







## ***Mechanical Seal Piping Plans***

-  **Single Seals** plans 01, 02, 03, 11, 13, 14, 21, 23, 31, 32, 41
-  **Dual Seals** plans 52, 53A, 53B, 53C, 54, 55
-  **Quench Seals** plans 62, 65A, 65B, 66A, 66B
-  **Gas Seals** plans 72, 74, 75, 76

***Experience In Motion***



## *Mechanical Seal Piping Plans*

Flowserve recognizes that one of the most effective ways to achieve long, uninterrupted mechanical seal life is to create a healthy environment around the seal faces. Piping plans help keep mechanical seals running cool and clean, promote safe handling of dangerous fluids, and extend the operational availability of rotating equipment. This reference book provides a concise summary of the most essential piping plans used successfully in today's process plants.

Each plan shows all the standard and optional auxiliary components referenced in ISO 21049 / API Standard 682 and recommended by Flowserve. Consult your local Flowserve sales engineer to identify the right solution that satisfies your application requirements.

## Page Layout

### Seal End View

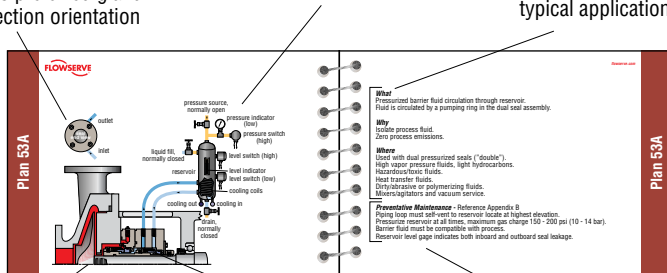
- Viewed from drive end
- Shows preferred gland connection orientation

### Piping Plan Layout

- Illustrated schematic of auxiliary components

### What, Why, and Where

- Describes piping plans, their purpose, and typical applications



### Pump Cross-section

- Simplified centrifugal pump shown for all plans

### Mechanical Seal

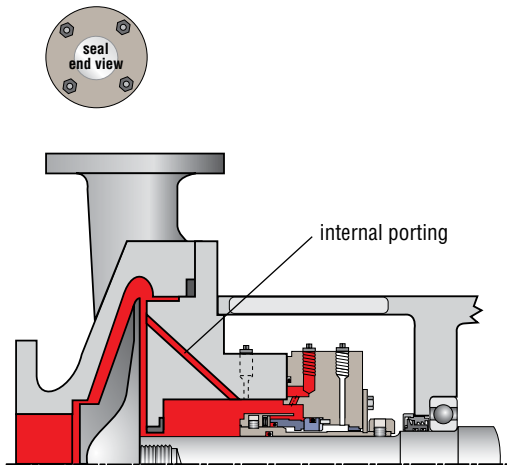
- Shows typical seal arrangements

### Preventative Maintenance

- Provides general tips to improve reliability and for troubleshooting



# Plan 01



***What***

Internal seal chamber flush from pump discharge.  
Operates similar to Plan 11.

***Why***

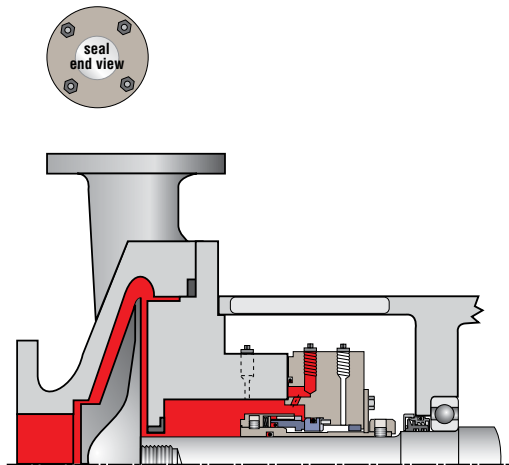
Seal chamber heat removal.  
Seal chamber venting on horizontal pumps.  
Reduce risk of freezing/polymerizing fluid in exposed Plan 11 piping.

***Where***

Custom seal chamber, most likely an ANSI/ASME pump.  
Clean, moderate temperature fluids.  
Used with single seals, rarely with dual seals.

***Preventative Maintenance***

Flush typically can not be directed over seal faces and seal heat removal is limited.  
Calculate flush flow rate based on head loss through internal porting.



***What***

Dead-ended seal chamber with no flush.

***Why***

No fluid recirculation needed.

***Where***

Cooling jacket seal chambers in high temperature services.

Clean fluids.

Top-entry mixers/agitators with dry seals.

Heating jacket seal chambers in fluids that solidify at low temperatures.

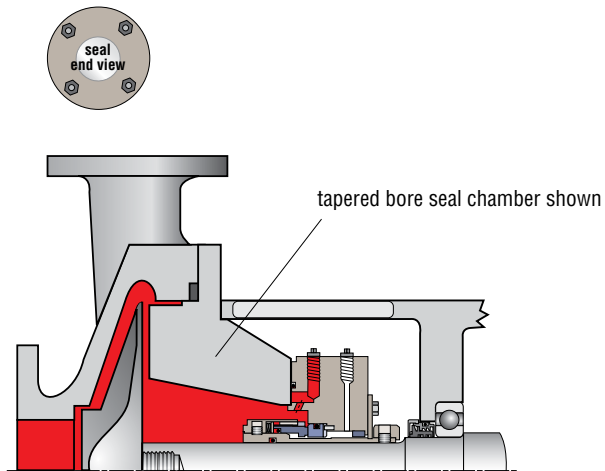
***Preventative Maintenance***

Process must have adequate boiling point margin to avoid vaporization.

Cooling fluid in seal chamber jacket may be needed at all times in hot services.

Horizontal equipment must be self-venting.

Often used in combination with steam quench, Plan 62.





***What***

Circulation created by the design of the seal chamber.

***Why***

No external fluid recirculation needed.

Solids removal from seal chamber.

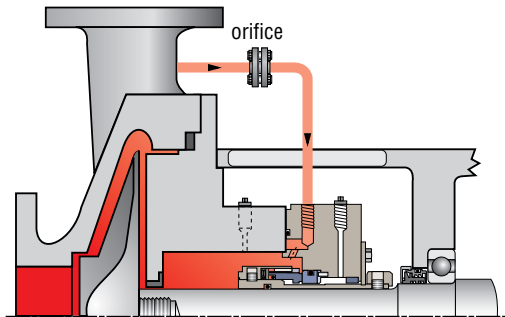
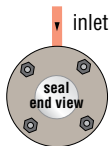
***Where***

Large bore/open throat seal chambers.

