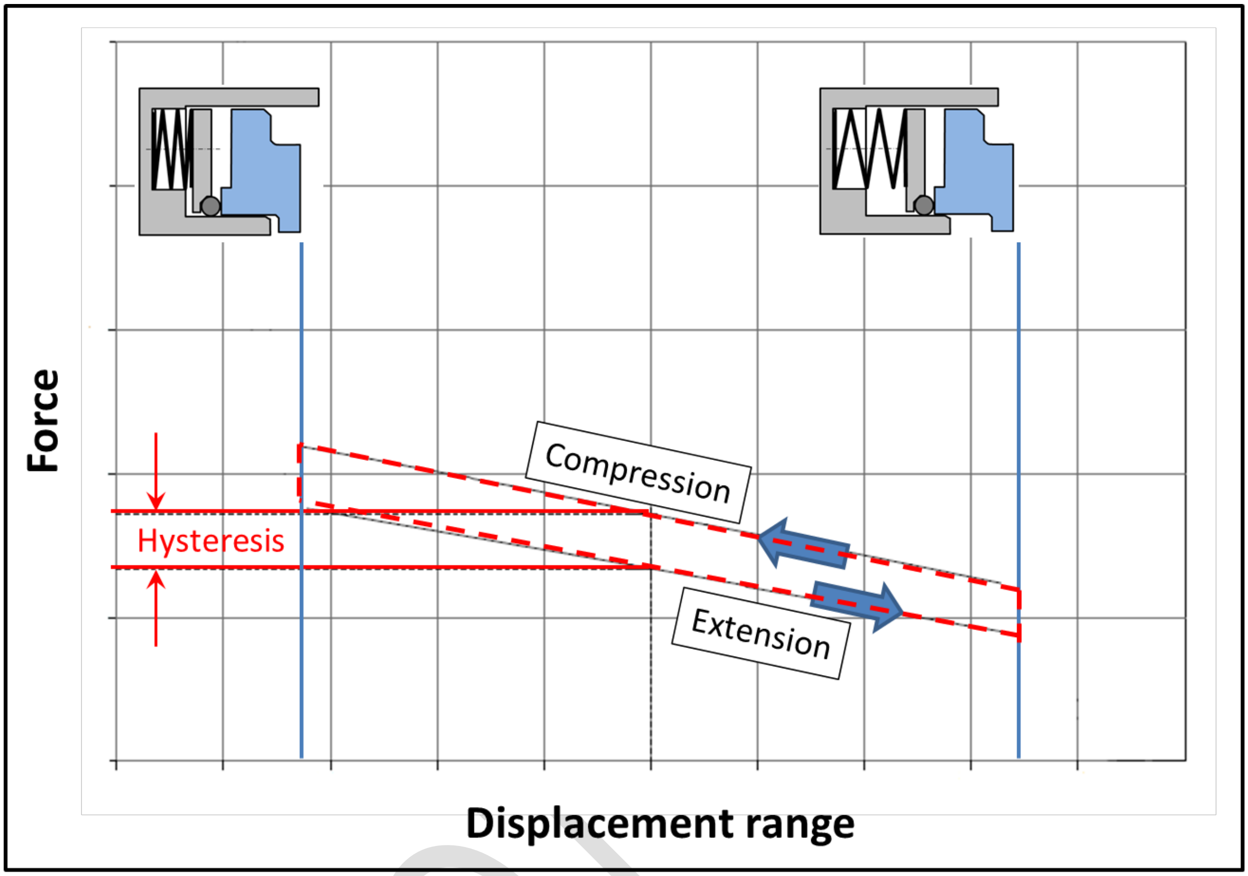


Figure G.1—Stationary Subassembly Definitions

G.3 The displacement range of the subassembly is plotted in a graph vs the measured force (Figure G.2).



NOTE Compression: Measured Force = Spring Force + Friction Force. Extension: Measured Force = Spring Force − Friction Force.

Figure G.2—Typical Hysteresis Test Plot

Annex H
(informative)

Dry Gas Seal Materials

H.1 General

The materials discussed in this annex are for information only and provide information relating to typical materials used at the time of publication of this document. Actual properties, seal face pairings, and applications should be selected based on the service and experience. Material selections for the dry gas seal shall be compatible with the process gas and specified operating conditions.

This section covers the materials that are most frequently used in the design of dry gas seals. It is, however, acknowledged that other types of materials could be used. The diverse nature of the processes into which dry gas seals are employed dictate that material selection, analysis, evaluation, and testing should be adopted wherever possible. The materials stated in this section relate only to components that typically form part of, or are connected to, the DGS cartridge assembly. Items used in dry gas seal supply systems are beyond the scope of this section.

Throughout this annex, numerical values are used to represent operating conditions or material properties that are typically encountered. These values are not intended to be absolute values; they are merely provided for representative purposes only. In situations where these values are approached or considered relevant, it is advisable to consult the appropriate vendor for specific guidance.

Where actual values encountered are similar to the stated guidance values, some additional insight should be sought from vendors. It should also be appreciated that many operational issues are interrelated and hence guidance values should be quantified so that application specific values can be identified.

Material listings in this section are categorized by the component, material types used for that component, narrative, listing, and other issues. The component names adopted can be referenced to Figure C.1 through C.4 in Annex C. The material types briefly describe the group or category of each material since it is possible to produce certain dry gas seal components out of completely different materials. The narrative briefly discusses the basic difference between alternative materials and why they could be favored or discounted for different duties. The material listing adopts a tabular form where relevant standards are cited together with typical usage or limitation for each material. Some notes are added at the end of each component category where other factors are considered.

H.2 Rotating Seal Face—Silicon Carbide, Silicon Nitride, Tungsten Carbide, and Steel

Selection of rotating seal face material is primarily based upon hardness, chemical compatibility, rigidity, thermal stability, and strength. Most of the materials used for rotary faces are proprietary brands where individual organizations have developed their own compositions and production methods. Industry standards governing such specific material properties do not exist. Therefore, each seal manufacturer abides by their own internal standards and applies these materials within their established guidelines. A comparison of material properties is provided in this annex.

Tungsten carbide (WC) materials have high strength, toughness, and rigidity. Several different grades are used for rotating seal faces. Common binders are cobalt and nickel. Each can be prone to chemical attack in certain media. Nickel binders have improved chemical resistance but are somewhat softer and are lower in strength. All tungsten carbide grades have a high density in comparison with other seal materials. Due to the high density, the suitability for elevated surface speeds (typically greater than 130 m/s) needs to be evaluated, as it is dependent on the material properties, drive mechanism, and centering device. In particular, where failure of the material occurs during operation, the fragments tend to be damaging to surrounding regions. Shroud features in the shaft and spacer sleeve designs can be provided to contain these fragments. One issue that could arise as a consequence of shrouding WC rotating seal faces is that the faces could become insulated from the gas, thereby restricting adequate cooling. This combined with the thermal properties of the seal face material can give rise to thermal degradation of the material in the form of heat checking, whereby excessive thermal stresses produce radial cracks at the sealing surface that develop and can result in fine fractures. On some seal arrangements, the mass of a seal rotor assembly with tungsten carbide rotating seal faces can be large thereby giving more onerous dynamic balance considerations. Generally its high stiffness makes it more deformation resistant than other rotating seal face materials.

Silicon carbide (SiC) is available in numerous grades, but for rotating seal face materials these fall into two basic types: reaction bonded and sintered. There are options of composite hybrids for both types where graphite and other materials are added to provide enhanced operating characteristics. Due to the manner in which SiC is produced, there can be considerable variation in properties due to pressing techniques, process aids, grain refinement, plus additional post-production annealing techniques that are conducted to provide improved material integrity. Liquid phase SiC is particular material grade where specialist processing has been adopted to improve properties. Composite grades tend to favor the addition of graphite to enhance tribological properties; however, this enhancement is at the expense of chemical resistance, hardness, and strength. Typical failure mechanisms for SiC are brittle fracture due to repeated contact at the sealing interface or at mating surfaces with adjoining parts. In most cases, this results in small fragments being dispersed around the seal. The sleeve shroud feature is adopted to contain this debris. In general, lower mechanical strength and fracture toughness can lead to chipping that in turn can cause other sealing integrity issues.

Silicon nitride (Si_3N_4 or SiN) tends to be used where the mechanical properties of SiC materials may not be able to withstand high rotational speeds (typically >180 m/s) where higher tensile strength and fracture toughness are desirable. Despite these advantages, SiN does not have the same chemical resistance as SiC materials and hence limiting its use. Typical failure mechanisms are similar to that of SiC.

Alloy steel is sometimes used in instances where the consequences of brittle failure need to be avoided. These rotating seal faces are often made out of a similar material as the other seal components. Sometimes the sealing surface is coated with a hard coating. The relative low stiffness of alloy steel material tends to limit usage to lower pressures (<50 bar) due to localized distortion issues. The typical failure modes are thermal distress and high leakage that would result in distortion of the sealing interface and heavy contact. This limits alloy steel rotary seats to lower sealing duties. Unlike carbide materials, alloy steel rotating seal face failure does not result in brittle fragments contaminating the surrounding region. Despite the latter, alloy steel rotating seal faces are still spin tested to verify the integrity of the bonding adhesion between the coating and substrate.

Since most rotating seal face materials are produced from powder-based materials, it is important that the structural integrity of the seal faces is verified. This is achieved by individually spin testing the seal faces to speeds that are well in excess of the intended operational conditions. While this appears unnecessary for coated alloy steel rotating seal faces, the same test can prove the bond strength integrity between the coating and substrate. Typical speed related failures are stress related, hence the overspeed test is normally conducted at 122 % of the MCS, thereby inducing a 50 % overstress condition in the material. Spin testing is covered in 6.11.4.

H.3 Stationary Seal Face—Carbon Graphite and Silicon Carbide

Carbon graphite materials are favored for tribological properties and the ability to withstand intermittent slight contact. Plain carbon graphite materials are porous and permeable; therefore, impregnation is required to make them gas tight. The impregnation process also improves strength characteristics. Resin impregnated grades provide good chemical resistance but are mechanically weak and tend to blister. Antimony impregnated grades offer higher strength and blister resistance at the expense of chemical resistance. Nickel chrome impregnation grades are also employed for improved properties and chemical resistance, but availability restricts usage. Irrespective of the binder, it should be stated that carbon graphite does not have anything like the same mechanical strength characteristics as other seal face materials, and this limits the use of carbon to moderate sealing pressures (typically 120 bar). Depending on the dew point, contact at low speeds can produce small dust-like particles that can fill groove features, thereby impairing the lift capability at the sealing interface.

The higher rigidity of silicon carbide makes it less prone to distortion than carbon graphite materials, thereby enabling it to be used as well for high-pressure (above the limit of carbon) seals. Its inability to withstand intermittent slight contact dictates that tribological coatings are required to protect the sealing interface surface during start-up/shutdown and ratcheting and turning gear operating conditions. In general, even slight contact between plain SiC face pairings can cause issues, particularly during ratcheting and turning gear.

Synthetic diamond coatings are now used in mechanical seal face technology. These coatings are applied in thicknesses that generally range between 1 μm and 5 μm. The technology is characterized into two groups; diamond-like carbon (DLC) and polycrystalline diamond (PCD). DLC coatings have a mixed hexagonal lattice sp2/sp3 bonded structure similar to that of graphite, giving it good frictional properties with hardness values similar to that of SiC materials (2,000 HV to 3,000 HV). PCD coatings have a~~n amorphous~~ crystalline structure similar to that of diamond giving to extreme hardness (10,000 HV). Synthetic diamond coatings are often applied to dry gas seals with hard face pairings so that the damaging effects of light contact during start-up, shutdown, and ratcheting and turning gear operating conditions can be minimized.

H.4 Seal Face Operation

Although the exact nature of seal face operation is beyond the scope of this document, it needs to be appreciated that dry gas seal faces can be regarded as having two operating modes separated by lift-off (speed and/or pressure dependent). The first is above lift-off, where there is no contact taking place between the rotating and stationary faces. The second is below lift-off, where light contact can occur between the seal faces. It should also be observed that any dry gas seal faces that are operating with substantial contact can result in seal failure.

In cases where the seal faces operate with no contact, the face pairing is not that much of an issue provided that the chemical compatibility is suitable and all that needs to be established is that the materials can withstand the maximum speed, temperature, and pressure. In order to achieve this, the modulus, strength, and fracture toughness need to be sufficient to withstand the imposed loads within deflection limits. The rotational loads are largely influenced by density where lower density materials produce the least force for a given speed (applies to rotating materials only). Histograms (Figures H.1 to H.7) are provided for typical values of these properties.

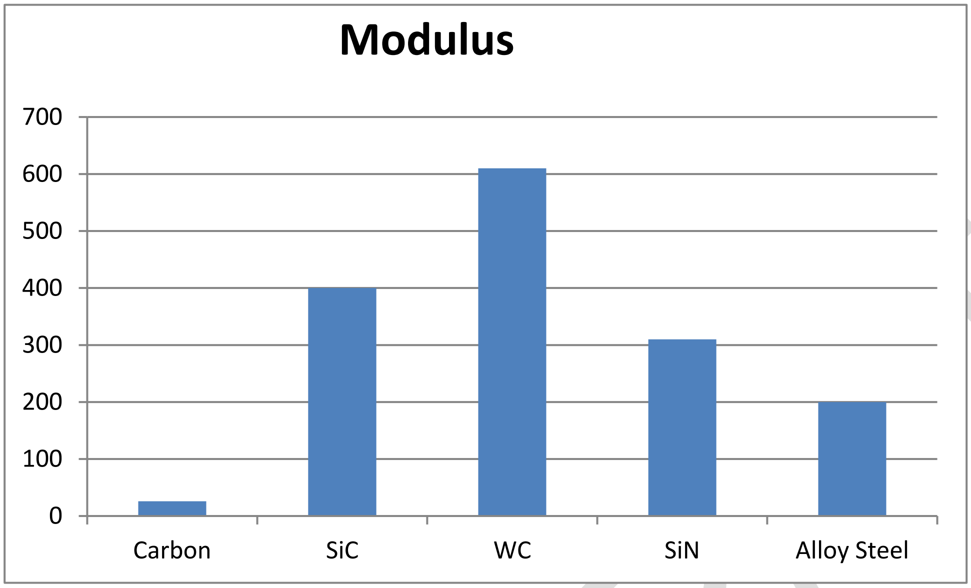


Figure H.1—Histogram Comparing the Elastic Modulus (kN/mm²) of Selected Face Materials. In general, materials with high modulus properties will resist pressure deformation.

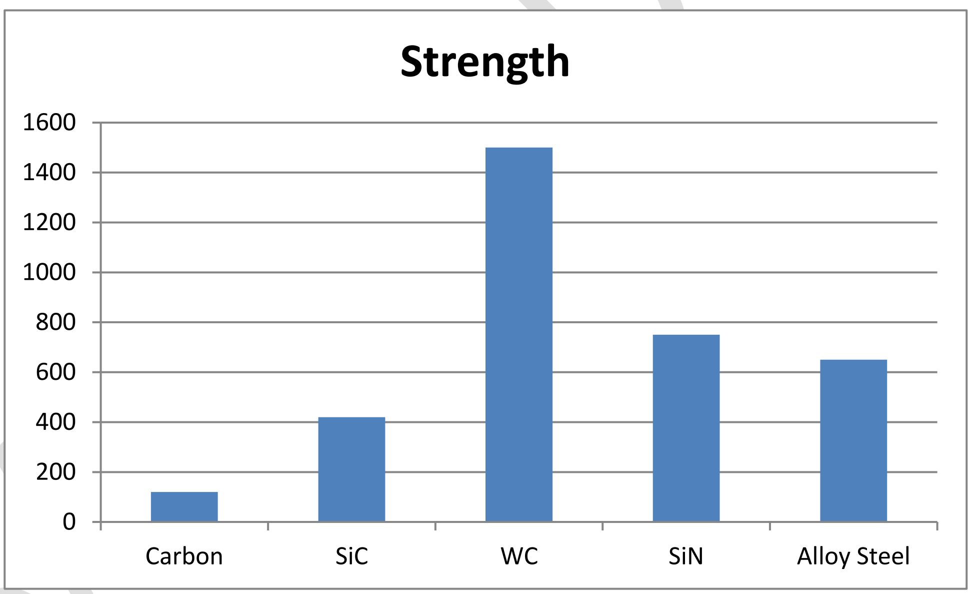


Figure H.2—Histogram Comparing the Strength (N/mm²) of Selected Face Materials. In general, materials with high strength properties can sustain higher loads.

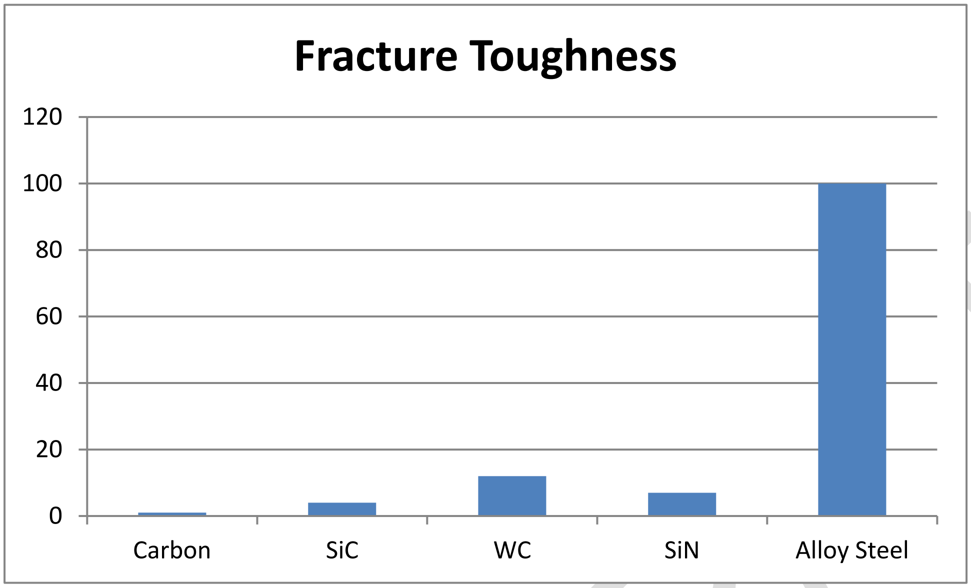


Figure H.3—Histogram Comparing the Fracture Toughness (MPa.m$^{0.5}$) of Selected Face Materials. In general, materials with high fracture toughness properties will resist higher loads before fracture.

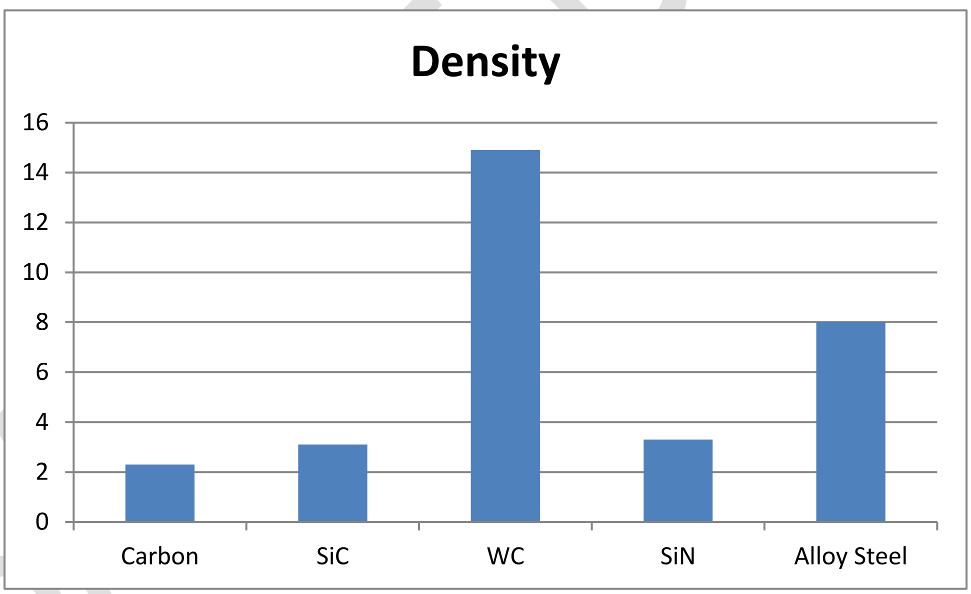


Figure H.4—Histogram Comparing Density (tonnes/m^3) of Selected Face Materials. The density of rotating components induces higher loading is more likely to cause dynamic instability than low-density materials.

When the seal is operating with light contact, other factors such as friction, hardness, and thermal conductivity all influence performance. Mating pairs with high friction would easily be damaged. Harder materials tend to be more resistant toward scoring and damage. The associated contact heat load also strongly influences stability so materials with low thermal conductivity would tend to thermally distress more easily due to heat generation retention within the material. Histograms are provided for typical values of these properties.

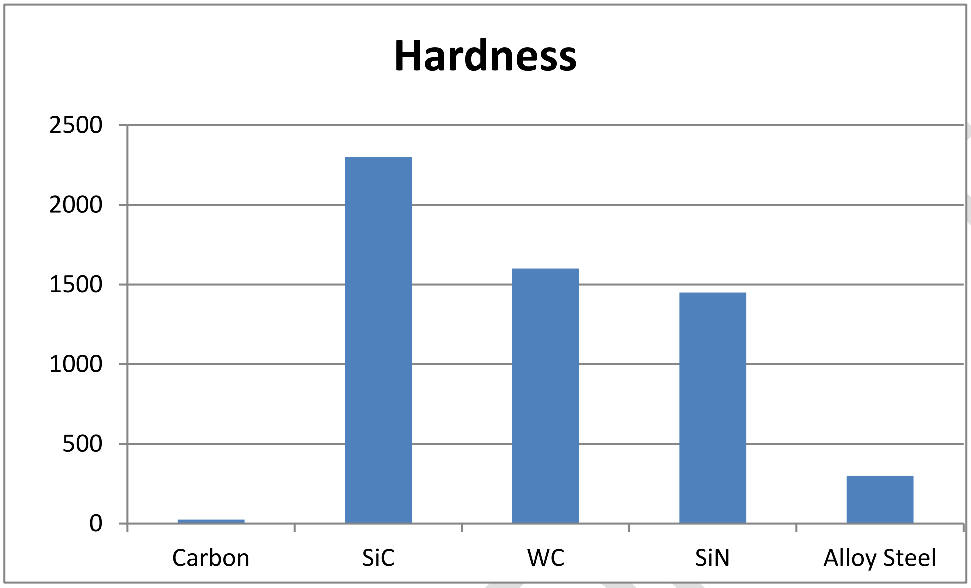


Figure H.5—Histogram Comparing Hardness (HV) of Selected Face Materials.
In general, materials with high hardness properties are more likely to resist surface degradation.

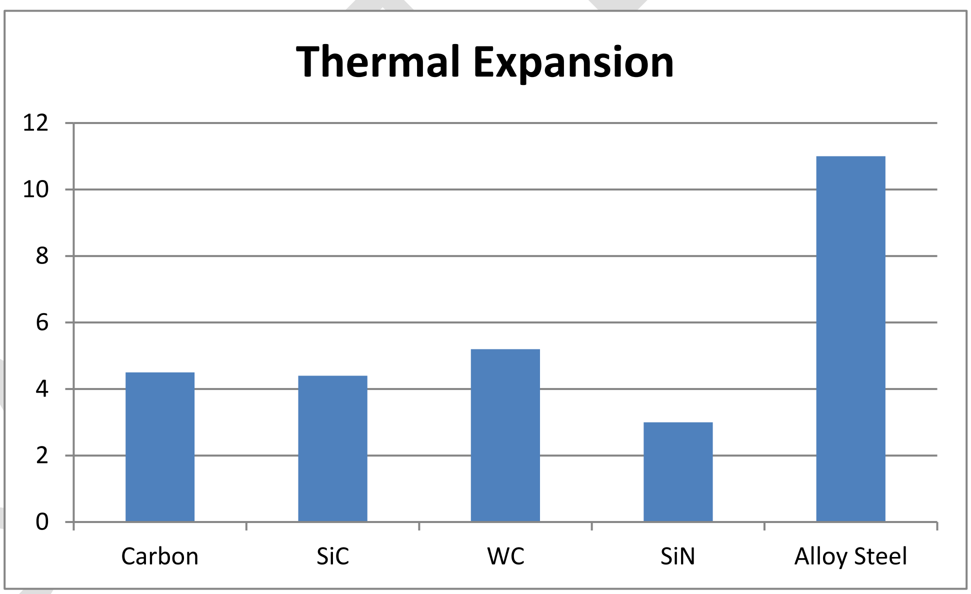


Figure H.6—Histogram Comparing Thermal Expansion (m/m/K×10^{-6}) of Selected Face Materials.
Where different materials are used in an assembly, the thermal expansion of each material should be evaluated so that assemblies do not suffer from unwanted interference or excessive clearances at operational temperature extremes.

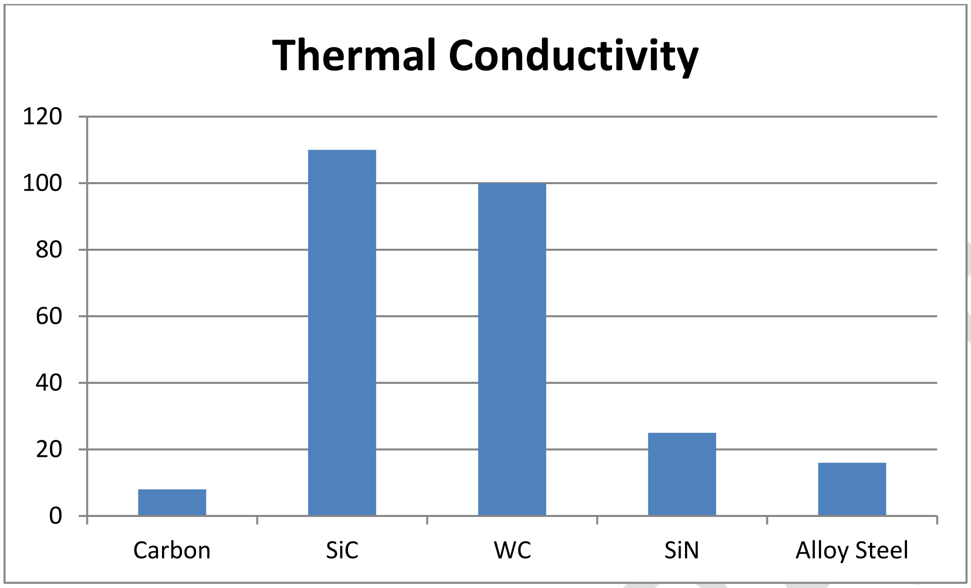


Figure H.7—Histogram Comparing Thermal Conductivity (W/mK) of Selected Face Materials. In general, materials with low thermal conductivity properties will thermally distress due to heat retention within the material.

Table H.1 provides details for typical dry gas seal face pairings; the notes are for general guidance only.

Table H.1—Seal Face Pairing Selection Guidance

Face Combination	Stationary Face	Application	Rotating Face	Application
C-WC	Carbon graphite	Carbon graphite susceptible to pressure distortion that limits the application pressure	Tungsten carbide	Tungsten carbide can be applied to speeds < 130 m/s
C-SiC			Silicon carbide	Silicon carbide can be applied to speeds < 140 m/s
C-SiN			Silicon nitride	Silicon nitride can be applied to speeds > 140 m/s
C-SS			Alloy steel coated	Pressure and thermal distortions limits the application pressure, typically < 80 bara
SiC-WC	Silicon carbide [a]	Silicon carbide minimizes pressure distortions and can be applied to extreme pressures	Tungsten carbide	Tungsten carbide can be applied to speeds < 130 m/s
SiC-SiC			Silicon carbide	Silicon carbide can be applied to speeds < 140 m/s
SiC-SiN			Silicon nitride	Silicon nitride can be applied to speeds > 140 m/s

[a] DLC surface coating is often applied to the sealing interface to enhance tribological properties.

H.5 Sleeves, Retainers, Housings, Disk, and Carrier—Metals

Primary material selection for these components is based upon temperature resistance, strength, and chemical compatibility. This makes stainless steel usage quite common due to commercial availability and the large amount of data available relating to performance in aggressive media. Although austenitic grades have good chemical resistance, their relatively low mechanical strength tends to limit usage to low pressure and moderate speeds. Martensitic materials are more widely employed due to much higher strength characteristics; however, care should be taken with selection of the material group on low-temperature applications. In cases where specialist steels are adopted, the composition and designation of these materials can be proprietary brands where no harmonized standards exist. High nickel content alloys are typical of such materials.

Table H.2 provides details for typical dry gas seal cartridge materials; the information is only for general guidance.

Table H.2—Seal Cartridge Materials

Material Description	Grade Name	ASTM	UNS	Usage
Austenitic stainless steel	316(L)	A479 Type 316L	S31603	Low duty seals requiring chemical resistance
Martensitic stainless steel	410	A479 Type 410	S41000	Moderate duty seals requiring moderate chemical resistance
Martensitic stainless steel	418	A479 Type 418	S41800	Moderate duty seals requiring moderate chemical resistance with low-temperature service
Martensitic stainless steel	Duplex	A276-S31803	S31803	Moderate duty seals requiring pitting and chemical resistance
Martensitic stainless steel	Super duplex	A276-S32760	S32750	High duty seals requiring pitting and chemical resistance
Martensitic stainless steel	17-4 PH	A564	S17400	High duty seals requiring moderate chemical resistance
Nickel, chrome, molybdenum	Alloy C276	B574	N10276	Moderate duty seals requiring extreme chemical resistance
Nickel-iron-chromium alloy	Alloy 20	B473	N08020	Moderate duty seals requiring particular chemical resistance
Nickel, copper alloy	Alloy 400	B164	N04400	Moderate duty seals requiring particular chemical resistance
PH nickel, copper alloy	Alloy 500	B865	N05500	High duty seals requiring particular chemical resistance
Nickel-chromium alloy	Alloy 625	B446	N06625	Moderate duty seals at elevated temperature.
Nickel-chromium alloy	Alloy 718	B637	N07718	Moderate duty seals at elevated temperature.
Nickel-chromium alloy	Alloy 725	B805	N07725	Moderate duty seals at elevated temperature.

For large seal sizes, bar stock is not readily available and hence forgings are often used as the preferred form for the materials. Equivalent forged materials to the relevant bar stock standards should be selected.

Selected metal surfaces can be treated or coated to further enhance material property or performance in critical areas. Hard facings and coatings can be required to prevent wear.

In applications where there is hydrogen sulfide present in the gas, steel components can be prone to various forms of chemical attack and pitting, especially cracking. Under such conditions, it is usual to find that steels with stabilized grain structure and tightly controlled hardness are necessary to limit the potential for cracking. These materials are covered by international standard NACE MR0103. Where such materials are specified, the appropriate documentation should be supplied with the seals as proof of conformance.

H.6 Static and Dynamic Sealing Elements

~~H.6.1~~ Elastomer or Polymer ~~and Steel~~

There are two main types of static and dynamic sealing elements used in dry gas seal assemblies; these are self-energizing elastomer seals and spring energized polymer seals. These sealing devices are used to prevent leakage between adjacent seal parts within the cartridge and along its interface to the compressor. Within the cartridge there are two types of sealing element modes: static and dynamic. The dynamic O-ring has to compensate for any relative movement of the sealing interface.

O-rings are elastomeric self-energized seals that are compressed within grooves to “affect” an initial sealing interface that is further influenced by the pressure and temperature of the sealed medium plus any motion with its surrounding.

Pressure limits for O-rings are influenced by the material, temperature, and geometry (particularly the groove fill ratio and the extrusion gap).

Rapid gas decompression (explosive decompression) is a particular issue when using elastomers to seal gases. The microstructure of the material allows high-pressure gases to permeate into the O-ring material, thereby forming pockets of high-pressure gas that become trapped within the material. Once the system pressure is lowered, these pockets remain at high pressures and damage can occur to the O-rings due to tensile loads produced due to gas expansion because of the pressure differentials between the pockets and lowered system pressure. This process is driven by the rate at which depressurization occurs where depressurization rates of 20 bar/minute (NORSOK M710) are often imposed to protect the sealing members from damage, although this rate should be modified to account for temperature variations. A further means to protect O-rings from RGD/ED damage is to use grades that are made more resistant to such effects. These devices are classed as RGD/ED resistant grades and have undergone specific tests to assess the integrity under rapid depressurization conditions. These grades tend to have higher hardness (90 Shore A), density, and strength than standard O-ring materials. Given also that the hardness (and other properties) vary greatly with temperature, care should be taken to account for increasing hardness of elastomers on low-temperature duties.

Elastomeric materials are prone to ageing effects where the original properties reduce with time, temperature, exposure, and constraint. The total life of an O-ring is normally not expected to exceed 15 years where the total life is the summation of its shelf time (when the O-ring is in storage awaiting use), fitted time (when it is first fitted into a groove or enclosure), and service time (when it is exposed to the sealed medium). While it should be appreciated that the severity of service conditions will have the largest influence on O-ring life, the total life expectancy should be verified. This dictates that O-rings should be stored in sealed opaque packages to prevent light exposure and stored away from temperature sources. All items should also be identified with compound, cure date, and batch details so that seal life can be established.

H.6.2 Spring Energized Polymer Seals

In situations where there are chemical compatibility, temperature extremes, high sealing pressures, and decompression issues, spring energized polymer seals can be used as an alternative to elastomeric O-rings. In general terms, they are designed to fit inside conventional O-ring grooves; however, they often require location features and tools to assist with fitting and functionality.

The construction of these seals consists of a polymer jacket and a ~~steel~~ spring. Unlike self-energized O-ring devices, a spring is required to provide a force onto the lip to overcome the additional stiffness and resilience of the jacket material. The jacket material is usually a PTFE material that can contain additional fillers such as glass, graphite, or aromatic materials to enhance pressure resistance or friction and wear characteristics.

Spring material selection is based upon mechanical strength and chemical resistance. PEEK or metallic backup devices are used to prevent extrusion in high-pressure situations.

H.6.3 Static and Dynamic Sealing Element Materials

Static and dynamic sealing element selection is usually based upon chemical resistance, pressure, and temperature limitations; however, the appropriate material should be able to withstand all expected pressure decompression rates for the given temperature.

Table H.3 provides general temperature limits for static and dynamic sealing elements; the information is only for general guidance.

Table H.3—Static and Dynamic Sealing Element Material Temperature Limits

Material	D1418	Lower Temperature Limit °C (°F)	Upper Temperature Limit °C (°F)	Notes
Fluoroelastomer	FKM	−7 (20)	176 (350)	General hydrocarbon service
Perfluoroelastomer	FFKM	0 (32)	290 (554)	Temperature (not cyclic) and chemical resistance
Nitrile	NBR	−40 (−40)	121 (250)	General service
Hydrogenated acrylonitrile-butadiene rubber	HNBR	−30 (−22)	150 (302)	General service
Tetrafluoroethylene propylene	FEPM/TFE	−7 (20)	210 (410)	General hydrocarbon service at high temperature
Silicone	VMQ	−55 (−67)	200 (392)	Low temperature duties
Fluorosilicone	FVMQ	−60 (−76)	121 (250)	Low temperature duties
Polytetrafluoroethylene	PTFE	−90 (−130)	315 (599)	Temperature (not cyclic) and chemical resistance
NOTE PTFE limits depend upon filler.				

H.7 Springs, Fasteners, Drive, Anti-rotation, Centralizing Devices, and Labyrinths

H.7.1 Springs

These are usually helical coil compression springs with squared and ground ends that provide better seating and connectivity between components. They are used to provide axial bias so that the stationary seal face will mate with the rotating seal face. Springs are supplied in a variety of materials that complements the metallurgy of the other metallic seal components.

Table H.4 provides details for spring materials; the information is only for general guidance.

Table H.4—Spring Materials

Spring Material Description	Name	ASTM Grade
Austenitic stainless steel	316	A313

Nickel chrome molybdenum alloy	Alloy C276	B574
PH nickel copper alloy	Alloy 500	4676
Nickel chrome alloy	Alloy 718	B637
Nickel chrome alloy	Alloy 750	AMS 5833
Cobalt chrome nickel alloy	Co Cr Ni	AMS 5833

H.7.2 Fasteners

These are used in a wide variety of forms due to differing roles that can or cannot be load bearing. Generally used to keep components together but can also provide alignment, torque transmission, or just provide ease of assembly. Material selection is usually based upon the seal metallurgical requirements, chemical resistance, and strength.

Table H.5 provides details for fastener materials; the information is only for general guidance.

Table H.5—Fastener Materials

Fastener Material Description	Name	ASTM Grade
Austenitic stainless steel	316	A193 B8M
Nickel, chrome, molybdenum	Alloy C276	SB 574
Martensitic stainless steel	Duplex	A276 S31803
Martensitic stainless steel	Super duplex	A276 S32760
Nickel chrome alloy	Alloy 600	B166
Nickel chrome alloy	Alloy 750	B637
Nickel copper alloy	Alloy 400	F467
PH nickel copper alloy	Alloy 500	B865-04

H.7.3 Dowels, Drive, and Anti-rotation Devices

The purpose of these devices is to provide alignment or to transmit or prevent rotary motion between mating parts. In general, they need to have the required strength plus the same corrosion resistance properties as the components onto which they are attached.

Table H.6 provides details for pin materials; the information is only for general guidance.

Table H.6—Pin Materials

Pin Material Description	ASTM Grade
Stainless steel	A582M
Nickel chrome molybdenum	B574

H.7.4 Centering Devices

In order to minimize undesirable inertial excitation of rotating seal assembly, the limits and fits between rotating components should be minimized. In certain situations, additional resilient centering devices are fitted that are used to maintain concentricity between rotating components. These devices are designed to keep different rotating element concentric during operation, thereby reducing the potential for out-of-balance inertial forces. When utilized, the material selection for these devices is usually metallic, elastomeric, or an engineering plastic provided that dimensional and thermal stability can be assured. Metallic centralizing devices tend to be in rolled strip form that are cut to length and fitted into grooves. In general, the material selection is based upon chemical compatibility and such that the likelihood of galling is slim. Elastomeric devices are usually fitted as complete rings where standard O-rings, with their sealing function removed, are often used. Despite not having a sealing function, selection should still be based upon chemical compatibility, temperature, and RGD/ED resistance so that service damage is avoided.

Table H.7 provides details for centering device materials; the information is only for general guidance.

Table H.7—Centering Device Materials

Description	Name	ASTM Grade
Nickel copper alloy	Alloy 500	B127
Elastomer (see Note)		
NOTE In accordance with Table H.3 (elastomer table above).		

H.7.5 Labyrinths

Annex E and Annex F show the typical location of labyrinths. Generally speaking, they are designed to have a toothed profile and clearance to provide a given flow regime. Corresponding clearances in the compressor bearings can dictate the risk of contact or pickup between the labyrinth teeth and the opposing mating surface. Given that such occurrences can cause damage, it is usually appropriate to use materials that are able to safeguard against contact. The design of labyrinth seals usually fall into two categories depending upon whether the teeth are rotary or stationary. In cases where the labyrinth is rotary, the tooth features are often machined directly onto the surface of the component (usually a sleeve) with the opposing plain surface being protected with either a coating or soft insert. Similarly where stationary labyrinths are used, the teeth tend to be made out a material that is softer than the opposing surface; however, there are instances where the latter can include a coating. In certain applications, engineered plastics are used provided that dimensional and thermal stability can be attained.

Table H.8 provides details for labyrinth materials; the information is only for general guidance.

Table H.8—-Labyrinth Materials

Description	ASTM Grade
Aluminum	Gr. 6082-T6 condition
PTFE (see Note)	
PEEK (see Note)	

NOTE Not usually in pure form, proprietary composites to suit requirements.

Selection of labyrinth materials can be very important. Some factors to consider when selecting materials are as follows:

1) function or purpose of the seal with regard to gas consumption and design type;

2) compatibility of the material with the gas it will be subjected to;

3) temperature limitation of the selected material;

4) coefficient of thermal expansion and heat transfer properties of the selected material compared to mating components.

Annex I
(normative)

Vendor Drawing and Data Requirements (VDDR)

DRY GAS SEAL VENDOR DRAWING AND DATA REQUIREMENTS

Job No.	Item No.
Purchase Order No.	Date
Requisition No.	Date
Inquiry No.	Date
Revision ………. by	Manufacturer
For	Unit
Site	Service

Proposal [a]—Bidder shall furnish number of paper copies /number of electronic copies of data as indicated
Review—Vendor shall furnish number of paper copies /number of electronic copies of data as indicated
Final—Vendor shall furnish number of paper copies /number of electronic copies of data as indicated

				Description (see text)	**Distribution record**				
					Review due from vendor [b c]	Review received from vendor	Review returned to vendor	Final due from vendor [c]	Final received from vendor
	/	/	/	1. Technical datasheets completed for “proposal” and “as-built”					
	/	/	/	2. Statement of manufacturer’s testing capabilities					
	/	/	/	3. Cross-sectional dry gas seal assembly drawing and part numbers					
	/	/	/	4. Reference list of similar dry gas seals (if required)					
	/	/	/	5. Gas consumption, flow, and leakage rates of all seals					
	/	/	/	6. Certified outline drawing(s)					
	/	/	/	7. Production and delivery schedule					
	/	/	/	8. Progress reports (if required)					
	/	/	/	9. Technical certifications, records, and reports (if required)					
	/	/	/	10. List of components requiring purchaser’s approval					

[a] Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such.
[b] Purchase may indicate in the column the desired time frame for submission of data.
[c] Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with the proposal.

DRY GAS SEAL VENDOR DRAWING AND DATA REQUIREMENTS		
	Job .... No.	Item .... No.
	Purchase Order .... No.	Date ....
	Requisition .... No.	Date ....
	Inquiry .... No.	Date ....
	Revision ……….. by	Manufacturer ....
	For	Unit ....
	Site	Service ....

Proposal [a]—Bidder shall furnish number of paper copies /number of electronic copies of data as indicated

Review—Vendor shall furnish number of paper copies /number of electronic copies of data as indicated

Final—Vendor shall furnish number of paper copies /number of electronic copies of data as indicated

				Description (see text)	**Distribution record**				
					Review due from vendor [b c]	Review received from vendor	Review returned to vendor	Final due from vendor [c]	Final received from vendor
	/	/	/	11. Dry gas seal testing procedure					
	/	/	/	12. Certified Dry gas seal test reports					
	/	/	/	13. Restrictions or requirements to operate at slow roll, turning gear, or ratcheting (if required)					
	/	/	/	14. Operating guidelines to protect dry gas seals during operation					
	/	/	/	15. List of recommended spare parts					
	/	/	/	16. List of special tools and lubricants					
	/	/	/	17. Preparation for storage at job site before installation					
	/	/	/	18. Installation manual					
	/	/	/	19. Operating and maintenance manual					
	/	/	/	20. Technical data manual					

[a] Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such.
[b] Purchase may indicate in the column the desired time frame for submission of data.
[c] Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with the proposal.

DRY GAS SEAL VENDOR DRAWING AND DATA REQUIREMENTS	Job .... No.	Item .... No.
	Purchase Order .... No.	Date ....
	Requisition .... No.	Date ....
	Inquiry .... No.	Date ....
	Revision ……….. by	Manufacturer ....
	For	Unit ....
	Site	Service ....

Notes:

1. Where necessary to meet the scheduled shipping date, the vendor shall proceed with manufacture upon receipt of the order and without awaiting the purchaser's approval of drawings.
2. The vendor shall send all drawings and data to the following:

____

____

____

3. All drawings and data shall show project, purchase order, and item numbers as well as plant location and unit. One set of the drawings and instructions necessary for field installation, in addition to the copies specified above, shall be forwarded with shipment.
4. See the descriptions of required items that follow.
5. All of the information indicated on the distribution schedule shall be received before final payment is made.
6. If typical drawings, schematics, and bills of material are used for proposals, they shall be marked up to show the expected weight and dimensions to reflect the actual equipment and scope proposed.

Nomenclature:

S—number of weeks before shipment.
F—number of weeks after firm order.
D—number of weeks after receipt of approved drawings.

Vendor____

Date____________________ Vendor Reference ______________________________________

Signature____

(Signature acknowledges receipt of all instructions)

DESCRIPTION

1) Dry gas seal technical datasheets completed for “proposal” and “as-built.”

2) A statement of the manufacturer’s capability regarding dry gas seal testing. Testing to include but not be limited to the following.

   a) Overspeed testing of rotating dry gas seal faces.

   b) Hysteresis testing of the stationary subassembly.

   c) Static and dynamic testing of dry gas seal assemblies.

   d) Specified special or optional testing.

3) Cross-sectional dry gas seal assembly drawing and part numbers.

4) A list of dry gas seals similar to the proposed dry gas seal that have been installed and operating under conditions analogous to those specified in the inquiry.

5) Gas consumption, flow, and leakage rates of all seals including associated labyrinths. Gas conditions such as molecular weight, pressure, and temperature to be provided. Flow and leakage information to be shown using a schematic format for clarity are as follows.

   a) Expected gas consumption.

      NOTE Seals may be supplied from the same or multiple sources.

   b) Expected and guaranteed leakage rates of each dry gas seal.

   c) Expected and guaranteed leakage rates of each carbon ring separation seal.

   d) Expected flow across labyrinth seals, including velocity and labyrinth clearance.

6) Certified outline drawing(s), including the following drawing(s).

   a) The location and naming of all customer connections/porting.

   b) Overall cavity dimensions including cartridge dimensions with installation plates for assembly and dis-assembly of cartridges.

   c) Dry gas seal installation dimension or dry gas seal mounting dimension.

