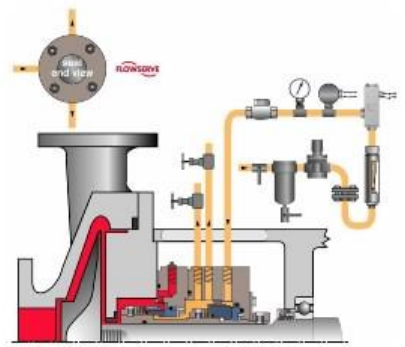
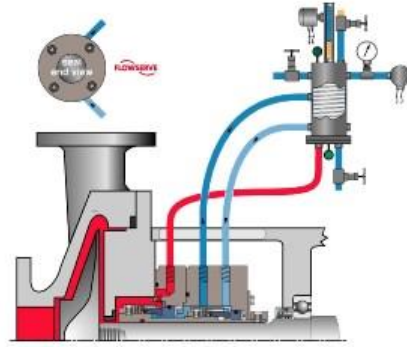
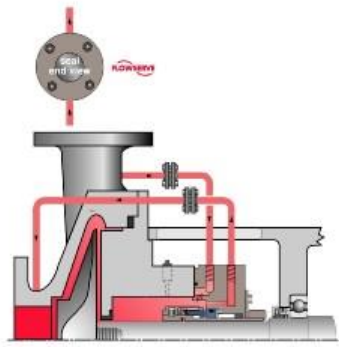
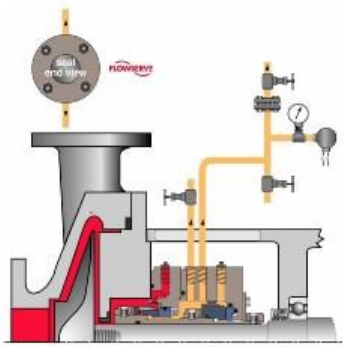
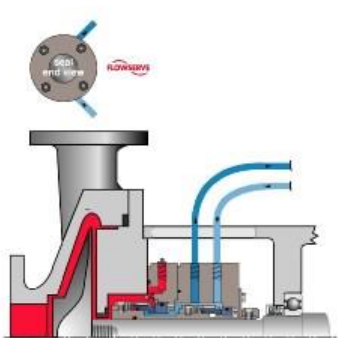
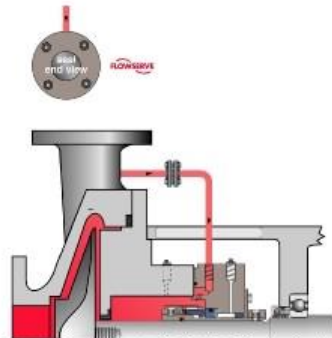
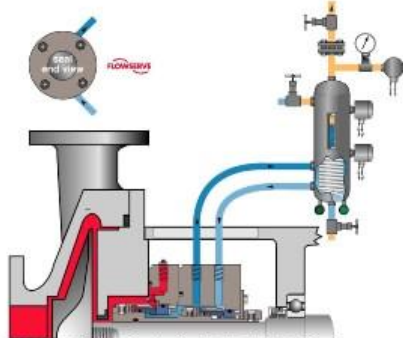
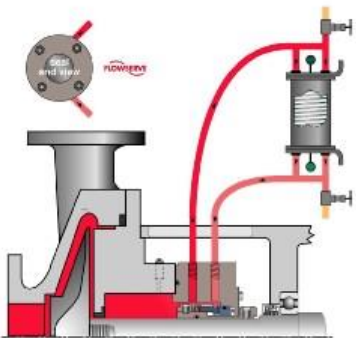




Review of Mechanical Seal Piping Plans



Requirements of Mechanical Seals

➤ Liquid seals

- Stable fluids
- Good lubricating properties
- Fluids do not flash or vaporize in seal chamber
- Free from contamination and solids
- Moderate viscosities



Requirements of Mechanical Seals

➤ Gas seals

- Gas or vapor suitable for sealing
- Constant supply of external buffer/barrier gas
- Process fluids free from contamination from both liquids and solids
- Process fluids which are not adversely affected by gas leakage



Purpose of Piping Plans

- Create a more favorable environment for the mechanical seal
 - Flushing to remove heat
 - Lowering fluid temperature
 - Altering the seal chamber pressure
 - Cleaning the process fluids
 - Control atmospheric side of seal



Purpose of Piping Plans

- Provide a means of detecting and controlling seal leakage
 - Capture and/or prevent leakage
 - Detect leakage
 - Route leakage to appropriate collection or disposal system
 - Provide fluid other than process fluid for the seal environment



Methods of Achieving Goals

- Piping or routing of process fluids
- Introduction of external fluids
- Auxiliary equipment
 - Seal coolers
 - Cyclone separators
 - Reservoirs
- Instrumentation



Piping Plans

➤ Standardized in:

- API 610
- API 682
- ISO 21049
- ASME B73

➤ Designated by numbers

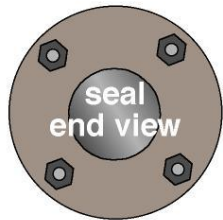
- API example 11, 32, or 53
- ASME example 7311, 7332, or 7353



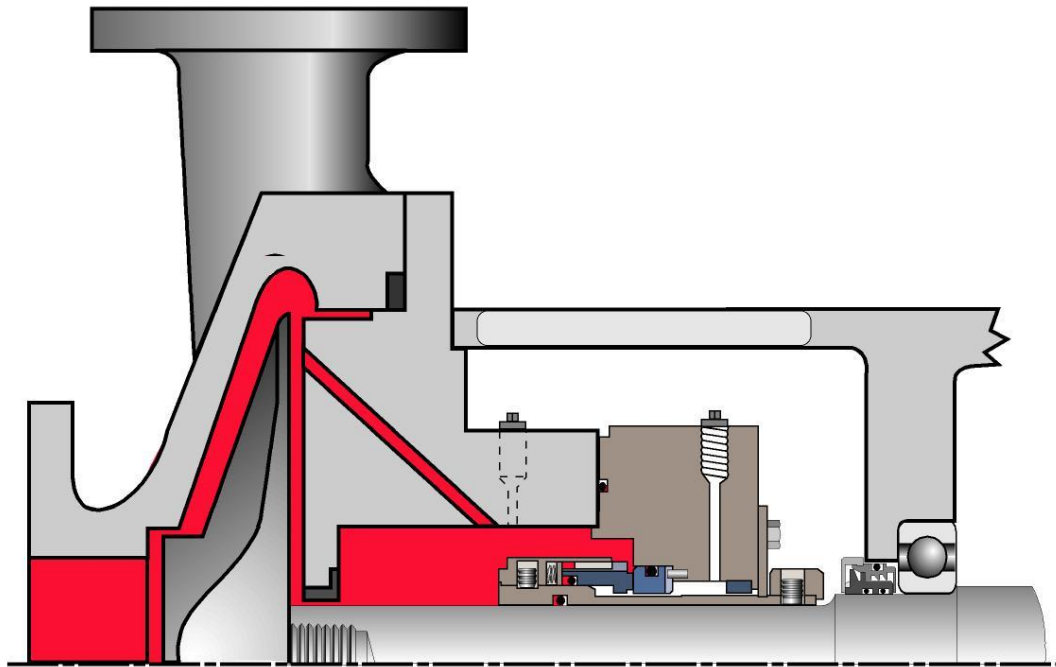
Plan 01

What

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



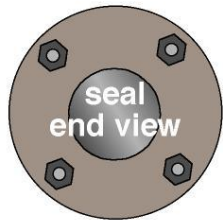
FLowsERVE



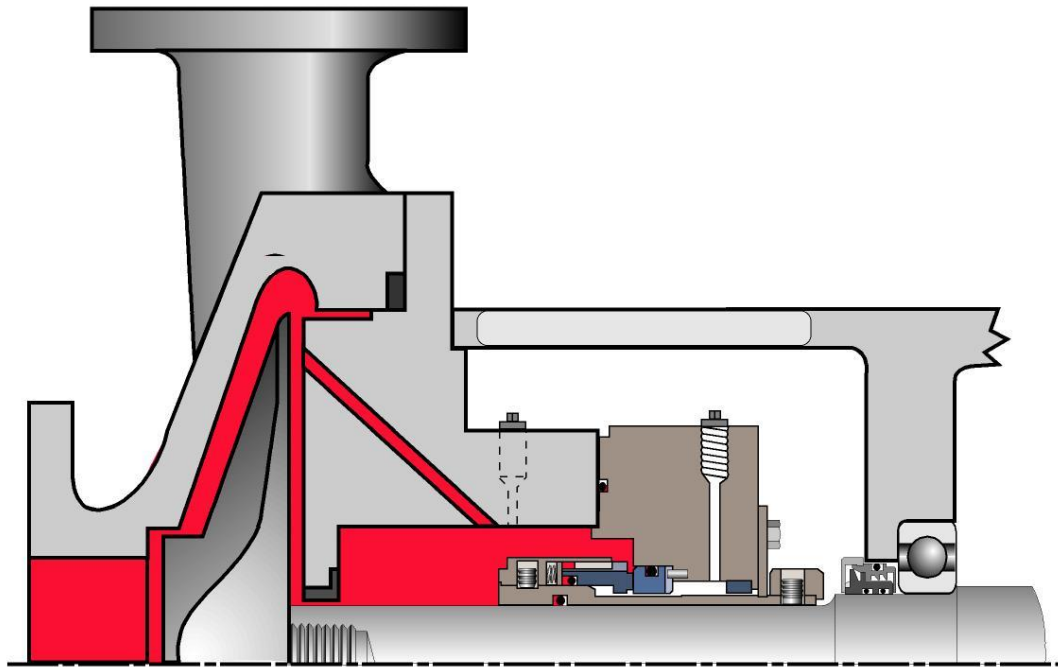
Plan 01

Why

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



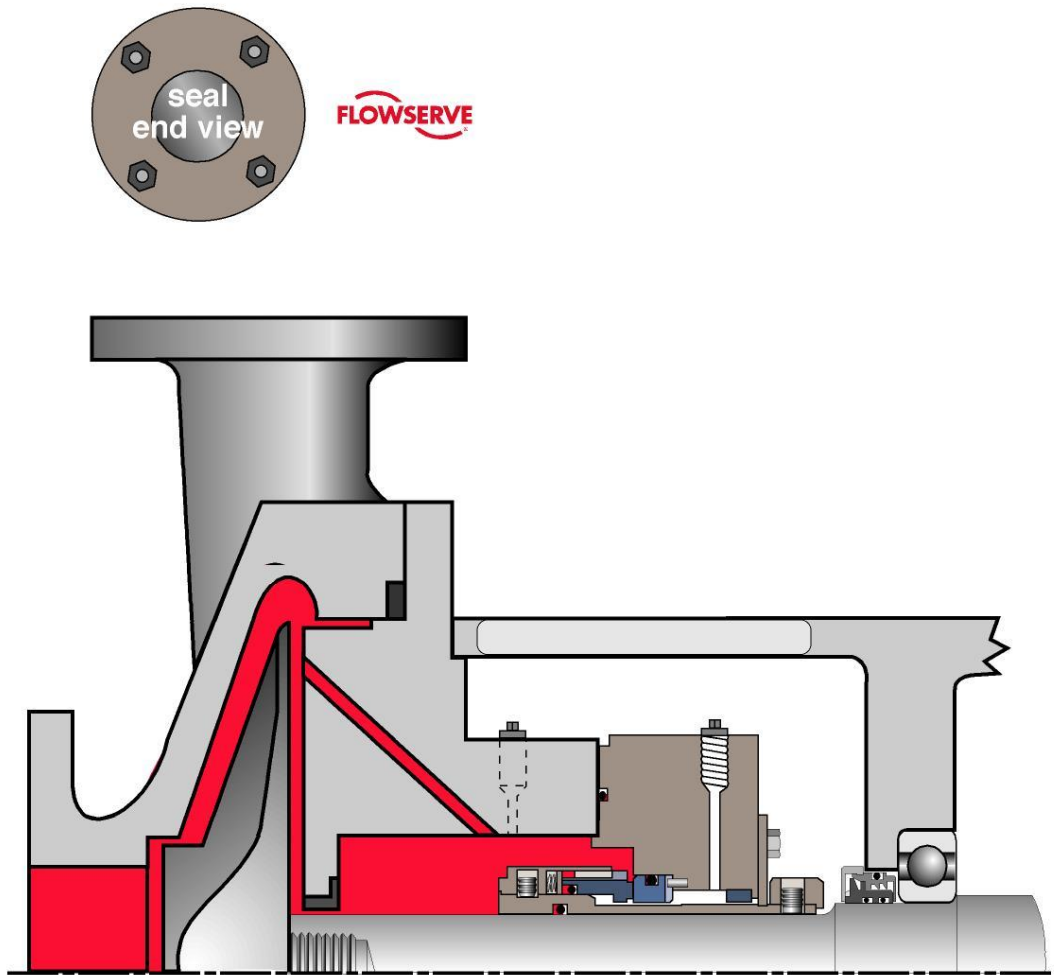
FLowsERVE



Plan 01

Where

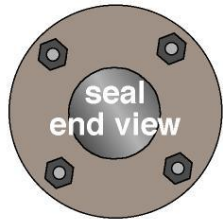
- Custom seal chamber, most likely an ASME/ANSI pump.
- Clean, moderate temperature fluids.
- Used with single seals, rarely used with dual seals.



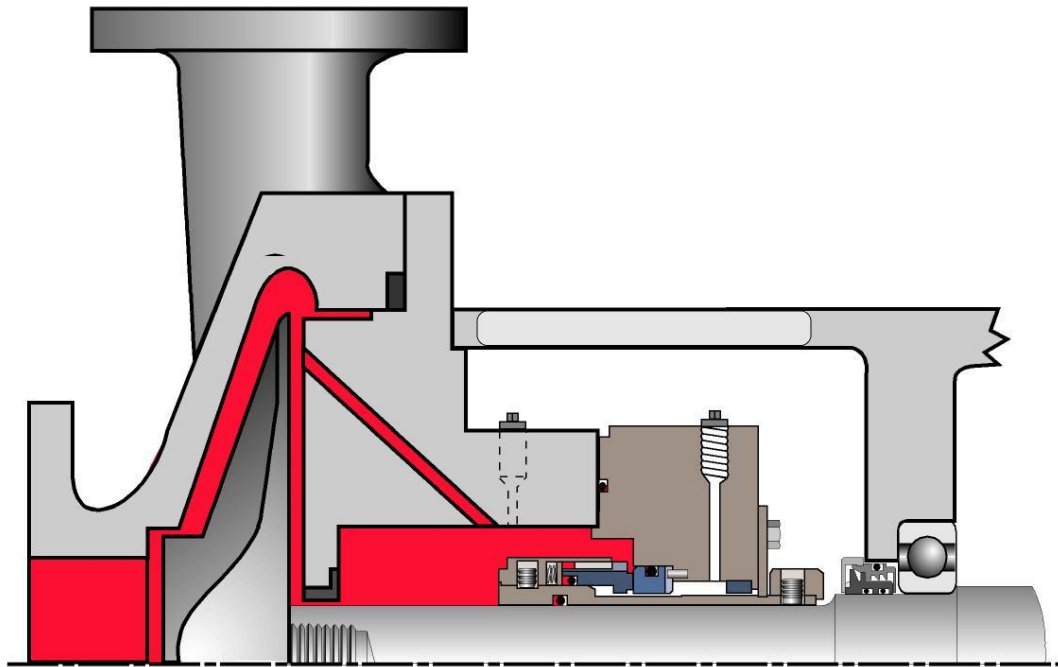
Plan 01

Preventative Maintenance

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



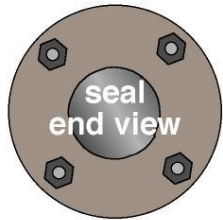
FLOWSERVE



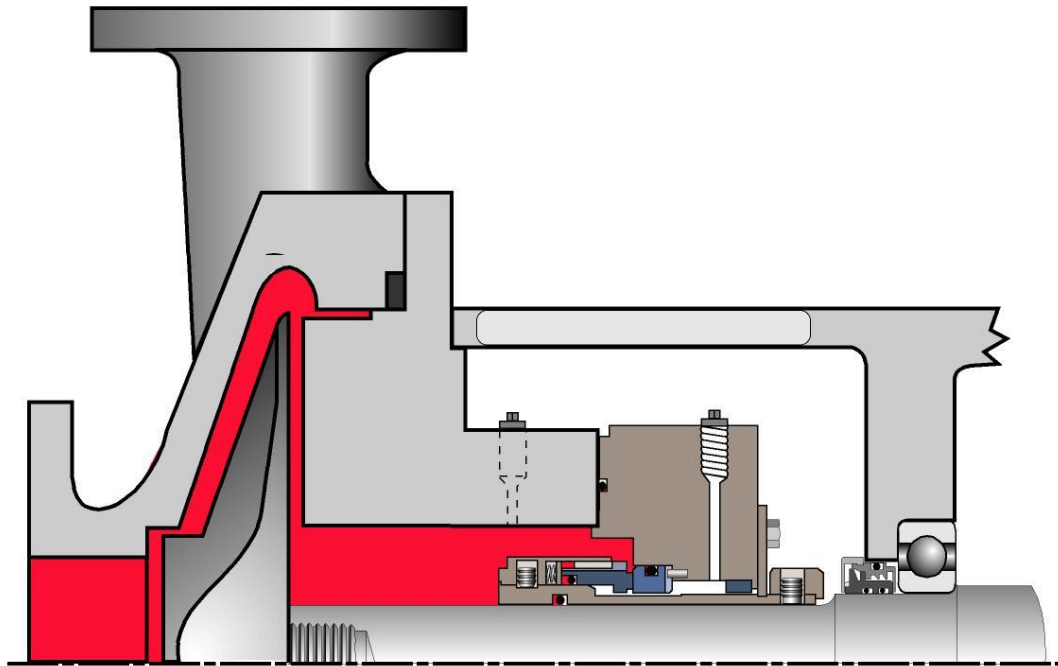
Plan 02

What

- Dead-ended seal chamber with no flush.



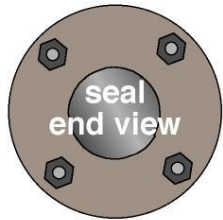
FLowsERVE



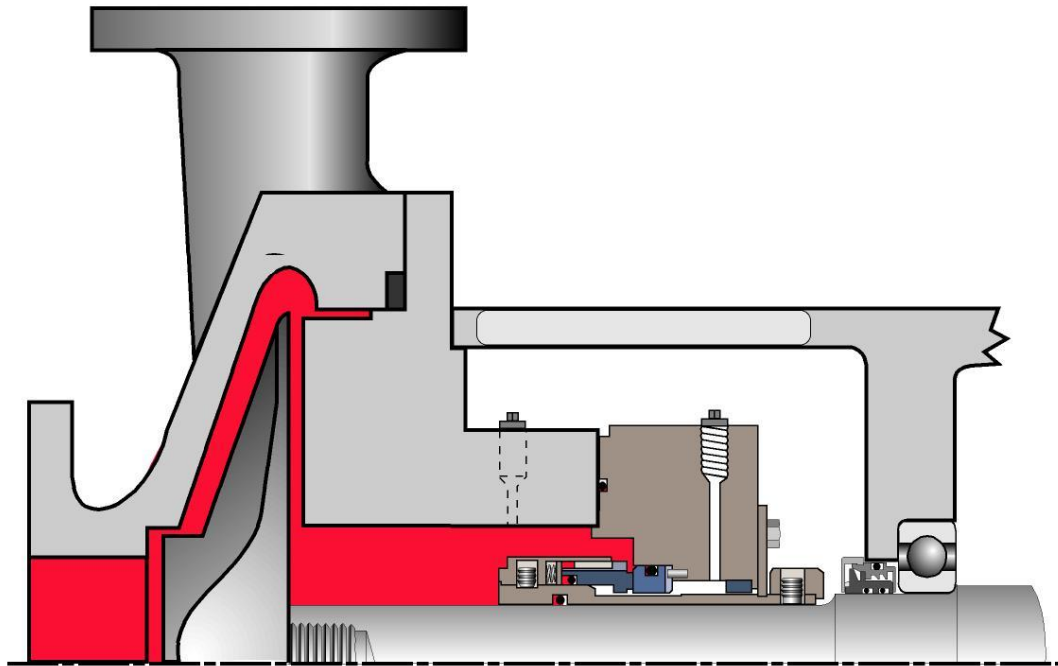
Plan 02

Why

- Simplicity – no environmental controls.



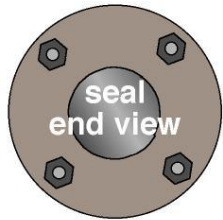
FLowsERVE



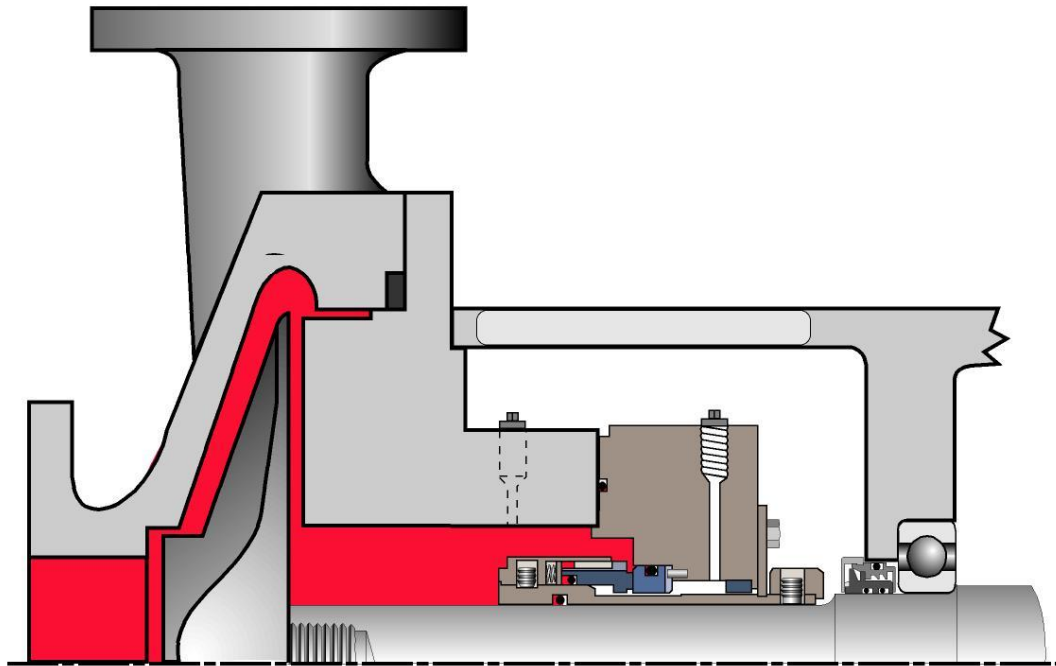
Plan 02

Where

- Large bore or open throat seal chambers in moderate temperature services.
- Clean fluids.
- Top-entry mixers or agitators with dry seals.



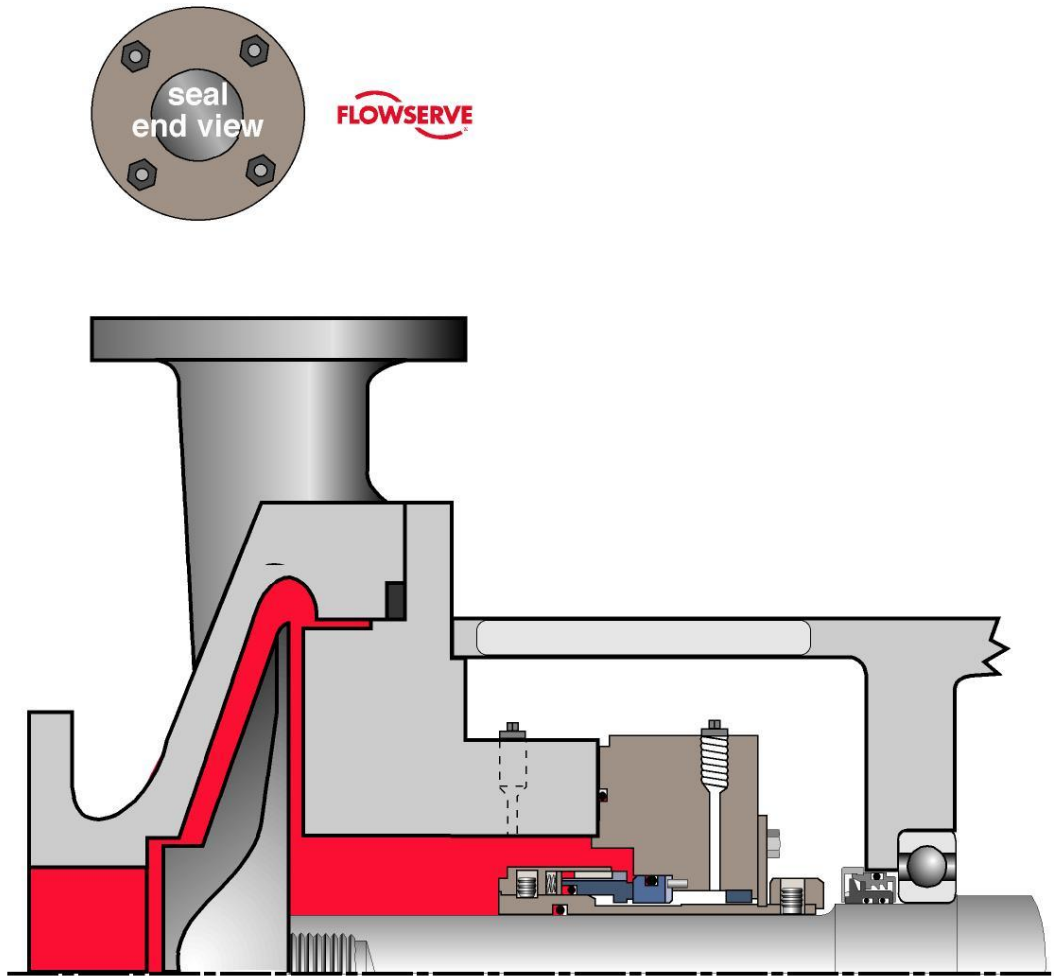
FLowsERVE



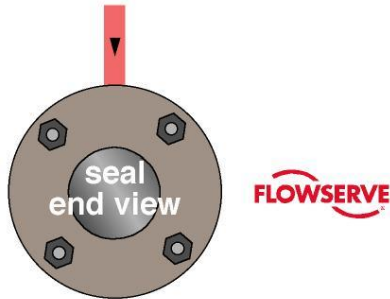
Plan 02

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.
- Often used in combination with steam quench, Plan 62.

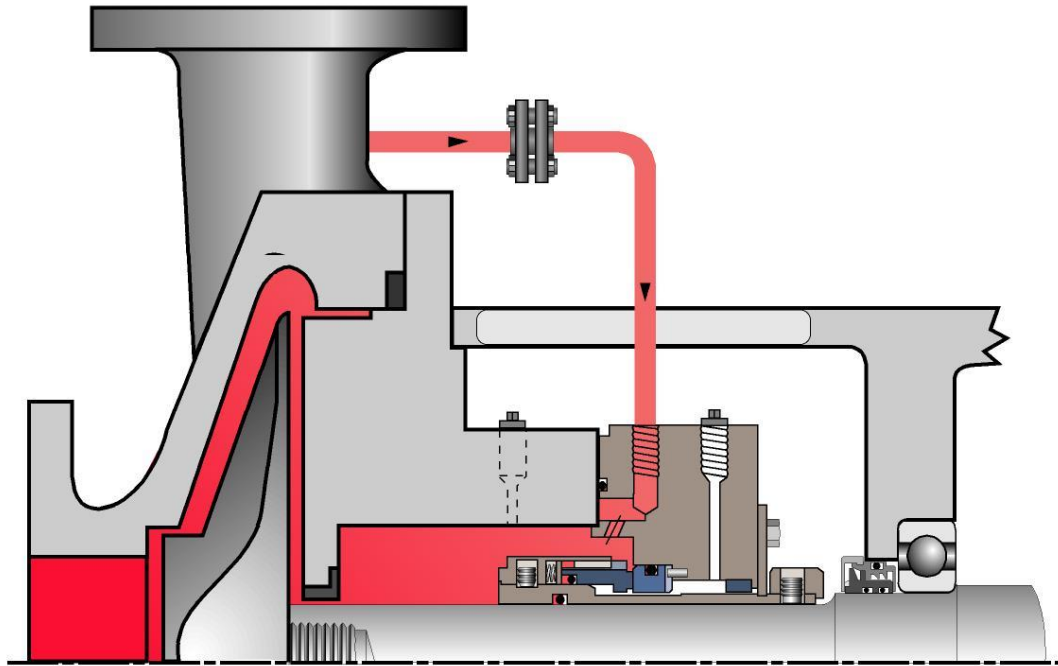


Plan 11

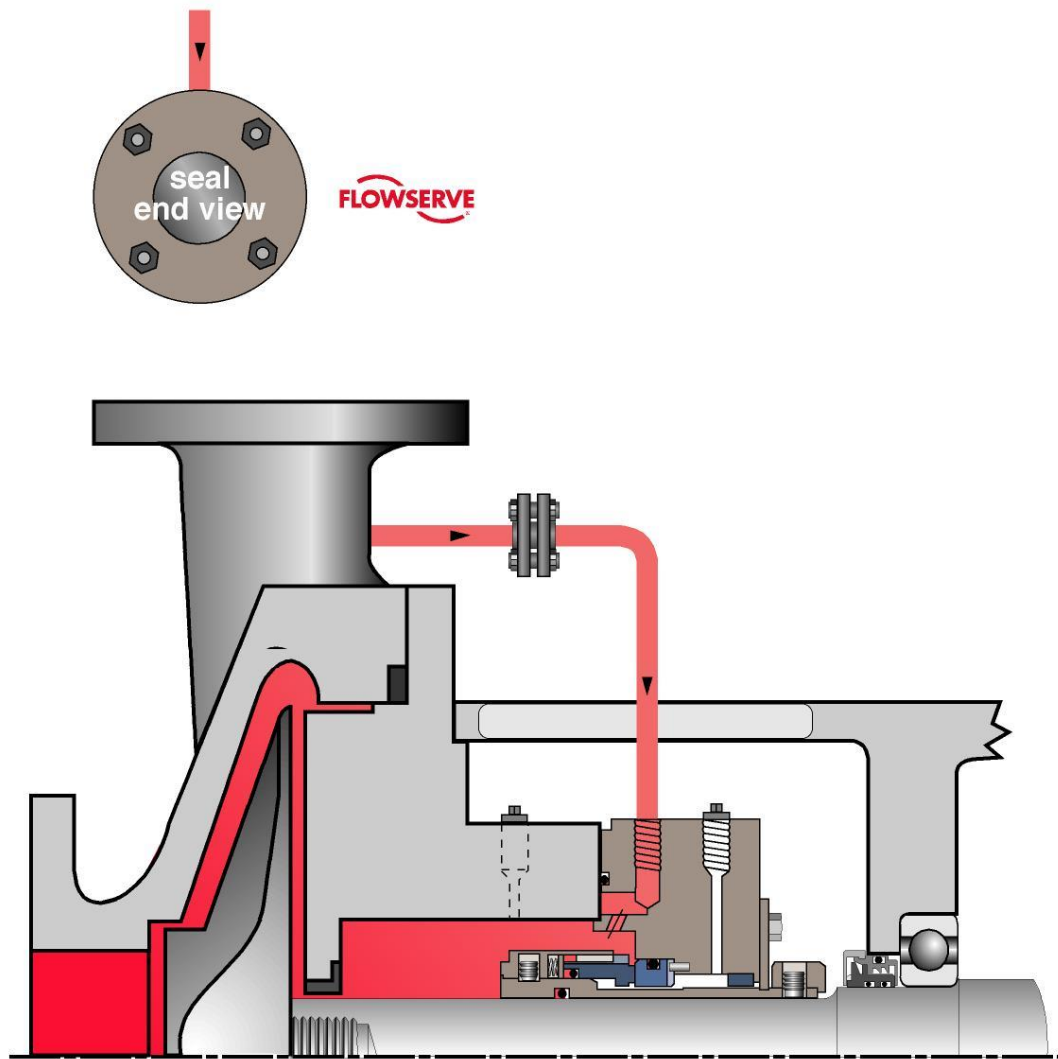


What

- Seal flush from pump discharge through orifice.
- Default single seal flush plan.



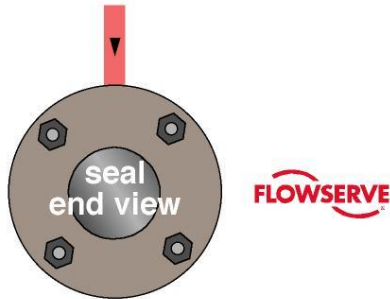
Plan 11



Why

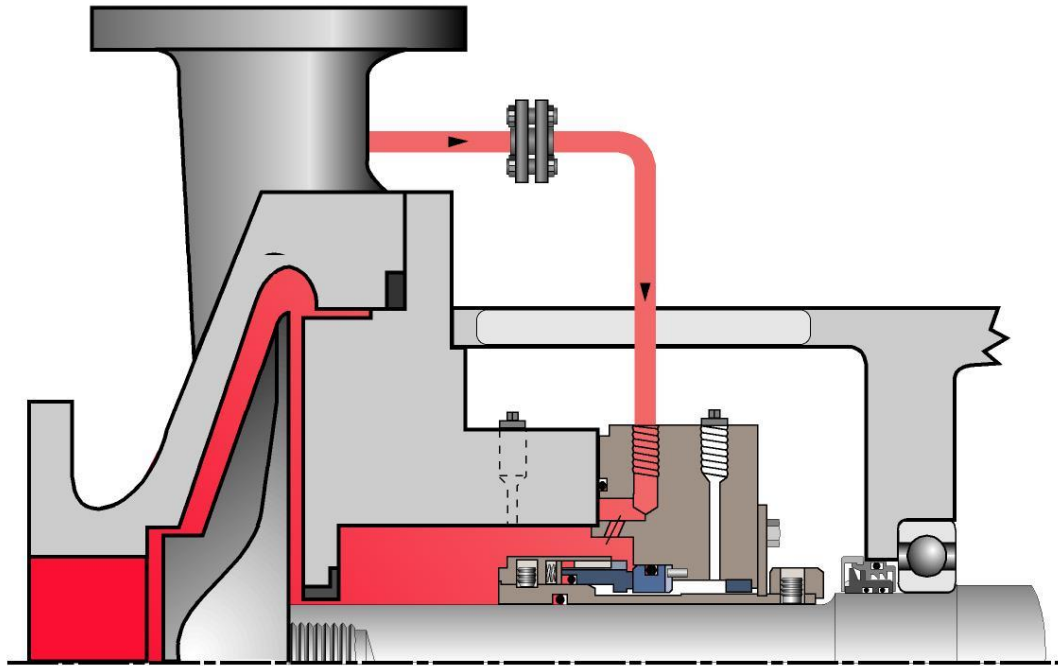
- Seal chamber heat removal.
- Seal chamber venting on horizontal pumps.
- Increase seal chamber pressure and fluid vapor margin.

Plan 11

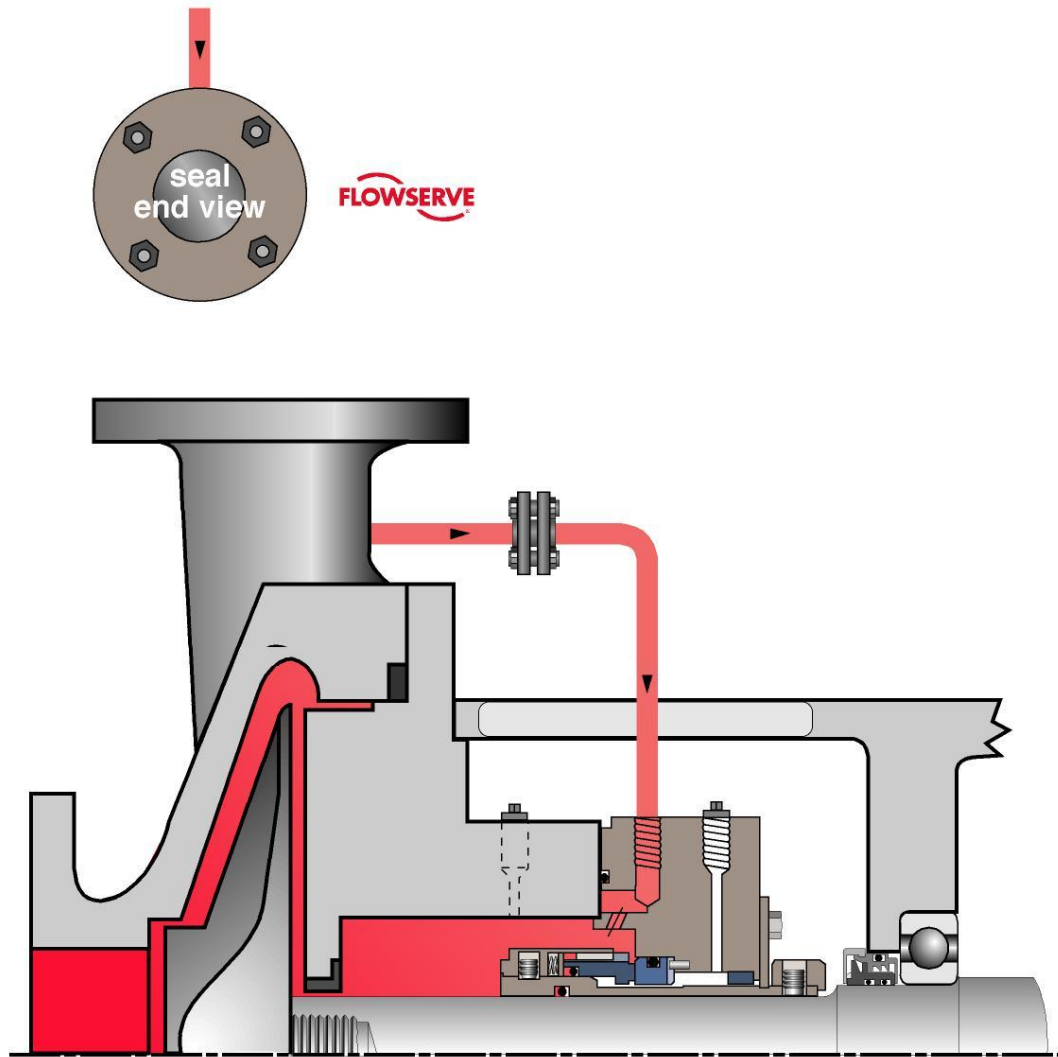


Where

- General applications with clean fluids.
- Non-polymerizing fluids.



Plan 11



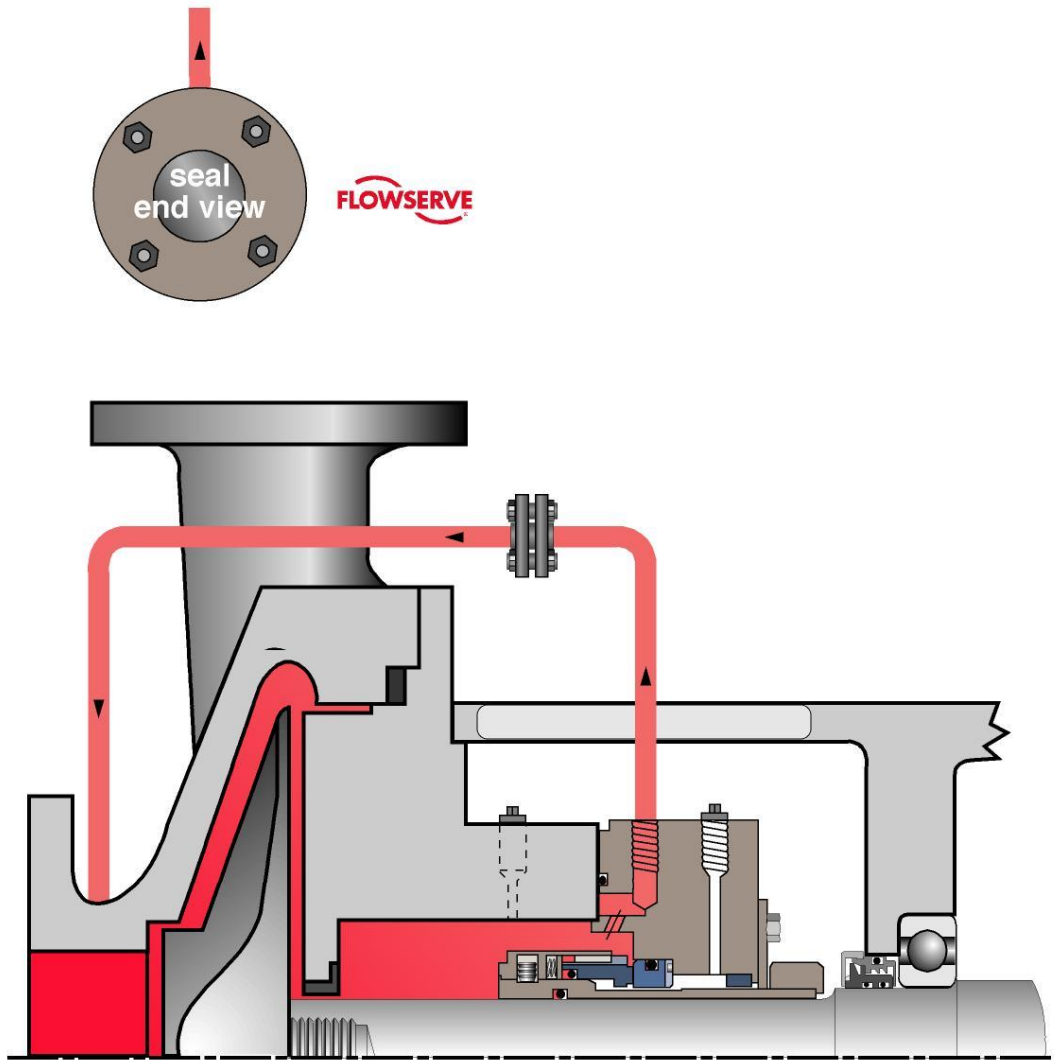
Preventative Maintenance

- Use an orifice with a minimum 0.125" (3 mm) 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.

