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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

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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 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

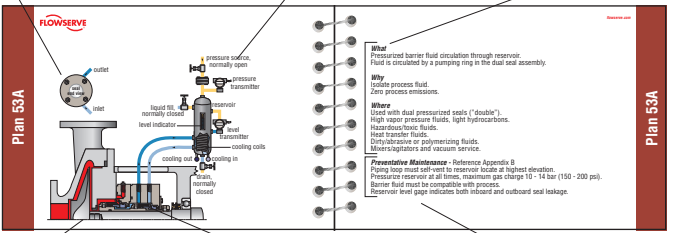
- Viewed from drive end
- Shows preferred gland connection orientation

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

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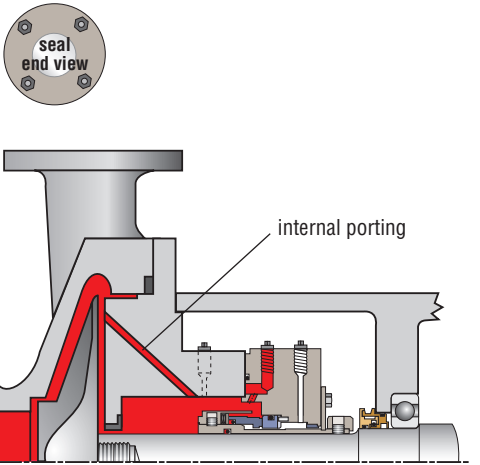
Plan 01



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.

Plan 02

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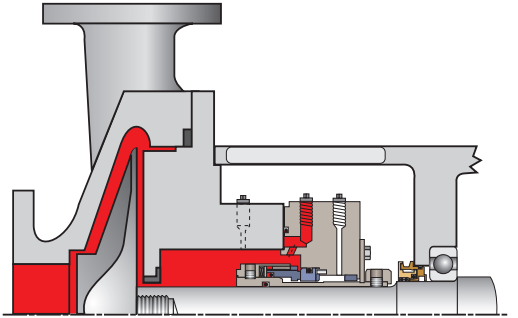


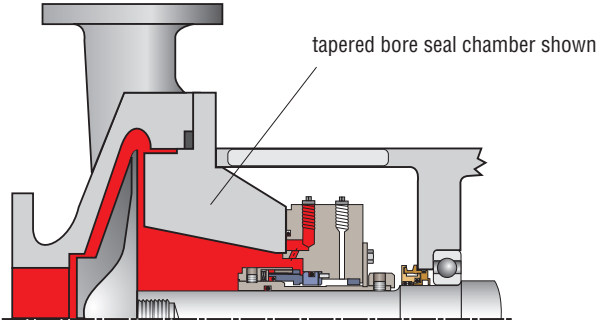
What
Dead-ended seal chamber with no flush.

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.

Plan 03



Plan 03

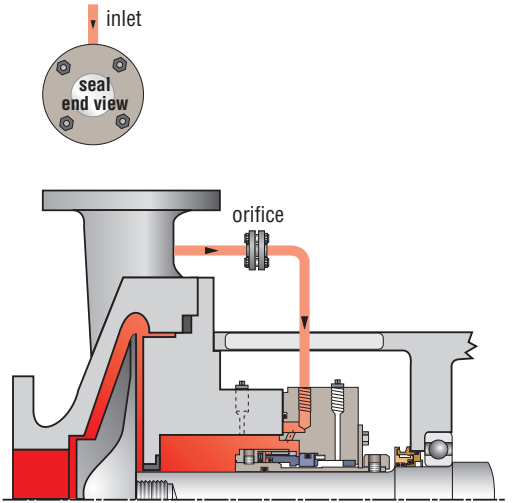
What
Circulation created by the design of the seal chamber.

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.