      NOTE This axial value is for the position of compressor components to allow for proper dry gas seal placement inside the compressor. This distance is typically from a rotating surface on the compressor rotor to a stationary surface on the compressor housing.

   d) Direction of dry gas seal rotation.

   e) Maximum dry gas seal pressure for static and dynamic operations.

   f) Maximum dry gas seal speed (RPM).

   g) Maximum and minimum dry gas seal temperature.

   h) Approximate handling mass of each dry gas seal cartridge with and without installation plates.

   i) Total mass for the dry gas seal rotating assembly.

j) Center of gravity for the dry gas seal rotating assembly.

k) Polar and transverse moments of inertia for the dry gas seal rotating assembly.

l) Dry gas seal axial movement ± length.

m) Dry gas seal radial movement ± length.

n) Customer data such as location and user name.

o) Normal service data such as pressure, temperature, and speed.

7) The vendor shall provide production and delivery schedules.

8) The vendor shall provide progress reports (if required).

9) Additional technical certifications, records, and reports (if required).

a) Certification of materials, such as mill test reports.

b) Summary of the materials of construction, including hardness for materials exposed to H_2S.

c) PMI testing reports.

d) Balance record of the rotating seal assembly.

e) Completion record of the rotating dry gas seal face overspeed test.

f) Completion record of the stationary subassembly hysteresis test.

~~g) Rotordynamic lateral analysis report.~~

10) A list of any components with less than 3 years of demonstrated successful operation shall be construed as being of alternative design, requiring purchaser's acceptance.

11) The vendor shall submit detailed test procedures for the dry gas seal test and all optional testing at least 6 weeks before the first scheduled test. Test procedure to including the following.

a) Test document number and revision.

b) Dry gas seal model, type, and rotation(s).

c) Dry gas seal drawing number(s).

d) Dry gas seal maximum testing conditions (static/dynamic pressure, temperature, and speed).

e) Test data (time, speed, pressure, temperature, motor load, seal leakage, and flow).

f) Acceptance criteria.

g) Test gas to be used.

12) Dry gas seal test report to include the following.

a) Dry gas seal model, type, and rotation(s).

b) Dry gas seal drawing(s) and serial number(s).

c) Test procedure document and revision number used for testing.

d) Test equipment used for test. This can be test rig or control panel used.

e) Gas/air used for the test.

f) Test data (time, speed, pressure, temperature, motor load, seal leakage, and flow). Leakage and flow rate conversions are needed to convert as read test values to corrected standard conditions.

g) Summary report of the visual inspection (if required).

h) Post-test static verification test data.

Immediately upon completion of each witnessed functional seal test, copies of the log and data recorded during the test shall be given to the witnesses.

13) The vendor shall provide any restrictions or requirements needed to operate at slow roll, turning gear, or ratcheting (if required).

14) To protect the integrity of the seals, the vendor shall provide the purchaser with operational guidelines for the following.

a) Start-up.

b) Shutdown.

c) Transient operating points.

15) List of spare parts and quantities recommended for start-up and normal purposes.

16) List of the special tools and lubricants furnished for assembly, disassembly, and maintenance of the seal. Special tools and materials can include but not be limited to the following.

a) Lifting fixtures or devices.

b) Jackscrews, guide rods, and alignment dowels.

c) Sleeves.

d) Recommended lubricant for static sealing elements.

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

18) All information required for the proper installation of the equipment shall be compiled in a manual that must be issued no later than the time of final certified drawings.

19) A manual containing all required operating and maintenance instructions shall be supplied not later than 8 weeks after all specified test shall have been successfully completed.

20) The vendor shall provide a “Manufacturer Data Report” within 30 days of completion of shop testing including the following.

a) Necessary or specified technical certifications, records, and reports.

b) Test data and results to verify the requirements of the specification have been met.

c) Results of specified quality control tests and inspections.

d) Purchase specification for all items on the bill of materials.

The vendor is also required to keep this data available for examination by the purchaser upon request, for at least 20 years.

Annex J
(informative)

Inspector's Checklist

Table J.1 can be used as an inspector's checklist.

Table J.1—Inspector's Checklist

Item	API 692		Date Inspected	Inspected By	Status
	Section	Part			
6.9 SEAL REQUIREMENTS					
Datasheet for dry gas seals complete	6.9	2			
Dry gas seal type specified	6.9.1.1	2			
Separation seal type specified	6.9.1.2	2			
Process side seal type specified	6.9.1.3	2			
Bidirectional or unidirectional seals specified	6.9.1.4	2			
Assembled perpendicularity in accordance with Table 1	6.9.1.5	2			
Stack up tolerance diagram provided	6.9.1.6	2			
Maximum sealing pressure specified	6.9.1.9	2			
Shrouded rotating seal faces	6.9.1.15	2			
Labyrinth seals have at least 3 teeth in direction of flow	6.9.1.17	2			
Normal flow rates provided	6.9.1.18	2			
6.10 SEAL CARTRIDGES					
Unidirectional seals designed to prevent incorrect installation	6.10.3	2			
Installation plate(s) provided	6.8.8	2			
6.11 BALANCE AND OVERSPEED					
Rotating assemblies balanced	6.11.1	2			
6.13 MINIMUM SPEED/SLOW ROLL/TURNING GEAR/RATCHETING					
Turning gear or ratcheting operation specified	6.13.1	2			
Conditions for all operating points specified	6.13.2	2			
6.15 MARKING AND ROTATION ARROWS					

Item	API 692		Date Inspected	Inspected By	Status
	Section	Part			
Seal cartridges and installation plates etched with required markings	6.15.1	2			
7 SPECIAL TOOLS					
Special tools provided	7.1	2			
Special tool drawings provided	7.2	2			
Demonstrated use of special tools	7.3	1			
Packaging of special tools	7.4	1			
Marking or tagging of special tools	7.5	1			
8.3 TESTING					
Hysteresis test performed on each stationary face	8.3.1	2			
Rotating seal faces overspeed tested	8.3.2	2			
Dry gas seals tested in accordance with Annex B	8.3.4	2			
Post-test visual inspection performed in accordance with Annex K	8.3.6	2			
8.4 PREPARATION FOR SHIPMENT					
Each seal stored in a padded box	8.4.1	2			
Package markings	8.4.2	2			
Each component placed in plastic bag with desiccant	8.4.4	2			
Spare static sealing elements provided	8.4.6	2			
Static sealing element lubricant provided	8.4.8	2			
Installation instructions and seal drawing provided	8.4.9	2			
9.8 PREPARATION FOR SHIPMENT					
Duplicate packing lists inside and out for crated equipment	9.8.5	1			
Spare parts preserved and packaged	9.8.6	1			
9.9 PACKAGE MARKINGS					
Permanent labelling on two opposite sides of shipping box or container	9.9.2	1			
Industry standard cautionary symbol markings	9.9.3	1			
Package markings	9.9.4	1			

Item	API 692		Date Inspected	Inspected By	Status
	Section	Part			
10.3.5 INSTALLATION, OPERATION, MAINTENANCE, AND TECHNICAL MANUALS					
Manual containing all required operating and maintenance instructions	10.3.5.3.1	1			
Technical data manual	10.3.5.4	1			

Annex K
(normative)

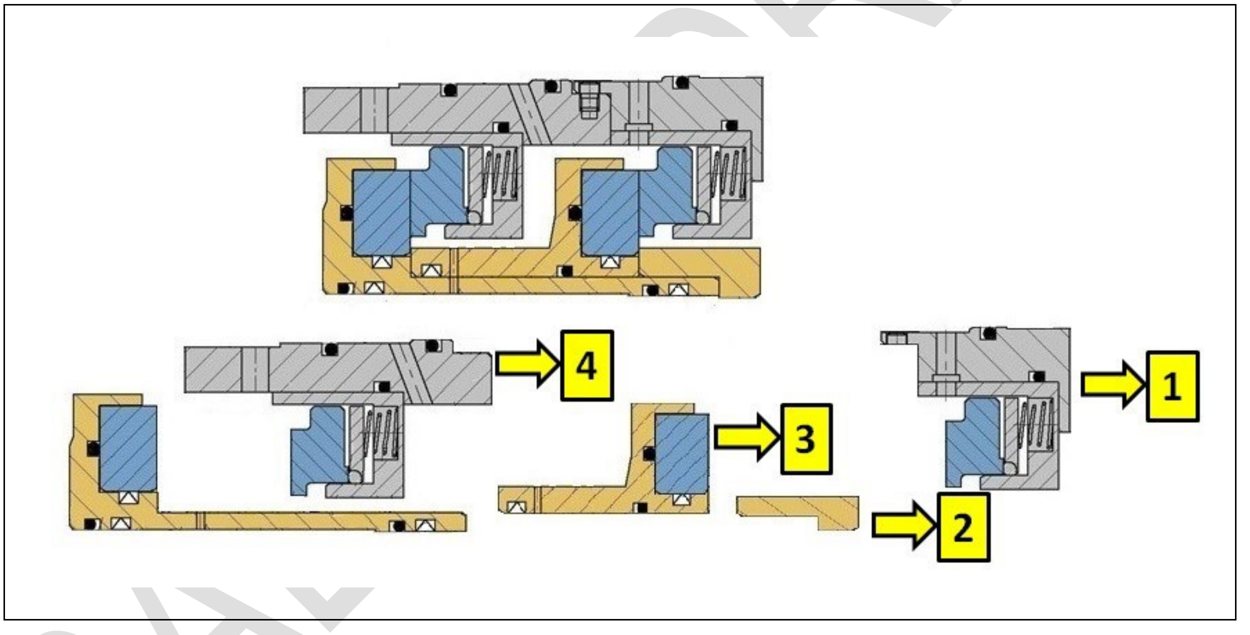
Post-test Dry Gas Seal Visual Inspection

K.1 General

This annex addresses minimum post-FAT visual inspection criteria. Seals that have not completed the full FAT (i.e. the test was stopped prematurely as a precaution or due to an incident) may require an inspection that is beyond the scope of this annex. All issues listed are visible indications when viewed in natural lighting, typically 0.1 mm (0.004 in.) or larger. Once identified, further evaluation is necessary to determine the root cause and if remedial action is required.

K.2 General Considerations

The seal should be disassembled to allow inspection of the seal faces as shown in typical Figures K.1 to K.5. At all stages of the inspection, attention should be given to signs of damage, deposits (lubrication, moisture, etc.), and debris.



Key

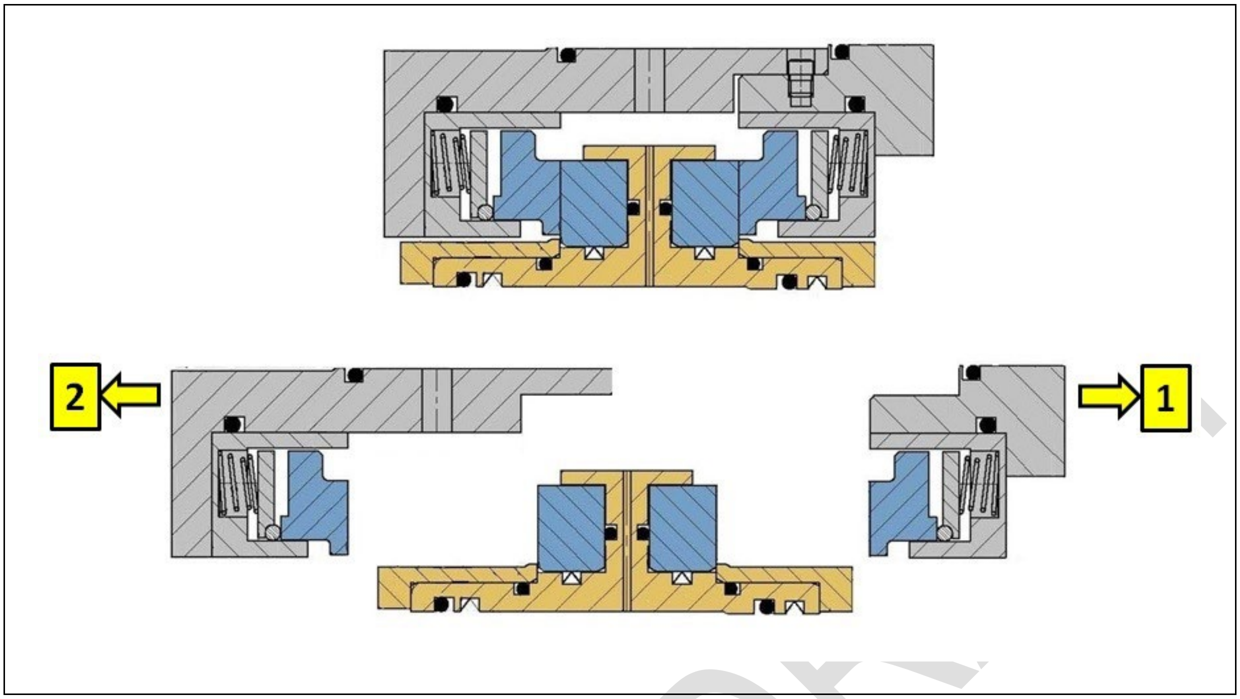
Stage 1 Remove secondary seal stationary subassembly

Stage 2 Remove retaining sleeve

Stage 3 Remove spacer sleeve subassembly

Stage 4 Remove primary seal stationary subassembly

Figure K.1—Stages in Disassembly of a Tandem Seal Arrangement

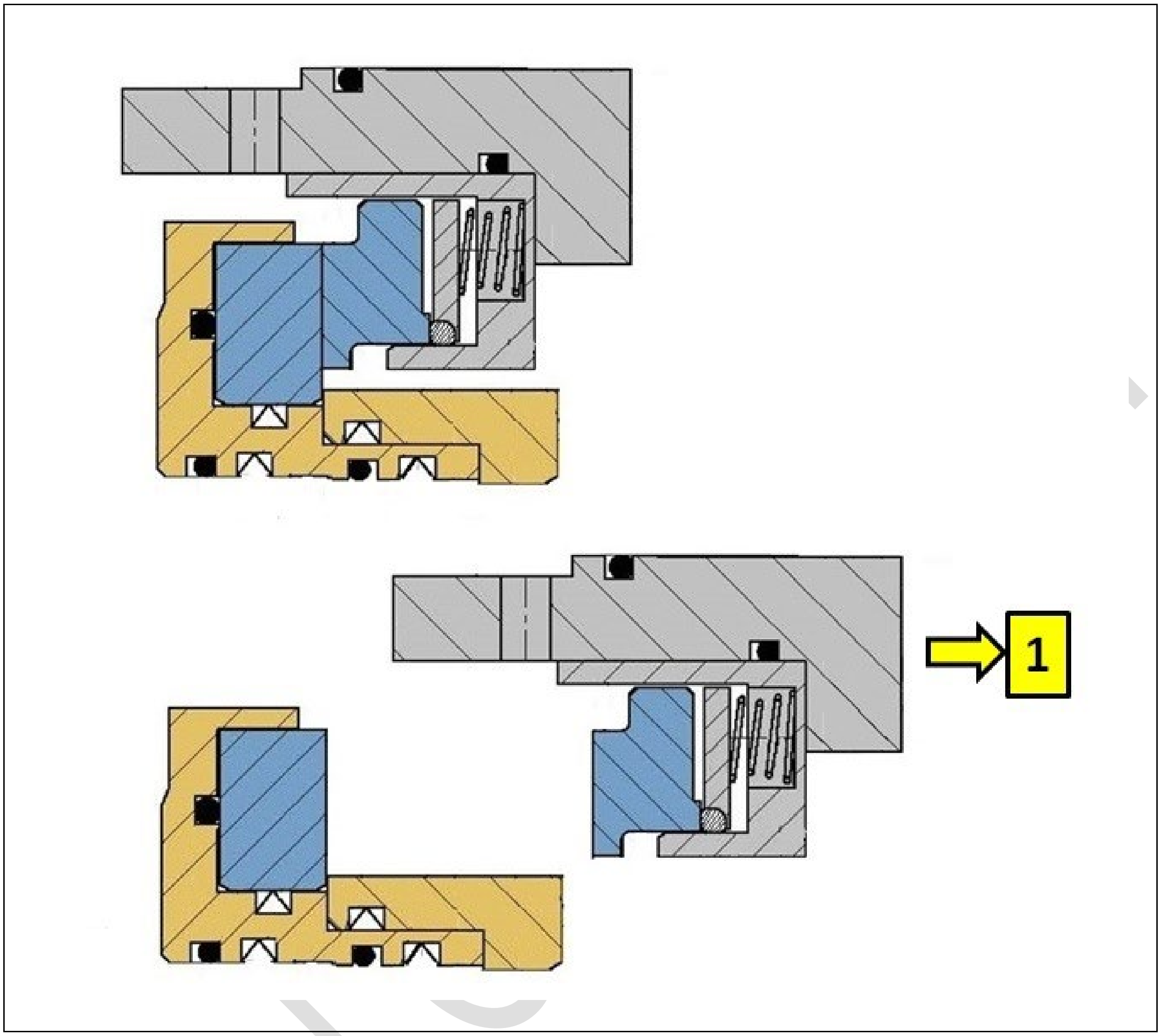


Key

Stage 1 Remove secondary seal stationary subassembly

Stage 2 Remove primary seal stationary subassembly

Figure K.2—Stages in Disassembly of a Double Seal Arrangement



Key

Stage 1 Remove primary seal stationary subassembly

Figure K.3—Stages in Disassembly of a Single Seal Arrangement

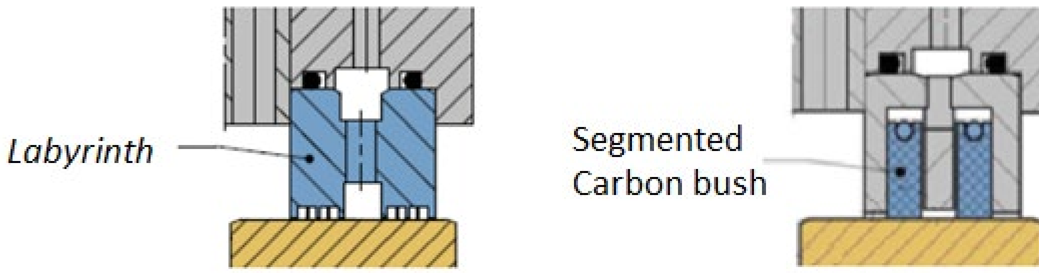


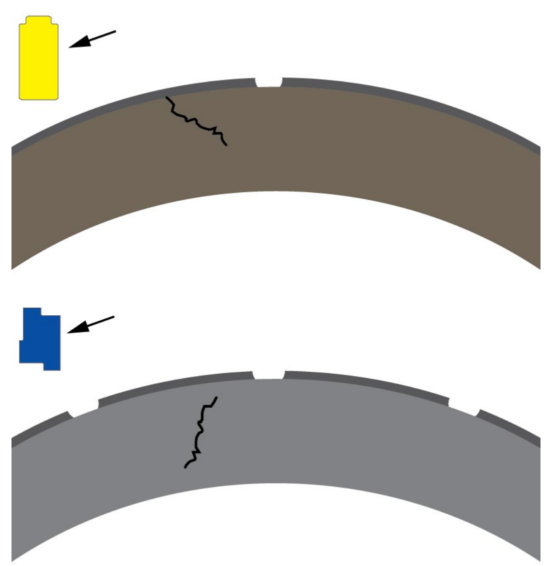
Figure K.4—Separation Seals

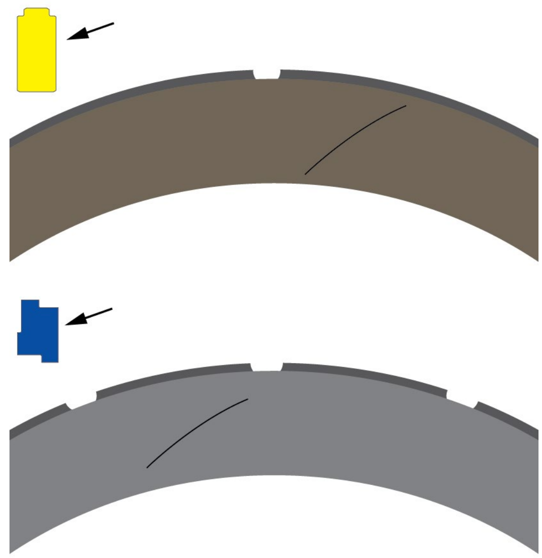
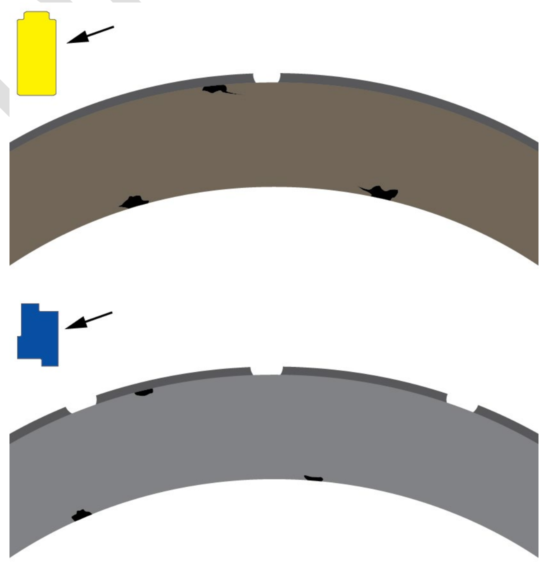
K.3 Damage Definitions

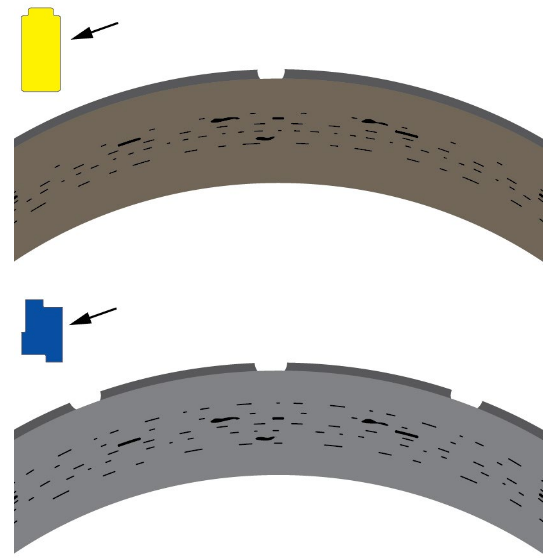
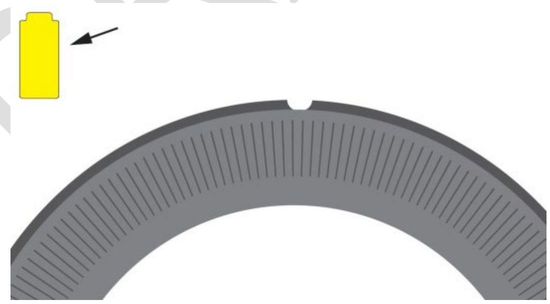
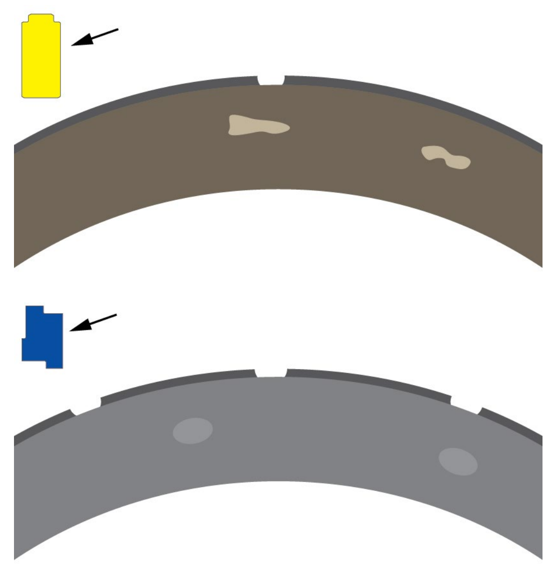
K.3.1 Seal Faces

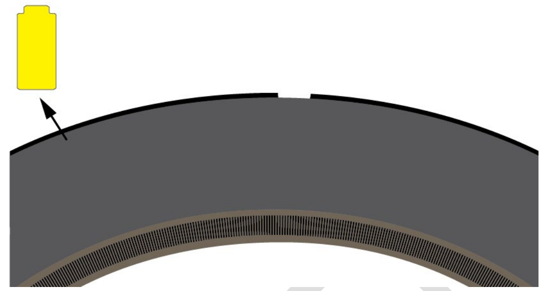
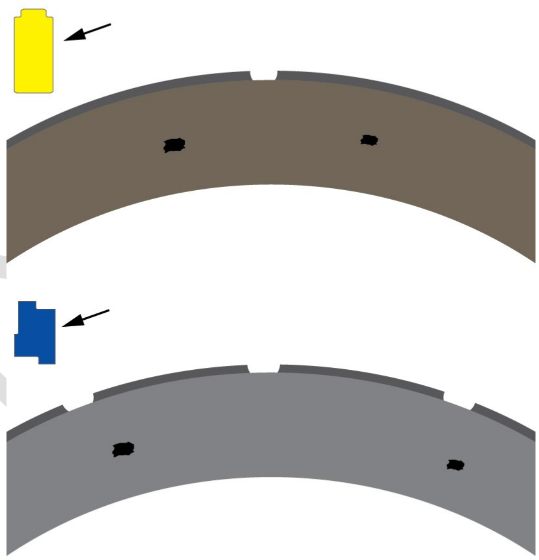
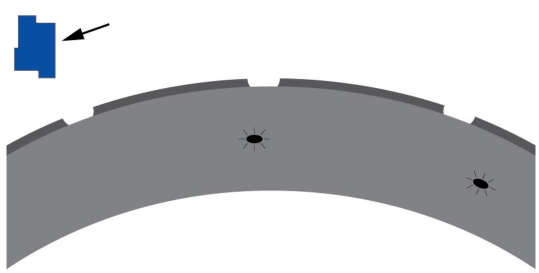
Applies to rotating and stationary seal faces. Damage to seal face can have a detrimental effect on the operation and longevity of the seal in service. Seal faces should not to be removed from their respective subassemblies. See Table K.1 for typical seal face defects, along with cause, appearance, and acceptance/remedial action.

Table K.1—Seal Face Damage Examples

Defect	Seal Face Damage Defects	Image
Crack	**Cause**—Loading applied to the material that is sufficient to cause the propagation of inherent flaws within the microstructure, handling, and impact loading. **Appearance**—Thin lines of negligible width compared with depth and/or length. Tends to grow along grain boundaries within the structure. **Acceptance/remedial action**—Unacceptable, replacement required. Full retest.	

Defect	Seal Face Damage Defects	Image
Scratch	**Cause**—Debris or particulate matter passing through the sealing interface. **Appearance**—Fine lines in either radial or circumferential direction. **Acceptance/remedial action**—Scratches exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest.	
Chip	**Cause**—Slight contact during assembly or load applied to close to an edge where there is an underlying inherent defect in the structure. **Appearance**—Small amounts of material removed from the edge of a face in a particular region or regions. **Acceptance/remedial action**—Chips exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest.	

Defect	Seal Face Damage Defects	Image
Scoring/scuffing	**Cause**—Face contact. **Appearance**—A series of marks on the surface that have the appearance of multiple scratches and irregular surface finish marks due to material transfer between the opposing seal face material. **Acceptance/remedial action**—Unacceptable. Replace. Full retest.	
Heat check	**Cause**—Inability of faces to dissipate heat generation through material in a controlled manner. **Appearance**—A series of thin radial cracks radially spanning the sealing interface, regions outside the interface are largely unaffected. **Acceptance/remedial action**—Unacceptable, replacement required. Full retest.	
Polish mark	**Cause**—Slight contact or characteristic that allow faces to operate with inadequate film. **Appearance**—Discoloration over an area. **Acceptance/remedial action**—Polishing exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest.	

Defect	Seal Face Damage Defects	Image
Fretting	**Cause**—Relative movement between the face bore and corresponding counter surface. **Appearance**—Discoloration that usually takes on a regular pattern (repeated feature). **Acceptance/remedial action**—Unacceptable. Replace. Full retest.	
Plucking	**Cause**—Small pieces of material removed from the central region of the face as a consequence of subsurface inherent defects (voids or inclusions) that locally weaken the structure thereby enabling pieces to be removed under sliding. **Appearance**—Small pockets/holes in the sealing interface. **Acceptance/remedial action**—Unacceptable. Replace. Full retest.	
Blistering	**Cause**—Process gas entering the microstructure of the carbon thereby causing local thermally induced affects that produce damage sites. **Appearance**—Small pockets/holes, cracks or raised spots on the carbon sealing interface. **Acceptance/remedial action**—Unacceptable. Replace. Full retest.	

K.3.2 Metallic Components

Applies to the external (exposed) surfaces of rotating shaft, spacer and retaining sleeves, and stationary retainers and housings. See Table K.2 for typical metallic component defects, along with cause, appearance, and acceptance/remedial action.

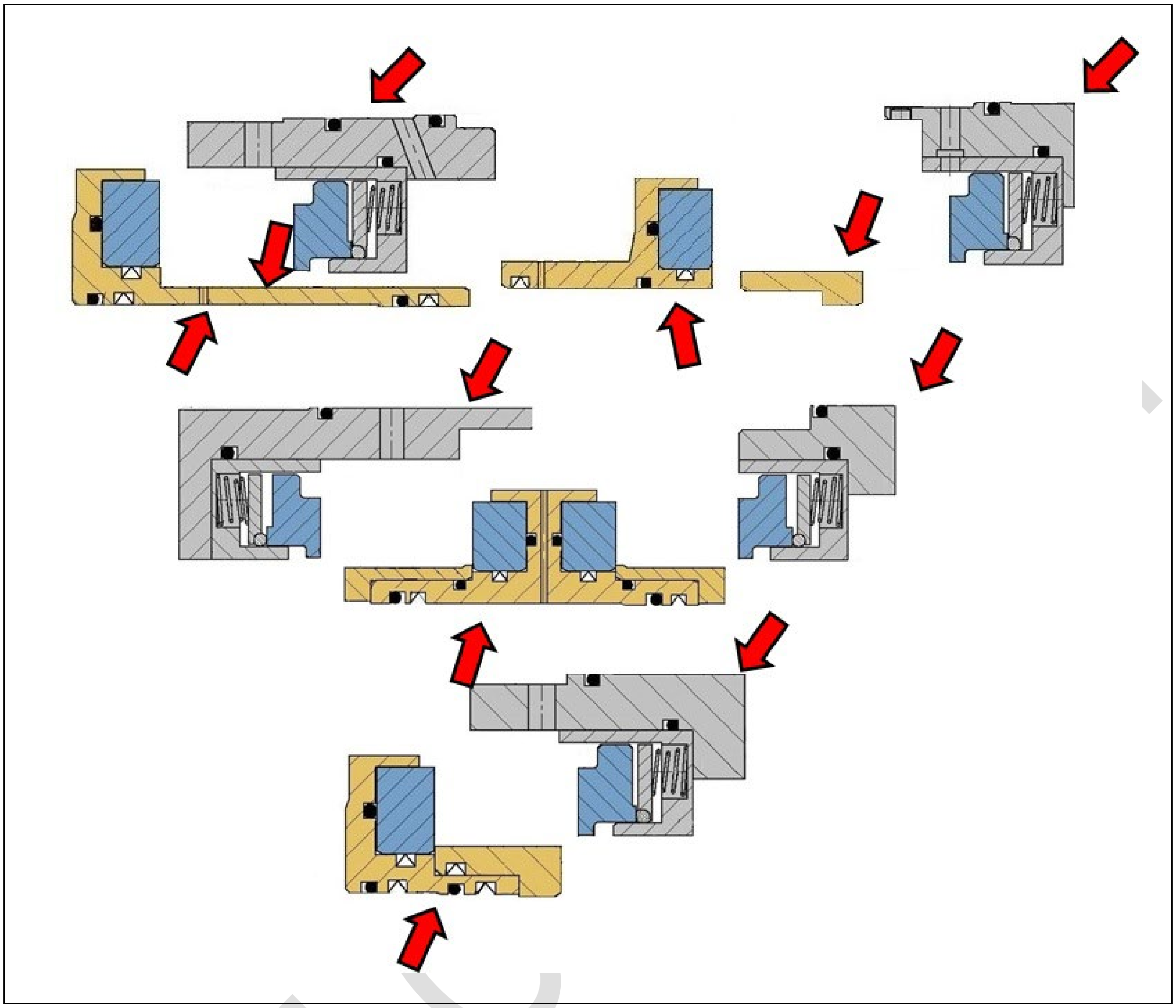
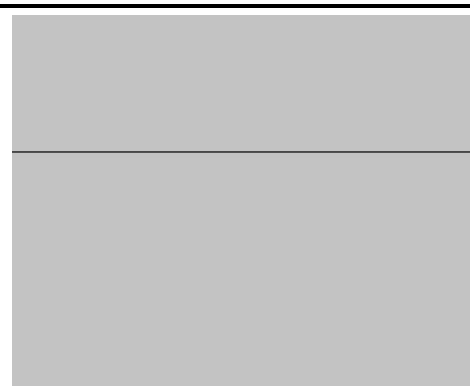
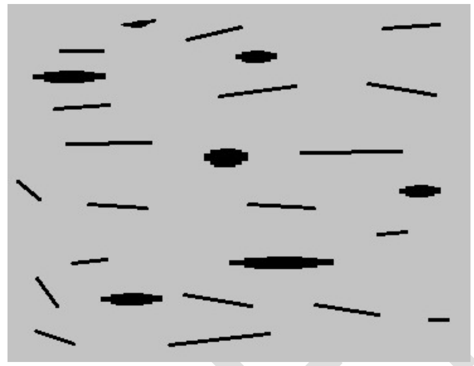
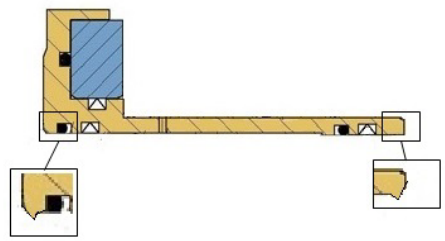
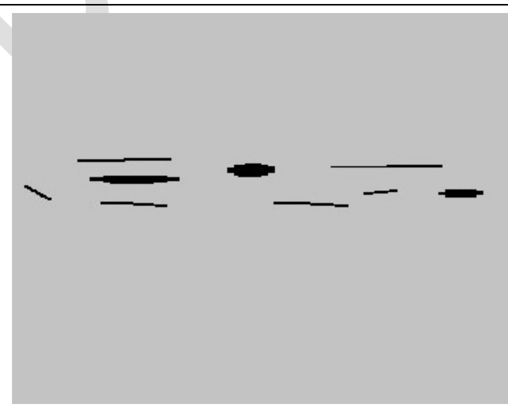
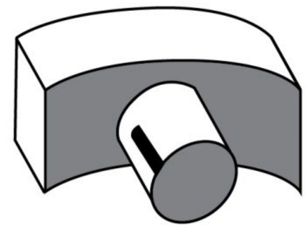


Figure K.5—Steelwork Inspection Sites

Table K.2—Seal Metallic Components

Item	Steelwork Damage Defects	Image
Scratch	**Cause**—Slight contact during assembly or debris passing through small clearances. **Appearance**—Fine lines in the direction of assembly or the debris path. **Acceptance/remedial action**—Scratches exceeding manufacturer’s documented acceptance criteria shall be reconditioned or replaced. Full retest.	

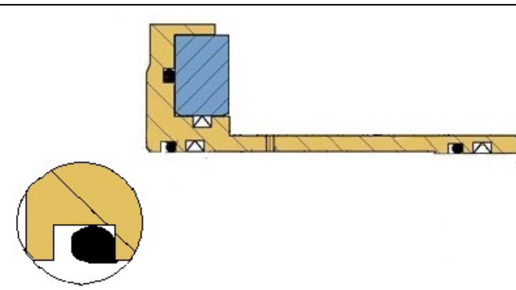
Item	Steelwork Damage Defects	Image
Scoring/galling	**Cause**—Undesirable interferences or contact between mating or adjoining parts. **Appearance**—Can be gouges or areas where material has been transferred. **Size**—Usually millimeters. **Acceptance/remedial action**—Unacceptable. Repair or replace. Full retest.	
Burrs/dents	**Cause**—Either incorrect dressing of components prior to installation or edges where contact has taken place. **Appearance**—Raised portions extending from edges. **Acceptance/remedial action**—Burrs and dents exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest required if replaced.	
Rubs	**Cause**—Contact between adjoining parts. **Appearance**—Surface degradation in the form of gouges and scoring. **Acceptance/remedial action**—Rub damage exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest required if replaced.	
Fretting/chatter	**Cause**—Vibration and excessive clearances. **Appearance**—Series of lines or worn surfaces between adjoining parts. **Acceptance/remedial action**—Fretting or chatter marks exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest required if replaced.	

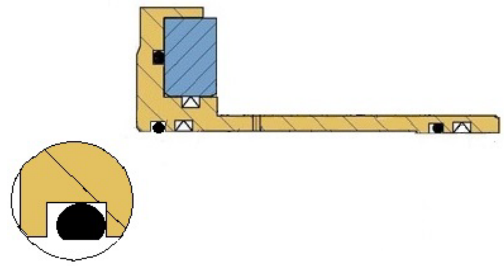
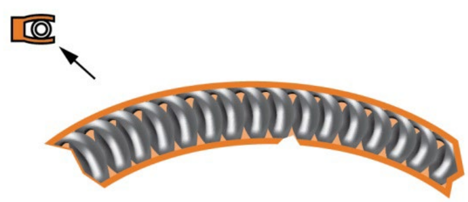
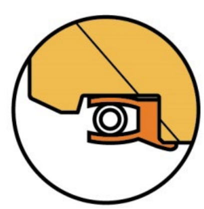
Item	Steelwork Damage Defects	Image
Dents/flats/wear (drive and anti-rotation pins—if applicable)	**Cause**—Incorrect sizing, misalignment, or excessive torque. **Appearance**—Flats, dents, or polish marks on drive feature. **Acceptance/remedial action**—Dents, flats, or wear exceeding manufacturer's documented acceptance criteria shall be replaced. Full retest.	

K.3.3 Static and Dynamic Sealing Elements

Damaged elements produce additional leakage. ~~All~~ No sealing elements should ~~not~~ be removed from the grooves. See Table K.3 for typical static and dynamic sealing element defects, along with cause, appearance, and acceptance/remedial action.

Table K.3—Seal Static and Dynamic Sealing Elements

Item	Flexible Sealing Element Damage Defects	Image
Cuts/nicks/tears	**Cause**—Insufficient fitting features/burrs or poor handling during in installation/removal of components. **Appearance**—Pieces removed from material or damage to structure. **Acceptance/remedial action**—Unacceptable. Replace. Re-inspect external O-rings after post-inspection static test.	
Explosive decompression	**Cause**—High-pressure gas trapped within the microstructure that rapidly expands causing tensile loads and tearing during depressurization. **Appearance**—Either sections removed from the material or bubble-like features when trapped gas is still within the material. **Acceptance/remedial action**—Unacceptable. Inspect all internal O-rings. Replace. Full retest.	
Extrusion	**Cause**—Combinations of excess pressure and/or temperature that cause the material to flow into clearance between adjoining parts or excessive clearance between mating parts. **Appearance**—Small like edge nibs that correspond with the working clearance of the surrounding components. **Acceptance/remedial action**—Unacceptable. ~~Repair~~, replace. Full retest.	

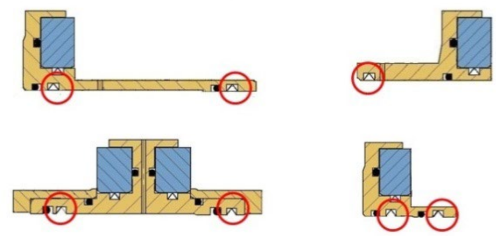
Item	Flexible Sealing Element Damage Defects	Image
Compression set	**Cause**—Excessive temperature most likely due to adverse operation. **Appearance**—Flat surface that would normally be expected to have curvature. **Acceptance/remedial action**—Unacceptable. ~~Repair,~~ replace. Full retest.	
Cracking	**Cause**—Exposure to excessive temperature most likely due to adverse operation (note chemical attack unlikely in a test situation where inert gases are used). **Appearance**—Hardening and cracks to affected regions. **Acceptance/remedial action**—Unacceptable. ~~Repair~~, replace. Full retest.	
PTFE sealing element		
Cuts/nicks/tears/shaving	**Cause**—Insufficient fitting features/burrs or poor handling during in installation/removal of components. **Appearance**—Pieces removed from material or damage to structure, deformation, embedded debris. **Acceptance/remedial action**—Unacceptable. Replace. Re-inspect external sealing elements after post-inspection static test.	
Extrusion	**Cause**—Combinations of excess pressure and/or temperature that cause the material to flow into clearance between adjoining parts, or excessive clearance between mating parts. **Appearance**—Small like edge nibs that correspond with the working clearance of the surrounding components. **Acceptance/remedial action**—Unacceptable~~. Repair~~, replace. Full retest.	

K.3.4 Miscellaneous Items

K.3.4.1 Centering Elements

Actual designs vary significantly. Damaged items will impair concentric mounting of rotating assembly and could cause equipment damage or prevent subsequent seal installation. See Table K.4 for typical seal centering element defects, along with cause, appearance, and acceptance/remedial action.

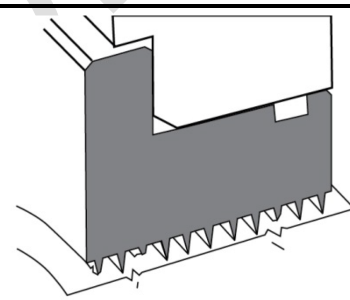
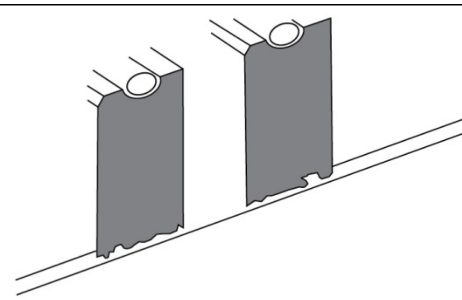
Table K.4—Seal Centering Elements

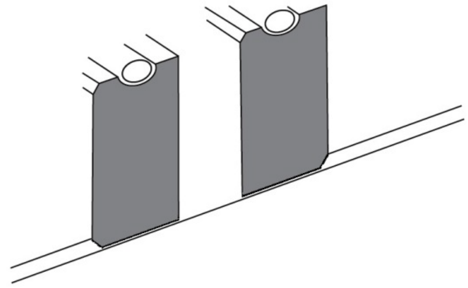
Item	Other Defects	Image
Centering elements	**Cause**—Incorrect fit, incorrect compression, fitting damage. **Appearance**—Dented, torn, and distorted. **Acceptance/remedial action**—Unacceptable. ~~Repair~~, replace. Full retest unless root cause is installation error.	

K.3.4.2 Labyrinths and Carbon Rings

The teeth should be free from damage and the mating surface should be free from markings (note these surface may be coated). See Table K.5 for typical labyrinth and carbon ring defects, along with cause, appearance, and acceptance/remedial action.

Table K.5—Labyrinths and Carbon Rings

Item	Other Defects	Image
Labyrinth	**Cause**—Incorrect clearance, misalignment. **Appearance**—Incorrect tooth form and markings. **Acceptance/remedial action**—Labyrinth damage exceeding manufacturer's documented acceptance criteria shall be reconditioned or replaced. Full retest required if replaced.	
Segmented, contacting, and non-contacting carbon rings		
ID wear	**Cause**—Incorrect clearance, incorrect sleeve surface finish, radial hang-up. **Appearance**—Scuffing, scratches, excessive dusting, sleeve discoloration, measurable wear. **Acceptance/remedial action**—Rings with ID wear damage exceeding manufacturer's documented acceptance criteria shall be replaced. Full retest required if replaced.	

Item	Other Defects	Image
Chips	**Cause**—Improper handling/installation. **Appearance**—Small amounts of material removed from the edge of a face in a particular region or regions. **Acceptance/remedial action**—Chips exceeding manufacturer's documented acceptance criteria shall be replaced. Full retest.	

Annex L
(informative)

Contract Documents and Engineering Design Data

L.1 If specified by the purchaser in 9.1.1, the contract documents and engineering design data shall be supplied by the vendor, as listed in this annex.

L.1.1 The information to be furnished by the vendor is specified in L.2, L.3 and L.4.

L.1.1.1 The vendor shall provide all documents listed in the VDDR form (Annex I).

L.1.1.2 Vendor shall complete and supply the agreed VDDR form (see Annex I for an example).

L.2 Proposals

Proposal data shall be in accordance with Annex D.2 of Part 1.

L.3 Contract Data

L.3.1 Contract data shall be in accordance with Annex D.3 of Part 1.

L.3.2 Vendor shall provide the weight of the rotating assembly, polar and transverse moments of inertia, and center of gravity.

L.3.3 Vendor shall provide normal and maximum flows, temperatures, and pressures per the conditions defined in Part 1, Sections 6.2.1 and 6.2.2.

L.3.4 Vendor shall provide a certified test report prior to shipment of the dry gas seals.

L.4 Drawings

L.4.1 Seal drawing shall define:

1) seal mounting details on the compressor shaft and seal cavity;

2) shaft and housing surface finish requirements;

3) installation plate details to indicate proper assembly;

4) bill of materials including materials of construction;

5) dry gas seal axial and radial travel limits;

6) the weight of the rotating assembly, polar and transverse moments of inertia, and center of gravity;

7) gas seal installation/assembly reference dimension.

