ENVIRONMENTAL CONTROL PLANS

POCKET AND REFERENCE GUIDE

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Global Solutions, Local Service.

Introduction

This pocket guide identifies and describes common environmental controls (e.g., piping plans) used with mechanical seals to enhance their reliability. No application is the same. Extended mechanical seal life in harsher applications is usually a function of being able to control the environment around the seal. Environmental controls have been established for this purpose.

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Index

References and Definitions

Environmental controls are support systems that are designed for use with mechanical seals. Each plan describes how the seal support systems are configured. The symbols used in the plans are described in the legend below.

Flow Control Orifices

An orifice is designed to limit the seal flush dilution and/or control the seal chamber pressure.

All orifices shall have a minimum bore of 3 mm (0.125").

When multiple orifices are required, they shall be mounted in a series a minimum of 150 mm (6.000") apart.

Seal flush systems using an external flush shall have provisions to monitor seal chamber pressure and flush pressure. A pressure gauge with a block valve on either side is recommended.

Heat Exchangers/Coolers

Heat exchangers shall provide enough flow to cool the seal per the manufacturer's requirements.

The seal flush fluid shall be on the tube side and the cooling liquid shall be on the shell side.

Heat exchanger tubes shall be 19 mm (0.750") in diameter by 2.4 mm (0.100") in thickness, unless otherwise specified.

Heat exchangers shall have a removable head, using bolts or studs with nuts on each side. Tapped holes are not acceptable.

Barrier/Buffer Fluid Tanks

The reservoir is part of the pumping system and shall be designed, fabricated, and tested to ISO 15649 (ASME B31.3) standards unless otherwise specified by local code or local plant specifications. The standard reservoir shall be a cylindrical vessel with fixed, ellipsoidal heads. A separate reservoir shall be provided for each dual seal installation.

The barrier fluid lines shall be a minimum of 12 mm (0.500") for shaft sizes 60 mm (2.375") or less and 18 mm (0.750") for shaft sizes greater than 60 mm (2.375"). The tubing material shall be 300 series austenitic stainless steel (EN 1.4401). Austenitic schedule 80 stainless pipe can be used under the same guidelines.

All lines (seal connections) shall have a continuous slope upwards from the seal gland plate to the reservoir at a minimum of 10 mm (0.375") per 240 mm (10.000") of length.

The volume of liquid in the reservoir shall be a minimum of 12 liters (3 gallons) for shaft diameters of 60 mm (2.375") and less. For shaft diameters greater than 60 mm (2.375"), the liquid volume should be a minimum of 20 liters (5 gallons).

Unless otherwise specified, the barrier/buffer fluid tank shall be equipped with a cooler.

API Plan Legend

Heat Exchanger

Y-type Strainer

Flow-regulating Valve

Block Valve

Check Valve

Orifice

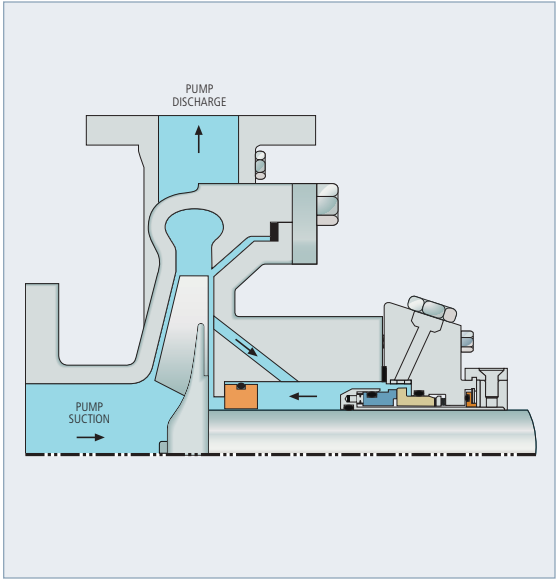
Single Seals

- Plan 1
- Plan 2
- Plan 11
- Plan 12
- Plan 13
- Plan 14
- Plan 21
- Plan 23
- Plan 32
- Plan 33H
- Plan 33S
- Plan 41
- Plan 65

PLAN 1

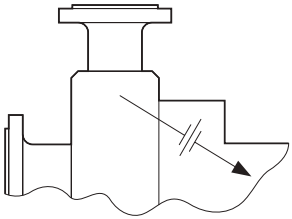
Internal Flush

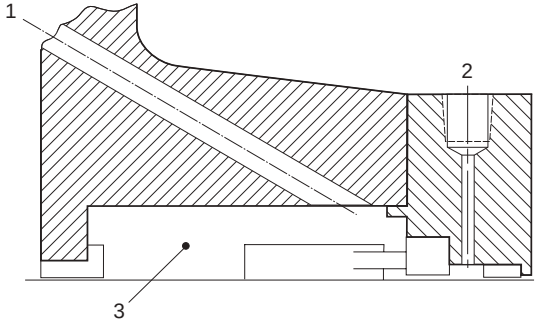
What	Internal recirculation of pumped fluid through internal passage.
Why	Increase pressure in the seal chamber or promote fluid circulation.
When	Sealing clean fluids with low vapor pressures.



KEY

1 — Inlet
2 — Quench/Drain (Q/D)
3 — Seal Chamber





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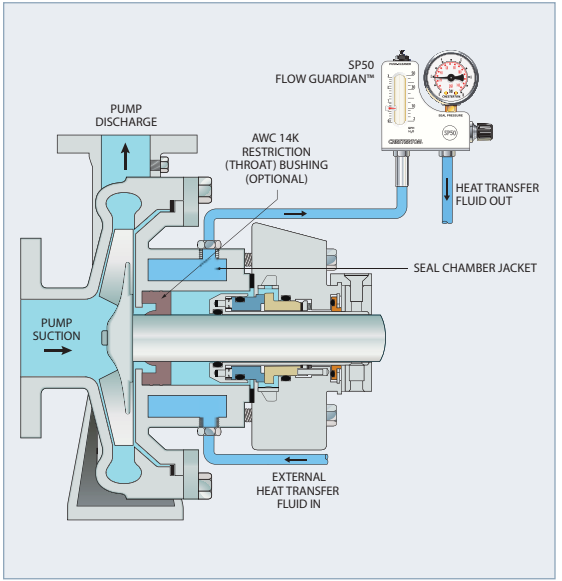
PLAN 2

Cooling Jacket/Dead-Ended Seal Chamber

What	External jacketed seal chamber. Dead-ended seal with no internal recirculation of pumped fluid.
Why	For cooling or heating process fluid.
When	Sealing fluids that are affected by temperature, for example, hot fluids or fluids that need heating to promote flow.

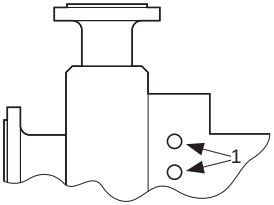


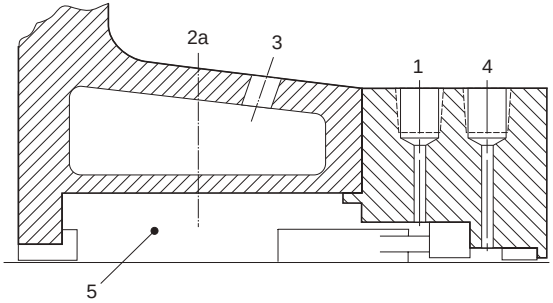
KEY

1 — Plugged Connections for Possible Future Circulating Fluid
2 — Vent (V), if Required
3 — Heating/Cooling Inlet (HI or CI), Heating/Cooling Outlet (HO or CO)
4 — Quench/Drain (Q/D)
5 — Seal Chamber

NOTES

a — Self-venting arrangements preferred on horizontal pumps





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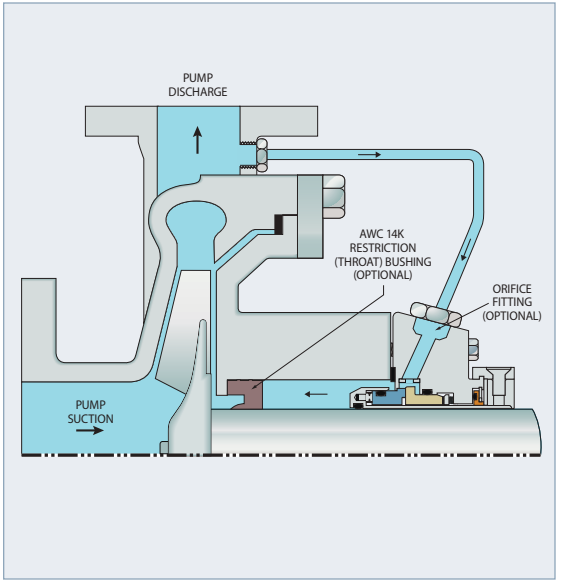
PLAN 11

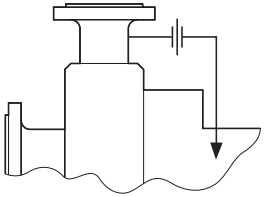
Discharge Recirculation

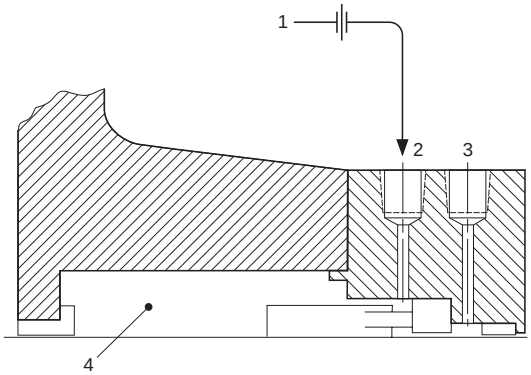
What	Discharge recirculation through an orifice to the seal flush port. The orifice is used to control discharge pressure to the seal chamber. A smaller orifice allows less pressure to enter the seal chamber.
Why	To raise the pressure in the seal chamber to limit flashing at the seal faces; to lower the temperature at the seal faces by circulating process fluid.
When	With clean process fluids. Process fluids with particulate may cause abrasion.



