

# ENVIRONMENTAL CONTROL PLANS

POCKET AND REFERENCE GUIDE



# 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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## ■ **Quench Seals**

Plan 62

## ■ **Containment Seals**

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## ■ **Gas Seals**

Plan 74

# 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.*

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## 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



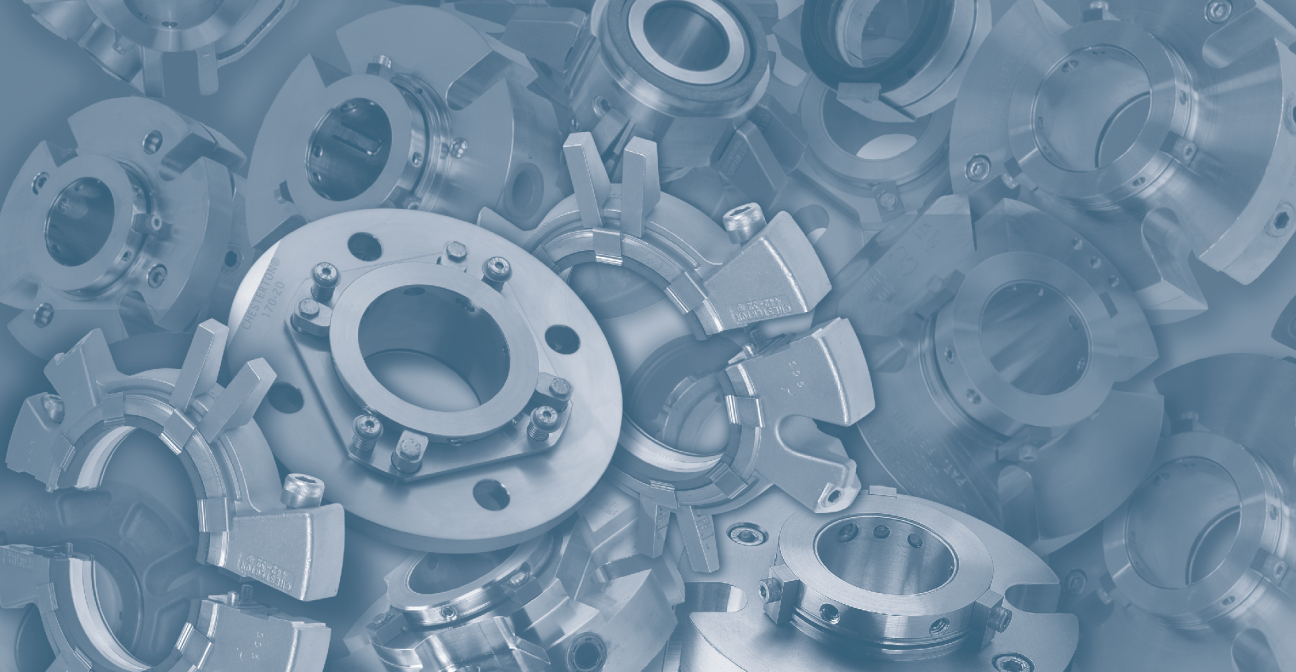
Block Valve



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

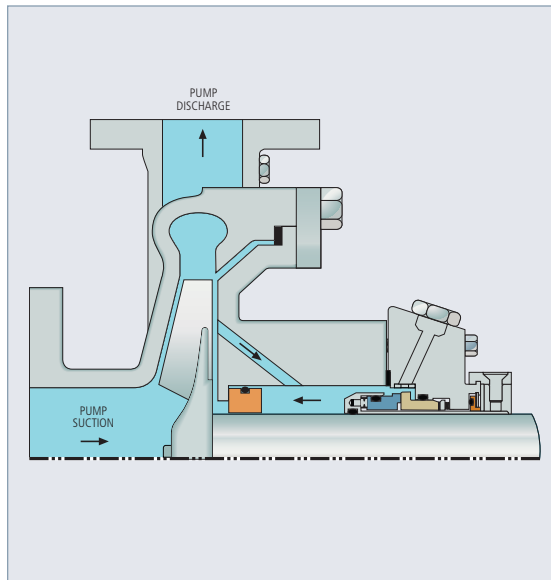
# PLAN 1

## Internal Flush

**What** Internal recirculation of pumped fluid through internal passage.

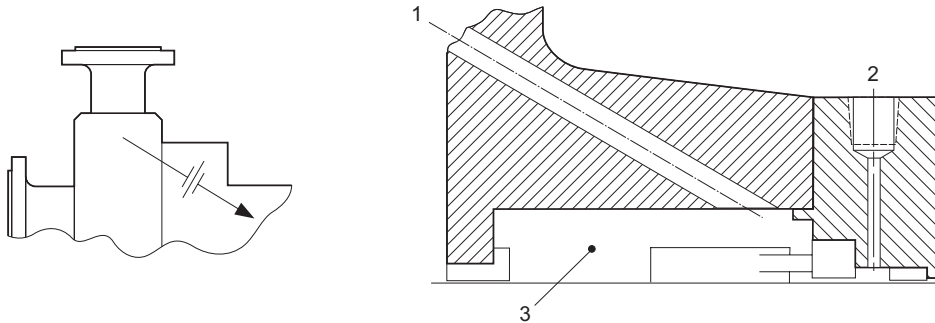
**Why** Increase pressure in the seal chamber or promote fluid circulation.

**When** Sealing clean fluids with low vapor pressures.



**KEY**

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



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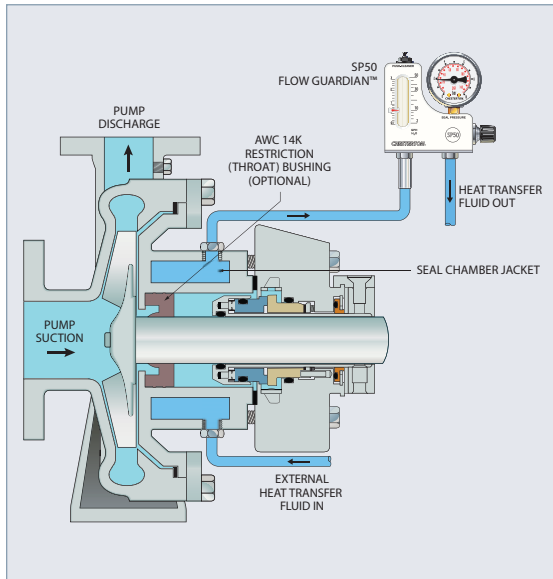
## PLAN 2

### 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.

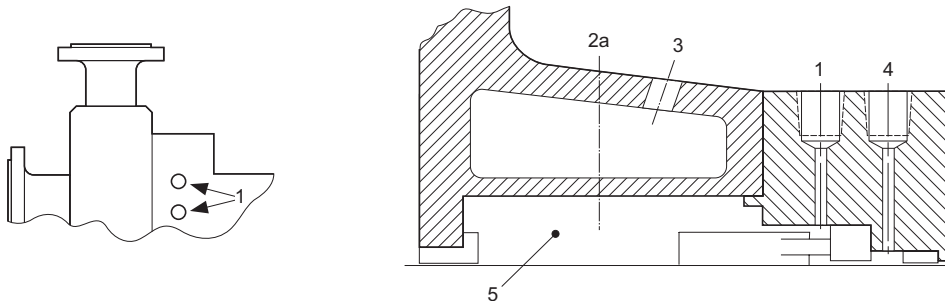


**KEY**

- 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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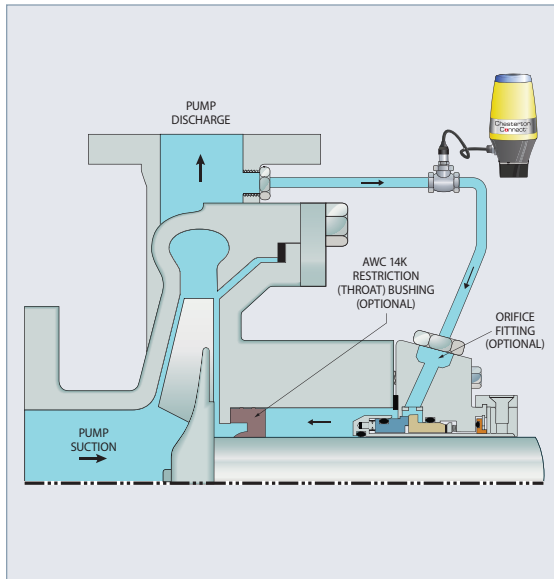
# PLAN 11

## 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.

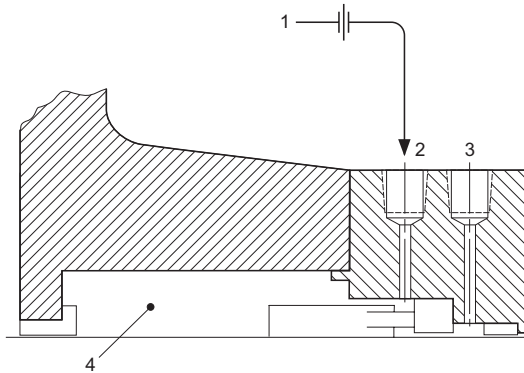
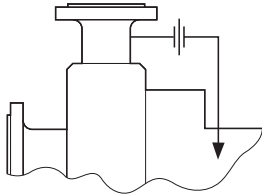
**When** With clean process fluids. Process fluids with particulate may cause abrasion.