Plan 11



Plan 11

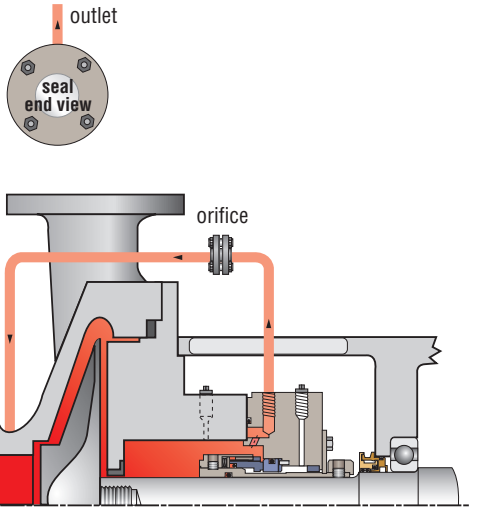
What
Seal flush from pump discharge through orifice.
Default single seal flush plan.

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.

Plan 13



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.

Plan 14

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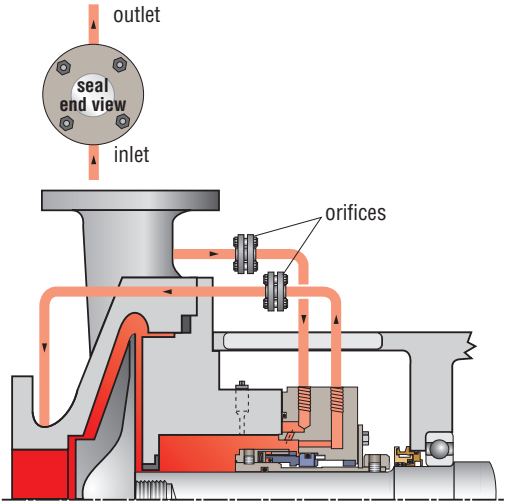

What
Seal flush from pump discharge and recirculation to pump suction with orifices.
Combination of Plan 11 and Plan 13.

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.

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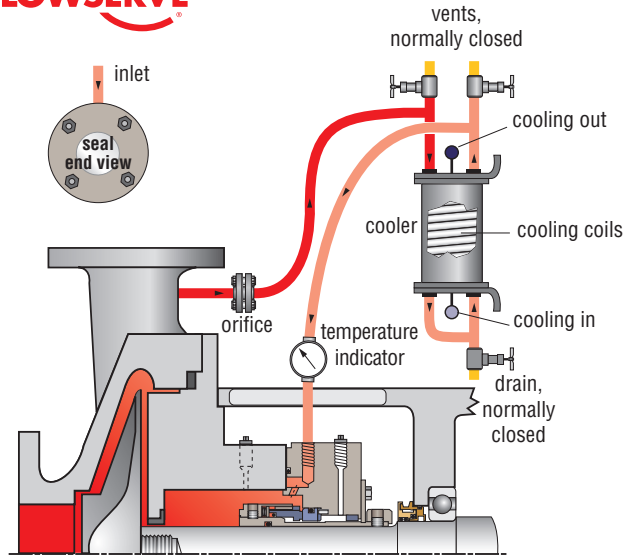
Plan 21



Plan 21

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.

Plan 23

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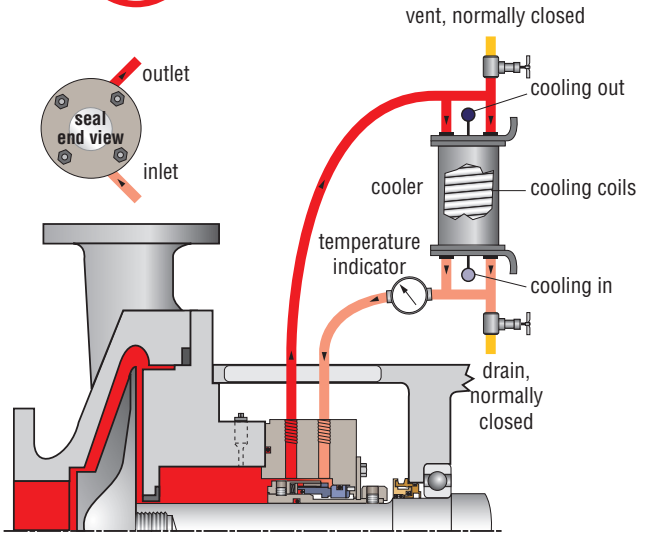