Part 3—Dry Gas Seal Support Systems

1 Scope

This part of API 692, in conjunction with API 692, Part 1, specifies requirements for dry gas seal support systems for axial, centrifugal, expander, and rotary screw compressors for use in the petroleum, chemical, and gas industry services as described in API 617 and API 619.

2 Normative References

For the purposes of this document, normative references are listed in Part 1.

3 Terms, Definitions, Acronyms, and Abbreviations

For the purposes of this document, the terms, definitions, acronyms, and abbreviations given in Part 1 apply.

4 General

The purchaser shall assume unit responsibility and shall assure that all vendors comply with the requirements of this standard and all reference documents.

5 Requirements

5.1 Standard Fasteners and Units of Measure

For the purposes of this document, standard fasteners and units of measure given in Part 1 apply.

5.2 Statutory Requirements

For the purposes of this document, statutory requirements given in Part 1 apply.

5.3 Alternative Designs

For the purposes of this document, alternative design requirements given in Part 1 apply.

5.4 Documentation Requirements

For the purposes of this document, documentation requirements given in Part 1 apply.

6 Basic Design

Normative and informative annexes are provided as part of the document. These annexes are as follows.

— Annex A—Datasheets (informative): provides datasheets for the dry gas seal support system.

— Annex B—System Diagrams (normative).

— Annex C—Inspector's Checklist (informative).

— Annex D—Module Comparison (informative).

— Annex E—Vendor Drawing and Data Requirements (VDDR) (normative).

— Annex F—Gas Filter Rating, Testing, and Performance (informative).

— Annex G - Contract Documents and Engineering Design Data (informative).

6.1 General

6.1.1 [●] The purchaser shall specify maximum dimensions and any special layout requirements of the dry gas seal support system and identifying skid and panel configurations.

6.1.2 [●] MAWP or pressure rating of the following dry gas seal support subsystems shall be no less than Class 150 ~~lb~~ rating and equal to or greater than the values listed in Table 1.

Table 1—Pressure Rating of Dry Gas Seal Systems

Seal gas	Maximum seal gas supply source pressure (refer to 6.1.3.1)
Secondary seal gas	Maximum pressure excursion during primary seal failure
Buffer gas	Maximum buffer gas supply source pressure
Primary vent	Maximum pressure excursion during primary seal failure
Secondary vent, vent, separation gas	No additional requirement above Class 150 ~~lb~~
Drains	MAWP of vent or supply systems connected to the cavity being drained
NOTE Vent study can indicate a need to raise ratings.	

6.1.2.1 If the seal gas or buffer gas system rating is less than MAWP of the compressor casing or the maximum seal gas and buffer gas source pressure, respectively, the purchaser and vendor shall agree on the system rating and mitigation plan.

6.1.2.2 Lower ratings, including use of relief valves and specification breaks, require purchaser approval.

6.1.3 [●] The purchaser shall specify seal gas conditions. Seal gas source shall be at a pressure greater than the maximum sealing pressure and include any pressure drops within the seal gas system and required margin specified by the vendor.

NOTE 1 Loss of seal gas due to unreliable systems can cause seal damage leading to possible compressor outages.

NOTE 2 Refer to Section 6.3 in Part 1 for seal gas description and requirements.

6.1.4 [●] The purchaser shall specify secondary seal gas conditions.

NOTE Refer to Sections 6.3 and 6.4 in Part 1 for description and requirements of the secondary seal gas and site utilities.

6.1.5 [●] The purchaser shall specify buffer gas conditions. Buffer gas shall be at a pressure greater than the maximum sealing pressure, which includes any pressure drops within the seal gas system and required margin specified by the vendor.

NOTE Refer to Section 6.3 in Part 1 for buffer gas description and requirements.

6.1.6 [●] The purchaser shall specify separation seal gas conditions.

NOTE Refer to Sections 6.3 and 6.4 in Part 1 for description and requirements of the separation seal gas and site utilities.

6.1.7 [●] The purchaser shall specify vent system pressure ranges (minimum, normal, and maximum).

6.1.8 Control systems shall provide minimum gas velocity across the labyrinths at all clearances, including minimum labyrinth clearance to twice the maximum design labyrinth clearance.

NOTE 1 Refer to Section 6.6 in Part 1, Table 1 for minimum recommended gas velocities for process, intermediate, and separation labyrinths.

NOTE 2 In a flow control system, velocity across labyrinths decreases as clearances increase.

6.1.9 All components of the dry gas seal support system shall be completely assembled and within the confines of the panel or skid.

6.1.10 All connections shall be flanged at the panel or skid edge and supported by the structure. It is possible that tubing used for instrument sensing lines may not require flanges.

6.1.10.1 Connection locations shall be approved by the purchaser.

6.1.10.2 Each utility service shall be manifolded to a single skid edge connection point.

6.1.11 [●] The purchaser shall define components and method of isolation necessary for on-line maintenance and removal of system components.

NOTE Typical isolation methods use single block, double block and bleed, or valve arrangements including spectacle blinds.

6.1.11.1 Vents, drains, piping, and tubing shall be provided with valves to permit draining, cleaning, purging, and pressurizing of idle components while the compressor is in operation.

6.1.12 Filters, liquid traps, separators, coolers, heaters, and other pressure vessels shall be in accordance with Section VIII of ASME *Boiler and Pressure Vessel Code* or other purchaser specified design codes.

6.1.13 [●] If specified, the vessels smaller than the size required for a code stamp shall be code stamped. Local codes, regulations, ordinances, or rules can require a code stamp.

NOTE Code stamping is in reference to ASME pressure design codes.

6.1.14 Socket weld connections shall not be used.

6.1.15 Welded connections shall be designed to eliminate pockets where debris can accumulate.

NOTE Weld-o-lets on piping and vessels can create a pocket due to the size of the through hole. Increasing the through hole size to match the line size will eliminate the pocket.

6.1.16 Threaded connections shall be approved by the purchaser. If approved, threaded connections shall comply with the requirements listed in 9.2.

NOTE 1 Small component size can dictate the use of threaded connections.

~~NOTE 2 Compression fittings are not threaded connections.~~

NOTE 2 Compression fitting connections are not considered threaded connections, however NPT to compression fittings are considered threaded connections.

6.1.17 Orifices less than 1.5 mm (1/16 in.) diameter shall be approved by the purchaser.

NOTE Orifice sizes smaller than 1.5 mm (1/16 in.) can plug easily.

6.1.18 [●] If specified, coatings, insulation, and heat tracing to be defined by the purchaser.

NOTE Refer to Section 8 in Part 1 for requirements.

6.2 Accessibility

6.2.1 The arrangement of the dry gas seal support system shall provide adequate clearance areas and safe access for operation and maintenance. Maintenance considerations include access areas sufficient for filter element replacement, cooler bundle removal, heater element removal, control valve calibration, instrument calibration, and repair of control valves or instruments without removal or dismantling of adjacent equipment, piping, or structure.

6.2.2 [●] The purchaser shall specify any additional accessibility requirements.

6.3 Tandem Seal—Seal Gas System

6.3.1 General

This section covers the seal gas system for a tandem seal. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE 1 Applications for using intermediate labyrinths are discussed in Part 2.

NOTE 2 Symbols are shown in Annex B-1

6.3.2 [●] Module A—Alternate Seal Gas Supply

If specified, alternate seal gas supply shall be provided per the requirements listed in 6.14.

NOTE Refer to 6.15.4 for use of boosters as a potential consideration rather than alternate seal gas.

6.3.3 Module B—Gas Conditioning System

A gas conditioning system shall be provided ~~to condition the seal gas~~ per the requirements listed in 6.15.

6.3.4 Module C—Duplex Filter System

Duplex filters shall be provided per the requirements listed in 6.16.

6.3.5 Seal Gas System Control (Modules DT, DT1, DT2, DT3, and DT4)

6.3.5.1 General

6.3.5.1.1 A pressure-indicating transmitter downstream of the control valve or upstream of any final flow control element shall be provided to monitor pressure.

6.3.5.1.2 A flow-indicating transmitter shall be provided for all modules to monitor flow to each seal.

6.3.5.2 Module DT —Seal Gas Flow Control

6.3.5.2.1 A flow control valve and orifices shall be provided to control seal gas flow.

6.3.5.2.2 The flow controller shall compare the seal gas flow to each seal and adjust the flow control valve to maintain the minimum required velocity based on low select.

6.3.5.3 Module DT1—Seal Gas Differential Pressure Control

6.3.5.3.1 [●] If specified, a differential pressure control valve shall be provided to control seal gas pressure.

6.3.5.3.2 The differential pressure controller shall regulate seal gas pressure relative to reference pressure to maintain the minimum required differential pressure.

6.3.5.3.3 Reference pressure shall be taken from the compressor end with the higher sealing pressure inboard of the process side labyrinth.

6.3.5.3.4 Reference pressure shall not be taken from the balance line.

NOTE Measurements taken in a flowing line like the balance line will not give an accurate indication of pressure at the dry gas seal.

6.3.5.3.5 Differential pressure control point shall be equal to or exceed pressure losses due to flow induced friction; flow contraction and/or expansion along the supply path and pressure drop in the labyrinth at normal flow.

NOTE Changes in the system flow rates will change the pressure profile.

6.3.5.3.6 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends in the event of a gas seal failure.

NOTE Flow measuring orifices and flow balancing orifices can be one orifice.

6.3.5.4 Module DT2—Seal Gas Orifice Flow Control

6.3.5.4.1 [●] If specified, an orifice to each seal shall be provided to regulate flow. This system should only be used with steady supply conditions and sufficient margin above maximum sealing pressure.

6.3.5.4.2 A pressure-indicating transmitter upstream of the flow-indicating transmitters shall be provided.

6.3.5.5 [●] Module DT3—Seal Gas Individual Flow Control

If specified, individual flow control valves to each seal shall be provided to control flow.

NOTE This system can be used with different sealing pressures on each seal, e.g. screw compressors.

6.3.5.6 Module DT4—Seal Gas Differential Pressure Control for Primary Vent Pressure Higher Than Suction Pressure

6.3.5.6.1 [●] If specified, a differential pressure control valve shall be provided to control seal gas pressure.

6.3.5.6.1.1 The differential pressure controller shall regulate seal gas pressure based on low select differential pressure between the supply pressure and reference pressure and between the supply pressure and each primary vent pressure.

6.3.5.6.1.2 The reference pressure shall be taken from the compressor end with the higher sealing pressure.

6.3.5.6.1.3 Primary vent pressure shall be taken upstream of any back pressure device.

NOTE This module can prevent reverse pressurization of the seal when primary vent pressure is equal to or higher than suction pressure.

6.3.5.6.2 Reference pressure shall not be taken from the balance line.

NOTE Measurements taken in a flowing line like the balance line will not give an accurate indication of pressure at the dry gas seal

6.3.5.6.3 Differential pressure control point shall be equal to or exceed pressure losses due to flow induced friction; flow contraction and/or expansion along the supply path and pressure drop in the labyrinth at normal flow.

NOTE Changes in the system flow rates will change the pressure profile.

6.3.6 Temperature Monitoring

6.3.6.1 Temperature transmitters shall be provided.

6.3.6.1.1 Sensing elements shall be placed as close to each seal gas inlet as possible before entering the equipment to monitor seal gas temperature.

6.3.6.2 When a gas conditioning system (Module B) is provided for the seal gas, the gas inlet temperature transmitters shall be used for heater control (Module B4).

6.4 Tandem Seal with Intermediate Labyrinth—Secondary Seal Gas System

6.4.1 General

This section covers the seal gas system for a tandem seal with an intermediate labyrinth. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.4.1.1 [●] The purchaser shall specify the location of any pressure rating breaks of pipe and equipment.

6.4.1.2 [●] The purchaser shall specify any additional requirements for back flow prevention.

NOTE Process pressure can be significantly higher than nitrogen systems supplying secondary seal gas.

6.4.2 Module C—Duplex Filter System

Duplex filters shall be provided and comply with the requirements listed in 6.16.

6.4.3 Secondary Gas System Control (Modules F, F1, F2, and F3)

6.4.3.1 A pressure-indicating transmitter shall be provided downstream of the control valve or upstream of any final orifice to monitor pressure.

6.4.3.2 A flow-indicating transmitter shall be provided to monitor flow to each seal.

6.4.3.3 A check valve shall be provided on each secondary seal gas supply line at the exit of the panel or skid as shown in Annex B.

6.4.3.4 A solenoid valve shall be provided on each secondary seal gas supply line at the entrance of the F module on the panel or skid as shown in Annex B.

6.4.4 Module F—Secondary Seal Gas Pressure Control

6.4.4.1 A pressure control valve shall be provided to regulate secondary seal gas pressure.

6.4.4.2 Flow to each seal shall be regulated by an orifice sized to maintain the minimum required velocity.

6.4.4.3 Positive back flow prevention shall be provided.

NOTE 1 This can be achieved with dual check valves or automated isolation valves.

6.4.5 Module F1—Secondary Seal Gas Flow Control

6.4.5.1 [●] If specified, a differential pressure control valve referenced to line pressure downstream of an orifice shall be provided to control secondary seal gas pressure.

NOTE This is flow control for fluctuating primary vent pressure.

6.4.5.2 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends during normal operation and in the event of a gas seal failure.

6.4.6 Module F2—Secondary Seal Gas Flow Control

6.4.6.1 [●] If specified, a flow control valve shall be provided to regulate secondary seal gas flow and provide required velocity across the intermediate labyrinth.

6.4.6.2 A flow controller shall compare the secondary seal gas flow to each seal and adjust the flow control valve to maintain the minimum required velocity based on low select.

6.4.6.3 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends during normal operation and in the event of a gas seal failure.

6.4.7 [●] Module F3—Secondary Seal Gas Individual Flow Control

If specified, individual flow control valves to each seal shall be provided to control the secondary seal gas flow.

6.5 Tandem Seal—Primary and Secondary Vent Systems

6.5.1 General

This section covers the primary and secondary vent system for tandem seals. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.5.2 Primary Vent (Modules G, H, and L)

6.5.2.1 General

The primary vent shall be routed to a safe location. Some safe locations can produce back pressure.

NOTE Primary vents are typically routed to a flare or other recovery systems.

6.5.2.2 [●] Module G—Primary Vent Pressure-relief Device

If specified, a pressure-relief device shall be provided per 7.10.

6.5.2.3 Module H—Primary Vent Pressure and Flow Monitoring

6.5.2.3.1 A pressure-indicating transmitter shall be provided to monitor the primary vent pressure.

6.5.2.3.2 Flow-indicating transmitter shall be provided to monitor the flow.

6.5.2.3.3 ~~**A check valve shall be provided downstream of the back pressure device.**~~

6.5.2.4 Module L—Primary Vent Back Pressure Regulator or Control Valve

6.5.2.4.1 A back pressure regulator or control valve shall control the primary vent pressure at least 5 psi (0.34 bar) above the minimum secondary seal differential pressure specified by the vendor. Using an orifice is not recommended for low-pressure applications unless secondary seal gas is used.

NOTE 1 This allows condition monitoring of the secondary seal. Secondary seal failure can be detected by a loss of primary vent pressure.

NOTE 2 Methods described in Module L and L2 can also provide restriction to monitor high pressure during primary seal failure where Module L1 may not.

6.5.2.4.2 A check valve shall be provided downstream of the back pressure device.

6.5.2.4.3 A single back pressure control device ~~can~~ may be supplied on the common vent header for multiple seals if approved by the purchaser.

6.5.2.4.3.1 Individual check valves shall be supplied upstream of the pressure control device.

6.5.2.4.3.2 ~~When a single back pressure control device is approved by the purchaser,~~ The vendor shall provide functional and design details to define the proposed system and the effects during failure (e.g. impact of failed seal on non-failed seal).

6.5.2.5 [●] Module L1—Primary Vent Back Pressure Check Valve

If specified, a spring-loaded check valve alone shall be provided to ensure adequate differential pressure exists across the secondary seal as specified in 6.5.2.4.1.

6.5.2.6 [●] Module L2—Primary Vent Back Pressure Orifice

If specified, an orifice shall be provided to ensure adequate differential pressure exists across the secondary seal as specified in 6.5.2.4.1

6.5.3 Secondary Vent (Modules I, J, and K)

6.5.3.1 General

Secondary vent shall be routed to a safe location with minimal back pressure.

NOTE 1 Secondary vent is typically routed to an atmospheric location to prevent reverse pressurization of the secondary seal.

NOTE 2 Secondary vent can require a flame arrestor.

6.5.3.2 [●] Module I—Secondary Vent Gas Analyzer

If specified, a gas analyzer shall be provided to monitor secondary vent gas composition.

NOTE Increased hydrocarbon content in secondary vent can indicate secondary seal failure.

6.5.3.3 Modules J and K—Secondary Vent Pressure and Flow Transmitters

6.5.3.3.1 [●] If specified, a pressure-indicating transmitter shall be provided to monitor secondary vent pressure.

6.5.3.3.2 [●] If specified, a non restricting flow-indicating transmitter shall be provided to monitor secondary vent flow. ~~The flow meter shall not create a restriction.~~

6.6 Tandem Seal—Drain System

6.6.1 General

This section covers the drain system for tandem seals. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.6.1.1 All seal cavities shall have low point drains. Drain lines with valve(s) shall be provided as shown in Annex B.

6.6.1.2 Flow glass, isolation valves, and associated piping shall be rated to the same pipe Class as the associated supply lines. Secondary seal vent cavity drain shall be rated to at least the same pipe Class as the separation seal gas system.

NOTE Secondary vent cavity drain can be exposed to pressures that exceed separation seal supply rating during failure events requiring a higher pressure rating.

6.6.2 Module N—Separation Gas Cavity Flow Glass and Isolation Valve

6.6.2.1 A flow glass and isolation valves shall be provided to drain the separation gas cavity.

6.6.2.2 The upstream valve shall be normally open to allow monitoring of liquid collection during operation.

6.6.2.3 The downstream valve shall be normally closed during operation.

6.6.2.4 [●] If specified, this line shall be routed to the lube oil return header or drain system.

NOTE Open drain lines will affect the cavity pressures and seal velocities that can result in problems with operation.

6.6.3 [●] Module N1—Separation Gas Cavity Automatic Drain

6.6.3.1 [●] If specified, a drain trap shall be provided for automatic draining of the separation gas cavity.

NOTE This can be used in series after Module N.

6.6.3.2 System shall be designed to maintain cavity pressure and seal velocity while the drain is open.

6.6.4 Module N2—Separation Gas Cavity Orifice

6.6.4.1 [●] If specified, an orifice for continuous draining shall be provided to drain the separation gas cavity.

NOTE 1 This can be used in series after Module N.

NOTE 2 Open drain lines will affect the cavity pressures and seal velocities that can result in problems with operation.

6.6.4.2 ~~Restrictive~~ Flow orifice shall be sized to maintain separation seal minimum velocity requirements.

NOTE Refer to Section 6.6 in Part 1 for requirements.

6.6.5 Module O—Secondary Vent Cavity Flow Glass and Isolation Valves

6.6.5.1 A flow glass and isolation valves shall be provided to drain the secondary vent cavity.

6.6.5.2 The upstream valve shall be normally open to allow monitoring of liquid collection during operation.

6.6.5.3 The downstream valve shall be normally closed during operation.

6.6.6 [●] Module O1—Secondary Vent Cavity Automatic Drain

If specified, a drain trap shall be provided for automatic draining of the secondary vent cavity.

NOTE This can be used in series after Module O.

6.6.7 Module P—Secondary Seal Gas Drain Valve

A normally closed valve shall be provided to drain the secondary seal gas vent cavity.

6.6.8 Module Q—Primary Vent Cavity Drain Valve

A normally closed valve shall be provided to drain the primary vent cavity.

6.6.9 Module R—Seal Gas Cavity Drain Valve

A normally closed valve shall be provided to drain seal gas cavity.

6.7 Double Seal—Seal Gas System

6.7.1 General

This section covers the seal gas system for a double seal. Modules shall be provided as shown in Annex B for the corresponding system diagram.

6.7.2 [●] Module A—Alternate Seal Gas Supply

If specified, alternate seal gas supply shall be provided and comply with the requirements listed in 6.14.

6.7.3 Module B—Gas Conditioning System

If specified, a seal gas conditioning system shall be provided to condition the seal gas per the requirements listed in 6.15.

NOTE Seal gas for double seal systems is typically an inert gas. Seal gas conditioning is not typically supplied for nitrogen seal gas but can be required for alternate seal gas sources.

6.7.4 Module C—Duplex Filter System

Duplex filters shall be provided and comply with the requirements listed in 6.16.

6.7.5 Seal Gas System Control (Modules DD, DD1, DD2, and DD3)

6.7.5.1 General

6.7.5.1.1 A flow-indicating transmitter shall monitor flow to each gas seal.

6.7.5.1.2 A check valve shall be provided on each seal gas line at the exit of the panel or skid as shown in Annex B.

6.7.5.1.3 A pressure-indicating transmitter shall be provided to monitor pressure to each seal downstream of the check valve.

NOTE Pressure reference and monitoring lines are after any restriction devices to provide accurate seal supply pressure readings.

6.7.5.2 Module DD—Double Seal Gas Differential Pressure Control

6.7.5.2.1 A differential pressure control valve shall be provided to control seal gas pressure.

6.7.5.2.2 The differential pressure controller shall regulate the common seal gas pressure based on low select of individual seal reference lines to maintain the minimum required differential pressure to the gas seals.

6.7.5.2.3 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends in the event of a gas seal failure.

6.7.5.3 Module DD1—Double Seal Gas Seal Flow Control

6.7.5.3.1 [●] If specified, no control valve shall be provided to control seal gas pressure.

NOTE 1 Pressure control valve is removed in this option since regulation is not required due to stable seal gas conditions within the defined seal design parameters considering all pressure losses within the seal gas system.

NOTE 2 This system can produce higher differential pressures than required, resulting in increased seal gas consumption.

6.7.5.3.2 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends in the event of a gas seal failure.

6.7.5.4 Module DD2—Double Seal Gas Pressure Control

6.7.5.4.1 [●] If specified, a pressure control valve shall be provided to control seal gas pressure.

6.7.5.4.2 The pressure control valve setting shall account for the maximum specified sealing pressure considering all pressure losses within the system.

NOTE This system can produce higher differential pressures than required resulting in increased seal gas consumption.

6.7.5.4.3 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends in the event of a gas seal failure.

6.7.5.5 Module DD3—Double Seal Gas Individual Differential Pressure Control

6.7.5.5.1 [●] If specified, individual differential pressure controllers shall be provided to each seal supply line to control seal gas pressure.

NOTE This control method can be utilized if there is potential for unbalanced sealing pressures between each gas seal cavity of the compressor. This can exist in screw (API 619) or integral gear (API 617, Part 3) compressors.

6.7.5.5.2 The control valves shall be sized for balancing between machine ends in the event of a gas seal failure.

6.7.6 Temperature Monitoring

6.7.6.1 [●] If specified, temperature transmitters shall be provided.

6.7.6.1.1 Sensing elements shall be placed as close to each seal gas inlet as possible before entering the equipment to monitor seal gas temperature.

6.7.6.2 ~~When~~ If a gas conditioning system (Module B) is provided for the seal gas, the gas inlet temperature transmitters shall be provided and used for heater control (Module B4).

6.8 Double Seal—Buffer Gas System

6.8.1 General

This section covers the buffer gas system for a double seal. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.8.2 [●] Module B—Gas Conditioning System

If specified, a gas conditioning system shall be provided to condition buffer gas per the requirements listed in 6.15.

NOTE Buffer gas for double seal systems is typically an inert gas. Seal gas conditioning is not typically supplied for nitrogen buffer gas but can be required for alternate buffer gas sources.

6.8.3 Module C—Duplex Filter System

Duplex filters shall be provided and comply with the requirements listed in 6.16.

6.8.4 Buffer Gas System Control (Modules T, T1, T2, and T3)

6.8.4.1 General

6.8.4.1.1 A pressure-indicating transmitter shall be provided downstream of the control valve or upstream of any final orifice to monitor pressure.

6.8.4.1.2 A flow-indicating transmitter shall be provided to monitor flow to each seal.

6.8.4.1.3 A check valve shall be provided on each buffer gas line at the exit of the panel or skid.

NOTE The use of the process gas as the buffer gas could eliminate the requirement for a check valve.

6.8.4.2 Module T—Buffer Gas Orifice Flow Control

6.8.4.2.1 Orifices shall be provided to control buffer gas flow to each dry gas seal.

NOTE This system should only be used with steady supply conditions and sufficient margin above normal sealing pressure.

6.8.4.2.2 A pressure-indicating transmitter upstream of the flow-indicating transmitters shall be provided.

6.8.4.3 Module T1—Buffer Gas Flow Control

6.8.4.3.1 [●] If specified, a flow control valve and orifices shall be provided to control buffer gas flow to each dry gas seal.

6.8.4.3.2 The flow controller shall compare the buffer gas flow to each seal and adjust the flow control valve to maintain the minimum required velocity based on low select.

6.8.4.4 Module T2—Buffer Gas Differential Pressure Control

6.8.4.4.1 [●] If specified, a differential pressure control valve and orifices shall be provided to control buffer gas flow.

6.8.4.4.2 The differential pressure controller shall regulate buffer gas pressure relative to reference pressure, maintaining the minimum required differential pressure.

6.8.4.4.3 The reference pressure shall be taken from the compressor end with the higher pressure.

6.8.4.4.4 This pressure shall be taken inboard of the process labyrinth and should be as close to the compressor case buffer gas inlet as possible to minimize dynamic loss effects.

6.8.4.4.5 The reference pressure shall not be taken from any balance line.

6.8.4.4.6 An orifice shall be provided in each seal supply line for the purpose of flow balancing between machine ends in the event of a gas seal failure.

6.8.4.5 Module T3—Buffer Gas Individual Flow Control

6.8.4.5.1 [●] If specified, individual flow control valves to each seal shall be provided to control flow.

NOTE This system can be used with unbalanced sealing pressures on each seal, e.g. screw compressors.

6.8.5 Temperature Monitoring

6.8.5.1 If a gas conditioning system (Module B) is provided for the buffer gas, temperature transmitters shall be provided.

6.8.5.2 Sensing elements shall be placed as close to each buffer gas inlet as possible before entering the equipment to monitor buffer gas temperature.

6.8.5.3 ~~When a gas conditioning system (Module B) is provided for the buffer gas,~~ The gas inlet temperature transmitters shall be used for heater control (Module B4).

6.9 Double Seal—Vent System

6.9.1 General

This section covers the vent system for a double seal. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.9.1.1 The vent shall be routed to a safe location with minimal back pressure.

NOTE The vent is typically routed to atmosphere.

6.9.1.2 [●] The purchaser shall specify if the vent is routed to a flare or recovery system that can create back pressure.

6.9.1.3 [●] The purchaser shall specify Module M2 or M3 for separation gas control if the vent can create back pressure.

6.9.2 [●] Module J—Vent Pressure Transmitter

If specified, a pressure-indicating transmitter shall be provided to monitor vent pressure.

6.9.3 [●] Module K—Vent Flow-indicating Transmitter

If specified, a flow-indicating transmitter shall be provided to monitor vent flow. The flow meter shall not create line restriction on vent.

6.10 Double Seal—Drain System

6.10.1 General

This section covers the drain system for a double seal. Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.10.1.1 All seal cavities shall have low point drains. Drain lines with valve(s) shall be provided as shown in Annex B.

6.10.2 Module N—Separation Gas Cavity Flow Glass and Isolation Valves

6.10.2.1 [●] If specified, a flow glass and isolation valve shall be provided to drain the separation seal gas cavity.

6.10.2.2 Flow glass, isolation valves, and associated piping shall be rated to the same pipe Class as the compressor cavity connection but not less than Class 150 ~~lb~~.

6.10.2.3 The upstream valve shall be normally open to allow monitoring of liquid collection during operation.

6.10.2.4 The downstream valve shall be normally closed during operation.

6.10.2.5 [●] The purchaser shall specify when applicable, where separation seal gas cavity drains are to be routed, the lube oil return header or drain system.

NOTE Open drain lines will affect the cavity pressures and seal velocities that can result in problems with operation.

6.10.3 [●] Module N1—Separation Seal Gas Cavity Auto Drain

6.10.3.1 [●] If specified, a drain trap shall be provided for automatic draining of the separation seal gas cavity.

NOTE This can be used in series after Module N.

6.10.3.2 System shall be designed to maintain cavity pressure and seal velocity while the drain is open.

6.10.4 [●] Module N2—Separation Seal Gas Cavity Orifice

If specified, an orifice shall be provided for continuous draining of the separation seal gas cavity.

NOTE 1 This can be used in series after Module N.

NOTE 2 Open drain lines will affect the cavity pressures and seal velocities that can result in problems with operation.

6.10.4.1 ~~Restrictive~~ Flow orifice shall be sized to maintain separation seal minimum velocity requirements.

NOTE Refer to Section 6.6 in Part 1 for requirements.

6.10.5 Module U—Vent Cavity Flow Glass and Isolation Valve

6.10.5.1 A flow glass and isolation valve rated to the same pipe Class as the compressor cavity connection but not less than Class 150 ~~lb~~ shall be provided to drain the vent cavity drain.

6.10.5.2 The upstream valve shall be normally open to allow monitoring of liquid collection during operation.

6.10.5.3 The downstream valve shall be normally closed during operation.

NOTE Vent cavity can be exposed to higher pressure during failure events requiring a higher pressure rating.

6.10.6 [●] Module U1—Vent Cavity Automatic Drain

If specified, a drain trap shall be provided for automatic draining of the vent cavity.

NOTE This can be used in series after Module U.

6.10.7 Module R—Seal Gas Drain Valve

A normally closed valve shall be provided to drain the seal gas cavity.

6.10.8 Module V—Buffer Gas Cavity Drain Valve

A normally closed valve shall be provided to drain the buffer gas cavity.

6.11 Single Seal—Seal Gas System

6.11.1 This section covers dry gas seal systems for a single seal. A single dry gas seal system consists of a seal gas system, vent-monitoring system, separation seal system, and drain system.

6.11.2 Seal gas requirements and recommended alarms shall be based on those for the tandem seal (Table 6).

6.11.3 Vent and drain requirements shall be based on those for the double seal (Table 8).

6.11.4 The vendor and purchaser shall agree on specific requirements for single seal support systems.

6.12 Separation Gas System

6.12.1 General

This section covers the separation gas system for a separation seal.

6.12.1.1 Modules shall be provided as shown in Annex B for the corresponding system diagram.

NOTE Symbols are shown in Annex B-1

6.12.1.2 Separation gas shall be supplied to each seal.

NOTE 1 Typically, separation gas is an inert gas.

NOTE 2 Unreliable gas supply can result in lube oil migration to seal cavity.

6.12.1.3 [●] The purchaser shall specify separation gas conditions.

6.12.2 Module C—Duplex Filter System

6.12.2.1 Duplex filters shall be provided and comply with the requirements listed in 6.16.

6.12.2.2 [●] If specified, separation gas shall use the same filter as the secondary seal gas.

NOTE 1 Separation gas is started prior to lube oil system while the case is depressurized. Using a common filter without isolating secondary seal gas can reverse pressurize the primary seal.

6.12.3 Separation Gas System Control (Modules M, M1, and M2~~, and M3~~)

6.12.3.1 General

6.12.3.1.1 A flow-indicating transmitter shall be provided to monitor flow to each seal.

6.12.3.1.2 A check valve shall be provided on each separation gas line at the exit of the panel or skid.

6.12.3.2 Module M—Separation Gas Individual Differential Pressure Control

~~If specified,~~ Individual differential pressure control valves shall be provided, referenced to the respective secondary vent for tandem seals, or to the respective vent for single and double seals.

NOTE The diagram shows a dome-loaded regulator, but other control valves can be used.

6.12.3.3 [●] Module M1 —Separation Gas Flow Control

6.12.3.3.1 A pressure control valve shall be provided to regulate pressure to maintain separation ~~seal~~ gas ~~pressure~~ flow.

6.12.3.3.2 A pressure-indicating transmitter shall be provided downstream of the pressure control valve to monitor pressure.

6.12.3.3.3 Orifices shall be provided to regulate flow to each seal.

NOTE If Module M is used with a contacting bushing seal, the orifices are provided for the purpose of flow balancing between machine ends in the event of a seal failure. Normally the seals regulate the flow.

6.12.3.4 [●] Module M~~1~~2—Separation Gas Individual Pressure Control

If specified, individual pressure control valves shall be provided to control separation seal gas pressure to each seal.

NOTE Self-venting pressure control valve could be necessary for contacting type seal.

6.12.3.5 ~~Module M2—Separation Gas Differential Pressure Control~~

6.12.3.5.1 ~~**[●] If specified, a differential pressure control valve referenced to the secondary vent for tandem seals, or to the vent for single and double seals, shall be provided. The vent with the highest potential back pressure should be used for the reference pressure.**~~

~~NOTE The diagram shows a dome-loaded regulator, but other control valves can be used.~~

6.12.3.5.2 ~~**A pressure-indicating transmitter shall be provided downstream of each orifice to monitor pressure.**~~

6.12.3.5.3 ~~**Orifices shall be provided in each supply line for the purpose of flow balancing between machine ends during normal operation and in the event of a seal failure.**~~

6.12.3.6 ~~[●] Module M3—Separation Gas Individual Differential Pressure Control~~

~~If specified, individual differential pressure control valves shall be provided, referenced to the respective secondary vent for tandem seals, or to the respective vent for single and double seals.~~

~~NOTE The diagram shows a dome-loaded regulator, but other control valves can be used.~~

6.13 Module A—Alternate Seal Gas Supply

6.13.1 An isolation valve and a check valve shall be provided in the alternate seal gas line.

NOTE 1 Check valves are required to prevent reverse flow into the seal gas supply or alternate seal gas supply systems.

NOTE 2 Refer to Section 6.3 in Part 1 for alternate seal gas supply requirements.

6.13.2 [●] If specified, an automatic transfer or isolation system shall be supplied. ~~the isolation valve shall be automatic.~~

6.13.2.1 ~~The purchaser shall specify details of the automatic transfer system when automatic is specified~~. The details of the automatic transfer or isolation system shall be agreed.

6.14 Module B—Gas Conditioning System

6.14.1 General

6.14.1.1 Gas conditioning systems shall be provided per the referenced module as shown in Annex B.

NOTE Symbols are shown in Annex B-1

6.14.1.2 Block and bypass valves shall be provided for each gas conditioning component.

6.14.1.3 The bypass valve shall be a full flow type.

6.14.1.4 [●] If specified, any or all of the gas conditioning components shall be provided in a duplex arrangement with a dedicated transfer valve.

6.14.1.5 [●] If specified, a common bypass shall be provided around the entire gas conditioning section.

NOTE When considering bypassing or duplex arrangements, the potential impacts need to be understood. Example: seal gas that is prone to saturation during normal operation would be more likely to require duplexing than a gas that is saturated only during starting conditions.

6.14.1.6 [●] If specified, gas conditioning system shall be provided on a separate skid.

6.14.2 Module B1—Coolers

6.14.2.1 Cooler(s) shall be provided as shown in Annex B (Module B1) and supplied per the requirements listed in 7.2.

6.14.2.2 ~~When a cooler is provided, a~~ A temperature transmitter shall be provided in the line downstream of the cooler outlet.

6.14.2.3 The cooler outlet line shall be sloped downward towards the separator inlet.

6.14.2.4 [●] If specified, cooler temperature control shall be provided.

6.14.3 Module B2—Separator

6.14.3.1 General

6.14.3.1.1 Separator(s) shall be provided as shown in Annex B (Module B2) and comply with the requirements listed in 7.3.

6.14.3.1.2 [●] Drain system capacity shall be sized for 5 times the normal expected condensate collection rate, or twice any higher condensate collection rate for alternate conditions specified by the purchaser, whichever is greater.

6.14.3.1.3 Liquid level inside the separator shall be monitored by a level-indicating transmitter as shown in Annex B, Module B2.

6.14.3.1.4 Liquid drain shall have a snap-acting level control valve as shown in Annex B (Module B2).

NOTE This system is typically applied when liquid could be present during normal operation.

6.14.3.1.5 Snap-acting level control valve cycle time shall not be less than 5 minutes at normal expected condensation rates.

NOTE An orifice can be used in the drain line for high differential pressure applications.

6.14.3.2 [●] Module B21—Continuous Drain

If specified, a continuously draining system shall be provided utilizing an orifice and bypass valves as shown in Annex B (Module B21). The sizing of the orifice for continuously draining systems shall be agreed.

NOTE This system is typically applied when continuous liquids are expected during normal operation.

6.14.3.3 [●] Module B22—Manual Drain

If specified, a normally closed, manually operated valve shall be provided as shown in Annex B (Module B22).

NOTE 1 This option should only be considered if condensation is unlikely to occur.

NOTE 2 An orifice can be needed in the drain line for high differential pressure applications.

6.14.3.3.1 [●] The purchaser shall specify where the drain system will be routed and the downstream back pressure for drain system.

6.14.4 Module B3—Booster

6.14.4.1 Booster(s) shall be provided as shown in Annex B (Module B3) and comply with the requirements listed in 7.4.

NOTE The requirement for a booster could be eliminated if the normal seal gas or alternate seal gas conditions are sufficient to maintain the minimum velocity, listed in Part 1, Table 1, across the process side seal during all normal and alternate operating conditions.

6.14.4.2 [●] Booster(s) shall be either reciprocating type (Annex B Module B31) or rotary type (Annex B Module B32)

6.14.4.3 A check valve shall be provided in the main seal gas line to ensure no back flow in the system as shown in Annex B (Module B3).

6.14.5 Module B4—Heater

6.14.5.1 Heater(s) shall be provided as shown in Annex B (Module B4) and comply with the requirements listed in 7.5.

6.14.5.2 Temperature indicators shall be provided and placed as close to each seal gas inlet as possible to monitor seal gas temperature.

6.15 Duplex Filter System (Module C)

6.15.1 Duplex filter system shall be supplied as shown in Annex B (Module C).

6.15.2 A pressure-indicating transmitter shall be provided to monitor the upstream gas pressure.

6.15.3 Gas filters shall be per the requirements listed in 7.6 and provided in a duplex arrangement as shown in Annex B (Module C).

6.15.4 Each filter body shall have a vent valve and a drain valve.

6.15.5 Filter housing ~~V~~vent and drain connections shall be flanged per ASME B16.5 or SAE J518 flange connections.

6.15.6 A differential pressure-indicating transmitter shall be provided to monitor filter differential pressure. Instrument manifold shall not allow bypassing of filter elements.

6.15.7 ~~A check valve shall be provided downstream of the duplex filters as shown in Annex B (Module C).~~

6.15.8 Transfer valves shall be provided per the requirements listed in 7.7.

7 Major Components

7.1 General

This section provided additional information about major components required for dry gas seal support systems.

7.2 Cooler

7.2.1 [●] Cooler(s) shall be water-cooled or air-cooled as specified.

7.2.2 Cooler(s) shall be fabricated with flanged vent and flanged drain connections on the water and gas side.

7.2.3 Cooler gas side shall be self-draining to the outlet.

7.2.4 All cooler materials in contact with the seal gas shall be a minimum of 316/316L stainless steel. Materials not in contact with the gas side may be carbon steel.

7.2.5 [●] The purchaser shall specify alternative materials for saltwater services.

7.2.6 Air coolers shall be supplied in accordance with API 661.

7.2.7 All shell-and-tube-type coolers shall be supplied with removable bundles and removable channel covers.

7.2.7.1 Shell-and-tube-type coolers shall have straight tube construction.

7.2.7.2 U-tube construction may be supplied with purchaser approval.

NOTE 1 Removable bundle allows for more thorough cleaning.

NOTE 2 U-tube bundles are more difficult to clean but can accommodate a greater amount of thermal growth.

7.2.8 Water-cooled shell-and-tube coolers shall be designed and constructed to TEMA Class R in accordance with API 660.

7.2.8.1 Water-cooled shell-and-tube coolers may be designed and constructed to TEMA C or other specified code if approved by the purchaser.

7.2.8.2 TEMA C Type W shall not be used.

7.2.8.3 ~~[●] Unless otherwise specified,~~ Cooling water system or systems shall be designed per the conditions in Table 2. ~~for the following conditions:~~

Table 2 – Cooling water system conditions

Water velocity over heat exchange surfaces	≥1.5 m/s to 2.5 m/s	≥5 ft/s to 8 ft/s
MAWP (gauge)	≥700 kPag (7 barg)	≥100 psig
Test pressure (≥1.5 MAWP)	≥1050 kPag (10.5 barg)	≥150 psig
Maximum pressure drop	100 kPa (1 bar)	15 psi

Maximum inlet temperature	30 °C	90 °F
Maximum outlet temperature	50 °C	120 °F
Maximum temperature rise	20 K	30 °F
Minimum temperature rise	10 K	20 °F
Water-side fouling factor	0.35 m^2K/kW	0.002 hr-ft^2-°F/Btu
Corrosion allowance for carbon steel shells	3 mm	$^1/_8$ in.

7.2.8.4 The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchange surfaces result in a conflict. If such a conflict exists, the purchaser shall approve the final selection.

NOTE 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.

7.2.8.5 [●] The purchaser shall specify whether the water is on the shell side or tube side.

NOTE 1 Water on the tube side allows for easier cleaning.

NOTE 2 Water on the shell side allows the shell to be rated to a lower pressure in high-pressure applications. This can require the addition of an overpressure protection device in the event of a tube leak.

7.2.8.6 Nominal tube OD shall be at least 16 mm ($^5/8$ in.), and nominal tube wall thickness shall be at least 16 BWG [1.65 mm (0.065 in.)].

7.2.8.7 [●] If specified, water-side thermal relief shall be provided.

7.2.8.8 [●] If specified, multi-plate-frame coolers shall be provided.

7.2.8.8.1 The vendor shall include in the proposal complete details of any proposed plate-frame cooler.

NOTE Plate coolers have low differential pressure capability of the plates and plates have a tendency to foul and require replacement if condensates form. Plate coolers are typically smaller in size compared to shell-and-tube coolers and in many cases supported by the piping and removing the need for additional supports.

7.2.8.8.2 Process connections shall all be at one end of the exchanger.

7.2.8.8.3 Elastomeric gaskets shall be provided between the welded plate pack and the frame.

7.2.8.8.4 [●] The gasket material shall be specified and be compatible with the process fluids and operating conditions.

7.2.8.8.5 [●] Plate material shall be 316/316L stainless steel for fresh cooling water, titanium for salt water, or as specified by the purchaser for compatibility with the process fluids.

NOTE Titanium plates are often used to eliminate chloride stress corrosion concerns.

7.2.8.8.6 As a minimum, the frame and carry bar shall be painted carbon steel.

7.3 Separator

7.3.1 Separators shall be provided with the following:

o) separation section,

p) liquid collection section,

q) level-indicating transmitter(s),

r) drain,

s) removable cover,

t) separate connections for individual devices.

7.3.2 Separator shall be sized for ~~three~~ two times seal gas normal flow with the following exit gas condition:

a) 98 % removal of 10 μm and larger solid particles,

b) 50 ppmw of liquid particles.

7.3.3 Use of filter elements to achieve the requirements in 7.3.2 shall be approved by the purchaser.

NOTE Duplex separators and additional instrumentation could be needed if filter elements are used.

7.3.4 If a separator contains a filter element, differential pressure indication shall be provided.

NOTE A mist eliminator is not considered a filter element.

7.3.5 Separation section shall be provided with an impingement plate and a demister pad. The use of vane packs, cyclone separators or other separation technology shall be approved by the purchaser.

7.3.6 Separators shall be sized with a liquid collection section that provides a working transmitter range equal to or greater than 10 minutes of collection at normal expected condensate rates, or not less than 10 liters (2.5 gallons) as shown in Figure 1. ~~The separator shall have at least the same volume available between the 100 % level and the bottom of the gas outlet port.~~

NOTE If no specified operating conditions generate condensate, the minimum 10 liters (2.5 gallons) sizing is intended for mitigating unexpected and off-line conditions where liquids can inadvertently be introduced to the system. The purchaser can specify a larger size based on factors such as upstream liquid pockets or if multiple compressors are supplied from one separator.

7.3.7 The vendor shall supply condensate rates assuming normal cooler operation and separator sizing calculations for purchaser approval.

7.3.8 Separators shall have removable bolted covers for top access for cleaning and maintenance.

7.3.8.1 The cover shall not have any piping connections.

7.3.8.2 Davits shall be provided for covers that exceed 15 kg (33 lb).

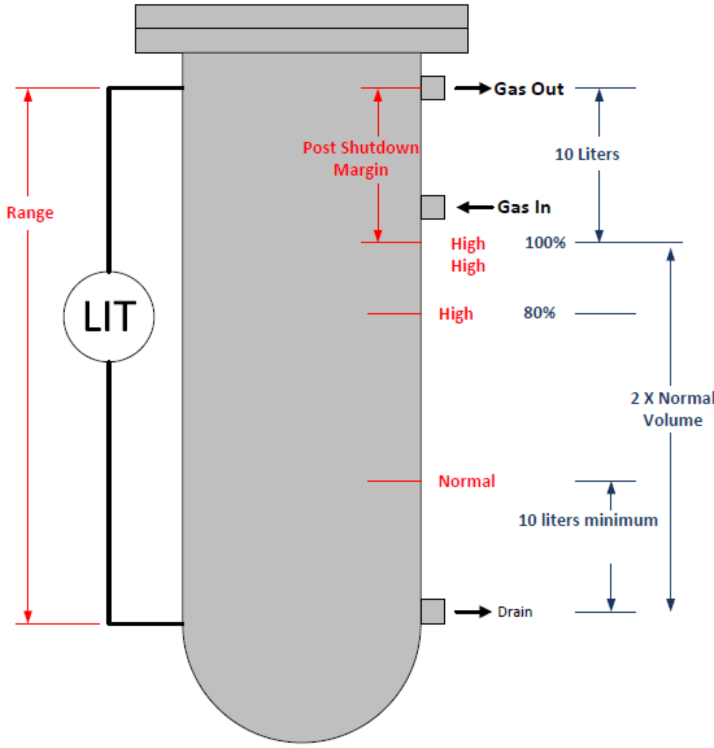


Figure 1—Recommended Separator Sizing for Liquid Knockout

7.3.9 Separator connections shall be flanged.

7.3.10 All separator materials in contact with gas shall be a minimum of 316/316L stainless steel.

7.3.11 [●] If specified, alternate separator materials shall be provided.