Dirty or contaminated fluids.

***Preventative Maintenance***

Proper seal chamber design helps prevent solids from collecting at the seal faces.



### ***What***

Seal flush from pump discharge through orifice.

Default single seal flush plan.

### ***Why***

Seal chamber heat removal.

Seal chamber venting on horizontal pumps.

Increase seal chamber pressure and fluid vapor margin.

### ***Where***

General applications with clean fluids.

Clean, non-polymerizing fluids.

### ***Preventative Maintenance***

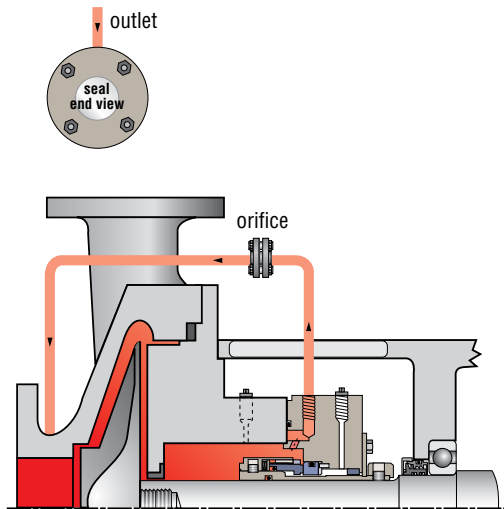
Use an orifice with a minimum 3 mm (1/8 inch) diameter.

Calculate flow rates to size orifice for adequate seal chamber flow.

Increase boiling point margin with proper orifice and throat bushing sizing.

Flush should be directed over seal faces with piping at 12 O'clock position.

Typical failure mode is a clogged orifice - check temperatures at pipe ends.



***What***

Recirculation from seal chamber to pump suction through orifice.  
Standard flush plan on vertical pumps.

***Why***

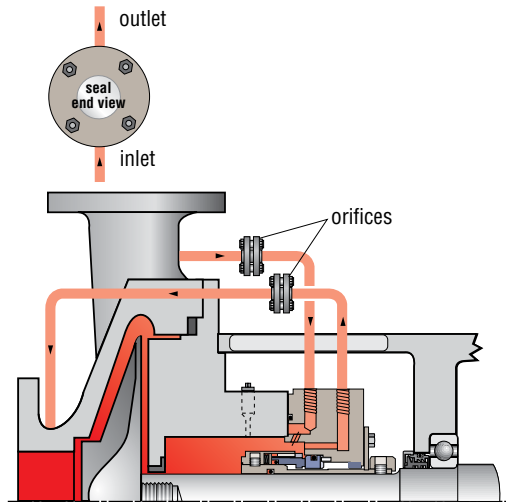
Continuous seal chamber venting on vertical pumps.  
Seal chamber heat removal.

***Where***

Vertical pumps.  
Seal chamber pressure is greater than suction pressure.  
Moderate temperature fluids with moderate solids.  
Non-polymerizing fluids.

***Preventative Maintenance***

Vent piping loop prior to starting vertical pumps.  
Use an orifice with a minimum 3 mm (1/8 inch) diameter.  
Calculate flow rates to size orifice for adequate seal chamber flow.  
Reduce seal chamber pressure with proper orifice and throat bushing sizing.  
Typical failure mode is a clogged orifice - check temperatures at pipe ends.



***What***

Seal flush from pump discharge and recirculation to pump suction with orifices.  
Combination of Plan 11 and Plan 13.

***Why***

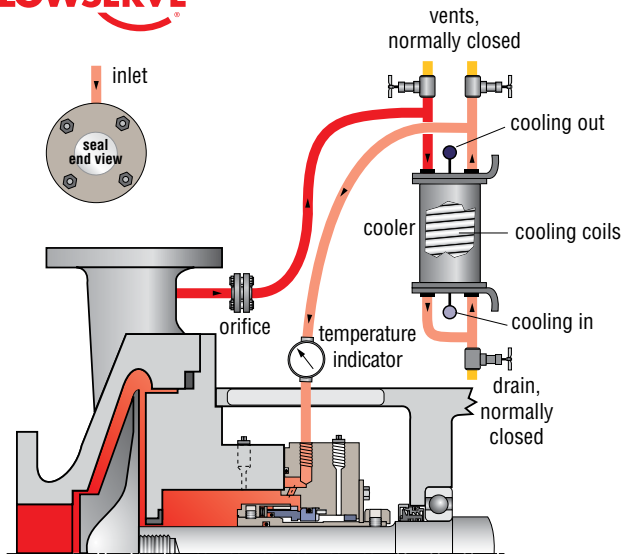
Continuous seal chamber venting on vertical pumps.  
Seal chamber heat removal.  
Increase seal chamber pressure and fluid vapor margin.

***Where***

Vertical pumps.  
Clean, non-polymerizing fluids at moderate temperatures.

***Preventative Maintenance***

Use an orifice with a minimum 3 mm (1/8 inch) diameter.  
Calculate flow rates to size orifice for adequate seal chamber flow.  
Increase boiling point margin with proper orifice and throat bushing sizing.  
Flush should be directed over seal faces.  
Vent piping loop prior to starting vertical pumps.  
Typical failure mode is a clogged orifice - check temperatures at pipe ends.





### ***What***

Seal flush from pump discharge through orifice and cooler.  
Cooler added to Plan 11 flush increases heat removal.

### ***Why***

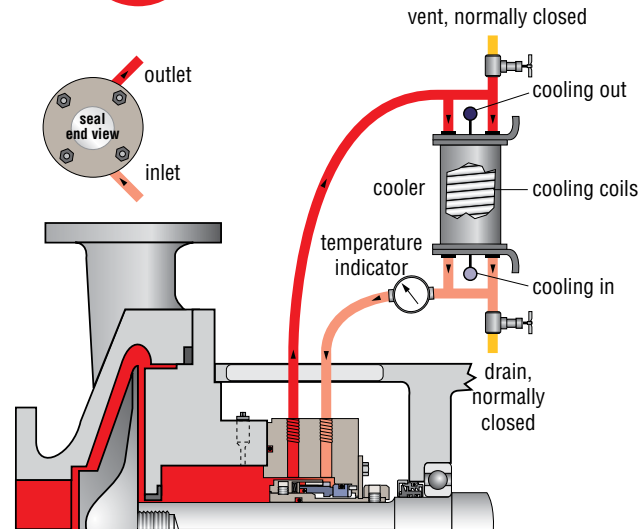
Seal cooling.  
Reduce fluid temperature to increase fluid vapor margin.  
Reduce coking.