KEY

1 — From Pump Discharge
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber





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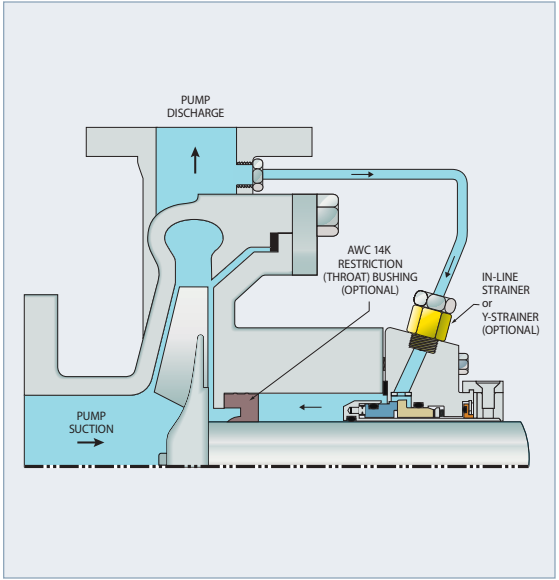
PLAN 12

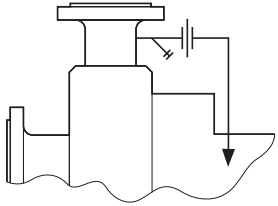
Discharge Recirculation with Strainer

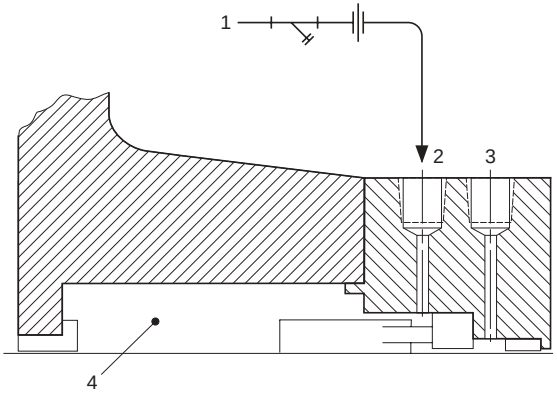
What	Discharge recirculation through a strainer and orifice to the seal.
Why	To remove large solids from the Plan 11 recirculation.
When	Not normally recommended because the strainer can clog and cause seal failure.



KEY

1 — From Pump Discharge
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber





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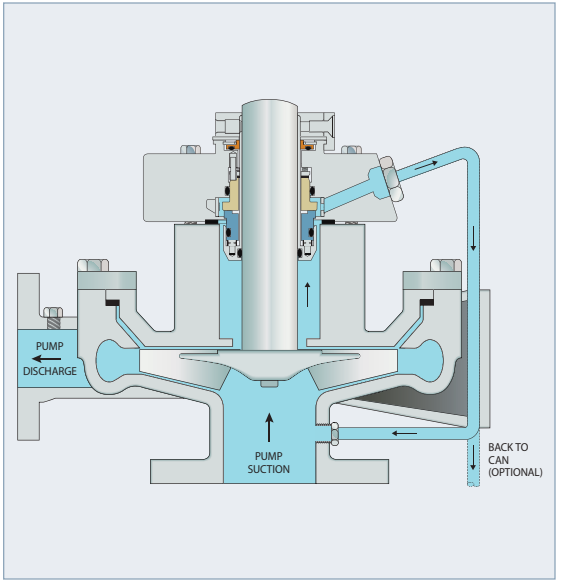
PLAN 13

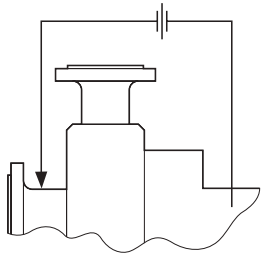
Suction Recirculation

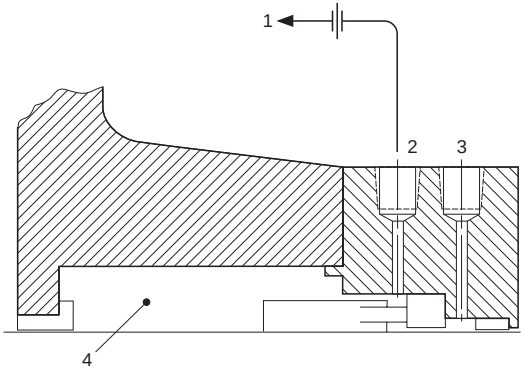
What	Suction recirculation through an orifice to the flush port of the seal.
Why	To vent the seal chamber area and/or to reduce the seal chamber pressure.
When	Seal chamber pressure must be reduced to increase/improve seal life or when solids in the process are accumulating around the seal faces. Used for seal chamber venting in a vertical pump.



KEY

1 — To Pump Suction
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber





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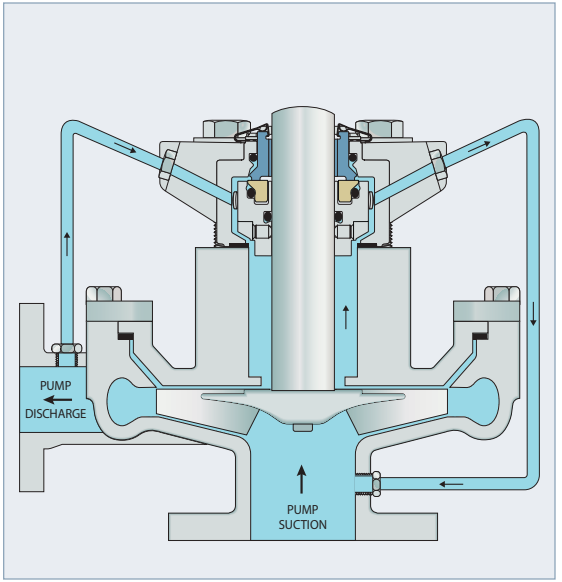
PLAN 14

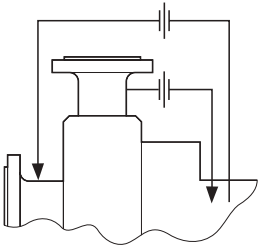
Suction and Discharge Recirculation

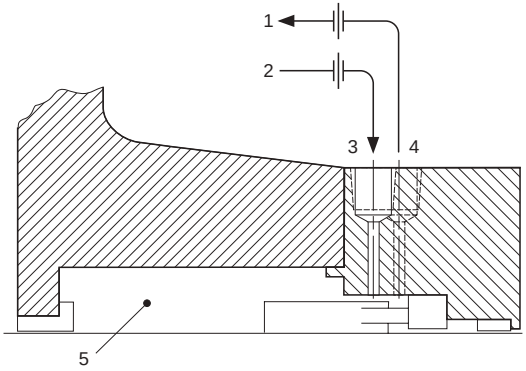
What	A combination of Plans 11 and 13. Recirculation from pump discharge through an orifice to the seal while also supplying a suction recirculation from the chamber through an orifice to pump suction.
Why	To promote flow through the seal chamber for cooling while also venting the seal chamber and lowering pressure.
When	Hot applications operating at high pressures; most commonly found in vertical applications.