**KEY**

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

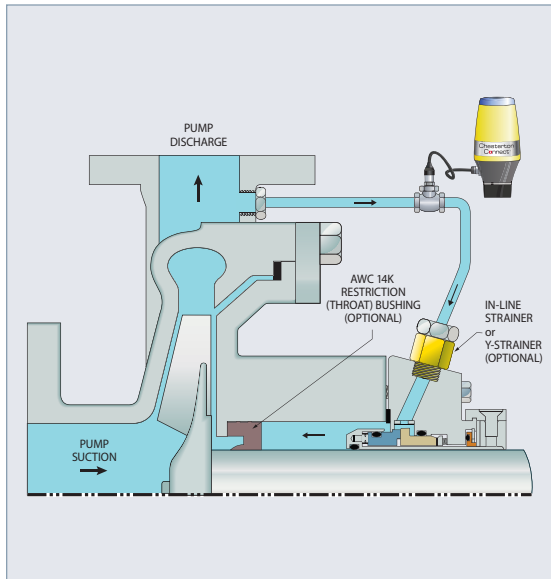


*Drawing reproduced from ANSI/API Standard 682, Third Edition, September 2004, courtesy of the American Petroleum Institute.*

## PLAN 12

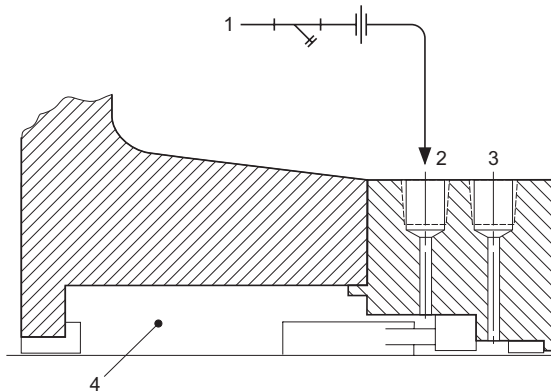
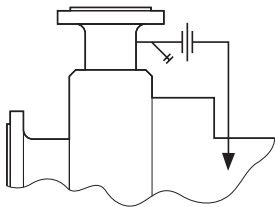
### Discharge Recirculation with Strainer

- 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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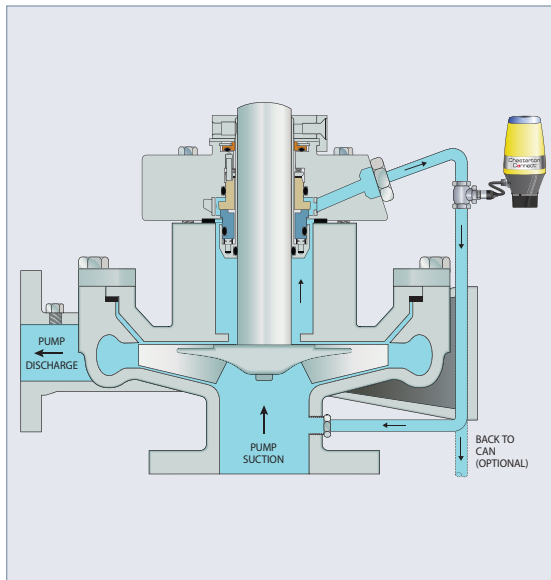
# PLAN 13

## Suction Recirculation

**What** Suction recirculation through an orifice to the flush port of the seal.

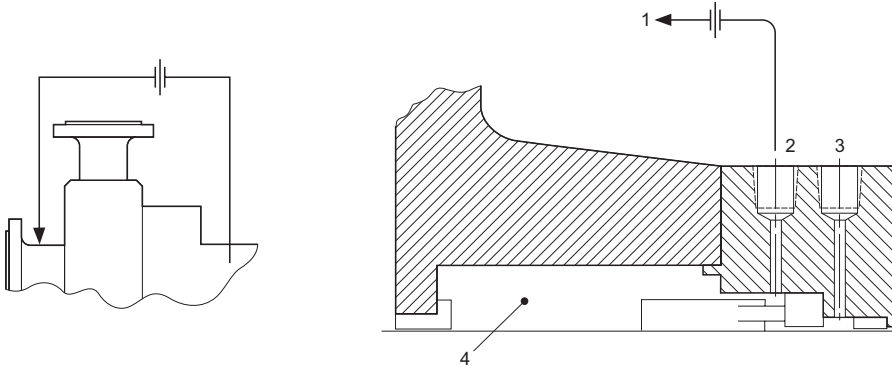
**Why** To vent the seal chamber area and/or to reduce the seal chamber pressure.

**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



*Drawing reproduced from ANSI/API Standard 682, Third Edition, September 2004, courtesy of the American Petroleum Institute.*

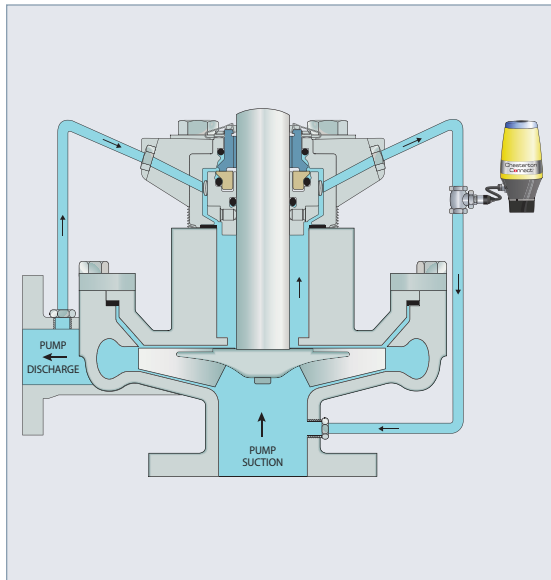
# PLAN 14

## 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.

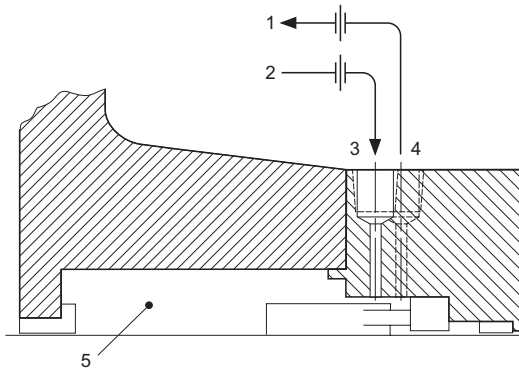
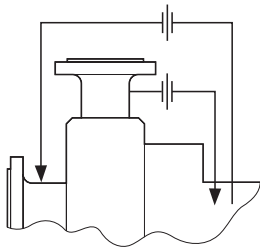
**Why** To promote flow through the seal chamber for cooling while also venting the seal chamber and lowering pressure.

**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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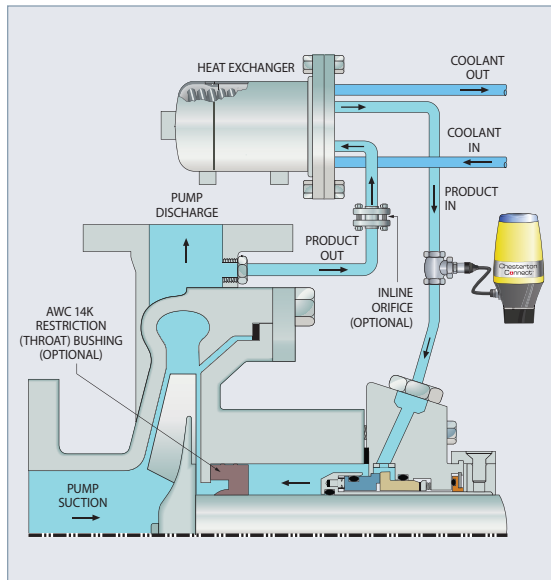
# PLAN 21

## 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.

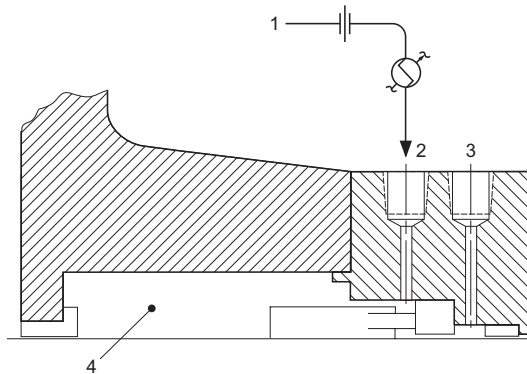
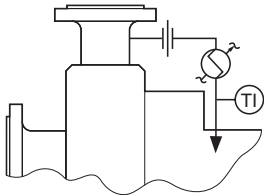
**When** Use with clean fluids. High-velocity solids may cause seal abrasion and score the seal faces if directed by the flush port.