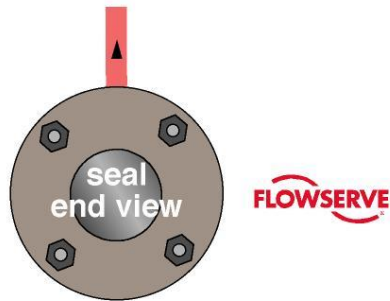
Plan 13

What

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

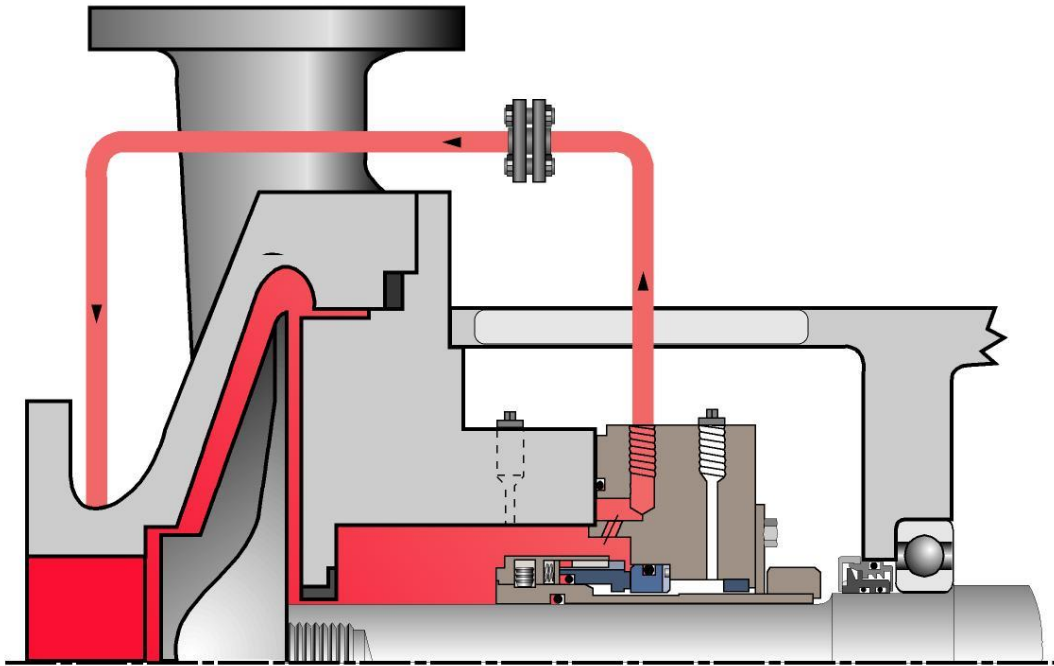


Plan 13

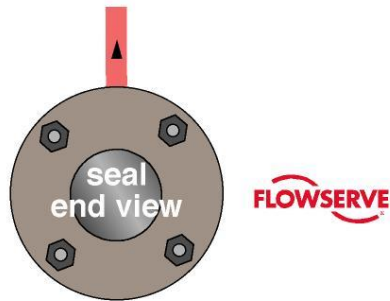


Why

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

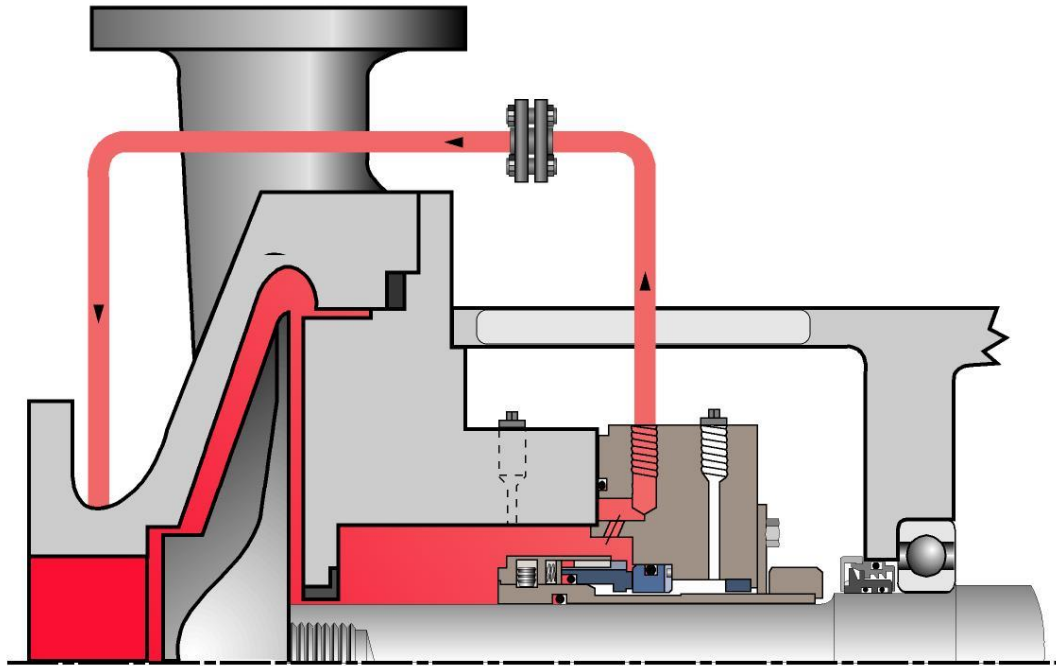


Plan 13

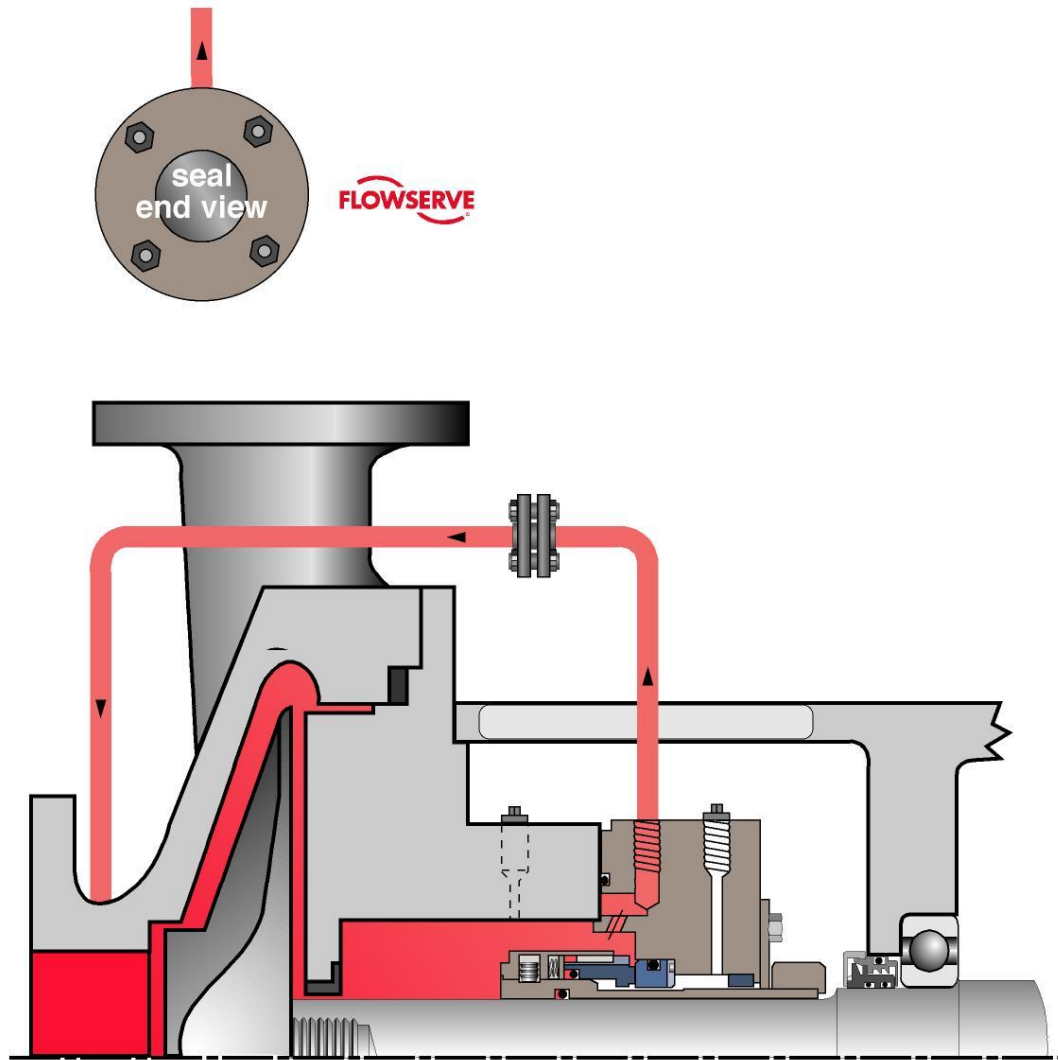


Where

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



Plan 13



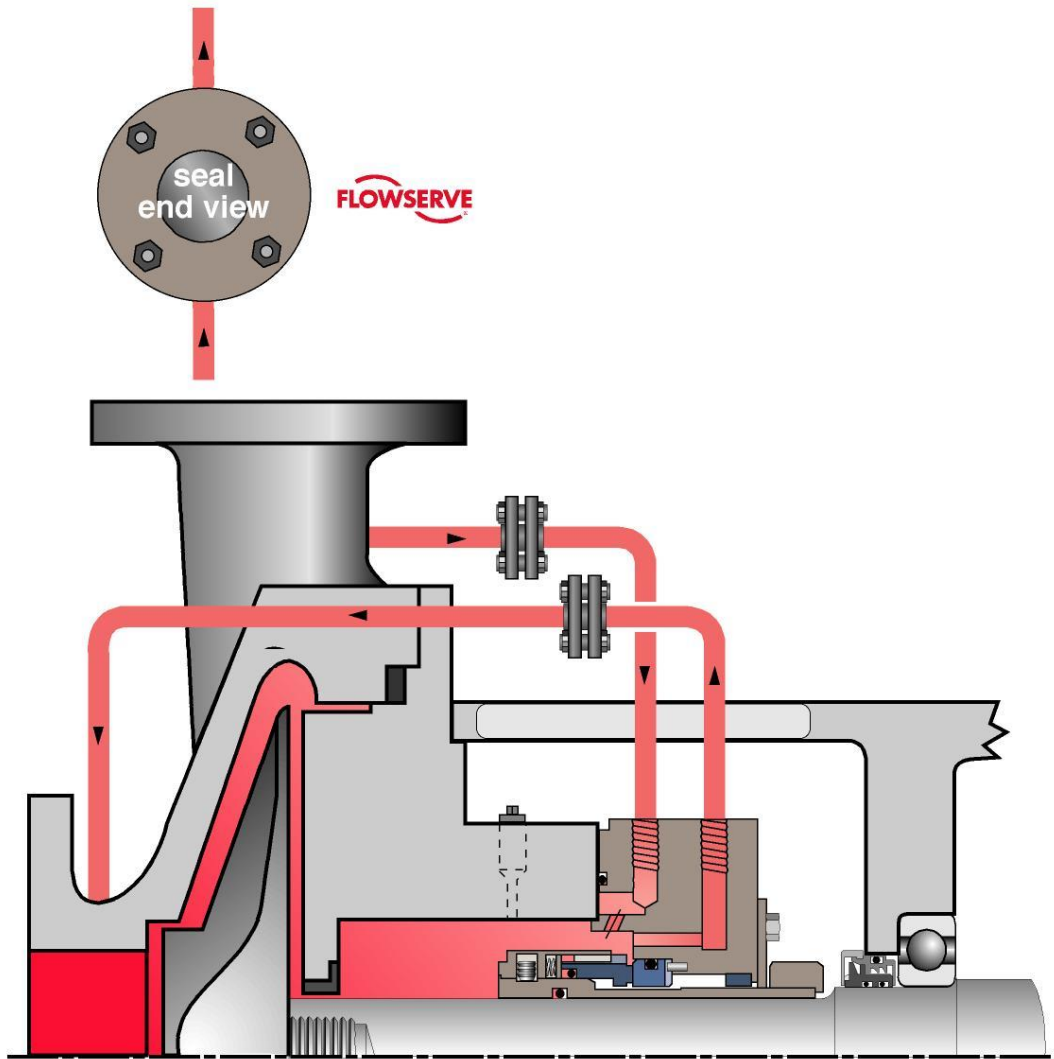
Preventative Maintenance

- Vent piping loop prior to starting vertical pumps.
- Use an orifice with a minimum 0.125" (3 mm) 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 temperature at pipe ends.

Plan 14

What

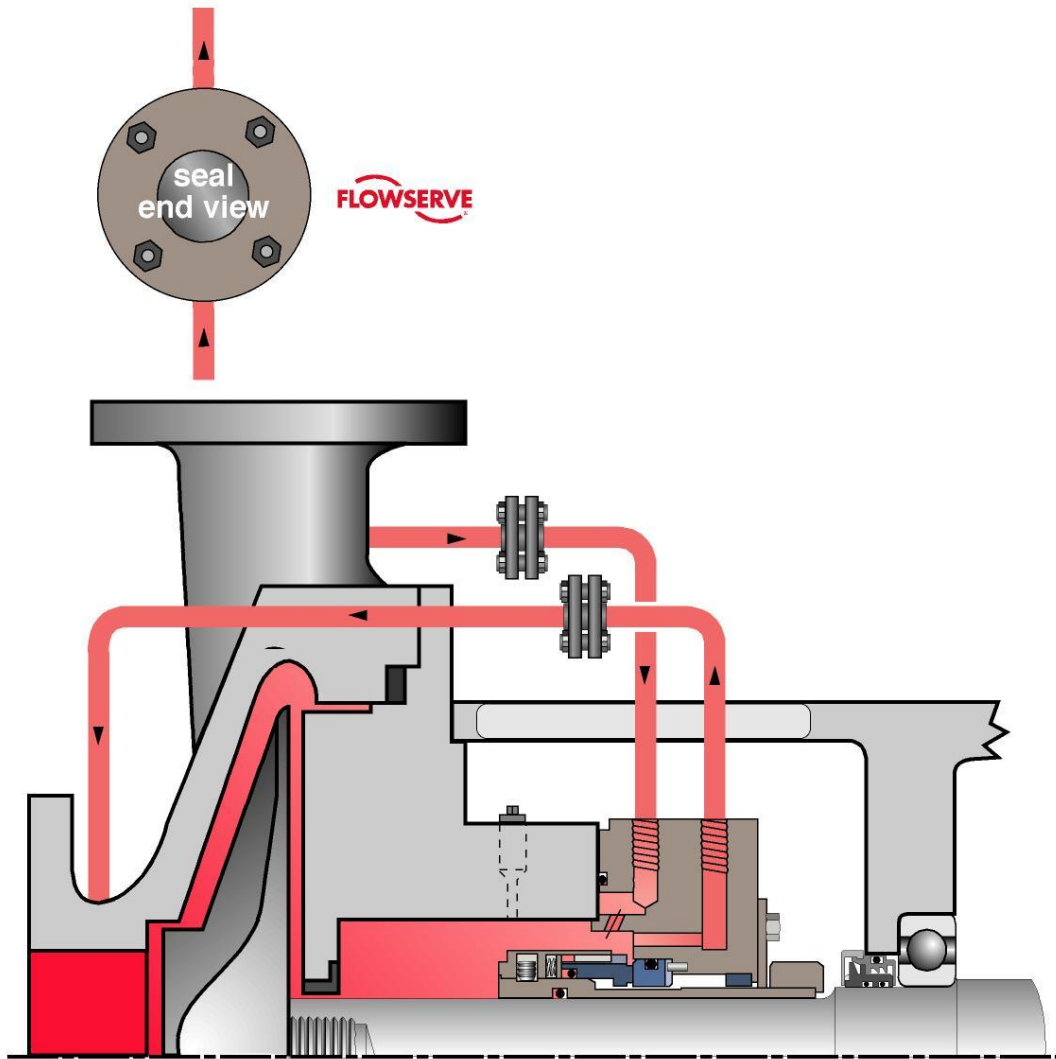
- Seal flush from pump discharge and recirculation to pump suction with orifices.
- Combination of Plan 11 and Plan 13.



Plan 14

Why

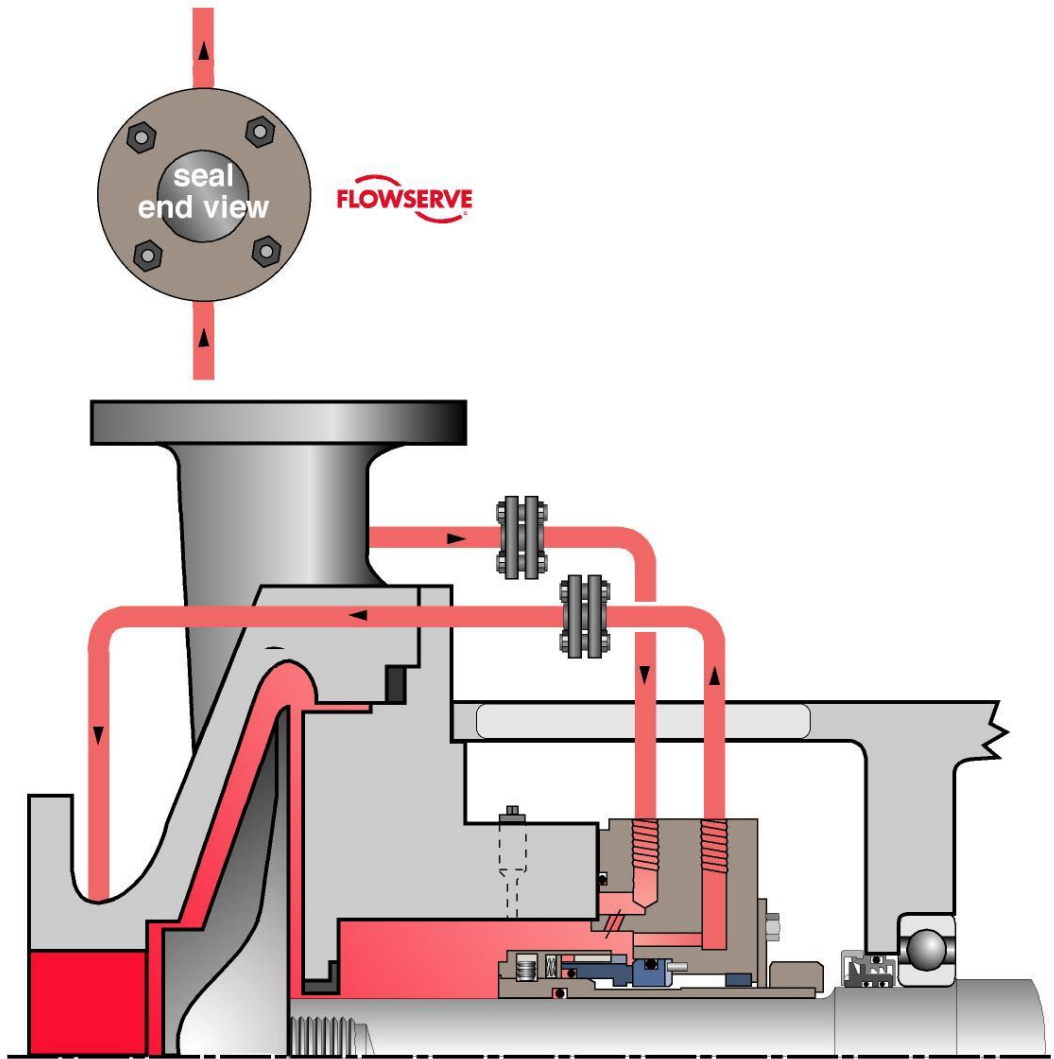
- Continuous seal chamber venting on vertical pumps.
- Seal chamber heat removal.
- Increase seal chamber pressure and fluid vapor margin.



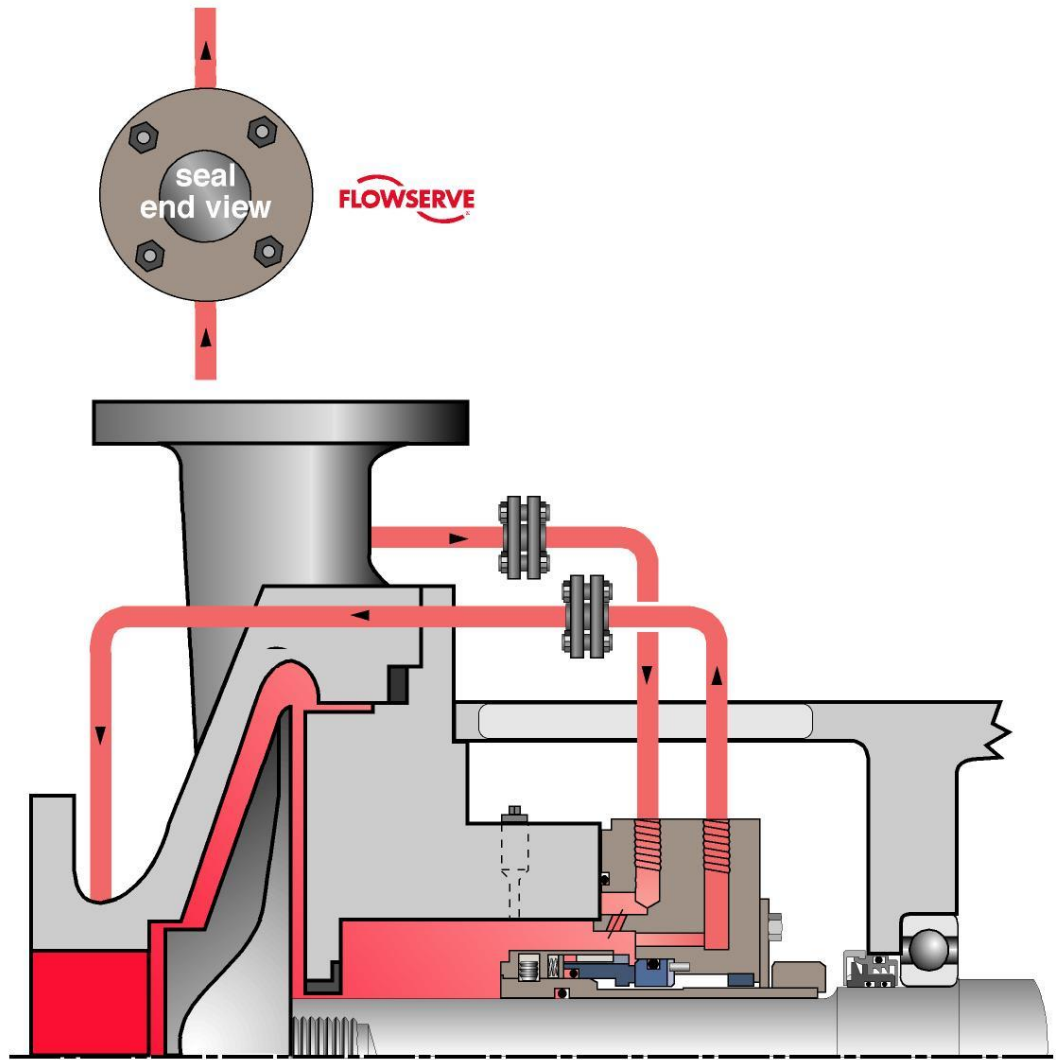
Plan 14

Where

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



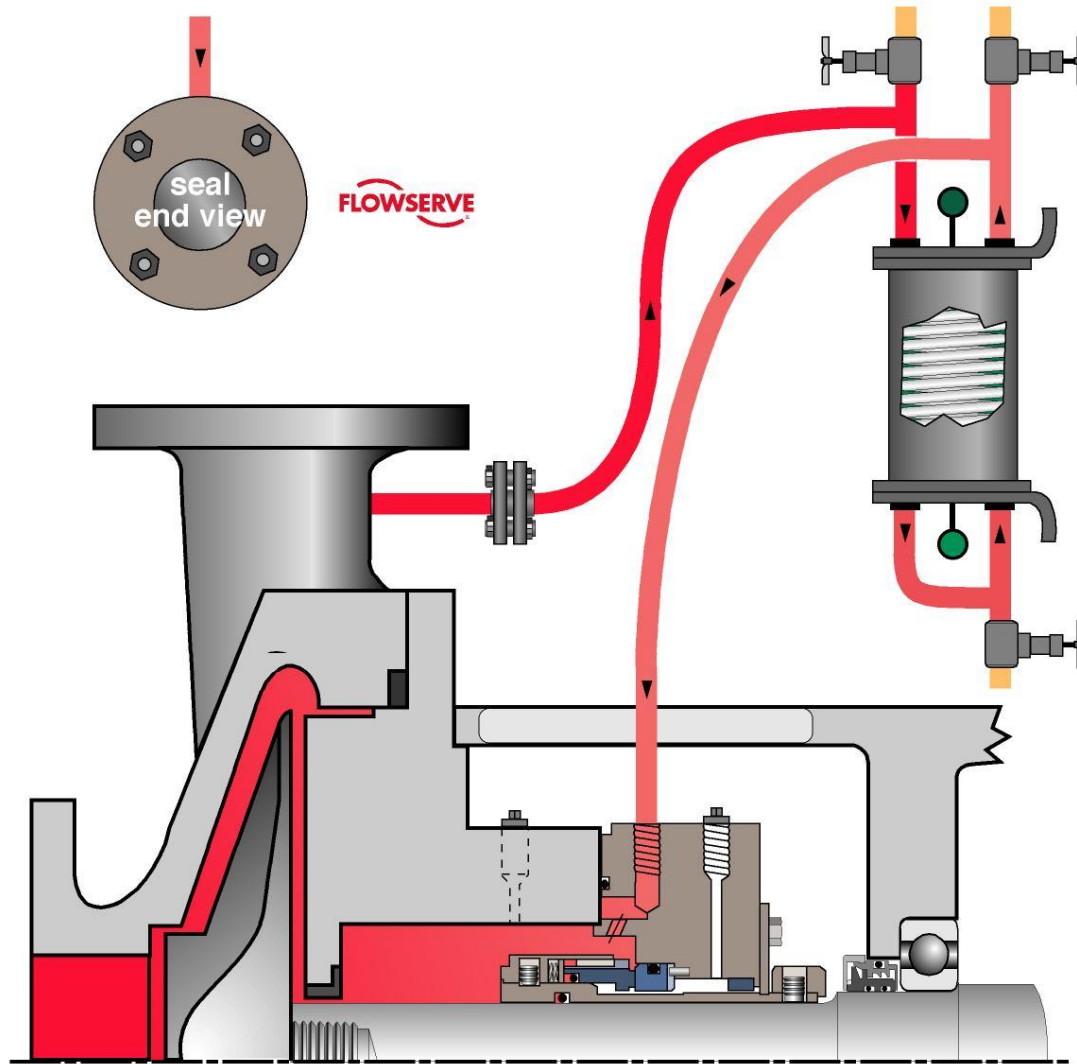
Plan 14



Preventative Maintenance

- Use an orifice with a minimum 0.125" (3 mm) 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.

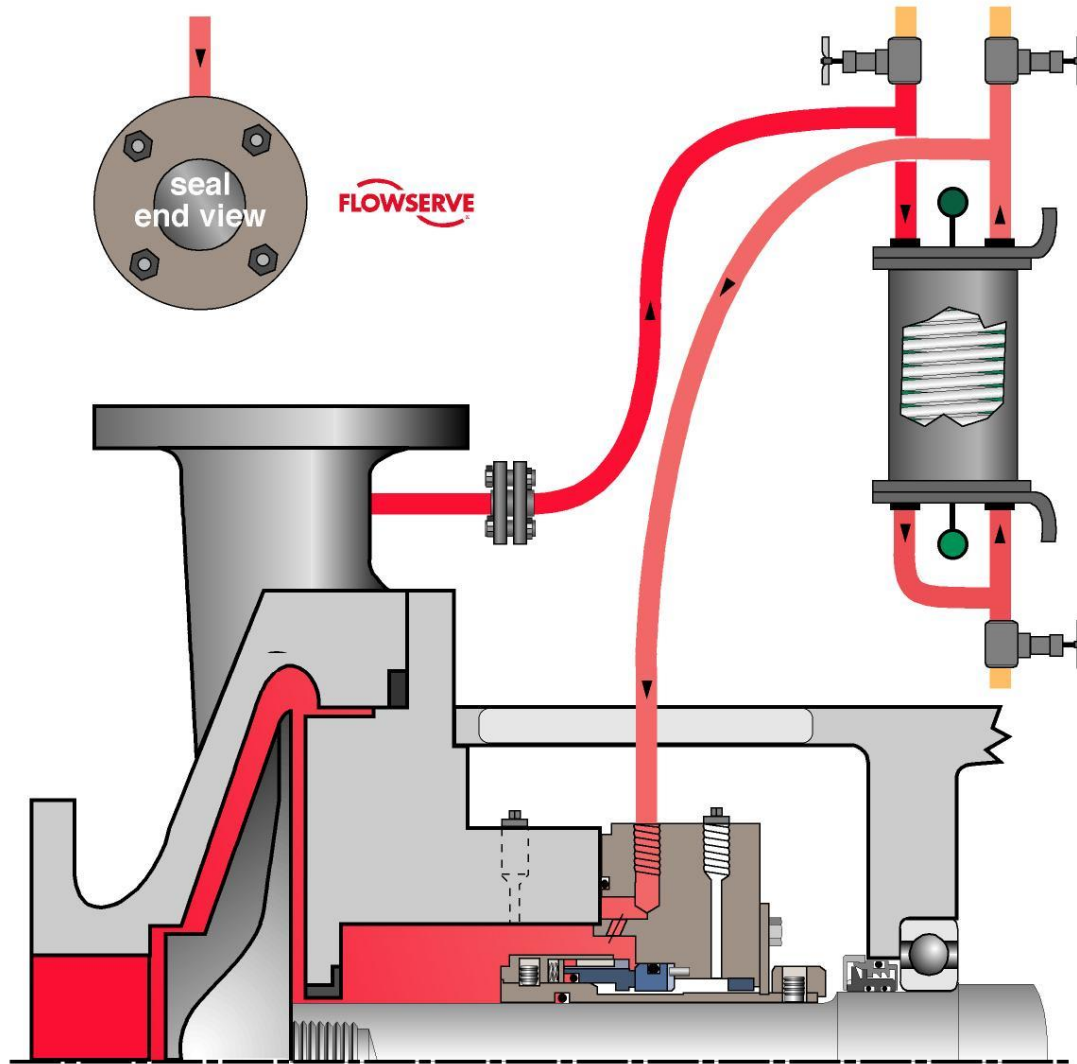
Plan 21



What

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

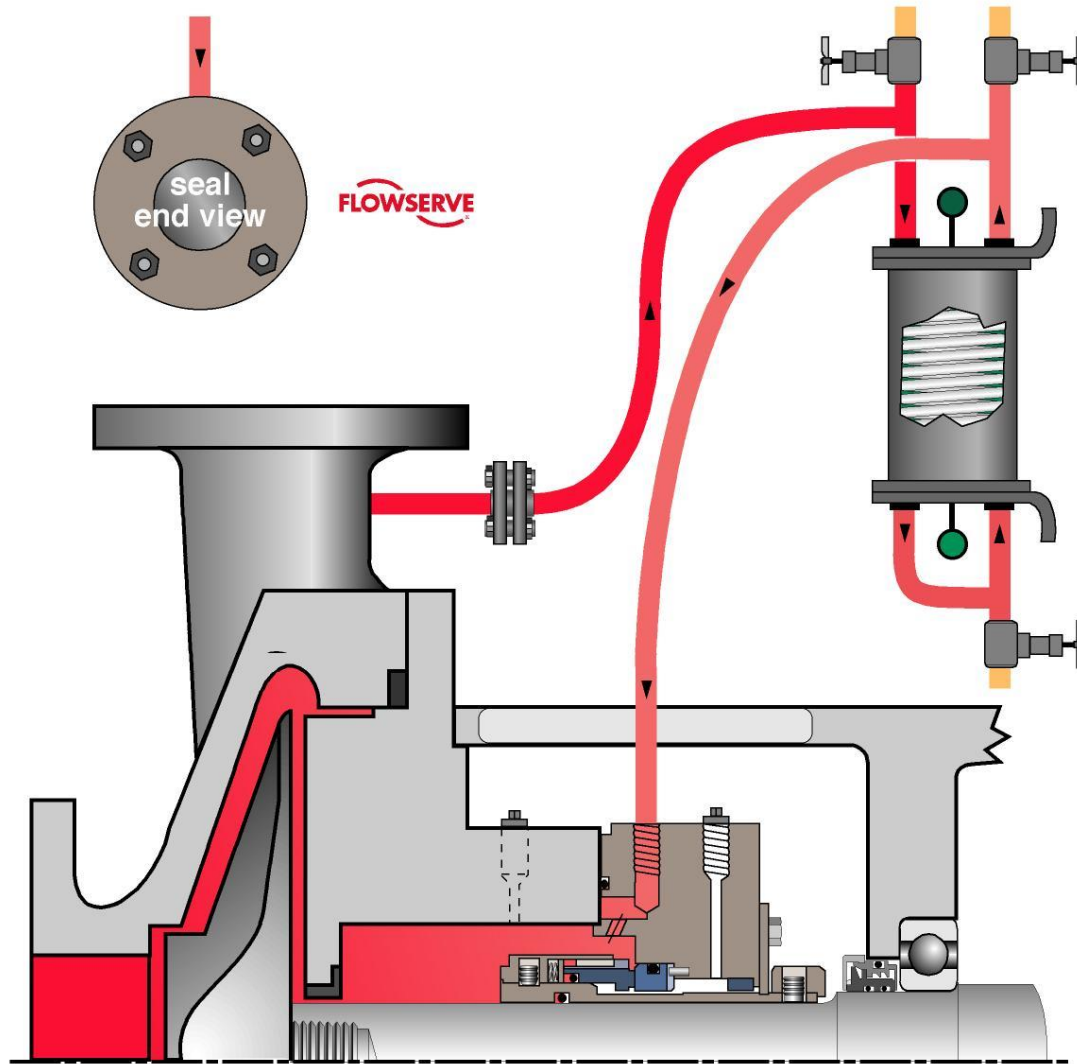
Plan 21



Why

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

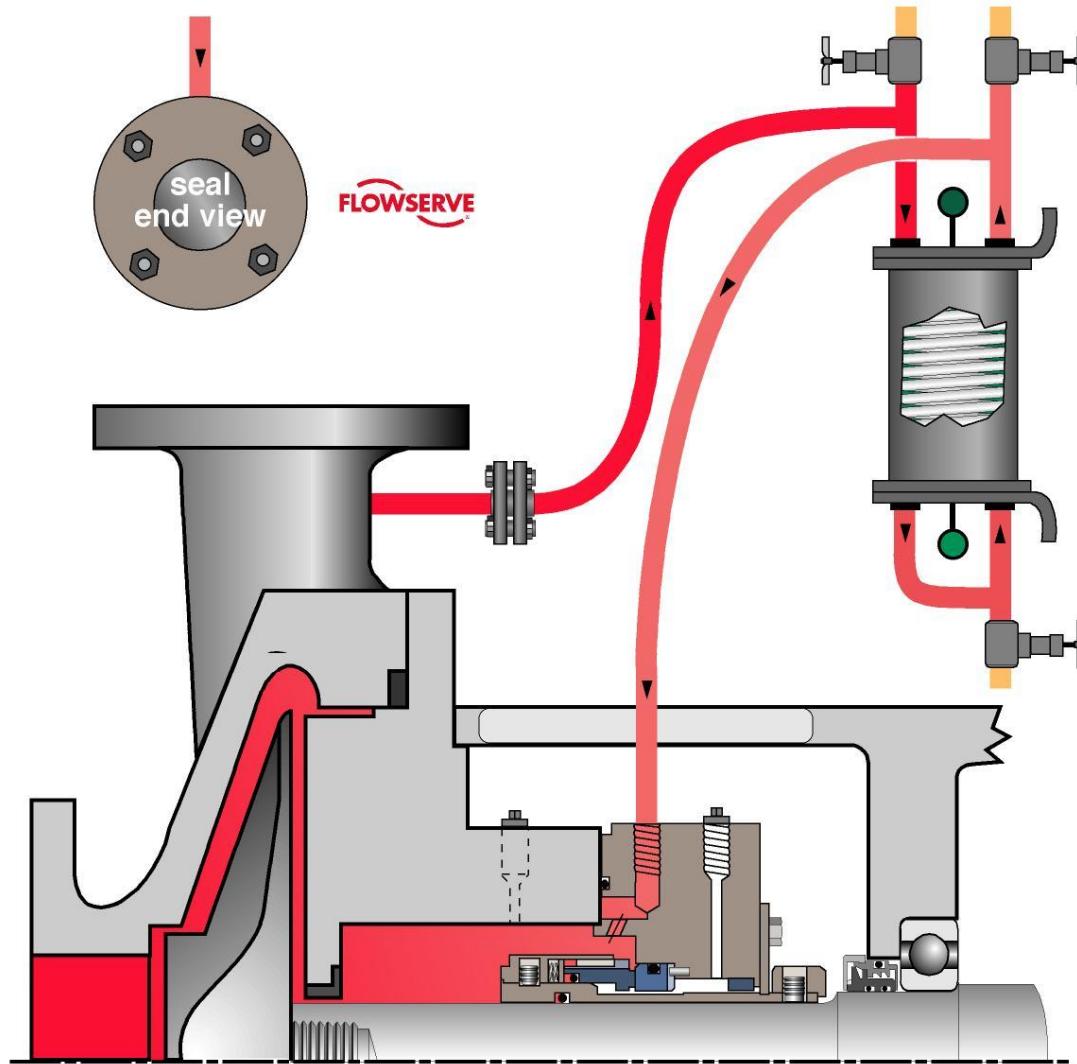
Plan 21



Where

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

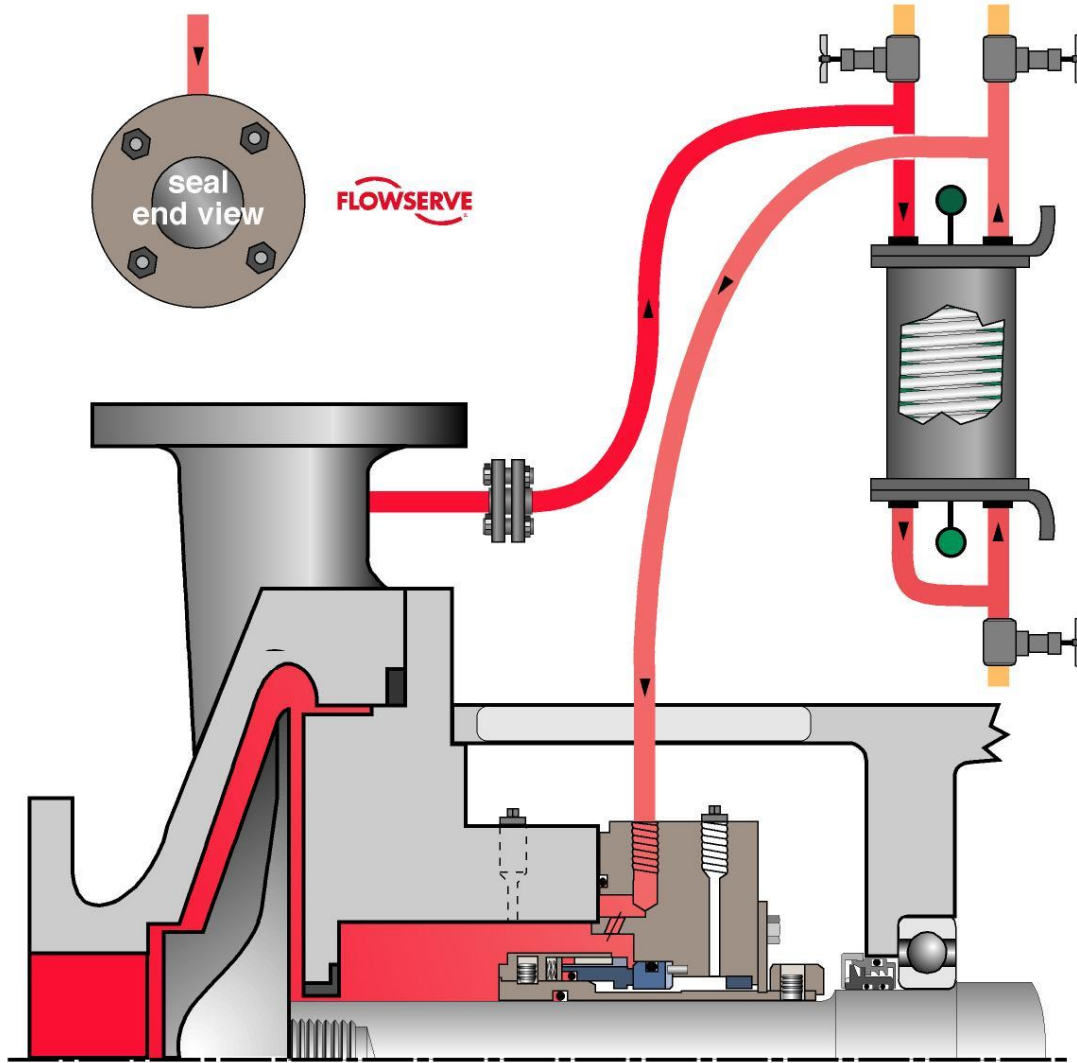
Plan 21



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 0.125" (3 mm) diameter.