KEY

1 — To Pump Suction
2 — From Pump Discharge
3 — Flush Inlet (FI)
4 — Flush Outlet (FO)
5 — Seal Chamber





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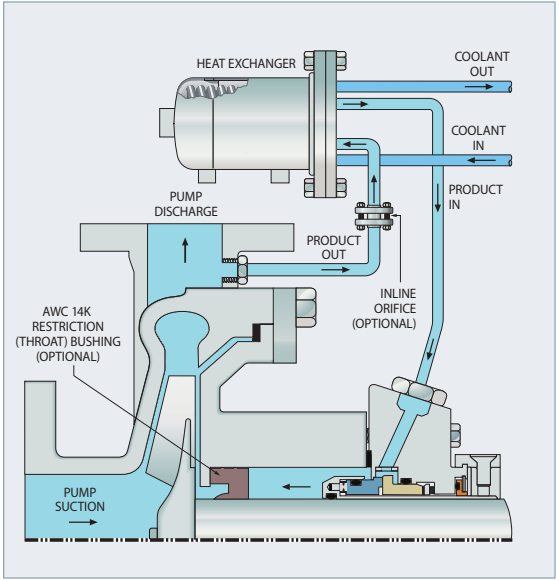
PLAN 21

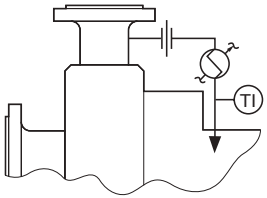
Cooled Discharge Recirculation

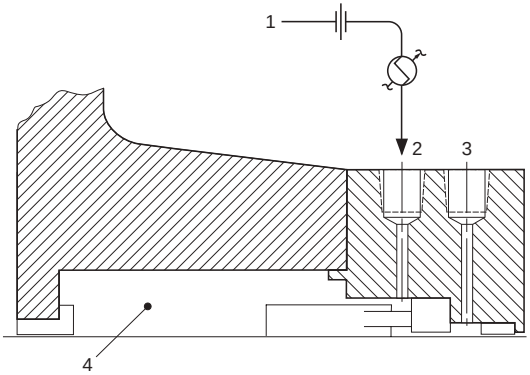
What	Discharge recirculation through an orifice and a heat exchanger to the flush port of the seal. A temperature indicator can be installed when specified.
Why	To raise the pressure in the seal chamber to limit flashing at the seal faces; to lower the temperature at the seal faces by using cooled product to remove heat from the seal faces.
When	Use with clean fluids. High-velocity solids may cause seal abrasion and score the seal faces if directed by the flush port.



KEY

1 — From Pump Discharge
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber
TI — Temperature Indicator





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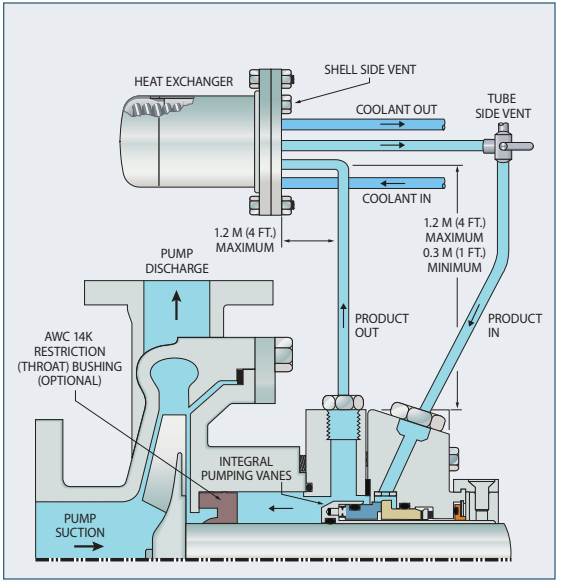
PLAN 23

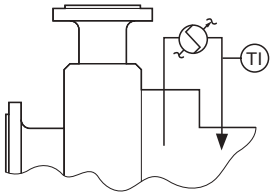
Cooled Seal Recirculation

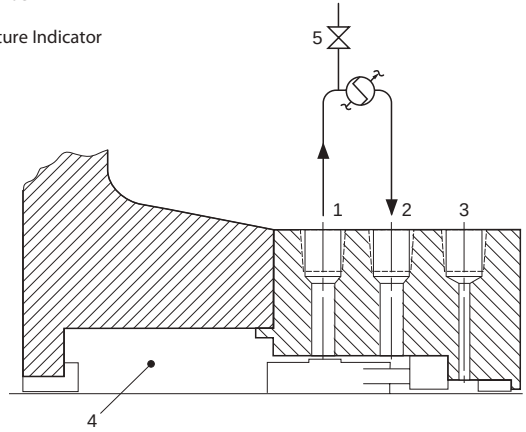
What	Cooling provided to the seal chamber using an internal pumping device on a single seal. The fluid passes through a heat exchanger and returns to the seal gland. Considered a closed-loop system.
Why	To lower the sealing temperature at the seal faces without increasing pressure. Limits vaporization at the seal faces.
When	Hot applications that exceed vapor pressure. Better on process fluid with solids compared to Plan 21.



KEY

1 — Flush Outlet (FO)
2 — Flush Inlet (FI)
3 — Quench/Drain (Q/D)
4 — Seal Chamber
5 — Vent
TI — Temperature Indicator





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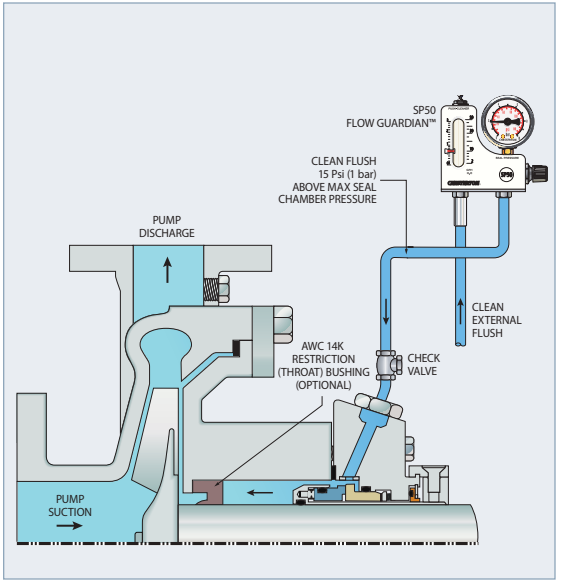
PLAN 32

Clean Flush

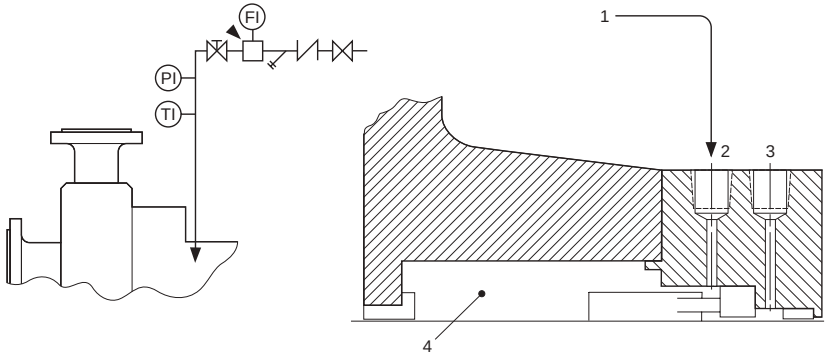
What	Clean flush from an external source.
Why	To cool and lubricate the seal faces; to provide clean fluid at the seal interface and prevent the buildup of solids in dirty process fluids.
When	Used with a product with excessive solids, crystallizing product, or a product with a low vapor pressure.



KEY

1 — From External Source
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber

FI—Flow Indicator
PI—Pressure Indicator
TI—Temperature Indicator



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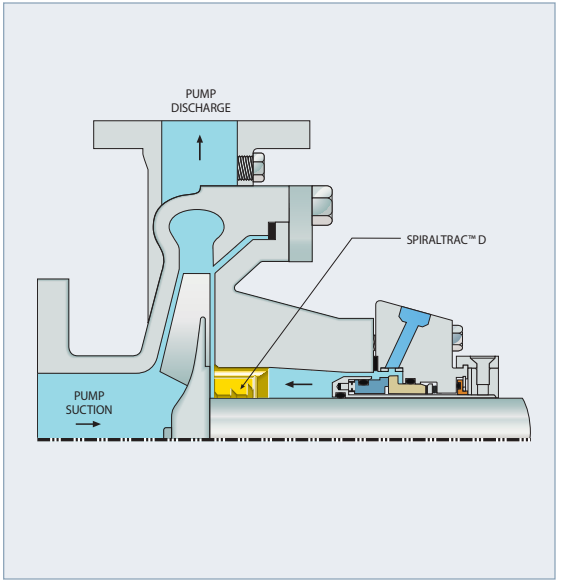
Chesterton® PLAN 33H

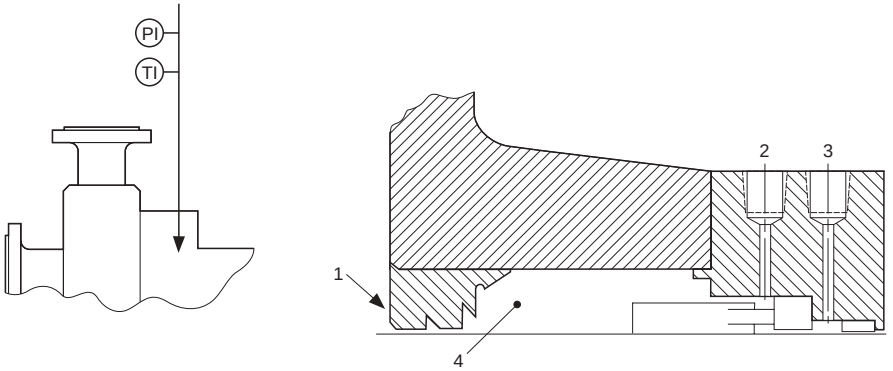
SpiralTrac™ Version D Type I

What	Used without flush to provide a cleaner sealing environment. This plan has been developed by Chesterton.
Why	To clean the seal chamber of solids.
When	Dilution is not permitted; sealing process fluids with solids.