### ***Where***

High temperature service, typically less than 177°C (350°F).  
Hot water over 80°C (180°F).  
Clean, non-polymerizing fluids.

### ***Preventative Maintenance***

Seal cooler and piping must have air vents at highest elevation - vent before starting.  
When using 682 Seal Cooler, pipe with series flow to maximize heat transfer.  
Use an orifice with a minimum 3 mm (1/8 inch) diameter.  
Calculate flow rates to size orifice for adequate seal chamber flow.  
Increase boiling point margin with proper orifice and throat bushing sizing.  
Regularly monitor cooler inlet and outlet temperatures for signs of clogging or fouling.



### ***What***

Seal flush from internal pumping device through cooler.  
Standard flush plan in hot water services.

### ***Why***

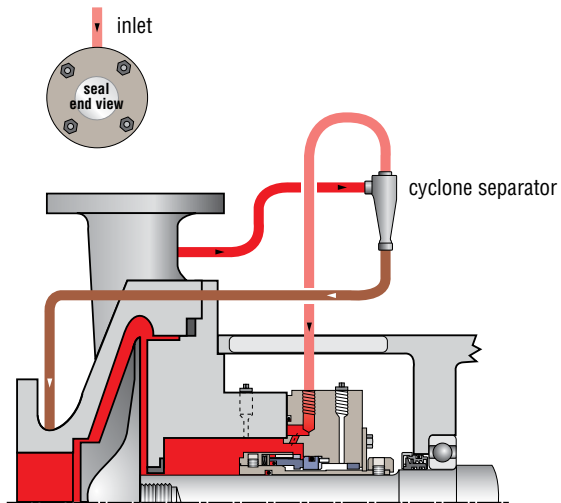
Efficient seal cooling with low cooler duty.  
Increase fluid vapor margin.  
Improve water lubricity.

### ***Where***

High temperature service, hot hydrocarbons.  
Boiler feed water and hot water over 80°C (180°F).  
Clean, non-polymerizing fluids.

### ***Preventative Maintenance*** - Reference Appendix A

Seal cooler and piping must have air vents at highest elevation - vent before starting.  
When using 682 Seal Cooler, pipe with parallel flow to minimize head loss.  
Seal chamber requires close clearance throat bushing to isolate process fluid.  
Tangential seal gland taps should enter at bottom and exit at top.  
Regularly monitor cooler inlet and outlet temperatures for signs of clogging or fouling.  
Process fluids with iron should flow through magnetic separator before cooler.



***What***

Seal flush from pump discharge through cyclone separator.  
Centrifuged solids are returned to pump suction.

***Why***

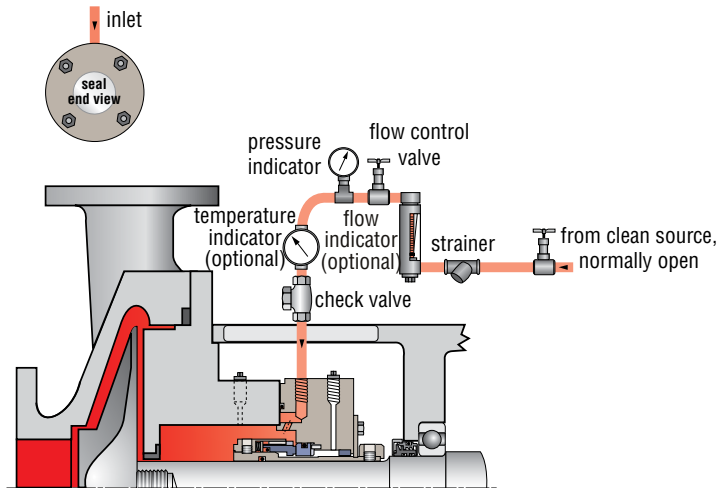
Seal chamber heat removal.  
Solids removal from flush and seal chamber.

***Where***

Dirty or contaminated fluids, water with sand or pipe slag.  
Non-polymerizing fluids.

***Preventative Maintenance***

Cyclone separator works best on solids with a specific gravity twice the process fluid.  
Seal chamber pressure must be nearly equal to suction pressure for proper flows.  
Piping should not include an orifice and is not expected to vent the seal chamber.  
Typical failure mode is clogged separator or pipes - check temperatures at pipe ends.



***What***

Seal flush from an external clean source.

***Why***

Seal chamber heat removal.

Process and solids removal from seal chamber.

Increase seal chamber pressure and fluid vapor margin.

***Where***

Dirty or contaminated fluids, paper pulp.

High temperature service.

Polymerizing and/or oxidizing fluids.

***Preventative Maintenance***

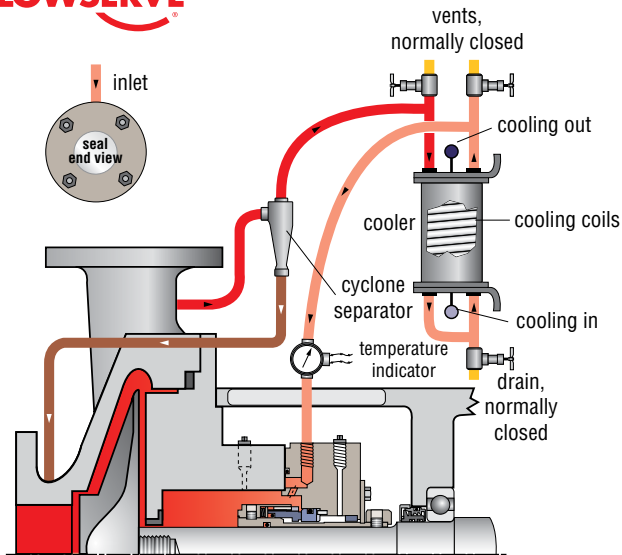
Use throat bushing sized to hold pressure or maintain flow velocity.

To restrict dirty process fluid, regulate injection flow rate.

To increase fluid vapor margin, regulate injection pressure.

Injection fluid must be compatible with process fluid.

Regularly monitor control system for closed valves or signs of plugging.





***What***

Seal flush from pump discharge through cyclone separator and cooler.  
Combination of Plan 21 and Plan 31.