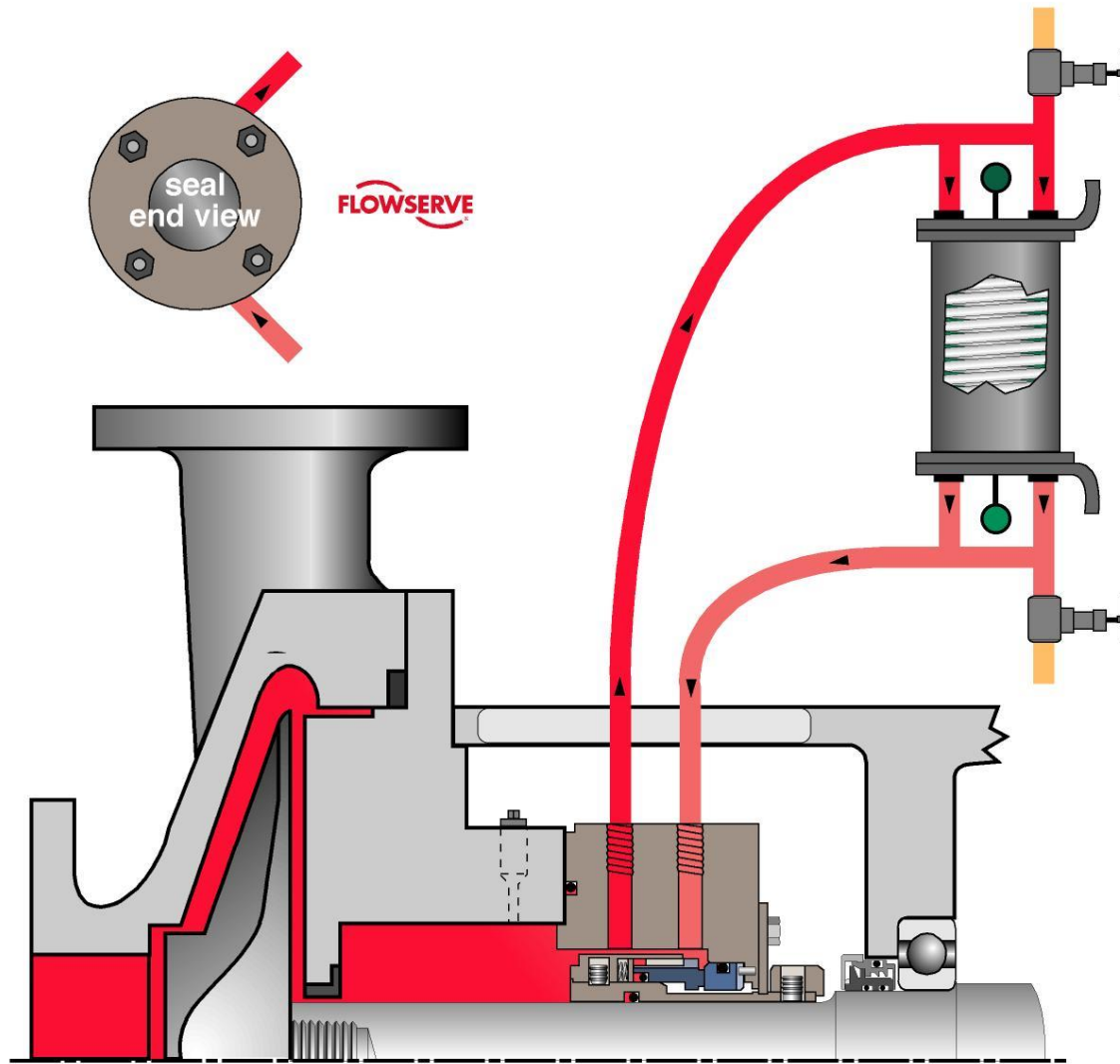
Plan 21



Preventative Maintenance (continued)

- Calculate flow rates to size orifice for adequate seal chamber flow.
- Increase boiling point margin with proper orifice and throat bushing sizing.
- Regularly monitor device inlet and outlet temperatures for signs of clogging or fouling.

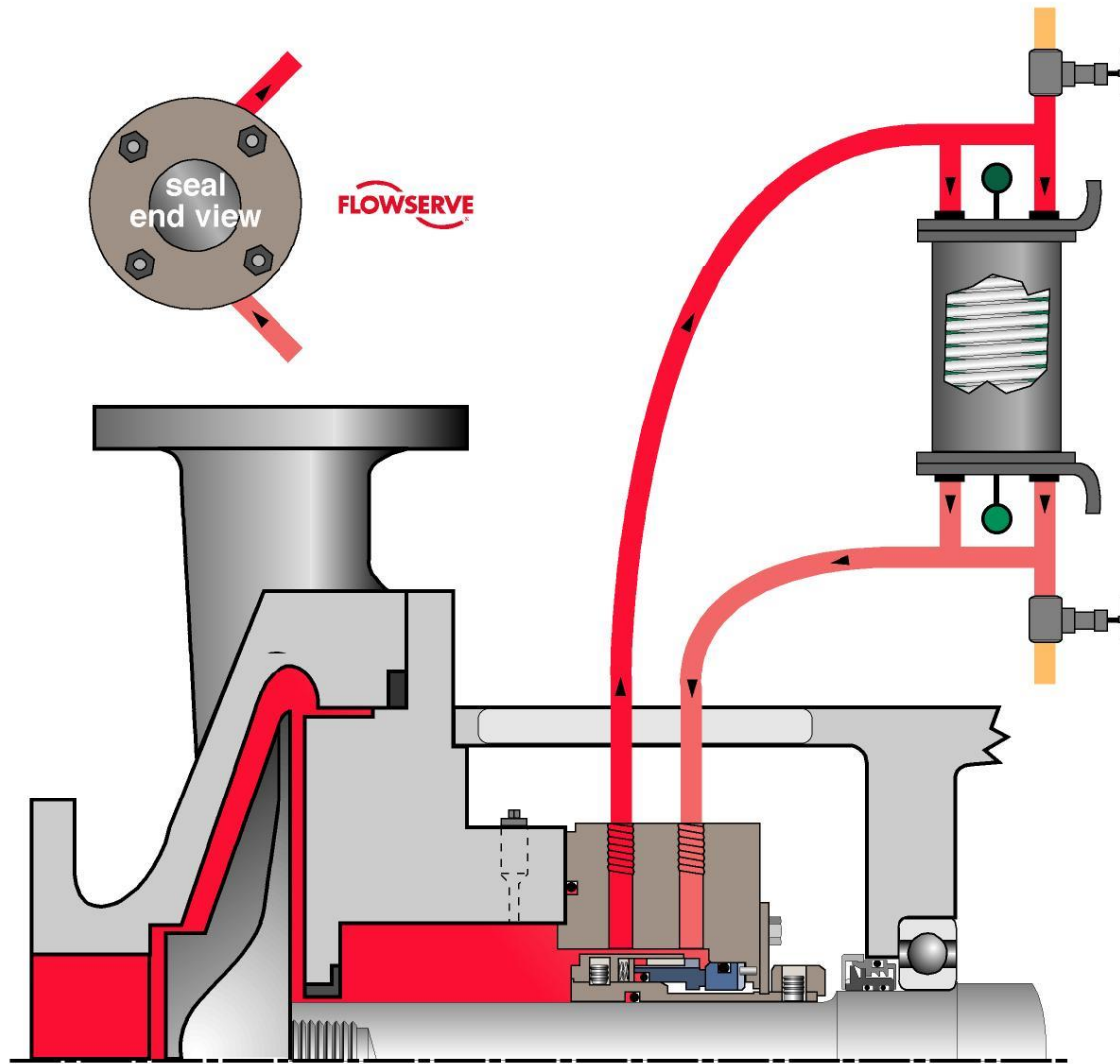
Plan 23



What

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

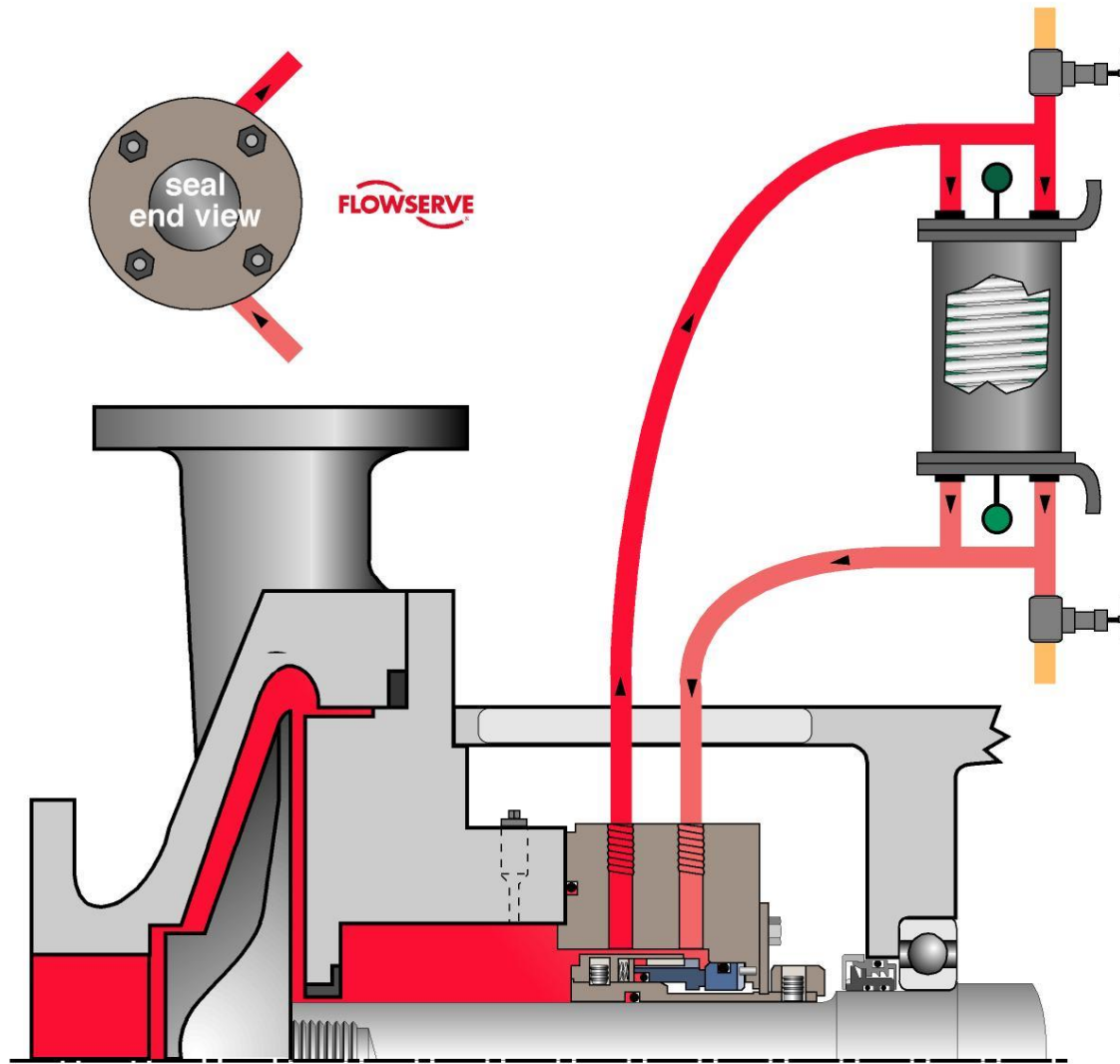
Plan 23



Why

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

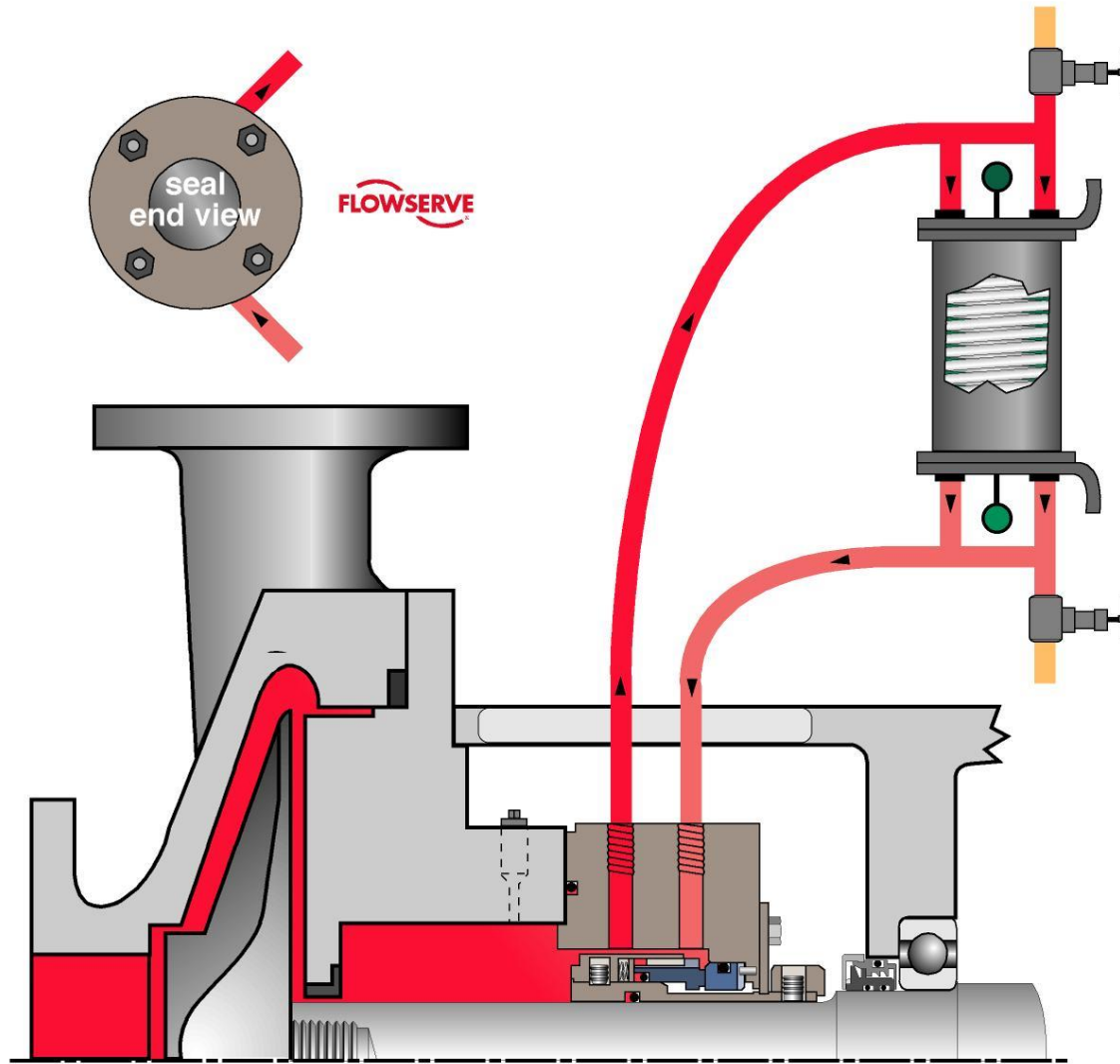
Plan 23



Where

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

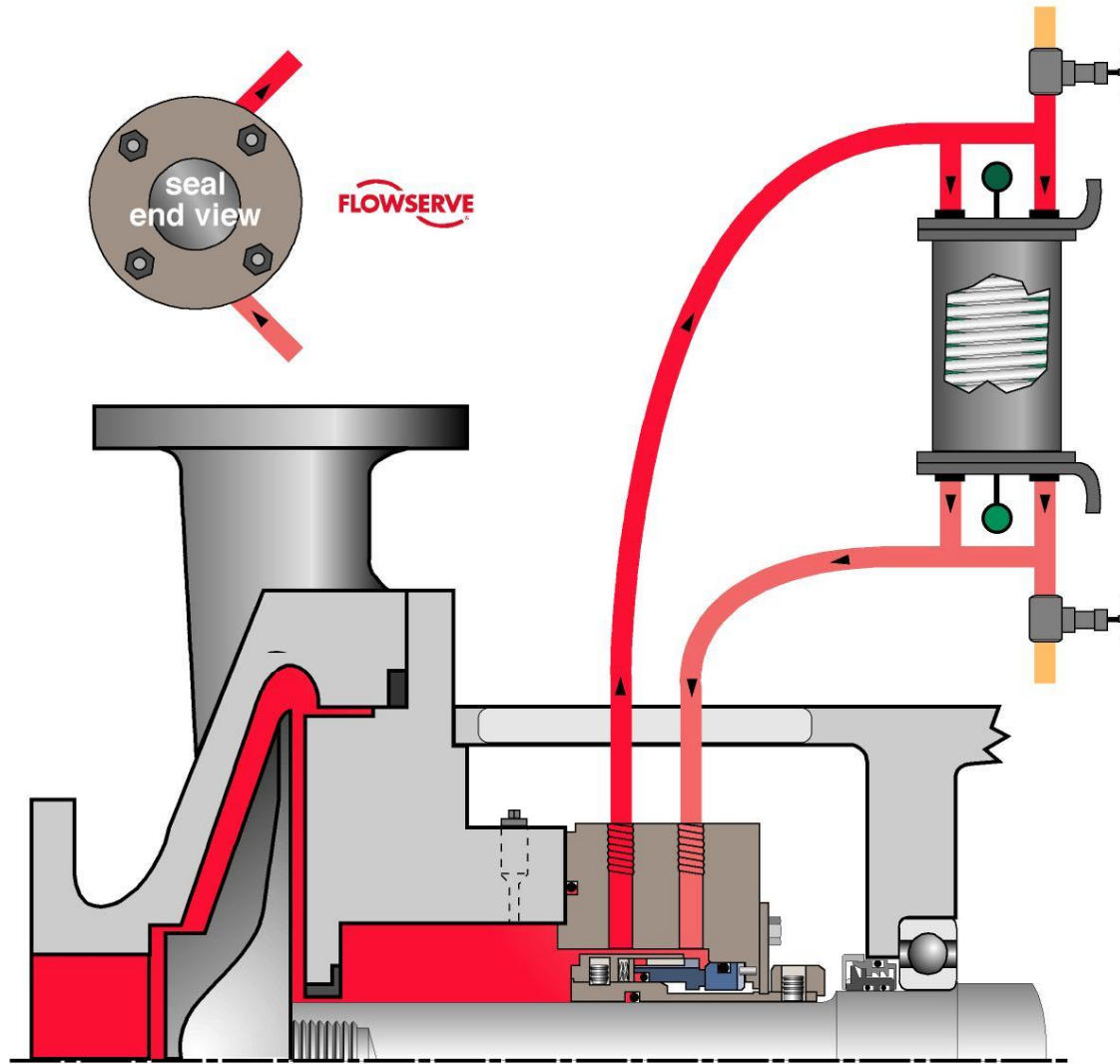
Plan 23



Preventative Maintenance

- Seal cooler 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.

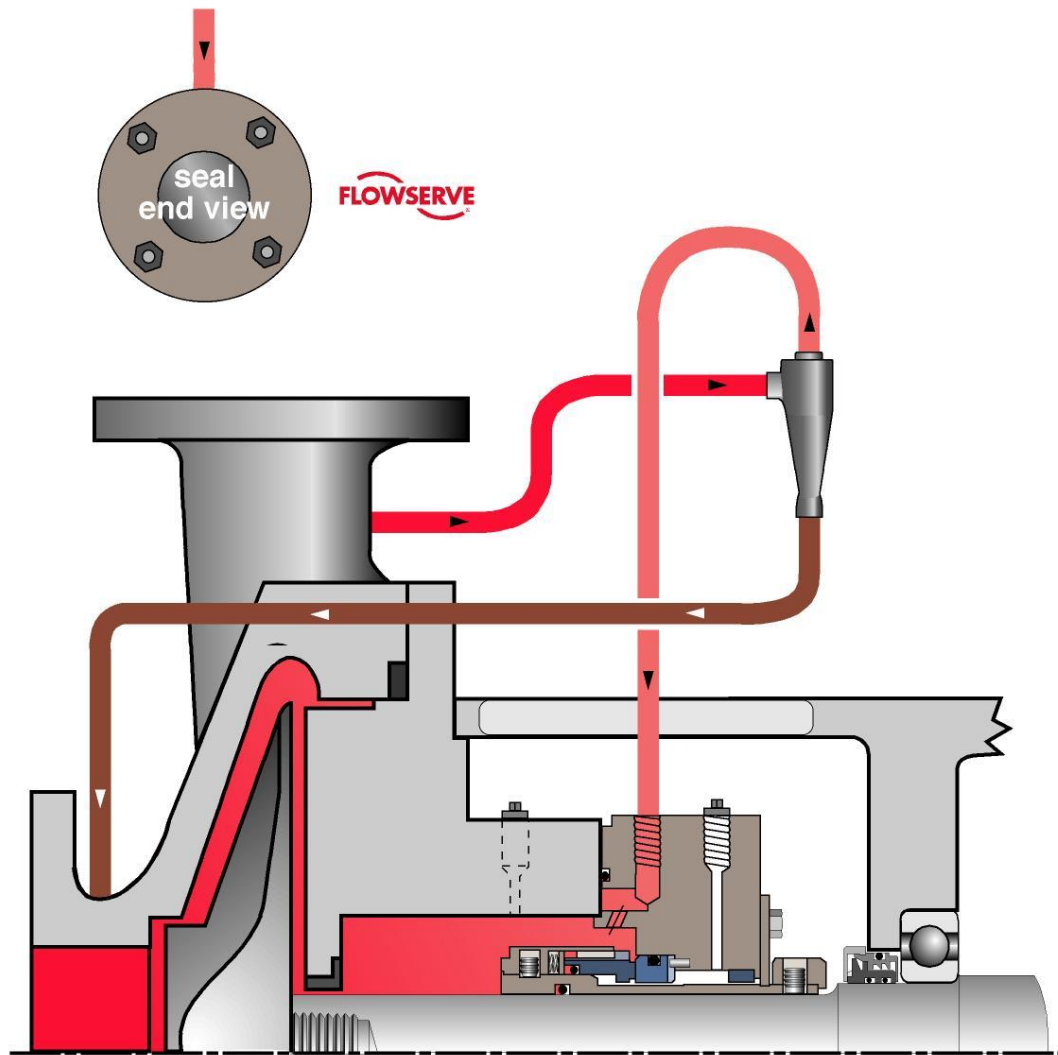
Plan 23



Preventative Maintenance (continued)

- Tangential seal gland taps should enter at bottom and exit at top.
- Regularly monitor cooler inlet and outlet temperatures for signs of plugging or fouling.
- Process fluids with iron should flow through magnetic separator before cooler.

Plan 31



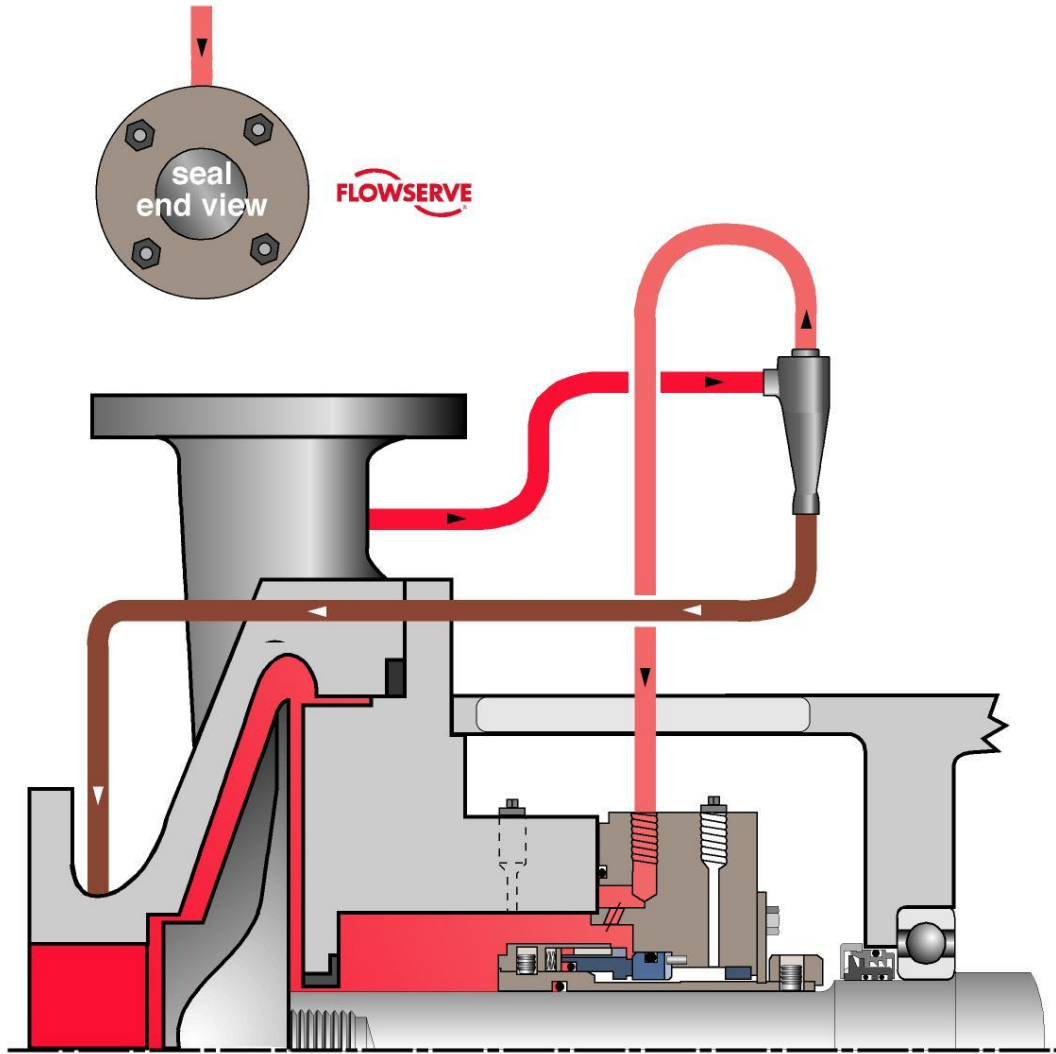
What

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

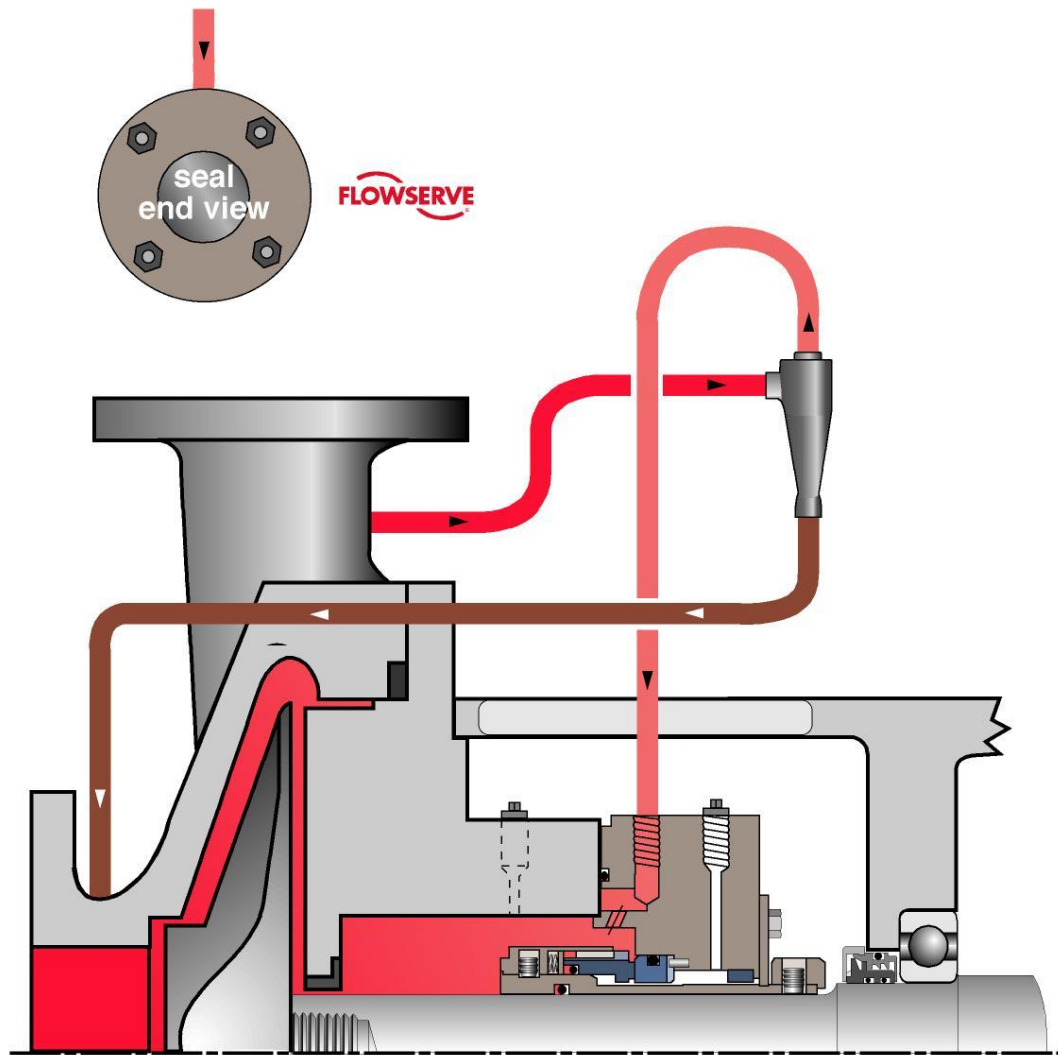
Plan 31

Why

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



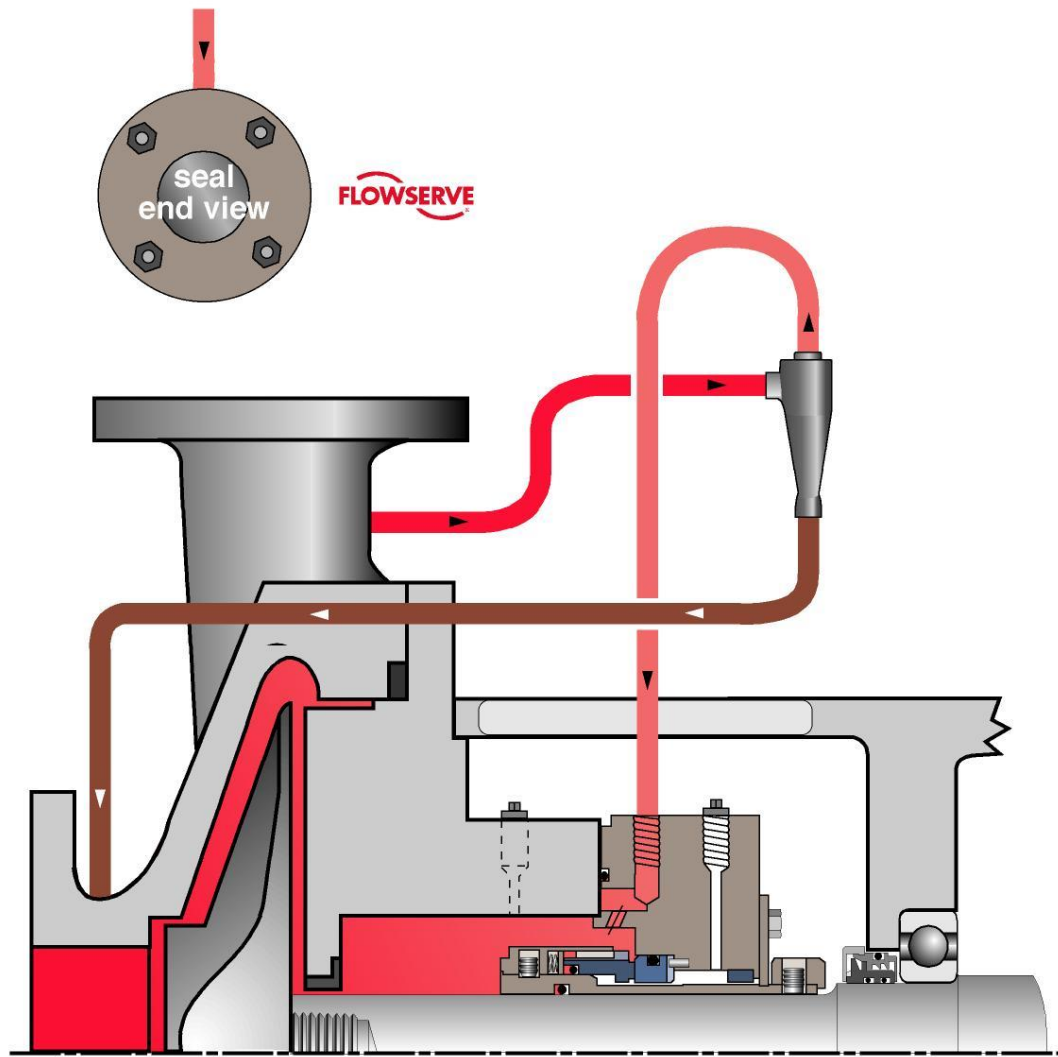
Plan 31



Where

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

Plan 31



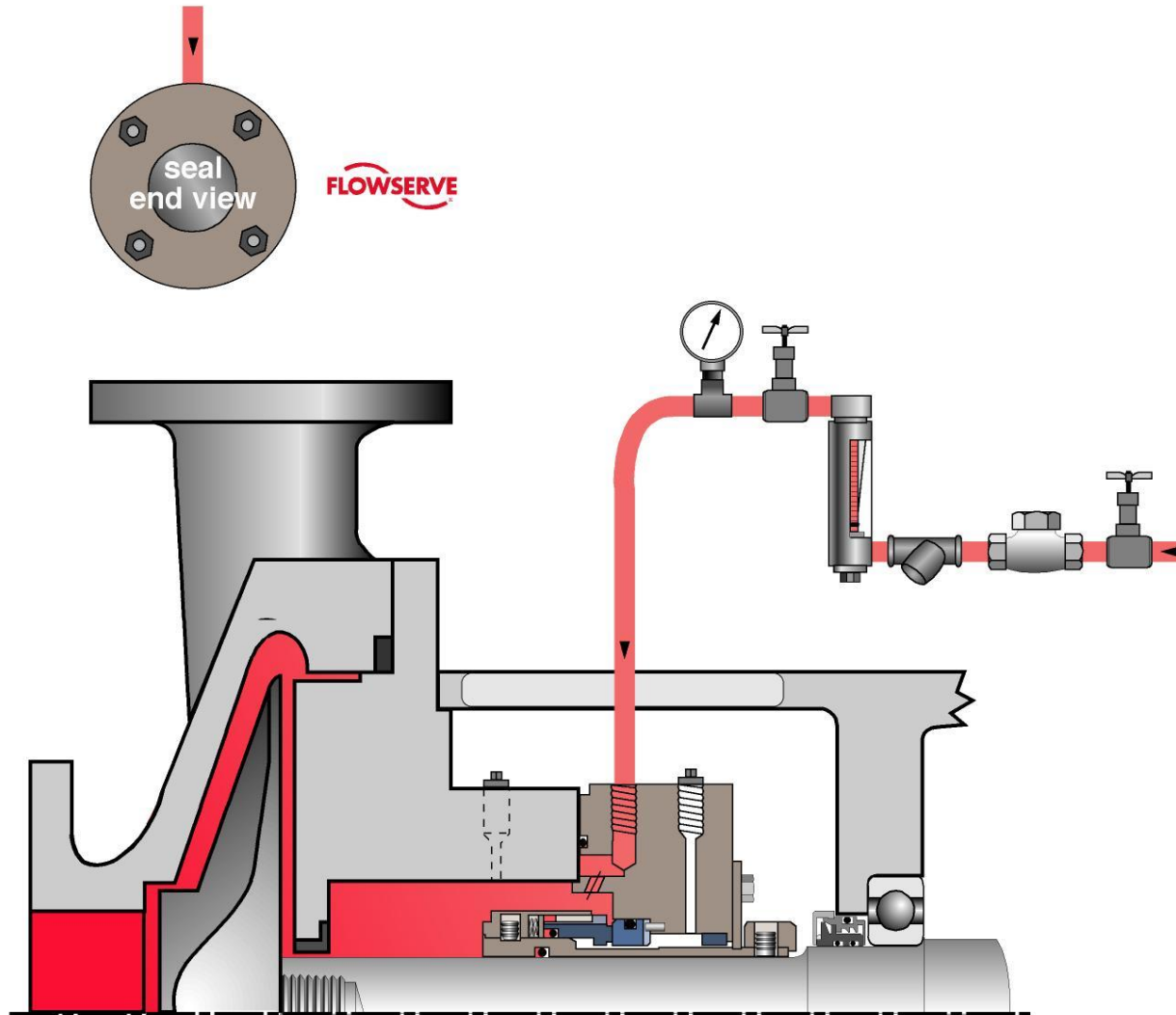
Preventative Maintenance

- 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 a clogged separator or pipes – check temperatures at pipe ends.

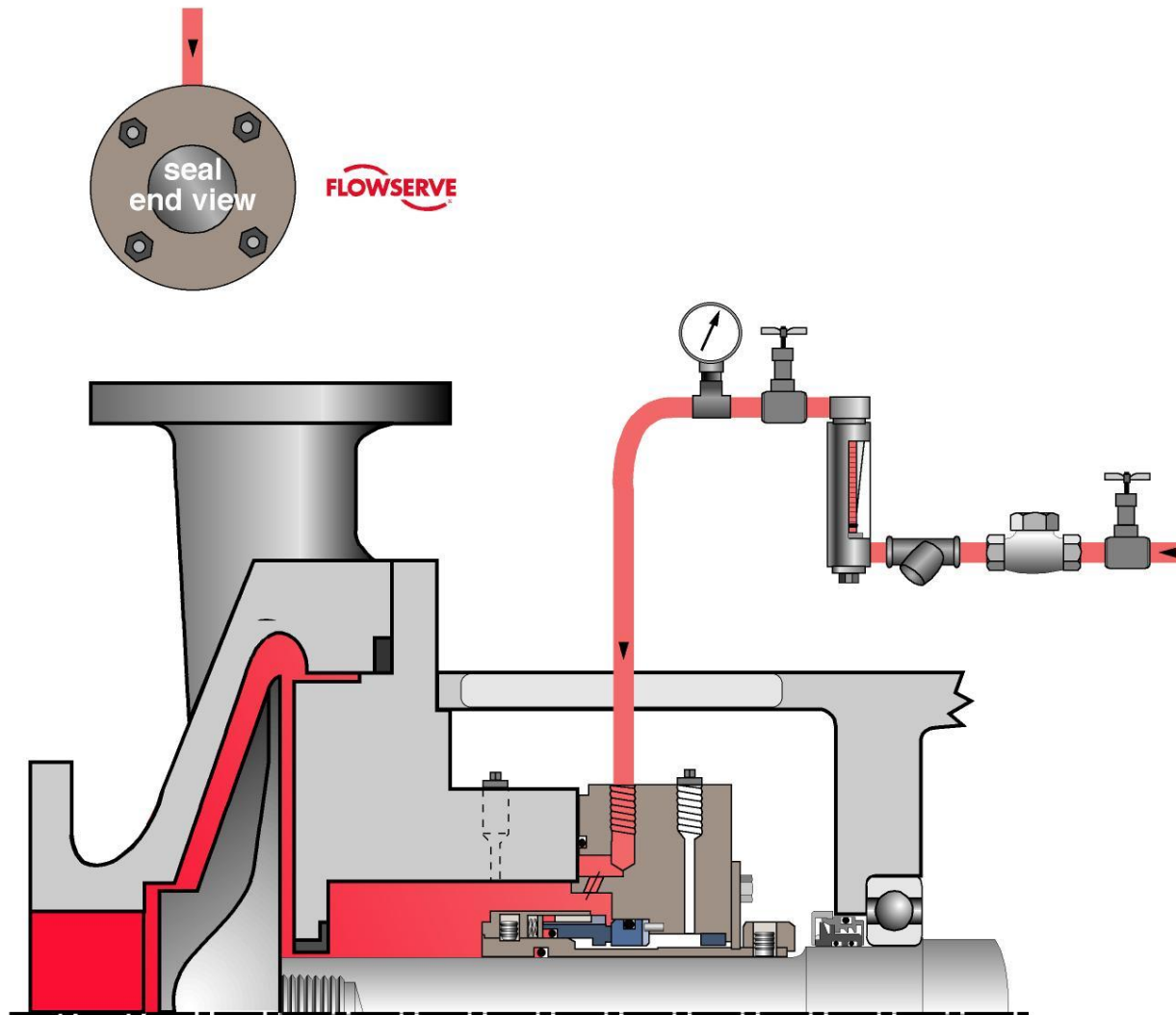
Plan 32

What

- Seal flush from an external clean source.