7.4 Booster

7.4.1 Booster shall be either Reciprocating or Rotary.
7.4.2 [●] If specified, duplex boosters shall be provided, each providing the required capacity.

7.4.3 Control of the booster(s) shall be in accordance with the seal gas control method (i.e., flow control or differential pressure control).

7.4.3.1 Boosters shall automatically start as needed.

7.4.3.2 Controls shall stop the booster manually or automatically as agreed.
7.4.4 The vendor shall specify condition requirements for the booster gas supply.

NOTE To meet the gas condition requirements for reliable operation, a pre-filter could be required.

7.4.5 Remote indication shall be provided to indicate booster operating status.

7.4.6 An alarm shall be provided to indicate when the booster fails to start or operate as needed.

7.4.7 Booster(s) shall be mounted to allow free draining of both supply and discharge lines away from the booster to prevent liquid collection.

7.4.8 Provisions shall be provided to allow removal of the booster(s) during operation from the seal gas conditioning system.

7.4.9 Booster shall be 316/316L stainless steel

7.4.10 [●] If specified, alternate booster materials shall be provided.

7.4.11 All connections in seal gas service shall be flanged.

7.4.12 Boosters shall be rigidly mounted to panel or skid.

7.4.13 Boosters shall be pneumatic or electrically driven.

7.4.14 The booster shall be sized to meet the minimum velocity, listed in Part 1, Table 1 for all specified operating conditions and/or transient conditions.

7.4.15 The use of multiple boosters in parallel to meet required flow shall be approved by purchaser

NOTE During pressurization or static conditions, a single positive displacement booster capacity could be insufficient to maintain the minimum velocity required.

7.4.16 The vendor shall provide the maximum pressure the booster can develop blocked in.

7.4.17 System Design shall allow testing the operability of boosters while the main process compressor is in service.

7.4.18 **Reciprocating Boosters**

7.4.18.1 Positive displacement booster shall be equipped with a cycle counter.

NOTE Boosters have typically been life-limited components and can require replacement based on number of cycles.

7.4.18.2 For pneumatic driven reciprocating boosters, maximum pressure developed shall be based on the range of motive gas conditions.

7.4.18.3 For rod and shaft seals, leakage shall be monitored to identify damaged or worn seals and vented to a safe location.

7.4.18.4 Threaded connections may be used in the motive gas if approved by the purchaser service.

7.4.18.5 [●] If specified, pulsation dampeners shall be provided to reduce pressure pulsations during booster operation.

7.4.18.6 The vendor shall specify the motive gas quality and utility requirements for pneumatic driven boosters.

7.4.18.7 The purchaser and vendor shall agree on motive gas filter requirements and selection.

7.4.18.8 For pneumatic driven boosters, design shall prevent motive gas from contacting process gas due to seal leakage.

7.4.18.9 Motive gas solenoid or actuated valve(s) shall fail open.

7.4.18.10 [●] If specified, motive gas exhaust shall be vented to a safe location.

7.4.18.11 A 10-micron filter shall be placed upstream of the reciprocating booster, as shown in Module B31

7.4.19 Rotary Boosters

7.4.19.1 Rotary boosters shall be driven by electric motors.

7.4.19.2 VFD to be agreed for required applications.

7.4.19.3 The purchaser shall specify the supply voltage, phase, and frequency available at the site to select the appropriate motor.

7.4.19.3.1 Low-voltage induction motors shall be in accordance with IEEE 841, or other standard as specified by the purchaser

7.4.19.3.2 Motor control centers shall be provided by the purchaser

7.4.19.4 Temperature transmitter shall be used for measurement of booster housing temperature.

7.4.19.5 [●] If specified, vibration monitoring shall be measured.

7.4.20 ~~[●] If specified, duplex boosters shall be provided. Each booster shall provide the required capacity.~~

7.4.21 ~~Control of the booster(s) shall be in accordance with the seal gas control method (i.e. flow control or differential pressure control).~~

7.4.21.1 ~~Boosters shall automatically start as needed.~~

7.4.21.2 ~~Controls shall stop the booster manually or automatically as agreed.~~

~~NOTE Booster will operate when process compressor is idle and pressurized, as well as when there is insufficient differential pressure provided by the main process compressor.~~

7.4.22 ~~The vendor shall specify condition requirements for the booster gas supply.~~

~~NOTE To meet the gas condition requirements for reliable operation, a pre-filter could be required.~~

7.4.23 ~~Remote indication shall be provided to indicate booster operating status.~~

7.4.24 ~~An alarm shall be provided to indicate when the booster fails to start or operate as needed.~~

7.4.25 ~~Positive displacement booster shall be equipped with a cycle counter.~~

~~NOTE Boosters have typically been life-limited components and can require replacement based on number of cycles.~~

7.4.26 ~~The booster shall be sized to provide the seal gas normal flow. The vendor shall supply the basis for these requirements for the range of all specified utility conditions.~~

~~NOTE Sizing criteria does not account for wear in the booster.~~

7.4.27 ~~The purchaser shall approve the use of multiple boosters in parallel operation to meet the seal gas normal flow requirements.~~

~~NOTE During pressurization or static conditions, a single positive displacement booster capacity could be insufficient to maintain the minimum velocity required per Part 1, Table 1.~~

7.4.28 ~~The vendor shall provide the maximum pressure the booster can develop blocked in. For gas-driven boosters, maximum pressure developed shall be based on the range of motive gas conditions.~~

7.4.29 ~~For rod and shaft seals, leakage shall be monitored to identify damaged or worn seals and vented to a safe location.~~

7.4.30 ~~Booster(s) shall be mounted to allow free draining of both supply and discharge lines away from the booster to prevent liquid collection.~~

7.4.31 ~~Provisions shall be provided to allow removal of the booster(s) during operation from the seal gas conditioning system.~~

7.4.32 ~~Booster shall be 316/316L stainless steel. The purchaser shall approve the selection of nonmetallic sealing materials.~~

7.4.33 ~~[●] If specified, alternate booster materials shall be provided.~~

7.4.34 ~~All connections in seal gas service shall be flanged. If approved by the purchaser, threaded connections may be used in the motive gas service.~~

7.4.35 ~~Boosters shall be rigidly mounted to panel or skid.~~

7.4.36 ~~[●] If specified, pulsation dampeners shall be provided to reduce pressure pulsations during booster operation.~~

7.4.37 ~~Booster shall have provisions for testing while the main process compressor is in service, as well as when idle and depressurized.~~

7.4.38 ~~The vendor shall specify, the motive gas quality and utility requirements for gas-driven booster(s). This should include but not be limited to dew point requirements or limitations, particle content, volume, minimum and maximum pressure, and temperature limits.~~

7.4.38.1 ~~The purchaser and vendor shall agree on motive gas filter requirements and selection.~~

7.4.38.2 ~~For gas-driven boosters, design shall prevent motive gas from contacting process gas due to seal leakage.~~

7.4.38.3 ~~Motive gas solenoid or actuated valve(s) shall fail open.~~

7.4.38.4 ~~[●] If specified, motive gas exhaust shall be vented to a safe location.~~

7.5 Heater

7.5.1 The vendor shall provide heater details in the proposal including rating and electrical requirements.

7.5.2 All heater materials in contact with the seal gas shall be a minimum of 316/316L stainless steel.

7.5.3 [●] If specified, alternate heater materials shall be provided.

7.5.4 Heaters shall be electric type. Alternate style heaters require purchaser approval.

7.5.5 Heater shall be provided with a cascade temperature control where the master temperature sensing point is located as close as possible to the seal housing inlet. This temperature sensing point may be located on the compressor skid.

7.5.5.1 The secondary temperature sensing point shall measure the heater internal gas temperature or the heater metal temperature in case on indirect contact type heater

7.5.5.2 The supplier shall provide set points and descriptions of control and protection logic for purchaser approval.

7.5.5.3 Heater controller shall be shipped loose for installation by the purchaser.

7.5.6 Heaters shall have an element temperature sensor for over-temperature protection.

7.5.7 Heater control system shall provide outputs for all temperature parameters.

7.5.8 [●] Heater shall be sized based on:

a) ~~three~~ two times the normal seal gas flow,

b) minimum temperature at seal gas cooler outlet,

c) maximum seal gas pressure,

d) any limits on seal gas contacting temperature specified by the user or recommended by the supplier.

7.5.9 System losses due to ambient conditions, piping without heat trace or insulation, and Joule-Thomson (JT) effect cooling shall be agreed.

7.5.10 If multiple seal gas supplies or compositions are specified, each gas shall be individually evaluated and the heater shall be sized to satisfy the highest heat input requirement.

7.5.11 Heater shall be self-draining toward the separator or a low point drain.

7.6 Filters

7.6.1 Filters ~~for seal gas supply, secondary seal gas supply, and separation gas supply for contacting bushing-type seals~~ shall be coalescing type and have a minimum efficiency of 99.9 % on particles larger than or equal to 1 μm (Beta Ratio, $\beta_1 \geq 1000$).

NOTE 1 Fine filter elements can quickly foul or plug if the gas stream is contaminated with solid particles or sediment. If dirty gas is expected, oversized filters or a pre-filter upstream of the main filters can be used.

NOTE 2 Refer to Annex F for information on fitter ratings, testing, and performance.

7.6.2 Filters in labyrinth separation seal gas supply and buffer gas supply ~~to non-contacting seals~~ may ~~shall be coalescing type and~~ have a minimum efficiency of 99.9 % on particles larger than or equal to 10 µm (Beta Ratio, $\beta_{10} \geq 1000$).

7.6.3 Where common filters are selected for separation gas, seal gas, and secondary seal gas, the requirements in 7.6.1 shall apply.

7.6.4 Gas filter elements shall be sized for a burst differential pressure of at least 500 KPa (5 bar; 75 psi).

7.6.5 Each filter shall be sized for a maximum clean pressure drop of 10 kPa (0.10 bar; 40 in. of water) across the duplex filter assembly at ~~three~~ two times normal flow ~~of all systems supplied~~.

NOTE Pressure drop is measured across the duplex filter system as shown in Annex B, Module C.

7.6.6 Filters shall be designed for the minimum and maximum gas temperature specified and shall be compatible with the gas filtered.

7.6.7 Filters shall be provided with removable bolted covers for top access element removal and installation.

7.6.7.1 Davits shall be provided for covers that exceed 15 kg (33 lb).

7.6.7.2 The purchaser shall approve in-line filters requiring housing removal for element replacement.

7.6.7.3 Filters shall not have removable bottom covers.

7.6.8 Filter housings shall be a minimum of 316/316L stainless steel.

7.6.9 [●] If specified, alternate materials shall be provided.

NOTE Higher-grade alloys can be specified for special process conditions.

7.6.10 Filters shall be non-bypass design.

7.6.11 Filter elements shall be single gasket design.

7.6.12 Captured filters with top and bottom seals or multi-stack elements shall not be provided.

7.6.13 [●] If specified, filters shall be equipped with a level transmitter.

7.7 Transfer Valves

7.7.1 Transfer valves shall be provided for ~~all~~ duplex ~~components~~ filters. ~~All transfer valves should be identical throughout the system~~.

7.7.2 Alternate valving arrangements may be provided for coolers, separators, and boosters if approved by the purchaser.

7.7.3 [●] If specified, transfer valves shall be provided for other duplex components.

7.7.4 Transfer valves shall be leakage Class VI per ANSI/FCI 70-2.

7.7.5 All transfer valve metallic materials shall be a minimum of 316/316L stainless steel.

7.7.6 [●] If specified, alternate materials shall be provided.

NOTE Higher-grade alloys can be specified for special process conditions.

7.7.7 Transfer valves shall be continuous-flow (no shutoff position) valves with resilient seats.

7.7.7.1 A single-body six-port straight plug valve or two three-way plug or ball valves permanently aligned and joined with a single operating lever shall be provided.

7.7.7.2 Valves shall be designed so that, if internal valve mechanisms fail, both flow paths shall not be blocked.

7.7.7.3 Valves and assemblies shall be designed to prevent incorrect assembly and operation.

7.7.7.4 Resilient seats shall be positively retained.

7.7.7.5 Resilient seat materials shall be selected to prevent explosive decompression during filter venting.

7.7.7.6 Permanent indicator shall be provided to indicate flow path and which component is active.

7.7.8 [●] If specified, double block and bleed valves or spectacle blinds shall be provided.

7.7.9 The vendor shall provide transfer valve operating procedures and details on any integral venting and pressure equalization valves.

7.8 Control Valves

7.8.1 Control valve(s) and self-contained regulators shall have a minimum 316/316L stainless steel bodies with stainless steel trim. All air supply or pressure-sensing tubing shall be made of austenitic stainless steel.

NOTE Replacement of control valves with self-contained regulators changes the system from automatic to manually adjusted system.

7.8.2 [●] If specified, alternate control and regulating valve materials shall be provided.

7.8.3 Pressure rating of the body and head shall not be less than the maximum pressure to which the component can be exposed in its failed position.

7.8.4 Failure modes for control valves shall be as shown on the module diagrams in Annex B. Failure modes not listed on the module diagrams shall be approved.

NOTE Failure modes are typically discussed during FMEA and HAZOP studies and the results thereof can alter the failure modes as shown in the modules.

7.8.5 Direct-acting control valves and self-contained regulators shall be sized to limit proportional offset to 10 % based on steady state and 25 % for maximum transients.

7.8.6 Direct-acting or pneumatically operated control valves shall have the following characteristics.

c) Pneumatic-control valves shall be sized to be no less than 10 % open with the minimum flow through the valve and no more than 90 % open with the maximum flow expected through the valve.

d) 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.

e) Control valves shall have visual valve stem position indication.

7.8.7 Control valves shall be flanged. Threaded valves require purchaser approval.

7.8.8 Control valves shall be removable without removing piping or tubing.

7.8.9 All control valves shall be supplied with block, bleed, and bypass valves allowing uninterrupted operation should valve replacement become necessary.

7.8.10 The bypass valve shall be a type suitable for flow throttling.

7.8.11 [●] If specified, control valves shall be provided with valve position transmitters.

7.9 Liquid Traps for Cavity Drains

7.9.1 Traps shall be austenitic stainless steel.

7.9.2 Traps shall be rated to the Class rating of corresponding compressor cavity connection but not less than Class 150 ~~lb~~.

7.9.3 Traps shall have a level gauge

7.10 Pressure-relieving Devices

7.10.1 [●] The purchaser shall specify the type of pressure-relieving devices.

NOTE Pressure-relieving devices include relief valves, safety valves, or rupture disks.

7.10.2 The vendor shall provide all pressure-relieving devices required on the vendor supplied equipment or piping. These shall be clearly indicated in the vendor's quotation.

NOTE ASME or other pressure design codes typically require pressure-relief devices.

7.10.3 [●] If specified, the purchaser shall provide all pressure-relieving devices.

7.10.4 [●] If specified, thermal relief valves shall be provided for vessels that can be blocked in.

7.10.5 The purchaser shall analyze relieving scenarios in accordance with API 521. The purchaser and vendor shall develop a list of expected pressure-relieving scenarios.

7.10.6 Sizing, selection, and installation of pressure-relieving devices shall meet the requirements of API 520, Parts I and II.

7.10.6.1 The vendor shall determine the size and set pressure of all pressure-relieving devices within his/her scope of supply and recommend size and setting of pressure-relieving devices supplied by others required to protect the equipment the vendor supplies.

7.10.6.2 Pressure-relieving device sizes and settings shall take into account all possible modes of equipment failure.

7.10.7 Pressure-relieving devices shall be in accordance with API 526. Pressure-relieving devices not in accordance with API 526 require purchaser approval.

7.10.8 The vendor shall provide all pressure-relieving device design data for purchaser approval.

7.10.9 [●] If specified, pressure-relieving devices shall be arranged to allow for removal without shutting down the equipment.

7.10.10 Rupture disks shall be provided with positive indication to show status.

7.10.11 Rupture disks shall be set sufficiently high to avoid spurious ruptures and shall be designed to avoid failures from causes other than over-pressurization.

8 Materials

8.1 General

8.1.1 Minimum materials of construction shall be in accordance with Tables 3 through 6.

Table 3—Minimum Materials Requirement—Cooling Water

Pipe	Carbon steel (e.g. ASTM A106-B and A53-B or the equivalent material designation located in Annex E), seamless
Pipe fitting	Carbon steel (e.g. ASTM A234 or the equivalent material designation located in Annex E), seamless Carbon steel (e.g. ASTM A105 or the material designation located in Annex E), Class 3000
Flange	Carbon steel (e.g. ASTM A105 or the equivalent material designation located in Annex E), weld neck or slip-on
Tubing	ASTM A269 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, non-asbestos type For greater than or equal to ANSI Class 600: spiral wound with non-asbestos filler, 304 or 316 windings and external centering ring
Flange bolting	Refer to 8.1.19 and 8.1.20
Valves	Carbon steel (e.g. ASTM A105 or the equivalent material designation located in Annex E), weld neck or slip-on

Table 4—Minimum Material Requirements Dry Gas Seal Support Systems

Pipe	ASTM A312 Type 316/316L stainless steel; seamless
Pipe fitting	ASTM A403 Type 316/316L stainless steel; seamless. ASTM A182 Type 316/316L stainless steel, Class 3000; socket weld fittings are prohibited
Flange	ASTM A182 Type 316/316L stainless steel, weld neck or slip-on; socket weld flanges are prohibited
Tubing	ASTM A269 Type 316/316L stainless steel
Tube fittings	Stainless steel Type 316 (vendor's standard with purchaser's approval)
Gaskets	Spiral wound with non-asbestos filler 316 windings with inner ring and external centering ring
~~Flange~~ bolting	Refer to 8.1.19, 8.1.20 and 8.1.21
Valves	Refer to 9.3

Control valves	Refer to 7.8
Transfer valves	Refer to 7.7
Coolers	Refer to 7.2
Filters	Refer to 7.6
Separators	Refer to 7.3
Heaters	Refer to 7.5
Boosters	Refer to 7.4
Instruments	Refer to 11.1
Liquid traps	Refer to 7.9
Skids and panels	Refer to 12.1

Table 5—Minimum Pipe Wall Thicknesses

Materials	NPS Minimum		
	DN	in.	Schedule
Carbon steel	≤DN 40	≤1 1/2	80
Carbon steel	>DN 40	>1 1/2	40
Stainless steel	≤DN 25	≤1	80S
Stainless steel	>DN 40	>1 1/2	40S

Table 6—Minimum Tubing Wall Thicknesses

Nominal Tubing Size [a]		Minimum Wall Thickness	
mm	in.	mm	in.
6	(1/4) [b]	1.0	0.035
10	(3/8) [b]	1.0	0.035
12	(1/2)	1.5	0.065
20	(3/4)	~~2.0~~ 2.4	0.095
25	(1)	~~2.6~~ 2.8	0.109

[a] The tubing size is the OD.
[b] The sizes 6 mm (1/4 in.) and 10 mm (3/8 in.) are permitted for instrument and control air only.

8.1.2 The vendor shall confirm all materials are suitable for all operating and site environmental conditions specified.

NOTE 316/316L can be supplied as single or dual certified.

8.1.3 [●] The purchaser shall specify alternate materials required based on process conditions.

NOTE Higher-grade alloys can be specified for special process conditions.

8.1.4 [●] If specified, all materials in contact with the process gas shall comply with NACE MR0103. Reference 8.1.10, 8.1.14, and 8.1.16 for further information.

8.1.5 Materials of construction for all major components shall be clearly stated in the vendor's proposal.

8.1.6 Materials shall be identified by reference to applicable international standards, including the material grade. Where international standards are not available, internationally recognized national standards (such as AISI or ASTM) or other standards may be used. 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.

NOTE Where international standards are not available, internationally recognized national or other standards can be used.

8.1.7 Copper and copper alloys shall not be used for parts in contact with corrosive gas or with gases capable of forming explosive copper compounds. Nickel-copper alloys (UNS N04400 Monel or its equivalent), aluminum, and precipitation-hardened stainless steels are excluded from this requirement. The purchaser shall approve use of copper-containing materials.

NOTE Certain corrosive fluids in contact with copper alloys have been known to form explosive compounds.

8.1.8 The vendor shall specify the tests and inspection required to ensure that materials selected are satisfactory for the service intended.

8.1.8.1 Such tests and inspections shall be listed in the proposal.

8.1.8.2 [●] The purchaser shall specify additional tests and inspections.

NOTE Additional tests and inspections can be specified, especially for materials used in critical components or in critical services.

8.1.9 Small parts such as nuts, springs, washers, gaskets, and keys shall have corrosion resistance at least equal to that of specified parts in the same environment.

8.1.10 [●] The purchaser shall specify the presence of any corrosive agents (including trace quantities) in the motive and process fluids and in the site environment.

NOTE 1 Typical agents of concern are hydrogen, oxygen, hydrogen sulfide, amines, chlorides, carbon dioxide, cyanide, mercury, fluoride, naphthenic acid, and polythionic acid.

NOTE 2 If amines are present, refer to API 945.14 for information on amine cracking and its prevention.

NOTE 3 Guidelines to avoid caustic stress corrosion cracking can be found in NACE SP0403.

8.1.11 When chlorides have been specified in any of the fluids, materials exposed to those fluids shall be selected and processed in accordance with the requirements of API 571. Chloride concentrations greater than 50 ppm may require alternate material selection.

8.1.12 If austenitic stainless steel parts exposed to conditions that may promote intergranular corrosion are to be fabricated, hard faced, overlaid, or repaired by welding, they shall be made of low-carbon or stabilized grades.

NOTE Overlays or hard surfaces that contain more than 0.10 % carbon can sensitize both low-carbon and stabilized grades of austenitic stainless steel unless a buffer layer that is not sensitive to intergranular corrosion is applied.

8.1.13 Where mating parts such as studs and nuts of austenitic stainless steel or materials with similar galling tendencies are provided, they shall be lubricated with an anti-seize compound suitable for the process temperatures and compatible with the material(s) and specified process fluid(s).

NOTE The required torque values to achieve the necessary bolt preload will vary considerably depending if anti-seize compounds are used on the threads.

8.1.14 All materials exposed to H_2S gas service shall be in accordance with the requirements of NACE MR0103. Ferrous materials not covered by NACE MR0103 shall not have a yield strength exceeding 620 N/mm^2 (90,000 psi) nor a hardness exceeding Rockwell C22.

8.1.15 [●] If specified, NACE MR0175 shall be used in place of NACE MR0103.

8.1.16 [●] In many applications, small amounts of wet H_2S are sufficient to require materials resistant to sulfide stress corrosion cracking. When there are trace quantities of wet H_2S known to be present or if there is any uncertainty about the amount of wet H_2S that could be present, the purchaser shall specify that materials resistant to sulfide stress corrosion cracking are required.

8.1.17 The vendor shall select materials to avoid conditions that can result in electrolytic corrosion. Where such conditions cannot be avoided, the purchaser and the vendor shall agree on the material selection and any other precautions necessary.

NOTE When dissimilar materials with significantly different electrical potentials are placed in contact when an electrolytic solution is present, galvanic coupling can be created resulting in serious corrosion of the less noble material. The *NACE Corrosion Engineer's Reference Guide* ~~*Book*~~ is one resource for selection of suitable materials in these situations.

8.1.18 O-ring and spring-energized polymer seal materials shall be compatible with all specified services including resistance to rapid gas decompression.

NOTE Susceptibility to rapid gas decompression depends on the gas to which the O-ring is exposed, the compounding of the elastomer, temperature of exposure, the rate of decompression, and the number of cycles.

8.1.19 Bolting shall be in accordance with ASTM A193 Grade B7 or Grade B7M. Carbon steel nuts such as ASTM A194, Grade 2H shall be provided.

8.1.20 Bolting and nuts in accordance with ASTM A320 shall be provided for temperatures below –30 °C (–20 °F). The grade of ASTM A320 will depend on design, service conditions, mechanical properties, and low-temperature characteristics.

8.1.21 [●] If specified, bolting material for heaters, boosters, and filters in marine type environments as defined in API 21TR1 shall be in accordance with ASTM B 637 (UNS N07718 Inconel 718)

8.2 Low-temperature Service

8.2.1 [●] The purchaser shall specify the minimum design metal temperature and concurrent pressure used to establish impact test and other material requirements.

NOTE Normally, this will be the lower of the minimum surrounding ambient temperature or minimum inlet gas temperature. The purchaser can specify a minimum design metal temperature based on properties of the process gas, such as auto- refrigeration at reduced pressures.

8.2.2 To avoid brittle failures, materials and construction for low-temperature service shall be suitable for the minimum design metal temperature in accordance with the codes and other requirements specified. The purchaser and vendor shall agree on any special precautions necessary with regard to conditions that can occur during operation, maintenance, transportation, erection, commissioning, and testing.

NOTE Design practices for low-temperature services include the selection of fabrication methods, welding procedures, and materials for steel pressure-retaining parts to ensure the ductile-to-brittle transition temperature is suitable for the service. The published design-allowable stresses for many materials in internationally recognized standards are based on minimum tensile properties. Some standards do not differentiate between rimmed, semi-killed, fully-killed hot-rolled, and normalized material, nor do they take into account whether materials were produced under fine- or course-grain practices.

8.2.3 All carbon and low alloy steel pressure-containing components, including nozzles, flanges, and weldments, shall be impact tested in accordance with the requirements of ASME Section VIII, Division 1, Sections UCS-65 through 68, or the specified pressure design code.

8.2.3.1 High-alloy steels shall be tested in accordance with ASME Section VIII, Division I, Section UHA-51, or the specified pressure design code. For materials and thicknesses not covered by ASME Section VIII, Division I or the specified pressure design code.

8.2.3.2 [●] Testing requirements shall be as specified by the purchaser.

NOTE Impact testing of a material can be omitted depending on material selection, the minimum design metal temperature, thermal, mechanical, and cyclic loading, and the governing thickness. Refer to requirements of ASME Section VIII, Division I, Section UG-20F, for example.

9 Piping and Tubing Systems

9.1 General

9.1.1 Piping design and joint fabrication examination and inspection shall comply with ASME B31.3 or the specified standard.

NOTE ASME B31.3 could be inadequate to fully satisfy requirements outside North America (e.g. Pressure Equipment Directive 2014/68/EU can have additional requirements).

9.1.2 Flange material shall comply with Tables ~~2~~ 3 or ~~3~~ 4 and be in accordance with ASME B16.5

9.1.2.1 SAE J518 may be used if approved by the purchaser.

NOTE: SAE flanges can be used where space is limited.

9.1.2.2 Bolt holes for flanged connections shall straddle lines parallel to the main horizontal or vertical centerline of the equipment.

(**9.1.2.3** [●] If specified, the vendor shall supply mating flanges, gaskets, and bolting for customer connections.

9.1.3 The design of systems shall achieve the following.

f) Proper support and protection to prevent damage from vibration or from shipment, operation, and maintenance.

g) Proper flexibility and normal accessibility for operation, maintenance, and cleaning.

h) Installation in a neat and orderly arrangement adapted without obstructing access (e.g. ~~adjusts~~ for the adjustment of valves or remove equipment for maintenance, etc.).

i) Complete drainage through low points without disassembly of piping.

9.1.4 Bending and welding shall be used to minimize the use of flanges and fittings where practical when fabricating the system. ~~Welded~~ Flanges are required at equipment connections.

9.1.5 Interconnecting lines between the panel or skid and the equipment shall be rigid pipe and comply with Tables 3 and 4.

9.1.6 [●] If specified, the vendor shall supply interconnecting rigid piping.

9.1.7 [●] The purchaser shall specify system construction of piping or tubing. Piping and tubing shall comply with Tables 2, 3, 4, and 5. Tubing size shall not exceed DN 25 (1 in.).

9.1.8 Minimum equipment and piping connection shall be DN 20 (NPS $^{3}/_{4}$).

NOTE Orifice flange taps can require DN 15 (NPS $^{1}/_{2}$).

9.1.9 Connections, piping, valves, and fittings that are NPS $1^{1}/_{4}$, $2^{1}/_{2}$, $3^{1}/_{2}$, 5, 7, or 9 in. size shall not be used.

9.1.10 DN 20 (NPS $^{3}/_{4}$) isolating (root) valve shall be provided for all pressure, level, and flow instrumentation. DN 15 (NPS $^{1}/_{2}$) piping or tubing, valves, and fittings may be used after the isolating (root) valve.

9.1.11 Pipe bushings shall not be used.

9.1.12 Manifold shall be sized to handle the maximum flow through all components requiring simultaneous use of the specified utility.

9.1.13 Piping and components between and including double block valves shall be suitable for the more severe line classification on either side of the double block valve.

9.1.14 Bolting for pressure joints, valves, and piping shall be in accordance with ASME B31.3 and/or ISO 15649 or the appropriate specified code. As a minimum, according to the requirements of ASME B1.1 or the appropriate specified code, this bolting shall be ASTM A193/A193M~~-07~~, Grade B7, or the equivalent material, and shall use ASTM A194/A194M~~-07~~, Grade 2H nuts or the equivalent material.

9.1.15 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. Gas metal flux core arc or welding may be used, when approved, for filler passes on DN 150 (6 in.) and larger pipe.

9.1.16 Studs and nuts shall be used for flanged connections.

9.1.17 Non-consumable backup rings and sleeve-type joints shall not be used.

9.2 Threads

9.2.1 Pipe threads shall be taper threads in accordance with ASME B1.20.1.

9.2.2 [●] If specified, threaded joints shall be seal welded <u>in accordance with ASME B31.3</u>.

9.2.2.1 Seal welding is not permitted on instruments or locations that require disassembly for maintenance.

9.2.2.2 ~~Seal-welded joints shall be made in accordance with the codes specified.~~

9.2.2.3 ~~Where no codes have been specified, seal-welded joints shall be in accordance with ASME B31.3.~~

9.2.3 Threaded openings not requiring connection to pipe or fitting shall be plugged with solid stainless steel plugs in accordance with ASME B16.11.

9.2.3.1 As a minimum, these plugs shall meet the material requirements of the module or system.

9.2.3.2 Plastic plugs are not permitted.

9.2.3.3 Plugs in instrument manifold valves shall be manufacturer's standard design of stainless steel material.

9.2.4 A process-compatible thread sealing lubricant that meets the proper temperature specification shall be used on all non-seal-welded threaded connections. Thread sealing tape shall not be used.

9.3 Valves

9.3.1 All piping valves shall be flanged.

9.3.2 Hand-operated gate and globe valves provided as block and bypass valves shall have bolted bonnets and glands. For service ratings greater than or equal to ANSI Class 900, block valves may be of bolted bonnet, welded bonnet, or no-bonnet construction with a bolted gland; these valves shall be suitable for repacking under pressure.

9.3.3 Gate valves shall be in accordance with API 600 or API 602.

9.3.4 Globe valves shall be in accordance with API 602.

9.3.5 Check valves in flammable or toxic gas services shall be in accordance with API 602.

NOTE API 602 is not applicable to tube-cartridge-type check valves.

9.3.6 Gate, globe, and check valves shall be supplied with minimum 13Cr stainless steel trim.

NOTE Certain fluid applications can require alternate trim materials (e.g. H_2S service).

9.3.7 Wafer check valves may be used only for non-hazardous services. They shall be in accordance with API 594 and may be only used in sizes DN 40 (NPS $1^1/_2$) and larger.

9.3.8 Ball valves may be used instead of gate valves for isolation and full flow bypass applications.

9.3.8.1 Ball valve construction shall be floating ball or trunnion-type design and shall comply with API 608.

9.3.8.2 Ball valves shall be quarter turn resilient seated valves for tight shutoff.

9.3.8.3 Resilient seat materials shall be selected to prevent explosive decompression during system depressurization.

9.3.8.4 Ball valve handles shall clearly indicate the valve's open or closed position.

9.3.8.5 [●] If specified, valve handles shall have locking provisions.

9.3.8.6 Ball valve internal metal trim materials such as the ball, stem, seat retainers, etc. shall be 316 stainless steel minimum.

9.3.8.7 Ball valves used in flammable gas service shall be "fire-rated" based on API 607 or ISO 10497.

9.3.9 Instrument valves located in sensing lines downstream of a primary service block valve can be bar-stock instrument valves, provided the instrument valves are protected against accidental disassembly.

9.3.10 Valves shall be stainless steel with stainless steel stems.

9.3.11 Bleed valves provided at instruments may be the manufacturer's standard bleed fitting.

9.3.12 Plugs in instrument valves shall be the manufacturer's standard design of stainless steel material.

9.3.13 The purchaser shall approve valves outside the above-mentioned specifications.

NOTE It is possible that valves in tubing systems cannot comply with the above requirements.

10 Recommended Alarms

10.1 [●] The purchaser shall specify all required permissive signals, alarms, and shutdowns.

NOTE The "LL" and "HH" values can be used as shutdowns based on a risk analysis.

10.2 [●] Tables ~~6~~ 7 through ~~9~~ 10 are minimum recommended alarms, with the following considerations.

a) Values listed are generic starting points. Actual values may be different based on application specific requirements or vendor recommendation.

b) Static or transient conditions can be different from normal operating conditions and may need to be adjusted.

c) Tables list minimum recommended alarms for all associated modules and identified options. Applicable alarms will depend on the modules and options chosen.

Table 7—Recommended Alarms for Tandem Seals

Parameter	L	LL	H	HH	Permissive	Recommended Value
Filter differential pressure			X			Typical alarm value is 70 kPad (10 psid) over clean. Supply pressure limitations and OEM recommendations should be considered for determination of actual alarm point.
Seal gas flow	X	X	X		X [a]	75 % normal flow (L) 50 % normal flow (LL) 200 % normal (H)
Seal gas differential pressure	X	X				50 % to 75 % minimum design differential pressure (L) 25 % to 50 % minimum design differential pressure (LL) Potential pressure losses should be considered due to piping and instrumentation layout.
Seal gas temperature	X		X		X [a]	Margin above dew point (L) Elastomer and system component temperature limits (H)
Primary vent pressure	X	X	X	X		Alarm values are dependent on back pressure regulation method, vent pressure, and process pressure.
Primary vent flow			X	X		300 % guaranteed leakage (H) 500 % guaranteed leakage (HH)
Rupture disk status			X		X [a]	Rupture status indication (H)
Separation seal gas pressure	X		X		X [b]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Separation seal gas flow	X [c]				X [b]	50 % normal flow (L)

Separation seal gas to vent differential pressure	X	X			X [b]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Secondary vent						If optional modules are applied (as listed on diagrams), then alarms can be determined.

[a] Permissive to slow roll/start turbine driven equipment or start motor driven equipment.

[b] Lube oil start permissive (only one of the three is required).

[c] Only applies to separation seals supplied by flow control.

Table 8—Recommended Alarms for Tandem Seals with Intermediate Labyrinth

Parameter	L	LL	H	HH	Permissive	Recommended Value
Filter differential pressure			X			Typical alarm value is 70 kPad (10 psid) over clean. Supply pressure limitations and OEM recommendations should be considered for determination of actual alarm point.
Seal gas flow	X	X	X		X [a]	75 % normal flow (L) 50 % normal flow (LL) 200 % normal flow (H)
Seal gas differential pressure	X	X				50 % to 75 % minimum design differential pressure (L) 25 % to 50 % minimum design differential pressure (LL) Potential pressure losses should be considered due to piping and instrumentation layout.
Seal gas temperature	X		X		X [a]	Margin above dew point (L) Elastomer and system component temperature limits (H)
Primary vent flow			X	X		Secondary seal gas normal flow plus 300 % guaranteed leakage (H) Secondary seal gas normal flow plus 500 % guaranteed leakage (HH)
Primary vent pressure	X	X	X	X		Values are dependent on back pressure regulation method, vent pressure, and process pressure.
Rupture disk status			X		X [a]	Rupture status indication (H)
Secondary seal gas flow	X		X			80 % normal flow (L) 150 % normal flow (H)
Secondary seal gas pressure						No default recommendation
Separation seal gas flow	X [c]				X [b]	50 % normal flow (L)
Separation seal gas pressure	X		X		X [b]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Separation seal gas to vent differential pressure	X	X			X [b]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Secondary vent						If optional modules are applied (.as listed on diagrams) then alarms can be determined.

[a] Permissive to slow roll/start turbine driven equipment, or start motor driven equipment.
[b] Lube oil start permissive (only one of the three is required).
[c] Only applies to separation seals supplied by flow control.

Table 9—Recommended Alarms for Double Seals

Parameter	L	LL	H	HH	Permissive	Recommended Value
Filter differential pressure			X			Typical alarm value is 70 kPad (10 psid) over clean. Supply pressure limitations and OEM recommendations should be considered for determination of actual alarm point.
Seal gas flow			X	X		300 % guaranteed flow (H) 500 % guaranteed flow (HH)
Seal gas differential pressure	X	X			X [a b]	75 % minimum design differential pressure (L) 50 % minimum design differential pressure (LL) Minimum design differential pressure shall not be less than 2 bar (30 psig). Potential pressure losses should be considered due to piping and instrumentation layout. No default recommendation. Refer to OEM for recommendations.
Seal gas pressure	X		X			(L) (H) No default recommendation. Refer to OEM for recommendations.
Buffer gas flow	X		X			50 % normal flow (L) 200 % normal flow (H)
Buffer gas differential pressure	X					25 % design differential pressure (L)
Buffer gas pressure	X		X			(L) (H)
Separation seal gas flow	X [d]				X [c]	50 % design flow (L)
Separation seal gas pressure	X		X		X [c]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Separation seal gas to vent differential pressure	X	X			X [c]	No default recommendation. Refer to OEM recommendations based on separation seal type.
Primary vent flow						If optional modules are applied (as listed on diagrams), then alarms can be determined.
Primary vent pressure						If optional modules are applied (as listed on diagrams), then alarms can be determined.

[a] Reverse pressurization avoidance to prevent introducing buffer gas and process gas to equipment. The latter is a typically a manual operation and can be achievable only with an alarm.

[b] Permissive to slow roll turbine driven equipment or start motor driven equipment.

[c] Lube oil start permissive (only one of the three is required).

[d] Only applies to separation seals supplied by flow control.

Table 10—Recommended Alarms for Gas Conditioning Unit

Parameter	L	LL	H	HH	Recommended Value
Separator level			X	X	80 % design level (H) ~~100~~ 90 % design level (HH)
Booster pressure or flow	X				Value to be agreed.
Reciprocating Booster cycles			X		Booster vendor to provide recommended value.
Reciprocating Motive gas pressure	X				Based on minimum outlet pressure requirements.
Rotary Booster Housing Temperature			X	X	
Heater element temperature				X	Heater vendor to provide recommended value.

11 Instrumentation, Control, and Electrical Systems

11.1 General

11.1.1 Systems should be instrumented for monitoring and control for all conditions defined in Part 1, Section 6.2.1.

11.1.2 Instrumentation and their installation shall conform to the requirements in Section 11.

11.1.3 [●] The purchaser shall specify hazardous area classification.

11.1.4 Controls and instrumentation shall be designed for outdoor installation and shall meet the requirements of IP 65 as detailed in IEC 60529 or NEMA 250, Type 4X.

11.1.5 [●] The purchaser shall specify winterization requirements.

11.1.6 Instrument and control terminal boxes shall be IP 66 as detailed in IEC 60529 or NEMA 250, Type 4X.

11.1.7 Where applicable, controls and instrumentation shall conform to API 551.

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

11.1.9 All wetted metallic parts of all instruments shall be made of 316/316L stainless steel.

NOTE Certain fluid applications can require alternate materials (e.g. H_2S service, chlorides).

11.1.10 Hazardous area classification shall be included on component nameplates where applicable.

11.1.11 If the vendor identifies that multiple seal system settings (modes) are required to satisfy the specified operating conditions, the means for switching among modes shall be approved by the purchaser.

11.1.12 [●] If specified, a control console shall be supplied.

NOTE The DGS instrumentation and controls are typically integrated with unit or machine train control and protective systems.

11.1.13 [●] Purchaser shall specify the requirements and scope of supply for the system including:

— human machine interface (HMI) and control system hardware;

— operator notification;

— programming;

— historian and trending requirements;

— communications and interface with other process or auxiliary equipment, controls, and communication equipment or facilities;

— FAT testing of the completed system.

11.2 Alarm and Shutdown Systems

11.2.1 An alarm system shall be provided which initiates an alarm if any one of the specified parameters reaches an alarm point. This system will also initiate shutdown of the equipment if any one of the specified parameters reaches the shutdown point.

11.2.2 [●] The purchaser shall specify the alarms and shutdowns required, which as a minimum should include the alarms listed in Tables 7 through 10.

11.2.3 The vendor should advise the purchaser of any additional alarms and/or shutdowns considered essential to safeguard the equipment.

11.2.4 [●] The purchaser shall specify the extent to which alarm/shutdown systems are supplied and installed by the equipment vendor.

11.2.5 For every shutdown parameter, the alarm/shutdown system shall provide an alarm at an alarm point set at a lesser deviation from the normal condition than the associated shutdown point.

11.2.6 [●] If specified, any alarm parameter reaching the alarm point shall initiate an audible warning, flashing light, or both. It shall be possible to determine which parameter initiated the alarm.

11.2.7 [●] If specified, any shutdown parameter reaching the shutdown point shall cause the equipment to shut down and shall initiate an audible warning, a flashing light, or both, which shall be distinguishable from those associated with an alarm. It shall be possible to determine which parameter initiated the shutdown.

11.2.8 When any component of the alarm/shutdown system malfunctions, an alarm shall be initiated.

NOTE To accomplish this, smart-type instruments and/or redundant sensors can be required.

11.2.9 When any malfunction of a component of the shutdown system results in the system being unable to recognize a shutdown condition, the equipment shall automatically shut down and an alarm shall be initiated (failsafe system). This alarm shall be distinguishable from alarms resulting from actual shutdown conditions.

11.2.10 With the exception of the final shutdown device (breaker, etc.), it shall be possible to test every component of every shutdown function while the equipment is in operation. Testing of components associated with a shutdown function shall not require disarming of any other shutdown function nor any alarm function.

11.2.11 Each function for which both an alarm and a shutdown have been specified shall be provided with three separate, individual taps and independent transmitters. The detail arrangement should be jointly developed between the purchaser and the vendor or vendors of the system and the served equipment.

11.2.12 Shutdown and alarm function outputs from the three instruments shall be connected through “two-out-of-three” voting logic and shall allow the operation of any one alarm or shutdown function to initiate an alarm.

11.2.12.1 Operation of two shutdown functions monitoring the same parameter initiates a separate alarm and shall cause the served equipment to shut down.

11.2.12.2 If any one transmitter is faulty, then the remaining two transmitters shall vote "one-out-of-two" for shutdown.

11.2.12.3 If a second transmitter becomes faulty, then the system shall shut down the served equipment.

11.2.13 Alarm functions not associated with a shutdown function shall be provided with a single transmitter. The purchaser and/or vendors of the system and the served equipment should jointly develop detailed arrangement.

11.3 Instrumentation

11.3.1 Instrument Installation and Panels

11.3.1.1 [●] If specified by the purchaser, procurement of components shall not proceed without the purchaser's review and acceptance of the components selected.

11.3.1.2 [●] If specified by the purchaser, the manufacturer of the dry gas seal support system shall not proceed without the purchaser reviewing the layout of components and piping.

11.3.1.3 [●] The purchaser shall specify local or panel mounted instruments.

11.3.1.4 [●] The purchaser shall specify termination of instruments locally or pre-wired and terminated in a local terminal box.

11.3.1.5 When more than one wiring point is required on a unit for control or instrumentation, wiring to each electrical control device or instrument shall be provided from common terminal boxes with terminal posts.

11.3.1.6 Unless otherwise specified, multiple terminal boxes are required for segregation of different AC and DC electrical signals.

11.3.1.7 Each terminal box shall be mounted on the panel or skid.

11.3.1.8 [●] If specified, ~~The purchaser shall specify installation of~~ wiring shall be installed in metal conduits, cable trays, or enclosures.

11.3.1.9 All leads and posts on terminal strips, cables, and instruments shall be tagged for identification in accordance with purchaser requirements.

11.3.1.10 Low-pressure alarms and shutdowns, which are activated by falling pressure, shall be equipped with valves on bleed or vent connection to allow controlled depressurizing so the operator can note the alarm set pressure on the associated pressure gauge.

11.3.1.11 High-pressure alarms and shutdowns, which are activated by rising pressure, shall be equipped with valves to test connections so a portable test pump can be used to raise the pressure.

11.3.2 Switches

Switches shall not be used unless approved by the purchaser.

11.3.3 Transmitters

11.3.3.1 [●] The purchaser shall specify output signal type, units, indicating or non-indicating (blind) type, housing type, and power supply requirements.

11.3.3.2 [●] The purchaser shall specify analog or digital type transmitters.

11.3.3.3 Response time for transmitters that provide alarm/trip signals shall be agreed based on vendor recommended response time.