***Why***

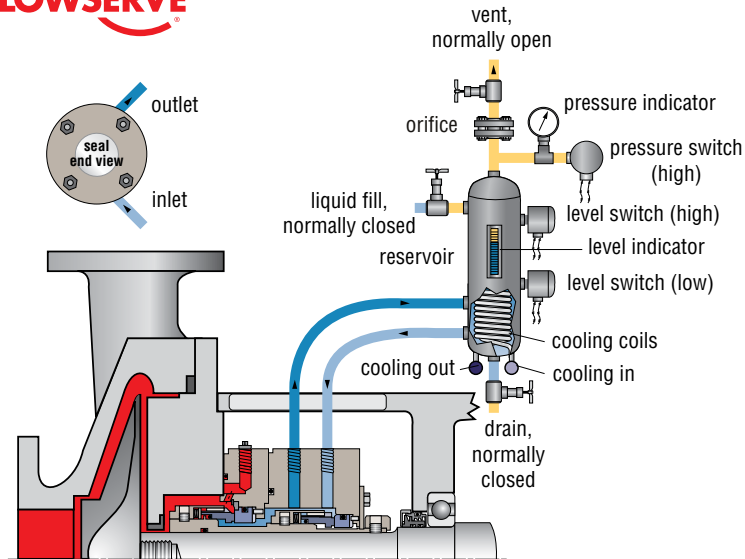
Seal cooling.  
Solids removal from flush and seal chamber.

***Where***

High temperature service, typically less than 177°C (350°F).  
Dirty or contaminated fluids, water with sand or pipe slag.  
Non-polymerizing fluids.

***Preventative Maintenance***

Seal cooler and piping must have air vents at highest elevation - vent before starting.  
When using 682 Seal Cooler, pipe with series flow to maximize heat transfer.  
Cyclone separator works best on solids with a specific gravity twice the process fluid.  
Seal chamber pressure must be nearly equal to suction pressure for proper flows.  
Typical failure mode is clogged separator or pipes - check temperatures at pipe ends.



### ***What***

Unpressurized buffer fluid circulation through reservoir.  
Fluid is circulated by a pumping ring in the dual seal assembly.

### ***Why***

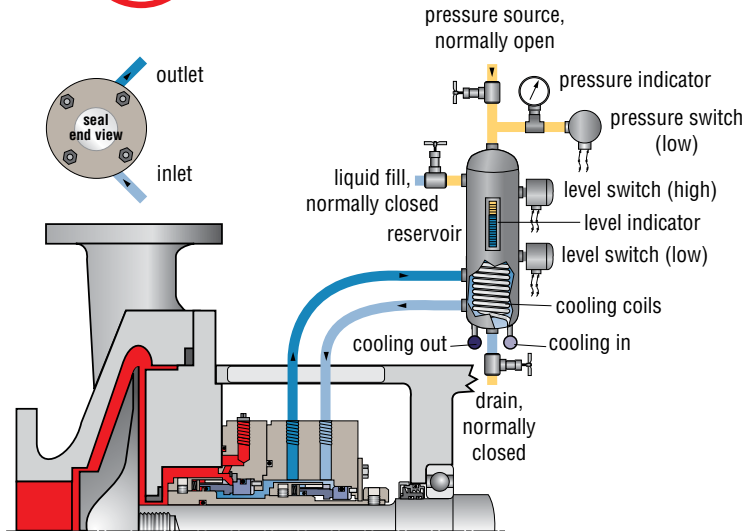
Outboard seal acts as a safety backup to the primary seal.  
Zero to very low process emissions.  
No process contamination is allowed.

### ***Where***

Used with dual unpressurized seals.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Heat transfer fluids.

### ***Preventative Maintenance*** - Reference Appendix B

Piping loop must self-vent to vapor recovery/flare system near atmospheric pressure.  
Process vapor pressure is generally greater than reservoir pressure.  
Buffer fluid must be compatible with process leakage.  
Primary seal leakage is indicated by increased vent pressure.  
Reservoir level indicator shows outboard seal leakage.



***What***

Pressurized barrier fluid circulation through reservoir.

Fluid is circulated by a pumping ring in the dual seal assembly.

***Why***

Isolate process fluid.

Zero process emissions.

***Where***

Used with dual pressurized seals.

High vapor pressure fluids, light hydrocarbons.

Hazardous/toxic fluids.

Heat transfer fluids.

Dirty/abrasive or polymerizing fluids.

Mixers/agitators and vacuum service.

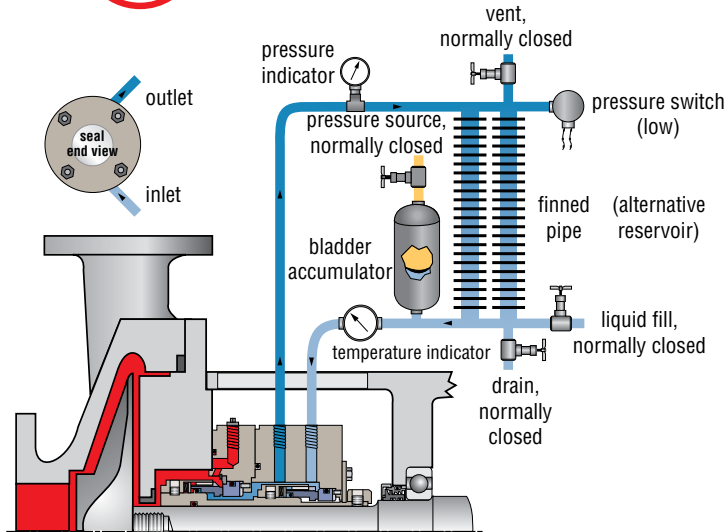
***Preventative Maintenance*** - Reference Appendix B

Piping loop must self-vent to reservoir located at highest elevation.

Pressurize reservoir at all times, maximum gas charge 10 - 14 bar (150 - 200 psi).

Barrier fluid must be compatible with process.

Reservoir level indicator shows both inboard and outboard seal leakage.



### ***What***

Pressurized barrier fluid circulation with bladder accumulator.  
Fluid is circulated by a pumping ring in the dual seal assembly.

### ***Why***

Isolate process fluid.  
Zero process emissions.  
Higher pressure than Plan 53A.