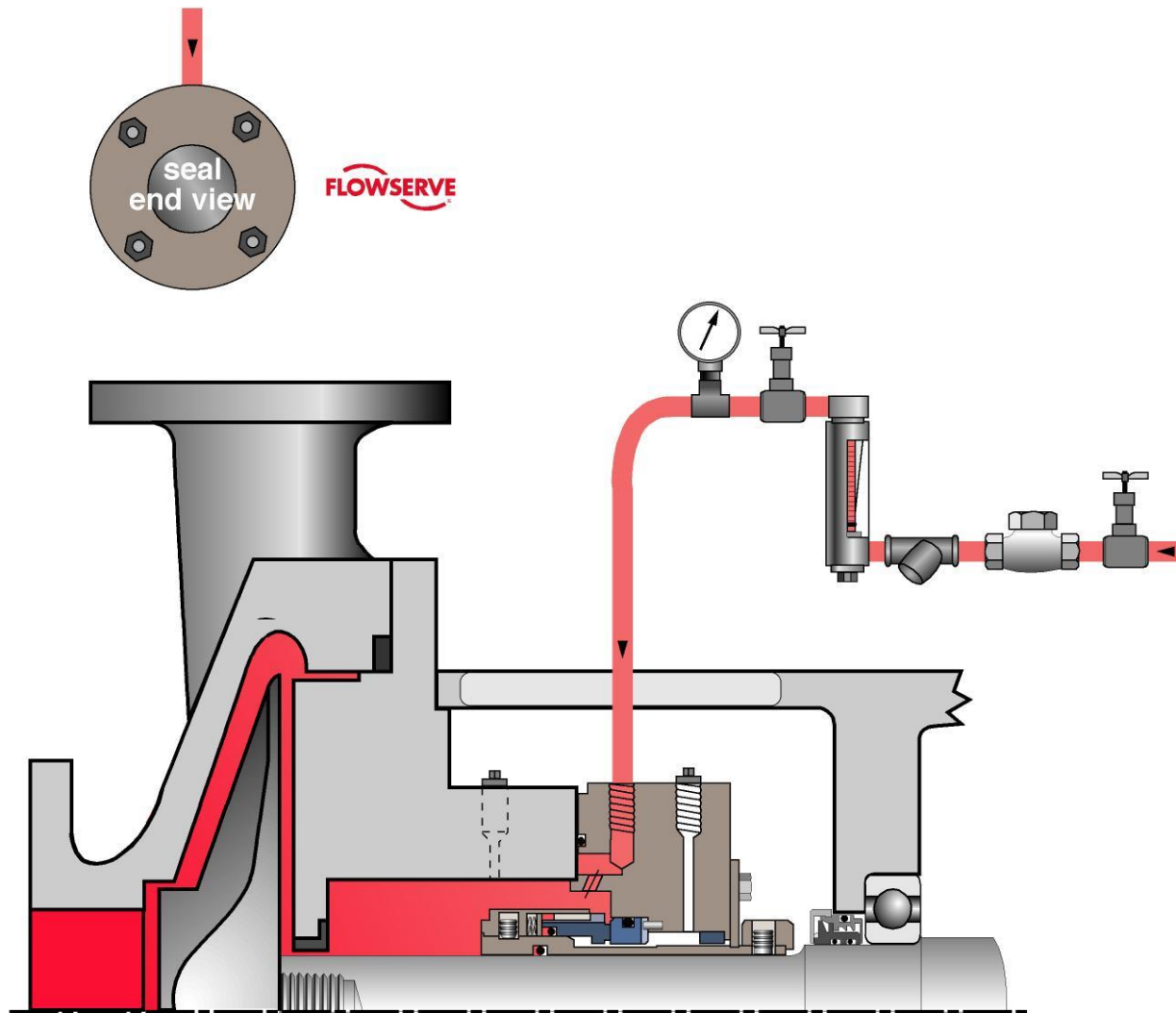
Plan 32



Why

- Seal chamber heat removal.
- Process and solids removal from seal chamber.
- Increase seal chamber pressure and fluid vapor margin.

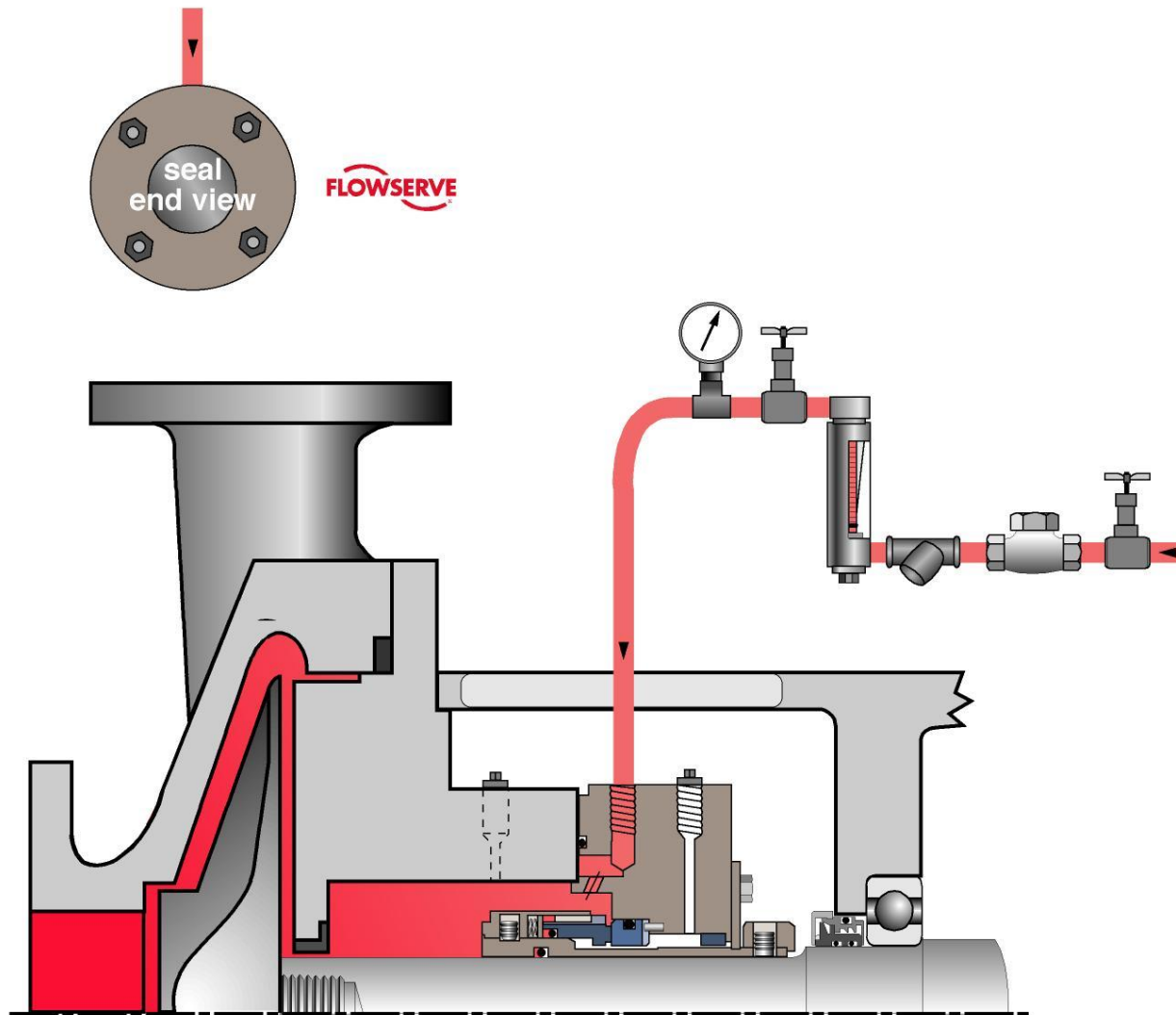
Plan 32



Where

- Dirty or contaminated fluids, paper pulp.
- High temperature service.
- Polymerizing and/or oxidizing fluids.

Plan 32



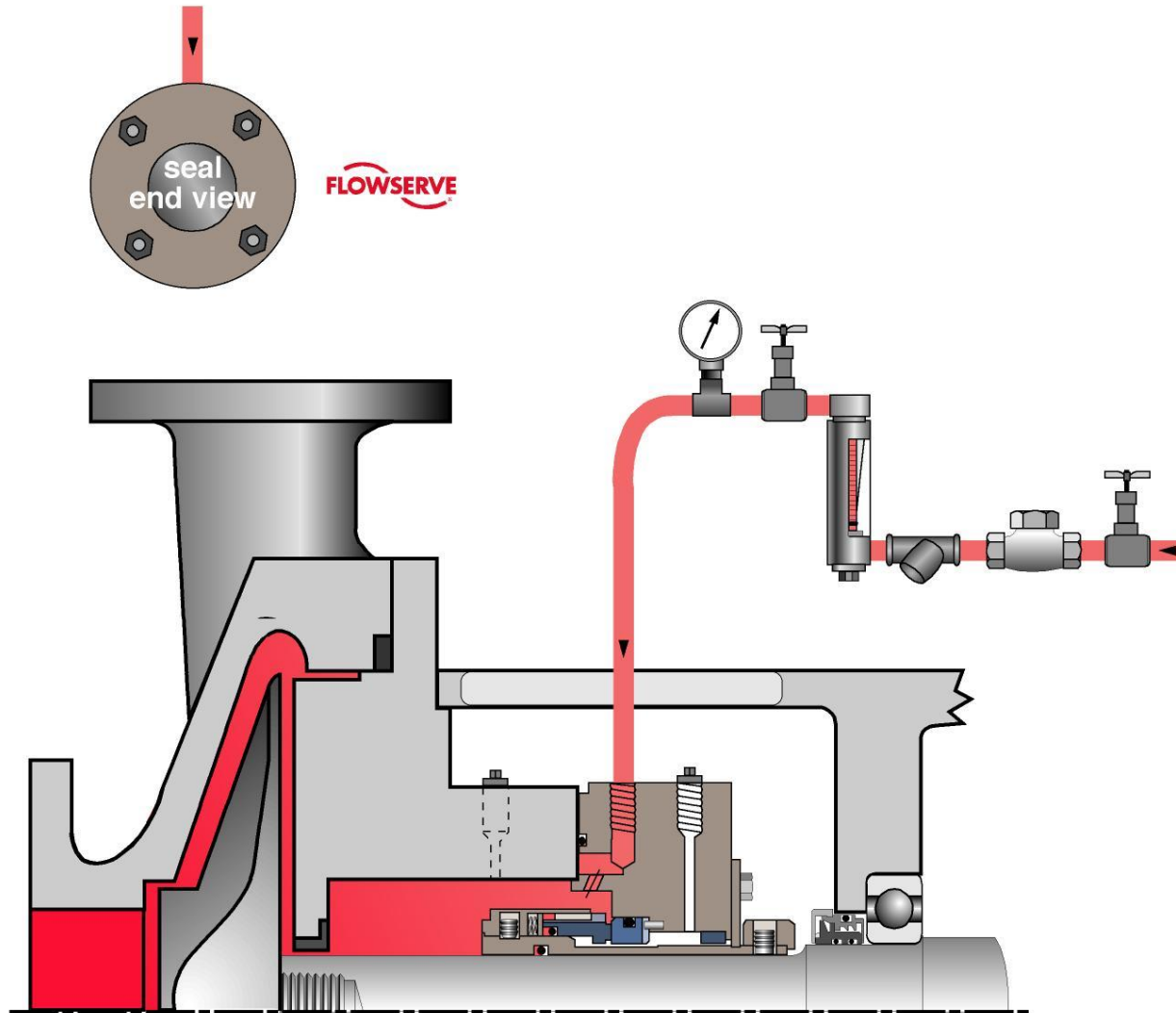
Preventative Maintenance

- 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.

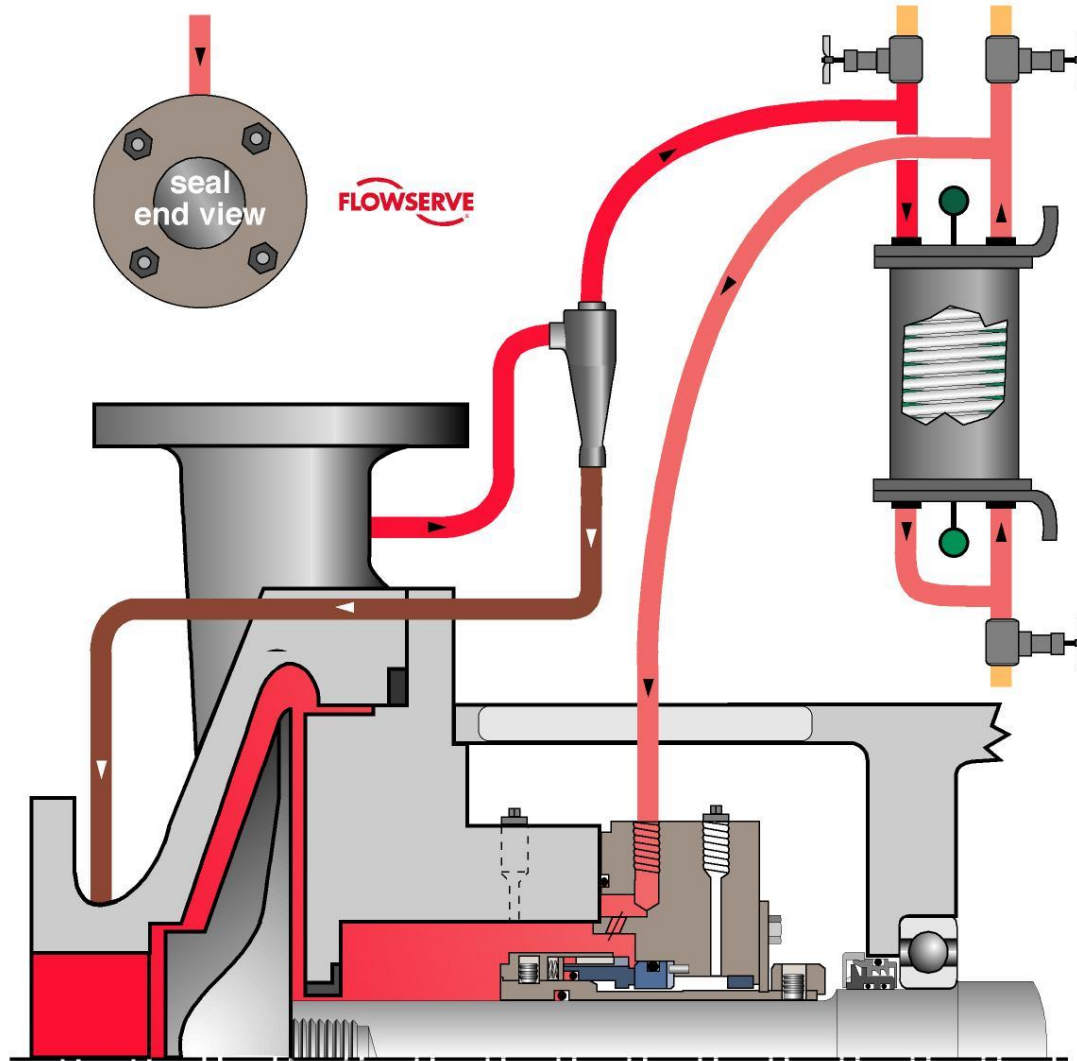
Plan 32

Preventative Maintenance (continued)

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



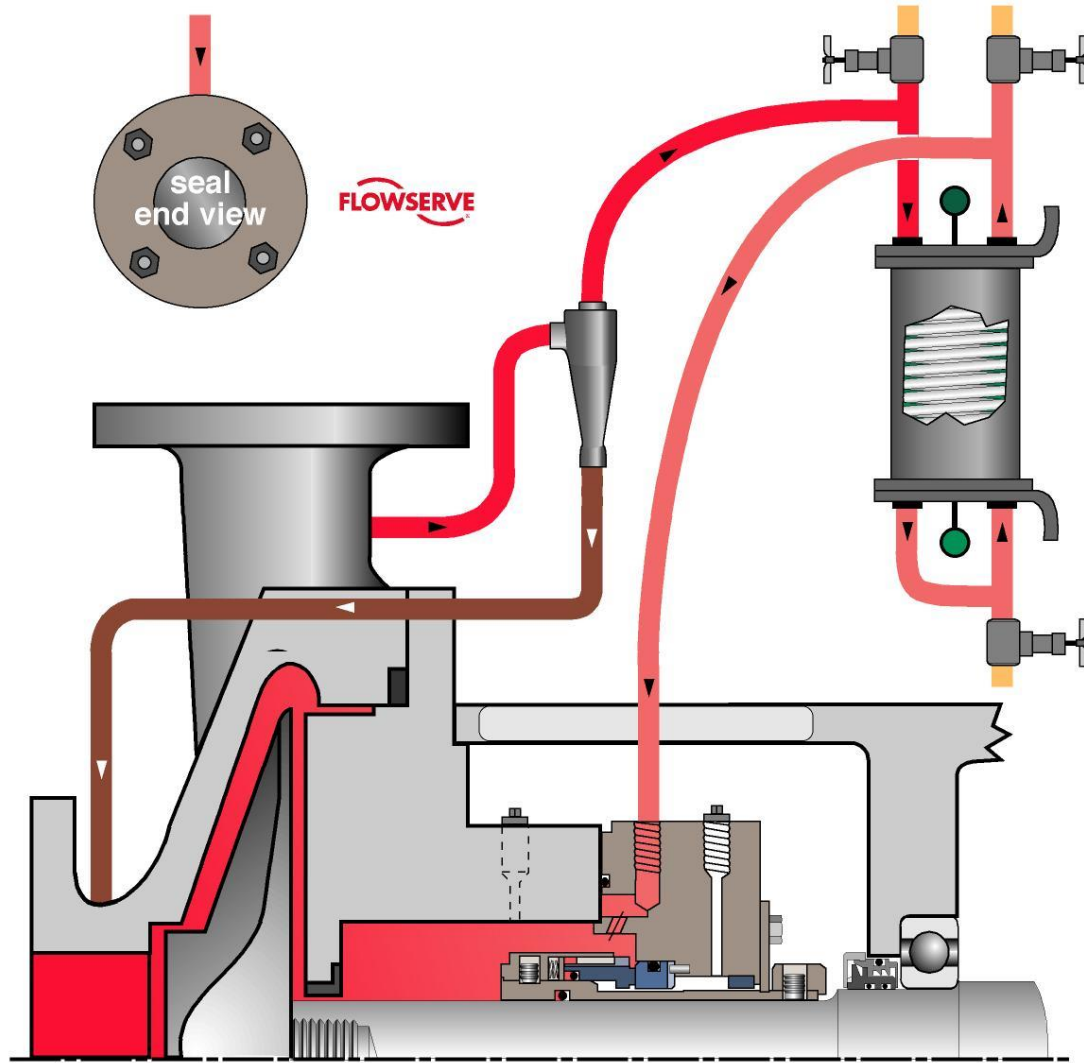
Plan 41



What

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

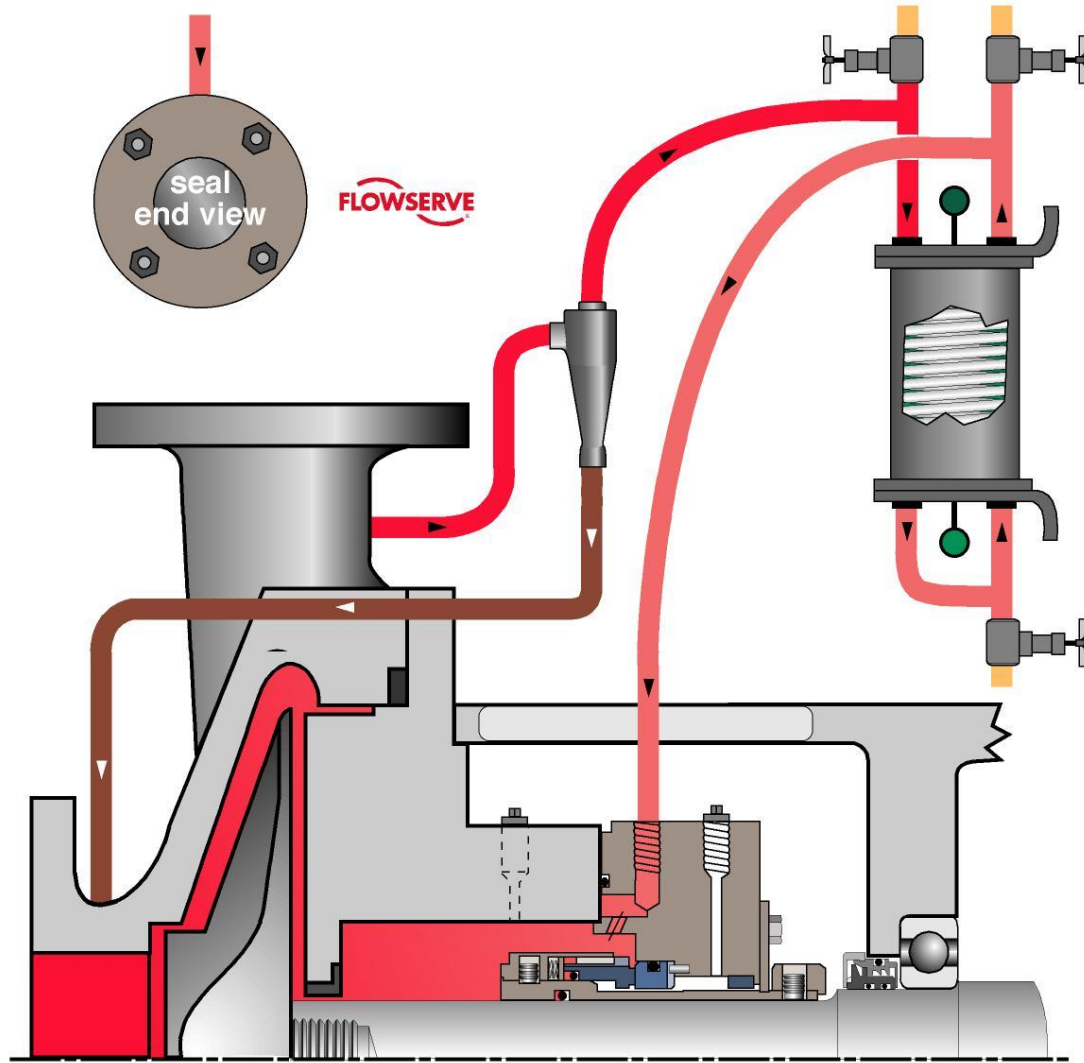
Plan 41



Why

- Seal cooling.
- Solids removal from flush and seal chamber.

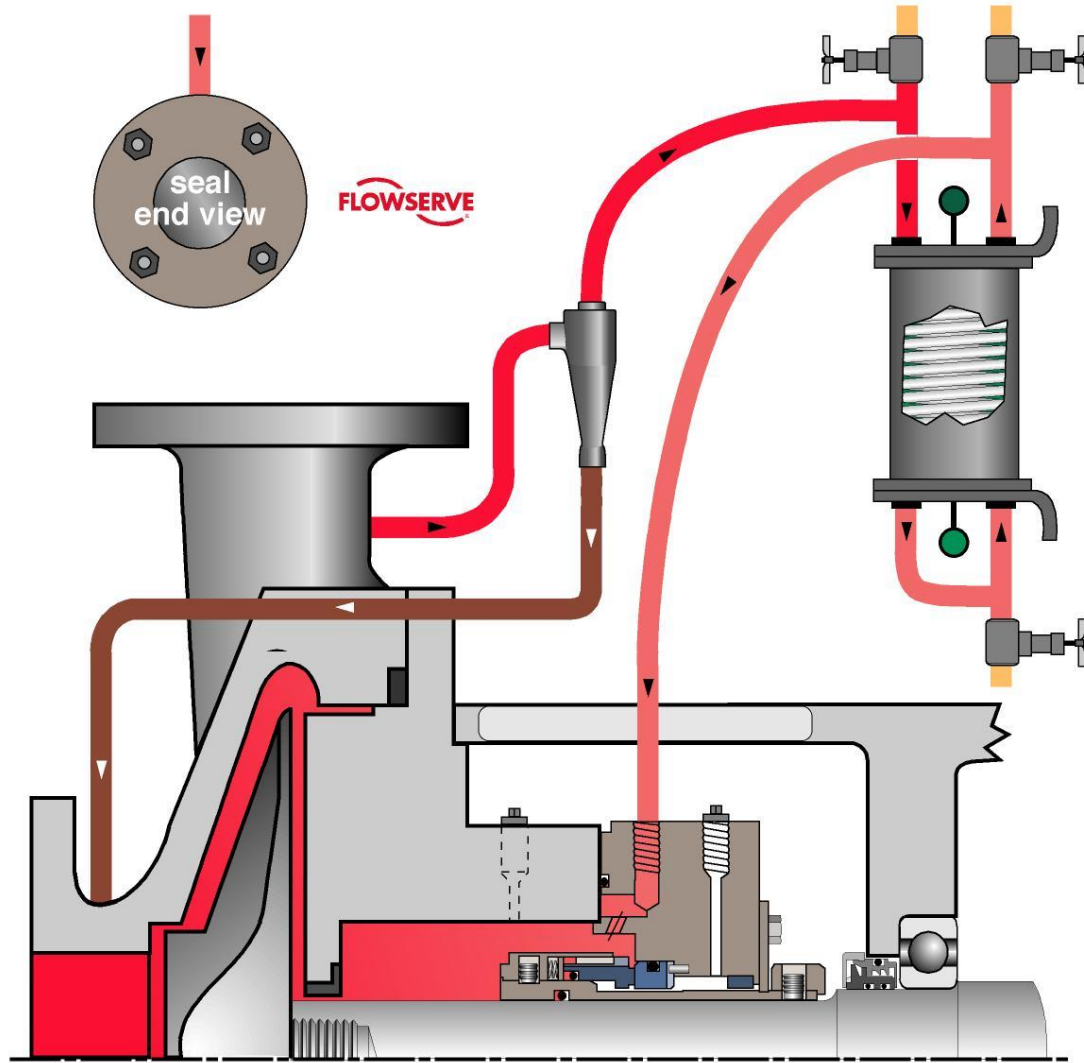
Plan 41



Where

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

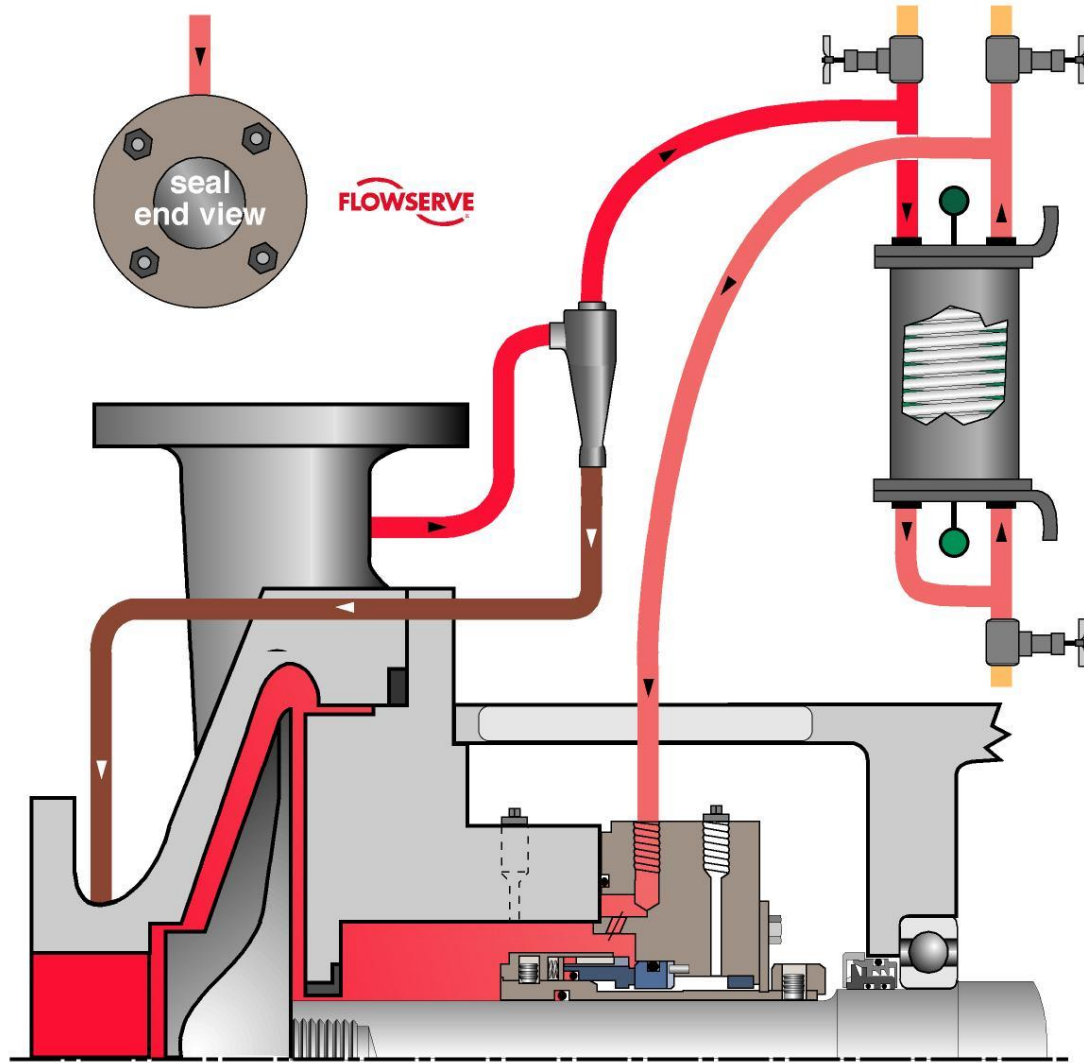
Plan 41



Preventative Maintenance

- Seal cooler 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.

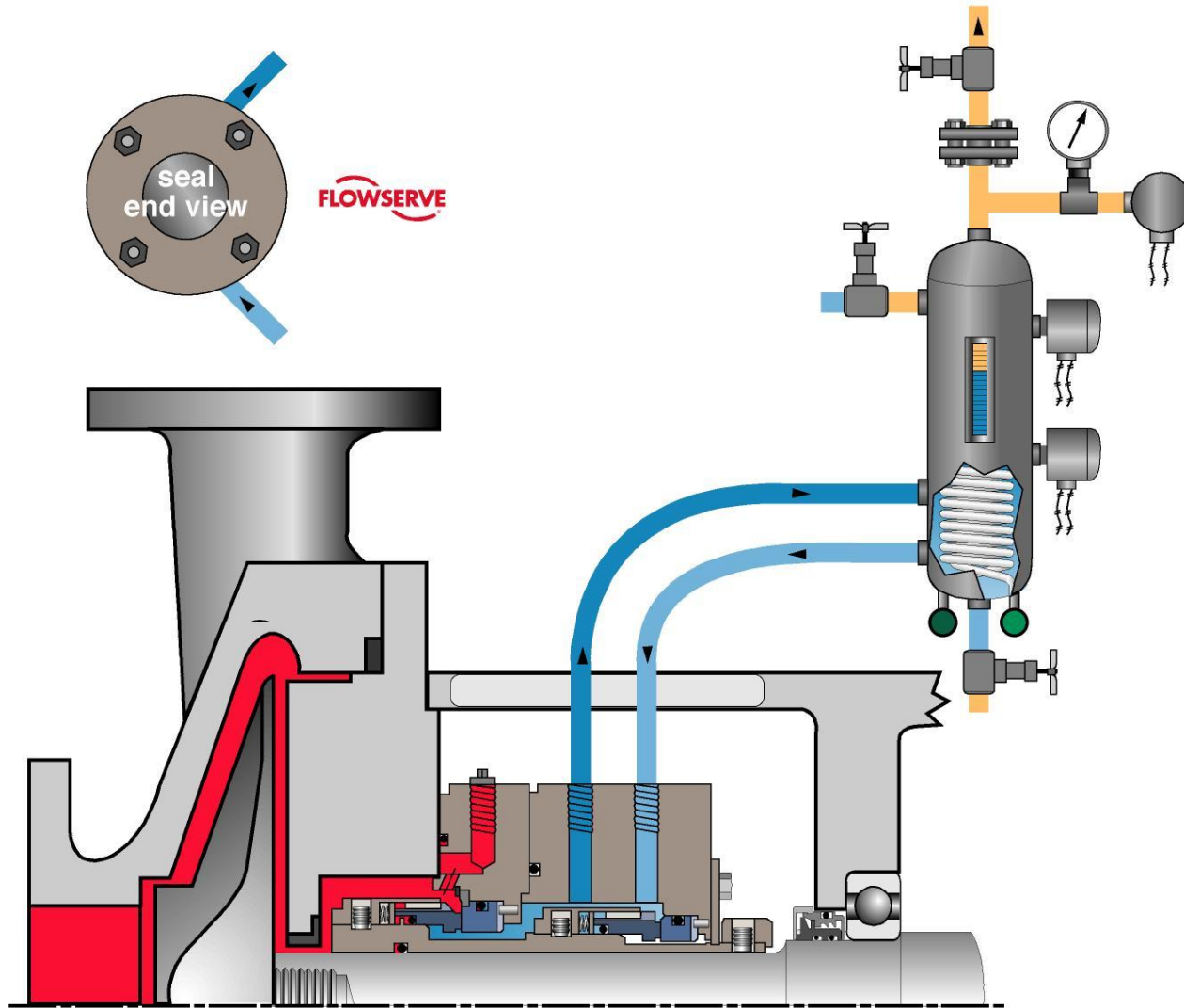
Plan 41



Preventative Maintenance (continued)

- 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.

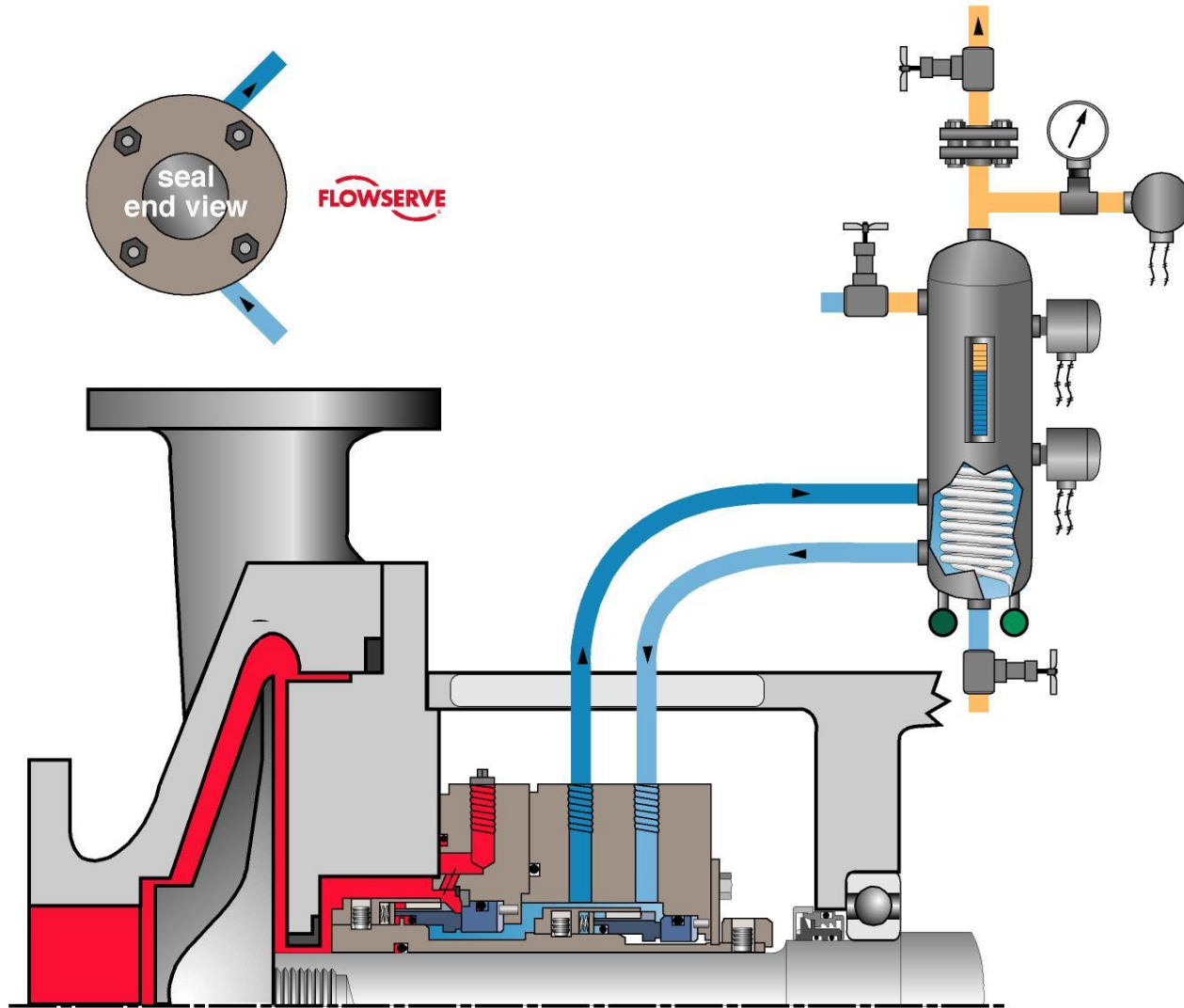
Plan 52



What

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

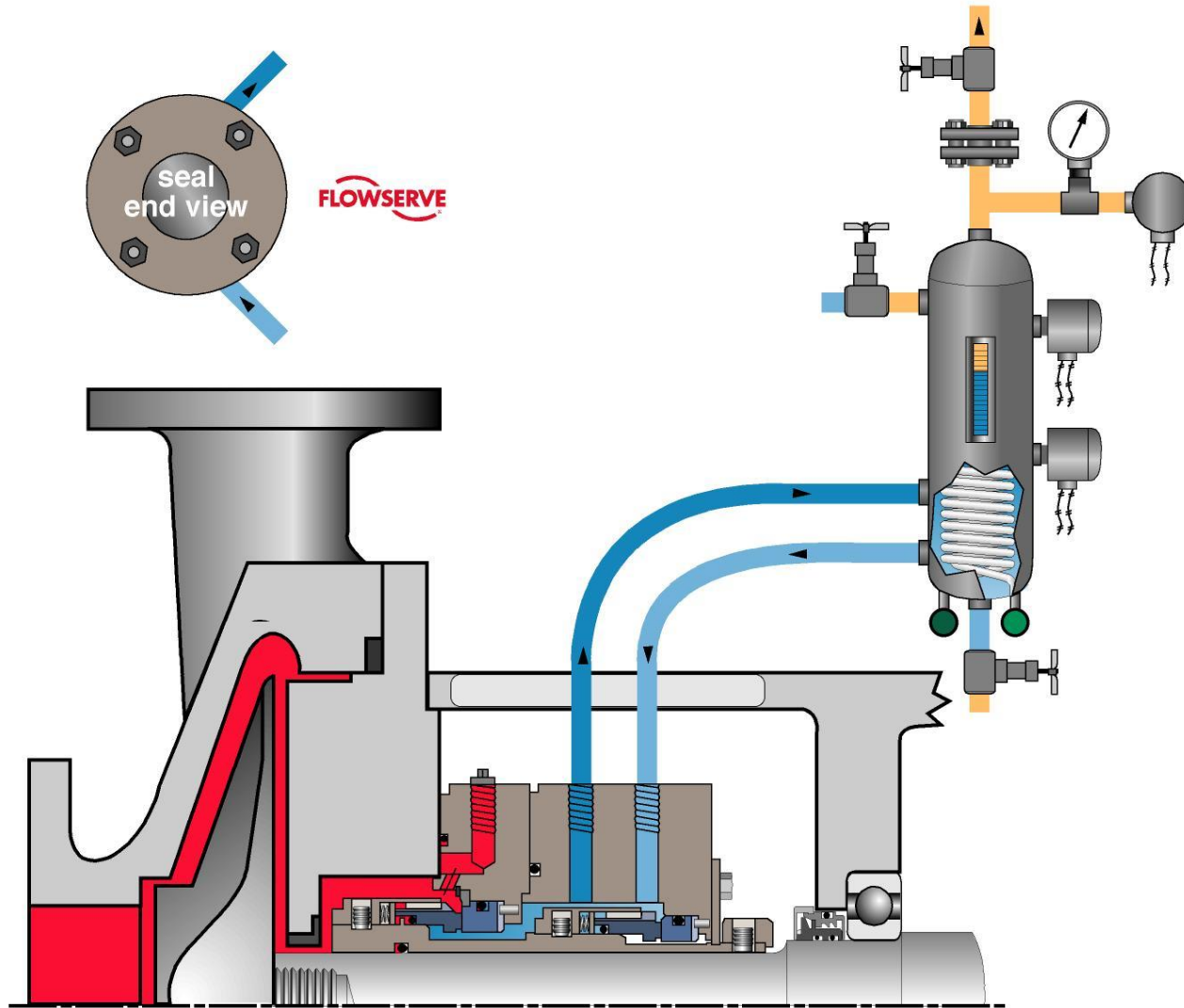
Plan 52



Why

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

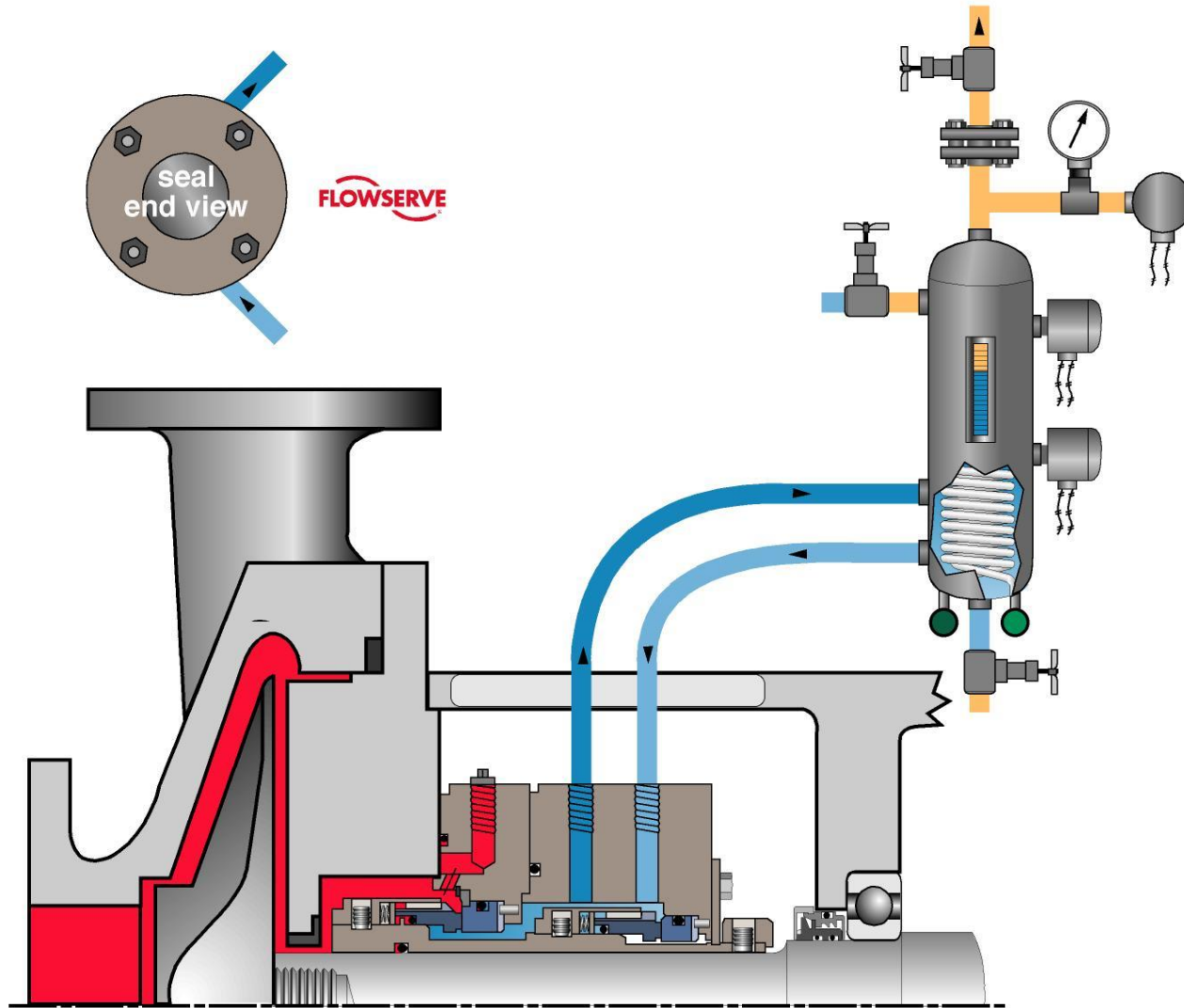
Plan 52



Where

- Used with dual unpressurized seals (“tandem”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Heat transfer fluids.