KEY

1 — SpiralTrac™ Bushing
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber
PI — Pressure Indicator
TI — Temperature Indicator



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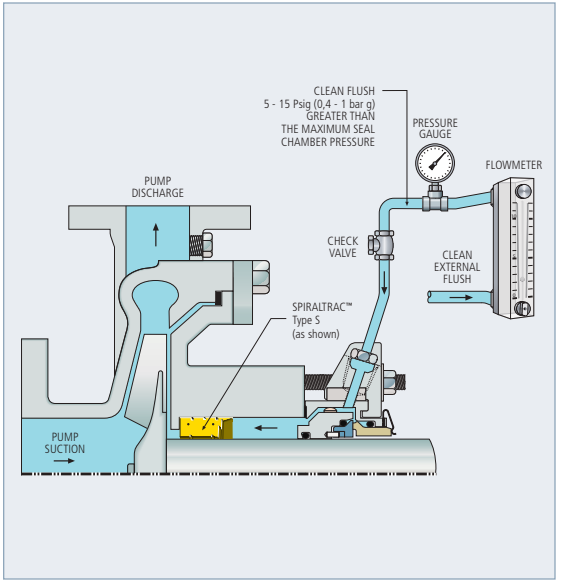
Chesterton® PLAN 33S

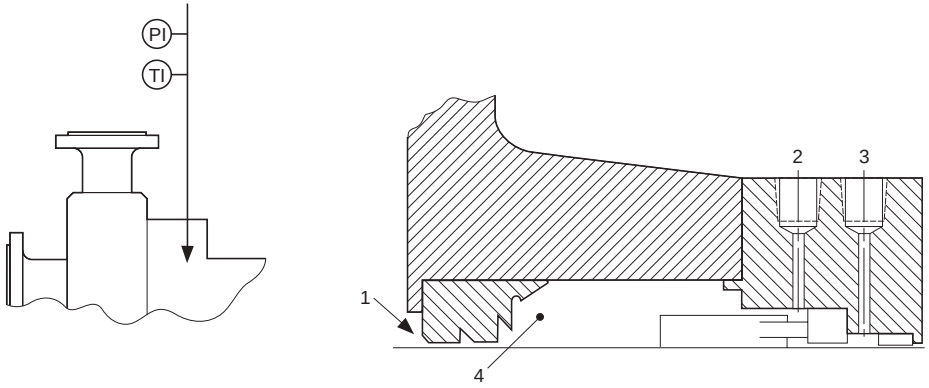
SpiralTrac™ Version F

What	Clean flush from an external source in combination with a SpiralTrac environmental controller. This plan has been developed by Chesterton.
Why	To clean the seal chamber of high-concentration solids.
When	Low dilution is permitted; sealing process fluids with solids.



KEY

1 — SpiralTrac™ Bushing
2 — Flush (F)
3 — Quench/Drain (Q/D)
4 — Seal Chamber
PI — Pressure Indicator
TI — Temperature Indicator



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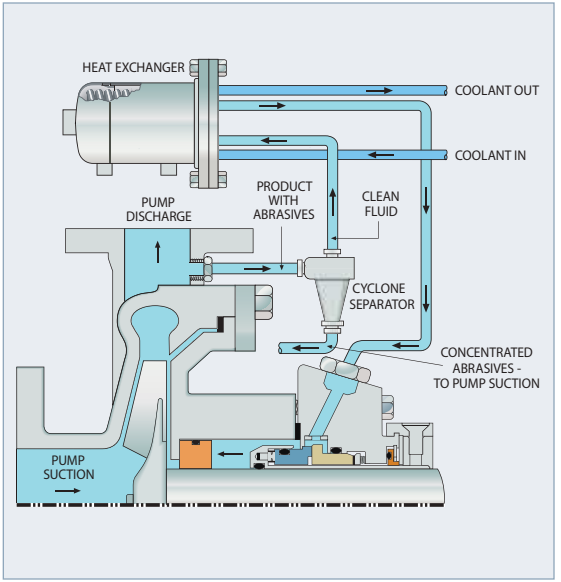
PLAN 41

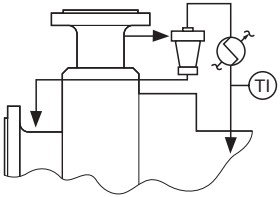
Cooled Discharge Recirculation with Cyclone Separator

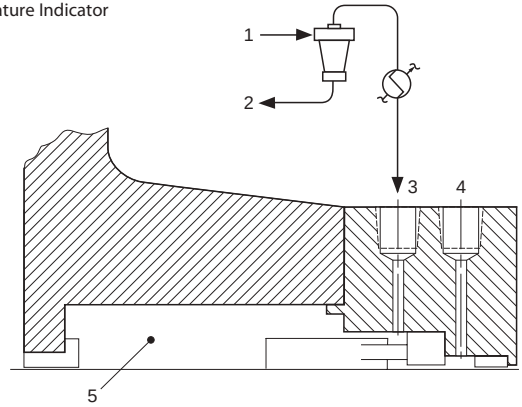
What	Clean flush supplied from pump discharge through a separator, then cooled through a cooler.
Why	To clean dirty process fluid and cool the process fluid to reduce seal clogging and provide cooling to the seal.
When	Sealing dirty, hot process fluids.



KEY

1 — From Pump Discharge
2 — To Pump Suction
3 — Flush (F)
4 — Quench/Drain (Q/D)
5 — Seal Chamber
TI — Temperature Indicator





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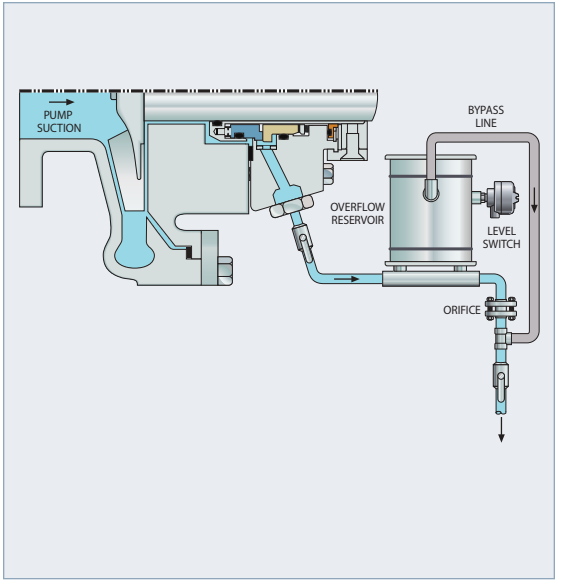
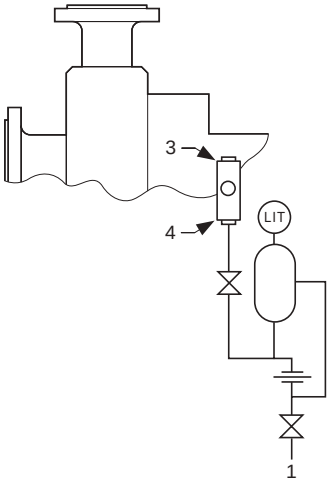
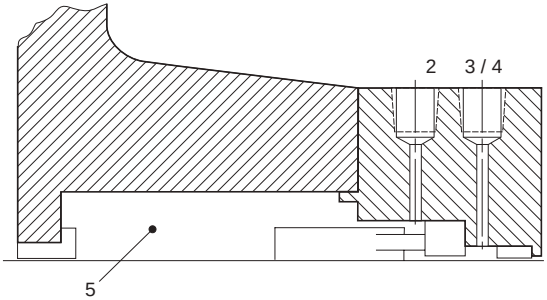
PLAN 65

Reservoir with Alarm System

What	External drain piping that is alarmed to detect high seal leakage to the atmosphere.
Why	Plan is used with a single mechanical seal. The alarm activates when the seal is leaking. It can be used with or without a quench.
When	Normally used in critical operations, in remote locations so that personnel know when the remote seal is leaking.







KEY

1 — To Liquid Collection System
2 — Flush (F)
3 — Quench (Q), plugged
4 — Drain (D)
5 — Seal Chamber
LIT — Level Transmitter with Local Indicator
(65A - High flow)
(65B - High level)

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Dual Seals

- Plan 52
- Plan 53A
- Plan 53B
- Plan 53C
- Plan 53P
- Plan 54
- Plan 55

PLAN 52

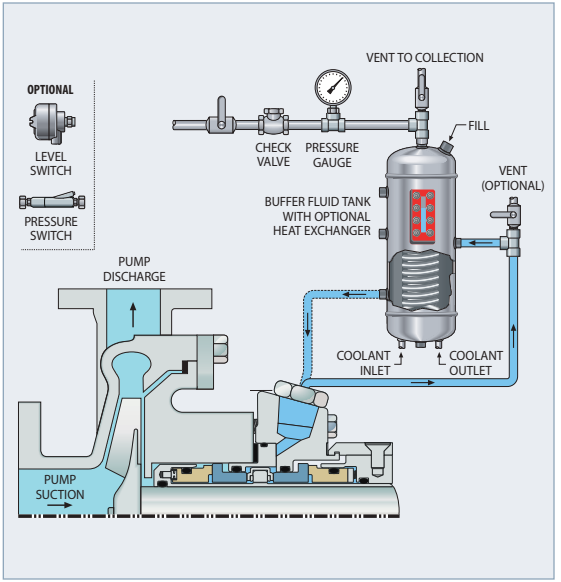
Circulation with External Buffer Fluid Tank

What Dual seal arrangement. External reservoir provides clean buffer fluid to the seal at a pressure lower than seal chamber pressure. A heat exchanger can be used when specified to cool the buffer fluid.