### ***Where***

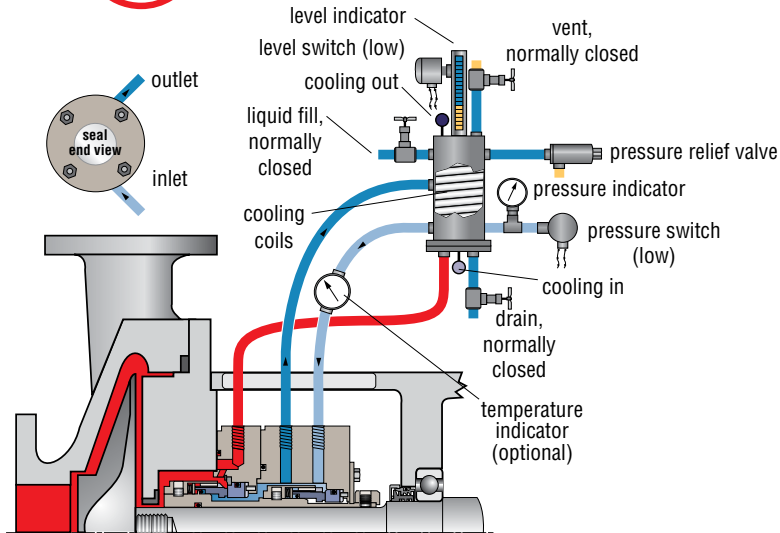
Used with dual pressurized seals.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Heat transfer fluids.  
Dirty/abrasive or polymerizing fluids.

### ***Preventative Maintenance*** - Reference Appendix B

Piping loop must be fully vented before starting.  
Accumulator must be pressurized at all times, usually by gas charge.  
Barrier fluid must be compatible with process.  
Regularly monitor barrier pressure - manually add barrier fluid when pressure decays.



# Plan 53C





***What***

Pressurized barrier fluid circulation with piston accumulator.  
Fluid is circulated by a pumping ring in the dual seal assembly.

***Why***

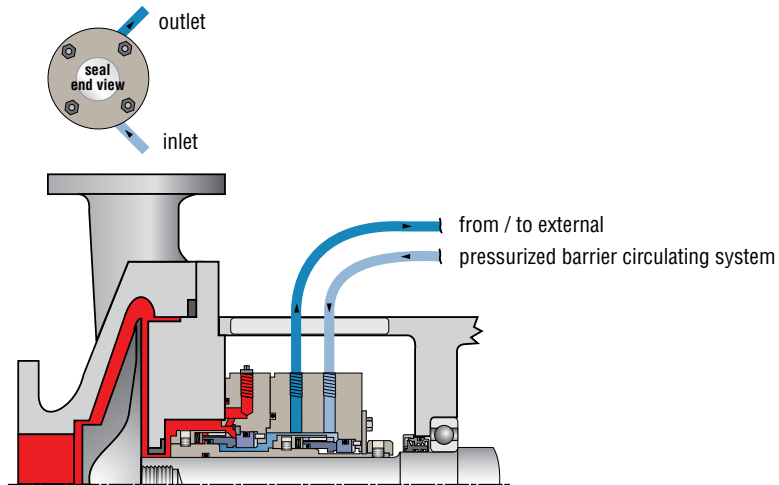
Isolate process fluid.  
Zero process emissions.  
Higher pressure than Plan 53A.  
Dynamic tracking of system pressure.

***Where***

Used with dual pressurized seals.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Heat transfer fluids.

***Preventative Maintenance*** - Reference Appendix B

Piping loop must be fully vented before starting.  
Reference line must tolerate process contamination without plugging.  
Barrier fluid must be compatible with process.  
Reservoir level indicator indicates both inboard and outboard seal leakage.



***What***

Pressurized barrier fluid circulation by external system.

***Why***

Isolate process fluid.

Zero process emissions.

Seal cannot induce circulation.

***Where***

Used with pressurized dual seals.

High vapor pressure fluids, light hydrocarbons.

Hazardous/toxic fluids.

Heat transfer fluids.

Dirty/abrasive or polymerizing fluids.

Mixers/agitators.

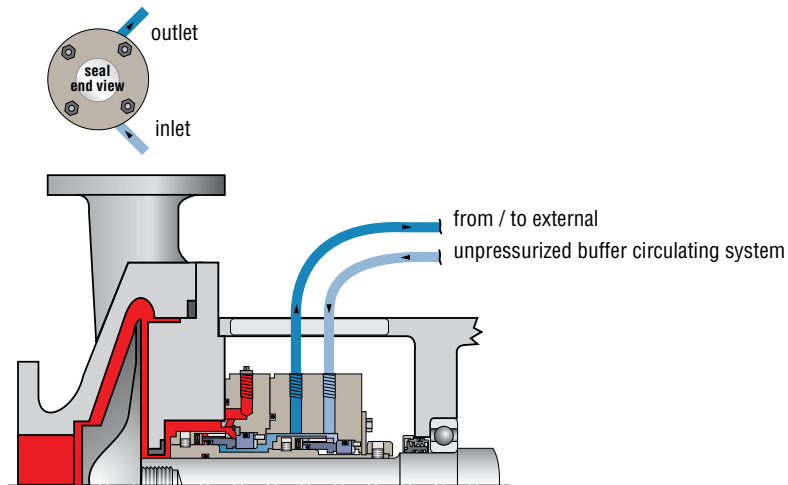
***Preventative Maintenance***

Piping loop must be fully vented before starting.

Circulating system must be pressurized and energized at all times.

Barrier fluid must be compatible with process.

Circulating system level indicator shows both inboard and outboard seal leakage.



***What***

Unpressurized buffer fluid circulation by external system.

***Why***

Outboard seal acts as a safety backup to the primary seal.

Zero to very low process emissions.

No process contamination is allowed.

Additional heat removal from the inner seal.

Seal cannot induce circulation.

***Where***

Used with unpressurized dual seals.

Hazardous/toxic fluids.

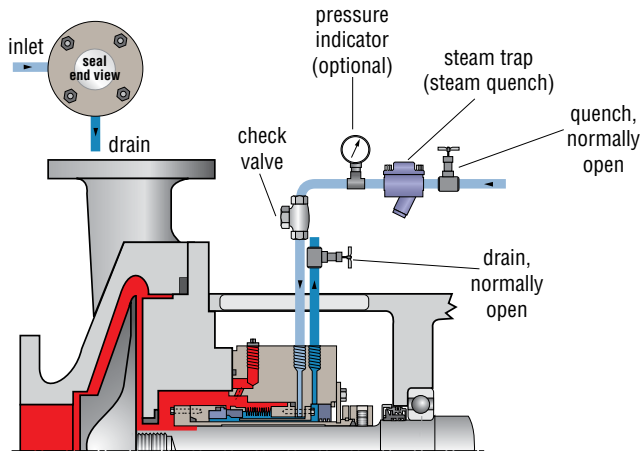
Fluids that may solidify in contact with atmosphere.