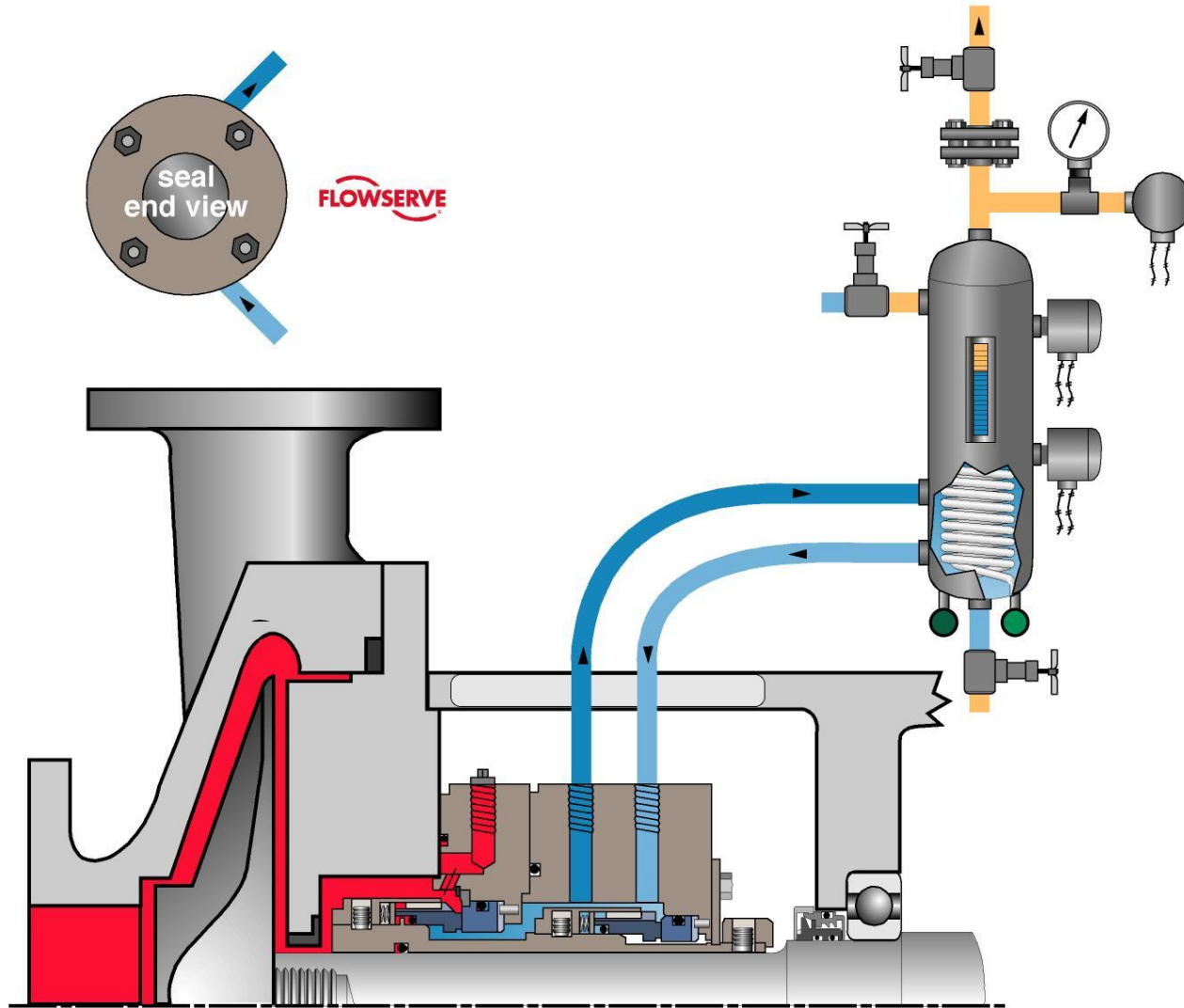
Plan 52



Preventative Maintenance

- 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.

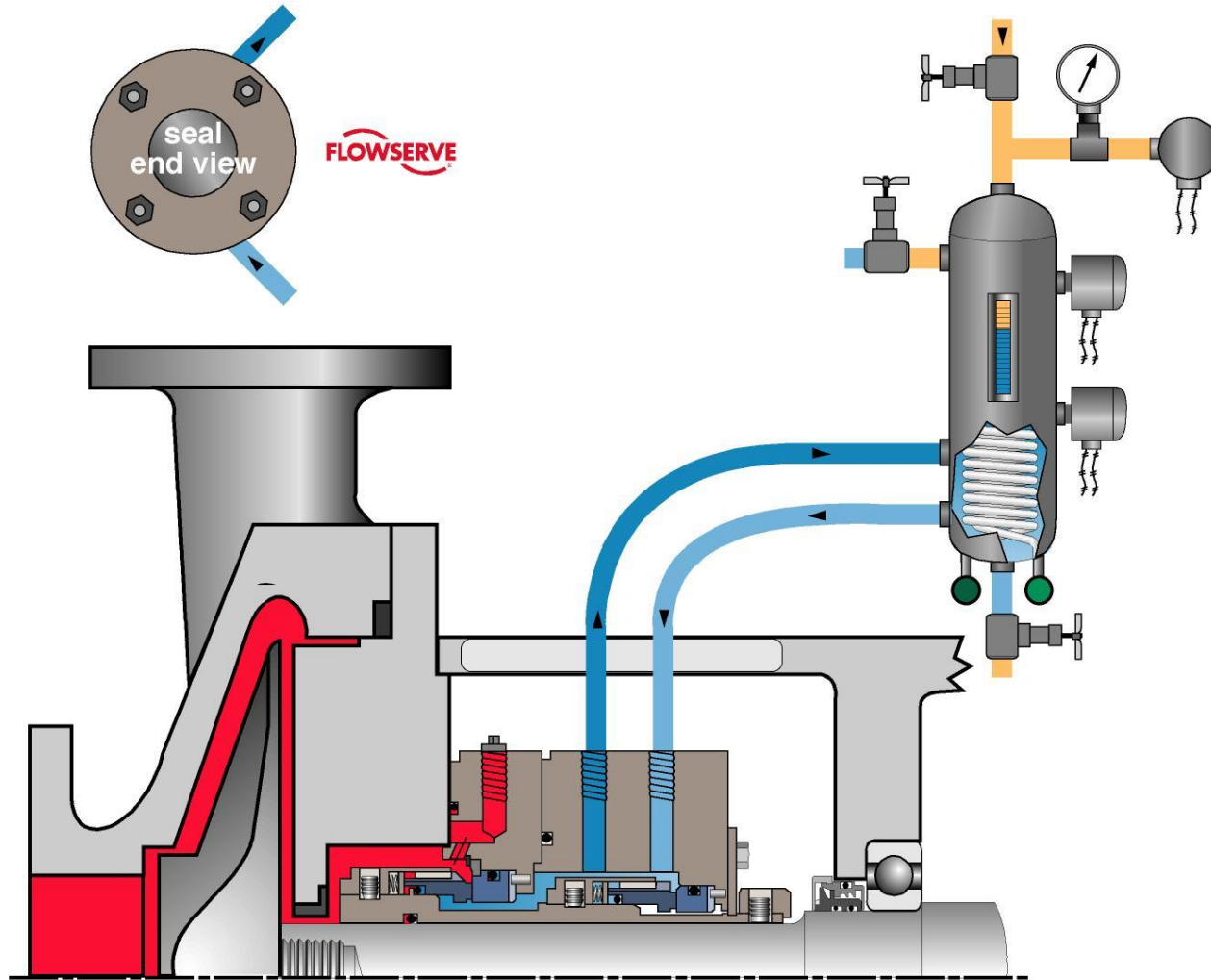
Plan 52



Preventative Maintenance (continued)

- Primary seal leakage is indicated by increased vent pressure.
- Reservoir level gage indicates outboard seal leakage.

Plan 53A



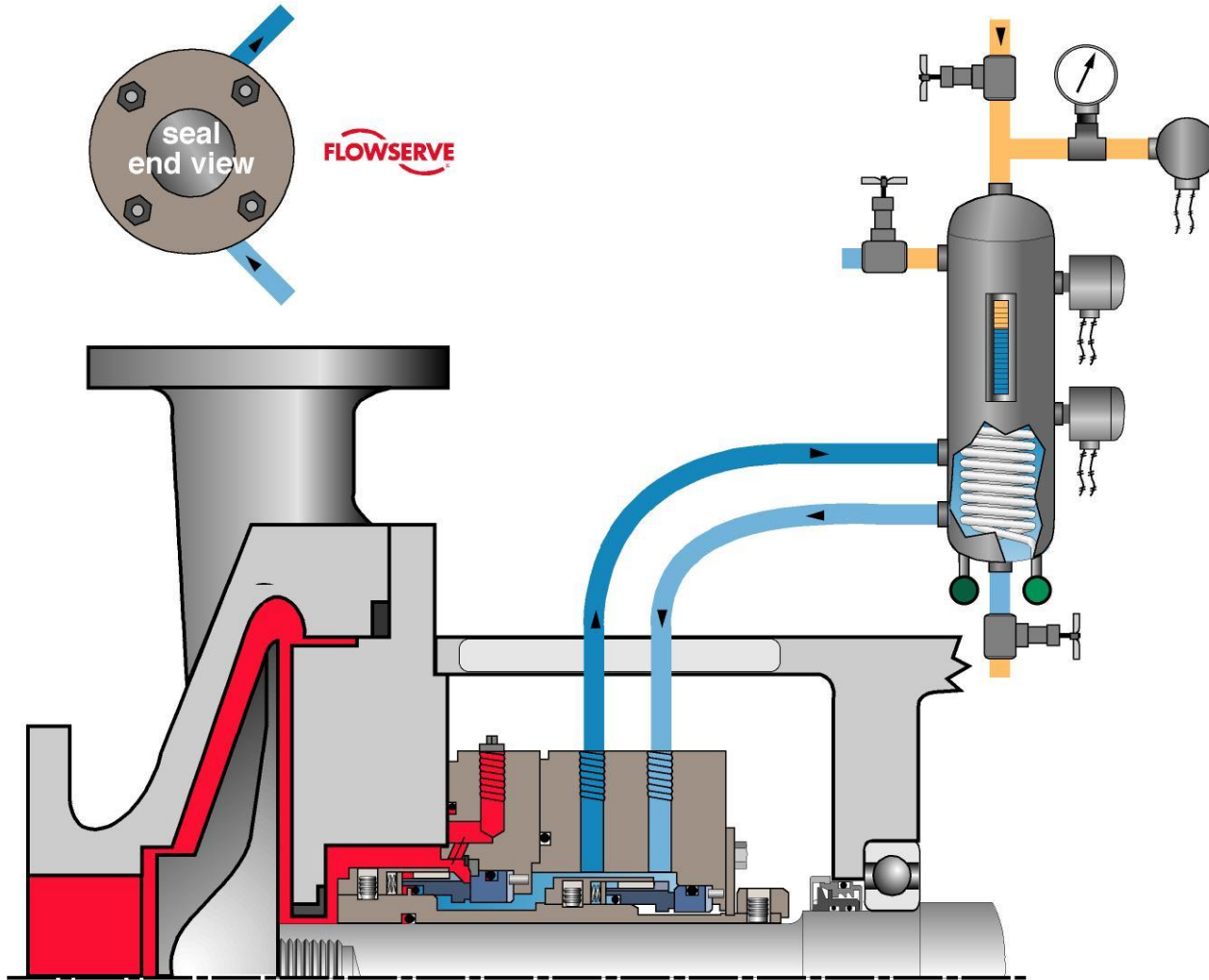
What

- Pressurized barrier fluid circulation through reservoir.
- Fluid is circulated by a pumping ring in the dual seal assembly.

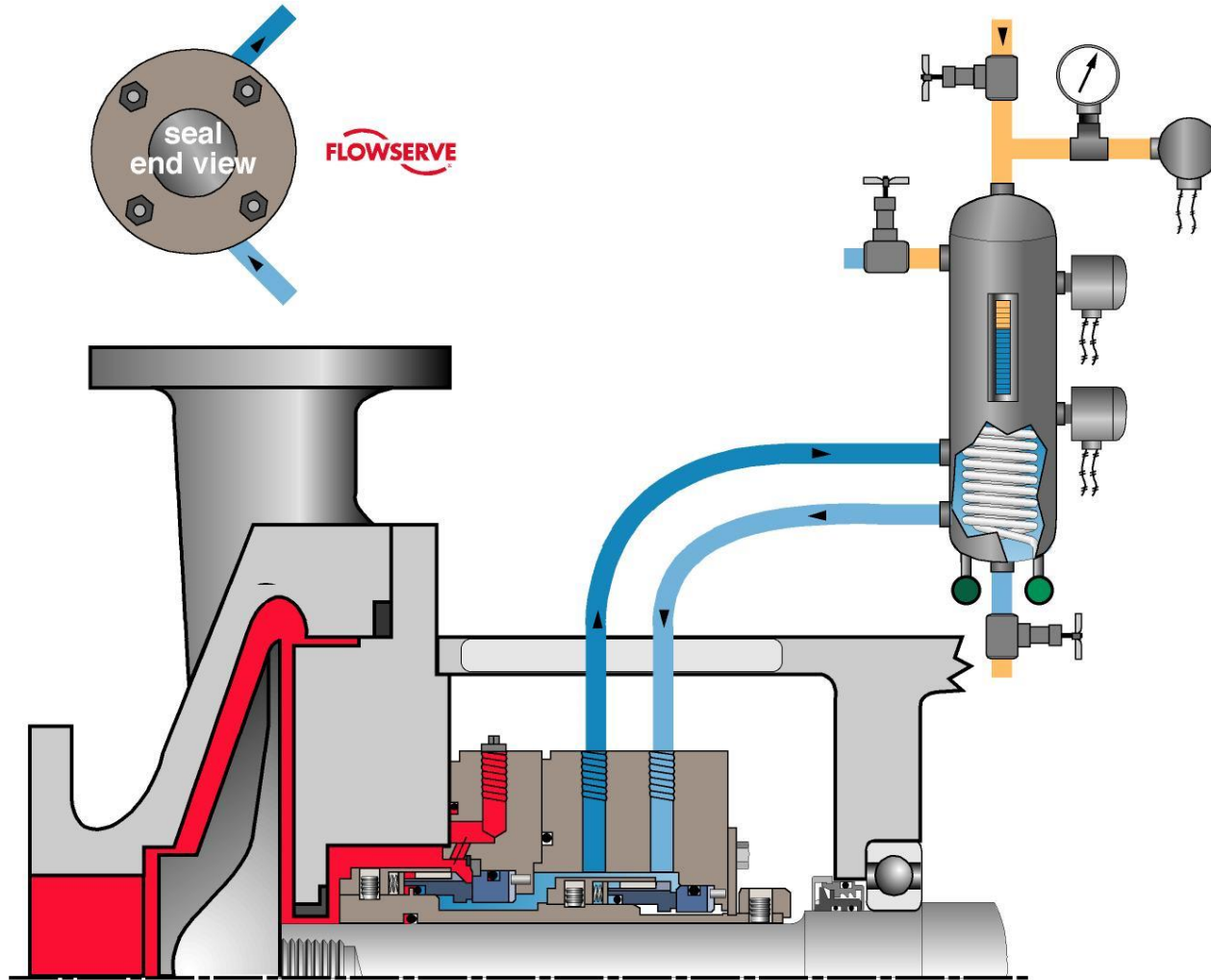
Plan 53A

Why

- Isolate process fluids.
- Zero process emissions.



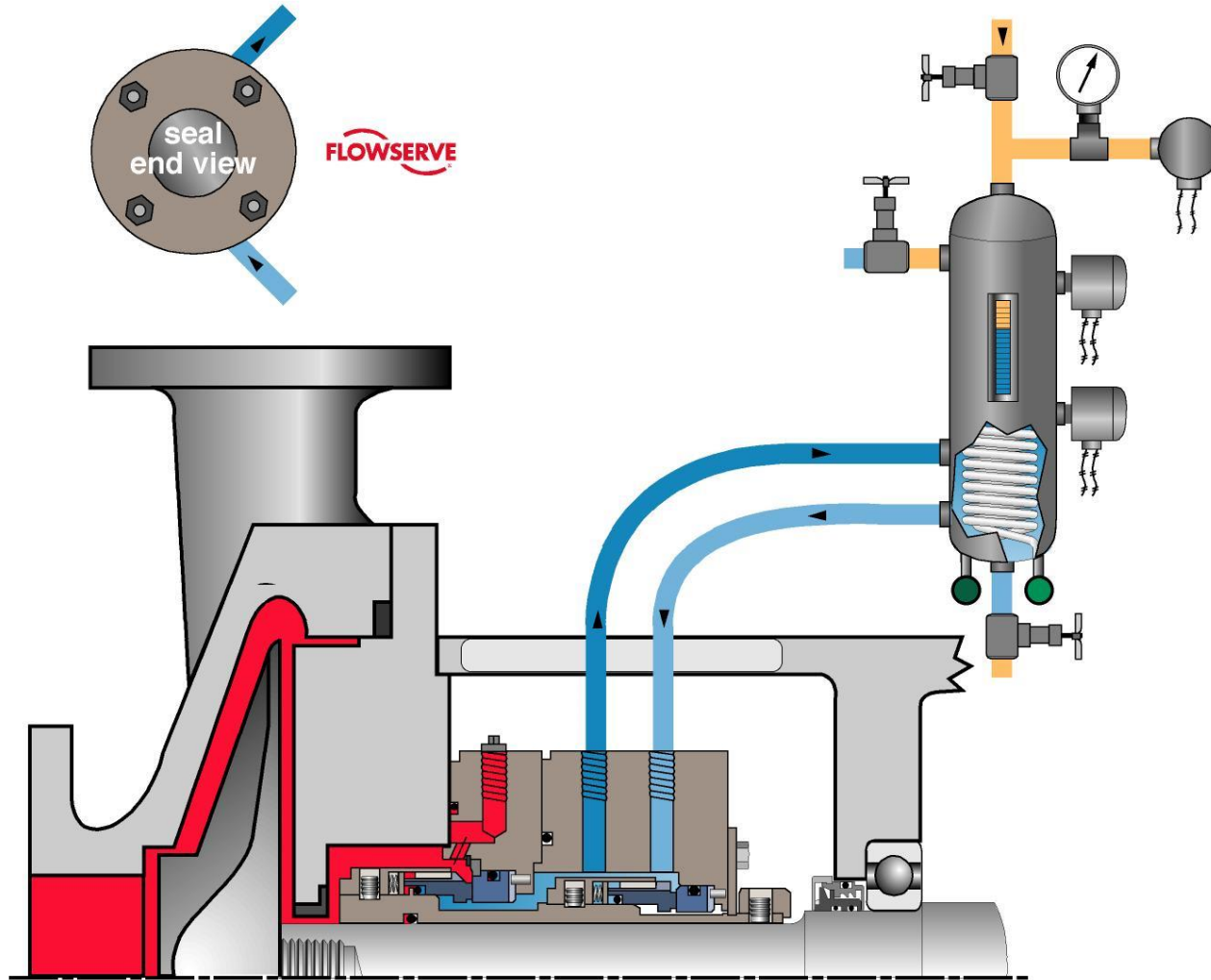
Plan 53A



Where

- Used with dual pressurized seals (“double”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Heat transfer fluids.
- Dirty, abrasive or polymerizing fluids.
- Mixers or agitators.
- Vacuum service.

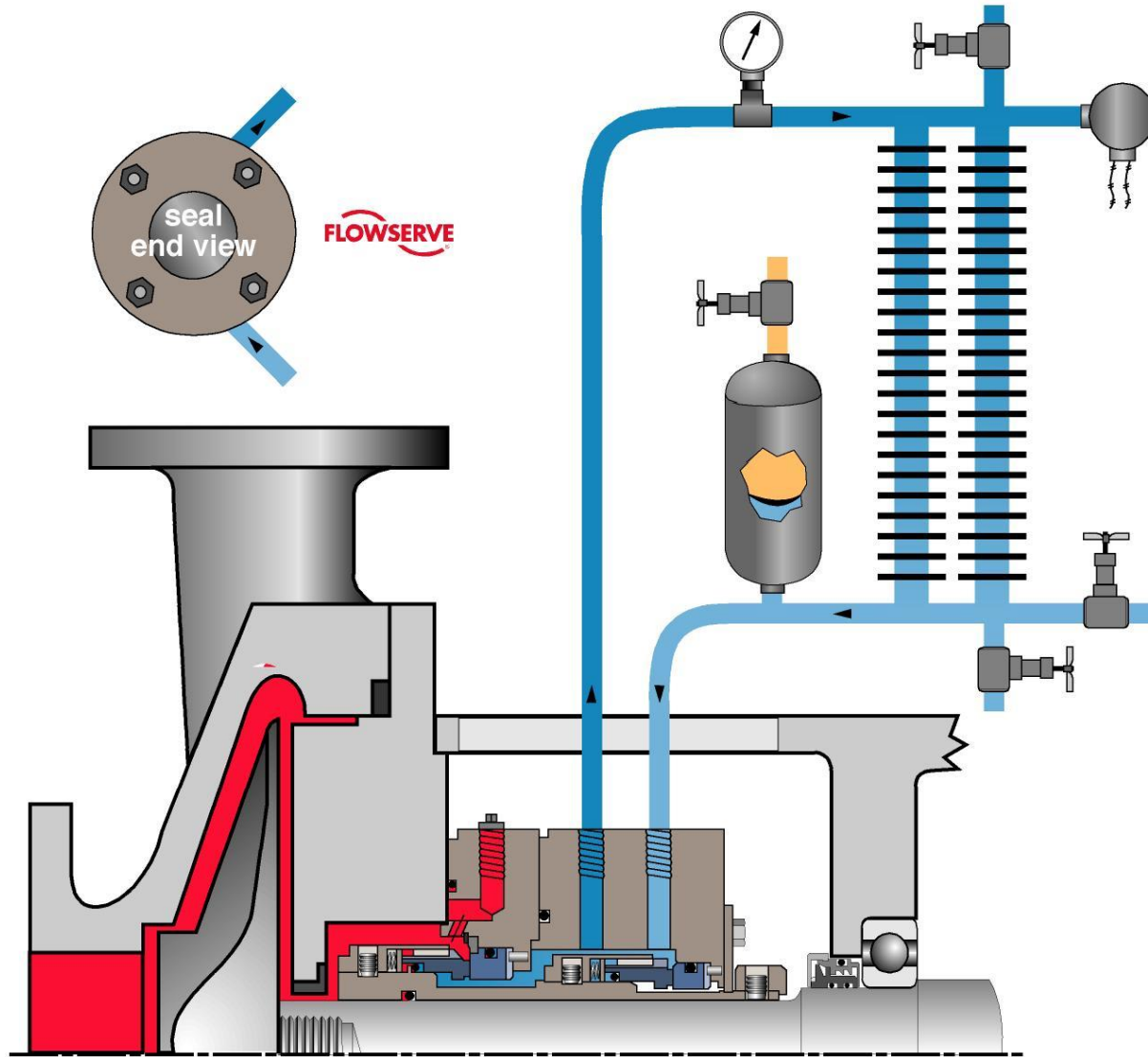
Plan 53A



Preventative Maintenance

- Piping loop must self-vent to reservoir located at highest elevation.
- Pressurize reservoir at all times, maximum gas charge 150 - 200 psi (10 - 14 bar)
- Barrier fluid must be compatible with process.
- Reservoir level gage indicates both IB and OB seal leakage.

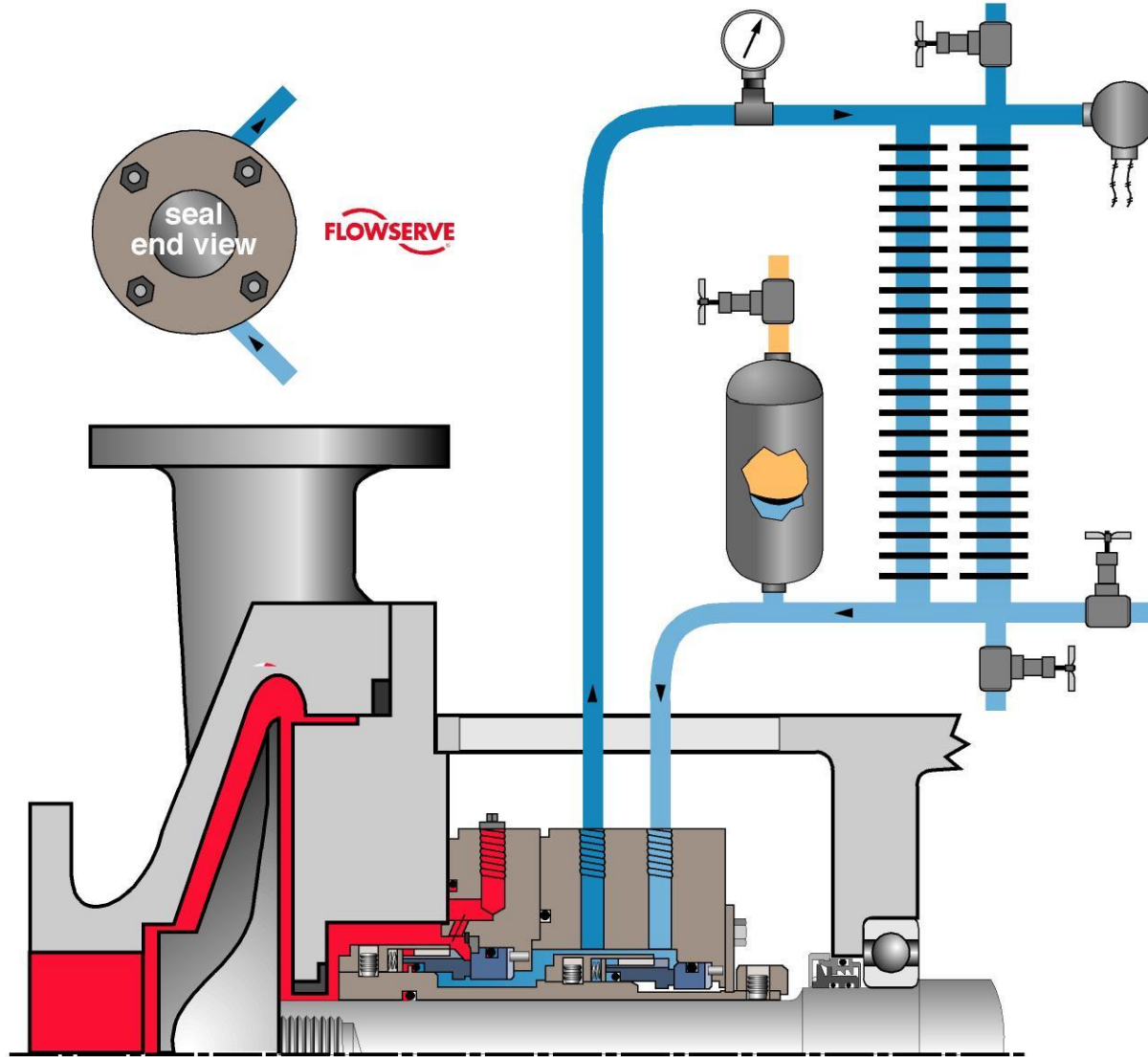
Plan 53B



What

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

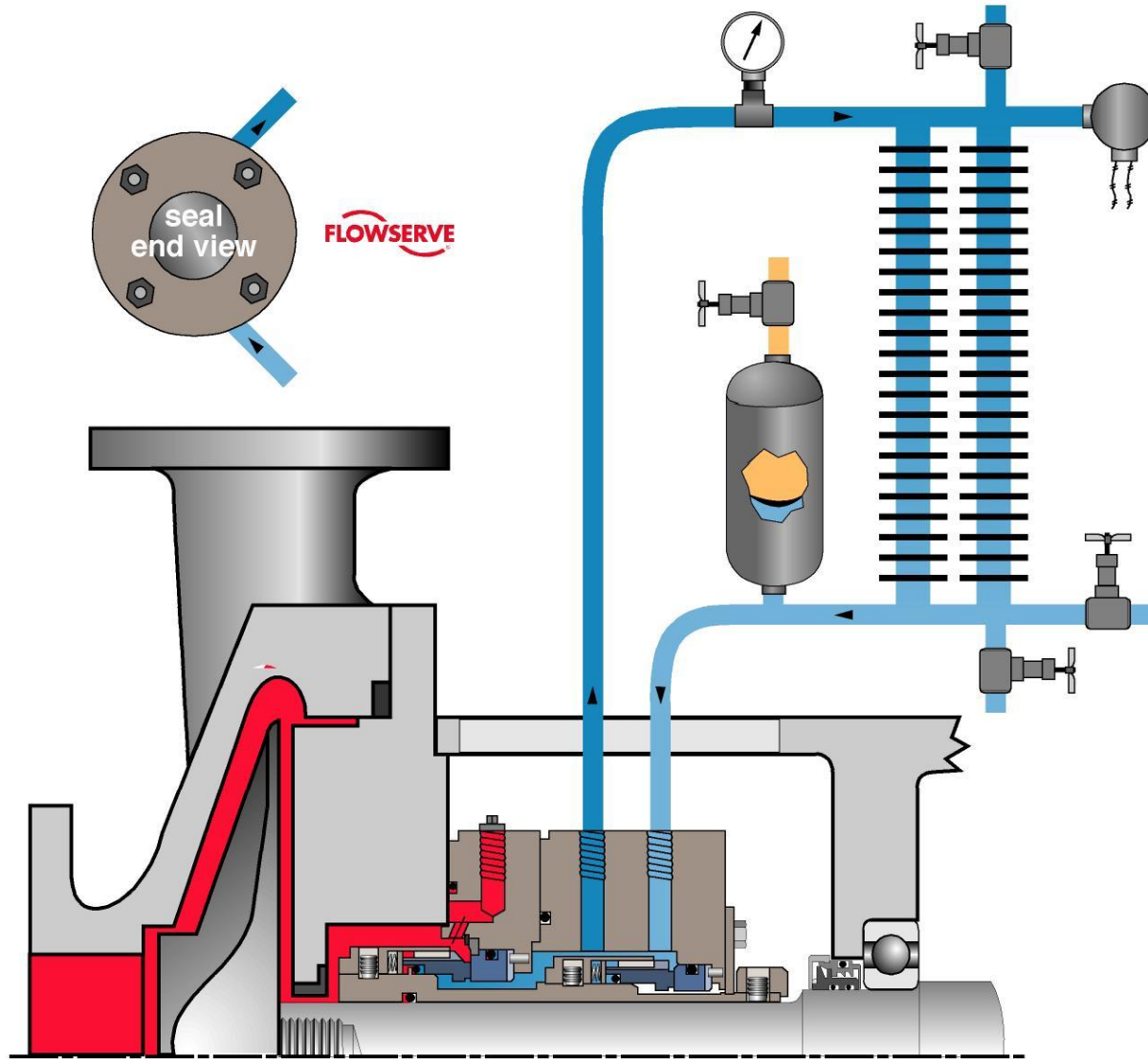
Plan 53B



Why

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

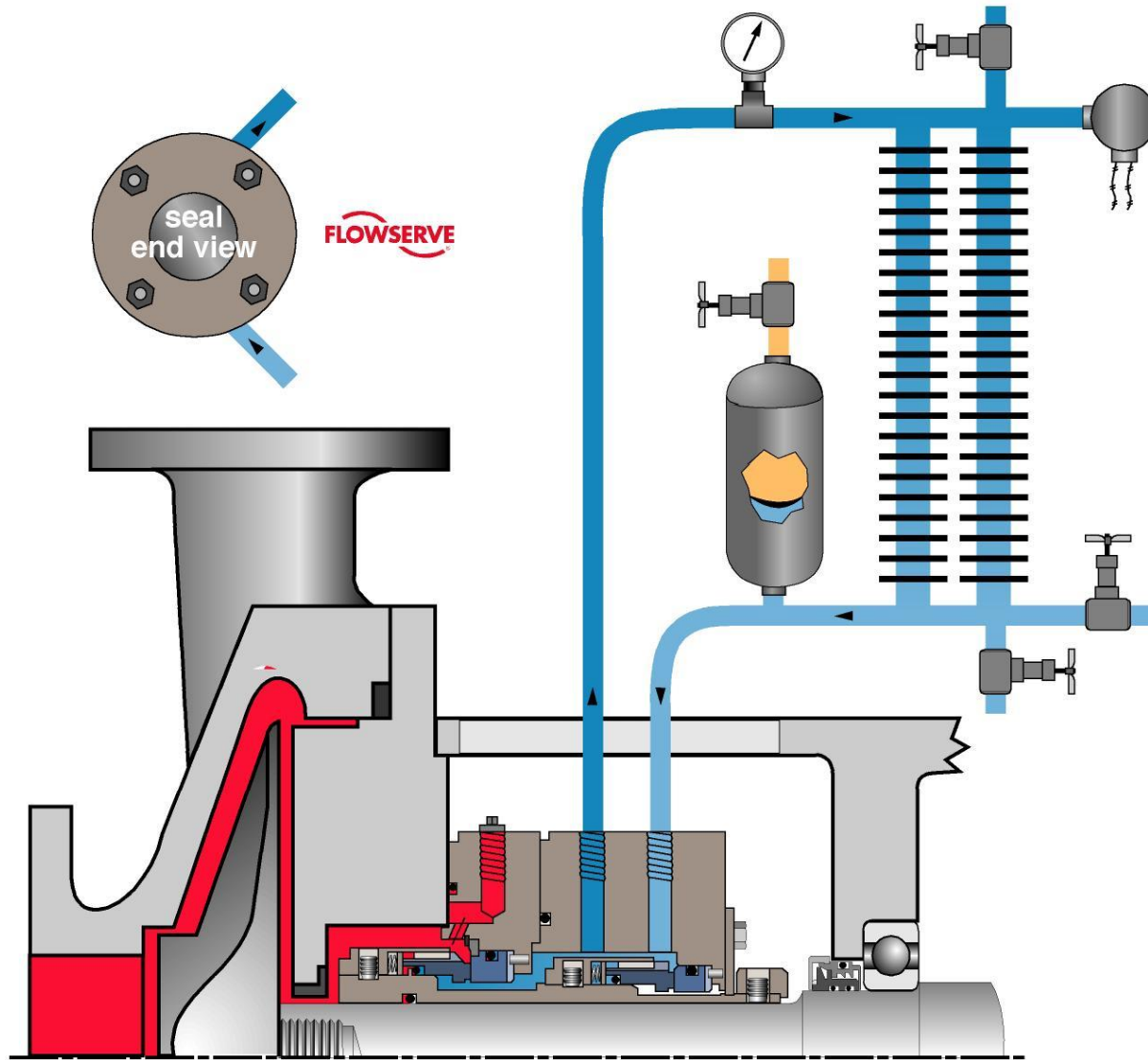
Plan 53B



Where

- Used with dual pressurized seals (“double”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Heat transfer fluids.
- Dirty, abrasive or polymerizing fluids.