**KEY**

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



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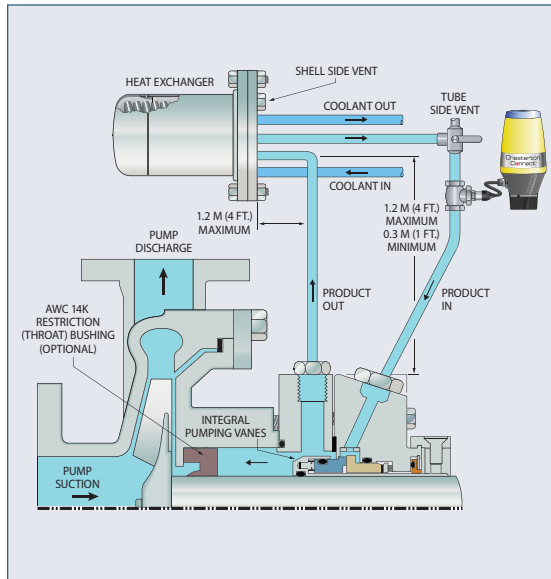
# PLAN 23

## 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.

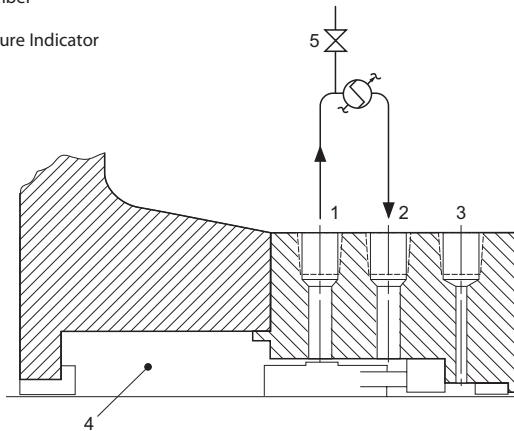
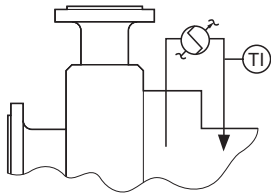
**When** Hot applications that exceed vapor pressure. Better on process fluid with solids compared to Plan 21.



**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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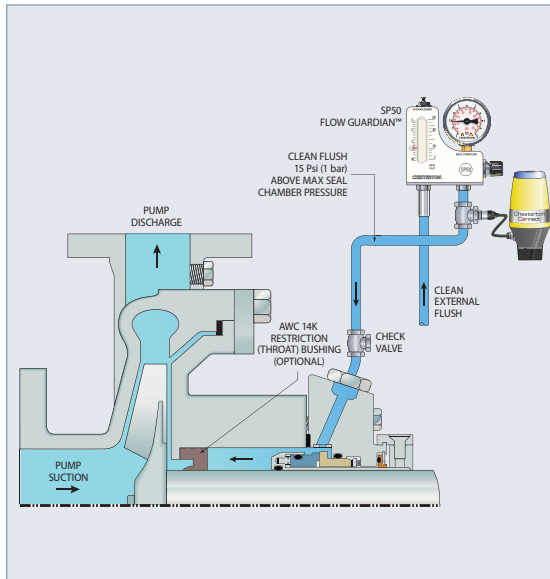
# PLAN 32

## 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.

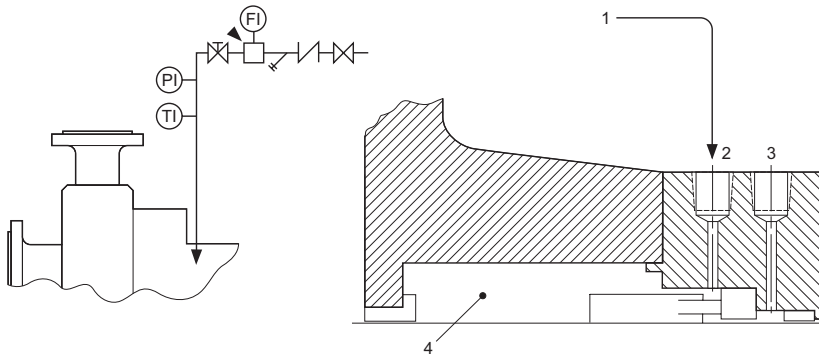
**When** Used with a product with excessive solids, crystallizing product, or a product with a low vapor pressure.



**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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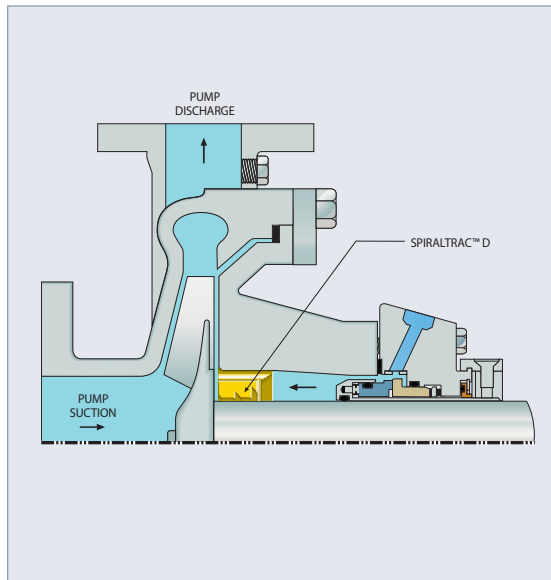
# Chesterton® PLAN 33H

## 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.

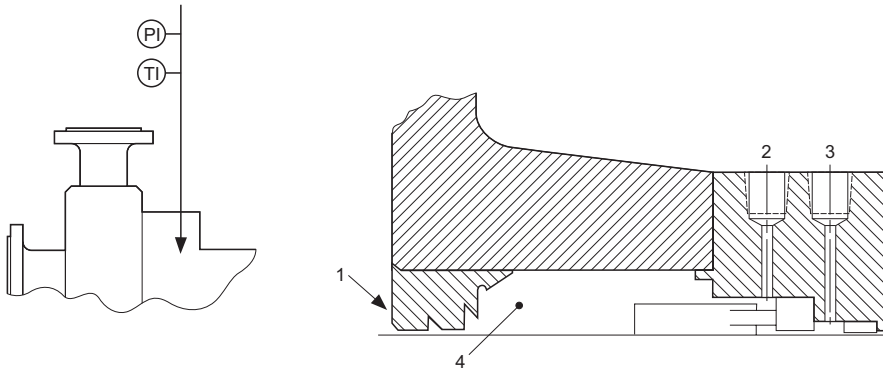


SpiralTrac™ is a trademark of EnviroSeal Engineering Products Ltd.

**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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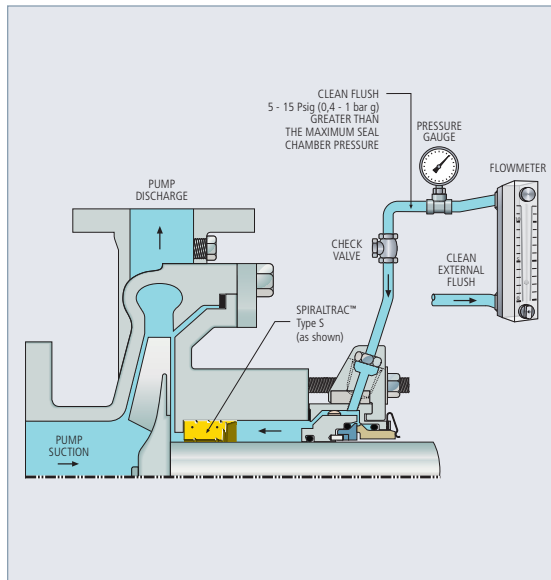
# Chesterton® PLAN 33S

## 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.



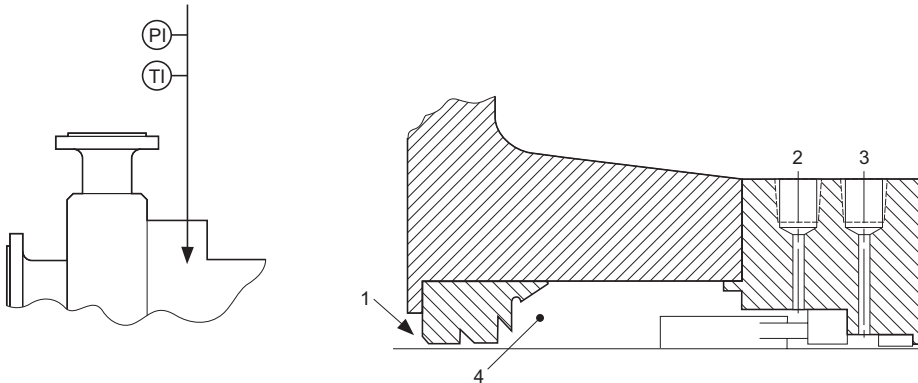
SpiralTrac™ is a trademark of EnviroSeal Engineering Products Ltd.