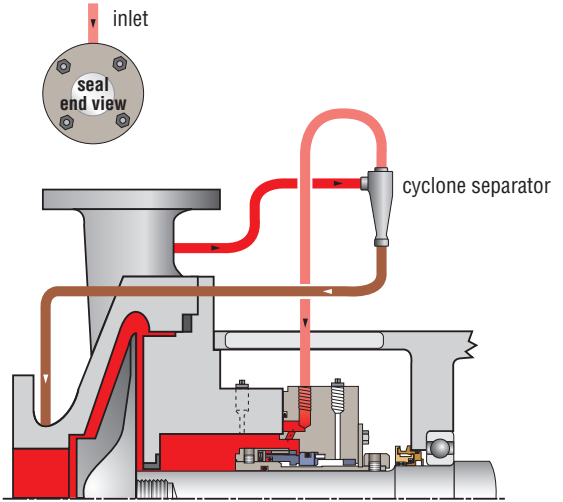
What
Seal flush from internal pumping device through cooler.
Standard flush plan in hot water services.

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.

Plan 31



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.

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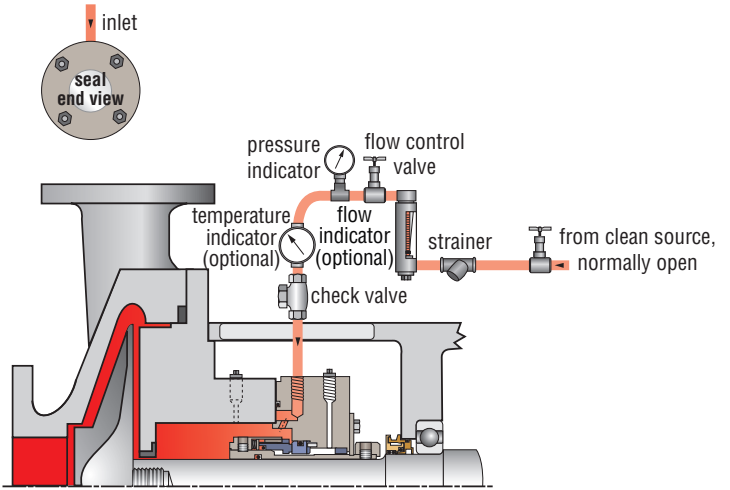
Plan 32



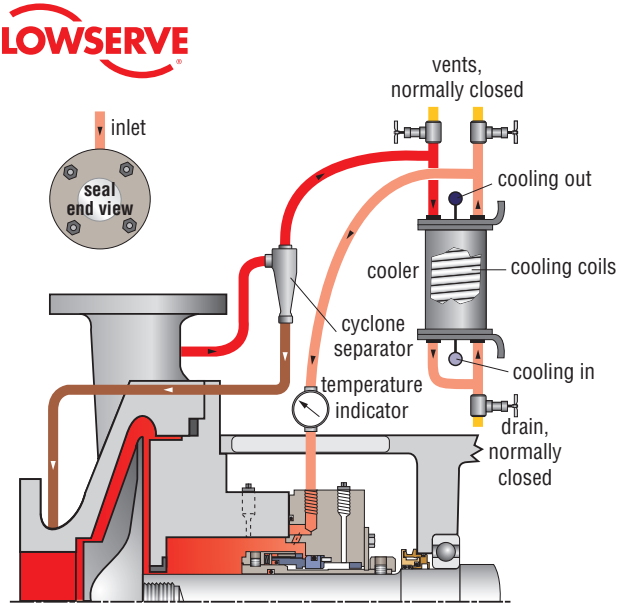
What
Seal flush from an external clean source.

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.

Plan 41


vents,
normally closed
inlet
seal
end view
cooling out
cooler
cooling coils
cyclone
separator
cooling in
temperature
indicator
drain,
normally
closed

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.