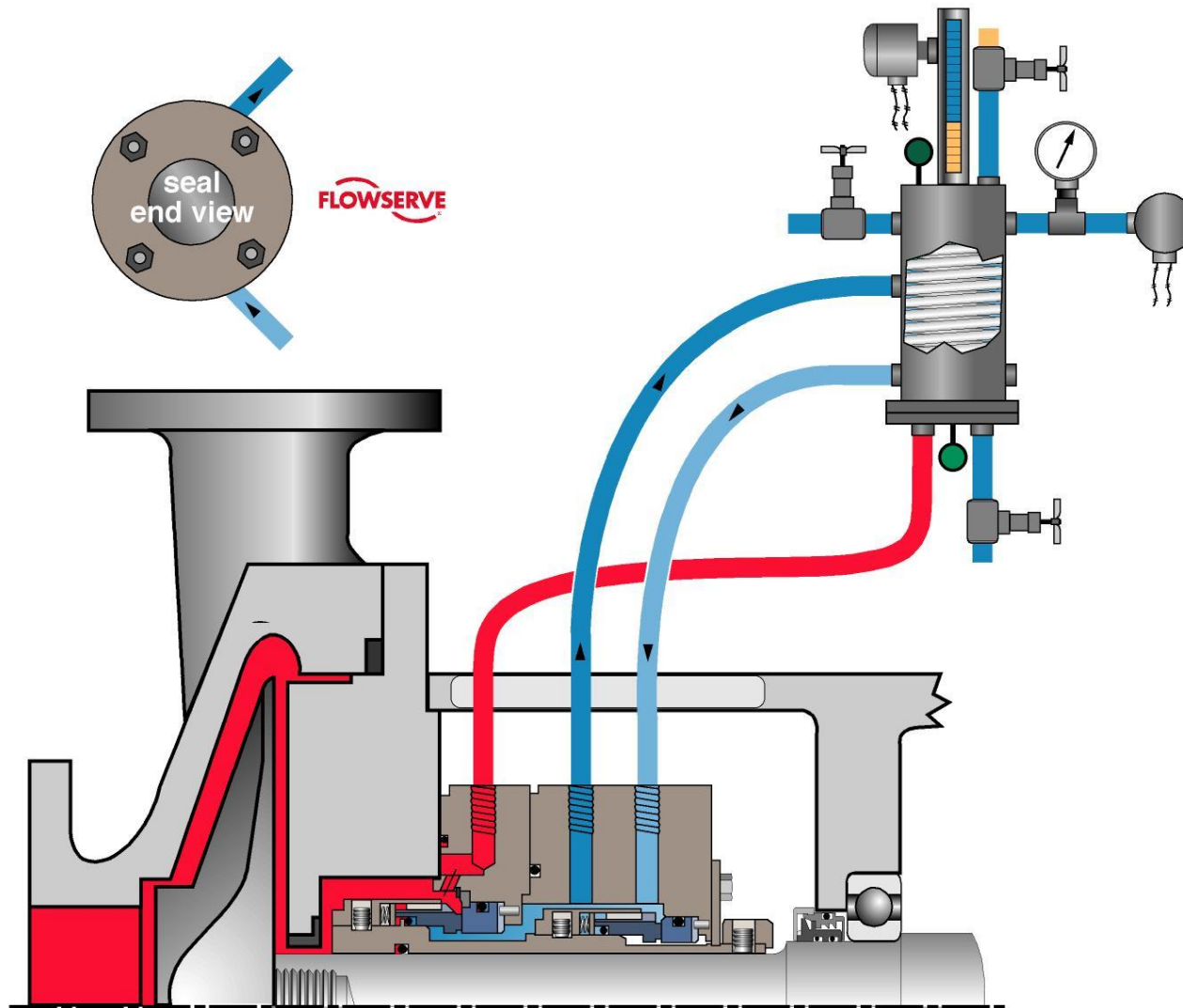
Plan 53B



Preventative Maintenance

- 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.

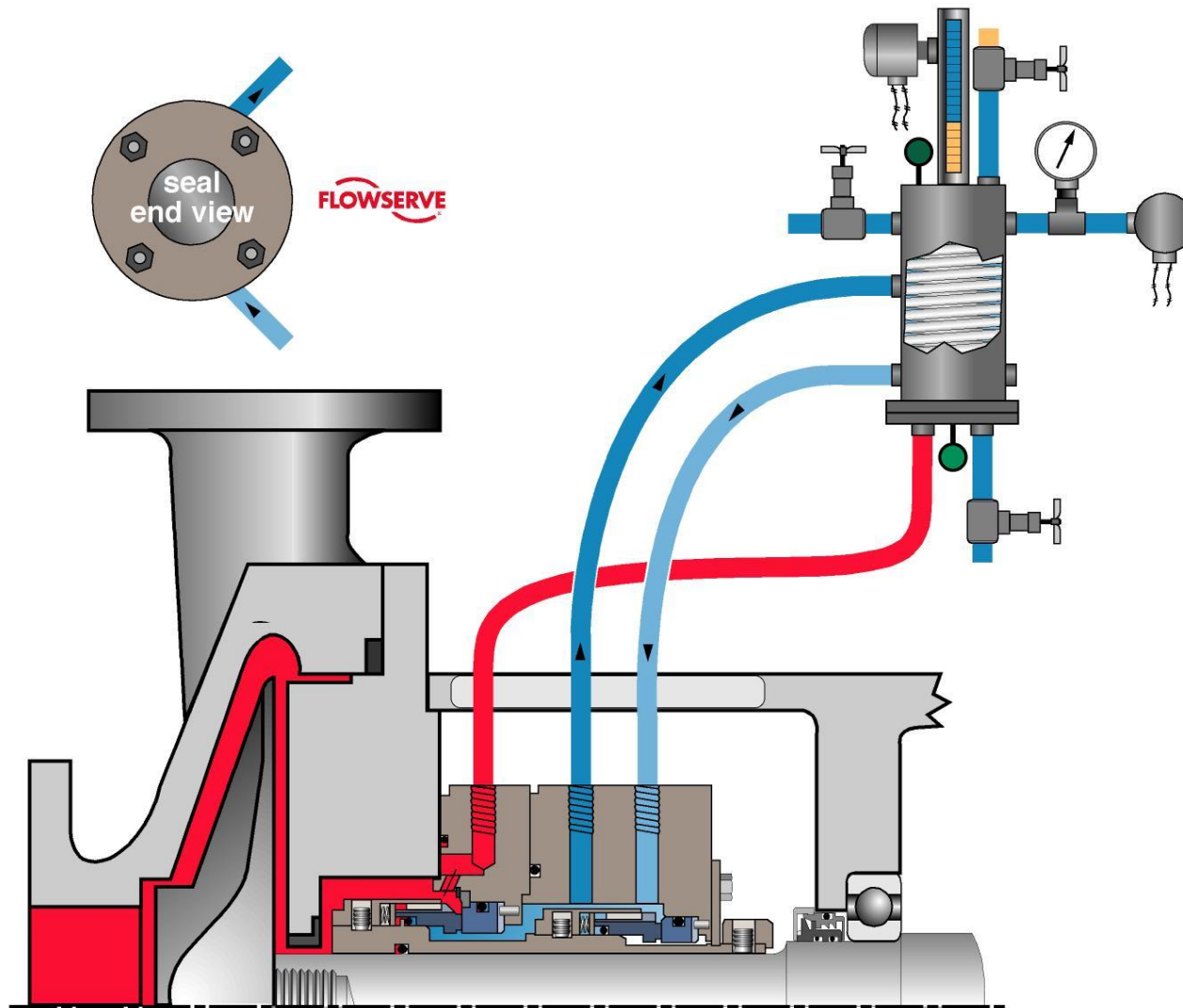
Plan 53C



What

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

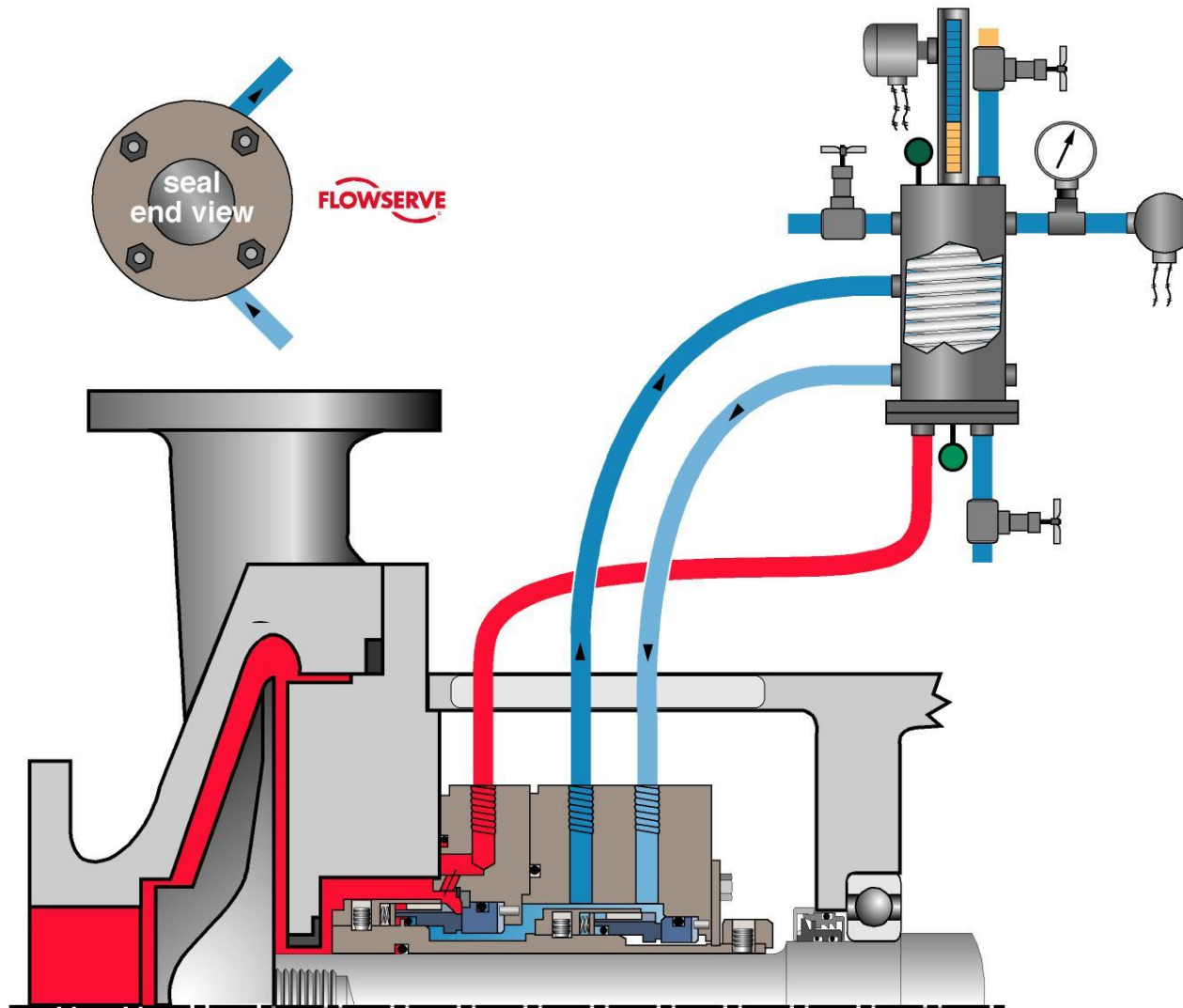
Plan 53C



Why

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

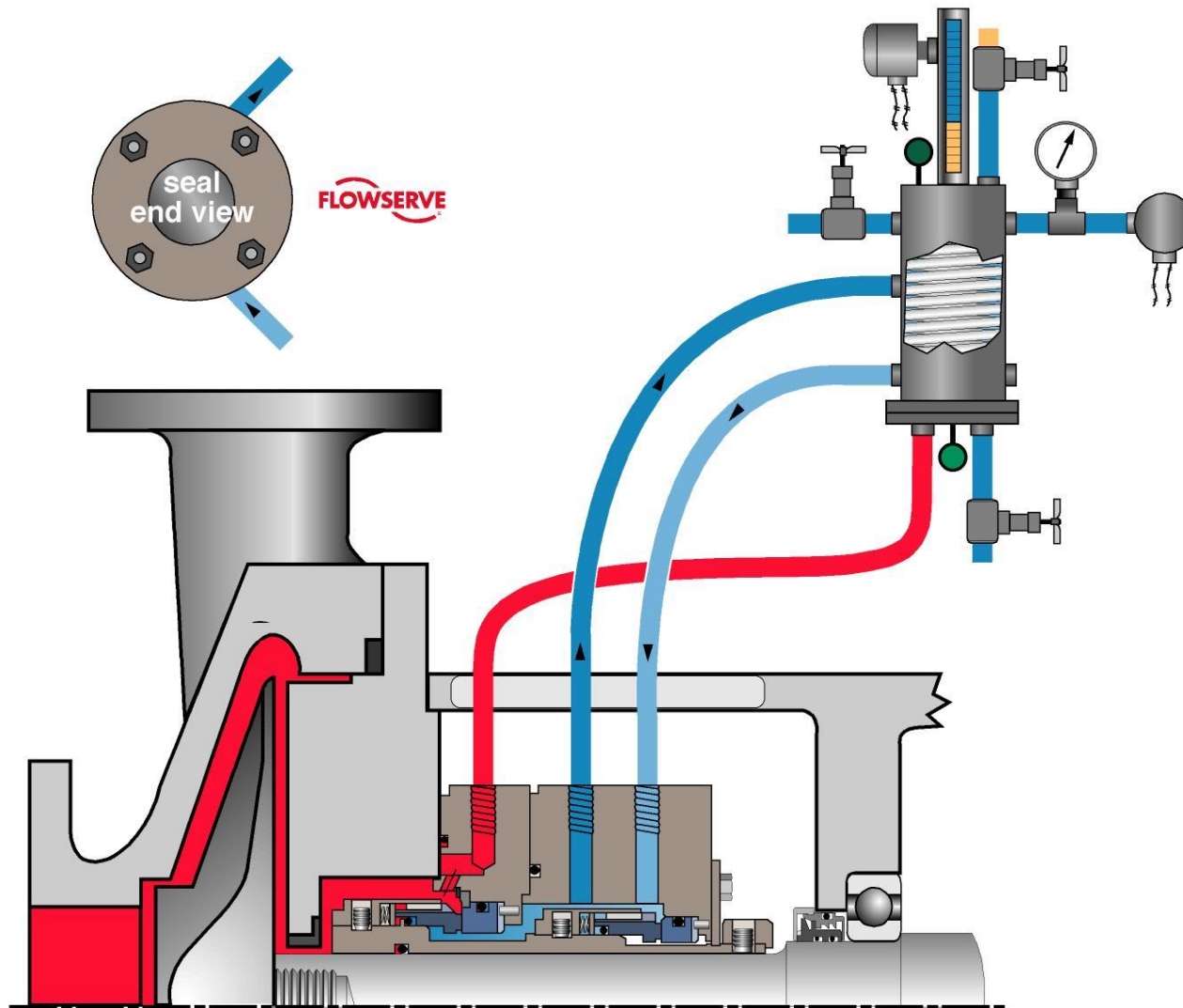
Plan 53C



Where

- Used with dual pressurized seals (“double”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Heat transfer fluids.

Plan 53C



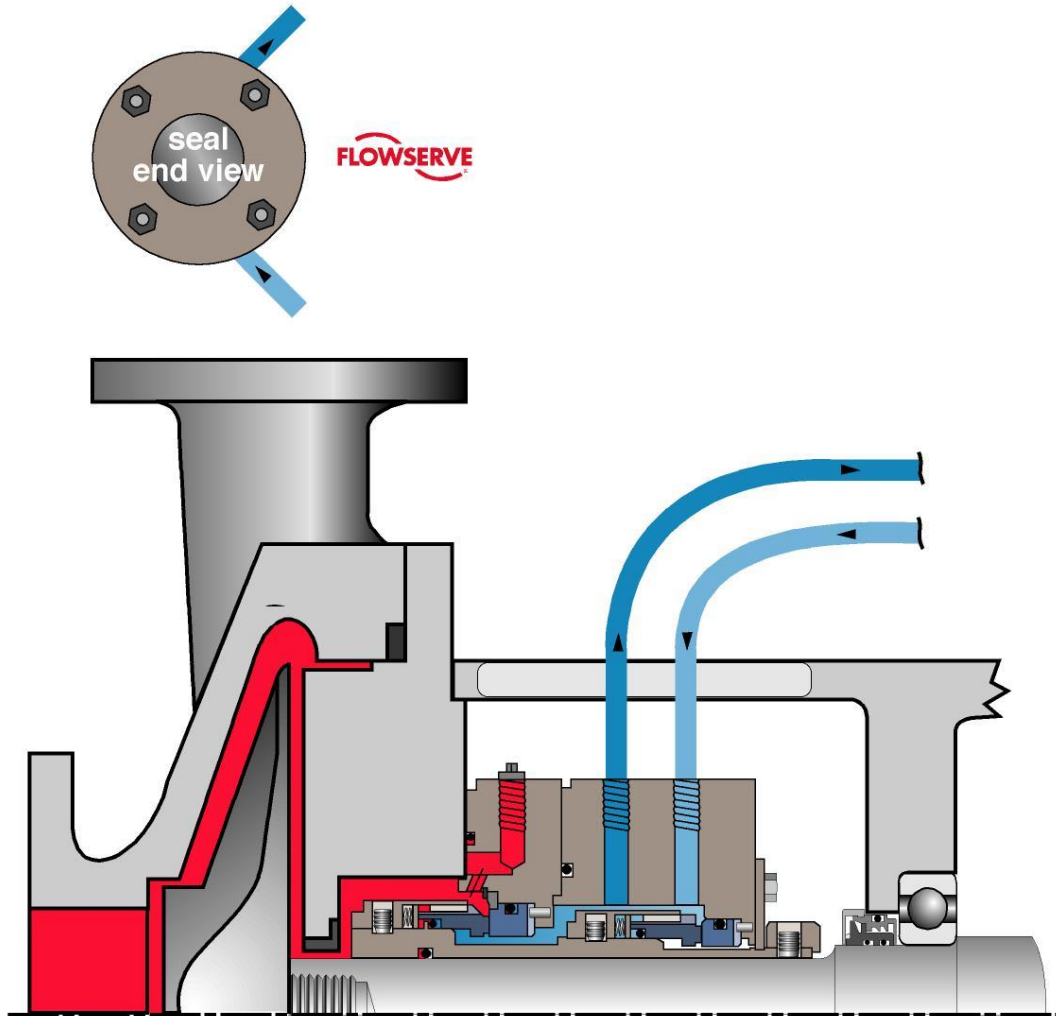
Preventative Maintenance

- 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 gage indicates both inboard and outboard seal leakage.

Plan 54

What

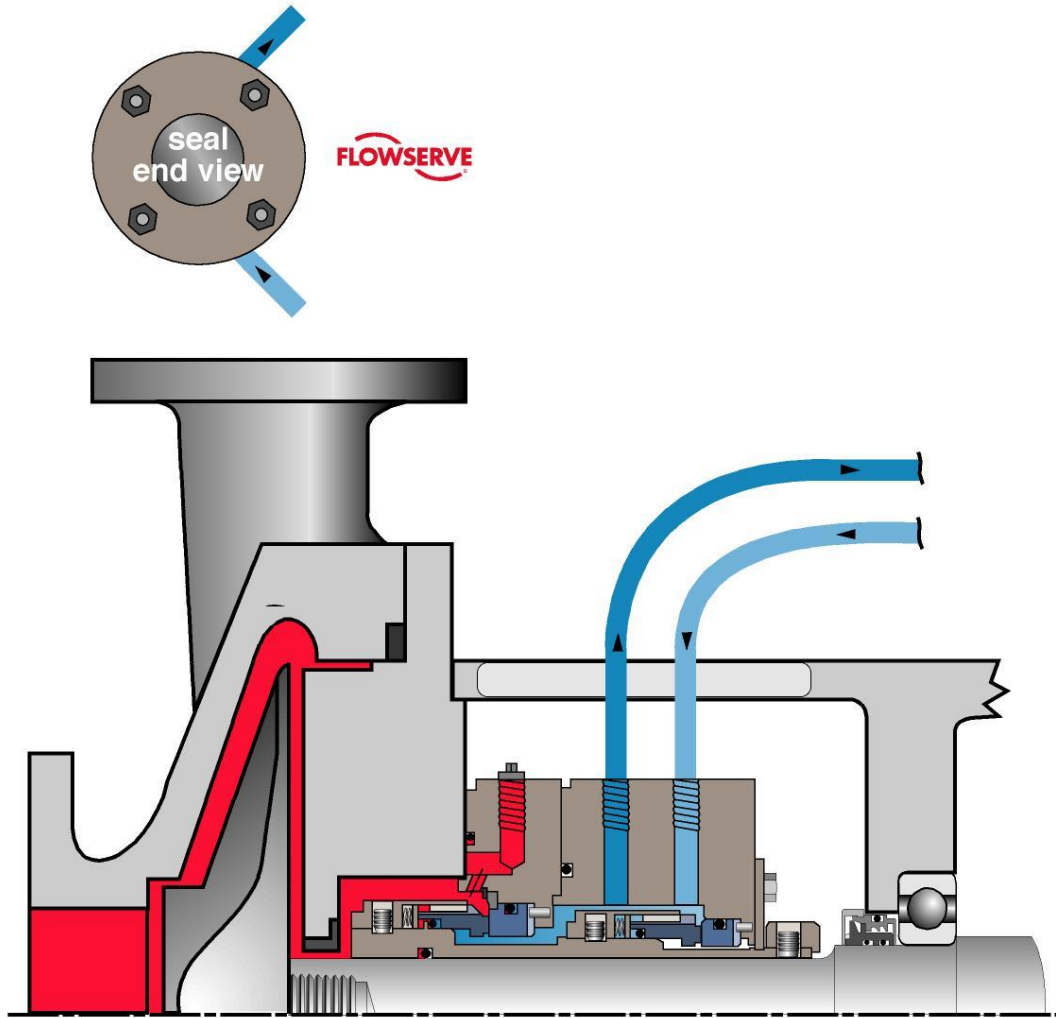
- Pressurized barrier fluid circulation by an external system.



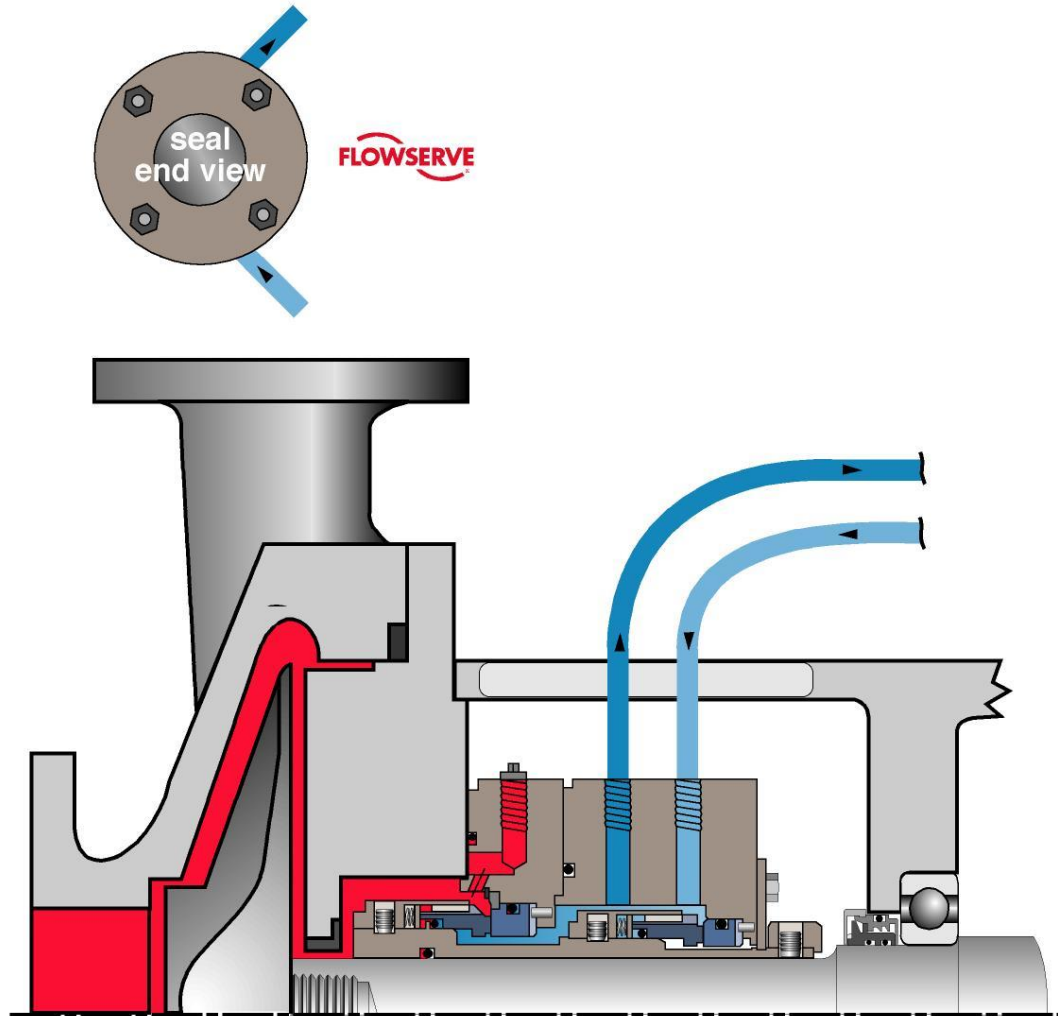
Plan 54

Why

- Isolate process fluid.
- Zero process emissions.
- Seal cannot induce circulation.



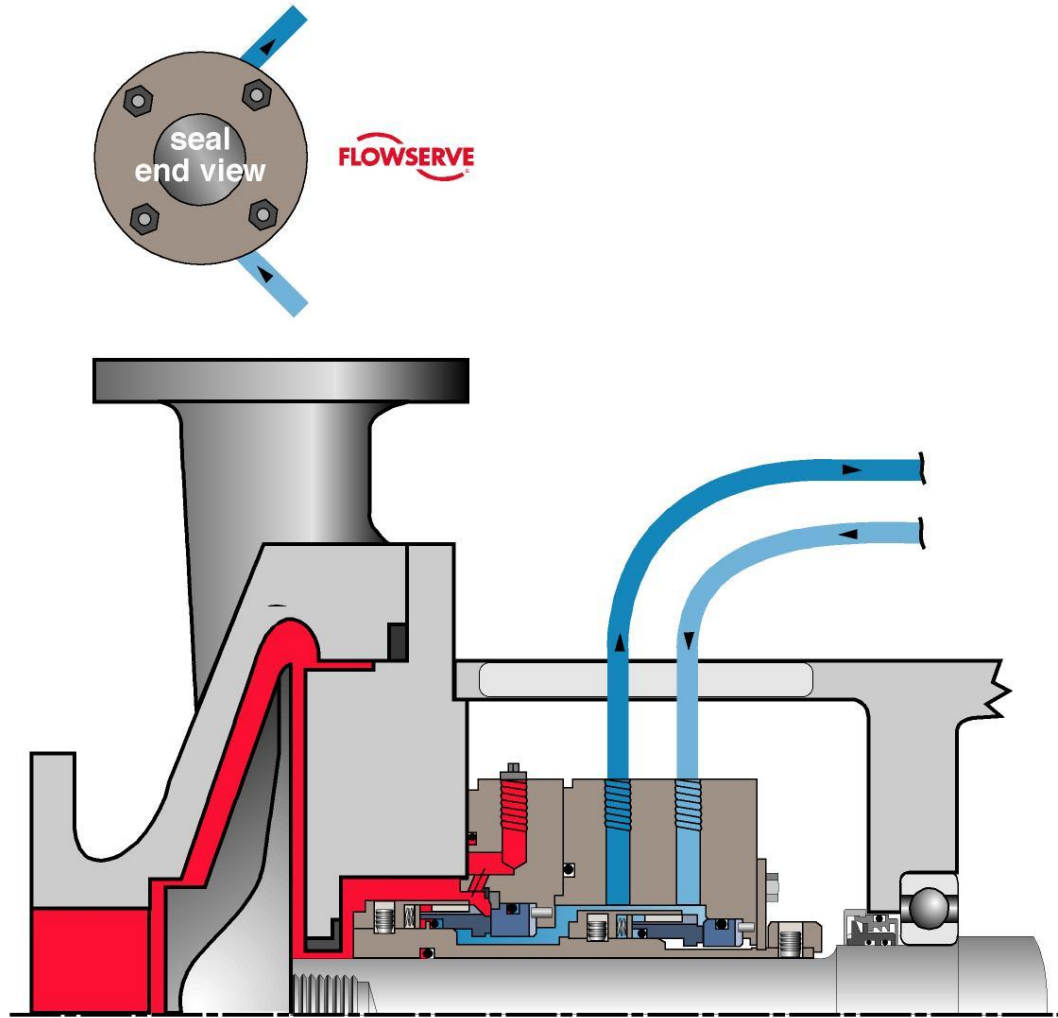
Plan 54



Where

- Used with dual pressurized seals (“double”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Heat transfer fluids.
- Dirty, abrasive, or polymerizing fluids.
- Mixers or agitators.

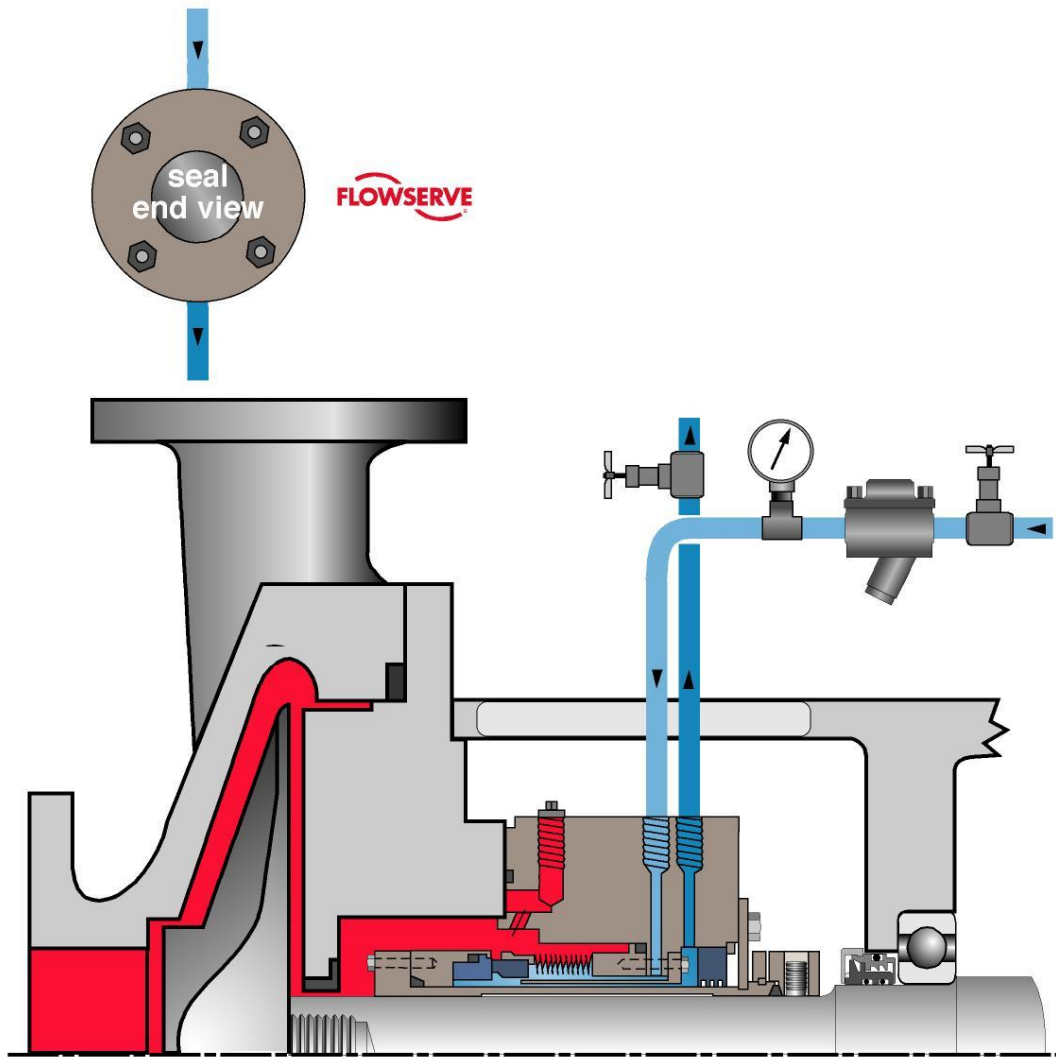
Plan 54



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.
- Circulation system level gage indicates both inboard and outboard seal leakage.

Plan 62



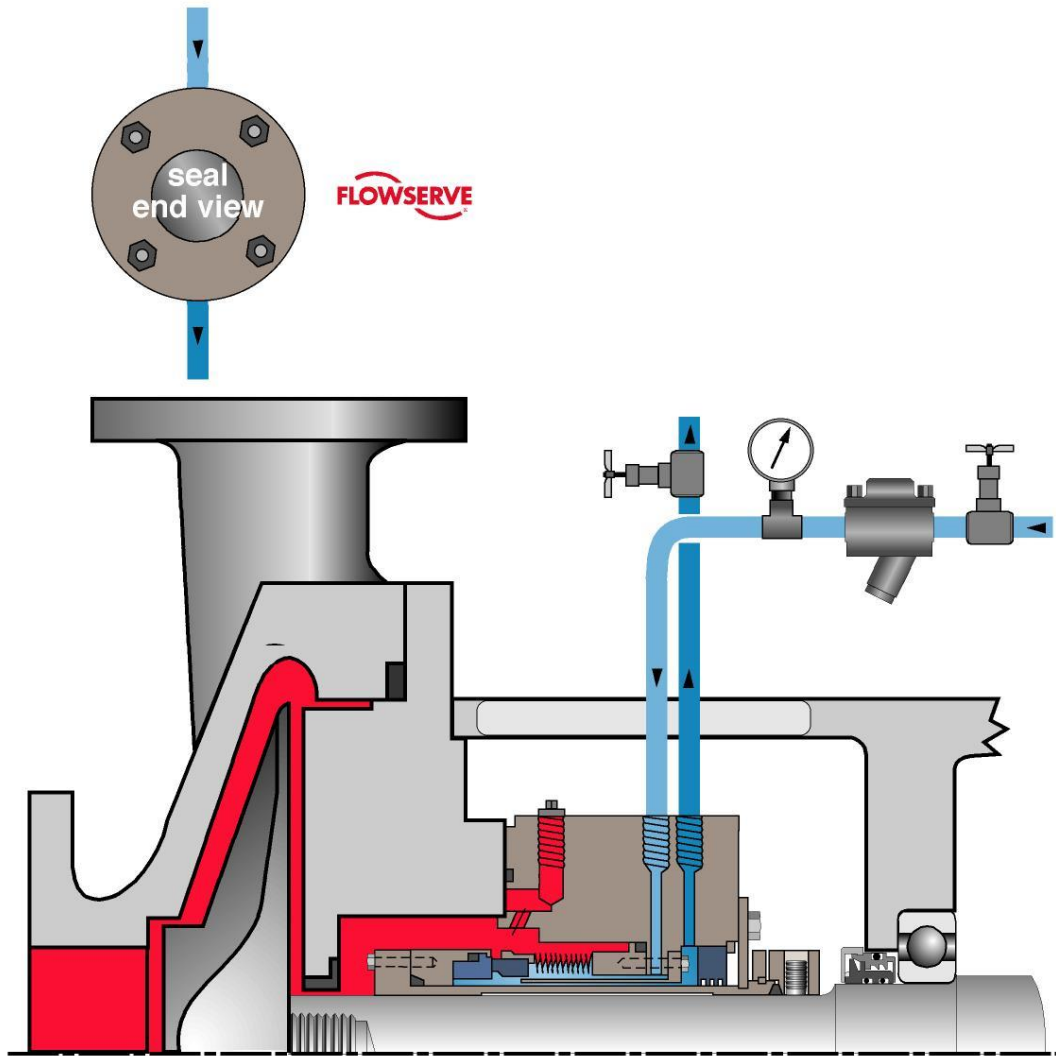
What

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

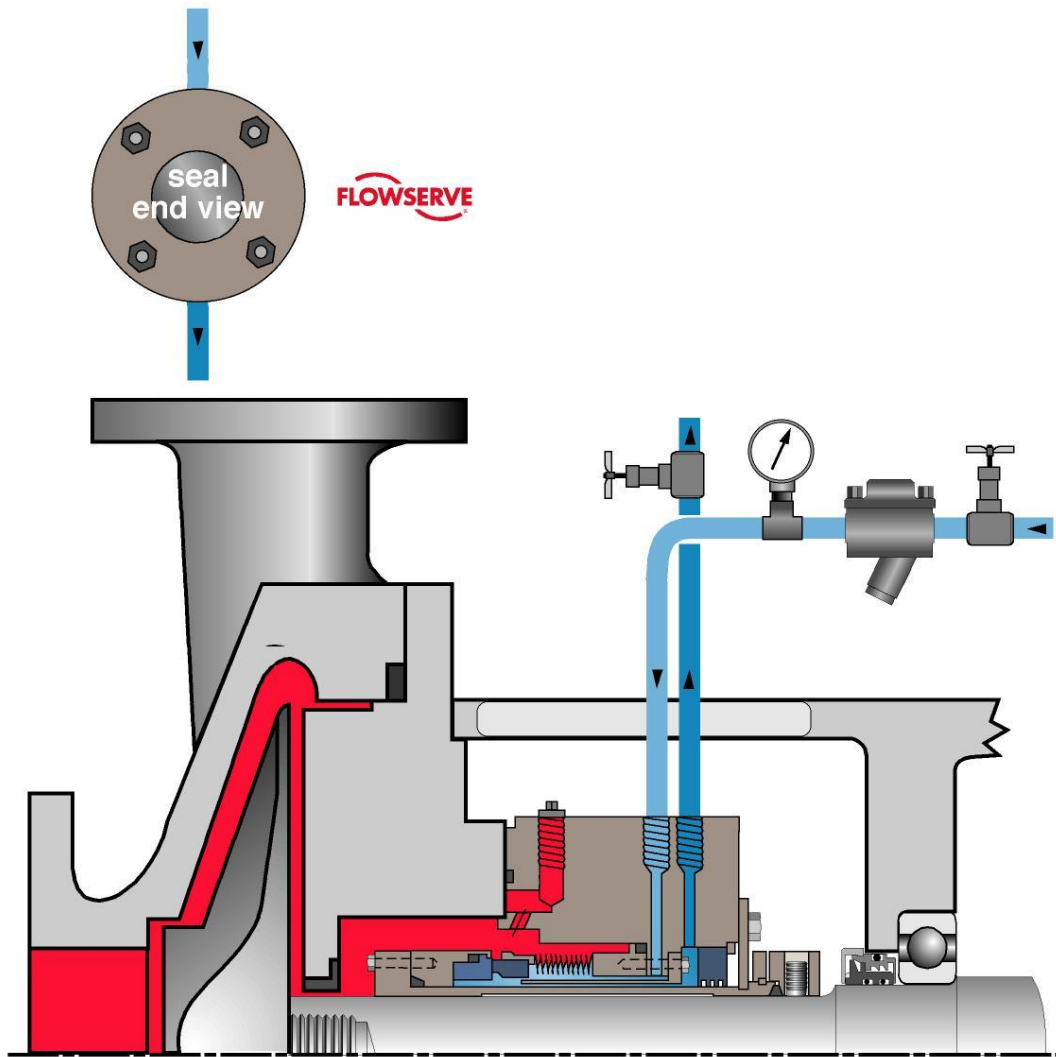
Plan 62

Why

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



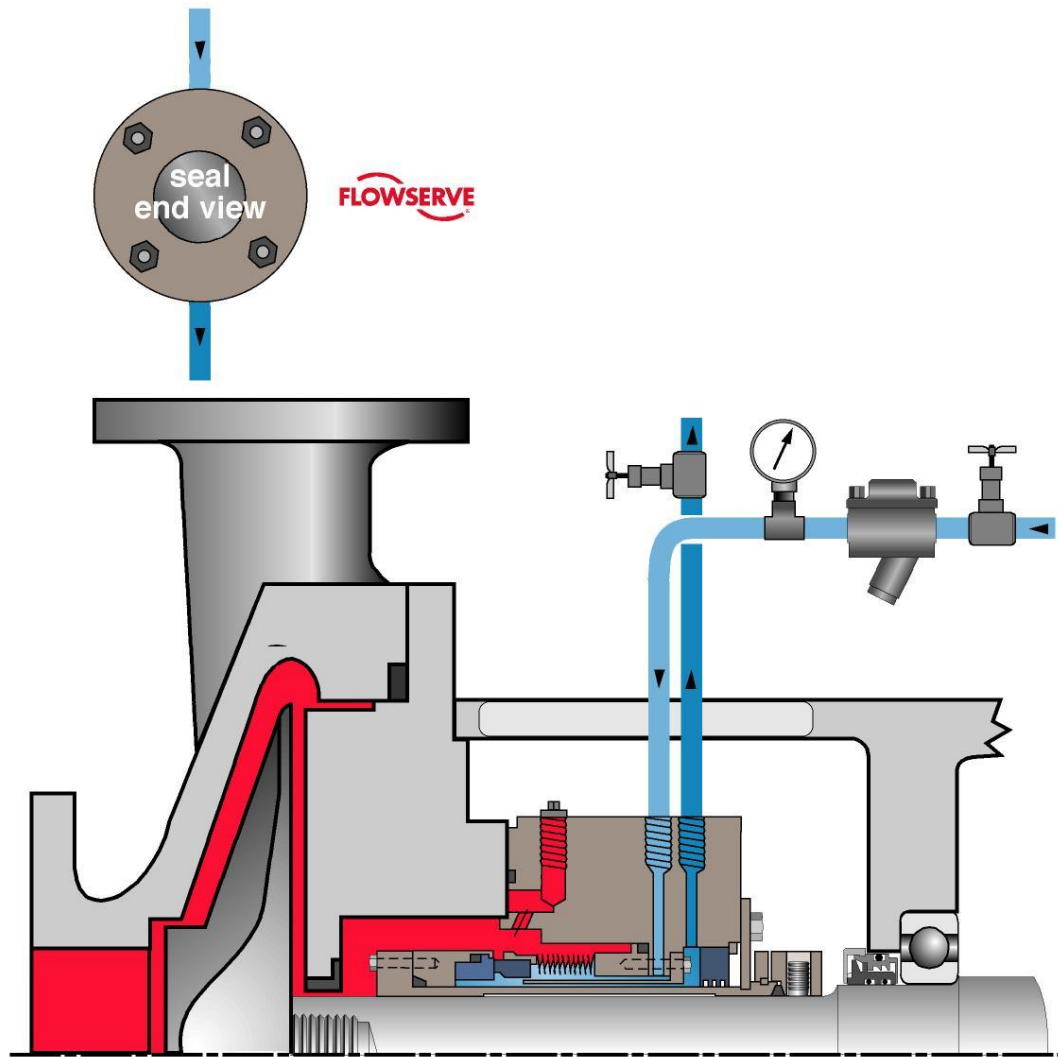
Plan 62



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 32 °F (0 °C).