Why To cool and lubricate the outboard seal; to provide a containment seal in case of inboard seal failure.

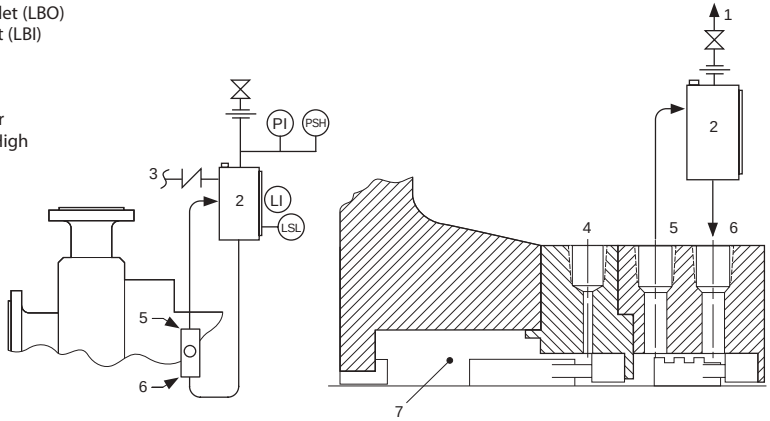
When Used with hazardous products. Not ideal for services where products have high solids content or low vapor pressure.

Note: Tank should be installed at least 0.3 M (1 ft.) above seal and at most 1.2 M (4 ft.) away. Piping should be continuously ascending with minimized bends.



KEY

1 — To Collection System
2 — Reservoir
3 — Make-up Buffer Fluid
4 — Flush (F)
5 — Liquid Buffer Outlet (LBO)
6 — Liquid Buffer Inlet (LBI)
7 — Seal Chamber
LSL — Level Switch Low
LI — Level Indicator
PI — Pressure Indicator
PSH — Pressure Switch High



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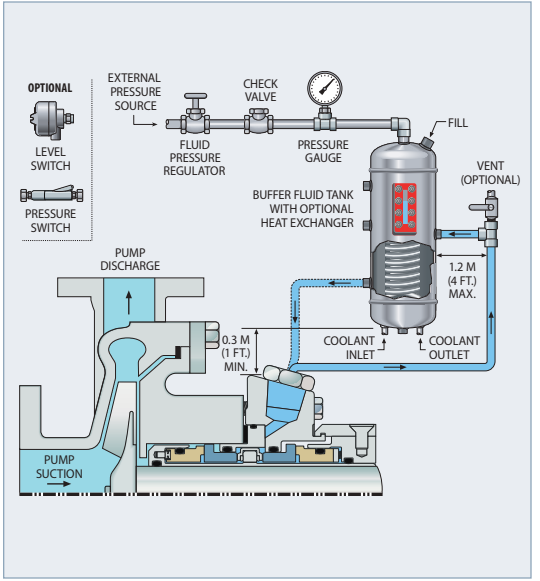
PLAN 53A

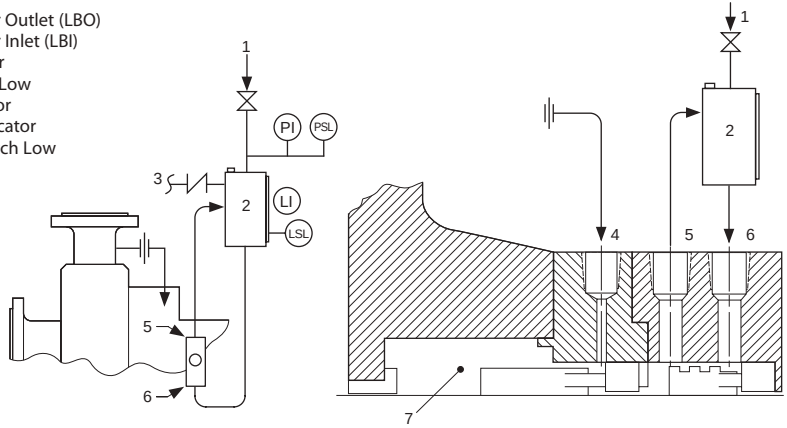
Circulation with Pressurized External Barrier Fluid Tank

What	Dual seal arrangement. A pressurized, external reservoir provides clean fluid to the inboard and outboard seals. Barrier fluid pressure is higher than seal chamber pressure. A heat exchanger can be used when specified to cool or heat the barrier fluid.
Why	To manage the temperature and lubricate the inboard and outboard seal faces; to provide clean lubrication to the inboard and outboard seal faces; to protect against solids penetrating and damaging the inboard seal faces.
When	Used with hazardous products and/or products with high solids content; sealing process fluids with low vapor pressure; Used with low viscosity, non-lubricating process fluids.



KEY

1 — From External Pressure Source
2 — Reservoir
3 — Make-up Buffer Fluid
4 — Flush (F)
5 — Liquid Barrier Outlet (LBO)
6 — Liquid Barrier Inlet (LBI)
7 — Seal Chamber
LSL — Level Switch Low
LI — Level Indicator
PI — Pressure Indicator
PSL — Pressure Switch Low



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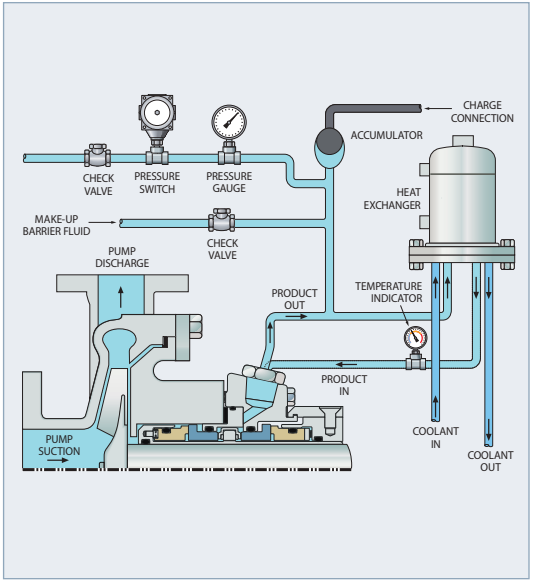
PLAN 53B

Closed Loop with Heat Exchanger and Accumulator

What Dual seal arrangement. A pressurized, external clean fluid is delivered to the seal via an external bladder-type accumulator. A heat exchanger can be used when specified to cool the fluid.

Why To cool the inboard and outboard seal faces; to provide clean lubrication to the inboard and outboard seal faces; to protect against solids penetrating and damaging the inboard seal faces.

When Used with hazardous products and/or products with high solids content; used when an automated Plan 53 is desired; used when sealing process fluids with low vapor pressure; used with low-viscosity, non-lubricating process fluids; used when the required barrier fluid pressure is higher than 10 bar (150 psi); prevents gas source from contaminating barrier fluid.

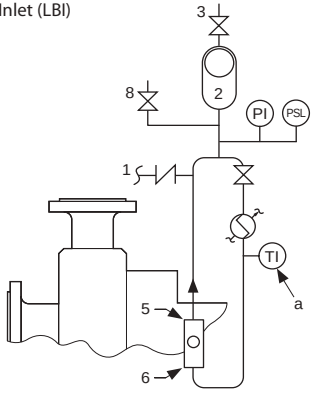


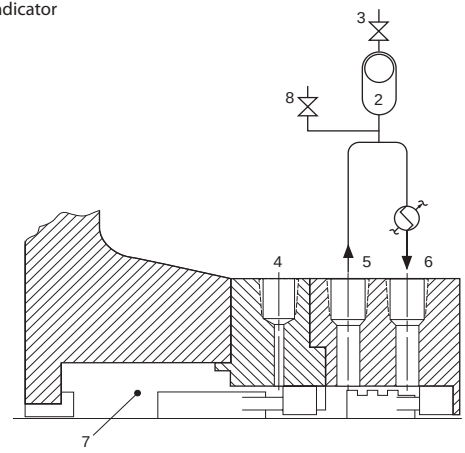
KEY

1 — Make-up Barrier Fluid
2 — Bladder Accumulator
3 — Bladder Charge Connection
4 — Flush (F)
5 — Liquid Barrier Outlet (LBO)
6 — Liquid Barrier Inlet (LBI)
7 — Seal Chamber
8 — Vent
PI — Pressure Indicator
PSL — Pressure Switch Low
TI — Temperature Indicator