11.3.4 Temperature Instruments

11.3.4.1 Temperature sensing elements shall be configured to extend adequately into the measured fluid.

11.3.4.2 [●] The purchaser shall specify temperature indicators or indicating transmitters.

11.3.4.3 Dial-type temperature indicators shall be heavy-duty and corrosion-resistant.

11.3.4.3.1 They shall be at least 100 mm (4 in.) in diameter and bimetallic-type or fluid-filled.

11.3.4.3.2 Black printing on a white background is standard for gauges.

11.3.4.3.3 Temperature indicators shall be located per the datasheets.

11.3.5 Thermowells

11.3.5.1 Temperature indicators or sensing elements shall be provided with flanged DN 20 (NPS $^3/_4$), minimum series 316/316L stainless steel, separable, solid-bar thermowells.

NOTE When considering pipe size, it should be noted that larger pipe sizes can be required to compensate for the restriction of flow by the thermowells.

11.3.6 Thermocouples and Resistance Temperature Detectors

11.3.6.1 The design and location of thermocouples and resistance temperature detectors in process lines shall permit replacement while the unit is operating.

NOTE Some heater configurations have non-replaceable temperature sensing elements.

11.3.6.2 The lead wires of the thermocouples or resistance temperature detectors shall terminate in the thermocouple or resistance detector conduit head.

11.3.6.3 If temperature element conduit heads are exposed to temperatures above 60 °C (140 °F), 20 mm ($^3/_4$ NPT) flexible conduits for rigid conduit systems or cables for cable-gland systems, rated for the hazardous area class in accordance with the specified electrical code, shall be provided for connections to the heads.

11.3.6.4 Flexible conduits shall be rated for the temperature element head exposure design temperature and shall have an interlocking stainless steel or galvanized steel core with an integral or separate grounding conductor.

NOTE Good design practice incorporates extended lagging on thermowells and/or extension nipples between the thermowells and conduit heads to reduce or limit the exposure temperature of the conduit heads.

11.3.6.5 The purchaser shall specify temperature element type.

11.3.7 Liquid Level Instruments and Flow Gauges

11.3.7.1 [●] The purchaser shall specify liquid level instrument type. Unless otherwise specified, sensing elements shall be made of 316/316L stainless steel.

11.3.7.2 [●] The purchaser shall specify flow gauge type.

11.3.7.3 Unless otherwise specified, metallic components shall be made of 316/316L stainless steel.

11.3.8 Flow Instruments

11.3.8.1 [●] Flow instruments shall be located per the datasheets.

NOTE This refers to local indication of flow and can be accomplished by a flow indicator and/or a flow-indicating transmitter.

11.3.8.2 [●] If specified, flow measurement shall be an electronic device such as mass flow, thermal dispersion, venturi, turbine, differential pressure, or differential pressure type with integral orifice.

11.3.8.2.1 The purchaser shall approve combining orifices used for measuring with those used for flow regulation, flow balancing, and/or creating back pressure into a single orifice.

11.3.9 Pressure Indicators

11.3.9.1 [●] The purchaser shall specify pressure indicators or indicating transmitters.

11.3.9.2 Pressure indicators (not including built-in instrument-air indicators) shall be provided with AISI Standard Type 316/316L stainless steel bourdon tubes and stainless steel movements, minimum 100 mm (4 in.) dials and 15 mm ($^1/_2$ NPT) male stainless steel connections.

11.3.9.3 Pressure-sensing elements shall be made of AISI Standard Type 316/316L stainless steel.

NOTE Black printing on a white background is standard for gauges.

11.3.9.4 All gauges shall be liquid-filled or dampened movement design.

11.3.9.5 Differential pressure indicators shall be provided with stainless steel pressure-containing housings and stainless steel movements.

11.3.9.5.1 Differential pressure indicators shall be designed to prevent damage by over-ranging.

11.3.9.5.2 Dial size shall be minimum 100 mm (4 in.) minimum with black printing on a white background.

NOTE Direct pressure-sensing, non-magnetic-drive differential pressure indicators can be damaged by over-ranging. Precautions can be required to prevent damage when selected for systems with operating pressures higher than their differential range.

11.3.10 Solenoid Valves

11.3.10.1 Direct solenoid-operated valves shall be used only in clean and dry instrument-air or nitrogen service.

11.3.10.2 Solenoid coils shall have Class F insulation rating or better with a continuous duty service rating.

11.3.10.3 If required for other services, the solenoid shall act as a pilot valve to pneumatic valves.

11.3.10.4 Single-coil solenoid valves shall not be used in continuous services that can affect normal operations; they can be used in intermittent instrument services.

11.3.10.5 [●] If specified, the vendor shall provide the purchaser with the coil rating and estimated service life of each solenoid coil based on continuously energized operation when used in trip circuits. Dual-coil solenoids can be specified for any trip function.

11.3.10.5.1 Each coil shall be capable of keeping the solenoid in its energized condition.

11.3.10.5.2 Separate circuits shall energize each coil.

11.3.11 Annunciators

NOTE An annunciator can be mounted on either a local or a remote control panel.

11.3.11.1 [●] If specified, the alarm/shutdown system shall incorporate a first-out annunciator facility to indicate which parameter first reached the alarm level and which parameter first reached the shutdown level, in the event that multiple alarms and/or shutdown result from a single initial event.

11.3.11.1.1 Where this facility is not incorporated as part of an integrated control and monitoring system, a separate annunciator instrument shall be provided.

11.3.11.1.2 The first parameter to reach alarm or shutdown shall cause the flashing of a light and the sounding of an audible device.

11.3.11.1.3 The alarm or shutdown condition shall be acknowledged by operating an alarm silencing button, common to all alarms and shutdowns.

11.3.11.1.4 When the alarm or shutdown is acknowledged, the audible device shall be silenced but the light shall remain steadily lit as long as that alarm or shutdown condition exists.

11.3.11.1.5 If another parameter reaches an alarm or shutdown level, the light shall return to the flashing condition and the audible device shall sound, even if the previous alarm/shutdown condition has been acknowledged but still exists.

NOTE These functions are commonly implemented through the use of an HMI or other systems.

11.3.11.2 [●] If specified, the annunciator sequence shall be selected from ISA 18.1 by the purchaser.

11.3.11.3 [●] If specified, a separate first-out indication shall be provided.

11.4 Electrical Systems

11.4.1 Motors, electrical instrumentation, 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 the applicable parts of IEC 60079 (NFPA 70, Articles 500, 501, 502, and 504) as well as any local codes specified. The purchaser shall provide local codes on request.

11.4.2 [●] The purchaser shall specify characteristics of electrical power supplies for motors, heaters, and instrumentation.

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

11.4.4 Stranded conductors shall be provided within the confines of the baseplate and in other areas subject to vibration.

11.4.5 [●] If specified, instrument and control wiring can be solid conductors in areas not subject to vibration.

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

11.4.7 Wiring shall be suitable for environmental temperatures.

11.4.8 All leads on terminal strips and electrical components shall be permanently tagged for identification.

11.4.9 All terminal boards in terminal boxes and control panels shall have at least 20 % spare terminal points.

11.4.10 To facilitate maintenance, adequate clearances shall be provided for all energized parts (such as terminal blocks and relays) on all components.

11.4.10.1 The clearances required for 600 V service shall also be provided for lower voltages.

11.4.10.2 Enclosures shall be provided for all energized parts to guard against accidental contact.

11.4.11 Electrical materials, including insulation, shall be corrosion resistant and non-hygroscopic insofar as is possible.

11.4.12 [●] The purchaser shall specify treatments for fungus attack, plating, or protective coatings for tropical locations.

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

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

11.4.13 Circuits for AC and DC shall be clearly labeled, connected to separate terminal blocks, and isolated from each other.

11.4.14 [●] 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.

11.4.15 Wiring installed in cable trays shall be secured and have sufficient radius to prevent sharp bends.

11.4.16 Conduits shall be arranged to permit removal of elements without conduit removal. Conduits can terminate with a flexible metallic conduit, suitable for the electrical class and long enough to permit access to the unit for maintenance without removal of the conduit.

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

11.4.18 All conduits 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.

11.4.19 Conduit drains shall be installed in all conduit low points for outdoor installations.

11.4.20 [●] If specified, conduit drains shall be provided in all conduit low points for indoor installations.

11.4.21 A minimum of two tapped grounding tabs shall be provided diagonal from each other on the panel or skid.

11.4.22 All terminal boxes shall be grounded.

12 Panels and Skids

12.1 General

12.1.1 Panel and skid shall be austenitic stainless steel.

12.1.2 [●] If specified, the panel and skid shall be carbon steel and painted.

12.1.3 Skid baseplates shall be single-piece deck plate construction.

12.1.4 [●] If specified, single-piece drain-rim or drain-pan baseplates shall be provided.

12.1.5 Non-skid metal decking covering all walk and work areas shall be provided on top of baseplate.

NOTE Non-skid surfaces can be achieved with non-skid coatings or textured metal decking.

12.1.6 [●] If specified, baseplate shall be supplied without a deck plate, i.e. open deck design.

12.1.7 Baseplate shall extend under the skid components. All equipment and connections shall fall within the maximum perimeter of the baseplate. Oversized junction boxes may overhang the perimeter of the baseplate with purchaser's approval.

12.1.8 Adequate clearance shall be provided between component drain connections and the baseplate so that drain piping the same size as the connection can be installed.

12.1.9 All joints shall be continuously seal welded on both sides to prevent crevice corrosion. Stitch welding, top or bottom, is unacceptable.

12.1.10 [●] If specified, baseplate shall be designed for grouting. Baseplates designed for grouting shall be in accordance with API 686.

12.1.11 [●] If specified, baseplate shall be designed for column mounting (i.e. sufficient rigidity to be supported at specified points) without continuous grouting under structural members Baseplate design shall be approved by the purchaser.

12.1.12 The bottom of the baseplate between structural members shall be open if the baseplate is designed for installing and grouting to a concrete foundation.

12.1.12.1 Accessibility shall be provided for grouting under all load-carrying members.

12.1.12.2 The bottom of the baseplate shall be in one plane to permit use of a single level foundation.

12.1.13 Reinforcing cross-members shall be shaped to lock positively into grout.

12.1.14 If the baseplate is designed for grouting, it shall be provided with the following.

a) A minimum of one grout hole having a clear area of at least 125 cm^2 (20 $in.^2$) and no dimension less than 75 mm (3 in.) in each bulkhead section.

b) Holes shall be located to permit filling the entire cavity under the baseplate without creating air pockets.

c) Holes shall be accessible for grouting with all panel or skid and components installed on baseplate.

d) Grout holes in walkways shall be level with deck plate.

e) Grout holes outside of walkways may have 13 mm (1/2 in.) raised-lip edges.

f) Minimum 13 mm (1/2 in.) vent holes at the highest point and located to vent the entire cavity in each bulkhead section.

12.1.15 Outside corners of the baseplate in contact with the grout shall have at least 50 mm (2 in.) radii in the plan view.

12.1.16 [●] If specified, the vendor shall commercially sand-blast, in accordance with ISO 8501, Grade Sa2 or SSPC SP 6, all grout contact surfaces of the baseplate and coat those surfaces with a primer compatible with the purchaser-specified epoxy grout.

NOTE Grouts other than epoxy can require alternative surface preparation.

12.1.17 Panels and skids shall be provided with provisions for lifting. Lifting with all equipment mounted shall not permanently distort or otherwise damage the equipment.

12.1.18 Lifting provisions shall be designed using a maximum allowable stress of one-third of the specified minimum yield strength of the material.

12.1.19 The vendor shall provide a lifting diagram that identifies panel or skid total weight, center of gravity, and necessary rigging.

12.1.20 The vendor shall provide for sufficient anchor bolting provisions and support.

12.1.21 Vertical levelling screws shall be provided on the outside perimeter of the baseplate adjacent to each anchor bolt to minimize distortion during the process of installation and to carry the weight of the components without excessive deflection.

12.1.22 All skid piping and conduit shall be located above the top surface of the baseplate.

13 Dry Gas Seal Support System Inspection and testing

13.1 General

13.1.1 [●] The purchaser shall specify the extent of participation in the inspection and testing.

13.1.2 [●] If specified, the purchaser's representative, vendor's representative, or both shall indicate compliance in accordance with the inspector's checklist in the applicable chapter by initialing, dating, and submitting completed checklist to the purchaser before shipment.

13.1.3 At least 6 weeks prior to first scheduled test, the vendor shall submit to the purchaser, for review and comment, detailed procedures for all functional dry gas seal support system testing, including acceptance criteria for all monitored parameters.

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

13.1.5 The vendor shall notify subvendors of purchaser's inspection and testing requirements.

13.1.6 [●] The vendor shall give at least 5 working days advanced notification of a witnessed or observed inspection or test. Expected dates of testing shall be communicated at least 30 days in advance of testing and the actual dates confirmed as agreed.

13.1.7 If shop inspection has been specified, the purchaser and vendor shall coordinate scheduling of manufacturing hold points and inspector visits.

13.1.8 A witnessed dry gas seal support system functional test requires confirmation of the successful completion of a preliminary test by the vendor.

13.1.9 [●] If specified, the dry gas seal support system shall be used during the main equipment's mechanical run and/or performance tests. Extent of testing shall be agreed. Gas conditions during the mechanical run or factory performance run should be considered in the dry gas seal support system design.

NOTE Compressor shop testing conditions can require the use of alternate items such as different orifice sizes, etc. due to different conditions for sealing gas, buffer gas, etc.

13.1.10 Equipment, materials, and utilities for the specified inspections and tests shall be provided by the vendor.

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

13.2 Radiography

13.2.1 General

13.2.1.1 The acceptance standard used for welded fabrications shall in accordance with the pressure design code. The acceptance standard used for castings shall be in accordance with the pressure design code.

13.2.1.2 A minimum of 5 % butt weld radiography is required for all welded pressure-containing piping.

13.2.1.3 [●] If specified, the purchaser may require additional radiograph (up to 100 %) for pressure-containing piping.

13.2.2 Ultrasonic Inspection

13.2.2.1 Ultrasonic inspection shall be based upon the procedures ASTM A609 (castings), ASTM A388 (forgings), or ASTM A578 (plate).

13.2.2.2 Ultrasonic inspection shall be in accordance with the pressure design code.

13.2.2.3 The acceptance standard used for welded fabrications shall be in accordance with the pressure design code.

13.2.3 Magnetic Particle Inspection

The acceptance standard used for welded fabrications shall be in accordance with the pressure design code.

13.2.4 Liquid Penetrant Inspection

The acceptance standard used for welded fabrications shall be in accordance with the specified pressure design code.

13.2.5 PMI

13.2.5.1 [●] If specified, the following items, when made out of alloy materials, shall be subject to PMI testing:

a) coolers,

b) separator vessels,

c) heater vessels,

d) pressure pulsation dampener vessels,

e) filters,

f) piping and piping welds,

g) structural components.

13.2.5.2 If PMI testing has been specified for a fabrication, the components comprising the fabrication, including welds, shall be checked after the fabrication is complete. Testing may be performed prior to any heat treatment.

13.2.6 Mechanical Inspection

13.2.6.1 During assembly of the dry gas seal support system and before testing, each component and all piping and appurtenances shall be inspected to ensure they have been cleaned and are free of foreign materials, corrosion products and mill scale.

13.2.6.2 [●] If specified, the purchaser shall inspect the equipment and all piping and appurtenances for cleanliness before heads are welded onto vessels, openings in vessels or exchangers are closed, or piping is finally assembled.

13.2.6.3 [●] If specified, hardness of parts, welds, and heat-affected zones shall be verified by testing to be within the allowable values.

13.2.6.4 [●] The purchaser shall specify method, extent, documentation, and witnessing of the testing.

13.2.6.5 Nondestructive examination (magnetic particle inspection or liquid penetrant inspection) shall be performed on welds attaching lifting lugs. Acceptance criteria shall be in accordance with applicable structural design codes.

13.3 Testing

13.3.1 General

Equipment shall be tested in accordance with 13.3.2 through 13.3.3.13.

13.3.2 Hydrostatic Test

13.3.2.1 All pressure-containing components such as vessels (coolers, separators, filters, etc.), pipe spools, and valve bodies shall be tested hydrostatically with liquid at a minimum of 1.5 times the MAWP irrespective of the pressure vessel design code requirements.

13.3.2.1.1 Minimum hydrostatic test pressure shall not be less than 150 kPag (1.5 barg; 20 psig).

NOTE 1 Tubing sections are not considered to be pipe spools.

NOTE 2 Due to concerns of residual hydrostatic test fluids remaining in assembled dry gas seal support systems, it is not recommended to hydrostatic test the assembled system.

13.3.2.1.2 Test liquid shall be at a higher temperature than the nil-ductility transition temperature of the material being tested. See ASTM E1003.

NOTE Nil-ductility temperature is the highest temperature at which a material experiences complete brittle fracture without appreciable plastic deformation.

13.3.2.2 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 the testing temperature, the hydrostatic test pressure shall be multiplied by a factor obtained by dividing the allowable working stress for the material at the testing temperature by that at the rated operating temperature.

13.3.2.2.1 The stress values (SE) used shall conform to those given in the piping system design code for piping or in the pressure design code for vessels.

13.3.2.2.2 The pressure thus obtained shall then be the minimum pressure at which the hydrostatic test shall be performed.

13.3.2.2.3 The datasheets shall list actual hydrostatic test pressures.

NOTE It is advisable to verify the applicability of this requirement to the material being tested before the hydrostatic test, as the properties of many grades of steel do not change appreciably at temperatures up to 200 °C (400 °F).

13.3.2.2.4 The temperature corrected hydrostatic test value is determined as follows:

$$\text{Hydrotest pressure} = 1.5P_{\text{Design}} \times (\text{SE}_{\text{@Test Temp}}/\text{SE}_{\text{@Design Temp}})$$

13.3.2.3 Chloride content of liquids used to test austenitic stainless steel materials shall not exceed 50 µg/g (50 ppm). To prevent deposition of chlorides on austenitic stainless steel as a result of evaporative drying, all residual liquid shall be removed from tested parts at the conclusion of the test.

NOTE Chloride content is limited in order to prevent stress corrosion cracking.

13.3.2.4 Hydrostatic tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic tests shall be considered satisfactory when neither leaks nor seepage through the pressure-containing parts or joints is observed for a minimum of 30 min.

13.3.3 Operational Tests

13.3.3.1 A pneumatic gas pressure leak test at 110 % of the MAWP shall be performed on the assembled seal support system.

13.3.3.1.1 The test shall be in accordance with ASME B31.3 or other specified piping design code.

13.3.3.1.2 Removal of spools, screens, or the loosening of flanges should not void the original pneumatic leak test.

13.3.3.2 Leak test gas shall be helium for systems with seal gas operating conditions of relative molecular mass (MW) of 12 or less and air or nitrogen for systems with seal gas of MW greater than 12.

13.3.3.3 A cleanliness test of the dry gas seal support system shall be conducted at the vendor's shop with the job filter or new test filter (of equal filtration capability) elements installed.

13.3.3.3.1 A 400 mesh screen shall be fastened to the outlet of the module flange for each gas line from the module. Initial flushing shall be completed without a screen to facilitate higher flush velocity.

13.3.3.3.2 The module shall be blown for a 5 minute period with a nominal 700 kPag (7 barg; 100 psig), dry-filtered [dew point not greater than −7 °C (20 °F) and filtered to $\beta_2 \geq 10$] gas.

13.3.3.3.3 The screen shall be inspected for discoloration and cleanliness.

13.3.3.3.4 Any particles or discoloration found on the screen shall be cause for rejection and the system shall be repeatedly tested until clean.

13.3.3.4 [●] If specified, transfer valves shall be demonstrated to have tight shutoff.

13.3.3.5 The system shall be verified for correct piping and tubing interconnections to agree with the P&ID or system diagram. Component tags and labels are to be verified correct.

13.3.3.6 Field connection locations and mounting bolt holes shall be verified they are within tolerances indicated on arrangement drawings.

13.3.3.7 Accessibility of system components for expected maintenance and operation shall be verified.

13.3.3.8 All instrument transmitters shall be verified they are functional by powering up and verifying the required calibration settings.

13.3.3.8.1 For pressure and differential pressure transmitters at least two (2) points of pressure (typical "zero" and a point in the upper $^1/_3$ range of span) are to be applied and the transmitter outputs and integral indicators (if applicable) checked for correctness.

13.3.3.8.2 Temperature elements (RTDs or thermocouples) shall be read with the appropriate electronic test instruments and verified to read the correct temperature based on the test or ambient conditions.

13.3.3.8.3 Testing of temperature transmitters automatically includes testing of the temperature elements.

13.3.3.8.4 Flow transmitters will typically only include a zero flow point of operation unless system flow testing has been specified.

13.3.3.8.5 Gas analyzer sensors may require specialized monitor test instrumentation and shop testing could not be feasible.

13.3.3.8.6 [●] If specified, the vendor shall provide manufacturer's factory instrument certifications.

13.3.3.9 All electro, electro-pneumatic, and solenoid-operated automatic valves shall be tested by valve cycling or stroke testing.

13.3.3.9.1 These valves shall also demonstrate the correct fail mode action.

13.3.3.9.2 Applying a position demand control signal and checking the valve response shall be used for testing modulating valves.

13.3.3.9.3 On/off valves shall be tested by applying the on/off (open/close) control signals.

13.3.3.10 All electrical instrument and control tests shall incorporate the panel, skid, or skid assembly wiring and test instruments shall be connected to the field terminals in the junction boxes.

NOTE This permits verification of a correct wiring assembly.

13.3.3.11 All electrical wiring shall be verified to comply with specified electrical codes and wiring practices. Wiring shall be verified to agree with wiring diagrams and include correct wiring labels, tags, grounding, and other applicable requirements.

13.3.3.12 Booster pressure containing parts shall be hydrostatically tested at a minimum of 1.5 times the MAWP.

13.3.3.13 Booster shall be pressure leak tested with nitrogen at 1.1 times MAWP after assembly.

13.3.3.14 ~~Pressure~~ Boosters shall be run to demonstrate operability.

13.3.3.14.1 ~~Booster(s) shall operate in a smooth manner within the manufacturer's limits~~.

13.3.3.14.2 Rotary boosters shall be performance tested and results provided with a curve.

13.3.3.14.3 Vibration levels shall be within the manufacturer's limits.

13.3.3.15 [●] If specified, the purchaser shall identify additional testing requirements.

NOTE Full flow testing of the dry gas seal support system as a standalone system without being part of a compressor test can be difficult to implement due to some of the controls being DCS or PLC based and the available gas for testing.

13.4 Nameplates

13.4.1 A nameplate shall be securely attached to the panel or skid at a readily visible location on the equipment and on any major piece of auxiliary equipment.

13.4.2 Nameplates shall be of austenitic stainless steel. Attachment pins shall be of the same material. Welding to attach the nameplate to the panel or skid is not permitted.

13.4.3 The following data shall be clearly stamped or engraved on the nameplate:

a) vendor's name,

b) serial number,

c) date of manufacture,

d) MAWP(s) and allowable temperature(s),

e) purchaser item number or other reference,

f) test pressure(s),

g) weight.

13.4.4 [●] If specified, a stainless steel system diagram shall be supplied permanently affixed to the panel or skid.

13.5 Preparation for Shipment

13.5.1 Except for machined surfaces, all exterior surfaces that can corrode during shipment, storage or in service shall be painted per the manufacturer's standard system. The paint shall not contain lead or chromates.

NOTE Austenitic stainless steels are typically not painted.

13.5.2 Exterior machined surfaces except for corrosion-resistant material shall be coated with suitable rust preventative.

13.5.3 Flanged openings shall be provided with stainless steel closures at least 5 mm ($^3/_{16}$ in.) thick with full face elastomer gaskets and at least four full-diameter bolts.

13.5.3.1 For studded openings, all nuts required for the intended service shall be provided to secure closures.

13.5.3.2 Each opening shall be car sealed so that the protective cover cannot be removed without the seal being broken.

13.5.4 Threaded openings shall be provided with steel caps or round-head steel plugs in accordance with ANSI/ASME 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 provided.

13.5.5 Lifting points and lifting lugs shall be clearly identified on the equipment package. The recommended lifting arrangement shall be as described in the installation manual.

13.5.6 Base and all components and piping of a package or an assembled dry gas seal module 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.

13.5.7 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."

13.5.8 [●] If specified, one copy of the manufacturer's standard installation instructions shall be packed and shipped with the equipment.

13.5.9 [●] If specified, the vendor shall submit certified copies of the test data to the purchaser before shipment.

13.5.10 Connections on auxiliary piping removed for shipment shall be match-marked for ease of assembly.

14 Vendor's Data

14.1 General

Vendor data shall be in accordance with Section 10 of Part 1.

14.1.1 [●] If specified, the information in Annex G shall be provided.

14.1.2 ~~The vendor shall provide all documents listed in the VDDR form (Annex E).~~

14.1.3 ~~Vendor shall complete and supply the agreed VDDR form (see Annex E for an example).~~

~~14.2 Proposals~~

~~Proposal data shall be in accordance with Section 10.2 of Part 1.~~

~~14.3 Contract Data~~

14.3.1 ~~General~~

14.3.1.1 ~~Contract data shall be in accordance with Section 10.3 of Part 1.~~

14.3.1.2 ~~Vendor shall provide normal and maximum flows, temperatures, and pressures per the conditions defined in Part 1, Sections 6.2.1 and 6.2.2.~~

14.3.1.3 ~~Vendor shall provide a certified test report prior to shipment of the dry gas seal support system.~~

14.3.2 ~~Drawings~~

~~Vendor shall provide drawings showing filter, transfer valve, and filter element details.~~

Annex A
(informative)

Datasheets

A representation of the datasheets is enclosed in this annex; however, MS Excel format datasheets have been developed and are available, for purchase from API publications distributors, with this standard. The MS Excel electronic datasheets have additional functionality over printed hard copies.

The following changes were made to the datasheets, this text box is for the ballot only and will be deleted prior to publication

- New datasheets have been developed

Annex A-1 - US Customary

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3) U.S. CUSTOMARY	Job No.: ______ Page: 1 of ____ Date: ______	Item No.: ______ By: ______ Revision: ______

		Rev
1	APPLICABLE TO: ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT	
2	For ______ Compressor Manufacturer ______	
3	Site ______ Unit Model / Serial No. ______	
4	Service ______ Dry Gas Seal Manufacturer ______	
5	Unit ______ Seal Gas System Manufacturer ______	
6	Inquiry No. ______ Requisition No. ______	
7		
8	Explanations: 1. The party to complete the information is indicated as follows:	
9	○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.	
10	2. An asterisk * specifies a requirement, value, or criterion.	
11	3. Designations in parenthesis ( ) are explained in the cited standard; numbers without a prefix are subclause	
12	numbers; those prefixed "T" are text figure numbers; those prefixed "B" are Annex "B" Figure numbers.	
13	○ Per API 692-2nd Edition ○ Governing Specification (If Different)	
14	**Referenced documents/standards**	
15	○ * API 614 (Site and Utility Datasheet) ○ * API 692 Annex 2A (Datasheets for Dry Gas Seals)	
16	○ * API 617 (Datasheet for Unit Operating Conditions)	
17	○ Local Instruments and Panel Items ○ Additional documents ______	
18	○ Instrument Suppliers ______ ○ Additional documents ______	
19	○ Owner P&ID ______ ○ Additional documents ______	
20	○ Referenced standards ______ ○ Additional documents ______	
21		
22	**Installation data:** (also see page 2)	
23	○ * General site data included in specification ______	
24	○ * Utility data included in specification ______	
25	○ Space available for oil system: L ______ W ______ H ______ (ft)	
26	○ Plot plan showing console location in relation to main equipment:	
27	(Sketch the equipment plot plan with relation to the console location here)	
28	○ Maximum allowable noise level not to exceed ______ dB or see ______	
29	○ Area classification: Class ______ Group ______ Division ______	
30	Zone ______ Group ______ Temp Class ______	
31		
32	○ Winterize ○ Tropicalize ○ Minimum clearance and access to components required (6.2.1, 6.2.2) (ft) ______	
33		
34	*** Site and Utility data** (Part 1; 6.4.1):	
35	○ For site ambient / environmental conditions and utility (cooling water, electric power) conditions, refer to API 614 (Site and Utility Datasheet)	
36	**Location:**	
37	○ Indoor ○ Heated ○ Under roof	
38	○ Outdoor ○ Unheated	
39		
40	**System responsibilty** (Part 1; 4.1):	
41	○ Vendor responsible for: ○ System design ○ Logic diagram ○ Installation	
42	○ Control narrative ○ Cause and effect diagram	
43		
44	**Supply arrangement:**	
45	○ Separate modules for each casing ○ Combined module for train	
46	○ Module mounted on compressor baseplate	
47		
48	Remarks: ______	
49	______	
50	______	
51	______	
52	______	
53	______	
54	______	
55	______	
56	______	
57	______	
58	______	

DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3) U.S. CUSTOMARY	Job No.:		Item No.:	
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	Date:		Revision:	

#					Rev
1	NOTE: INFORMATION TO BE COMPLETED BY:	○ Purchaser	☐ Vendor	▽ Either, but by vendor if not by purchaser.	
2	**Dry gas seal specifics:**				
3	○ Double seal	○ Tandem seal with intermediate labyrinth	○ Tandem seal	○ Single seal	
4	○ Seal manufacturer		○ Seal model		
5	○ Equalized (Y/N)	Is each dry gas seal sealing against the same or different pressures. (e.g. balance line used)			
6					
7	**Gas conditions (6.1.4, 6.1.5, 6.1.6, 6.1.7, 6.1.8):**				
8	○ **Seal gas source:**	○ **Secondary seal gas source:**	○ **Separation seal gas source:**	○ **Buffer gas source:**	
9	○ Unit Discharge	○ Nitrogen	○ Nitrogen	○ Unit Discharge	
10	○ External supply	○ Other	○ Other	○ External supply	
11					
12		Seal gas	Alternate seal gas	Secondary seal gas or Buffer gas	Separation seal gas
13					
14	○ Normal supply pressure (psig)				
15	○ Minimum supply pressure (psig)				
16	○ Maximum supply pressure (psig)				
17	○ Normal supply temperature (°F)				
18	○ Minimum supply temperature (°F)				
19	○ Maximum supply temperature (°F)				
20	☐ Flow rate SCFM (14.7 psia & 60°F DRY)				
21	○ Description of Gas				
22	○ Seal gas hazardous (yes/no)				
23	○ Seal gas composition refer to API 617 (Datasheet for Unit Operating Conditions)				
24	☐ Special provisions for back-up supply are necessary				
25					
26	**System design conditions:**	Design Pressure	Design Temperature	Design basis (Default to Part 3; Table 1)	
27		(psig)	(°F)		
28	▽ Seal Gas				
29	▽ Secondary seal gas (Tandem w/ int. laby)				
30	▽ Buffer gas (Double)				
31	▽ Primary vent (Tandem)				
32	▽ Secondary vent (Tandem)				
33	▽ Vent (Single/Double)				
34	▽ Separation seal gas				
35	▽ Drains				
36	○ Settle-out condition				
37	○ System minimum design metal temperature (MDMT) (°F)	at pressure (psig)			
38					
39	**Plant Flare/Vent Conditions:**	Minimum operation	Normal operation	Maximum operation	
40	Primary vent (Tandem): (psig)				
41	Secondary vent (Tandem): (psig)				
42	Vent (Single/Double): (psig)				
43					
44	**System Construction:**				
45	▽ Seal gas console constructed from	▽ Piping	○ Through-studs required		
46		▽ Tubing	▽ Tubing fitting manufact. & model		
47	▽ Materials (8.1.1)	▽ Per Table 3 and Table 4	▽ See specification		
48	○ Special elastomer materials needed to meet gas and temperature conditions				
49	○ Materials to comply with NACE:	○ MR0103 (8.1.4)	○ MR0175 (8.1.15)		
50					
51	○ Isolation and maintenance (6.1.12)	○ Single block valves	○ Lockable handles	○ Spectacle blinds	
52		○ Double block valves w/ bleed	○ Car-sealed		
53	○ Interconnecting piping between seal gas console and compressor by:	○ Purchaser	○ Vendor		
54	▽ Heat tracing required (Part 1: 8.3, 8.5; Part 3: 6.1.19)	Materials by: ▽ Purchaser	Installation by: ▽ Purchaser		
55	Insulation	▽ Vendor	▽ Vendor		
56	**Painting** (Part 1: 8.1; Part 3: 6.1.19)				
57	○ Component supplier standard	○ Unified per system supplier standard	○ Purchaser standard per		
58					

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3)
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Rev

1 NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.
2 Definement of Basic Modules (6.3 - 6.13)
3 **Tandem / Tandem with intermediate labyrinth seals (6.3 - 6.6)**
4 ○ Alternate Seal Gas Supply (6.3.2) ○ Not Required ○ Required ○ Automatic isolation valve
5 ○ Seal Gas System Control Module (6.3.5) ○ DT ○ DT 1 ○ DT 2 ○ DT 3 ○ DT 4
6 ○ Secondary Seal Gas System Control Module (6.4) ○ F ○ F1 ○ F2 ○ F3
7 ○ Pressure rating break of Pipe and Equipment ____
8 ○ Additional requirements for backflow prevention ____
9 ○ Primary Vent (6.5.2) Per Figure B.5 ○ Module H ○ Module L
10 ○ Optional Module(s) - Per Figure B.5 & B.6 ____
11 ○ Secondary Vent (6.5.3) ○ Optional Module(s) - Per Figure B.5 ____
12 ○ Tandem Seal - Drains (6.6) ○ Module N, O, P, Q, R - Per Figure B.7 ____
13 ○ Optional Module(s) - Per Figure B.8 ____
14
15 **Double seals (6.7 - 6.11)**
16 ○ Alternate Seal Gas Supply (6.7.2) ○ Not Required ○ Required ○ Automatic isolation valve
17 ○ Seal Gas Conditioning System (6.7.3) ○ Not Required ○ Required
18 ○ Seal Gas System Control Module (6.7.5) ○ DD ○ DD1 ○ DD2 ○ DD3
19 ○ Buffer Gas Conditioning System (6.8.2) ○ Not Required ○ Required
20 ○ Buffer Gas System Control Module (6.8.4) ○ T ○ T1 ○ T2 ○ T3
21 ○ Vent System (6.10) ○ Optional Module(s) - Per Figure B.13 ____
22 ○ Double Seal - Drains (6.11) ○ Module N, U, R, V - Per Figure B.14 ____
23 ○ Optional Module(s) - Per Figure B.15 ____
24
25 **Single seals (6.12)**
26 ○ Seal Gas System Control Module (6.3.5) ○ DT ○ DT 1 ○ DT 2 ○ DT 3 ○ DT 4
27 ○ Vent System (6.10) ○ Optional Module(s) - Per Figure B.13 ____
28 ○ Single Seal - Drains (6.11) ○ Module N, U, R, V - Per Figure B.15 ____
29 ○ Optional Module(s) - Per Figure B.15 ____
30
31 **Separation Gas System (6.13)**
32 ○ Separation Gas System Control Module (6.13.3) ○ M ○ M1 ○ M2
33
34 **Major Components (Section 7)**

Line	Filters (7.6)	○ Seal Gas	○ Secondary Seal Gas	○ Separation Seal Gas	○ Buffer Gas
35	**Filters (7.6)**				
36	Service application :				
37	○ Purchaser item number				
38	○ Duplex arrangement				
39	○ Filtration level (7.6.1, 7.6.2, 7.6.3)				
40	○ Coalescing filter element				
41	○ Material: Case and top				
42	○ Material: Element				
43	○ Code construction / Code stamp (6.1.14)	○ / ○	○ / ○	○ / ○	○ / ○
44	○ Thermal protection of offline filter				
45	○ Filters equipped with Level Transmitter (7.6.13)				
46	○ Filters drain to automatic traps				
47	▽ Manufacturer				
48	▽ Model				
49	▽ Design temperature (°F)				
50	▽ Design pressure (psig)				
51	▽ Test pressure (psig)				

52 ○ Common filter system for separation and secondary seal gas allowed (6.13.2.2)
53
54 Remarks: ____
55
56
57
58
59
60
61

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3) U.S. CUSTOMARY	Job No.: Page: 4 of Date:	Item No.: By: Revision:

1	NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser □ Vendor ▽ Either, but by vendor if not by purchaser.					Rev
2	Continuous Flow Transfer Valves (7.7)	○ Seal Gas	○ Secondary Seal Gas	○ Separation Seal Gas	○ Buffer Gas	
3	Service application					
4	○ Type (7.7.5.1)					
5	○ Pressure rating : (psig)					
6	○ Component isolation required (7.7.6)					
7	▽ Body material					
8	▽ Plug / ball material					
9	▽ Seat material					
10						
11	Seal Gas Coolers (7.2)					
12	○ Seal Gas Cooler Required					
13	○ Simplex or Duplex arrangement					
14	○ Purchaser Item Number(s):					
15	○ Cooling medium (Part 3: 7.2.1)					
16	○ Cooler designed and constructed per:	○ / ○	○ / ○	○ / ○	○ / ○	
17	○ TEMA class					
18	○ Code construction / Code stamp (6.1.14)					
19	○ Details on data sheet					
20	▽ Water side corrosion allowance (in)					
21	▽ Manufacturer					
22	▽ Model					
23	▽ Duty:					
24	▽ Fouling factor (water side / gas side): (BTU/hr)					
25	▽ Tube: L/OD/BWG					
26	▽ Design / test pressure shell side (psig)					
27	▽ Design / test pressure tube side (psig)					
28	▽ Water on shell side or tube side (7.2.8.5)					
29	▽ Shell material					
30	▽ Channel & cover materials					
31	▽ Tube sheets & tube materials					
32	○ Multi-plate-frame coolers (7.2.8.8)					
33	○ Plate materials (7.2.8.8.5)					
34	○ Water side thermal relief required (7.2.8.7)					
35	○ Removable tube bundle					
36	○ U-bend tubes permitted (7.2.7.2)					
37	○ Component isolation required (6.1.12)					
38						
39	Seal Gas Separator (7.3)					
40	○ Seal Gas Separator Required					
41	○ Purchaser Item Number:					
42	▽ Material: Vessel					
43	▽ Demisting mesh					
44	▽ Design / test pressure (psig)					
45	○ Separator Drain Module Option (6.15.3)					
46	○ Construction code / Code stamp (6.1.14)	○ / ○	○ / ○	○ / ○	○ / ○	
47	○ Component isolation required (6.1.12)					
48						
49	Remarks:					
50						
51						
52						
53						
54						
55						
56						
57						
58						

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
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					Rev
1	NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.				
2	Seal Gas Booster (7.4)	LP	MP	HP	
3	○ Seal Gas Booster Required				
4	☐ Quantity required to achieve required flow rate				
5	○ Simplex or Duplex arrangement (7.4.1)				
6	○ Purchaser Item Number(s):				
7	▽ Seal Gas Booster - Type:				
8	▽ Driver type:				
9	▽ Materials in contact with Seal Gas				
10	○ Pulsation dampeners (7.4.17)				
11	☐ Motive gas quality (7.4.19)				
12	▽ Motive gas filter required				
13	○ Motive gas exhaust vented to safe location (7.4.19.4)				
14	○ Component isolation required (6.1.12)				
15	▽ Automatic or manual stop				
16	☐ Maximum discharge pressure developed (psig)				
17					
18	Seal Gas Heater (7.5)				
19	○ Seal Gas Heater Required				
20	○ Purchaser Item Number:				
21	○ Heater electric (7.5.4)				
22	○ Code construction / Code stamp (6.1.14)	○ / ○	○ / ○	○ / ○	
23	○ Thyristor control panel provided by:				
24	○ Installation area classification:				
25	▽ Materials in contact with Seal Gas				
26	▽ Electrical rating of Seal Gas Heater (kW)				
27	○ Component isolation required (6.1.12)				
28					

	Instrumentation, Alarms and Shutdowns (Sections 10 & 11)							Rev
30	Condition	L - Alarm	LL - Alarm	H - Alarm	HH - Alarm	Shutdown	Permissive	
31	Filter Differential Pressure							
32	Seal Gas Flow							
33	Seal Gas Differential Pressure							
34	Seal Gas Pressure							
35	Seal Gas Temperature							
36	Primary Vent Flow							
37	Primary Vent Pressure							
38	Rupture Disk Status							
39	Secondary Seal Gas Flow							
40	Secondary Seal Gas Pressure							
41	Separation Seal Gas Flow							
42	Separation Seal Gas Pressure							
43	Separation Seal Gas Differential Pressure							
44	Buffer Gas Flow							
45	Buffer Gas Differential Pressure							
46	Buffer Gas Pressure							
47	Secondary Vent							
48	Separator Level							
49	Booster Pressure							
50	Booster Flow							
51	Reciprocating Booster Cycles							
52	Reciprocating Motive Gas Pressure							
53	Rotary Booster Housing Temperature							
54	Heater Element Temperature							

		Rev
55	Remarks:	
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DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
U.S. CUSTOMARY

Job No.: ____ Item No.: ____
Page: 6 of ____ By: ____
Date: ____ Revision: ____

				Rev
1	NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.			
2	Instrument suppliers:	Manufacturer	Description / Type	
3	Pressure indicators / gauges			
4	Pressure transmitters			
5	Pressure switches (11.3.2)			
6	Differential pressure indicators / gauges			
7	Differential pressure transmitters			
8	Differential pressure switches (11.3.2)			
9	Flow indicators / gauges			
10	Flow transmitters			
11	Temperature indicators / gauges			
12	Temperature transmitters			
13	Temperature switches (11.3.2)			
14	Level indicators / gauges			
15	Level transmitters			
16	Level switches			
17	Control valves			
18	Transfer valves			
19	Solenoid valves			
20	Annunciators			
21	Thermocouples (TC's)			
22	Resistance temperature detectors (RTD's)			
23	Thermowells			
24	Pressure relief valves			
25	Thermal relief valves			
26	Sight flow indicators			
27				
28	Purchaser's review and acceptance of components prior to purchase (11.3.1.1) ○ Required ○ Not Required			
29	Purchaser's review and acceptance of components and layout prior to manufacture (11.3.1.2) ○ Required ○ Not Required			
30	○ Instrument display (11.3.1.3) ○ Local ○ Panel mounted			
31	○ Instrument termination (11.3.1.4) ○ Local ○ Pre-wired to local junction box			
32	Wiring to be installed in (11.3.1.8): ○ Metal Conduit ○ Cable trays ○ Enclosures			
33				
34	Switches shall be wired / programmed to: ○ Open (de-energize) or ○ Close (energize) to initiate alarms and shutdowns (11.3.2)			
35	○ Signal segration required (11.3.1.6)			
36	○ Transmitters shall be provided (11.3.3.1) Output signal type ____ Housing type ____			
37	○ Analog ○ Digital (11.3.3.2) ○ Indicating type ○ Non-indicating (blind) type			
38	○ Non-Hazardous ○ Non-incendive ○ Explosion proof ○ Intrinsically safe (IS)			
39				
40	○ Provide solenoid coil rating and estimated service life (11.3.10.5) ○ Dual-coil solenoids required for trip functions (11.3.10.5)			
41	○ Thermal relief valves provided for components that may be blocked in by isolation valves (7.10.4)			
42	○ Instrument and control wiring may be solid conductors in areas not subject to vibration (11.4.5)			
43				
44	Wiring installed in (11.4.14) ○ Metal Conduit ○ Cable trays ○ Enclosures			
45	○ Conduit drains provided in all conduit low points for indoor installations (11.4.20)			
46				
47	○ Provide list of alarms and shutdowns (11.2.2)			
48	Any alarm shall initiate (11.2.6) ○ Audible warning ○ Flashing light ○ Both Audible Warning and flashing light			
49	Any shutdown shall initiate (11.2.7) ○ Audible warning ○ Flashing light ○ Both Audible Warning and flashing light			
50				
51	Remarks:			
52				
53				
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DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3) U.S. CUSTOMARY	Job No.: ______ Page: 7 of ______ Date: ______	Item No.: ______ By: ______ Revision: ______	Rev

1	NOTE: INFORMATION TO BE COMPLETED BY:	○ Purchaser	☐ Vendor	▽ Either, but by vendor if not by purchaser.	
2	**Panels and Skids (Section 12)**				
3	Panel material of construction (12.1.2)	○ Austenitic stainless steel	○ Painted carbon steel		
4	Skid material of construction (12.1.2)	○ Austenitic stainless steel	○ Painted carbon steel		
5	Skid drainage (12.1.4)	○ Drain rim	○ Drain pan		
6	Skid supplied with: (12.1.5)	○ Non-skid metal decking	○ Open deck		
7					
8	Skid designed for grout installation (12.1.10)	○ Required	○ Not required	○ Prepare skid for grout installation (12.1.16)	
9	Skid designed for column mounting (12.1.11)	○ Required	○ Not required		
10					

			Required	Witness	Observed
11	**Dry Gas Seal Support System Inspection and Testing (Section 13)**				
12	○ Compliance with inspector's check list (13.1.2)	○ Cleanliness (13.3.3.3)	○	○	○
13	○ Cleanliness required during system assembly (13.2.6.1)	○ Hydro test of components (13.3.2.1)	○	○	○
14	○ Cleanliness prior to closure (13.2.6.2)	○ Operational testing (13.3.3)	○	○	○
15	○ Material certification to be furnished	○ Pneumatic test of assembly	○	○	○
16	○ Additional radiography (13.2.1.3) ______ %	○ Check controls	○	○	○
17	○ PMI testing (13.2.5.1)	○ Changeover filters	○	○	○
18	○ Hardness testing (13.2.6.3)	○ Transfer valves tight shutoff	○	○	○
19	○ Certified copies of all test logs and data	○ Use for unit mechanical test (13.1.9)	○	○	○
20	○ Submit prior to shipment (13.5.9)	○ Use for unit performance test (13.1.9)	○	○	○
21	○ Amount of advance notification required before a				
22	witnessed or observed inspection (13.1.6) ______ days				
23					