***Preventative Maintenance***

Piping loop must be fully vented before starting .

Buffer fluid must be compatible with process leakage.

Accumulated process leakage should be routed to a recovery system.



***What***

External quench on atmospheric side of seal.  
Quench fluids typically steam, nitrogen, or water.

***Why***

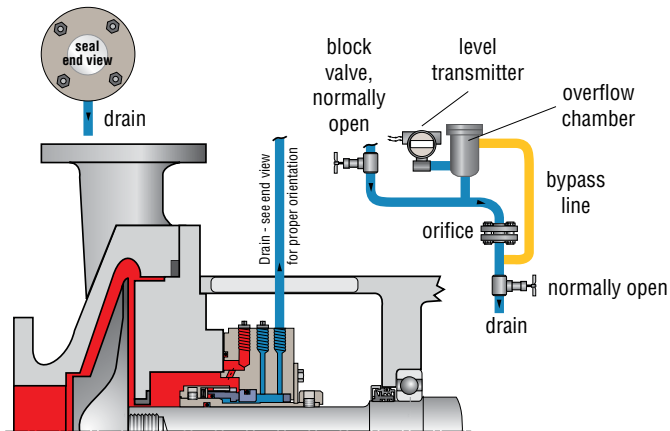
Prevent solids buildup on atmospheric side of seal.  
Prevent icing.

***Where***

Used with single seals.  
Oxidizing fluids or fluids that coke, hot hydrocarbons.  
Crystallizing fluids or fluids that salt out.  
Caustic.  
Cold fluids less than 0°C (32°F).

***Preventative Maintenance***

Quench inlet should be on top of gland with outlet/drain on bottom.  
Quench pressure should be limited to 0.2 bar (3 psi) or less.  
Use throttle bushing on atmospheric side of seal to direct quench flow to seal drain.  
Monitor regularly, checking for closed valves, blocked lines, and steam trap condition.





***What***

External drain with leakage detection on atmospheric side of seal.

***Why***

Safety indicator for primary seal detects failure.

***Where***

May be used alone or with Plan 62 quench.

Used with close clearance throttle bushing.

Useful with single seals in remote locations and critical services.

***Preventative Maintenance***

Drain must be on bottom of gland with downward-sloped piping.

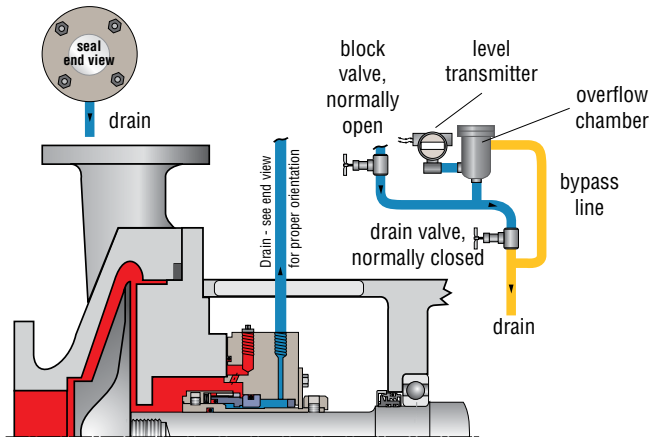
Continuously drain to liquid recovery system.

Orifice downstream of level switch transmitter 5 mm (1/4 inch) must be oriented vertically.

Bypass line from overflow chamber must re-enter below orifice.

Piping may require heat tracing when used with solidifying fluids.

Monitor regularly, checking for closed valves, blocked lines, and working level transmitter.



### ***What***

External drain with leakage detection on atmospheric side of seal.

### ***Why***

Leakage collection to detect for process leakage.

Safety indicator to detect seal failure.

Continuous monitoring of leakage rates to atmosphere.

### ***Where***

Use with close clearance throttle bushing.

Use with non-flashing, condensing fluids.

Useful with seals in remote locations and critical services.

### ***Preventative Maintenance***

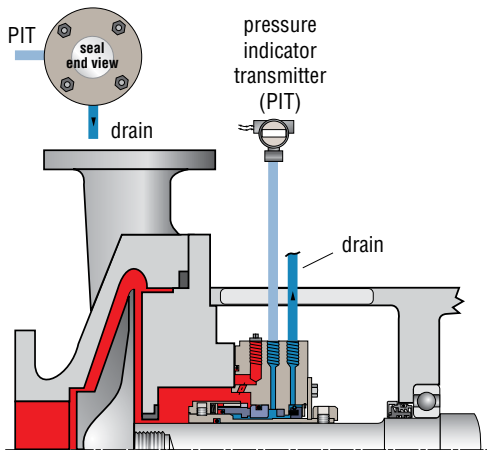
Drain must be on bottom of gland with downward sloped piping.

Empty collection vessel when level transmitter indicates the vessel is full.

Bypass line from collection vessel must re-enter below drain valve.

Piping may require heat tracing when used with solidifying fluids.

Monitor regularly, checking for closed valves, blocked lines, and working level transmitter.



***What***

Leakage detection on atmospheric side of seal utilizing two throttle bushings in series.

***Why***

Safety indicator for primary seal to detect failure.

Minimize leakage from seal gland in case of seal failure.

***Where***

May be used alone or with Plan 65A or Plan 65B.

Used with flashing or non-flashing fluids.

Useful with single seals in remote locations and critical services.

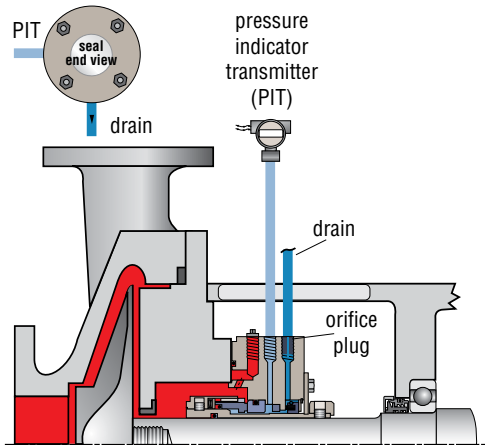
Used with close clearance throttle bushings.