NOTES

a — If specified





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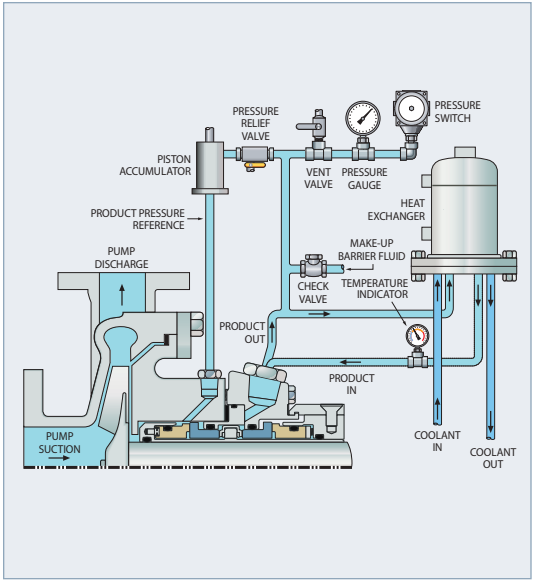
PLAN 53C

Heat Exchanger and Piston Accumulator

What	Dual seal arrangement. A pressurized, external clean fluid is delivered to the seal via an external piston-type accumulator. A heat exchanger can be used when specified to cool the fluid.
Why	To cool the inboard and outboard seal faces; to provide clean lubrication to the inboard and outboard seal faces; to protect against solids penetrating and damaging the inboard seal faces.
When	Used to closely regulate barrier fluid pressure with respect to seal chamber pressure; used with hazardous products and/or products with high solids content; used when an automated Plan 53 is desired; used when sealing process fluids with low vapor pressure; used with low-viscosity, non-lubricating process fluids.

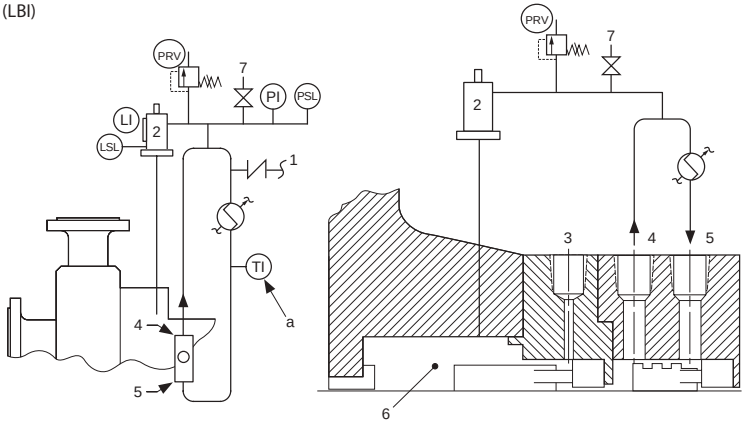


KEY

1 — Make-up Barrier Fluid
2 — Piston Accumulator
3 — Flush (F)
4 — Liquid Barrier Outlet (LBO)
5 — Liquid Barrier Inlet (LBI)
6 — Seal Chamber
7 — Vent
LI — Level Indicator
LSL — Level Switch Low
PI — Pressure Indicator
PRV — Pressure Relief Valve
PSL — Pressure Switch Low
TI — Temperature Indicator

NOTES

a — If specified



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Chesterton® PLAN 53P

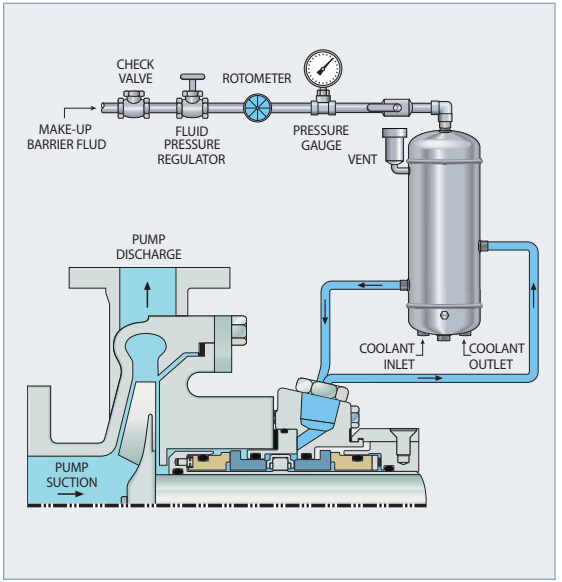
Circulation with Pressurized External Barrier Fluid Tank

What Dual seal arrangement used with an automatic make-up tank. A pressurized, external fluid source provides clean fluid to the seal via an external pressure reservoir. This plan has been developed by Chesterton.

Why To provide a barrier of clean fluid to lubricate the inboard and outboard seal faces; to protect against solids penetrating and damaging the inboard seal faces.

When Used in products with high solids content; used when cooling is a primary requirement; can be used to heat the seal; used when a secure source of external fluid is available.

Note: Tank should be installed at least 0.3 M (1 ft.) above seal and at most 1.2 M (4 ft.) away. Piping should be continuously ascending with minimized bends.



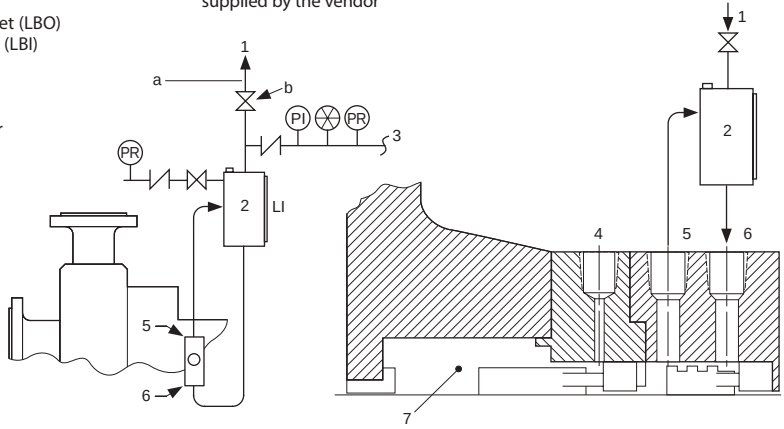
KEY

1 — From External Pressure Source
2 — Reservoir
3 — Make-up Buffer Fluid
4 — Flush (F)
5 — Liquid Barrier Outlet (LBO)
6 — Liquid Barrier Inlet (LBI)
7 — Seal Chamber
LI — Level Indicator
PI — Pressure Indicator
PR — Pressure Regulator

NOTES

a — Items above this line are the responsibility of the purchaser; items below this line shall be supplied by the vendor

b — Normally closed



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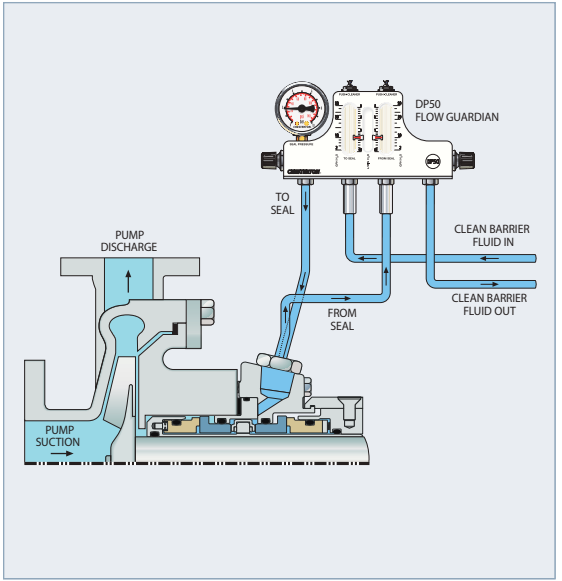
PLAN 54

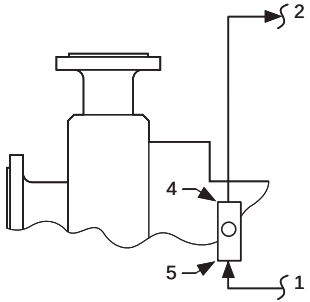
Circulation with Pressurized External Barrier Fluid Source and Flow Guardian™ DP50

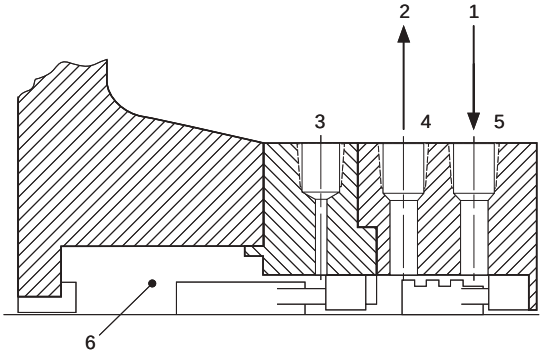
What	Dual seal arrangement used with a dual flow meter measuring flow in and out of the seal. A pressurized, external fluid source provides clean fluid to the seal via an external pressure header.
Why	To provide a barrier of clean fluid to lubricate the inboard and outboard seal faces; to prevent solids from penetrating and damaging the inboard seal faces.
When	Used with products with high solids content; used when cooling is a primary requirement; can be used to heat the seal; used when a secure source of external fluid is available.