**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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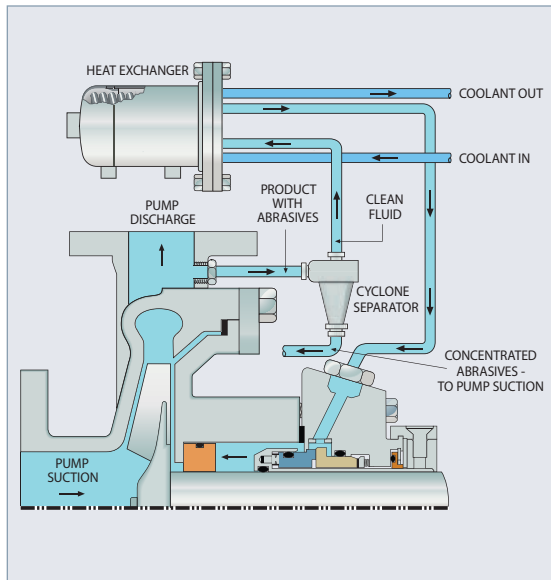
## PLAN 41

### 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.

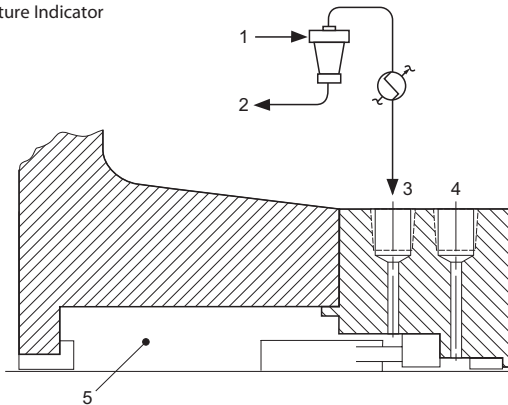
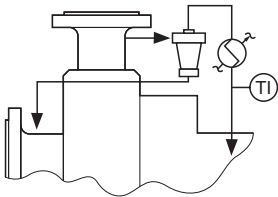
**When** Sealing dirty, hot process fluids.



**KEY**

- 1 — From Pump Discharge
- 2 — To Pump Suction
- 3 — Flush (F)

- 4 — Quench/Drain (Q/D)
- 5 — Seal Chamber
- TI — Temperature Indicator



*Drawing reproduced from ANSI/API Standard 682, Third Edition, September 2004, courtesy of the American Petroleum Institute.*

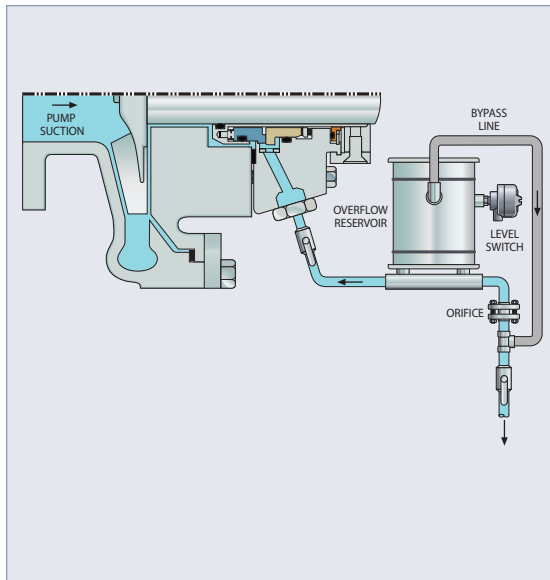
# PLAN 65

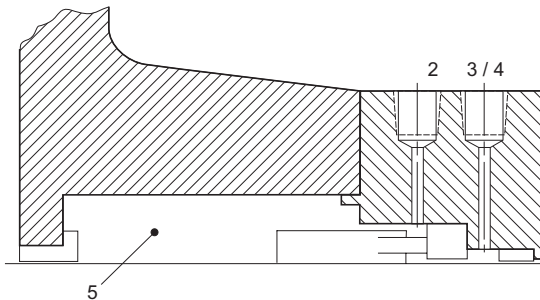
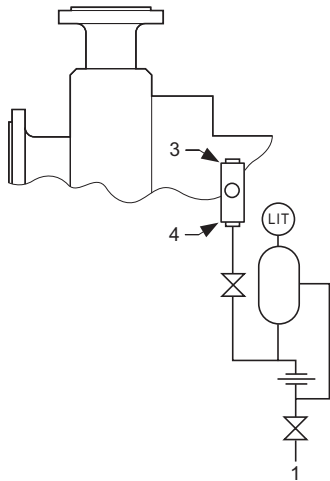
## Reservoir with Alarm System

**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.



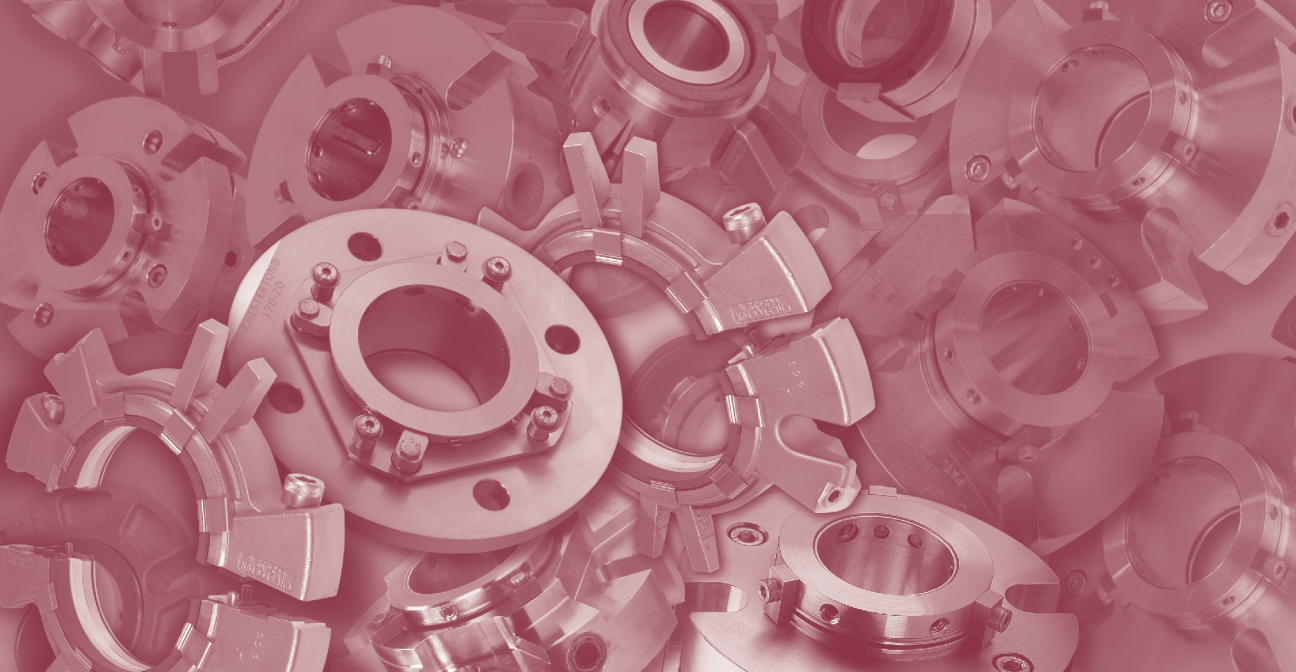


**KEY**

- 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

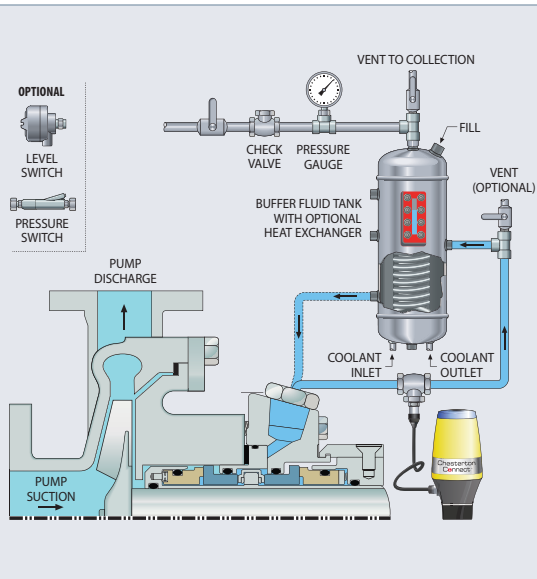
### Circulation with External Buffer Fluid Tank