***Preventative Maintenance***

Drain must be on bottom of gland with downward sloped piping.

Continuously drain to a liquid recovery system.

Monitor for high pressure.



***What***

Leakage detection on atmospheric side of seal utilizing a throttle bushing and orifice plug.

***Why***

Safety indicator for primary seal detects failure.

***Where***

May be used alone or with Plan 65A or Plan 65B.

Used with close clearance throttle bushing.

Used with flashing or non-flashing fluids.

Useful when adding atmospheric side leakage detection to an existing seal.

Useful with single seals in remote locations and critical services.

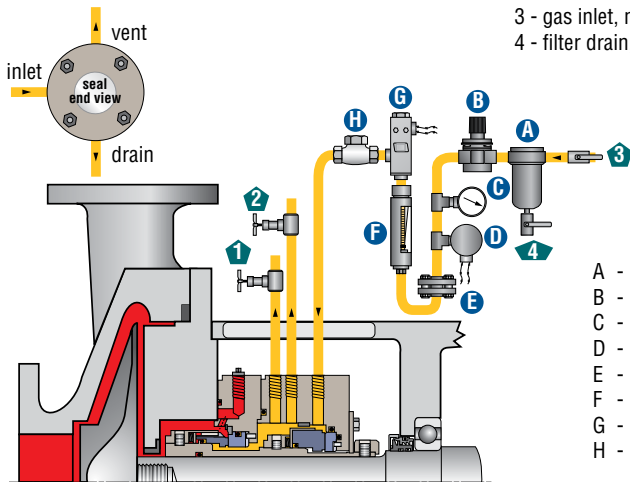
***Preventative Maintenance***

Drain must be on bottom of gland with downward sloped piping.

Continuously drain to a liquid recovery system.

Monitor for high pressure.

Check orifice regularly for build up and plugging.





***What***

Unpressurized buffer gas control system.

Containment seal support typically with nitrogen buffer gas.

***Why***

Zero to very low process emissions.

Safety backup to primary seal.

***Where***

Used with dual unpressurized containment seals.

High vapor pressure fluids, light hydrocarbons.

Hazardous/toxic fluids.

Clean, non-polymerizing, non-oxidizing fluids.

Used in combination with Plan 75 and/or Plan 76.

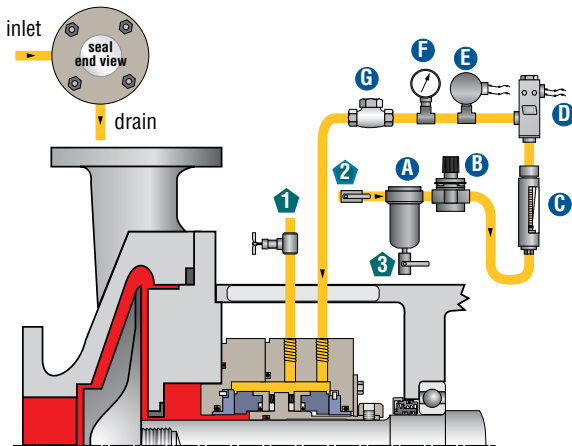
***Preventative Maintenance***

Clean, reliable, low pressure gas must be supplied to seal at all times.

Bottled gas supply is not recommended except as part of emergency backup system.

Primary seal leakage is indicated by pressure in the vent line.

Vent or drain are usually connected to low pressure vapor recovery/flare system.



- 1 - upset drain, normally closed
- 2 - gas inlet, normally open
- 3 - filter drain, normally closed

- A - coalescing filter
- B - regulator
- C - flow indicator
- D - flow switch (high)
- E - pressure switch (low)
- F - pressure indicator
- G - check valve

### ***What***

Pressurized barrier gas control system.  
Gas seal support typically with nitrogen barrier gas.

### ***Why***

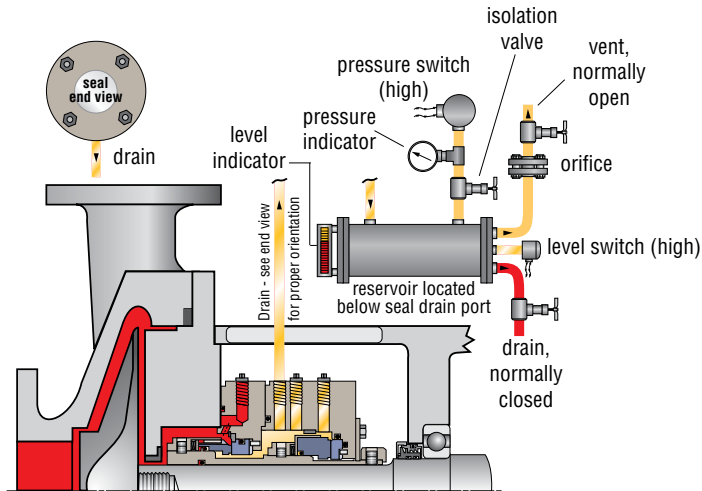
Isolate process fluid.  
Zero process emissions.

### ***Where***

Used with dual pressurized gas seals.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Services that do not tolerate liquid barrier seals.  
Clean, non-polymerizing fluids.  
Moderate temperature fluids.

### ***Preventative Maintenance***

Clean, reliable, pressurized gas must be supplied to seal at all times.  
Barrier pressure is typically at least 1.75 bar (25 psig) above seal chamber pressure.  
Flow indicator shows both inboard and outboard seal leakage.  
Bottled gas supply is not recommended except as part of emergency backup system.



***What***

Drain from containment seal cavity to liquid collector and vapor recovery.

***Why***

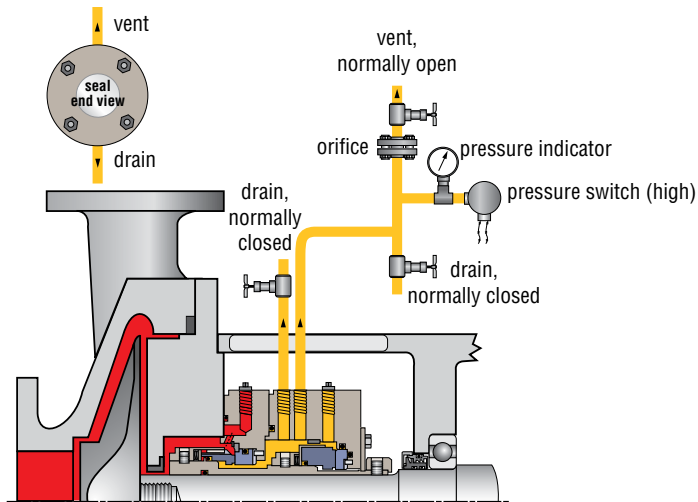
Leakage collection for zero to very low process emissions.  
Safety indicator for primary seal.