24	**Preparation for shipment**					
25	○ Install new filter elements and tag	☐ Weights	______ Skid			
26	○ Include ____ sets of extra filter elements	(lb)	______ Panel			
27	○ Box extra sets with the ______ system		______			
28	Other spares:					
29	○ ______	☐ Dimensions:	Length	Width	Height	
30	○ ______	(ft)	______	______	______	Skid
31	○ ______		______	______	______	Panel
32	○ ______		______	______	______	
33						

34	**Shipment** (System and components)				**Shipment** (Spare parts for DGS conditioning skid)			
35		Vendor Std.	Purch.	Spec.	Vendor Std.	Purch.	Spec.	
36	○ Domestic	☐	☐	______	☐	☐	______	
37	○ Export	☐	☐	______	☐	☐	______	
38	○ Extended Storage ______ months							
39								

40	**Miscellaneous documentation**	
41	○ Spare parts quotation with proposal	○ Complete inspector's checklist
42	○ Spare parts quotation after contract	○ Progress reports every ______ weeks (Part 1 - 10.3.3)
43	○ Above based on normal supply for ______ months	○ Technical data manual (Part 1 - 10.3.6.4)
44	○ ______	○ ______
45		
46	Remarks: ______	
47	______	
48	______	
49	______	
50	______	
51	______	
52	______	
53	______	
54	______	
55	______	
56	______	
57	______	
58		

Annex A-2 - SI Units

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM DATASHEET (API 692-2nd, Part 3) SI UNITS (bar)	Job No.:	Item No.:
	Page: 1 of	By:
	Date:	Revision:

		Rev
1	**APPLICABLE TO:** ☐ PROPOSAL ☐ PURCHASE ☐ AS BUILT	
2	For ____ Compressor Manufacturer ____	
3	Site ____ Unit Model / Serial No. ____	
4	Service ____ Dry Gas Seal Manufacturer ____	
5	Unit ____ Seal Gas System Manufacturer ____	
6	Inquiry No. ____ Requisition No. ____	
7		
8	**Explanations:** 1. The party to complete the information is indicated as follows:	
9	○ Purchaser ☐ Vendor ▽ **Either, but by vendor if not by purchaser.**	
10	2. An asterisk * specifies a requirement, value, or criterion.	
11	3. Designations in parenthesis ( ) are explained in the cited standard; numbers without a prefix are subclause	
12	numbers; those prefixed "T" are text figure numbers; those prefixed "B" are Annex "B" Figure numbers.	
13	○ Per API 692-2nd Edition ○ Governing Specification (If Different)	
14	**Referenced documents/standards**	
15	○ * API 614 (Site and Utility Datasheet) ○ * API 692 Annex 2A (Datasheets for Dry Gas Seals)	
16	○ * API 617 (Datasheet for Unit Operating Conditions)	
17	○ Local Instruments and Panel Items ○ Additional documents ____	
18	○ Instrument Suppliers ____ ○ Additional documents ____	
19	○ Owner P&ID ____ ○ Additional documents ____	
20	○ Referenced standards ____ ○ Additional documents ____	
21		
22	**Installation data:** (also see page 2)	
23	○ * General site data included in specification ____	
24	○ * Utility data included in specification ____	
25	○ Space available for oil system: L ____ W ____ H ____ (m)	
26	○ Plot plan showing console location in relation to main equipment:	
27	(Sketch the equipment plot plan with relation to the console location here)	
28	○ Maximum allowable noise level not to exceed ____ dB or see ____	
29	○ Area classification: Zone ____ Group ____ Temp Class ____	
30	Zone ____ Group ____ Temp Class ____	
31		
32	○ Winterize ○ Tropicalize ○ Minimum clearance and access to components required (6.2.1, 6.2.2) (m) ____	
33		
34	*** Site and Utility data** (Part 1; 6.4.1):	
35	○ For site ambient / environmental conditions and utility (cooling water, electric power) conditions, refer to API 614 (Site and Utility Datasheet)	
36	**Location:**	
37	○ Indoor ○ Heated ○ Under roof	
38	○ Outdoor ○ Unheated	
39		
40	**System responsibilty** (Part 1; 4.1):	
41	○ Vendor responsible for: ○ System design ○ Logic diagram ○ Installation	
42	○ Control narrative ○ Cause and effect diagram	
43		
44	**Supply arrangement:**	
45	○ Separate modules for each casing ○ Combined module for train	
46	○ Module mounted on compressor baseplate	
47		
48	Remarks: ____	
49	____	
50	____	
51	____	
52	____	
53	____	
54	____	
55	____	
56	____	
57	____	
58		

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
SI UNITS (bar)

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

Rev

1 NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.

2 **Dry gas seal specifics:**

3 ○ Double seal ○ Tandem seal with intermediate labyrinth ○ Tandem seal ○ Single seal

4 ○ Seal manufacturer ______ ○ Seal model ______

5 ○ Equalized (Y/N) ______ Is each dry gas seal sealing against the same or different pressures. (e.g. balance line used)

6

7 **Gas conditions (6.1.4, 6.1.5, 6.1.6, 6.1.7, 6.1.8):**

8 ○ Seal gas source: ○ Secondary seal gas source: ○ Separation seal gas source: ○ Buffer gas source:

9 ○ Unit Discharge ○ Nitrogen ○ Nitrogen ○ Unit Discharge

10 ○ External supply ○ Other ______ ○ Other ______ ○ External supply

11

Line	Item	Units	Seal gas	Alternate seal gas	Secondary seal gas or Buffer gas	Separation seal gas
12–13						
14	○ Normal supply pressure	(barG)				
15	○ Minimum supply pressure	(barG)				
16	○ Maximum supply pressure	(barG)				
17	○ Normal supply temperature	(°C)				
18	○ Minimum supply temperature	(°C)				
19	○ Maximum supply temperature	(°C)				
20	☐ Flow rate	NM³/H (1.013 barA & 0°C DRY)				
21	○ Description of Gas					

22 ○ Seal gas hazardous (yes/no) ______

23 ○ Seal gas composition refer to API 617 (Datasheet for Unit Operating Conditions)

24 ☐ Special provisions for back-up supply are necessary

25

Line	System design conditions:	Design Pressure (psig)	Design Temperature (°C)	Design basis (Default to Part 3; Table 1)
26–27				
28	▽ Seal Gas			
29	▽ Secondary seal gas (Tandem w/ int. laby)			
30	▽ Buffer gas (Double)			
31	▽ Primary vent (Tandem)			
32	▽ Secondary vent (Tandem)			
33	▽ Vent (Single/Double)			
34	▽ Separation seal gas			
35	▽ Drains			
36	○ Settle-out condition			

37 ○ System minimum design metal temperature (MDMT) (°C) ______ at pressure(barG) ______

38

	Plant Flare/Vent Conditions:		Minimum operation	Normal operation	Maximum operation
39					
40	Primary vent (Tandem):	(barG)			
41	Secondary vent (Tandem):	(barG)			
42	Vent (Single/Double):	(barG)			

43

44 **System Construction:**

45 ▽ Seal gas console constructed from ▽ Piping ○ Through-studs required

46 ▽ Tubing ▽ Tubing fitting manufact. & model ______

47 ▽ Materials (8.1.1) ▽ Per Table 3 and Table 4 ▽ See specification ______

48 ○ Special elastomer materials needed to meet gas and temperature conditions

49 ○ Materials to comply with NACE: ○ MR0103 (8.1.4) ○ MR0175 (8.1.15)

50

51 ○ Isolation and maintenance (6.1.12) ○ Single block valves ○ Lockable handles ○ Spectacle blinds

52 ○ Double block valves w/ bleed ○ Car-sealed

53 ○ Interconnecting piping between seal gas console and compressor by: ○ Purchaser ○ Vendor

54 ▽ Heat tracing required (Part 1: 8.3, 8.5; Part 3: 6.1.19) Materials by: ▽ Purchaser Installation by: ▽ Purchaser

55 Insulation ▽ Vendor ▽ Vendor

56 Painting (Part 1: 8.1; Part 3: 6.1.19)

57 ○ Component supplier standard ○ Unified per system supplier standard ○ Purchaser standard per ______

58

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM **DATASHEET (API 692-2nd, Part 3)** **SI UNITS (bar)**	Job No.: ______ Page: 3 of ____ Date: ______	Item No.: ______ By: ______ Revision: ______

No.	Item	Options	Rev
1	NOTE: INFORMATION TO BE COMPLETED BY:	○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.	
2	Definement of Basic Modules (6.3 - 6.13)		
3	**Tandem / Tandem with intermediate labyrinth seals (6.3 - 6.6)**		
4	○ Alternate Seal Gas Supply (6.3.2)	○ Not Required ○ Required ○ Automatic isolation valve	
5	○ Seal Gas System Control Module (6.3.5)	○ DT ○ DT 1 ○ DT 2 ○ DT 3 ○ DT 4	
6	○ Secondary Seal Gas System Control Module (6.4)	○ F ○ F1 ○ F2 ○ F3	
7	○ Pressure rating break of Pipe and Equipment	______	
8	○ Additional requirements for backflow prevention	______	
9	○ Primary Vent (6.5.2) Per Figure B.5	○ Module H ○ Module L	
10		○ Optional Module(s) - Per Figure B.5 & B.6 ______	
11	○ Secondary Vent (6.5.3)	○ Optional Module(s) - Per Figure B.5 ______	
12	○ Tandem Seal - Drains (6.6)	○ Module N, O, P, Q, R - Per Figure B.7 ______	
13		○ Optional Module(s) - Per Figure B.8 ______	
14			
15	**Double seals (6.7 - 6.11)**		
16	○ Alternate Seal Gas Supply (6.7.2)	○ Not Required ○ Required ○ Automatic isolation valve	
17	○ Seal Gas Conditioning System (6.7.3)	○ Not Required ○ Required	
18	○ Seal Gas System Control Module (6.7.5)	○ DD ○ DD1 ○ DD2 ○ DD3	
19	○ Buffer Gas Conditioning System (6.8.2)	○ Not Required ○ Required	
20	○ Buffer Gas System Control Module (6.8.4)	○ T ○ T1 ○ T2 ○ T3	
21	○ Vent System (6.10)	○ Optional Module(s) - Per Figure B.13 ______	
22	○ Double Seal - Drains (6.11)	○ Module N, U, R, V - Per Figure B.14	
23		○ Optional Module(s) - Per Figure B.15 ______	
24			
25	**Single seals (6.12)**		
26	○ Seal Gas System Control Module (6.3.5)	○ DT ○ DT 1 ○ DT 2 ○ DT 3 ○ DT 4	
27	○ Vent System (6.10)	○ Optional Module(s) - Per Figure B.13 ______	
28	○ Single Seal - Drains (6.11)	○ Module N, U, R, V - Per Figure B.15	
29		○ Optional Module(s) - Per Figure B.15 ______	
30			
31	**Separation Gas System (6.13)**		
32	○ Separation Gas System Control Module (6.13.3)	○ M ○ M1 ○ M2	
33			

No.	Major Components (Section 7)					Rev
35	**Filters (7.6)**	○ Seal Gas	○ Secondary Seal Gas	○ Separation Seal Gas	○ Buffer Gas	
36	Service application :					
37	○ Purchaser item number					
38	○ Duplex arrangement					
39	○ Filtration level (7.6.1, 7.6.2, 7.6.3)					
40	○ Coalescing filter element					
41	○ Material: Case and top					
42	○ Material: Element					
43	○ Code construction / Code stamp (6.1.14)	○ / ○	○ / ○	○ / ○	○ / ○	
44	○ Thermal protection of offline filter					
45	○ Filters equipped with Level Transmitter (7.6.13)					
46	○ Filters drain to automatic traps					
47	▽ Manufacturer					
48	▽ Model					
49	▽ Design temperature (°C)					
50	▽ Design pressure (barG)					
51	▽ Test pressure (barG)					
52	○ Common filter system for separation and secondary seal gas allowed (6.13.2.2)					
53						
54	Remarks:					
55						
56						
57						
58						
59						
60						
61						

DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
SI UNITS (bar)

Job No.: ______ Item No.: ______
Page: 4 of ______ By: ______
Date: ______ Revision: ______

							Rev
1	NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.						
2	**Continuous Flow Transfer Valves (7.7)**		○ Seal Gas	○ Secondary Seal Gas	○ Separation Seal Gas	○ Buffer Gas	
3	**Service application**						
4	○ Type (7.7.5.1)						
5	○ Pressure rating :	(barG)					
6	○ Component isolation required (7.7.6)						
7	▽ Body material						
8	▽ Plug / ball material						
9	▽ Seat material						
10							
11	**Seal Gas Coolers (7.2)**						
12	○ Seal Gas Cooler Required						
13	○ Simplex or Duplex arrangement						
14	○ Purchaser Item Number(s):						
15	○ Cooling medium (Part 3: 7.2.1)						
16	○ Cooler designed and constructed per:		○ / ○	○ / ○	○ / ○	○ / ○	
17	○ TEMA class						
18	○ Code construction / Code stamp (6.1.14)						
19	○ Details on data sheet						
20	▽ Water side corrosion allowance	(mm)					
21	▽ Manufacturer						
22	▽ Model						
23	▽ Duty:						
24	▽ Fouling factor (water side / gas side):	(kJ/hr)					
25	▽ Tube: L/OD/BWG						
26	▽ Design / test pressure shell side	(barG)					
27	▽ Design / test pressure tube side	(barG)					
28	▽ Water on shell side or tube side (7.2.8.5)						
29	▽ Shell material						
30	▽ Channel & cover materials						
31	▽ Tube sheets & tube materials						
32	○ Multi-plate-frame coolers (7.2.8.8)						
33	○ Plate materials (7.2.8.8.5)						
34	○ Water side thermal relief required (7.2.8.7)						
35	○ Removable tube bundle						
36	○ U-bend tubes permitted (7.2.7.2)						
37	○ Component isolation required (6.1.12)						
38							
39	**Seal Gas Separator (7.3)**						
40	○ Seal Gas Separator Required						
41	○ Purchaser Item Number:						
42	▽ Material: Vessel						
43	▽ Demisting mesh						
44	▽ Design / test pressure	(barG)					
45	○ Separator Drain Module Option (6.15.3)						
46	○ Construction code / Code stamp (6.1.14)		○ / ○	○ / ○	○ / ○	○ / ○	
47	○ Component isolation required (6.1.12)						
48							
49	Remarks:						
50							
51							
52							
53							
54							
55							
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DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
SI UNITS (bar)

Job No.: | Item No.:
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Date: | Revision:

#			LP	MP	HP	Rev
1	NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser □ Vendor ▽ Either, but by vendor if not by purchaser.					
2	**Seal Gas Booster (7.4)**		LP	MP	HP	
3	○ Seal Gas Booster Required					
4	□ Quantity required to achieve required flow rate					
5	○ Simplex or Duplex arrangement (7.4.1)					
6	○ Purchaser Item Number(s):					
7	▽ Seal Gas Booster - Type:					
8	▽ Driver type:					
9	▽ Materials in contact with Seal Gas					
10	○ Pulsation dampeners (7.4.17)					
11	□ Motive gas quality (7.4.19)					
12	▽ Motive gas filter required					
13	○ Motive gas exhaust vented to safe location (7.4.19.4)					
14	○ Component isolation required (6.1.12)					
15	▽ Automatic or manual stop					
16	□ Maximum discharge pressure developed	(barG)				
17						
18	**Seal Gas Heater (7.5)**					
19	○ Seal Gas Heater Required					
20	○ Purchaser Item Number:					
21	○ Heater electric (7.5.4)					
22	○ Code construction / Code stamp (6.1.14)		○ / ○	○ / ○	○ / ○	
23	○ Thyristor control panel provided by:					
24	○ Installation area classification:					
25	▽ Materials in contact with Seal Gas					
26	▽ Electrical rating of Seal Gas Heater	(kW)				
27	○ Component isolation required (6.1.12)					
28						

29 Instrumentation, Alarms and Shutdowns (Sections 10 & 11)

#	Condition	L - Alarm	LL - Alarm	H - Alarm	HH - Alarm	Shutdown	Permissive
31	Filter Differential Pressure						
32	Seal Gas Flow						
33	Seal Gas Differential Pressure						
34	Seal Gas Pressure						
35	Seal Gas Temperature						
36	Primary Vent Flow						
37	Primary Vent Pressure						
38	Rupture Disk Status						
39	Secondary Seal Gas Flow						
40	Secondary Seal Gas Pressure						
41	Separation Seal Gas Flow						
42	Separation Seal Gas Pressure						
43	Separation Seal Gas Differential Pressure						
44	Buffer Gas Flow						
45	Buffer Gas Differential Pressure						
46	Buffer Gas Pressure						
47	Secondary Vent						
48	Separator Level						
49	Booster Pressure						
50	Booster Flow						
51	Reciprocating Booster Cycles						
52	Reciprocating Motive Gas Pressure						
53	Rotary Booster Housing Temperature						
54	Heater Element Temperature						

55 Remarks:

56

57

58

59

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DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
SI UNITS (bar)

Job No.: ______ Item No.: ______
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Date: ______ Revision: ______

Rev

1	NOTE: INFORMATION TO BE COMPLETED BY:	○ Purchaser ☐ Vendor	▽ Either, but by vendor if not by purchaser.
2	**Instrument suppliers:**	**Manufacturer**	**Description / Type**
3	Pressure indicators / gauges		
4	Pressure transmitters		
5	Pressure switches (11.3.2)		
6	Differential pressure indicators / gauges		
7	Differential pressure transmitters		
8	Differential pressure switches (11.3.2)		
9	Flow indicators / gauges		
10	Flow transmitters		
11	Temperature indicators / gauges		
12	Temperature transmitters		
13	Temperature switches (11.3.2)		
14	Level indicators / gauges		
15	Level transmitters		
16	Level switches		
17	Control valves		
18	Transfer valves		
19	Solenoid valves		
20	Annunciators		
21	Thermocouples (TC's)		
22	Resistance temperature detectors (RTD's)		
23	Thermowells		
24	Pressure relief valves		
25	Thermal relief valves		
26	Sight flow indicators		

27
28 Purchaser's review and acceptance of components prior to purchase (11.3.1.1) ○ Required ○ Not Required
29 Purchaser's review and acceptance of components and layout prior to manufacture (11.3.1.2) ○ Required ○ Not Required
30 ○ Instrument display (11.3.1.3) ○ Local ○ Panel mounted
31 ○ Instrument termination (11.3.1.4) ○ Local ○ Pre-wired to local junction box
32 Wiring to be installed in (11.3.1.8): ○ Metal Conduit ○ Cable trays ○ Enclosures
33
34 Switches shall be wired / programmed to: ○ Open (de-energize) or ○ Close (energize) to initiate alarms and shutdowns (11.3.2)
35 ○ Signal segration required (11.3.1.6)
36 ○ Transmitters shall be provided (11.3.3.1) Output signal type ______ Housing type ______
37 ○ Analog ○ Digital (11.3.3.2) ○ Indicating type ○ Non-indicating (blind) type
38 ○ Non-Hazardous ○ Non-incendive ○ Explosion proof ○ Intrinsically safe (IS)
39
40 ○ Provide solenoid coil rating and estimated service life (11.3.10.5) ○ Dual-coil solenoids required for trip functions (11.3.10.5)
41 ○ Thermal relief valves provided for components that may be blocked in by isolation valves (7.10.4)
42 ○ Instrument and control wiring may be solid conductors in areas not subject to vibration (11.4.5)
43
44 Wiring installed in (11.4.14) ○ Metal Conduit ○ Cable trays ○ Enclosures
45 ○ Conduit drains provided in all conduit low points for indoor installations (11.4.20)
46
47 ○ Provide list of alarms and shutdowns (11.2.2)
48 Any alarm shall initiate (11.2.6) ○ Audible warning ○ Flashing light ○ Both Audible Warning and flashing light
49 Any shutdown shall initiate (11.2.7) ○ Audible warning ○ Flashing light ○ Both Audible Warning and flashing light
50
51 Remarks: ______
52 ______
53 ______
54 ______
55 ______
56 ______
57 ______
58 ______
59 ______
60

API 692 Annex 3A — Datasheets for Dry Gas Seal Support System

DRY GAS SEAL SUPPORT SYSTEM
DATASHEET (API 692-2nd, Part 3)
SI UNITS (bar)

Job No.: ________ Item No.: ________
Page: 7 of ________ By: ________
Date: ________ Revision: ________

Rev

NOTE: INFORMATION TO BE COMPLETED BY: ○ Purchaser ☐ Vendor ▽ Either, but by vendor if not by purchaser.

Panels and Skids (Section 12)

Panel material of construction (12.1.2) ○ Austenitic stainless steel ○ Painted carbon steel
Skid material of construction (12.1.2) ○ Austenitic stainless steel ○ Painted carbon steel
Skid drainage (12.1.4) ○ Drain rim ○ Drain pan
Skid supplied with: (12.1.5) ○ Non-skid metal decking ○ Open deck

Skid designed for grout installation (12.1.10) ○ Required ○ Not required ○ Prepare skid for grout installation (12.1.16)
Skid designed for column mounting (12.1.11) ○ Required ○ Not required

Dry Gas Seal Support System Inspection and Testing (Section 13)

○ Compliance with inspector's check list (13.1.2)
○ Cleanliness required during system assembly (13.2.6.1)
○ Cleanliness prior to closure (13.2.6.2)
○ Material certification to be furnished
○ Additional radiography (13.2.1.3) ______ %
○ PMI testing (13.2.5.1)
○ Hardness testing (13.2.6.3)
○ Certified copies of all test logs and data
  ○ Submit prior to shipment (13.5.9)
  ○ Amount of advance notification required before a witnessed or observed inspection (13.1.6) ______ days

	Required	Witness	Observed
○ Cleanliness (13.3.3.3)	○	○	○
○ Hydro test of components (13.3.2.1)	○	○	○
○ Operational testing (13.3.3)	○	○	○
○ Pneumatic test of assembly	○	○	○
○ Check controls	○	○	○
○ Changeover filters	○	○	○
○ Transfer valves tight shutoff	○	○	○
○ Use for unit mechanical test (13.1.9)	○	○	○
○ Use for unit performance test (13.1.9)	○	○	○

Preparation for shipment

○ Install new filter elements and tag
○ Include ___ sets of extra filter elements
○ Box extra sets with the ______ system
Other spares:
○ ________
○ ________
○ ________
○ ________

☐ Weights (kg) ______ Skid
______ Panel

☐ Dimensions: (m)

Length	Width	Height	
______	______	______	Skid
______	______	______	Panel

Shipment (System and components)

	Vendor Std.	Purch.	Spec.
○ Domestic	☐	☐	________
○ Export	☐	☐	________

○ Extended Storage ______ months

Shipment (Spare parts for DGS conditioning skid)

Vendor Std.	Purch.	Spec.
☐	☐	________
☐	☐	________

Miscellaneous documentation

○ Spare parts quotation with proposal
○ Spare parts quotation after contract
○ Above based on normal supply for ______ months
○ ________

○ Complete inspector's checklist
○ Progress reports every ______ weeks (Part 1 - 10.3.3)
○ Technical data manual (Part 1 - 10.3.6.4)
○ ________

Remarks:

Annex B
(normative)

System Diagrams

Diagrams shown in Annex B are schematic diagrams with basic representation of system components, instrumentation and piping to define the fundamental flow path, control and monitoring requirements associated with each identified system. Each system is comprised of various modules that are interchangeable for specific applications.

Functional descriptions and requirements for each module are located in Section 6.

They are not to be interpreted as detailed piping and instrument diagrams. Actual monitoring and control schemes may vary on project specific detailed designed piping and instrumentation diagrams.

NOTE 1 Basic designs are based on beam style compressors, API 617, Part 2.

NOTE 2 Vent diagrams are intended per seal.

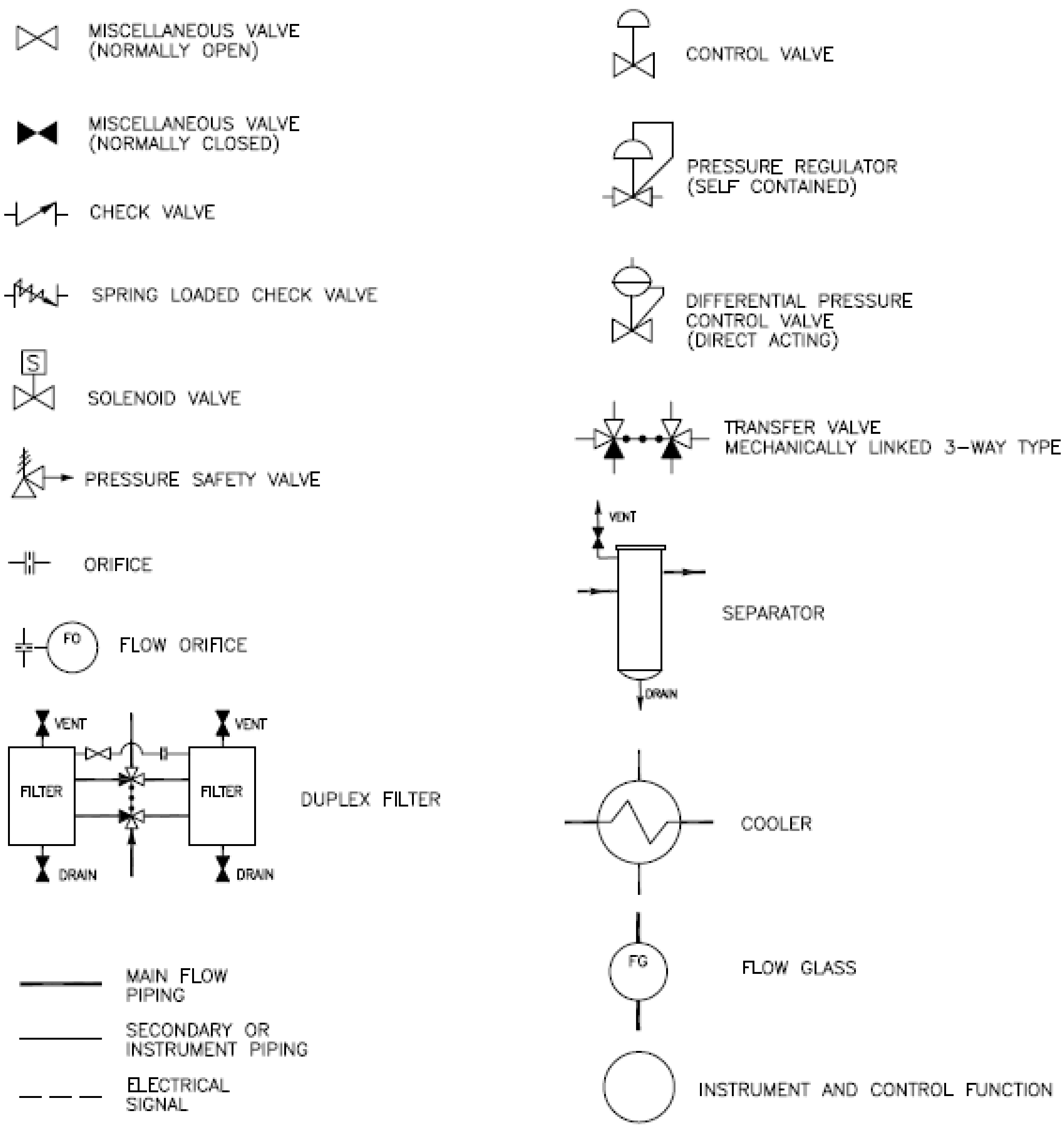
NOTE 3 Diagrams do not show all isolation valves, vents, and drains that can be required.

NOTE 4 Devices can be combined if design conditions allow. For example, flow-indicating transmitter (FIT) and orifice (FO) can be a single device in some applications.

The included diagrams are as follows.

- Figure B.~~0~~1 - Symbols
- Figure B.~~1~~2—Tandem Seal—Seal Gas Supply.
- Figure B.~~2~~3—Tandem Seal—Seal Gas Optional Modules.
- Figure B.~~3~~4—Tandem Seal—Secondary Seal Gas Supply.
- Figure B.~~4~~5—Tandem Seal—Secondary Seal Gas Optional Modules.
- Figure B.~~5~~6—Tandem Seal—Vents.
- Figure B.~~6~~7—Tandem Seal—Vent Options.
- Figure B.~~7~~8—Tandem Seal—Drains.
- Figure B.~~8~~9—Tandem Seal—Drain Options.
- Figure B.~~9~~10—Double Seal—Buffer Gas Supply.
- Figure B.~~10~~11—Double Seal—Buffer Gas Supply Options.
- Figure B.~~11~~12—Double Seal—Seal Gas Supply.
- Figure B.~~12~~13—Double Seal—Seal Gas Supply Options.

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication
-New Symbols diagram



INSTRUMENTATION SYMBOL CODE TABLE

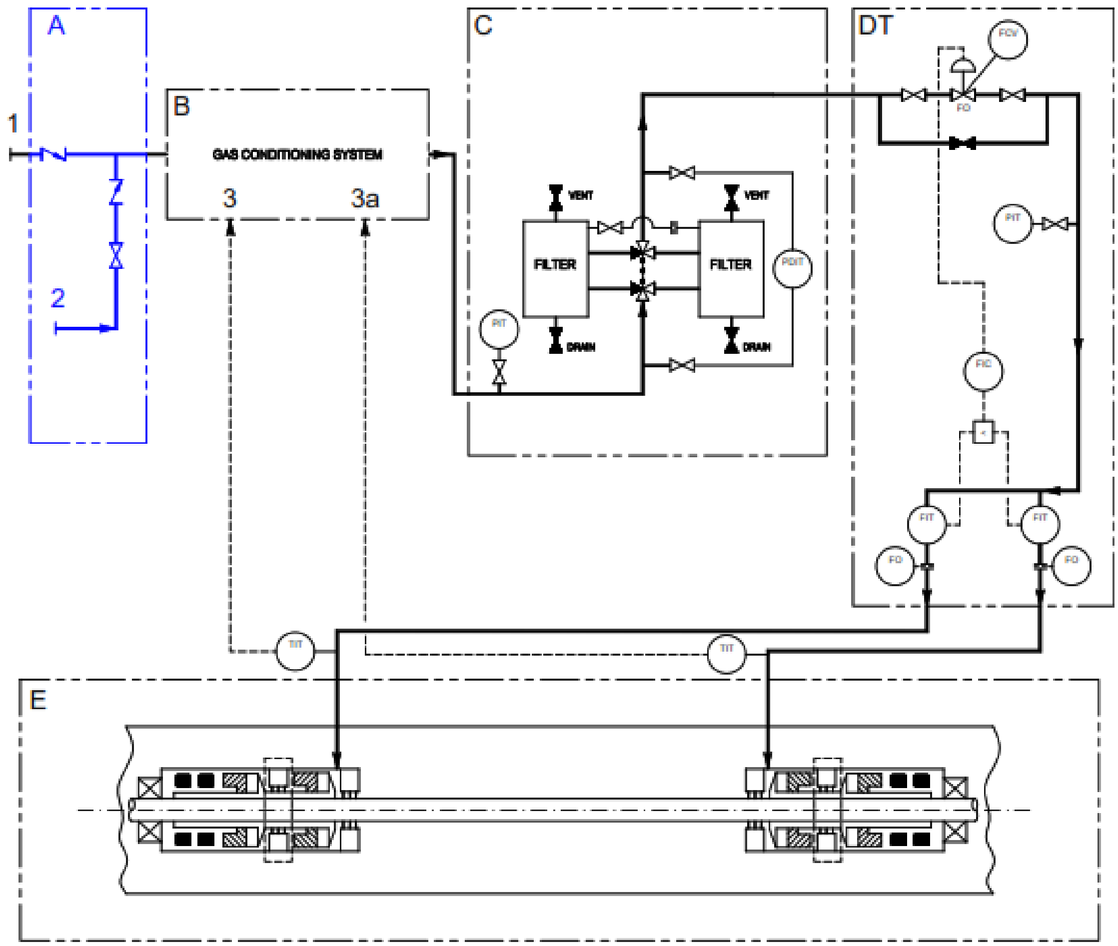
	INSTRUMENT FUNCTION					
MEASURED VARIABLE	CONTROL VALVE	ELEMENT	INDICATOR	INDICATING CONTROLLER	SAFTEY VALVE	INDICATING TRANSMITTER
ANALYSIS		AE				
FLOW	FCV			FIC		FIT
LEVEL	LCV			LIC		LIT
PRESSURE	PCV			PIC	PSV	PIT
PRESSURE DIFFERENTIAL	PDCV			PDIC		PDIT
TEMPERATURE				TIC		TIT

DIAGRAM ABBREVIATIONS

FO FAIL OPEN
FL FAIL IN LAST POSITION
TSHH SEAL GAS HEATER CUT OUT

Figure B.~~0~~1—Symbols

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication
-Mod B1 TIT Moved
- Removed check valve in Mod C



CONNECTIONS LIST

1- SEAL GAS SUPPLY.
2- ALTERNATE SEAL GAS SUPPLY.
3- SEAL GAS SUPPLY TEMPERATURE.
3a-SEAL GAS SUPPLY TEMPERATURE.

MODULES DESCRIPTIONS

A- ALTERNATE SEAL GAS (OPTIONAL).
B- GAS CONDITIONING SYSTEM.
C- FILTERS.
DT-FLOW CONTROL BY FLOW MEASUREMENT. OPTIONAL MODULES MAY BE DT1, DT2, DT3 AND DT4.
E- COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.

Figure B.~~1~~2—Tandem Seal—Seal Gas Supply

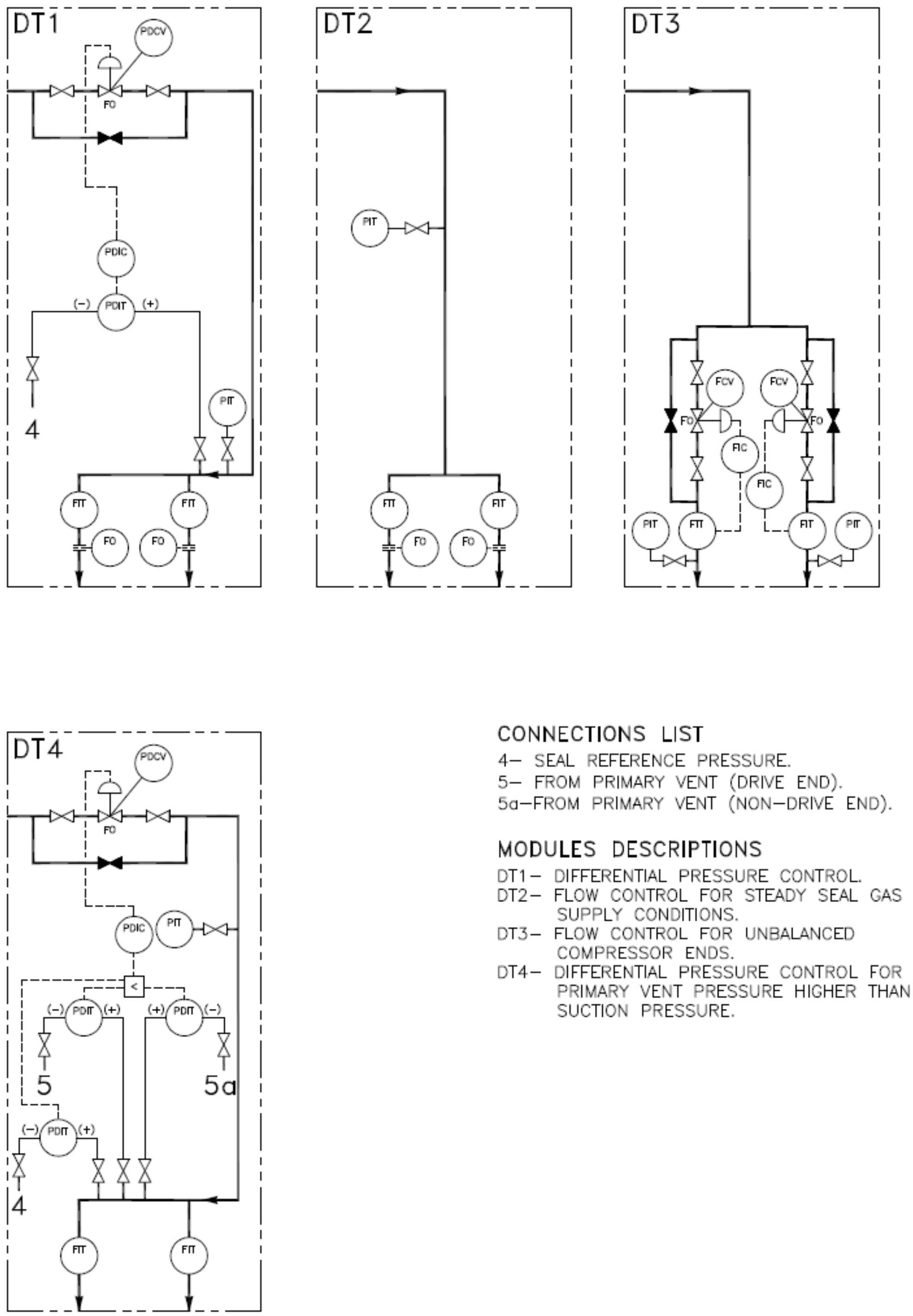
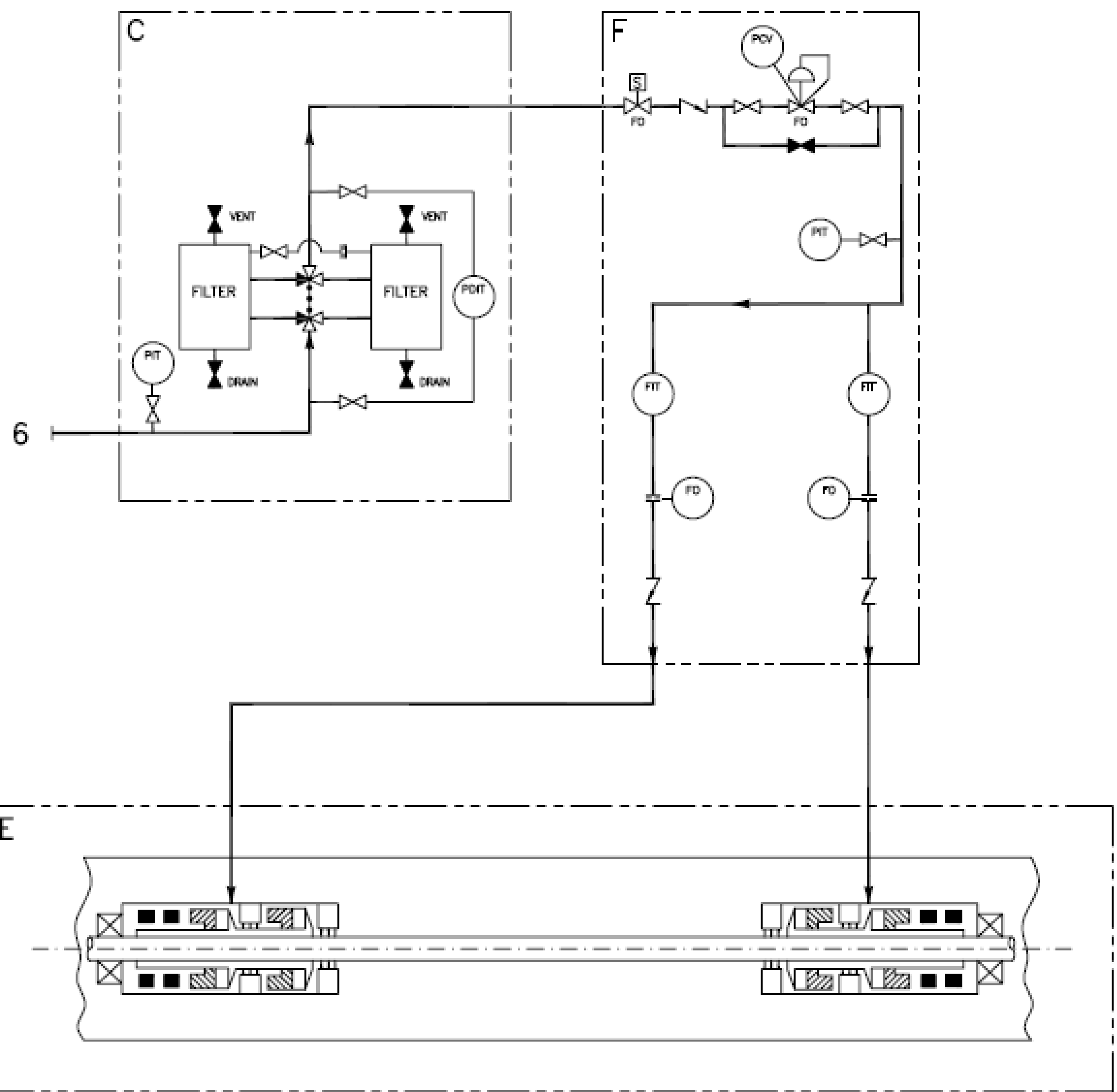


Figure B.~~2~~3—Tandem Seal—Seal Gas Optional Modules

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Moved check valve to Mod F
- Added solenoid



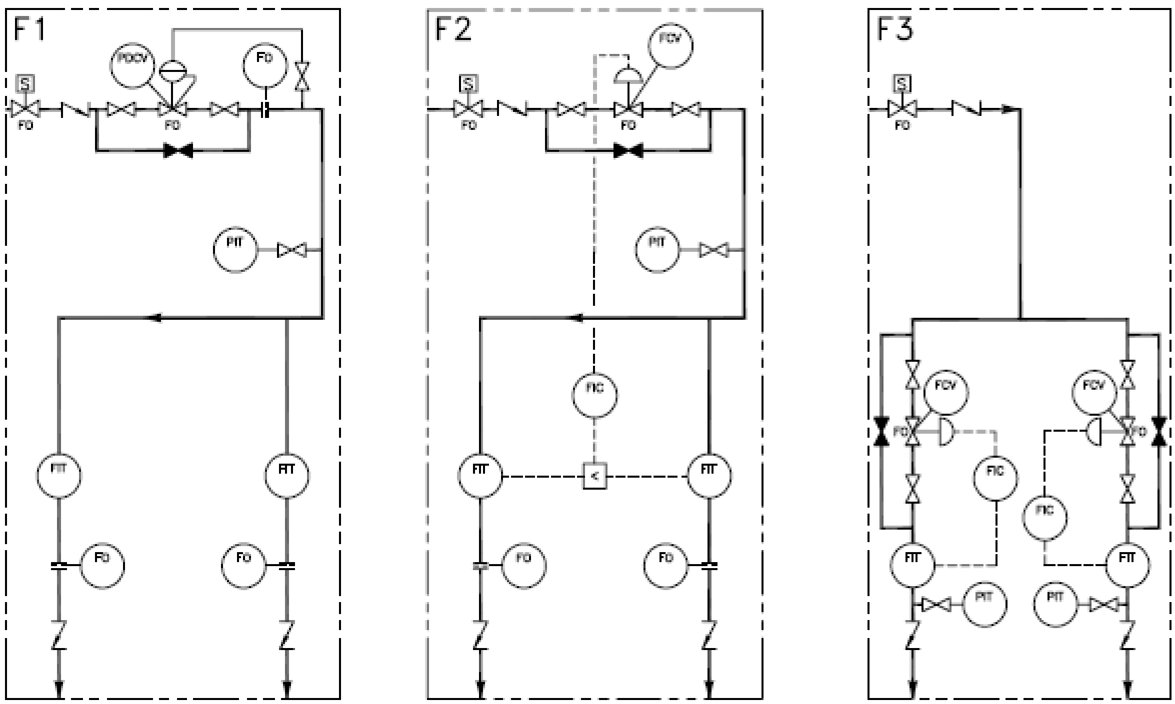
CONNECTIONS LIST
6– SECONDARY SEAL GAS SUPPLY.

MODULES DESCRIPTIONS
C– FILTERS.
E– COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.
F– FLOW CONTROL BY ORIFICE. OPTIONAL MODULES MAY BE F1, F2 AND F3.

Figure B.~~3~~4—Tandem Seal—Secondary Seal Gas Supply

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Added Check
- Added solenoid to F1, F2, F3



MODULES DESCRIPTIONS

F1– FLOW CONTROL FOR FLUCTUATING PRIMARY VENT PRESSURE.
F2– LOW SELECT FLOW CONTROL.
F3– INDIVIDUAL FLOW CONTROL.