**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.

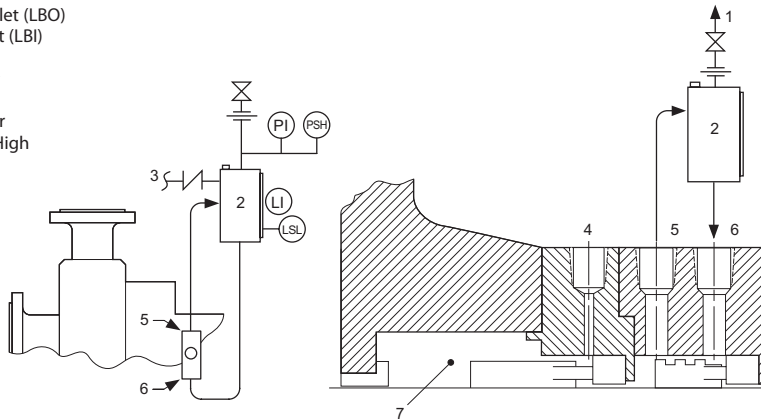
Note: Tank should be installed at least 0.3 M (1 ft.) above seal and at most 1.2 M (4 ft.) away. Piping should be continuously ascending with minimized bends.





**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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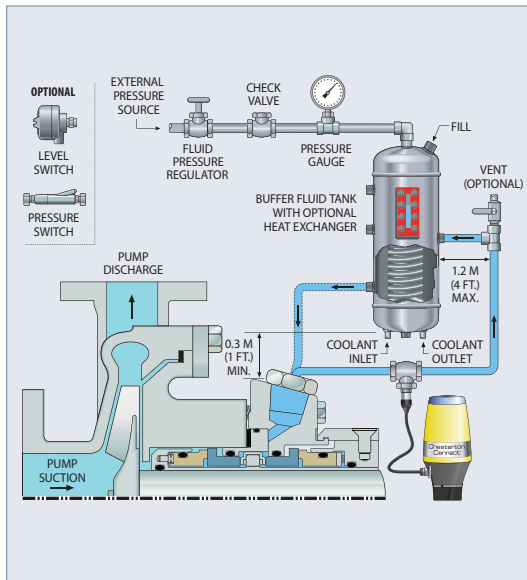
# PLAN 53A

## 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)

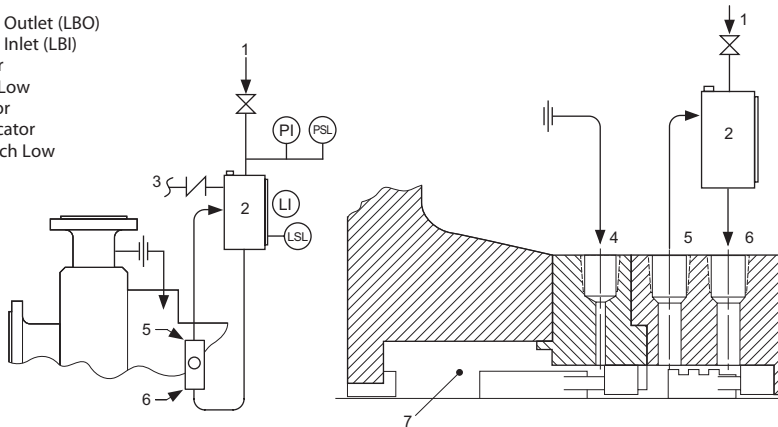
7 — Seal Chamber

LSL — Level Switch Low

LI — Level Indicator

PI — Pressure Indicator

PSL — Pressure Switch Low



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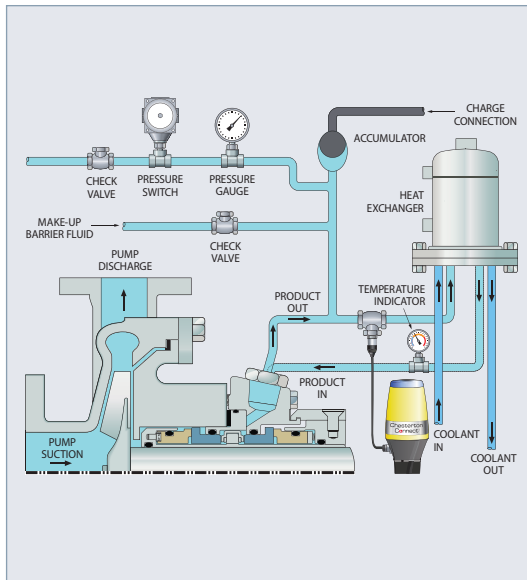
## PLAN 53B

### 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.

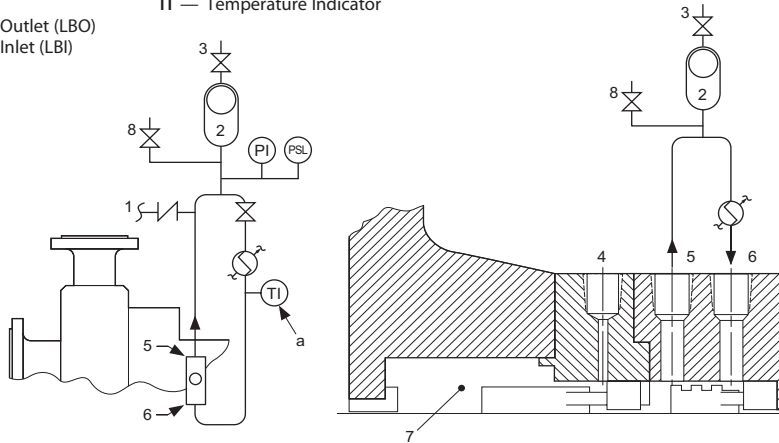


**KEY**

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

**NOTES**

- a — If specified



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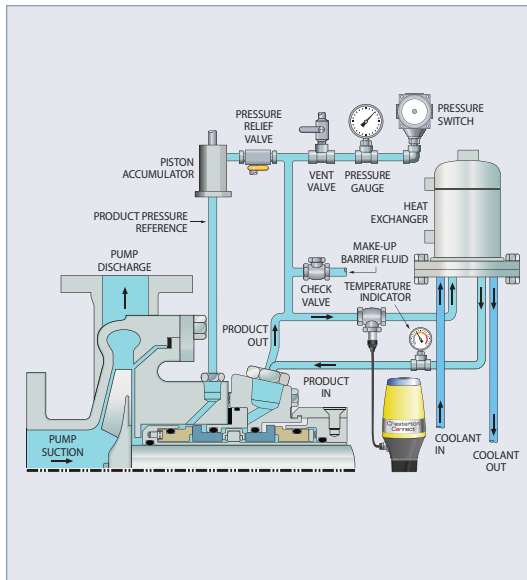
## PLAN 53C

### 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.



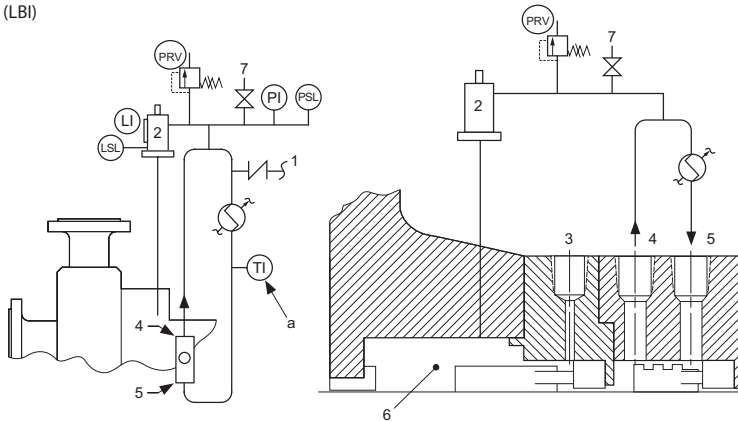
**KEY**

- 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

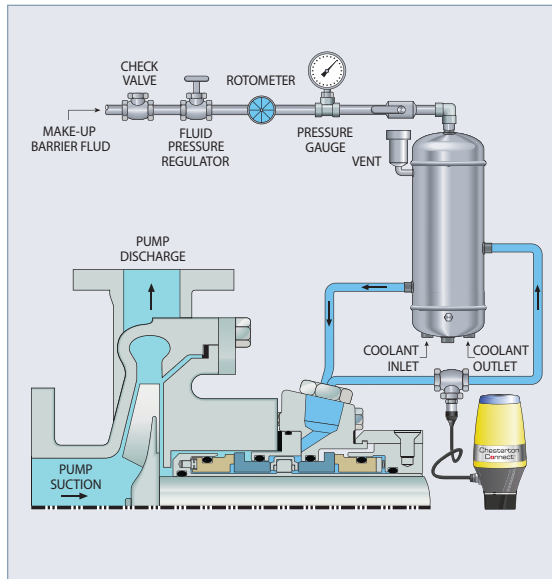
## Circulation with Pressurized External Barrier Fluid Tank