KEY

1 — From External Source
2 — To External Source
3 — Flush (F)
4 — Liquid Barrier Outlet (LBO)
5 — Liquid Barrier Inlet (LBI)
6 — Seal Chamber





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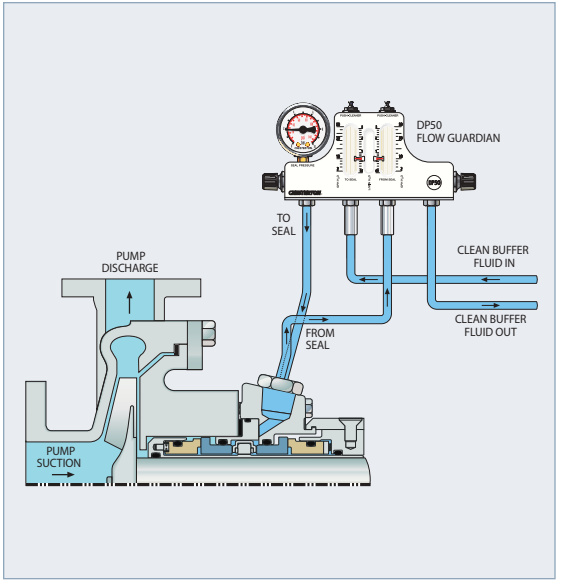
PLAN 55

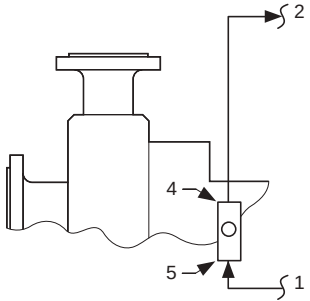
Circulation External Buffer Fluid Source and Flow Guardian™ DP50

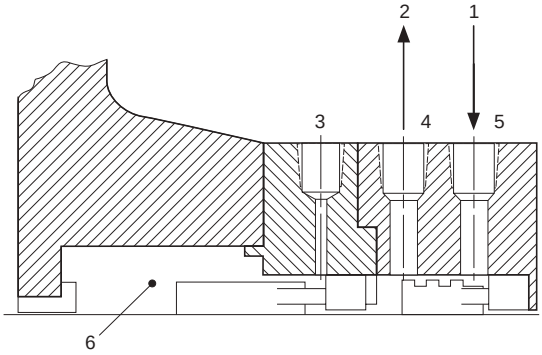
What	Dual seal arrangement used with a dual flow meter measuring flow in and out of the seal.
Why	To provide a buffer of clean fluid to lubricate the inboard and outboard seal faces.
When	Used with products with high solids content.



KEY

1 — From External Source
2 — To External Source
3 — Flush (F)
4 — Liquid Buffer Outlet (LBO)
5 — Liquid Buffer Inlet (LBI)
6 — Seal Chamber





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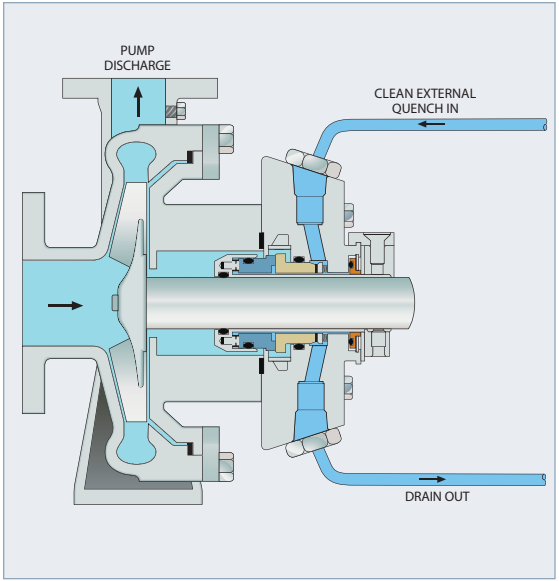
Quench Seals

- Plan 62

PLAN 62

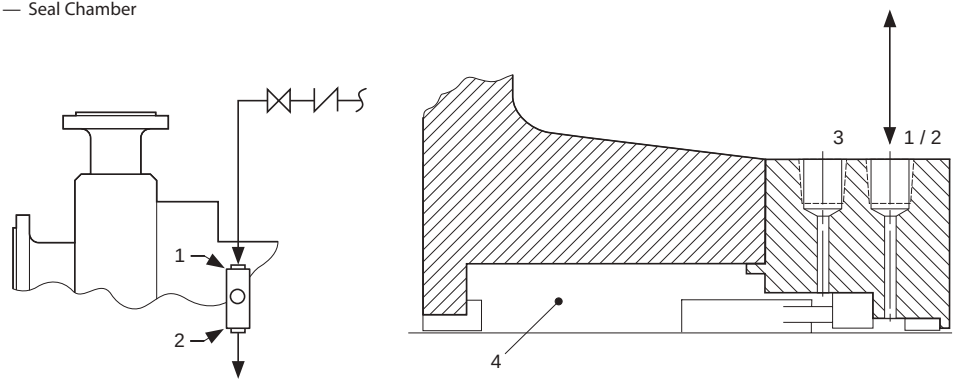
Quench

What	A steam or water quench.
Why	To remove solids from the seal internals or to control the temperature at the seal faces, while not contaminating the product; to minimize air contact at the seal faces.
When	Used when product cokes, hardens, or crystallizes across the seal faces due to temperature reduction or contact with air.



KEY

1 — Quench (Q)
2 — Drain (D)
3 — Flush (F)
4 — Seal Chamber



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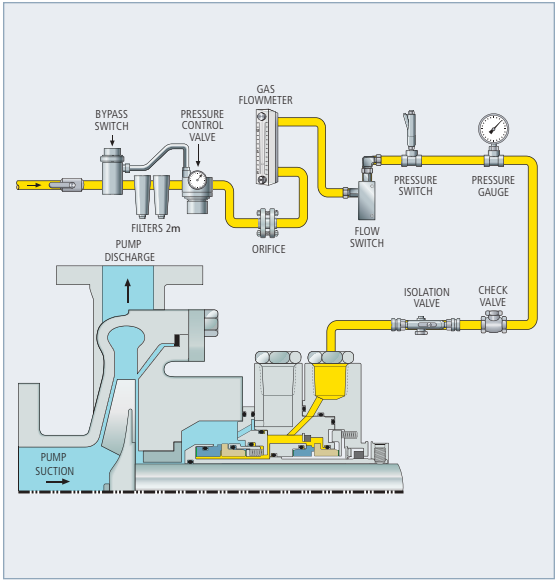
Containment Seals

- Plan 72
- Plan 75
- Plan 76

PLAN 72

Externally Supplied Buffer Gas

What	A low-pressure buffer gas is regulated between the primary seal and the containment seal; typically, nitrogen is used as the buffer gas.
Why	Can reduce emissions, cools the containment seal which is typically dry running and protects against icing in cryogenic services.
When	Normally used in conjunction with Plan 75 or Plan 76.

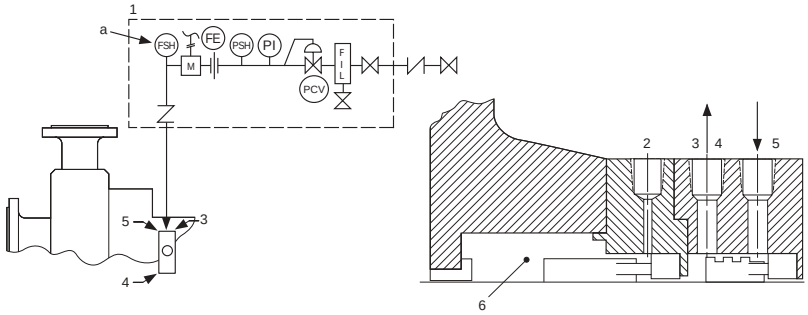


KEY

1 — Buffer Gas Panel
2 — Flush (F)
3 — Containment Seal Vent (CSV)
4 — Containment Seal Drain (CSD)
5 — Gas Buffer Inlet (GBI)
6 — Seal Chamber
FE — Flow Meter (magnetic type shown)
M — Monitoring
FIL — Coalescing Filter – Used to ensure solids and/or liquids which might be present in buffer gas do not contaminate seals
PCV — Pressure Control Valve – Used to limit buffer gas pressure to prevent reverse pressurization of inner seal and/or limit pressure applied to containment seal
PI — Pressure Indicator
PCL — Pressure Switch Low (optional, not shown)
FSH — Flow Switch High