***Where***

May be used alone or with Plan 72 on containment seals.  
Fluids that condense at ambient temperature.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Clean, non-polymerizing, non-oxidizing fluids.

***Preventative Maintenance***

Collection reservoir must be located below seal drain and downward-sloped piping.  
Continuously vent collection reservoir to low pressure vapor recovery/flare system.  
Drain collection reservoir to liquid recovery system as needed.  
Primary seal leakage is indicated by increased vent pressure.  
Monitor regularly for liquid level, valve settings, and low vent pressure.



### ***What***

Vent from containment seal cavity to vapor recovery.

### ***Why***

Leakage collection for zero to very low process emissions.  
Safety indicator for primary seal.

### ***Where***

May be used alone or with Plan 72 on containment seals.  
Fluids that do not condense at ambient temperature.  
High vapor pressure fluids, light hydrocarbons.  
Hazardous/toxic fluids.  
Clean, non-polymerizing, non-oxidizing fluids.

### ***Preventative Maintenance***

Continuously vent to low pressure vapor recovery/flare system.  
Vent piping should include a condensate drain.  
Primary seal leakage is indicated by increased vent pressure.  
Monitor regularly for valve settings, blocked lines, and low vent pressure.

## Single Seals - Plan 23 shown

### What

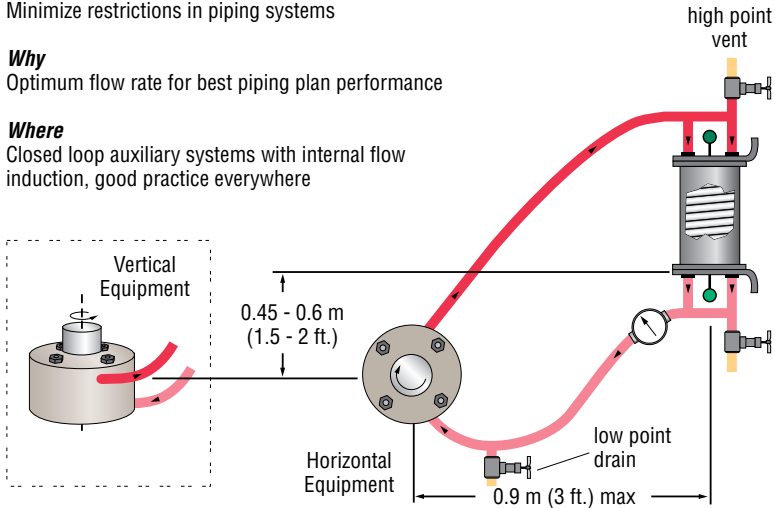
Minimize restrictions in piping systems

### Why

Optimum flow rate for best piping plan performance

### Where

Closed loop auxiliary systems with internal flow induction, good practice everywhere

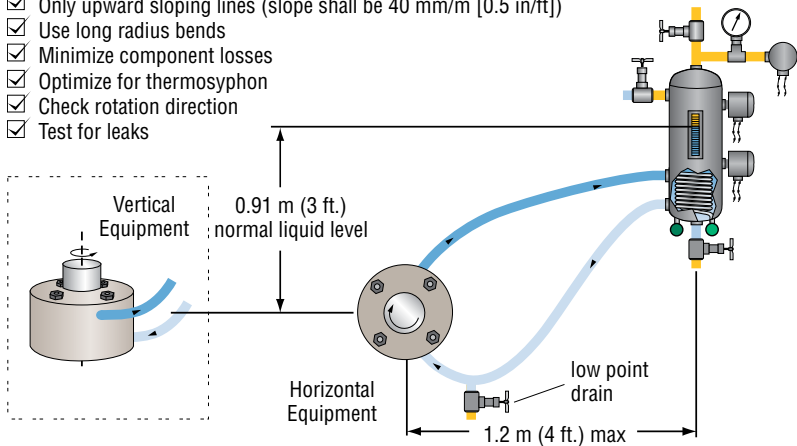




## Good Piping Practices

## Dual Seals - Plan 53A shown

- ✓ Minimize line losses
- ✓ Use large diameter tubing
- ✓ Only upward sloping lines (slope shall be 40 mm/m [0.5 in/ft])
- ✓ Use long radius bends
- ✓ Minimize component losses
- ✓ Optimize for thermosyphon
- ✓ Check rotation direction
- ✓ Test for leaks





### *Airfin Cooler*

Forced air or natural convection seal coolers



Plans 21, 23 & 41

### *Seal Cooler*

Compact design dual coil seal cooler



Plans 21, 23 & 41

### *682 Seal Cooler*

Seal cooler for complete API 682 specifications



Plans 21, 23 & 41

### *Reservoirs*

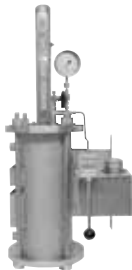
General duty and API 682 compliant reservoirs



Plans 53, 53A & 53B

***Piston  
Accumulator***

Hydraulically charged  
reservoir for dual seals



Plan 53C

***Circulator***

Standalone dual seal  
support system



Plan 54

***Refill Cart***

Mobile cart to manually  
fill liquid reservoirs



Plans 52 & 53

***Gas Barrier  
Control Panel***

Complete control  
system for dual gas  
seals



Plans 72 & 74

### ***Seal Gard I & II***

Combination flush flow regulator and meter



Plan 32

### ***Orifice***

Plug and plate style flush line orifices



Plans 11, 13, 14, & 21

### ***Magnetic Separator***

Iron particle separator for seal flush



Plan 23

### ***Cyclone Separator***

Solid particle separator used in dirty flush stream



Plans 31 & 41

***Gestra®  
Steam Trap***

Family of reliable  
steam traps for  
quench flows



Plan 62

***SLD***

Quench lubrication  
device with synthetic  
grease



Plan 62 modified

***DuraClear***

Synthetic lubricants  
from barrier fluid to  
bearing oil



Plans 52, 53 & 54

***Bearing Gard II  
& BGM***

Bearing frame  
protection devices



# Notes



# Notes







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