**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.





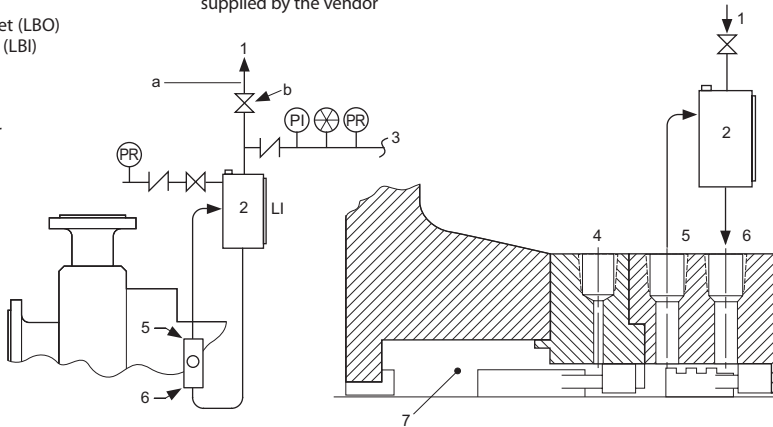
**KEY**

- 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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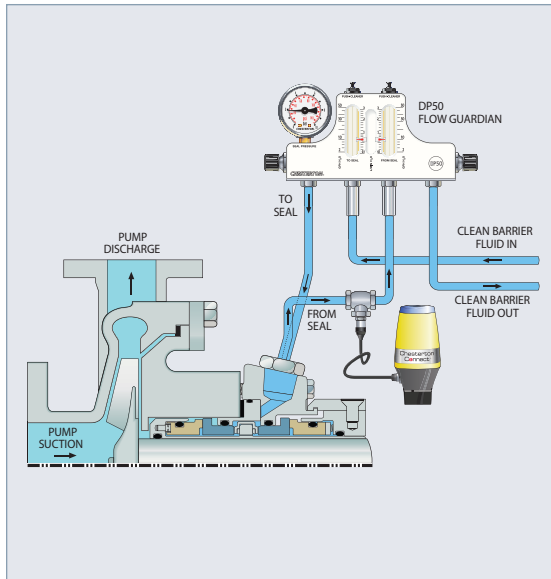
## PLAN 54

### 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.

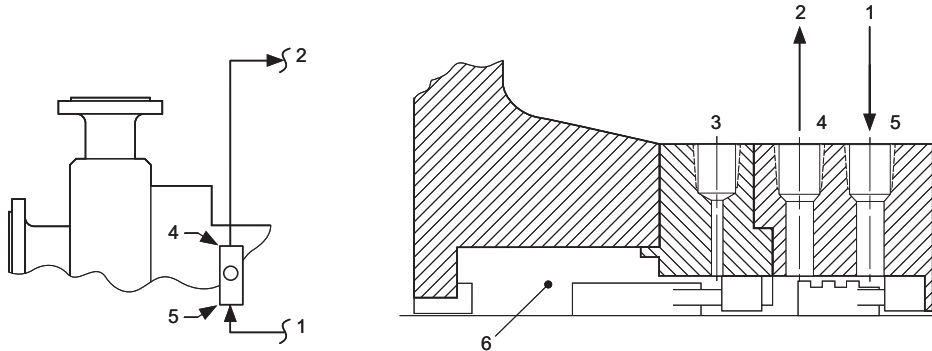
**Why** To provide a barrier of clean fluid to lubricate the inboard and outboard seal faces; to prevent solids from penetrating and damaging the inboard seal faces.

**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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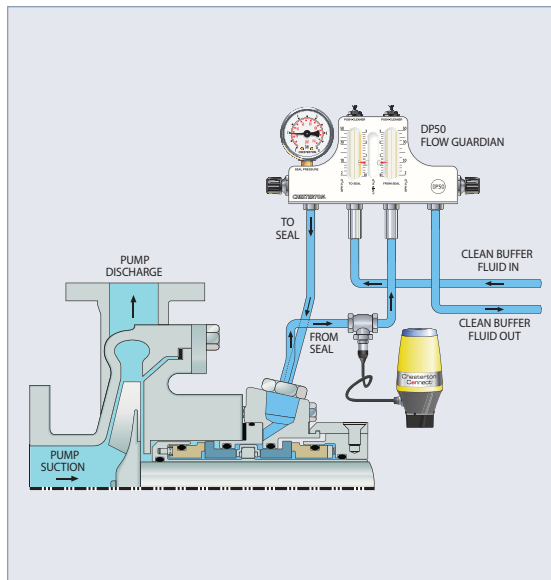
## PLAN 55

### 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.

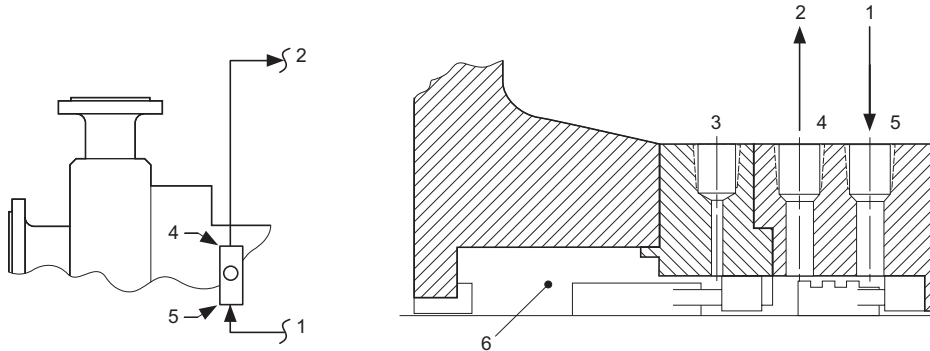
**Why** To provide a buffer of clean fluid to lubricate the inboard and outboard seal faces.