NOTES

a — If specified



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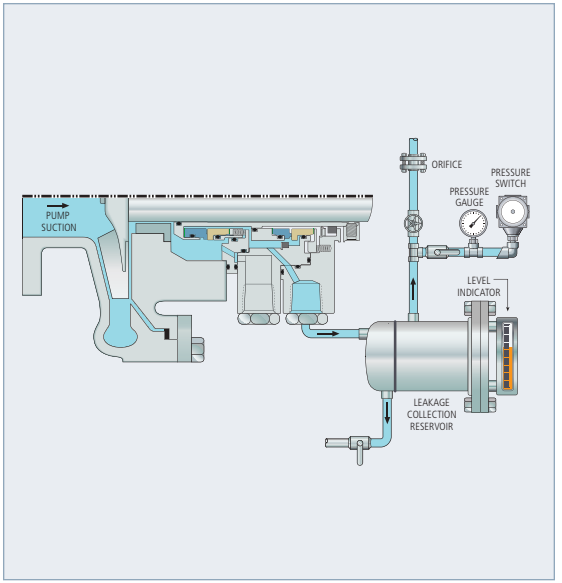
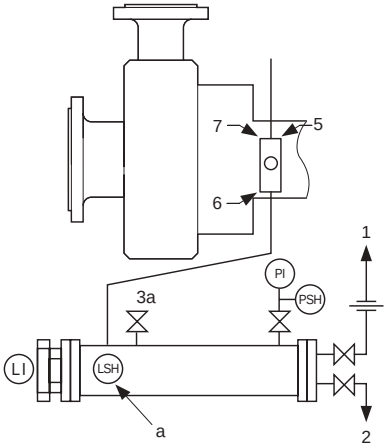
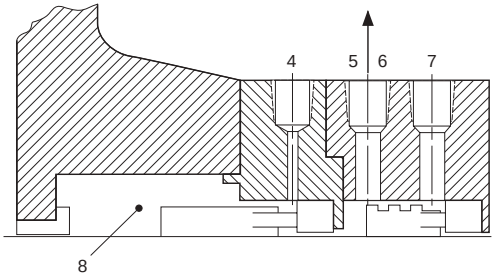
PLAN 75

Reservoir Containment

What	A collection reservoir used with a dual containment seal to capture liquid that is collecting or condensing in the seal cavity.
Why	Collects leakage that might possibly escape into the atmosphere, therefore eliminating process emissions.
When	Normally used with fluids that are typically a liquid or condensate in conjunction with Plan 72.







KEY

1 — To Vapor Collection System
2 — To Liquid Collection System
3 — Test Connection
4 — Flush (F)
5 — Containment Seal Vent (CSV), plugged
6 — Containment Seal Drain (CSD)
7 — Gas Buffer Inlet (GBI)
8 — Seal Chamber
LI — Level Indicator
LSH — Level Switch High
PI — Pressure Indicator
PSH — Pressure Switch High
FSH — Flow Switch High (optional, not shown)

NOTES

a — If specified

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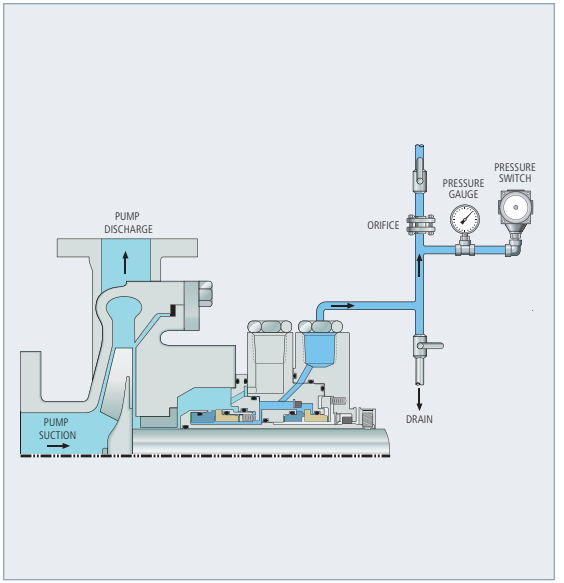
PLAN 76

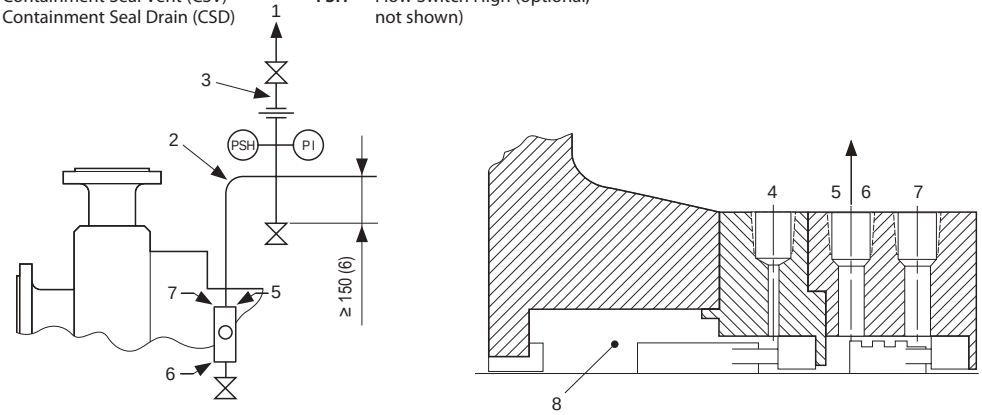
Vent to Flare

What	Used with a dual containment seal where primary seal leakage is piped to a flare or a vapor recovery system.
Why	Collects vapor that might possibly escape into the atmosphere, therefore eliminating process emissions.
When	Normally used where any process leakage remains in vapor form and will not condense to a liquid in lower temperatures or pressures; used in conjunction with Plan 72.



KEY

1 — To Vapor Recovery System
2 — Tube
3 — Pipe
4 — Flush (F)
5 — Containment Seal Vent (CSV)
6 — Containment Seal Drain (CSD)
7 — Gas Buffer Inlet (GBI)
8 — Seal Chamber
PI — Pressure Indicator
PSH — Pressure Switch High
FSH — Flow Switch High (optional, not shown)



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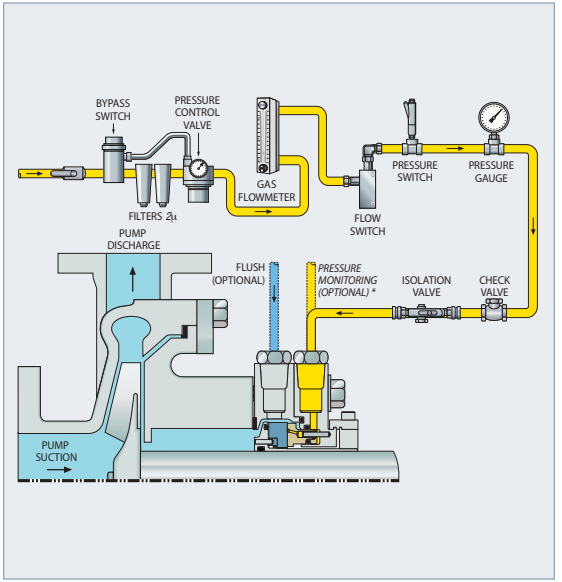
Gas Seals

- Plan 74

PLAN 74

Externally Supplied Barrier Gas

What	A barrier gas provided for a gas seal at a pressure higher than process.
Why	To promote face lift-off and non-contact gas sealing. Also prevents process fluid from leaking into the atmosphere.
When	Gas sealing is the requirement for difficult applications; use with process fluids with low vapor pressure or fluids with poor lubricating properties.

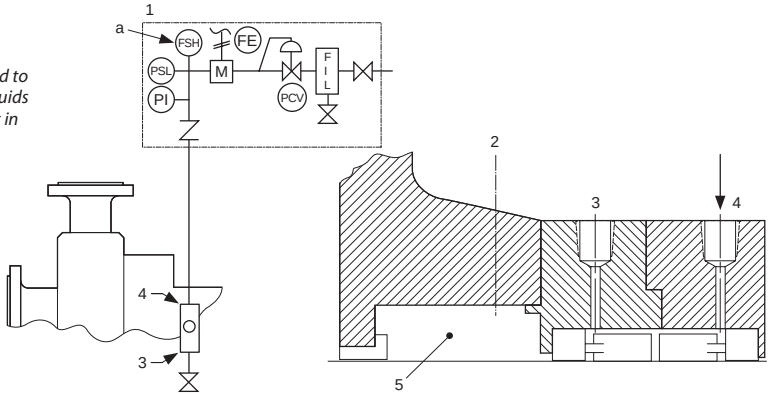


KEY

- **1** — Gas Barrier Panel
- **2** — Vent (If Required)
- **3** — Gas Barrier Outlet (Normally Closed) – *Used only to depressurize seal chamber.*
- **4** — Gas Barrier Inlet
- **5** — Seal Chamber
- **FE** — Flow Meter
- **FIL** — Coalescing Filter – *Used to ensure solids and/or liquids which might be present in barrier gas do not contaminate seals.*
- **FSH** — Flow Switch High
- **M** — Monitoring
- **PI** — Pressure Indicator
- **PCV** — Pressure Control Valve – *Set pressure above process side of inner seal.*
- **PSL** — Pressure Switch Low

NOTES

a — If specified



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- Over 1200 trained local Service Specialists and Technicians

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