Figure B.45—Tandem Seal—Secondary Seal Gas Optional Modules

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Mod J is moved Upstream of others
- Changed PCV to control valve

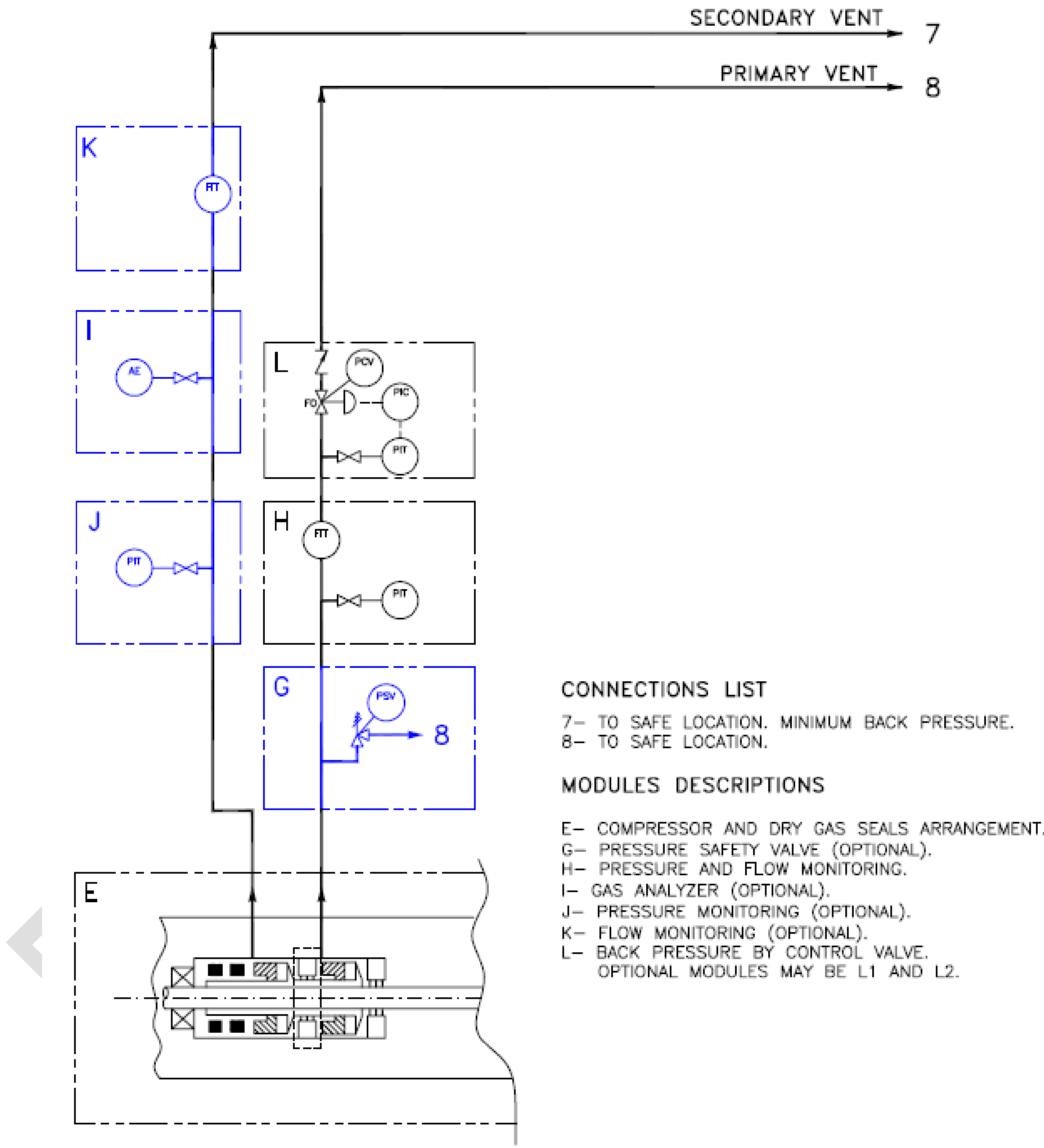
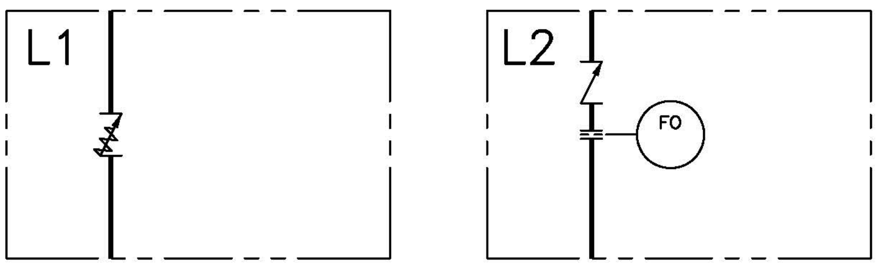


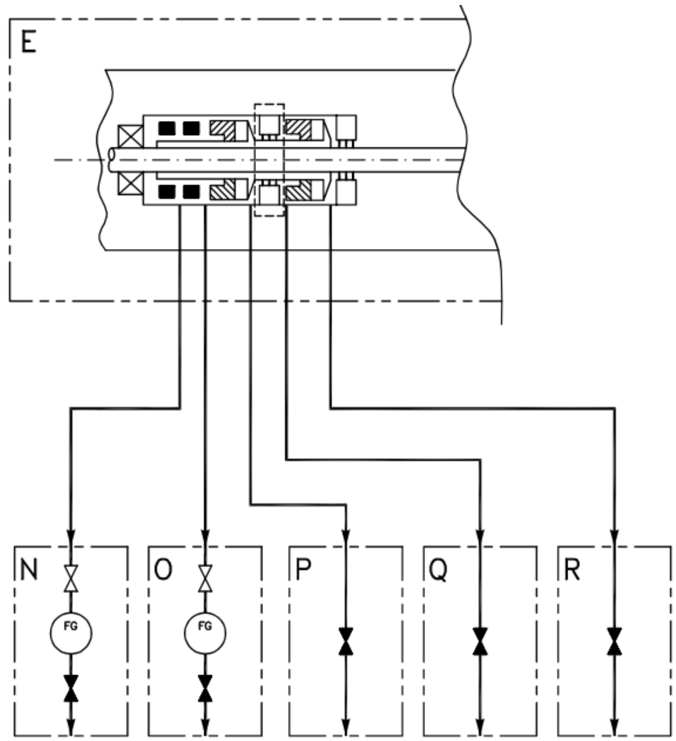
Figure B.56—Tandem Seal—Vents



MODULES DESCRIPTIONS

L1– BACK PRESSURE BY SPRING LOADED CHECK VALVE.
L2– BACK PRESSURE BY ORIFICE.

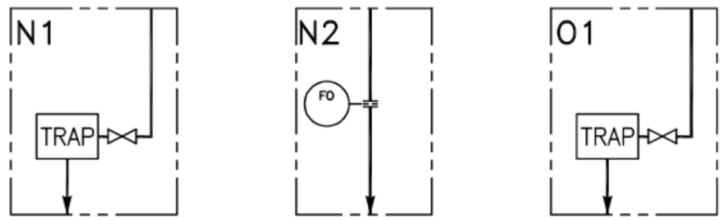
Figure B.~~6~~7—Tandem Seal—Vent Options



MODULES DESCRIPTIONS

E— COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.
N— SEPARATION GAS CAVITY DRAIN. OPTIONAL MODULES MAY BE N1 AND N2.
O— SECONDARY VENT CAVITY DRAIN. OPTIONAL MODULE MAY BE O1.
P— SECONDARY SEAL GAS CAVITY DRAIN.
Q— PRIMARY VENT CAVITY DRAIN.
R— SEAL GAS CAVITY DRAIN.

Figure B.~~7~~8—Tandem Seal—Drains



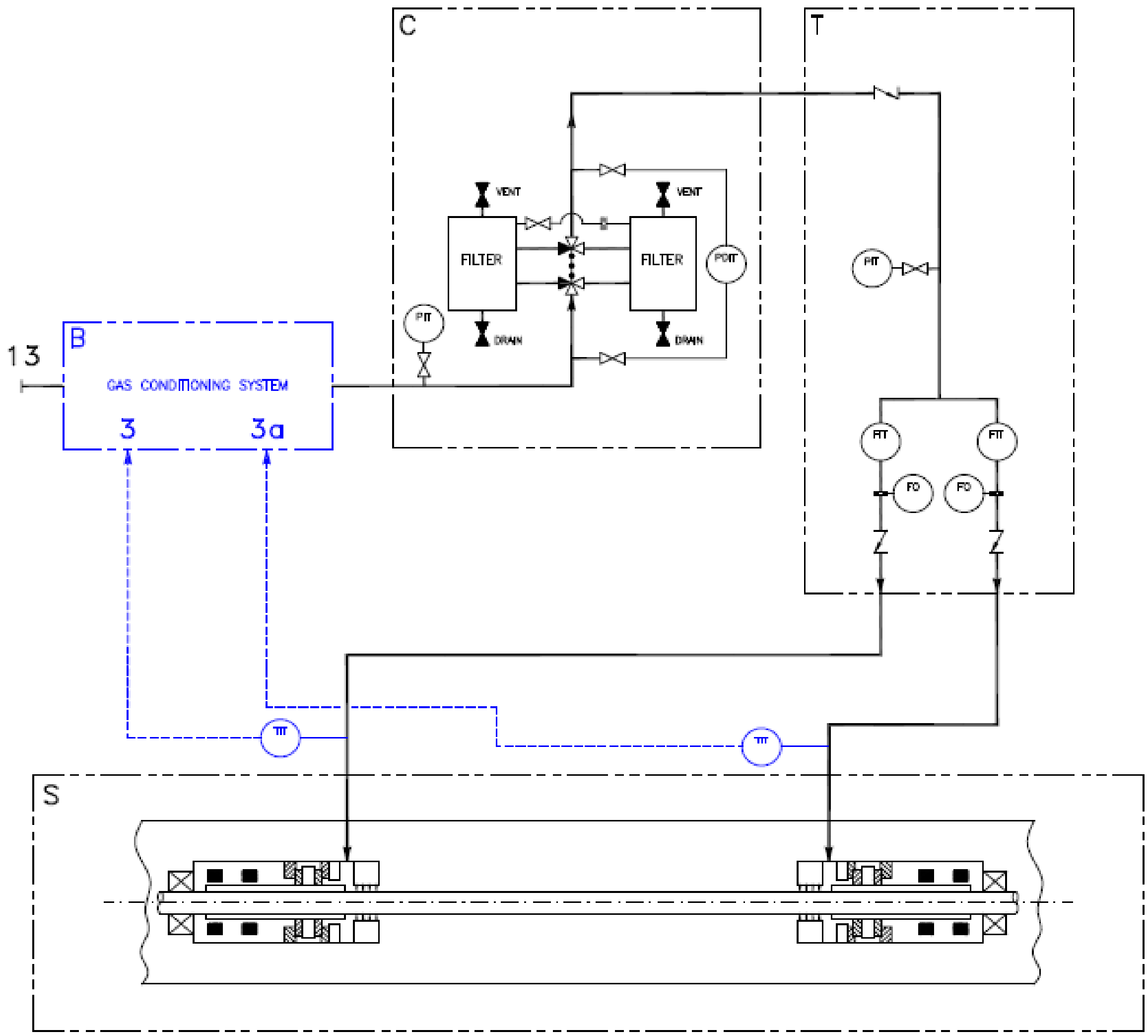
MODULES DESCRIPTIONS

N1— SEPARATION GAS CAVITY DRAIN BY TRAP.
N2— SEPARATION GAS CAVITY CONTINUOUS DRAIN BY ORIFICE.
O1— SECONDARY VENT CAVITY DRAIN BY TRAP.

Figure B.~~8~~9—Tandem Seal—Drain Options

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Changed to TIT, Made Blue and moved outside box.
- Removed Check in Mod C and added to Mod T



CONNECTIONS LIST

3– BUFFER GAS SUPPLY TEMPERATURE
3a–BUFFER GAS SUPPLY TEMPERATURE
13– BUFFER GAS SUPPLY.

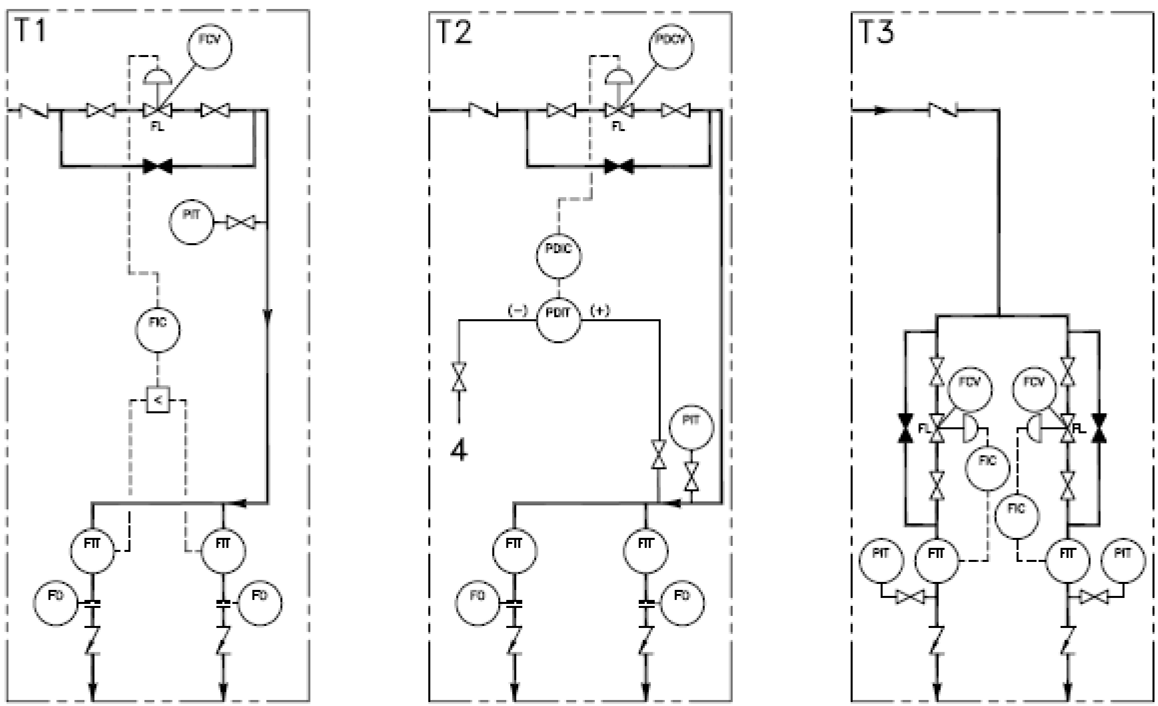
MODULES DESCRIPTIONS

B– GAS CONDITIONING SYSTEM (OPTIONAL)
C– FILTERS.
S– COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.
T– FLOW CONTROL BY ORIFICE. OPTIONAL MODULES MAY BE T1, T2 AND T3.

Figure B.~~9~~10—Double Seal—Buffer Gas Supply

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Added check valve to T1, T2, T3 that was moved from Mod C



CONNECTIONS LIST

4— SEAL REFERENCE PRESSURE.

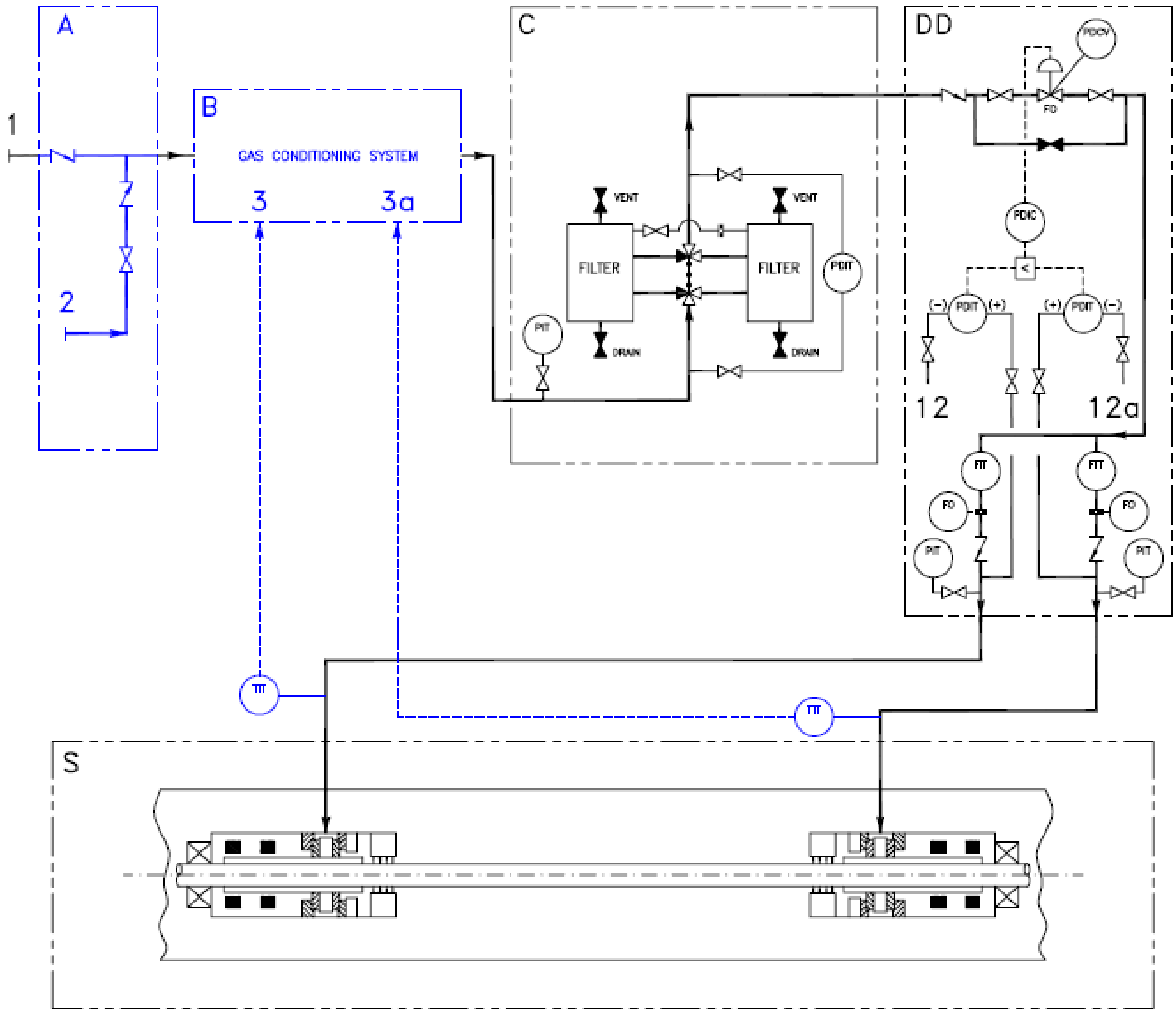
MODULES DESCRIPTIONS

T1— FLOW CONTROL BY FLOW MEASUREMENT.
T2— DIFFERENTIAL PRESSURE CONTROL.
T3— FLOW CONTROL FOR UNBALANCED COMPRESSOR ENDS.

Figure B.~~10~~11—Double Seal—Buffer Gas Supply Options

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Changed to TIT
- Removed Check in Mod C and added to DD



CONNECTIONS LIST

1– SEAL GAS SUPPLY.
2– ALTERNATE SEAL GAS SUPPLY.
3– SEAL GAS SUPPLY TEMPERATURE.
3a–SEAL GAS SUPPLY TEMPERATURE.
12– DRIVE END: HIGHER BETWEEN MAX SEALING PRESSURE AND VENT (TO SEAL BUFFER GAS INJECTION IF PRESENT).
12a–NON-DRIVE END: HIGHER BETWEEN MAX SEALING PRESSURE AND VENT (TO SEAL BUFFER GAS INJECTION IF PRESENT).

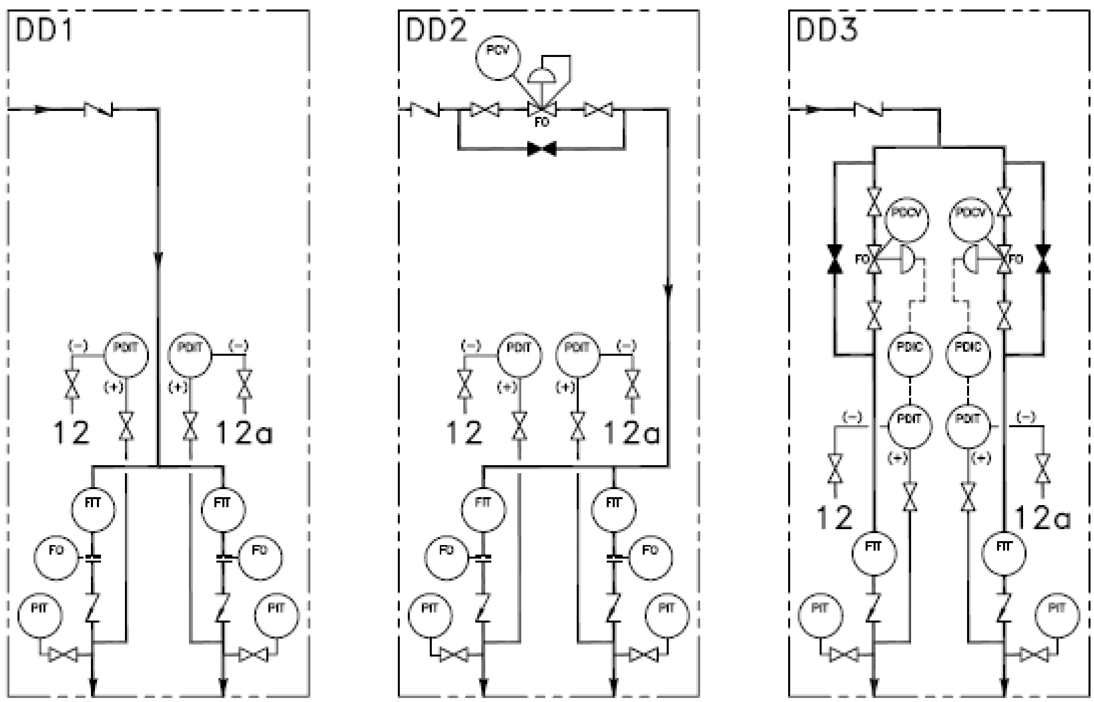
MODULES DESCRIPTIONS

A– ALTERNATE SEAL GAS (OPTIONAL).
B– GAS CONDITIONING SYSTEM (OPTIONAL).
C– FILTERS.
DD–DIFFERENTIAL PRESSURE CONTROL. OPTIONAL MODULES MAY BE DD1, DD2, DD3.
S– COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.

Figure B.~~11~~12—Double Seal—Seal Gas Supply

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Added check valve to DD1, DD2, DD3 that was removed from Mod C



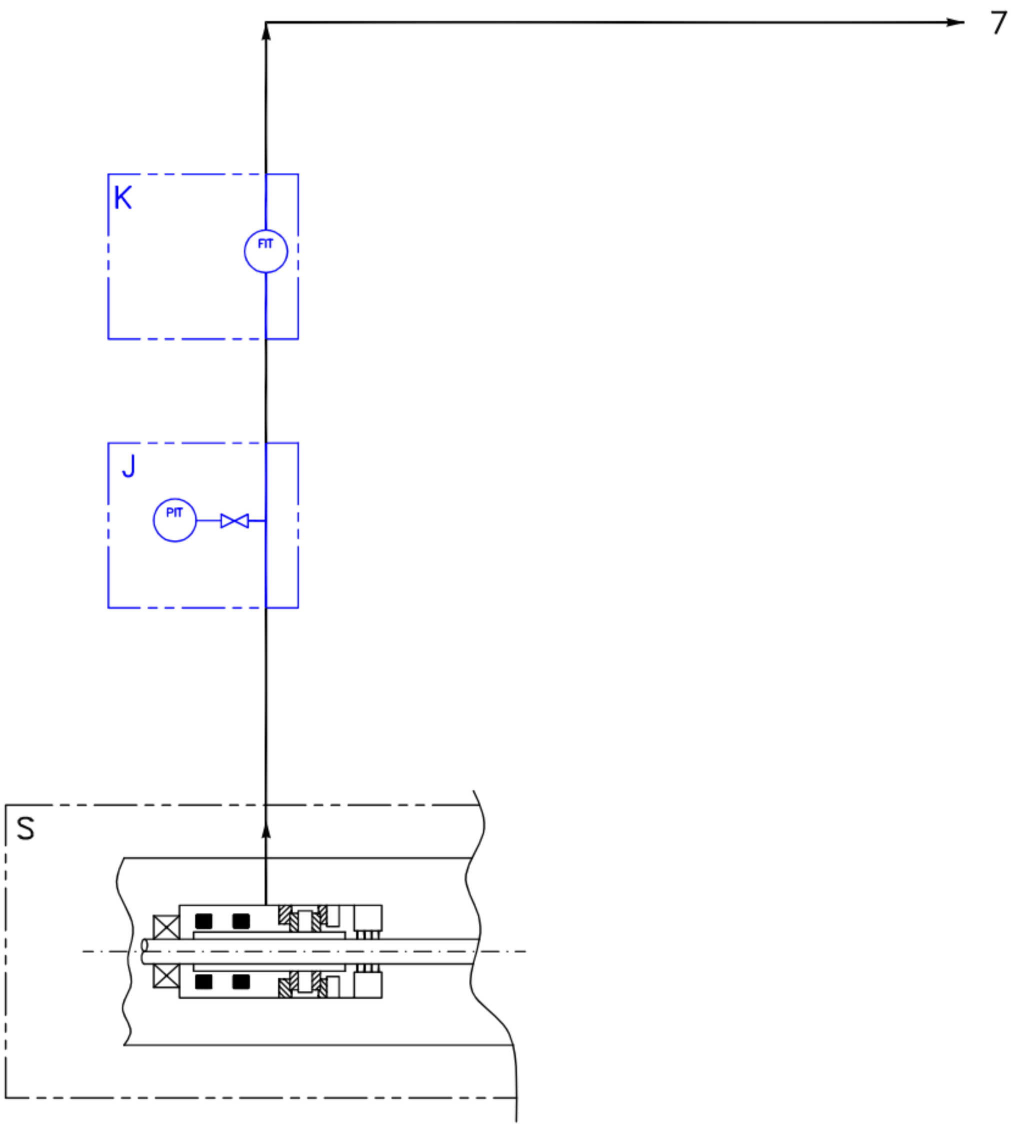
CONNECTIONS LIST

12– DRIVE END: HIGHER BETWEEN MAX SEALING PRESSURE AND VENT (TO SEAL BUFFER GAS INJECTION IF PRESENT).
12a–NON-DRIVE END: HIGHER BETWEEN MAX SEALING PRESSURE AND VENT (TO SEAL BUFFER GAS INJECTION IF PRESENT).

MODULES DESCRIPTIONS

DD1– UNREGULATED SUPPLY.
DD2– PRESSURE CONTROL.
DD3– INDIVIDUAL DIFFERENTIAL PRESSURE CONTROL FOR UNBALANCED COMPRESSOR ENDS.

Figure B.~~12~~13—Double Seal—Seal Gas Supply Options



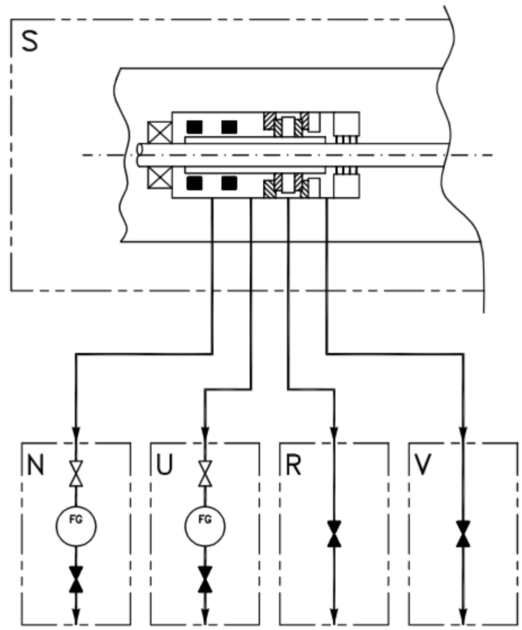
CONNECTIONS LIST

7— TO SAFE LOCATION. MINIMUM BACK PRESSURE.

MODULES DESCRIPTIONS

J— PRESSURE MONITORING (OPTIONAL).
K— FLOW MONITORING (OPTIONAL).
S— COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.

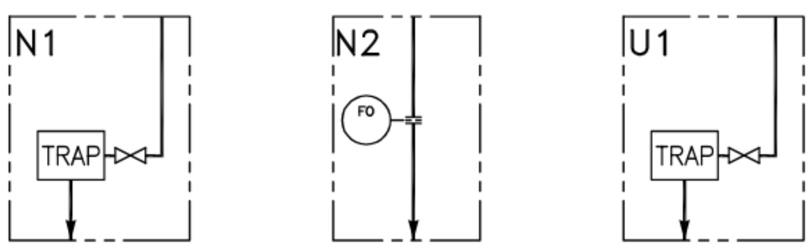
Figure B.~~13~~14—Double Seal—Vent



MODULES DESCRIPTIONS

N– SEPARATION GAS CAVITY DRAIN. OPTIONAL MODULES MAY BE N1 AND N2.
R– SEAL GAS CAVITY DRAIN.
S– COMPRESSOR AND DRY GAS SEALS ARRANGEMENT.
U– VENT CAVITY DRAIN. OPTIONAL MODULE MAY BE U1.
V– BUFFER GAS CAVITY DRAIN.

Figure B.~~14~~15—Double Seal—Drains



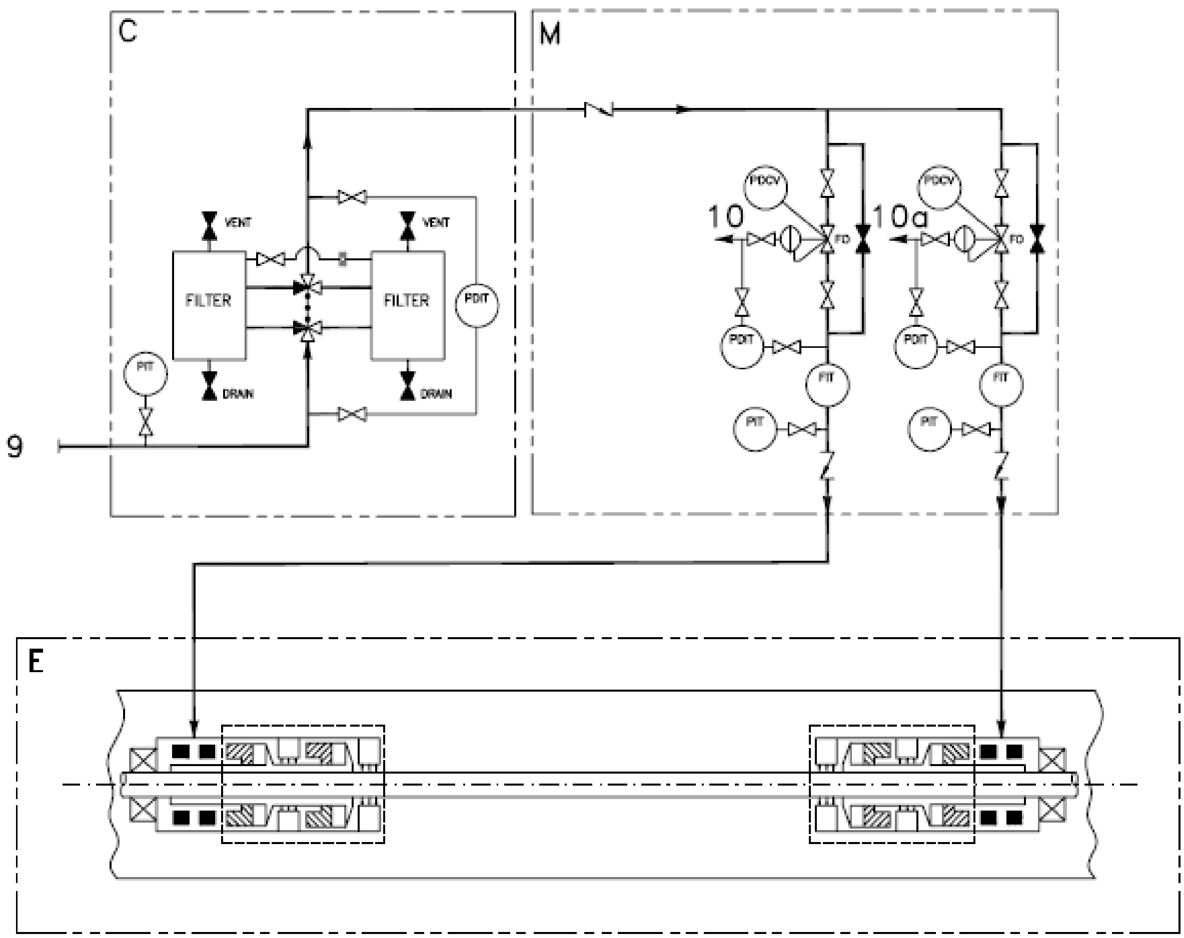
MODULES DESCRIPTIONS

N1– SEPARATION GAS CAVITY DRAIN BY TRAP.
N2– SEPARATION GAS CAVITY CONTINUOUS DRAIN BY ORIFICE.
U1– VENT CAVITY DRAIN BY TRAP.

Figure B.~~15~~16—Double Seal—Drain Options

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Replaced M with M3 and renamed M3 to M as new default
- Moved Check from C to M3
- Added Connections 10 and 10a
- Updated name M in legend



CONNECTIONS LIST

9– SEPARATION GAS SUPPLY.
10– DRIVE END: TO SECONDARY VENT LINE FOR TANDEM SEALS OR TO VENT LINE FOR SINGLE AND DOUBLE SEALS.
10a– NON–DRIVE END: TO SECONDARY VENT LINE FOR TANDEM SEALS OR TO VENT LINE FOR SINGLE AND DOUBLE SEALS.

MODULES DESCRIPTIONS

C– FILTERS.
E– COMPRESSOR AND DRY GAS SEAL ARRANGEMENT.
M– INDIVIDUAL DIFFERENTIAL PRESSURE CONTROL. OPTIONAL MODULES MAY BE M1 AND M2.

Figure B.~~16~~17—Separation Gas Supply

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Deleted Mod 2
- Renamed Mods to Mod1 and Mod 2
- Add Check to M1 and M2

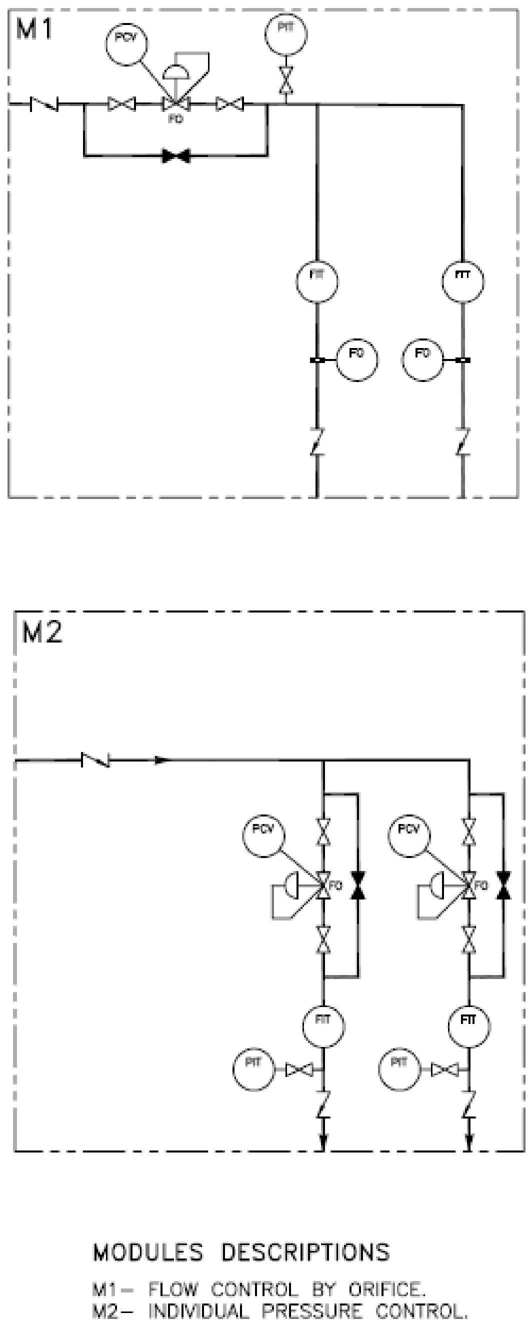
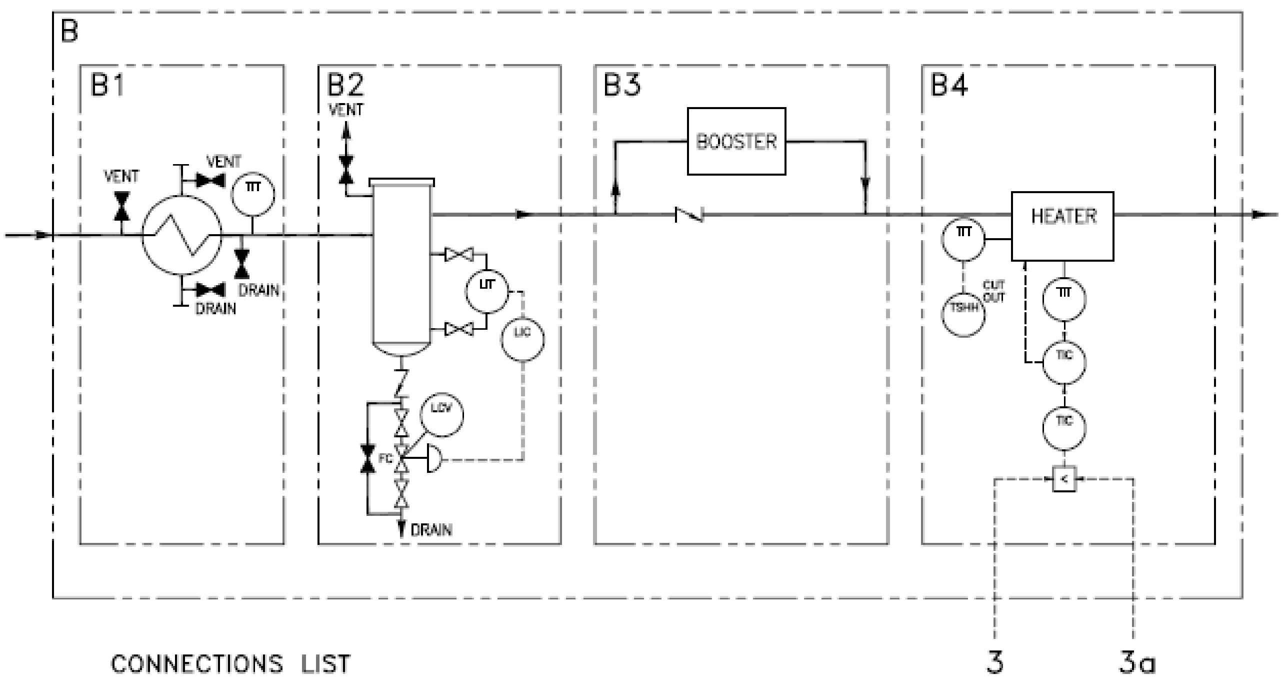


Figure B.~~17~~18—Separation Gas Supply Options

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Added check to B2
- Changed to TIT
- Moved booster to above the main supply line



CONNECTIONS LIST

3— SEAL GAS OR BUFFER GAS SUPPLY TEMPERATURE.
3a— SEAL GAS OR BUFFER GAS SUPPLY TEMPERATURE.

MODULES DESCRIPTIONS

B1— COOLER.
B2— SEPARATOR WITH AUTOMATIC DRAIN. OPTIONAL MODULES MAY BE B21 AND B22.
B3— BOOSTER.
B4— HEATER.

Figure B.~~18~~19—Gas Conditioning System

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- Added Check to B21
- Moved separator inlet line to above the LIT

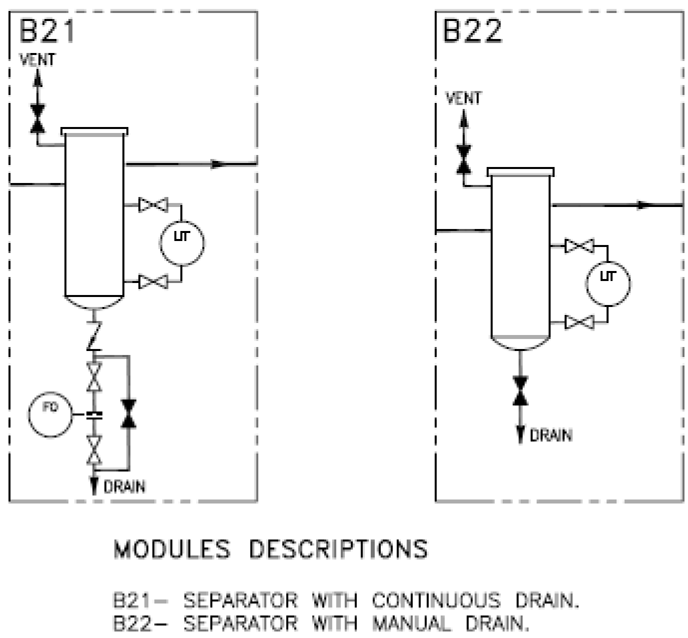
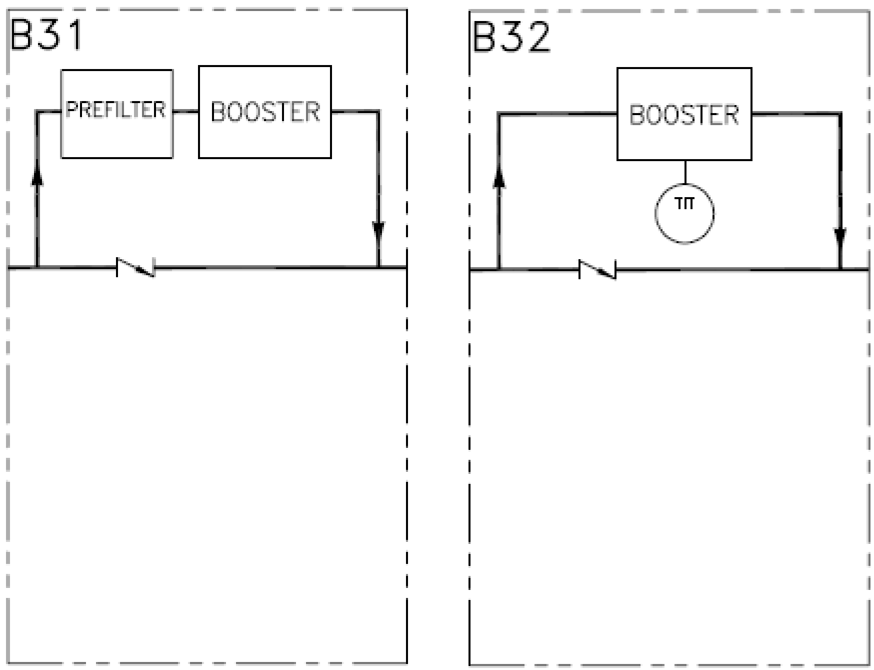


Figure B.~~19~~20—Gas Conditioning System—Separator Drain Options

The following changes were made to the diagrams, this test box is for the ballot only and will be deleted prior to publication

- New drawing for booster options



MODULES DESCRIPTIONS

B31– RECIPROCATING BOOSTER.
B32– ROTARY BOOSTER.