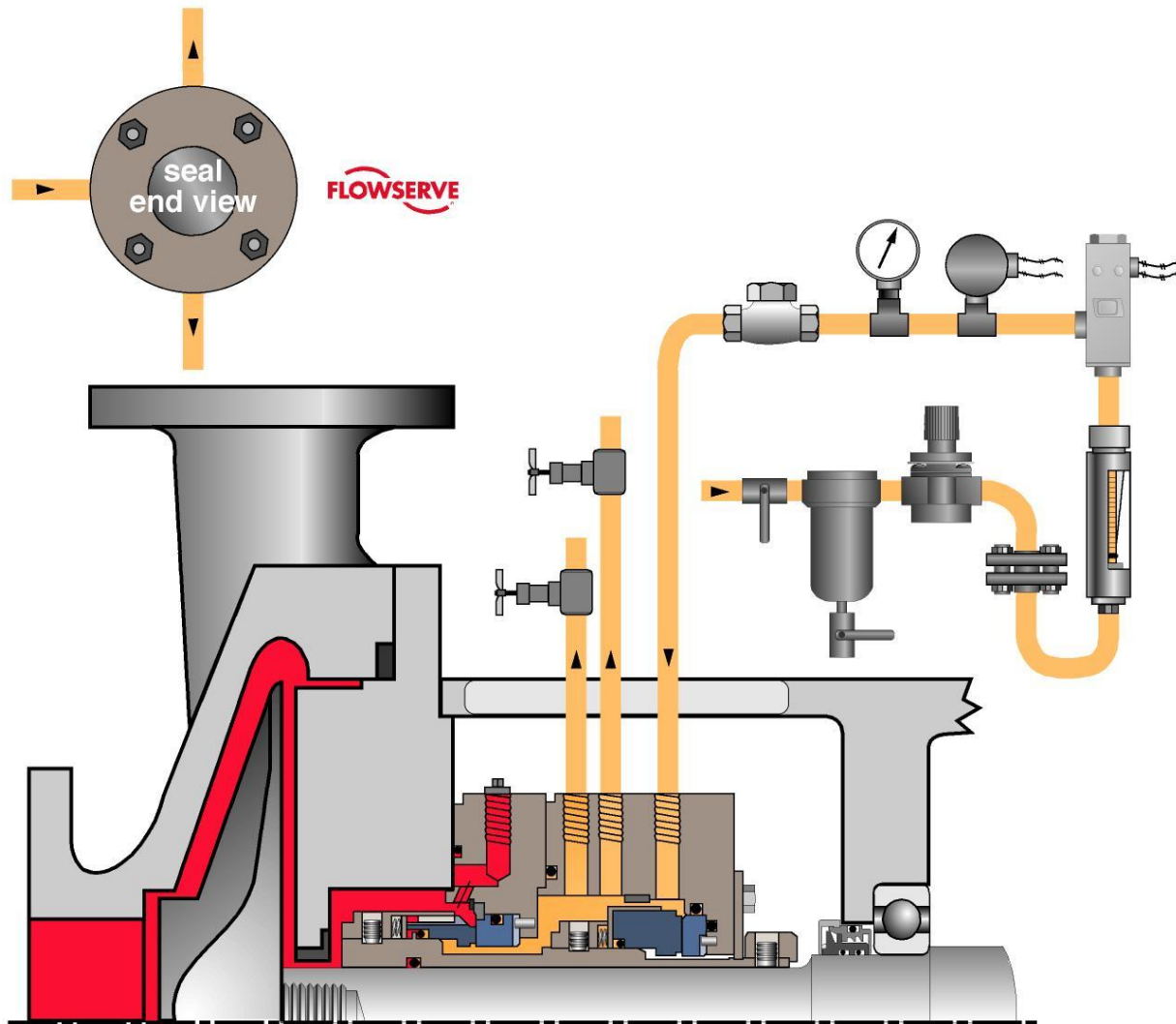
Plan 62



Preventative Maintenance

- Quench inlet should be on top of gland with drain/outlet on bottom.
- Quench pressure should be limited to 3 psi (0.2 bar) 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.

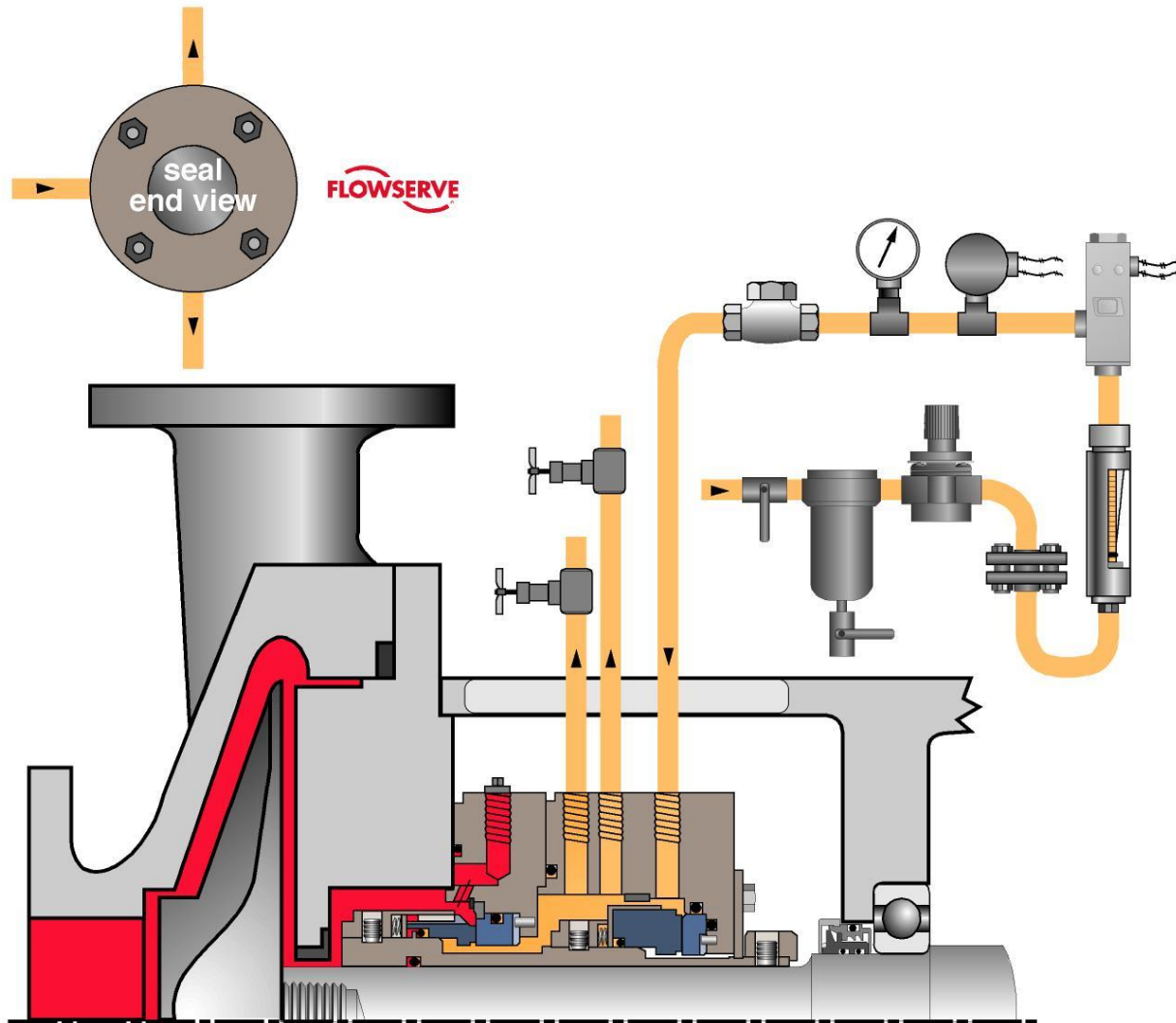
Plan 72



What

- Unpressurized buffer gas control system.
- Containment seal support typically with nitrogen buffer gas.

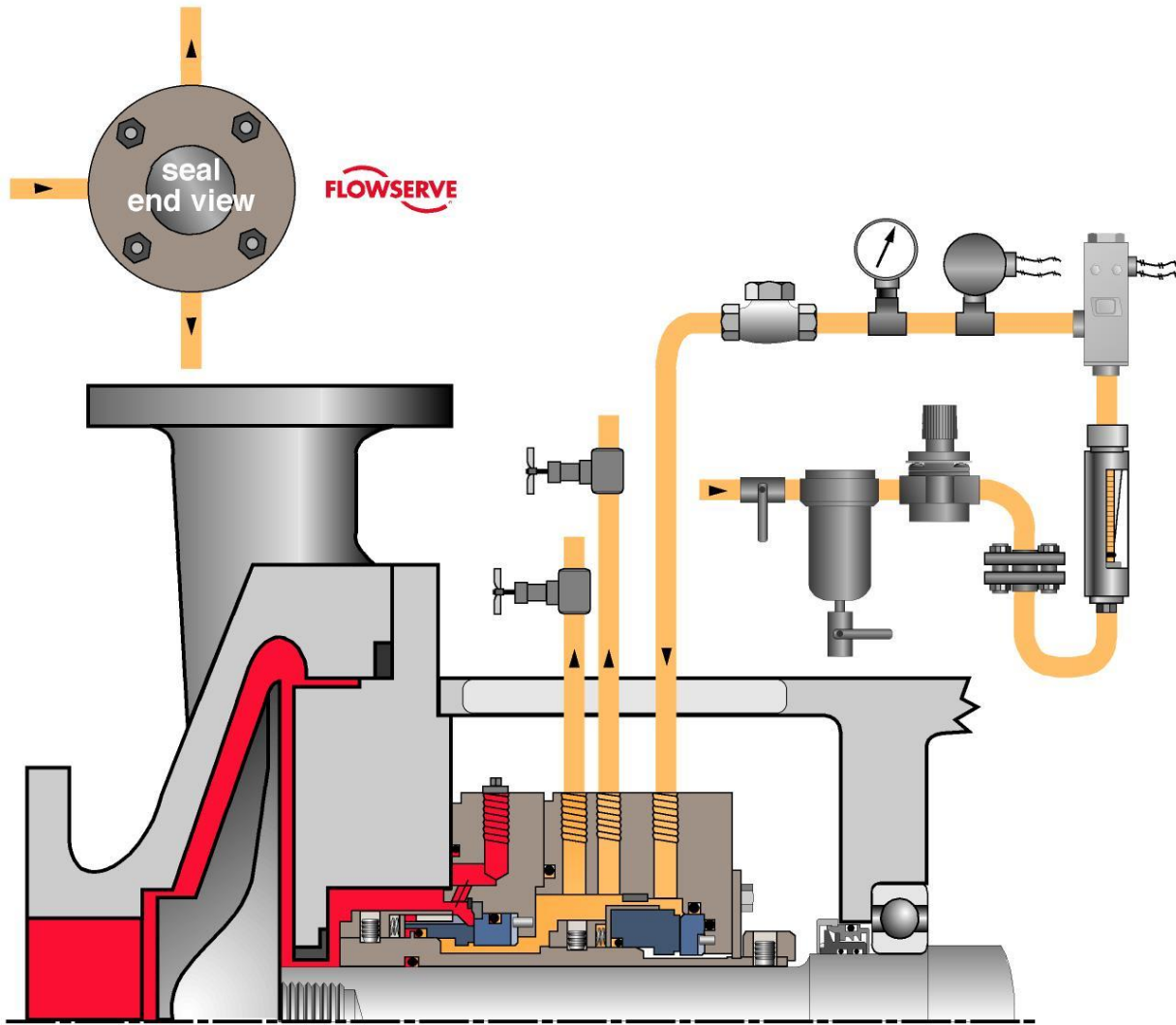
Plan 72



Why

- Zero to very low process emissions.
- Safety backup to primary seal.

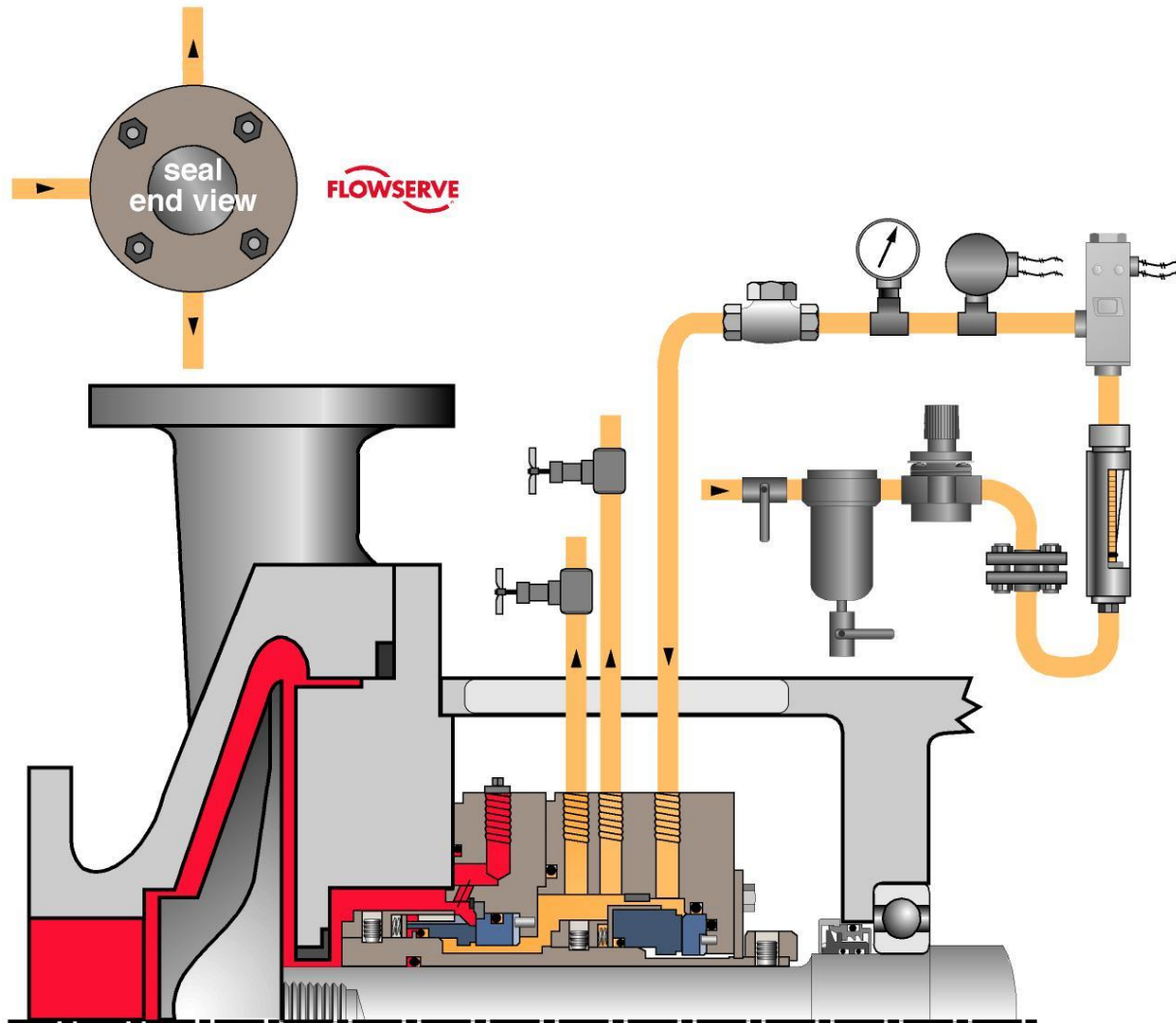
Plan 72



Where

- Used with dual unpressurized containment seals (“tandem”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Clean, non-polymerizing, non-oxidizing fluids.
- Used in combination with Plan 75 and/or Plan 76.

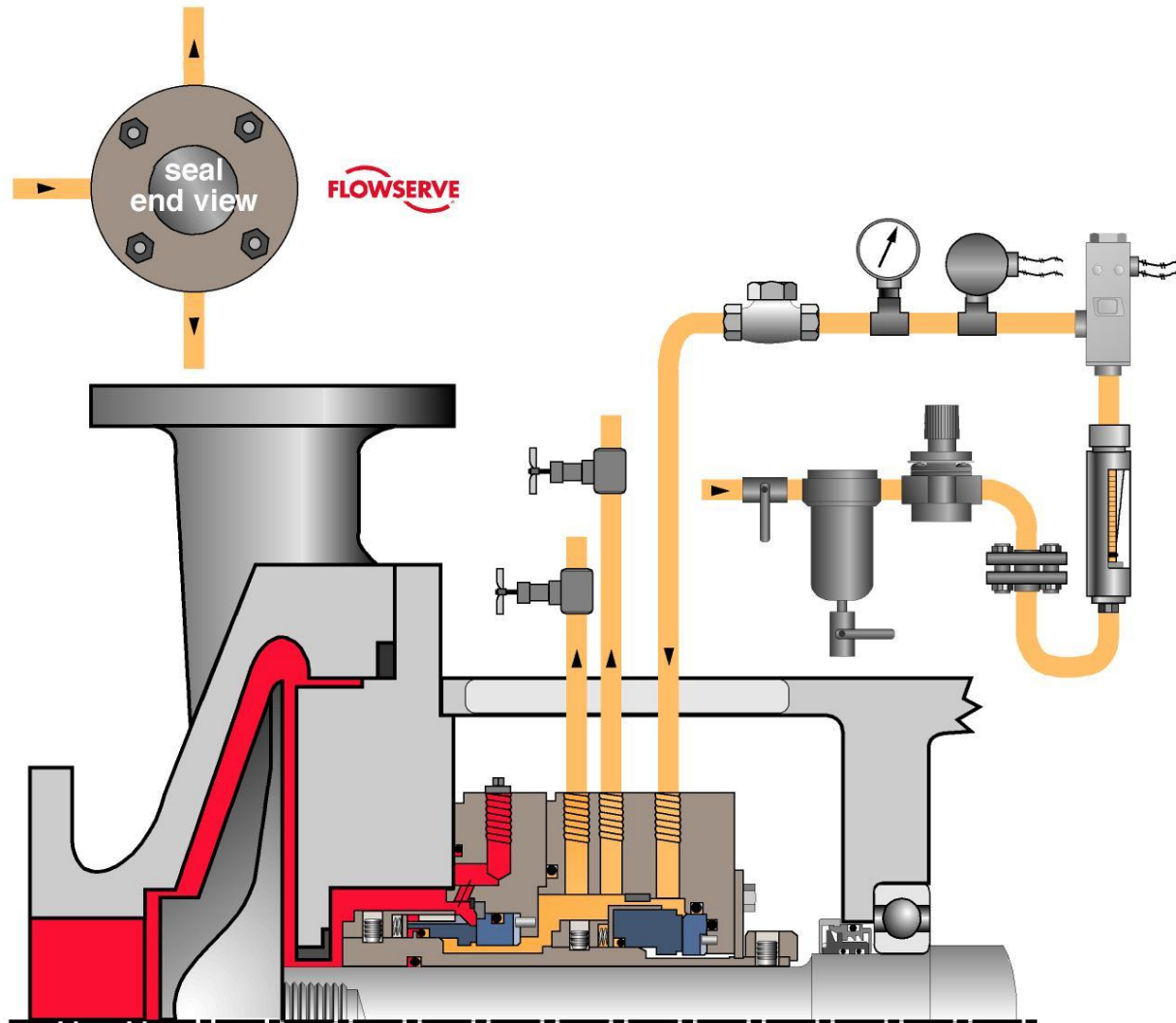
Plan 72



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 an emergency backup system.
- Primary seal leakage is indicated by pressure in the vent line.

Plan 72



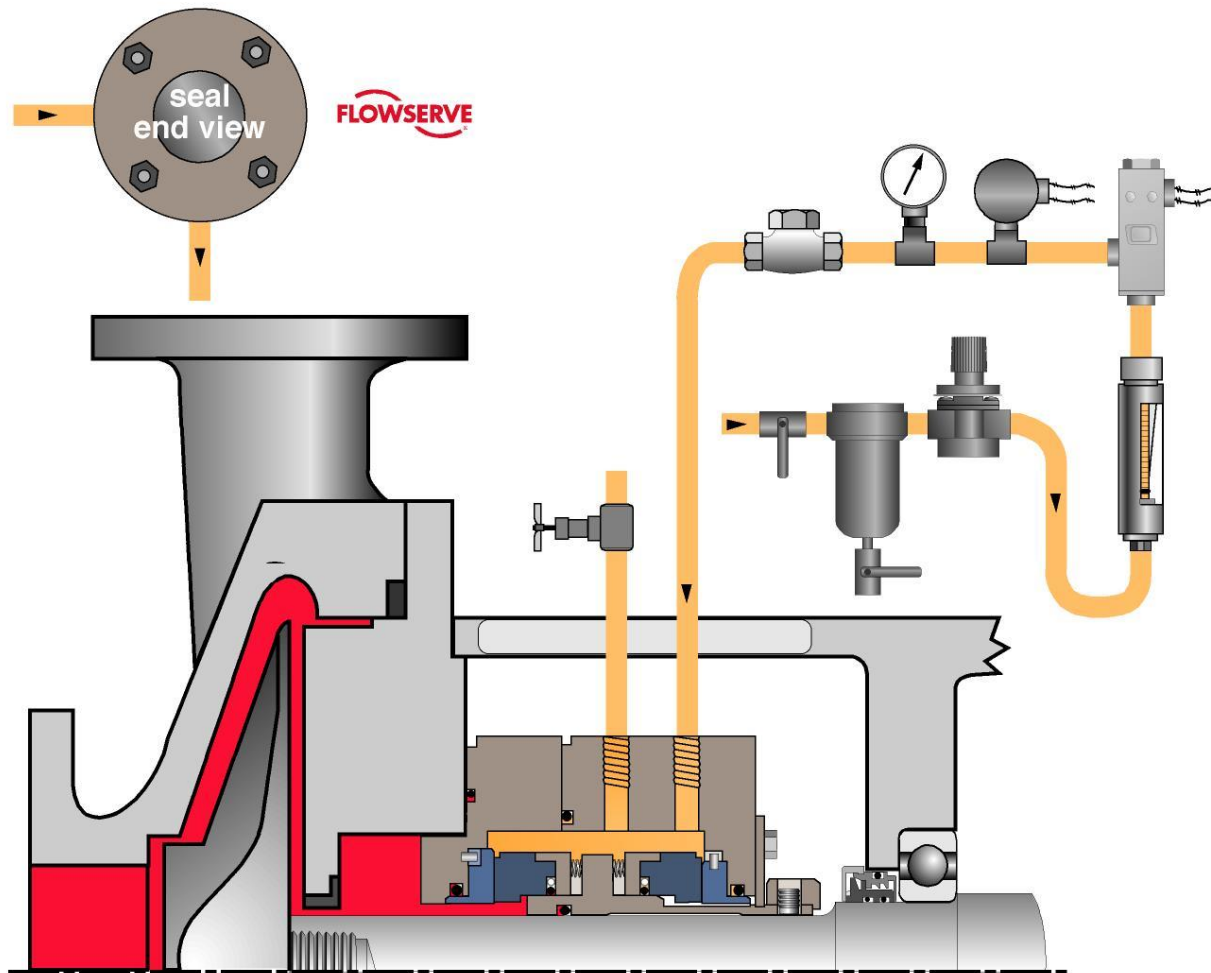
Preventative Maintenance (continued)

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

Plan 74

What

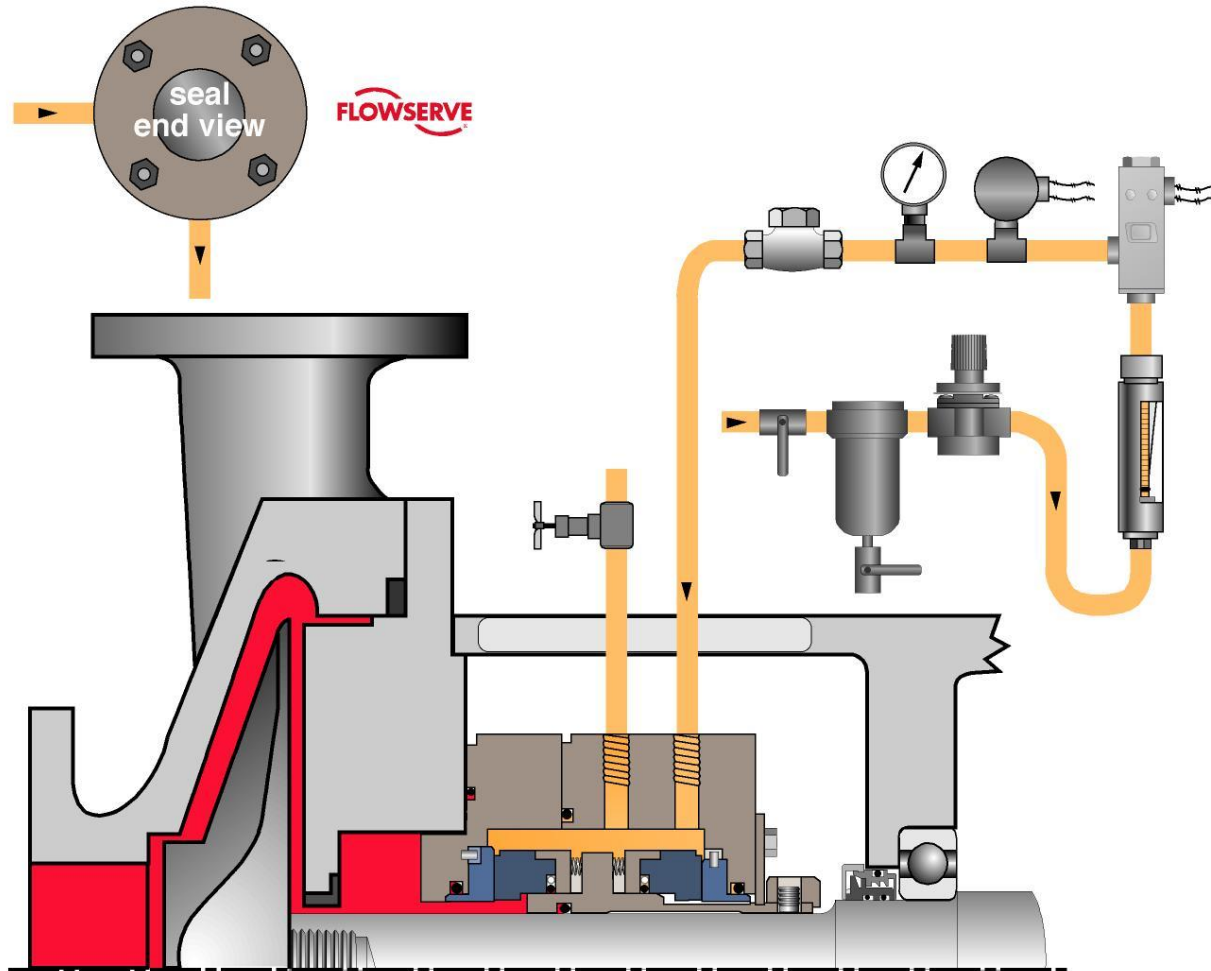
- Pressurized barrier gas control system.
- Gas seal support typically with nitrogen barrier gas.



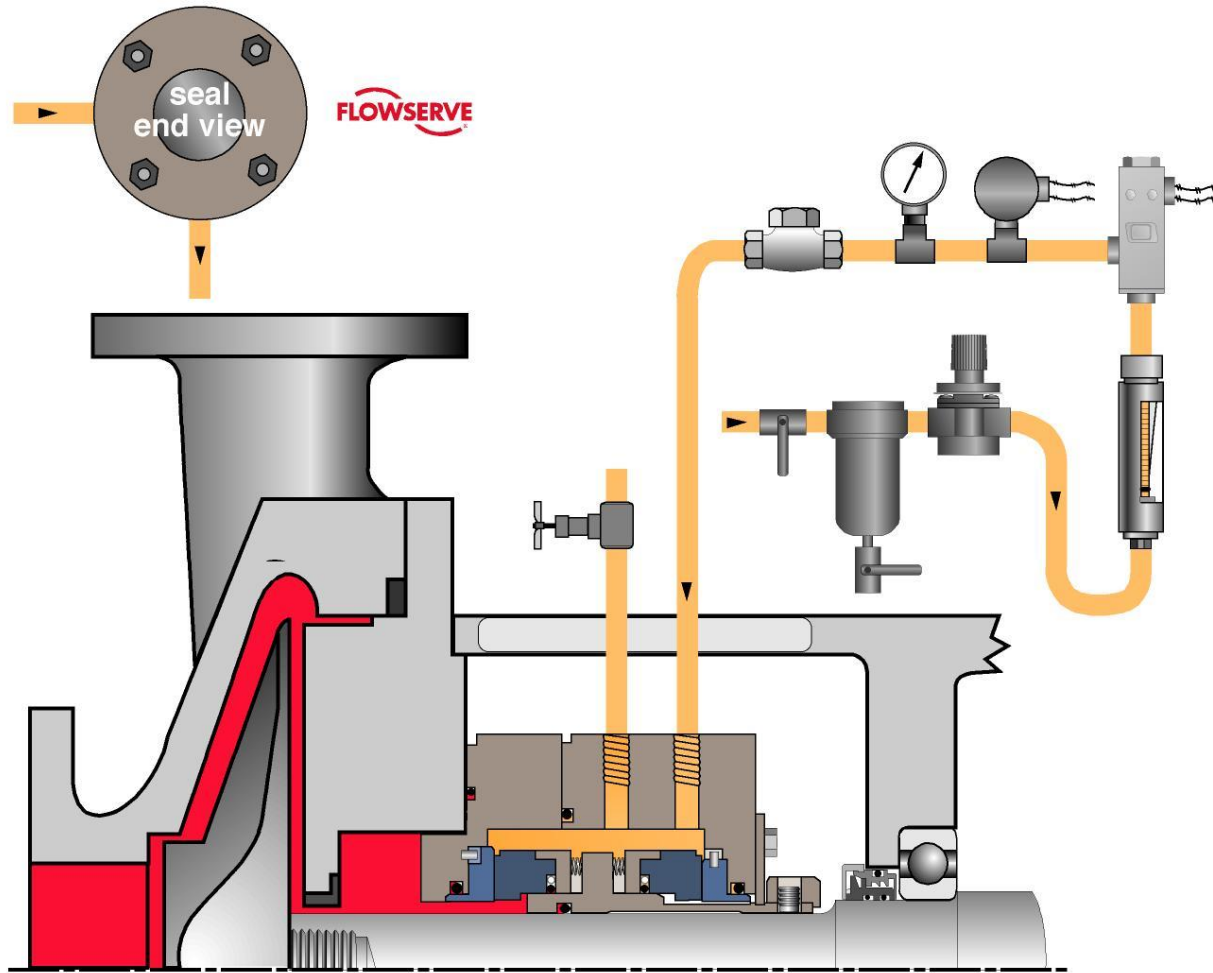
Plan 74

Why

- Isolate process fluid.
- Zero process emissions.



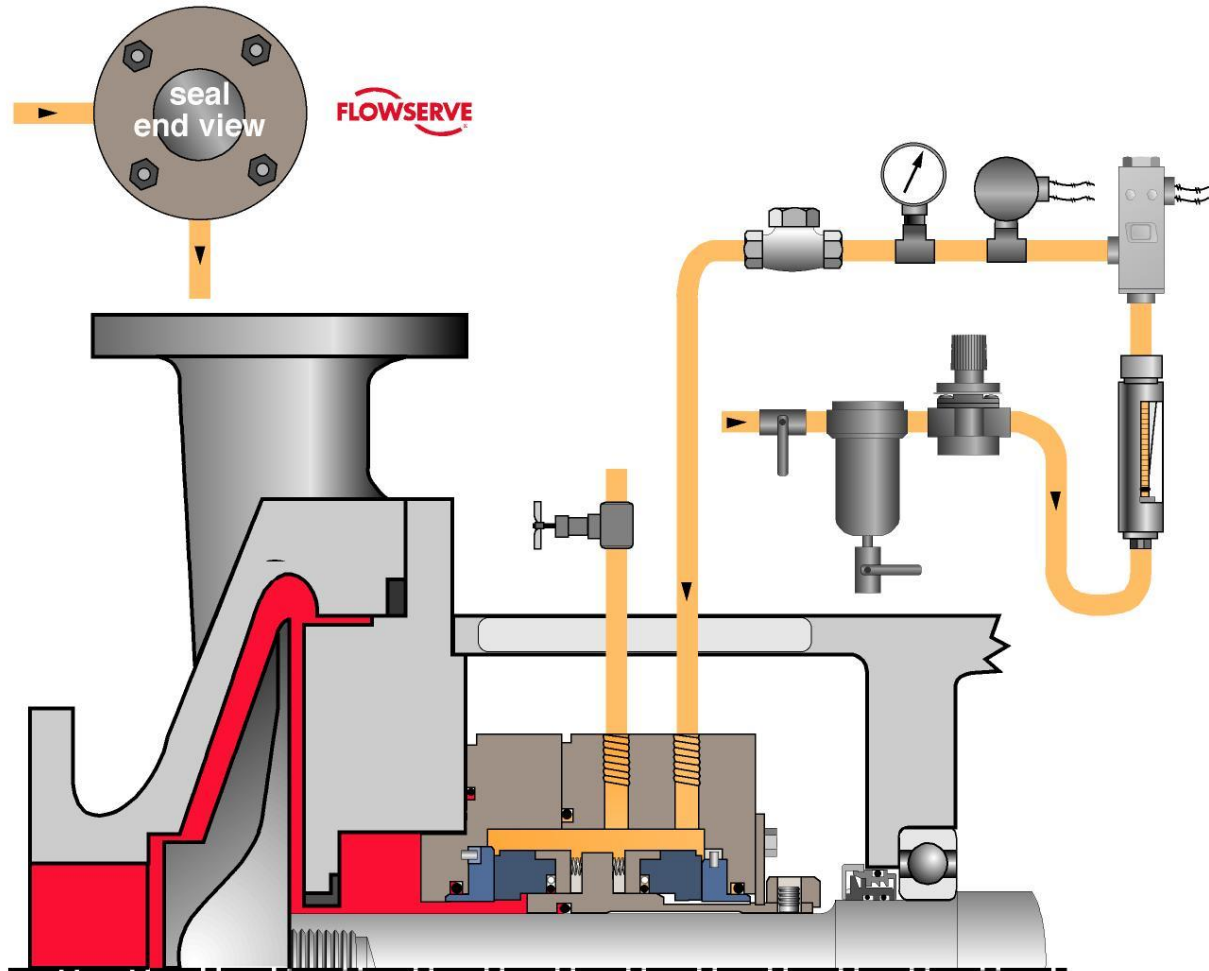
Plan 74



Where

- Used with dual pressurized gas seals (“double”).
- High vapor pressure fluids, light hydrocarbons.
- Hazardous or toxic fluids.
- Services that do not tolerate barrier fluids.
- Clean, non-polymerizing fluids.
- Moderate temperature fluids.

Plan 74

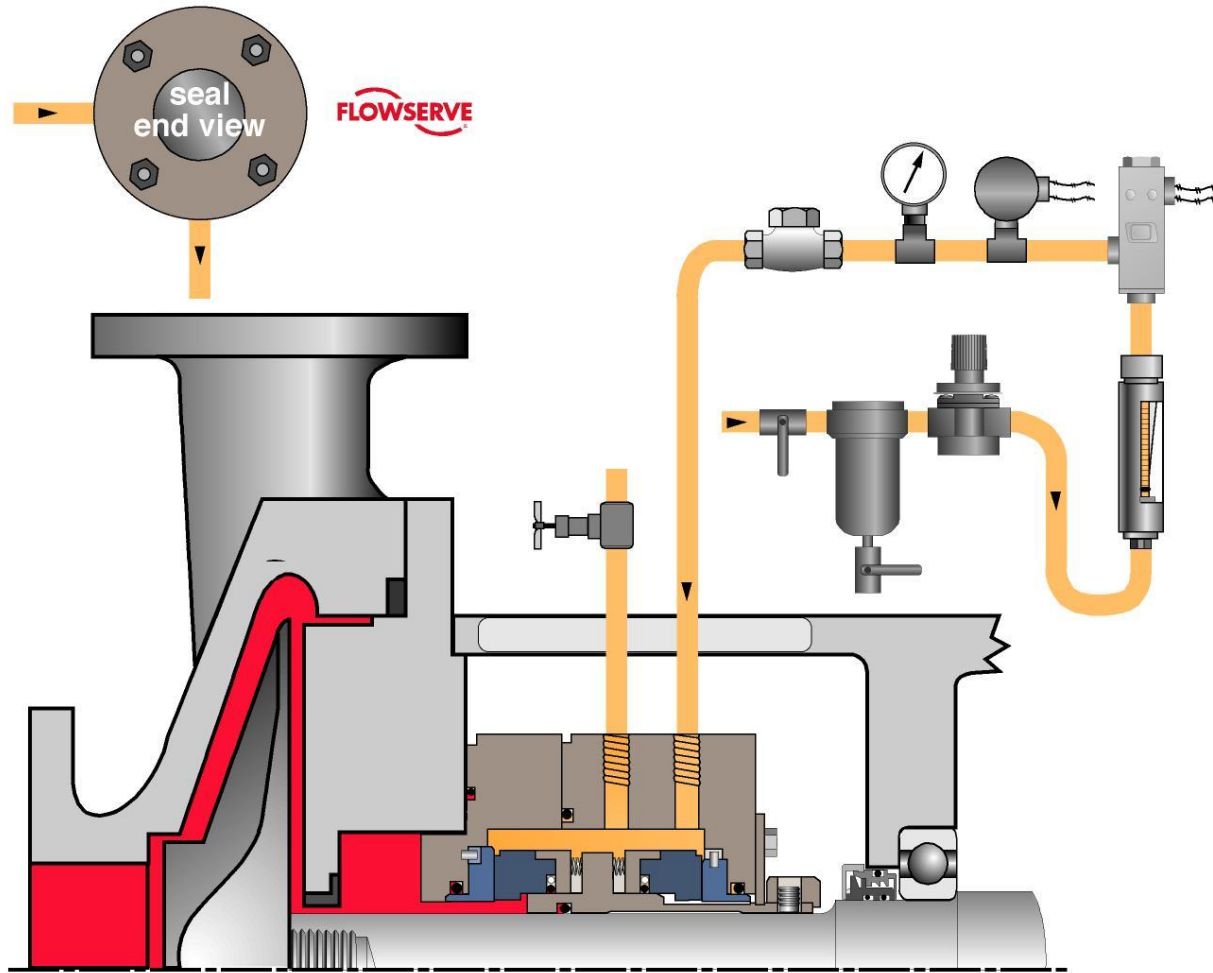


Preventative Maintenance

- Clean, reliable, pressurized gas must be supplied to seal at all times.
- Barrier pressure is typically at least 25 psi (1.75 bar) above seal chamber pressure.
- Flow meter indicates both inboard and outboard seal leakage.