**When** Used with products with high solids content.

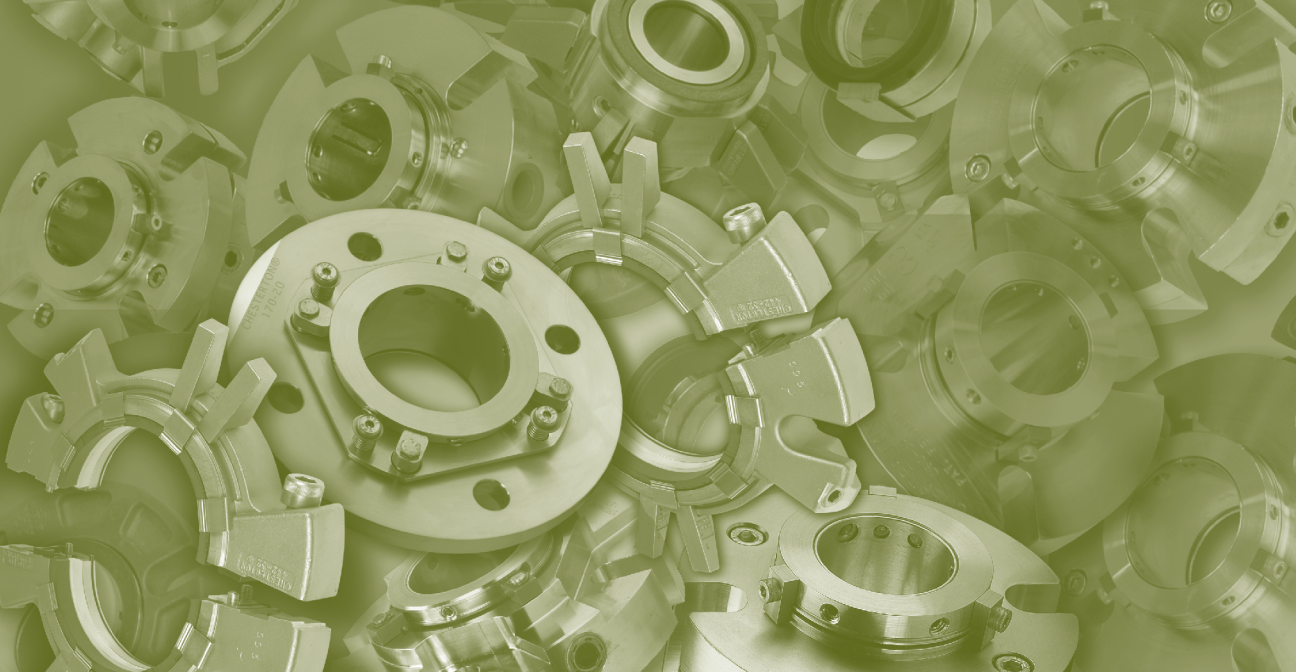


**KEY**

- 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

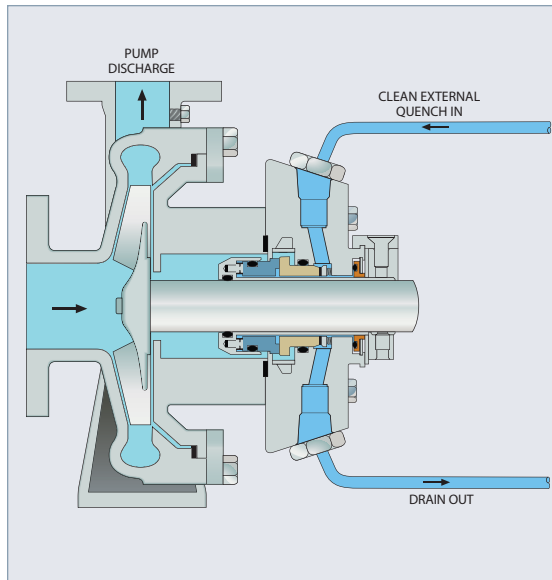
# PLAN 62

## 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.

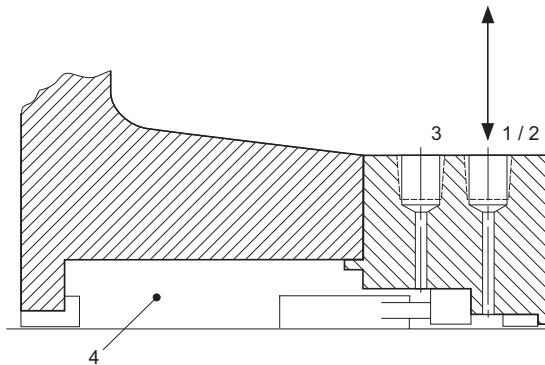
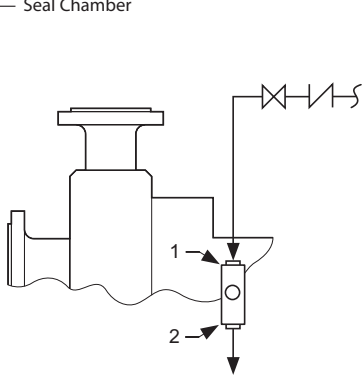
**When** Used when product cokes, hardens, or crystallizes across the seal faces due to temperature reduction or contact with air.



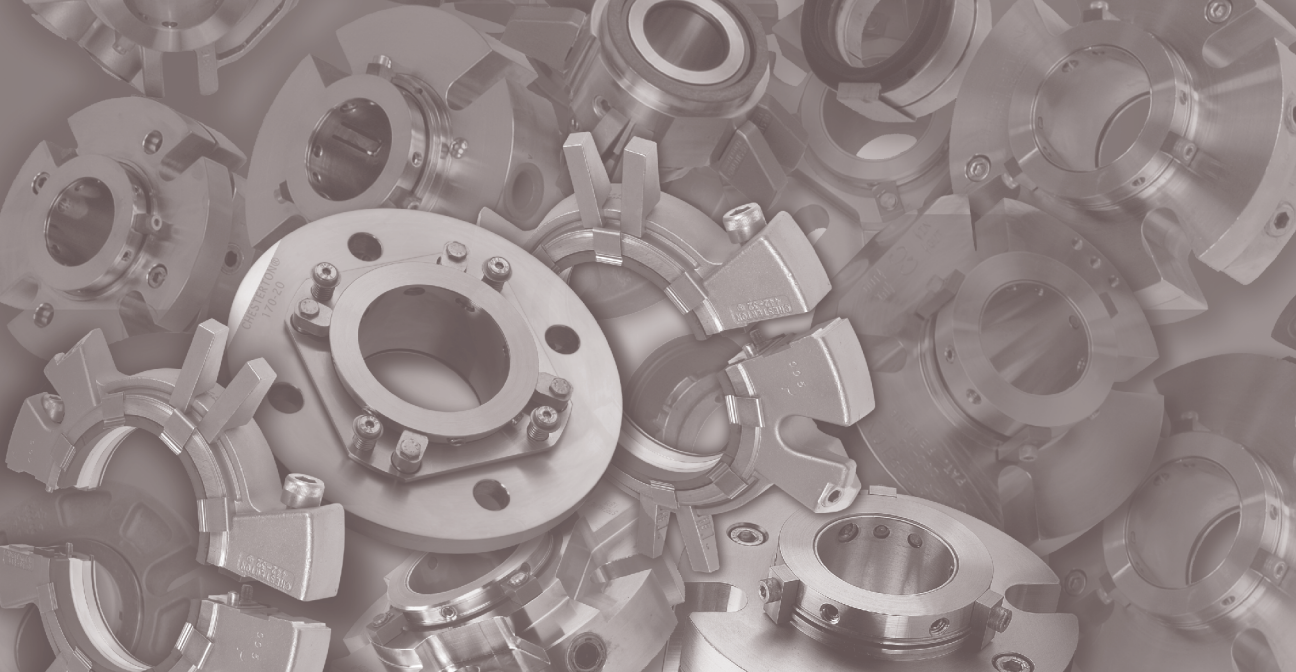


**KEY**

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



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# Containment Seals

- Plan 72
- Plan 75
- Plan 76

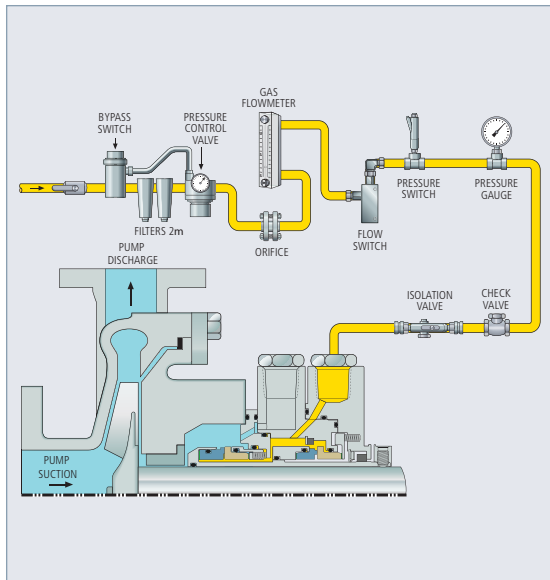
# PLAN 72

## 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.



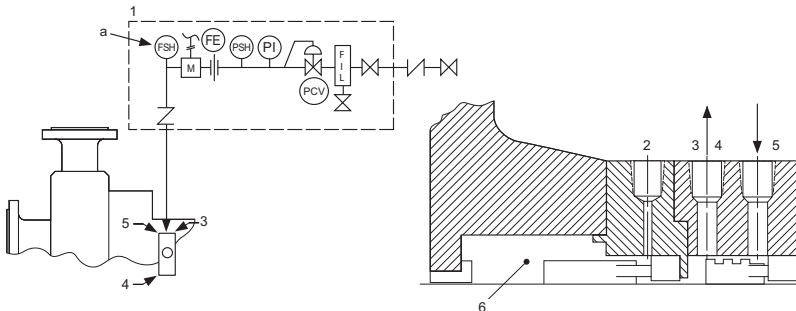
## KEY

- 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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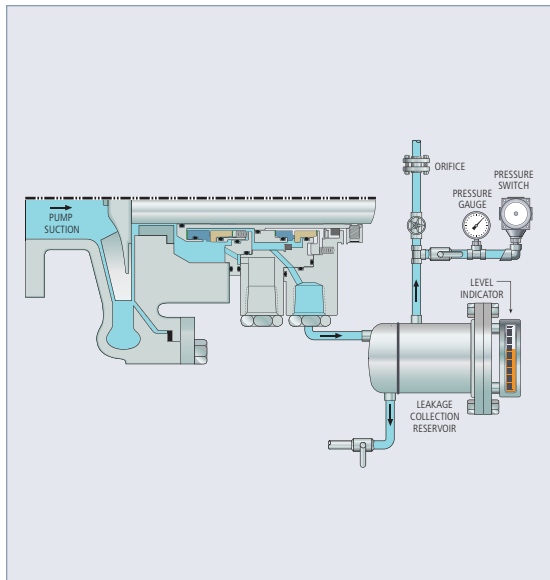
# PLAN 75