Figure B.~~20~~21—Gas Conditioning System—Booster Options

Annex C
(informative)

Inspector's Checklist

Table C.1—Inspector's Checklist

Item	API 692		Date Inspected	Inspected By	Status
	Section	Part			
6 DESIGN					
Datasheet for dry gas seal support system complete	6.1	3			
Maximum dimensions and special layout requirements specified	6.1.1	3			
Allowable temperatures of the system specified	6.1.2	3			
MAWP specified	6.1.3	3			
Seal gas conditions specified	6.1.4	3			
Secondary seal gas conditions specified	6.1.5	3			
Buffer gas conditions specified	6.1.6	3			
Separation seal gas conditions specified	6.1.7	3			
Vent system pressure ranges specified	6.1.8	3			
All connections flanged and supported at panel or skid edge	6.1.11	3			
Each utility service manifolded to single connection point	6.1.11.2	3			
Components and method of isolation specified	6.1.12	3			
Components in accordance with applicable design codes	6.1.13	3			
No socket welded connections	6.1.15	3			
Adequate clearance for operation and maintenance	6.2.1	3			
Vent study provided, if specified	6.2.7	1			
Supporting calculations for gas velocity compliance	6.6.1.1	1			
Low point drains	6.7.1	1			
Cavity drains	6.7.2	1			
7 SPECIAL TOOLS					
Demonstrated use of special tools	7.3	1			
Packaging of special tools	7.4	1			
Marking or tagging of special tools	7.5	1			
8 COATINGS, INSULATION, AND HEAT TRACING					
Minimum of 50 mm (2 in.) clearance around insulated lines and components	8.4	1			
9.1 PIPING AND TUBING SYSTEMS—GENERAL					
Flanged connection bolt holes straddle horizontal and vertical centerlines	9.1.2.1	3			

System construction of piping or tubing as specified	9.1.7	3			
Minimum equipment and piping connection of DN 20 (NPS $^3/_4$)	9.1.8	3			
9.3 PIPING AND TUBING SYSTEMS—VALVES					
Piping valves are flanged	9.3.1	3			
Ball valve handles have locking provisions	9.3.8.5	3			
9.8 PREPARATION FOR SHIPMENT					
Duplicate packing lists inside and out for crated equipment	9.8.5	1			
Spare parts preserved and packaged	9.8.6	1			
9.9 PACKAGE MARKINGS					
Permanent labelling on two opposite sides of shipping box or container	9.9.2	1			
Industry standard cautionary symbol markings	9.9.3	1			
Package markings	9.9.4	1			
10.3.5 INSTALLATION, OPERATION, MAINTENANCE, AND TECHNICAL MANUALS					
Manual containing all required operating and maintenance instructions	10.3.5.3.1	1			
Technical data manual	10.3.5.4	1			
11.3 INSTRUMENTATION					
Pressure gauges are liquid-filled or dampened movement design	11.3.9.4	3			
Pressure gauge dial sizes 100 mm (4 in.) minimum	11.3.9.5.2	3			
Pressure gauge printing is black on white background	11.3.9.5.2	3			
13 DRY GAS SEAL SUPPORT SYSTEM INSPECTION AND TESTING					
Nondestructive examination of lifting lug welds	13.2.6.5	3			
Hydrostatic testing	13.3.2	3			
Operational testing	13.3.3	3			
Nameplates	13.4	3			
13.5 PREPARATION FOR SHIPMENT					
Non-machined exterior surfaces are painted	13.5.1	3			
Machined exterior surfaces coated with rust preventative	13.5.2	3			
Flanged openings have stainless steel closures	13.5.3	3			
Lifting points are clearly identified	13.5.5	3			
Each filter tagged to identify clean elements installed	13.5.7	3			

Annex D
(informative)

Module Comparison

Seal Gas Supply Module Comparison—Tandem					
Module Designator	DT	DT1	DT2	DT3	DT4
Module Description	Flow control by flow measurement	Differential pressure control	Flow control for steady seal gas supply conditions	Flow control for unbalanced compressor ends	Differential pressure control for primary vent pressure higher than suction pressure
Gas Consumption	M	M	H	L	M
Field Adjustability	M	M	L	H	M
General Application	— For suction pressure higher than flare pressure — For balanced DE and NDE sealing pressure applications		— For suction pressure higher than flare pressure but not recommended for high pressure ratios — For balanced DE and NDE sealing pressure applications — The system should have a suitable constant seal gas supply source — Good for steady state operation	— For suction pressure higher than flare pressure — For balanced and unbalanced DE and NDE sealing pressure applications — Good for steady and variable operating conditions	— Suitable for low and variable suction pressure (could be lower than primary vent) — For balanced DE and NDE sealing pressure applications

Secondary Seal Gas Supply Module Comparison—Tandem				
Module Designator	F	F1	F2	F3
Module Description	Flow control by orifice	Flow control for fluctuating primary vent pressure	Low select flow control	Individual flow control
Gas Consumption	H	M	M	L
Field Adjustability	L	M	M	H
General Application	— Low flare pressure — Low variation of flare pressure	— Better control with varying vent pressure	— More precise control with varying vent pressure	— Best volumetric control of supply to individual seal — Best flow control for variable primary vent conditions

Seal Gas Supply Module Comparison—Double				
Module Designator	DD	DD1	DD2	DD3
Module Description	Differential pressure control	Unregulated supply	Pressure control	Individual differential pressure control for unbalanced compressor ends
Gas Consumption	M	H	M	L
Field Adjustability	H	L	L	H
General Application	— Use when there is a large variation in sealing pressure (i.e. dynamic to static) — Supports unbalanced sealing pressures	— Use when there is a minimum seal gas supply pressure 50 psi (3.4 bar) higher than max sealing pressure — Use when there is a stable seal gas pressure	— Use when there is a minimum seal gas supply pressure 50 psi (3.4 bar) higher than max sealing pressure — Use when there is a stable seal gas pressure — Low seal gas consumption when seal gas supply pressure is high — High fluctuation of seal gas supply pressure	— Used for unbalanced sealing pressures to optimize seal gas consumption

Buffer Gas Supply Module Comparison—Double				
Module Designator	T	T1	T2	T3
Module Description	Flow control by orifice	Flow control by flow measurement	Differential pressure control	Flow control for unbalanced compressor ends
Gas Consumption	H	M	M	L
Field Adjustability	L	M	M	H
General Application	— Use when there is low risk of process contamination affecting seal performance — Use in balanced sealing pressure applications — Use when there is low differential to suction — Use when source pressure is lower than seal gas supply pressure	— Maintains minimum velocity requirements — Compensates for variable process pressures	— Use on non-contacting, labyrinth, or contacting seal design	— Use when there is limited buffer gas supply — Use when process contamination should be minimal

Separation Seal Supply Module Comparison—Tandem and Double				
Module Designator	M	M1	~~M2~~	M2 ~~3~~
Module Description	Individual differential pressure control ~~Flow control by orifice~~	Flow control by orificel ~~Individual pressure control~~	~~Differential pressure control~~	Individual ~~differential~~ pressure control
Gas Consumption	~~M~~ L	~~L~~ M	~~M~~	L
Field Adjustability	~~L~~ H	~~H~~ L	~~M~~	~~H~~ M
General Application	— Use on non-contacting/ labyrinth, or contacting seal design ~~as flow control with orifices~~ — Allows extra protection for seal where secondary vent could become pressurized	— Use on non-contacting/ labyrinth seal design as flow control with orifices — Use on contacting seal design as differential pressure control with orifices	~~— Use on non-contacting/ labyrinth, or contacting seal design~~ ~~— Allows extra protection for seal where secondary vent could become pressurized~~	~~—~~ Use primarily on contacting seal ~~Use on non-contacting/ labyrinth, or contacting seal design~~ — ~~Allows extra protection for seal where secondary vent could become pressurized~~

Annex E
(normative)

Vendor Drawing and Data Requirements (VDDR)

DRY GAS SEAL SUPPORT SYSTEM VENDOR DRAWING AND DATA REQUIREMENTS		
	Job No.	Item No.
	Purchase Order No.	Date
	Requisition No.	Date
	Inquiry No.	Date
	Revision ……….. by	Manufacturer
	For	Unit
	Site	Service

Proposal [a]—Bidder shall furnish number of paper copies/number of electronic copies of data as indicated
Review—Vendor shall furnish number of paper copies/number of electronic copies of data as indicated
Final—Vendor shall furnish number of paper copies/number of electronic copies of data as indicated

	Proposal	Review	Final	**Description** (see text)	Distribution record: Review due from vendor [b c]	Review received from vendor	Review returned to vendor	Final due from vendor [c]	Final received from vendor
	/	/	/	1. Dry gas seal support system datasheet					
	/	/	/	2. Piping and instrument diagram and connection list					
	/	/	/	3. General arrangement drawing and component bill of material					
	/	/	/	4. Production delivery schedule and progress reports					
	/	/	/	5. Electrical schematic, terminal box layout, and connection list					
	/	/	/	6. Component and Instrument datasheets					
	/	/	/	7. Weld plan					
	/	/	/	8. Certified dimensional outline drawing					
	/	/	/	9. Utility list					

	/	/	/	10. Testing procedure(s)					

[a] Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such.
[b] Purchase may indicate in the column the desired time frame for submission of data.
[c] Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with the proposal.

DRY GAS SEAL SUPPORT SYSTEM VENDOR DRAWING AND DATA REQUIREMENTS

Job No.	Item No. ....
Purchase Order No.	Date ....
Requisition No.	Date ....
Inquiry No.	Date ....
Revision ……….. by	Manufacturer ....
For	Unit ....
Site	Service ....

Proposal [a]—Bidder shall furnish number of paper copies/number of electronic copies of data as indicated
Review—Vendor shall furnish number of paper copies/number of electronic copies of data as indicated
Final—Vendor shall furnish number of paper copies/number of electronic copies of data as indicated

				Description (see text)	**Distribution record**				
					Review due from vendor [b c]	Review received from vendor	Review returned to vendor	Final due from vendor [c]	Final received from vendor
	/	/	/	11. List of recommended spare parts					
	/	/	/	12. List of recommended special tools					
	/	/	/	13. List of recommended lubricants					
	/	/	/	14. Installation manual					
	/	/	/	15. Operating and maintenance manual					

	/	/	/	16. Manufacturer data report					
	/	/	/						
	/	/	/						
	/	/	/						
	/	/	/						

[a] Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such.
[b] Purchase may indicate in the column the desired time frame for submission of data.
[c] Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with the proposal.

DRY GAS SEAL SUPPORT SYSTEM VENDOR DRAWING AND DATA REQUIREMENTS	Job No.	Item No. ....
	Purchase order No.	Date ....
	Requisition No.	Date ....
	Inquiry No.	Date ....
	Revision ……….. by	Manufacturer ....
	For	Unit ....
	Site	Service ....

Notes:

1. Where necessary to meet the scheduled shipping date, the vendor shall proceed with manufacture upon receipt of the order and without awaiting the purchaser’s approval of drawings.

2. The vendor shall send all drawings and data to the following:

____

____

____

3. All drawings and data shall show project, purchase order, and item numbers as well as plant location and unit. One set of the drawings and instructions necessary for field installation, in addition to the copies specified above, shall be forwarded with shipment.

4. See the descriptions of required items that follow.

5. All of the information indicated on the distribution schedule shall be received before final payment is made.

6. If typical drawings, schematics, and bills of material are used for proposals, they shall be marked up to show the expected weight and dimensions to reflect the actual equipment and scope proposed.

Nomenclature:
S—number of weeks before shipment.
F—number of weeks after firm order.
D—number of weeks after receipt of approved drawings.

Vendor____

Date________________ Vendor Reference ______________________________

Signature____
(Signature acknowledges receipt of all instructions)

DESCRIPTION

1) “For purchase” dry gas seal system datasheet completed for “proposal” and “as-built”.
2) Piping and instrument diagram, including the following:
   a) The size and rating of all customer connections.
   b) Flows, temperatures and pressures at each connection.
   c) Pipe, valve, and orifice sizes.
   d) Instrumentation, safety devices, and control schemes.
   e) Control, alarm, and shutdown settings for pressure, flow, or temperature.
   f) Utility requirements.
   g) Filtration requirements.
3) General arrangement drawing and component bill of material.
4) The vendor shall provide production delivery schedule and progress reports.
5) Electrical schematic, terminal box layout, and list of connections.
6) Dry gas seal system component datasheets, including the following:
   a) Filters.
   b) Control valves.
   c) Instrumentation.
7) Weld plan.
   a) Weld procedures.
   b) Weld map.
8) Certified dimensional outline drawing and list of connections, including the following:
   a) The size, rating, and dimensional location of all customer connections.
   b) Approximate overall and handling weights.
   c) Overall dimensions and maintenance and dismantling clearances.
   d) Dimensions of baseplate (if furnished) for train or skid mounted package, complete with diameters, number and locations of bolt holes, and thicknesses of sections through which the bolts must pass.
   e) Grounding details.
   f) Center of gravity and lifting points.
   g) Winterization, tropicalization, and/or noise attenuation details, when required.
   h) Sketches to show lifting of assembled package and major components.

9) A complete list of utility requirements: quantity, filtration, and supply pressure of the following.
   a) Gas.
   b) Air.
   c) Electricity.
   d) Water.
   e) Steam.
10) The vendor shall submit detailed procedures, including acceptance criteria for the mechanical running test and all optional tests, at least 6 weeks before the first running test.
   a) Pressure test.
   b) Leak test.
   c) Functional test.
   d) Cleanliness
11) List of spare parts recommended for start-up, normal maintenance purposes, and special tools furnished for maintenance.
12) All information required for the proper installation of the equipment shall be compiled in a manual that must be issued no later than the time of final certified drawings.
   a) The vendor shall provide the purchaser with instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up.
   b) A description of any special weather protection required for start-up, operation, and period of idleness under the site conditions specified on the datasheets.
13) A manual containing all required operating and maintenance instructions shall be supplied not later than 2 weeks after all specified test shall have been successfully completed.
   a) Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment, including any unacceptable speeds due to natural frequencies.
   b) Component drawings and bills of materials
   c) Drawings, details, and descriptions of the operations of instrumentation and controls as well as the make, materials, and type of auxiliary equipment. The vendor shall also include a complete description of the alarm and shutdown facilities to be provided.
14) The vendor shall provide a "Manufacturer Data Report" within 30 days of completion of shop testing, including the following:
   a) Necessary certification of materials.
   b) Pressure Vessel Manufacturer Reports.
   c) Instrumentation Manufacturer Calibration Certificates.
   d) Purchase specification for all items on the bill of materials.
   e) Test data to verify requirements of specifications have been met.

f) Results of quality test and inspections.

g) Functional test data log.

The vendor is also required to keep this data available for examination by the purchaser upon request, for at least 20 years.

Annex F
(informative)

Gas Filter Rating, Testing, and Performance

F.1 Scope

This annex provides information on coalescing gas filter performance, rating, and testing. This information identifies various industry standards, background, and associated considerations for comparison and evaluation of filters to be used in gas seal systems.

F.2 Purpose

The purpose of a coalescing filter is to remove fine particles and liquid-phase contaminants. Debris and small particles can cause excessive wear of the sealing surfaces and silt up seal components. Residual liquids and aerosols can cause damage to seal faces.

Unlike lube oil filters, gas coalescing filters are not part of a recycling or multi-pass system; therefore, the filter element Beta Ratio ratings or particle-removal efficiencies are identified and determined by single-pass basis testing. Multi-pass test methods commonly used in liquid filter testing, such as covered in ISO 16889, are not adequate for gas coalescing filter element testing and rating.

Filters should retain contaminants, not fail nor plug during operation or transient conditions including pulsating gas pressures. For this reason, it is necessary for filter elements to withstand high differential pressures. Part 3 of this standard defines the minimum required burst differential pressure rating of at least 5 bar (75 psi).

Coalescing filter elements are disposable (non-cleanable) and should be replaced when fouled.

F.3 Gas Supplies

Gas supplies can vary considerably throughout the range of operating conditions and sources. Gas filtration for dry gas seals cannot be properly selected and evaluated unless the characteristics of the gas supplies are known for all operating conditions. Gas supplies can vary from dry, inert gas with dew points below −7 °C (20 °F) to complex hydrocarbon mixtures at their dew points with droplets or aerosols of hydrocarbon liquids in phase equilibrium.

F.4 Particle Size and Seal Clearances

In order to provide protection for equipment, it is necessary that the filter be able to remove particles that are smaller in size than the range of the operating clearances of the seal components. For some insight into particle sizes and operating clearances, Tables F.1 and F.2 are provided.

Table F.1—Relative Size Comparison of Particles of Some Common Materials

Particle size μm	Comparison
159	100 mesh screen opening
100	Table salt
74	200 mesh screen opening
60	Pollen
30–40	Lower limit of human vision
37	400 mesh screen opening
10	Typical lube oil filtration particle size
1.0–5.0	Atmospheric dust particle
1.0	Cement dust particle
0.5	Tobacco smoke particle
0.1–2	Bacteria

Table F.2—Typical Seal Operating Clearances

Component	Clearance μm
Dry gas seal face separation lifted (running) condition	3–5
Non-contacting separation seal	10–20

F.5 Filter Specifications—Beta Ratio

The Beta Ratio is expressed as $\beta_x \geq y$, where x is the filter element particle size rating, expressed in micrometers, and y is the ratio of particles x μm equal to or larger entering a filter; divided by the number of particles x μm equal to or larger exiting or passing through a filter.

API 614, Fifth Edition, Part 4 specified a Beta Ratio rating of $\beta_4 \geq 85$ (4 μm spherical particle size with 98.8 % removal efficiency), which can allow damaging materials to enter the seal. Part 3 of this standard modified the specification to $\beta_1 \geq 1000$ (1 μm spherical particle size with 99.9 % removal efficiency) for seal gas and separation gas for contacting separation seals. A rating of $\beta_{10} \geq 1000$ (10 μm spherical particle size with 99.9 % removal efficiency) is specified for buffer gas and non-contacting separation seals.

The terms "*nominal*" and "*absolute*" are often used to define a level of particle removal efficiency or element effectiveness. However, there can be significant performance variations between different filters rated as 10 μm "*absolute*." It is more precise to rate filter elements using Beta Ratio (β) for a given particle size.

Particle-removal efficiency, E_{PR}, expressed in percent, for a filter with a known Beta Ratio rating, can be determined from Equation (F.1):

$$E_{\text{PR}} = \left[1 - \left(1/y\right)\right] \times 100 \tag{F.1}$$

For the example, where $\beta_1 \geq 1000$ and $y \geq 1000$ for particles 1 µm and larger, the minimum E_{PR} is calculated as

$$E_{\mathrm{PR}}(1\ \mu\mathrm{m}) = \left[1 - \left(\frac{1}{1000}\right)\right] \times 100$$

$$E_{\mathrm{PR}}(1\ \mu\mathrm{m}) = 99.9\ \%$$

A curve of the Beta Ratio plotted against the micron size can usually be provided. Some filter elements can have a very wide band of performance and others can have a narrow band due to construction features.

Table F.3 shows a comparison of Beta Ratios and corresponding efficiencies along with associated downstream particle counts (particles that have passed through the filter element).

Table F.3—Element Beta Ratio and Efficiency from Particle Count

Beta Ratio Value	Efficiency	No. of Particles Upstream	No. of Particles Downstream
4	75.00 %	100,000	25,000
10	90.00 %	100,000	10,000
75	98.67 %	100,000	1,333
100	99.00 %	100,000	1,000
200	99.50 %	100,000	500
1,000	99.90 %	100,000	100
2,000	99.95 %	100,000	50
5,000	99.98 %	100,000	20

NOTE This table is independent of particle size rating. It is simply for identifying the efficiency of a filter with a given Beta Ratio rating.

For example, for a filter element with a $\beta_1 \geq 1000$, the efficiency is 99.90 % [also determined from Equation (F.1)]. Further for every 1000 particles of 1 micron size entering into the filter, 1 would pass through.

F.6 Testing

F.6.5 Applicable Standards

Currently there are no existing industry standards specifically for the testing and rating of seal gas filters. The filter testing standards ISO 16889, ISO 4406, and SAE AS 4059E identified in the Fifth Edition of API 614 are applicable to hydraulic fluid (liquid) filtration, testing, and rating. These are not considered adequate for the testing and rating of filter elements intended for use in gas seal systems defined in this standard.

A number of industry high air quality filtration classification and testing standards exist from which various aspects can and are utilized for the testing and rating of filters used in seal gas systems. These standards fall into two categories. The first is for compressed air systems used in many industries requiring high-purity compressed air systems including the semiconductor, pharmaceutical, bio-medical, and food processing industries. The second is for ambient air pressure systems commonly used in high-quality environmental air ventilation systems and inlet air filtration systems.

Generally, the compressed air standards are considered to be more appropriate for use in the testing and rating of filters for seal gas applications.

The primary standard for comparative purposes is ISO 12500, *Filters for compressed air—Test methods*, a multi-part document that defines critical filter performance parameters such as coalescing effectiveness, oil vapor removal, and liquid and solid particulate removal.

F.6.6 Particulate Filtration Testing

The purchaser can require Beta Ratio performance type test documentation per ISO 12500-3 to verify $\beta_1 \geq 1000$ compliance.

ISO 12500-3, *Filters for compressed air—Test methods—Part 3: Particulates*, provides appropriate test and measurement methods for determining the solid particulate removal efficiency ratings by particle size.

The testing methods are performed as "type-tests" and are representative of a range of particle sizes. Two particle diameter size ranges are identified in the standard, for dry gas seal applications. The Fine Filter Range (0.01 μm ≤ particle size ≤ 5.0 μm) should be used.

F.6.7 Coalescing Tests

F.6.7.3 General

Coalescing performance, efficiency and pressure drop, can be quantified per ISO 12500-1 for aerosols (hydrocarbon mist) and ISO 12500-4 for water mist. Coalescing performance requirements cannot be defined because upstream aerosol and water mist conditions are indeterminate. These tests are useful for comparing filter designs and can be used to select filters with higher coalescing efficiencies and suitable pressure drops.

F.6.7.4 Aerosol Coalescing Testing

ISO 12500-1, *Filters for compressed air—Test methods—Part 1: Oil aerosols,* provides a set of testing methods to determine oil aerosol carryover in mg/m^3 (1 mg/m^3 = 0.84 ppm by weight) and saturated (or wet) pressure drop in mbar. Two inlet oil aerosol concentrations of 10 mg/m^3 and 40 mg/m^3 provide a wide aerosol challenge variance. It is possible that filter manufacturers' test results could not be available for both concentrations.

For the specific inlet aerosol concentration challenge, the testing will determine:

— oil aerosol filtration (removal) efficiency (expressed in percent % captured),

— pressure drop (Δp) across the filter,

— oil aerosol penetration (expressed as mass per unit volume (mg/m^3)].

NOTE ISO 12500-2, *Filters for compressed air—Test methods—Part 2: Oil vapours*, is not applicable because adsorption-type filters are not generally utilized in gas seal systems since they are not designed for continuous unattended operation.

F.6.7.5 Water Coalescing Testing

ISO 12500-4, *Filters for compressed air—Test methods—Part 4: Water,* provides testing methods to determine the water removal efficiency and pressure drop of a filter designed for water removal from compressed air.

Annex G
(informative)

Contract Documents and Engineering Design Data

G.1 If specified by the purchaser in 14.1.1, the contract documents and engineering design data shall be supplied by the vendor, as listed in this annex.

G.1.1 The information to be furnished by the vendor is specified in D.2 and D.3.

G.1.1.1 The vendor shall provide all documents listed in the VDDR form (Annex E).

G.1.1.2 Vendor shall complete and supply the agreed VDDR form (see Annex E for an example).

G.2 Proposals

Proposal data shall be in accordance with Annex D.2 of Part 1.

G.3 Contract Data

G.3.1 Contract data shall be in accordance with Annex D.3 of Part 1.

G.3.2 Vendor shall provide normal and maximum flows, temperatures, and pressures per the conditions defined in Part 1, Sections 6.2.1 and 6.2.2.

G.3.4 Vendor shall provide a certified test report prior to shipment of the dry gas seal support system.

G.4 Drawings

Vendor shall provide drawings showing filter, transfer valve, and filter element details.

Part 4—Installation and Commissioning

1 Scope

This part of API 692, in conjunction with API 692, Part 1, specifies the installation requirements for dry gas seals and seal systems for axial, centrifugal, expander, and rotary screw compressors as described in API 617 and API 619.

NOTE Refer to API 686 for additional information on equipment installation, installation design, and commissioning.

2 Normative References

For the purposes of this document, normative references are listed in Part 1.

3 Terms, Definitions, Acronyms, and Abbreviations

For the purposes of this document, the terms, definitions, acronyms, and abbreviations given in Part 1 apply.

4 General

The purchaser shall assume unit responsibility and shall assure that all vendors comply with the requirements of this standard and all reference documents.

5 Requirements

5.1 Standard Fasteners and Units of Measure

For the purposes of this document, standard fasteners and units of measure given in Part 1 apply.

5.2 Statutory Requirements

For the purposes of this document, statutory requirements given in Part 1 apply.

5.3 Alternative Designs

For the purposes of this document, alternative design requirements given in Part 1 apply.

5.4 Documentation Requirements

For the purposes of this document, documentation requirements given in Part 1 apply.

6 Installation Design

Normative and informative annexes are provided as part of the document. These annexes are as follows.

— Annex A—Installation Checklist (informative).

— Annex B—Cleaning/Flushing of Field Installed Piping (normative).

— Annex C—Commissioning Checklist (informative).

— Annex D—Start-up Checklist (informative).

6.1 All field piping, tubing, and components (including plugs, gaskets, and blind flanges) in the gas seal system shall conform to the requirements in API 692, Part 3.

6.2 All field piping and tubing shall be sloped to low point drains. Sloped lines shall not drain through the compressor seal cavities.

6.3 Lines shall be supported to prevent sagging and the formation of pockets.

6.4 Additional design and sloping requirements shall be defined by the vendor.

6.5 Piping layout shall be approved by the purchaser.

6.6 Low point and dead-legs shall have drains.

6.7 Hydrotest of field fabricated piping shall conform to the requirements listed in API 692, Part 3.

6.8 Grouted equipment installation shall conform to the requirements in API 686.

6.9 All flange bolting shall conform to the requirements listed in API 692, Part 3.

6.10 PMI of field installed or fabricated piping, tubing, and components shall conform to the requirements listed in API 692, Part 3.

6.11 Heat tracing and insulation design shall conform to the requirements listed in API 692, Part 1~~3~~.

6.12 Purchaser to define vendor support requirements during installation, commissioning, and start-up.

NOTE Vendor representatives are typically used during seal installation and start-up activities.

7 Receiving, Inspection, and Storage

7.1 General

7.1.1 All receiving, inspection, and storage plans shall be approved prior to shipment of equipment.

7.1.2 If vendor's requirements or recommendations differ from the instructions provided in this standard ~~document~~, the purchaser shall determine which takes precedence.

7.1.3 All procurement schedules, shipping lists, vendor's storage recommendations, installation manuals, and drawings shall be provided to the purchaser's designated representative.

7.1.4 Extra drawings and manuals shipped with the equipment shall be saved and handed over to the purchaser.

7.1.5 Special tools shall be kept by the installer until work has been completed and then turned over to the purchaser's designated representative.

7.1.6 All records documenting the receiving, inspection, and storage of equipment shall be maintained by the purchaser's designated representative.

7.2 Receiving and Inspection

7.2.1 All equipment shall be inspected upon receipt by the purchaser's designated representative as follows.

a) Visually inspect for physical damage or contamination. Any apparent damage shall be reported per the terms of the purchase order.

b) Sealed boxes or shipping/storage containers shall not be opened unless there is suspicion of damage or approved by the purchaser.

c) Verify that loose components and separate packages match the packing lists.

d) Verify that flange covers and gaskets, pipe plugs, and caps are in place.

e) Verify that any inert-gas-purged equipment is pressurized and maintained to the specified pressure. Report failures to the vendor and request corrective action.

f) Verify special packaging of components (e.g. secondary sealing elements) is per vendor recommendations.

7.2.2 The vendor shall define any specific incoming inspection and receiving requirements.

7.2.3 Weights, center of gravity, configuration, lifting details, and method of shipping shall be provided by the vendor before arrival of equipment at the jobsite.

7.2.4 Vendor shall clearly identify on the shipping container any opening restrictions.

7.3 Storage

7.3.1 General

7.3.1.1 Vendor shall identify storage requirements that may include the following:

a) climate-controlled storage;

b) purging or buffering with nitrogen or dry air;

NOTE Nitrogen purging and blanketing provides protection by removing the moisture laden oxygenated atmosphere.

c) coverings;

d) humidity monitoring;

e) temperature monitoring;

f) desiccants and vapor phase inhibitors (VPIs);

g) export crated in sealed foil bags.

7.3.1.2 All equipment shall be stored indoors or in a covered area free from direct ground contact and away from areas subject to ponding water. As a minimum, laydown areas shall be graveled.

NOTE Explosion-proof enclosures are not necessarily weatherproof enclosures. Open conduit connections can allow entrance of moisture.

7.3.1.3 Seals not installed in the compressor shall be stored in the seal vendor's container or packaging.

7.3.1.4 Temporary protective coverings shall allow free air circulation to prevent humidity condensation and collection of water.

7.3.1.5 Flanged openings shall have stainless steel closures at least 5 mm ($^{3}/_{16}$ in.) thick with full face elastomer gaskets and at least four full-diameter bolts.

7.3.1.5.1 Threaded piping connections shall have stainless steel plugs and caps in place.

7.3.1.5.2 Nonmetallic (such as plastic) flange covers, plugs, and caps shall not be used.

7.3.1.6 Damaged painted surfaces shall be touched up, using the vendor's recommended methods and materials.

7.3.1.7 Items such as instruments and valves that have been shipped loose shall be stored indoors in their original factory boxes and be properly tagged.

7.3.2 Preservatives

7.3.2.1 The use of preservatives, type, and location, shall be approved by the purchaser.

7.3.2.2 All preservative material safety data sheets (MSDSs) shall be available and associated hazards reviewed with all personnel handling and using these materials.

7.3.2.3 Grease or oil-based products can adversely affect the seal or seal system and shall not be used where contact with seal system fluids may occur.

7.3.2.4 Preservatives shall not be used on surfaces that could reduce the function of the component or where prohibited by process.

NOTE Preservatives can adversely affect the operating life and performance of equipment if they react with the process fluid or operating lubricant.

7.3.2.5 Vendor shall advise any desiccants to be used where there can be contact with the process or sealing gas.

7.3.2.6 All desiccants shall be defined according to vendor standard ~~have prior approval from the user-designated representative~~.

7.3.2.7 Desiccant locations shall be identified with externally visible tags.

7.3.2.8 VPIs shall have prior approval from the vendor or the purchaser's designated representative.

NOTE Some VPIs can contain nitrites that attack copper and bronze.

8 Installation and Construction

8.1 General

8.1.1 Installation and preservation requirements shall be supplied by the vendor ~~and approved by the purchaser~~.

8.1.2 Installation checklist (see example in Annex A) shall be completed.

8.1.3 All equipment shall be kept clean, closed, and preserved during installation.

8.1.4 Items purchased as spare parts shall be identified and handed over to the user-designated representative in the as-shipped condition.

8.2 Dry Gas Seal Installation

NOTE This section does not apply if the seals remain in the compressor case from the compressor vendor.

8.2.1 Vendor installation procedure shall be used for the proper installation of the compressor dry gas seals.

8.2.2 The vendor documentation shall define the proper use of all special tooling.

8.2.3 Prior to installing the dry gas seal, the following items shall be completed.

h) Verify all gas seal connection ~~compressor casing~~ lines between the seal support system and the compressor and seal cavity are clean and dry. Verification on the primary vent lines should include all piping upstream of the check valves.

NOTE Some materials can leave a residue or particles (lint) following cleaning.

a) Confirm all case ports are correct and externally labeled.

b) Verify shaft and case chamfers are free from burrs and sharp edges.

c) Protect shaft areas from damage during seal installation.

d) Verify rotor is in correct angular position to align drive keys with shaft sleeve keyways as positioned by the installation plates.

e) Verify rotor is in the expected axial running position.

f) Verify rotor is locked in the expected axial position. The locked position shall be maintained throughout the seal installation process even with moving the locking device from end to end.

g) Verify rotor is radially centered or can be centered during the seal installation.

NOTE Typically, smaller compressors do not require rotor centering.

h) Record all seal installation reference dimensions and rotor position and verify they are within vendor requirements.

i) Seal sleeve retaining components shall be inspected for proper fit and condition per vendor instructions. Mating surfaces shall be checked for high spots.

j) Verify special tools and instructions for use are available.

8.2.4 During installation of the dry gas seal, the following items shall be completed.

a) Ensure seal cleanliness is maintained during handling and installation.

NOTE Debris can enter the seal from overhead equipment once protective coatings are removed.

b) Identify correct seal installation location for direction-sensitive seals.

c) Record serial numbers for all components.

d) Verify seal temperature is ambient to allow installation on the rotor.

e) The seal cartridge should be dry fit without the shaft sleeve or cartridge secondary sealing elements to verify fit and position. During the dry fitting process, polymer secondary sealing elements should not be removed.

f) Secondary sealing elements shall be lubricated with a process-compatible lubricant per the vendor installation instructions.

NOTE Over-lubrication can result in a seal failure.

g) Remove, account, and retain installation plate screws per vendor seal drawing.

h) Set the seal housing or gland to the compressor case per the vendor’s instructions.

i) Affix the seal sleeve to the rotor per the vendor’s instructions.

j) Record all seal installation reference dimensions and rotor position and verify that vendor requirements are met.

k) Install separation seal assembly.

8.2.5 Seal boxes and installation plates from the installed seals shall be stored for use when the seals are removed from the compressor.

8.3 Dry Gas Seal Support System Installation

8.3.1 Vendor installation procedure shall be used for the proper installation of the compressor dry gas seal system.

8.3.2 The vendor installation procedure shall verify that the installation design requirements listed in Section 6 are met.

NOTE System cleaning is covered in the field commissioning section.

8.3.3 Field piping and tubing shall be isolated from the compressor during construction to prevent contamination.

8.3.4 All hydrotested equipment shall be drained and dried prior to connecting to the dry gas seal panel, skid, or compressor.

9 Field Commissioning

9.1 This section covers commissioning of the seal and the seal system. The following conditions typically exist.

a) The process boundary blinds are still installed and no hydrocarbon gas or liquids will be introduced into the system during this stage.

b) Electrical systems are de-energized.

c) Gas, water, nitrogen, or instrument air is blinded from main systems.

d) Utilities required during commissioning are supplied from temporary sources.

e) Installation checklists have been completed and all punch list items are identified.

NOTE Commissioning is typically completed by the owner-operator and not the construction contractor.

9.2 Commissioning procedures ~~from the vendors~~ shall be ~~approved~~ supplied by the vendors ~~purchaser~~.

9.3 A field P&ID verification shall be completed on all systems. All tagging, routing, valve positions, insulation, and heat tracing shall be included in the review.

NOTE Insulation and heat tracing is typically completed after pipe flushing.

9.4 Field installed piping shall be flushed per the procedure listed in Annex B.

9.5 When a compressor gas leakage test is performed, filtered seal gas shall be provided maintaining minimum gas velocities listed in Table 1 of Part 1

NOTE: Field leakage test to verify assembly integrity, similar to shop assembled machine gas leakage test defined in API 617

9.6 Verify that the filters have the correct filter elements installed.

9.7 Loop check of all instrumentation together with set points, range, and function for the control system. As a minimum, the following are to be verified.

a) Devices authorized to initiate shutdowns of the train shall be loop checked to the final trip device.

b) All control set points.

c) All calibrations.

d) Stroking of control valves.

e) Calibration and mode of all control valves.

f) All solenoid valves for proper actuation.

g) All alarms and shutdowns tested.

h) All permissives.

i) All interlocks such as separation seal gas, lube oil, booster, and heater.

j) All temporary measures, including software modifications and jumpers, installed to facilitate pre-commissioning activities shall be removed.

9.8 Verify power and control wiring for components such as heater, boosters, etc. are connected and functioning.

NOTE Heaters can be damaged if energized without gas flow.

9.9 Verify all electrical conduit sealers/junction boxes and/or connections are properly sealed/poured after loop checks have been completed.

9.10 Commissioning checklist (see example in Annex C) shall be completed.

10 Start-up

10.1 This section covers the seal and the seal system from the conclusion of the commissioning phase through the start-up phase and placing the equipment into service. Process and utility fluids, e.g. nitrogen and hydrocarbon gas, will be introduced into the systems.

10.2 ~~The purchaser shall approve~~ start-up procedures shall be supplied by the vendor. Seal system start-up procedures are typically included with the compressor start-up procedures.

NOTE Vendor representative can assist during start-up.

10.3 The dry gas seal system fittings, gasketed components, and instruments shall be leak tested at the normal operating pressure. Leak testing should be completed at intermediate pressures before reaching the normal operating pressure. Pressure limits due to material nil ductility transition temperature limits or rapid gas decompression shall be identified.

10.4 All compressor drains, seal system drains, and low points shall be drained or blown down prior to and after the introduction of process gas.

10.5 Pressure, flow, and temperature of all fluids shall be verified to be within normal parameters prior to start-up.

10.6 Lube oil shall not be supplied to the bearings unless all interlocks and alarms are in service and the separation gas is in service at the normal operating pressures and flows.

10.7 The seal system shall not be operated beyond the limits specified in the design datasheet. Alarm settings and trips shall remain within these limits.

10.8 During start-up and while the equipment is in service, as a minimum the following items shall be verified.

a) Pressure, flow, and temperature of all systems are within normal ranges.

b) All systems are functioning as designed; tuning of control loops could be required.

c) Supply filters are lined up correctly using only a single filter and not both filters of a duplex arrangement.

d) Heat tracing is functioning and is at the correct set point.

e) All normally closed vents and drains have threaded plugs or blind flanges.

10.9 Static and initial operating data shall be documented to establish a baseline condition.

10.10 Start-up checklist (see example in Annex D) shall be completed.

Annex A
(informative)

Installation Checklist

Section	Requirements	Name	Date
8.2.3 a)	Verify compressor casing lines and seal cavity are clean and dry. NOTE Some materials can leave a residue or particles (lint) following cleaning.		
8.2.3 b)	Confirm all case ports are correct and externally labeled.		
8.2.3 i)	Record all seal installation reference dimensions and rotor position and verify within vendor requirements.		
8.2.4 c)	Record serial numbers for all components.		
8.2.4 f)	Secondary sealing elements shall be lubricated with a process compatible lubricant per the vendor installation instructions. NOTE Over-lubrication can result in a seal failure.		
8.2.4 j)	Record all seal installation reference dimensions and rotor position and verify that vendor requirements are met. NOTE It is recommend that final seal position be measured with the thrust bearing installed.		

Annex B
(normative)

Dry Gas Seal System Cleaning and Flushing

B.1 Scope

This annex covers the requirements of cleaning and flushing dry gas seal system fabricated piping, tubing, and components in the shop, commissioning, and repairs before connecting to the equipment. All dry gas seal lines including seal gas supply, alternate/secondary gas supply, DGS panel, nitrogen gas supply panel, interconnecting piping/tubing, GCU, bypass lines up to first compressor flange shall be flushed with flushing medium as listed in B.3.

B.2 Prepare Plan for Flushing

Each compressor dry gas seal and auxiliary system should have a site-specific procedure since all differ in configuration, layout, design and functionality.

Prior to starting the equipment flushing activities, the following tasks should be completed:

— Confirm P&ID is correct per field configuration.

— Identify system loops and define scope of what is to be flushed.

— Develop detailed flushing plan.

— Establish cleanliness acceptance criteria.

— QA/QC for proper reassembly (e.g., list of orifices, filters, and valves size/direction)

— Gather materials required to execute the work and any associated safety datasheets.

— Flushing risk assessment performed.

B.3 Cleaning of Dry Gas Seal System

— Each system line shall be cleaned by flushing with a flushing medium with the following characteristics:

- A solvent that evaporates.
- Does not leave residues (which can cause seal face damages or can lead to potential fire hazards)
- Is compatible with all system materials.
- Is not hygroscopic

— Isopropyl Alcohol (IPA) is typically compatible with all system materials and is the default flushing medium of this Annex.

— Use of alternate flushing medium shall be agreed by all parties.

— A flushing loop with a container, pump, bag filter, and temporary lines shall be used for the flushing process.

— Isolate and/or remove devices that can cause restriction and equipment damage (e.g. strainer, orifices, permanent filters, relief device, etc.).

— The pump shall be sized to provide turbulent flow, Reynolds Number > 4000, within the lines to be flushed.

— Filter differential pressure shall be monitored during the flushing operation.

— Flushing procedure may start out with higher micron bag filters (lower filtration level) to lower micron bag filters (higher filtration level) as system cleanliness improves.

— Final flushing shall use a bag filter element with a 1-micron rating ($\beta 1 \geq 1000$).

— The condition of the flushing medium shall be monitored throughout the flushing process and replaced if it becomes contaminated.

— Each loop shall be flushed for a minimum of 30 minutes between filter inspections.

— For systems with redundancy (e.g. coolers, downcomers/scrubbers, heaters, filters, bypasses etc.) cycle the flushing, forcing flow first to one side then to the other.

— Bag filters shall be visually inspected for cleanliness. Two successive clean 1 micron bag filter inspections are required to complete the test.

— Low point drains may be used to validate system cleanliness.

— After flushing has been completed, the system shall be drained of all flushing fluid.

— All low point drains shall be used to drain residual fluids from the system prior to drying.

B.4 System Drying and Final Inspection

Each line shall be blown dry with dry filtered nitrogen through the dry gas seal system until dry prior to connecting the piping to the compressor. Dry nitrogen should have a –40 °F/C dew point or lower.

Warning: Ensure the nitrogen is vented to a safe location

— During drying, low point drains shall be periodically opened to check for and assist in removal of any remaining fluid.

— Drying blows shall continue until there is no evidence of remaining flushing fluid in the system.

NOTE: The timeframe to fully dry out the system can vary depending on system arrangement, design and flushing medium.

— All piping shall be re-attached to the compressor and components previously removed (e.g. orifices, etc.) shall be reinstalled

— New seal gas filter elements shall be installed

~~Cleaning/Flushing of Field Installed Piping~~

~~B.1 Scope~~

~~This annex covers the requirements to clean the field installed and fabricated piping, tubing, and system components before connecting to the equipment. The dry gas seal panel or skid may not require field cleaning~~

~~since it was certified clean at the factory. If cleaning of the panel or skid is necessary, the requirements in Part 3 shall apply. Nitrogen piping to the seal panel shall be blown down with dry air or nitrogen as listed in B.2. All interconnecting piping and tubing between the dry gas seal panel or skid and compressor shall be flushed with isopropyl alcohol as listed in B.3.~~

~~THE FOLLOWING PROPOSED CHANGES ARE PENDING NEW GUIDELINE:~~

~~B.1/2 Add flushing of nitrogen system~~

~~B.2 All interconnecting piping and tubing between the dry gas seal panel or skid and compressor should be blowed. Flushing could be performed with isopropyl alcohol (as listed in B.3) or alternative methods defined by vendor.~~

~~B.2 Blow each nitrogen supply line from the supply header to the dry gas seal panel or skid with dry oil free filtered air or nitrogen according to vendor method statement to remove any loose material in the line~~

~~B.2 Verify cleanliness of the gas path on the final blow with the vendor's approved method and acceptance criteria~~

~~B.3 Each line should be cleaned by flushing with isopropyl alcohol or equivalent that evaporates, does not leave a residue, and is compatible with all system materials. Alternative methods should be evaluated by vendor standard~~

~~B.2 Cleaning of Nitrogen Supply Line~~

~~Blow each nitrogen supply line from the supply header to the dry gas seal panel or skid with dry oil free filtered air or nitrogen for 30 minutes to remove any loose material in the line. Dried air should have a −40 °F dew point.~~

— ~~Filter—10 micron.~~

— ~~Velocity—2 times maximum flow and/or turbulent flow.~~

— ~~Repeat the cycle a minimum of 3 times.~~

— ~~Verify cleanliness of the gas path on the final blow with the purchaser's approved method and acceptance criteria.~~

~~B.3 Cleaning of Interconnecting Piping and Tubing~~

~~Each line shall be cleaned by flushing with isopropyl alcohol or equivalent that evaporates, does not leave a residue, and is compatible with all system materials.~~

— ~~A flushing loop with a container, pump, filter, and temporary lines shall be used for the flushing process.~~

— ~~The pump shall be sized to provide turbulent flow, Reynolds Number > 3000, within the line to be flushed.~~

— ~~The filter shall have a replaceable element. Initial flushing may be completed with a 5 micron filter. Final flushing shall use a 1 micron filter. Filter differential pressure shall be monitored during the flushing.~~

— ~~Isopropyl alcohol condition shall be monitored throughout the flushing process and replaced if it becomes contaminated.~~

- ~~Each loop shall have a 400 mesh screen backed by a 25 mesh screen.~~
- ~~Each loop shall be flushed for a minimum of 30 minutes between screen inspections.~~
- ~~Screens shall be visually inspected for cleanliness. Two successive clean screens are required to complete the test.~~

~~B.4 System Drying and Final Inspection~~

~~Each line shall be blown with filtered nitrogen through the dry gas seal system until dry prior to connecting the piping to the compressor.~~

- ~~All piping shall be re-attached to the compressor with 400 mesh screens in the seal gas, separation gas, and buffer gas supply lines.~~
- ~~System shall be blown for 6 hours through the vented compressor. Screens shall be removed and new gaskets installed.~~
- ~~New gas seal filter elements shall be installed.~~
- ~~The system shall be energized through the balance of the pre-start-up and start-up activities.~~

Annex C
(informative)

Commissioning Checklist

Section	Requirements	Name	Date
9.2	Commissioning procedures from the vendors shall be ~~approved by~~ supplied to the purchaser.		
9.3	A field P&ID verification shall be completed on all systems. All tagging, routing, valve positions, insulation, and heat tracing shall be included in the review. NOTE Insulation and heat tracing is typically completed after pipe flushing.		
9.4	Field installed piping shall be flushed per the procedure listed in Annex B.		
9.5	Verify that the filters have the correct filter elements installed.		
9.6	Loop check of all instrumentation together with set points, range, and function for the control system. As a minimum, the following are to be verified. a) Devices authorized to initiate shutdowns of the train shall be loop checked to the final trip device. b) All control set points. c) All calibrations. d) Stroking of control valves. e) Calibration and mode of all control valves. f) All solenoid valves for proper actuation. g) All alarms and shutdowns tested. h) All permissives. i) All interlocks such as separation seal gas, lube oil, booster, and heater. j) All temporary measures, including software modifications and jumpers, installed to facilitate pre-commissioning activities shall be removed.		
9.7	Verify power and control wiring for components such as heater, boosters, etc. are connected and functioning. NOTE Heaters can be damaged if energized without gas flow.		
9.8	Verify all electrical conduit sealers/junction boxes and/or connections are properly sealed/poured after loop checks have been completed.		

Annex D
(informative)

Start-up Checklist

Section	Requirements	Name	Date
10.2	~~The purchaser shall approve start-up procedures~~ Start-up procedures from the vendors shall be supplied to purchaser for information before start-up. Seal system start-up procedures are typically included with the compressor start-up procedures.		
10.3	The dry gas seal system fittings, gasketed components, and instruments shall be leak tested at the normal operating pressure. Leak testing should be completed at intermediate pressures before reaching the normal operating pressure. Pressure limits due to material nil ductility transition temperature limits or rapid gas decompression shall be identified.		
10.4	All compressor drains, seal system drains, and low points shall be drained or blown down prior to and after the introduction of process gas.		
10.5	Pressure, flow, and temperature of all fluids shall be verified to be within normal parameters prior to start-up.		
10.8	During start-up and while the equipment is in service, as a minimum the following items shall be verified. a) Pressure, flow, and temperature of all systems are within normal ranges. b) All systems are functioning as designed; tuning of control loops can be required. c) Supply filters are lined up correctly using only a single filter and not both filters of a duplex arrangement. d) Heat tracing is functioning and at correct set point. e) All normally closed vents and drains have threaded plugs or blind flanges.		
10.9	Static and initial operating data shall be documented to establish a baseline condition.		

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