Plan 74



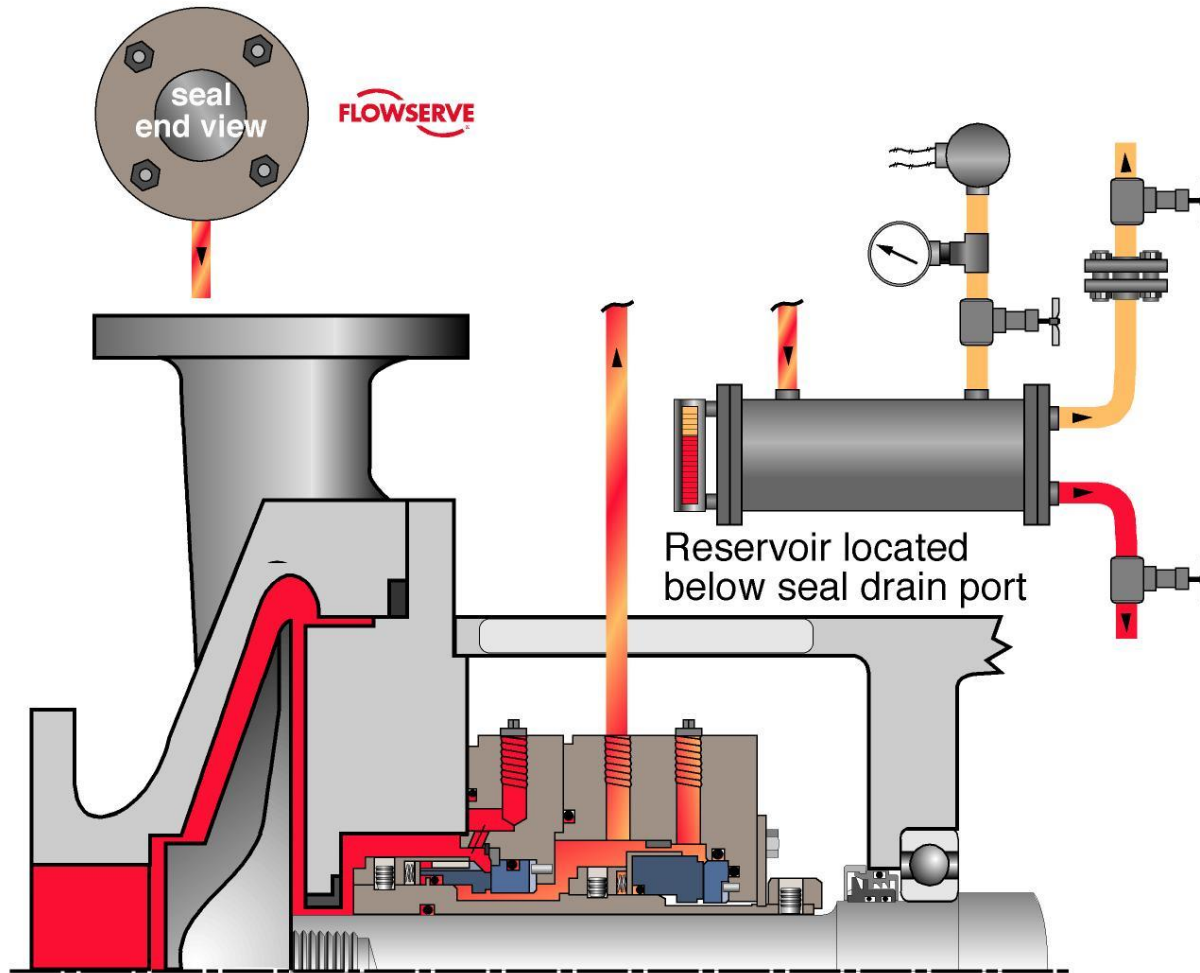
Preventative Maintenance (continued)

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

Plan 75

What

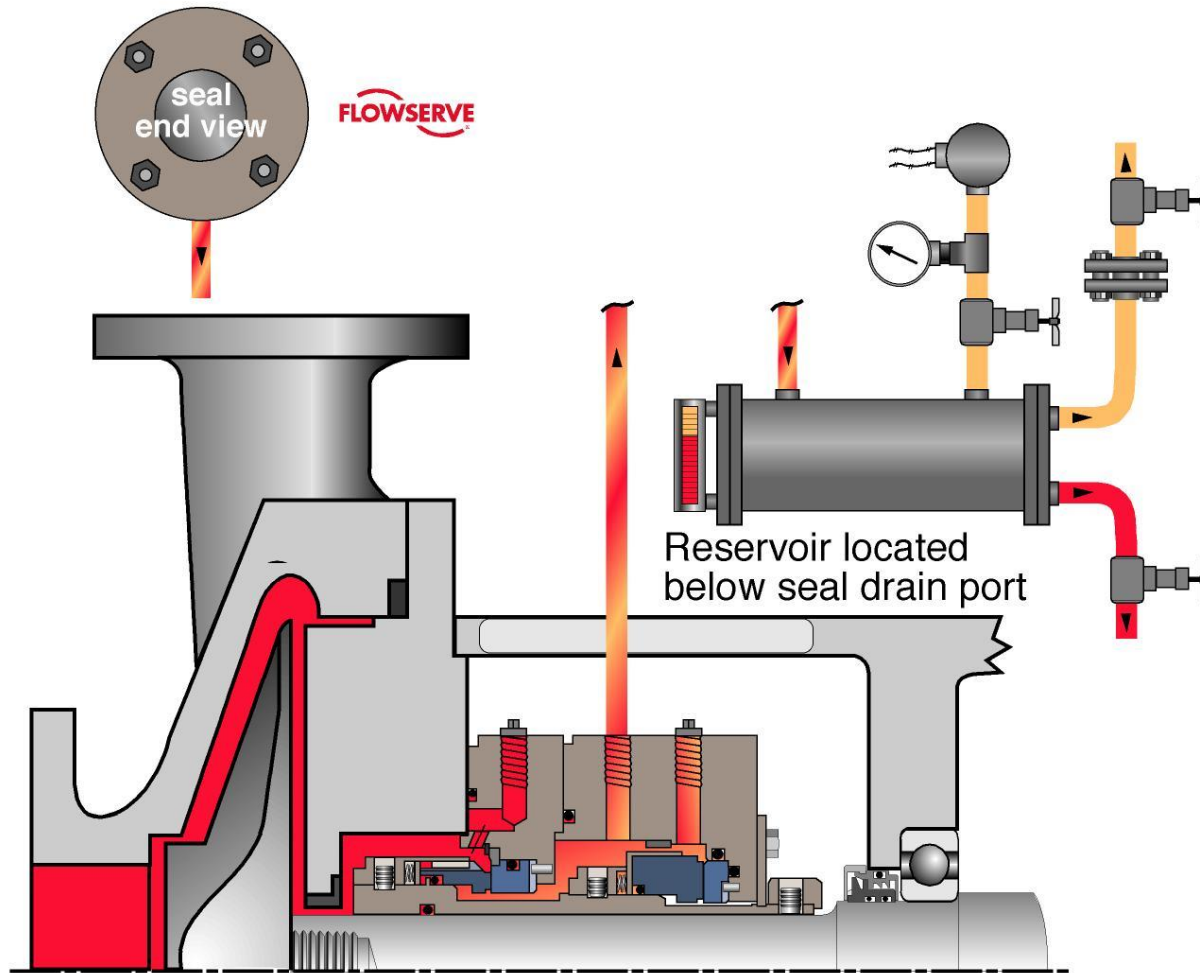
- Drain from containment seal cavity to liquid collector and vapor recovery.



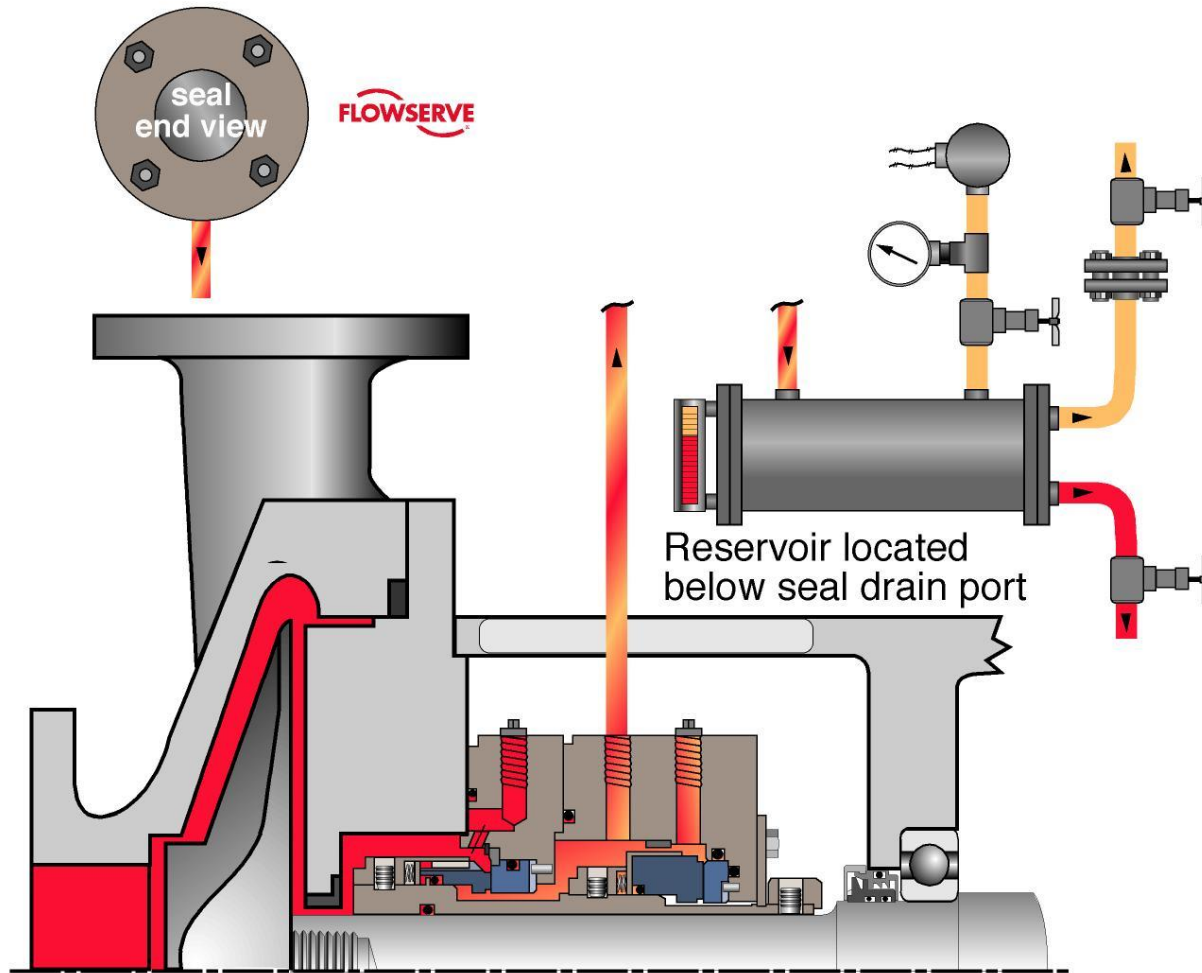
Plan 75

Why

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



Plan 75



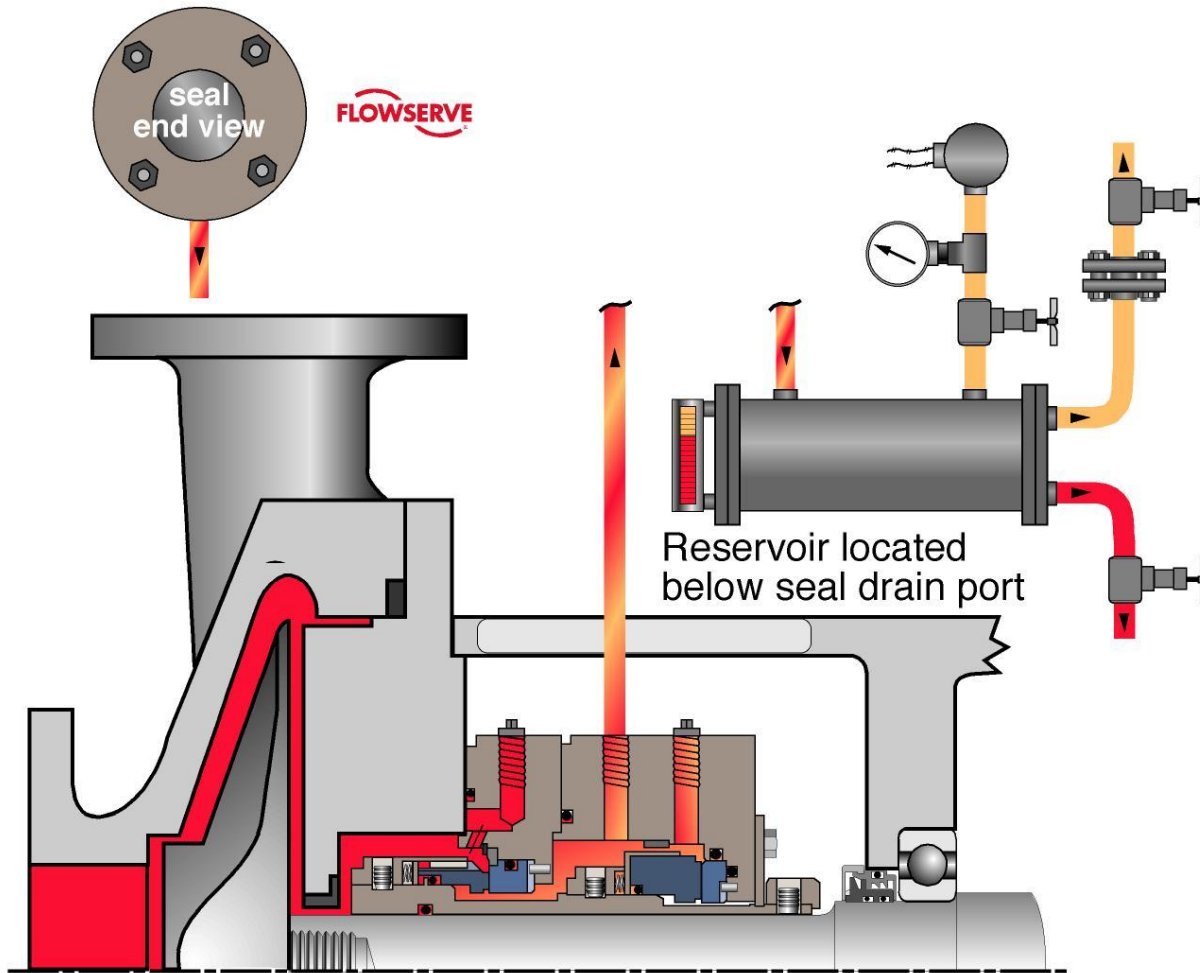
Where

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

Plan 75

Preventative Maintenance

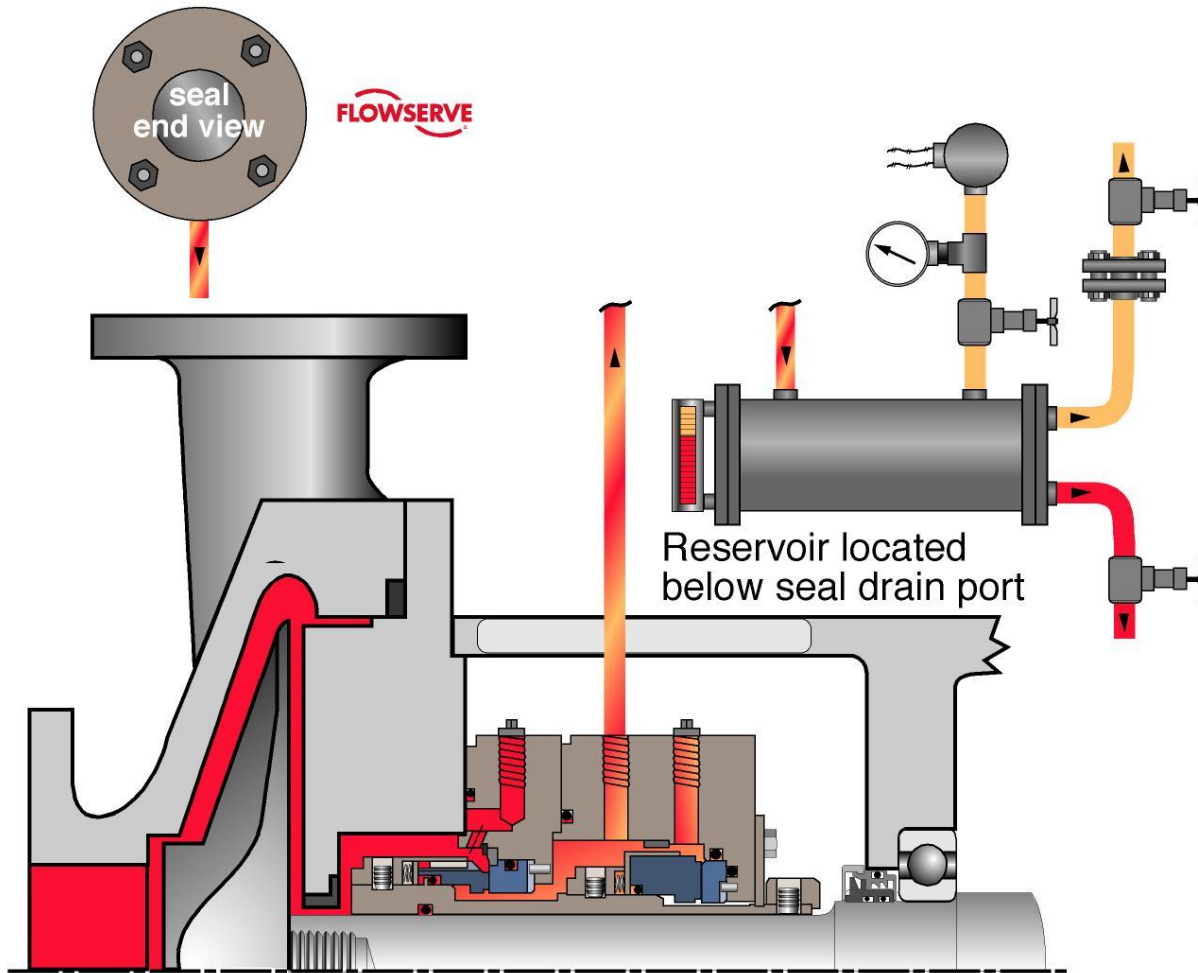
- Collection reservoir must be located below seal drain and downward-sloped piping.
- Continuously vent collection reservoir to low pressure vapor recovery/flare system.
- Drain collection reservoir to liquid recovery system as needed.



Plan 75

Preventative Maintenance (continued)

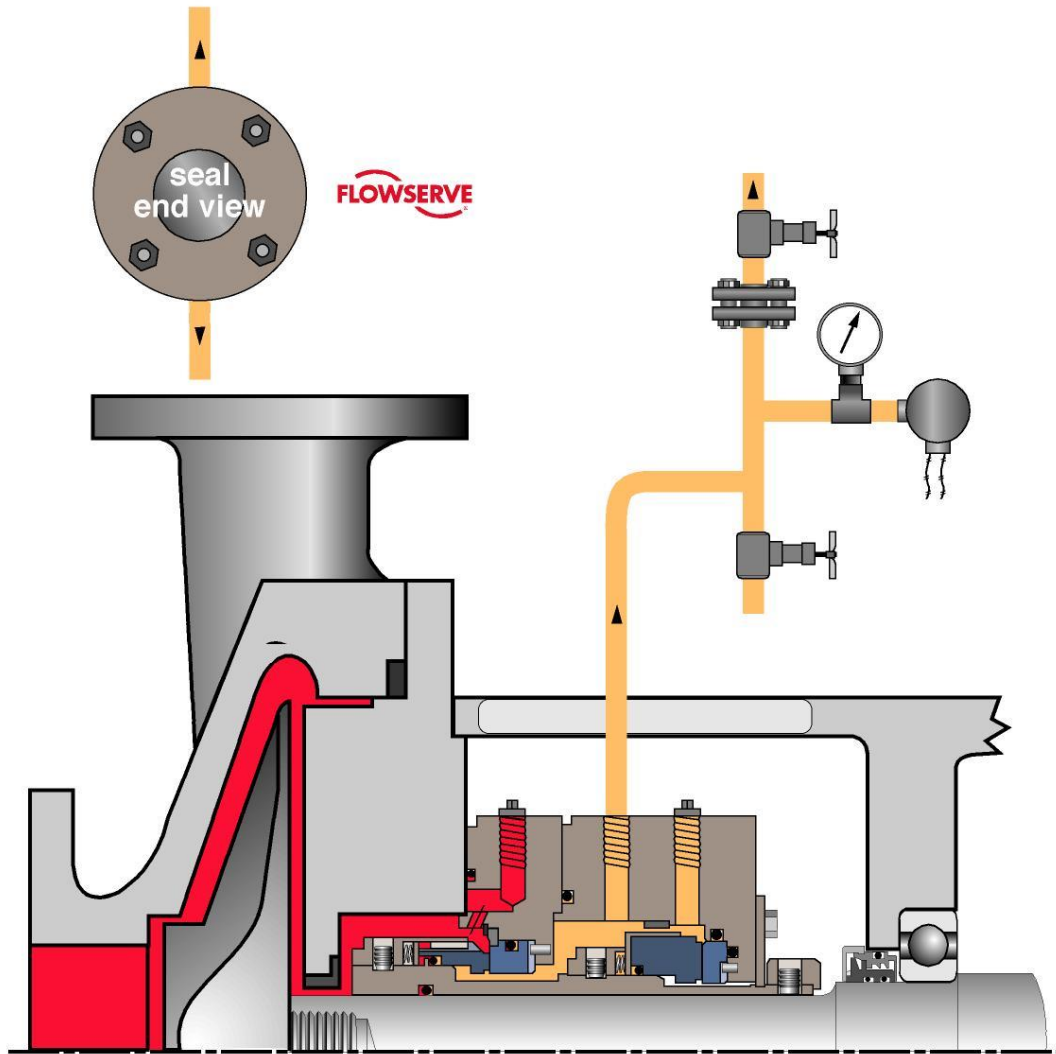
- Primary seal leakage is indicated by increased vent pressure.
- Monitor regularly for liquid level, valve settings, and low vent pressure.



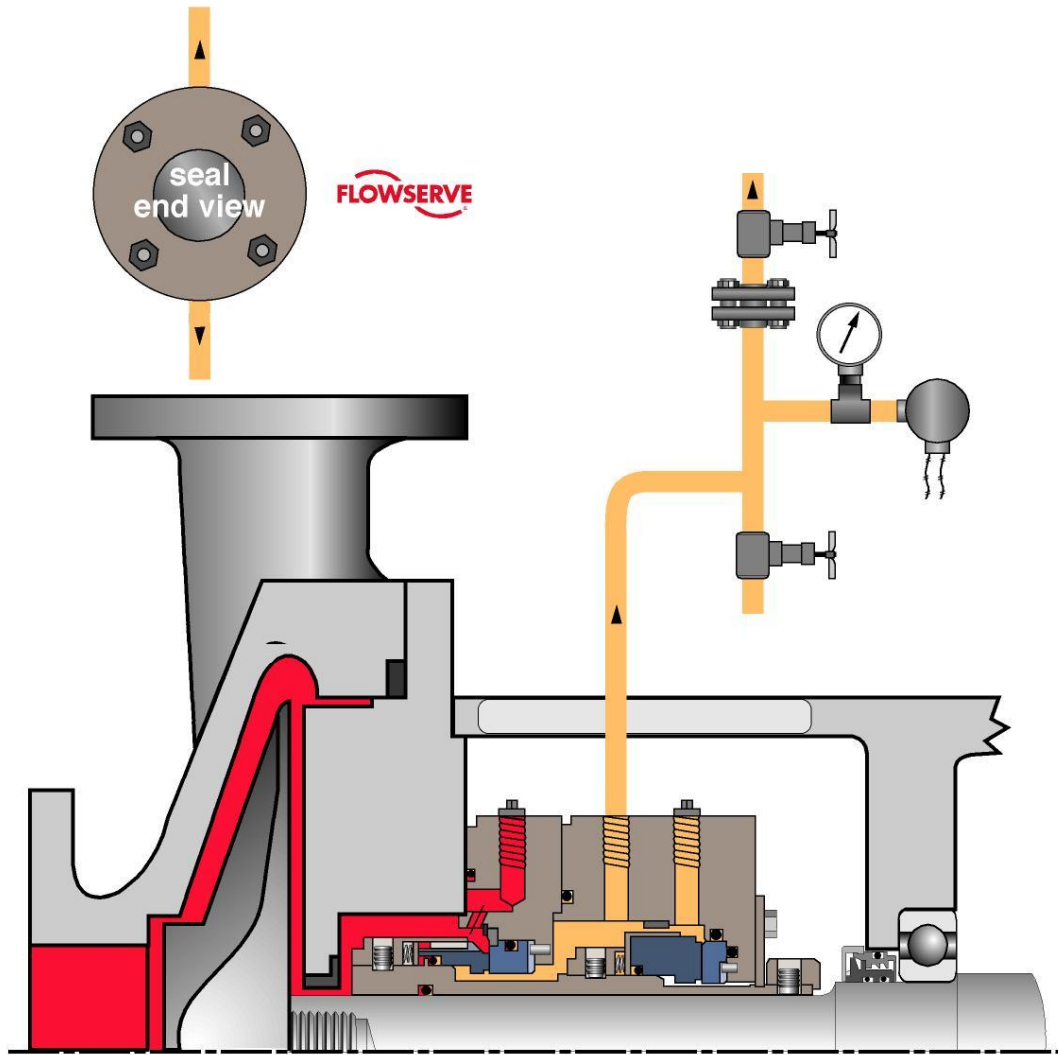
Plan 76

What

- Vent from containment seal cavity to vapor recovery.



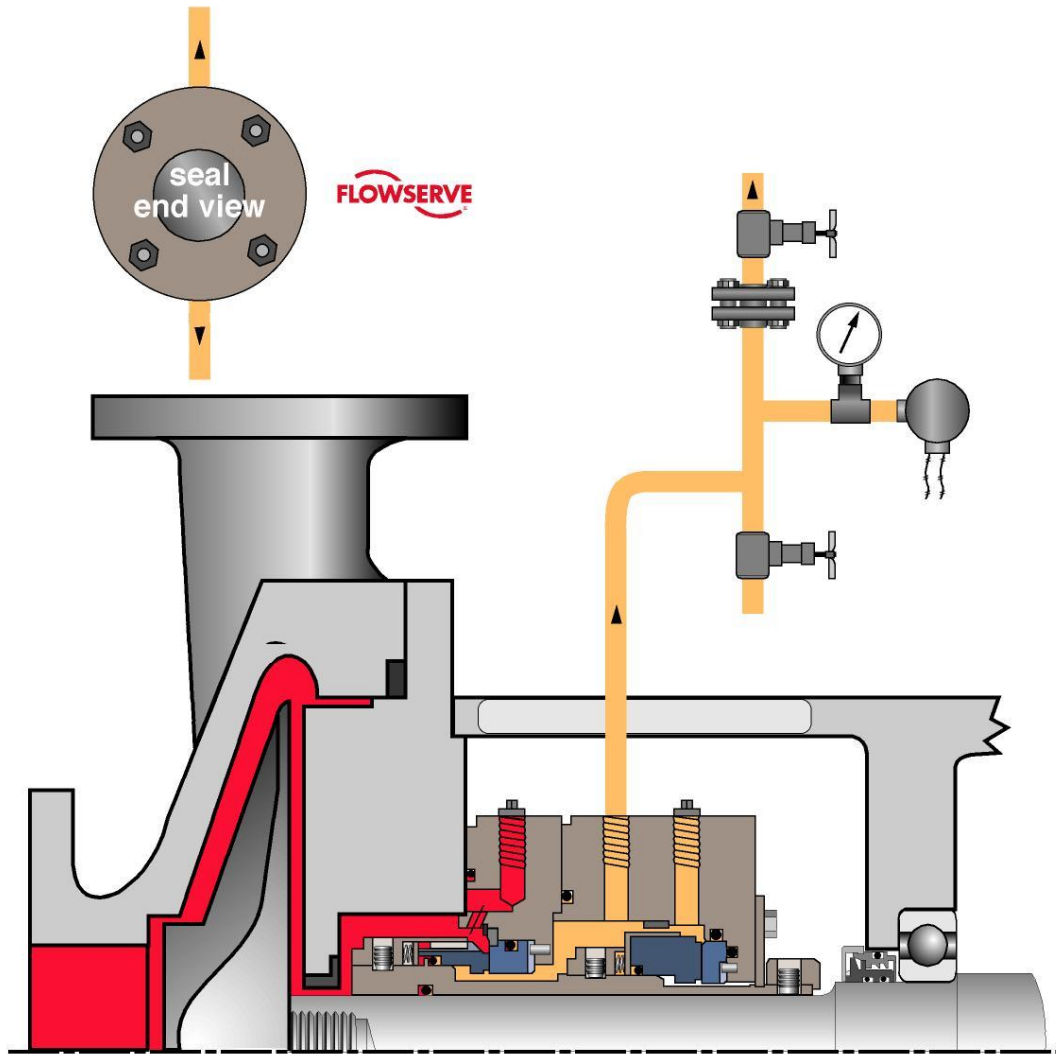
Plan 76



Why

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

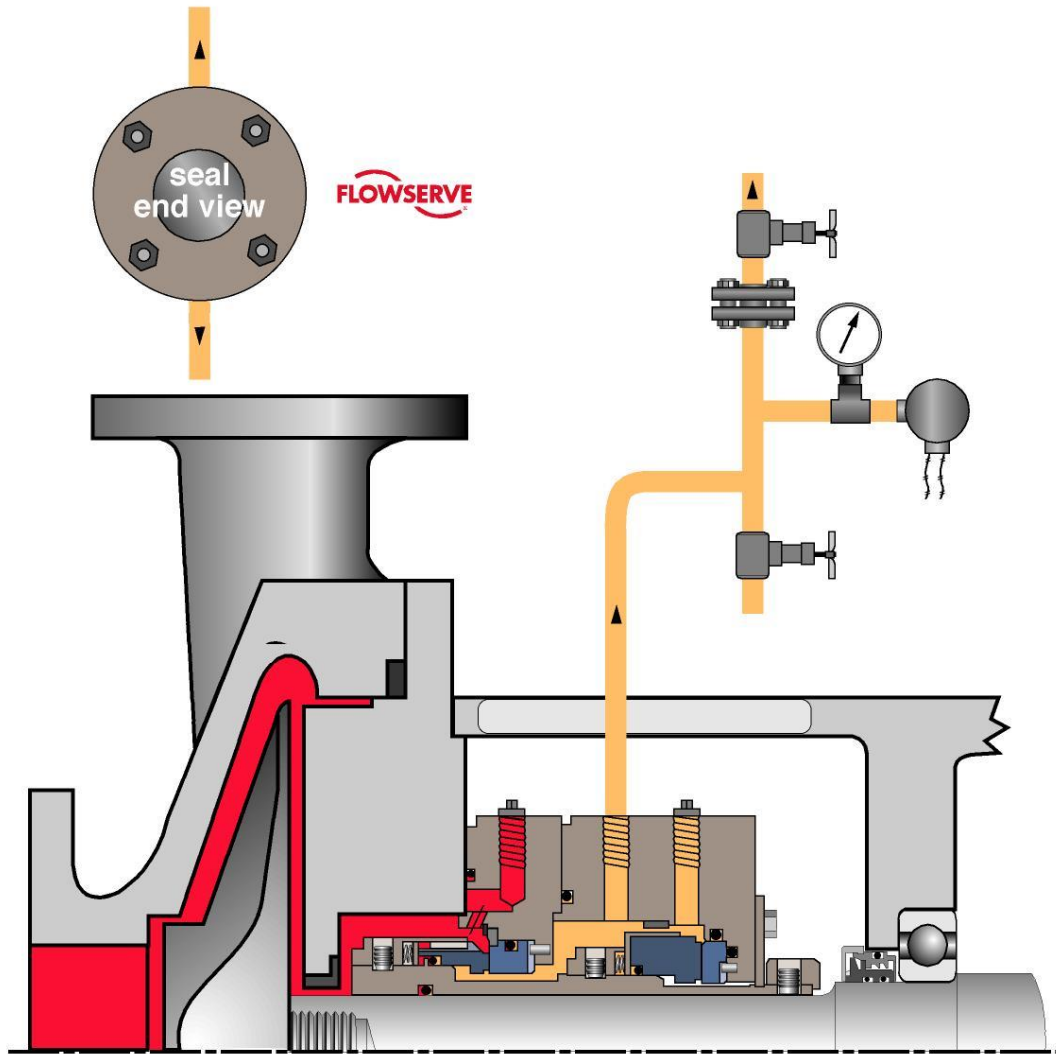
Plan 76



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 or toxic fluids.
- Clean, non-polymerizing, non-oxidizing fluids.

Plan 76



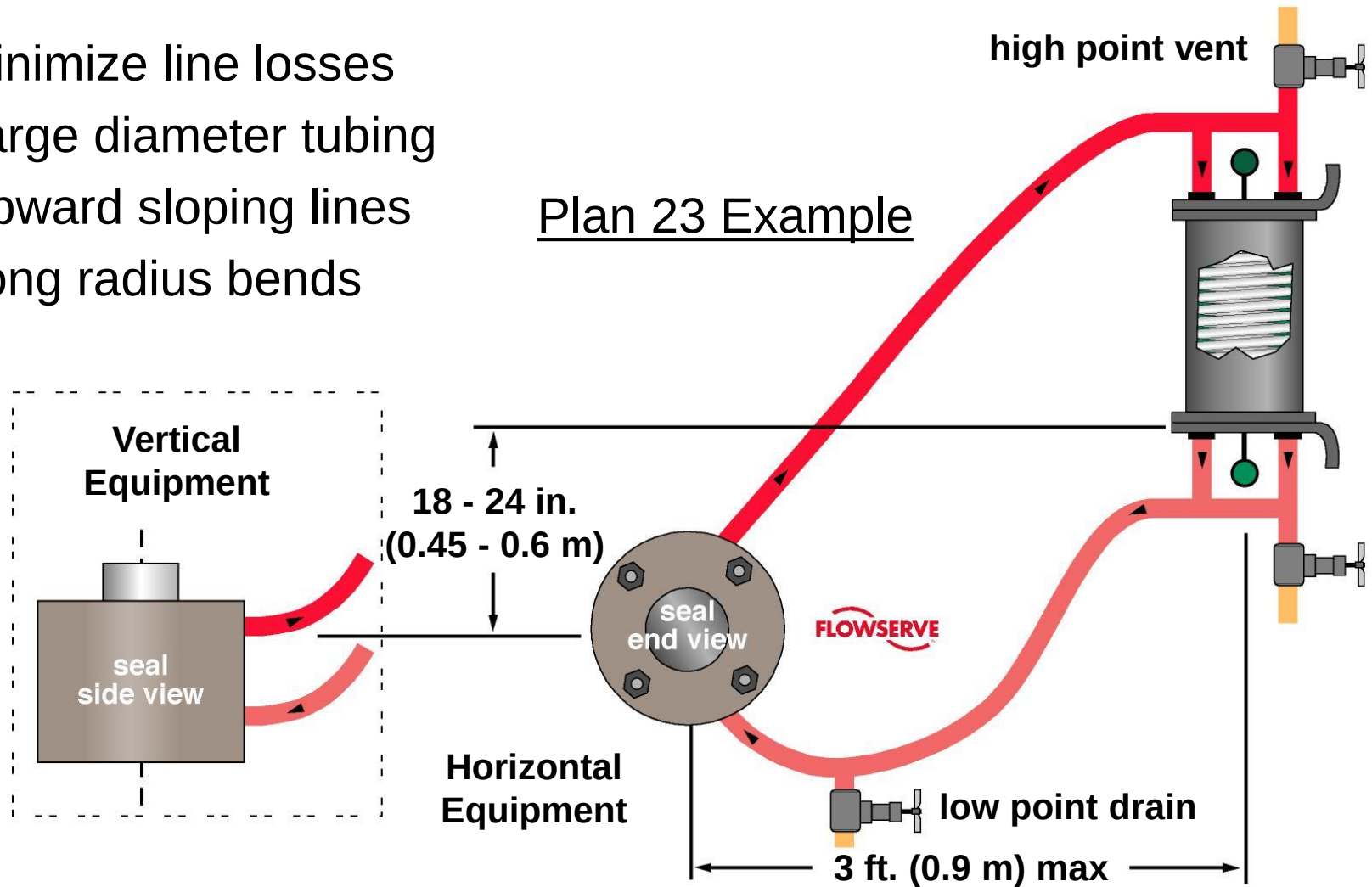
Preventative Maintenance

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

Good Piping Practices

- ✓ Minimize line losses
- ✓ Large diameter tubing
- ✓ Upward sloping lines
- ✓ Long radius bends

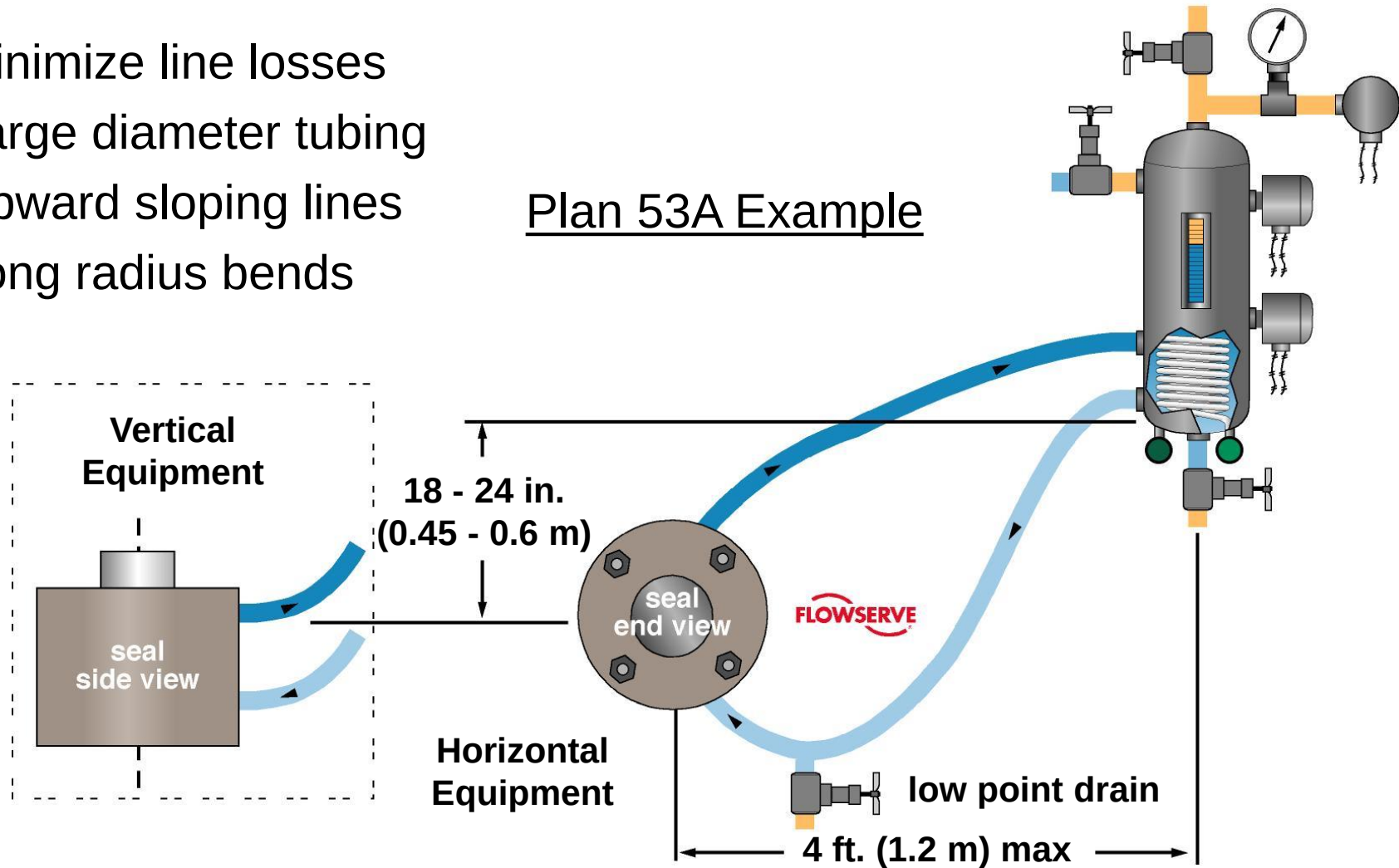
Plan 23 Example



Good Piping Practices

- ☑ Minimize line losses
- ☑ Large diameter tubing
- ☑ Upward sloping lines
- ☑ Long radius bends

Plan 53A Example



Other Piping Plans

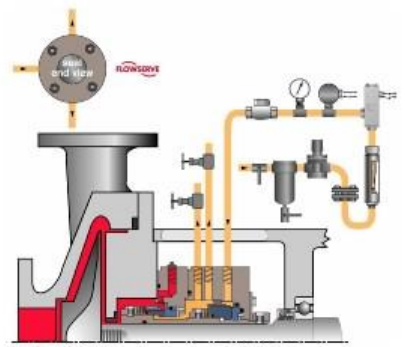
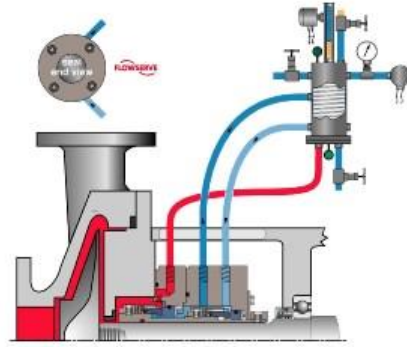
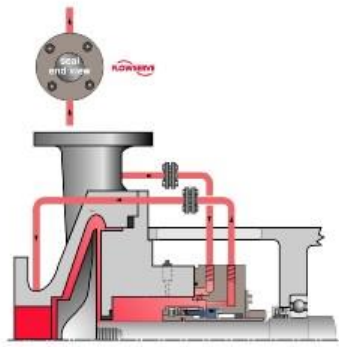
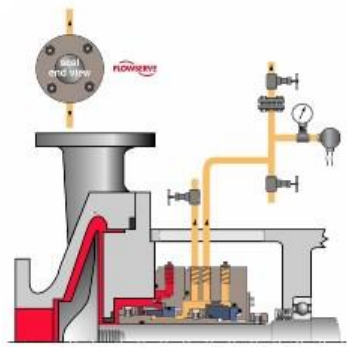
- Plan 12 – Flush through a strainer
- Plan 22 – Flush through a strainer and seal cooler
- Plan 61 – Porting to atmospheric side of seal plugged for future use
- Plan 65 – Collection of atmospheric liquid leakage (new in ISO 21049 / 682 3rd edition)
- Plan 71 – Porting to containment seal cavity plugged for future use



Review

- Intended to create a more favorable environment for the seal
- Collect and detect seal leakage and provide safety backup
- Documented in several API, ASME, and ISO standards
- May require auxiliary equipment or external sources of fluids
- Necessary to improve seal reliability





Questions?