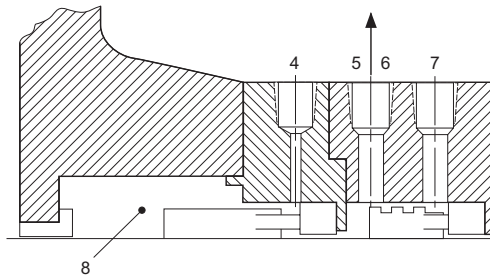
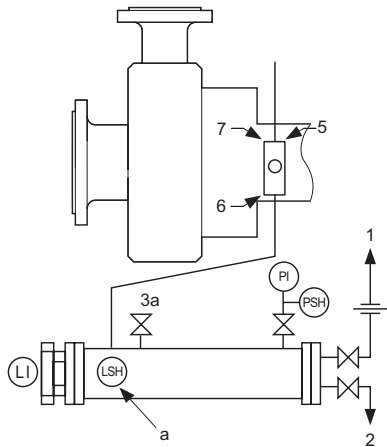
## Reservoir Containment

**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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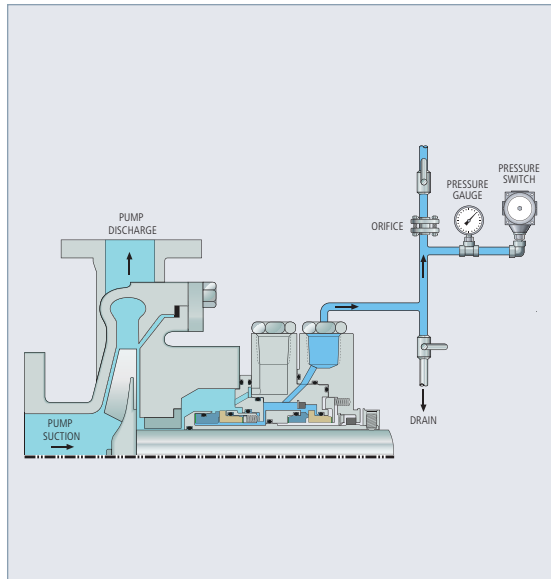
# PLAN 76

## 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)

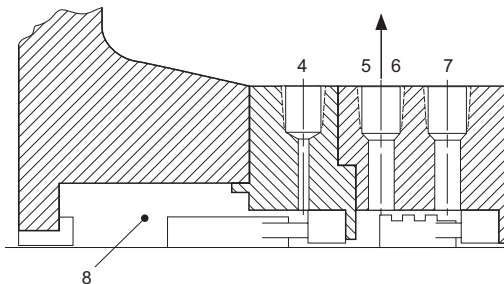
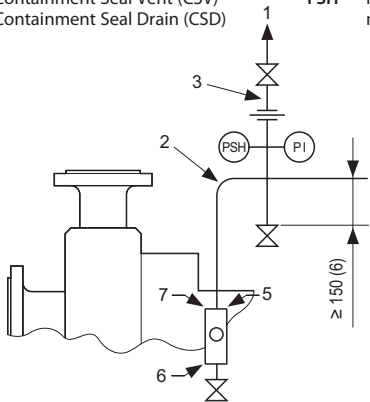
7 — Gas Buffer Inlet (GBI)

8 — Seal Chamber

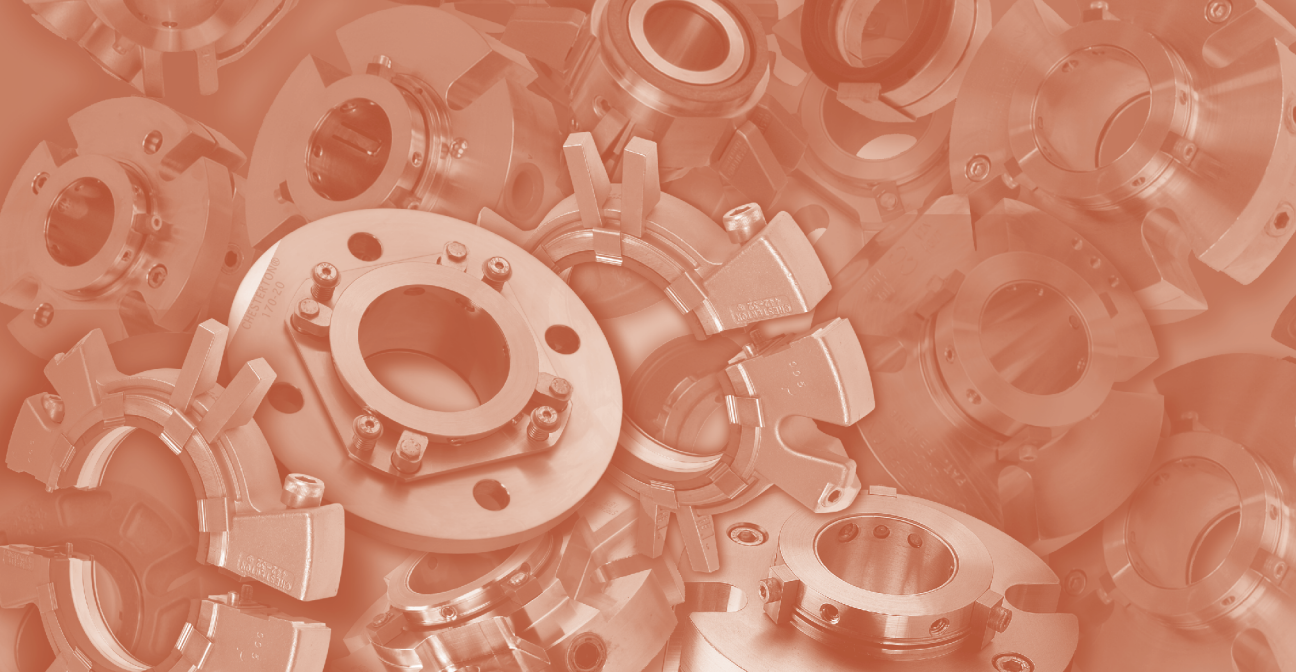
PI — Pressure Indicator

PSH — Pressure Switch High

FSH — Flow Switch High (optional,  
not shown)



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# Gas Seals

- Plan 74

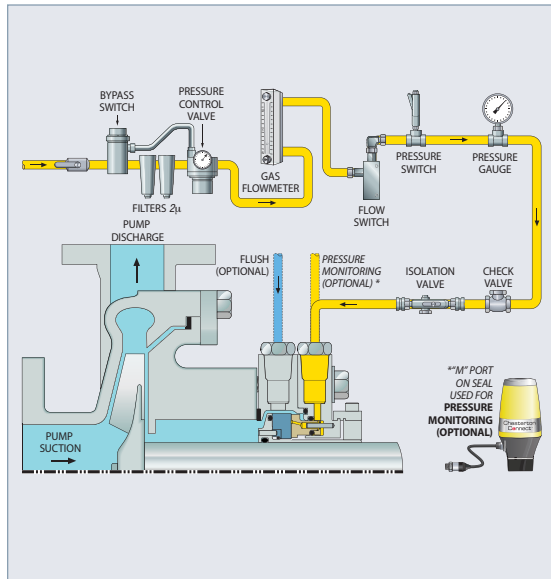
# PLAN 74

## 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.



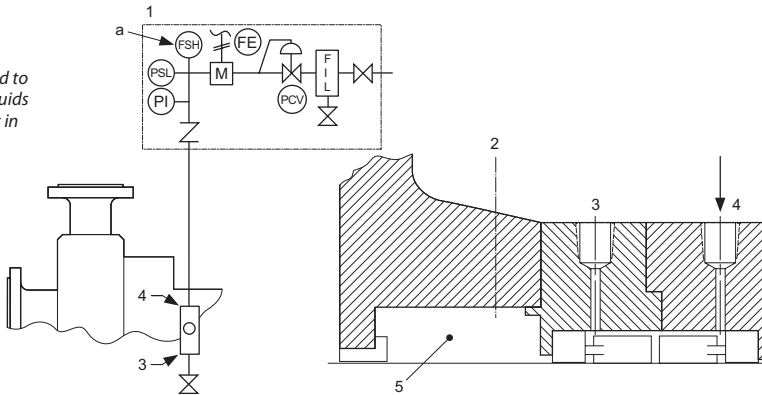
**KEY**

- 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

**NOTES**

a — If specified

- PCV — Pressure Control Valve –  
*Set pressure above process side of inner seal.*
- PSL — Pressure Switch Low



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- More than 500 Service Centers and Sales Offices worldwide
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