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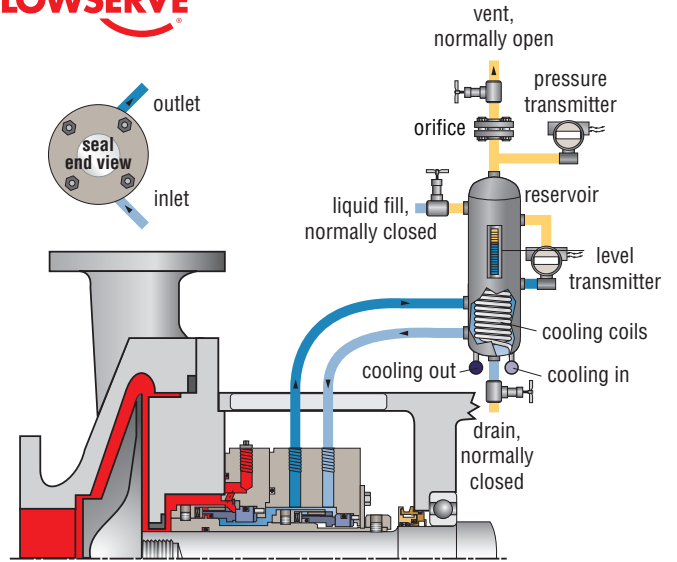
Plan 52



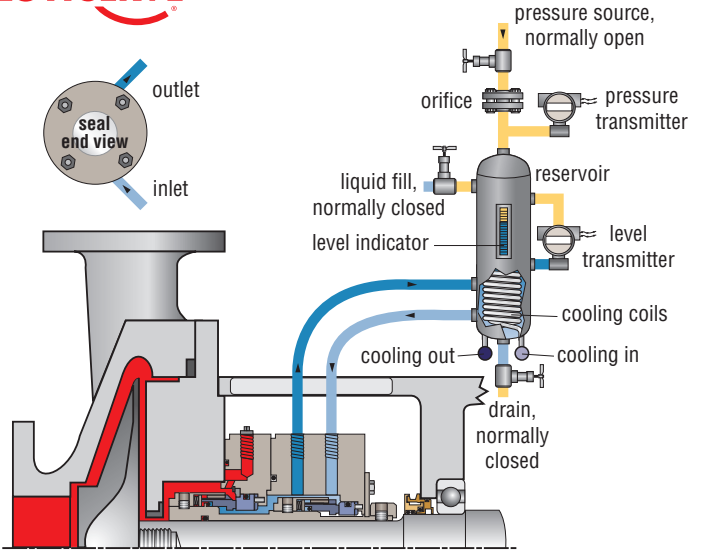
What
Unpressurized buffer fluid circulation through reservoir.
Fluid is circulated by a pumping ring in the dual seal assembly.

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.

Plan 53A


seal
end view
outlet
inlet
pressure source,
normally open
orifice
pressure
transmitter
reservoir
liquid fill,
normally closed
level indicator
level
transmitter
cooling coils
cooling out
cooling in
drain,
normally
closed

Plan 53A

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.

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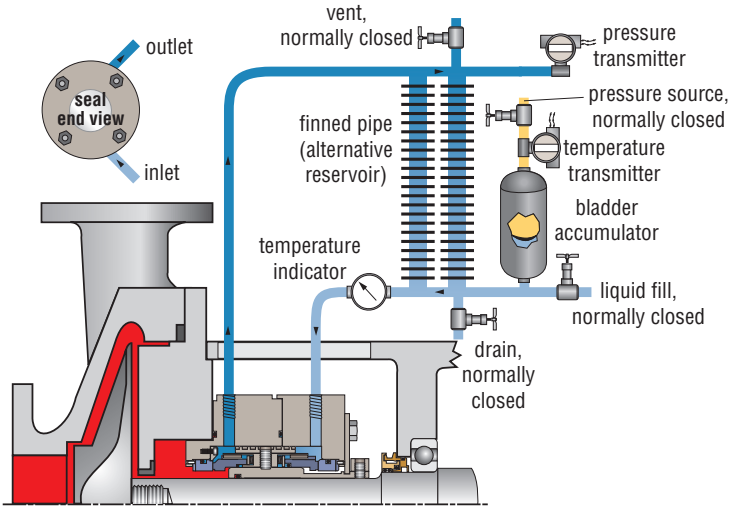
Plan 53B



Plan 53B

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.

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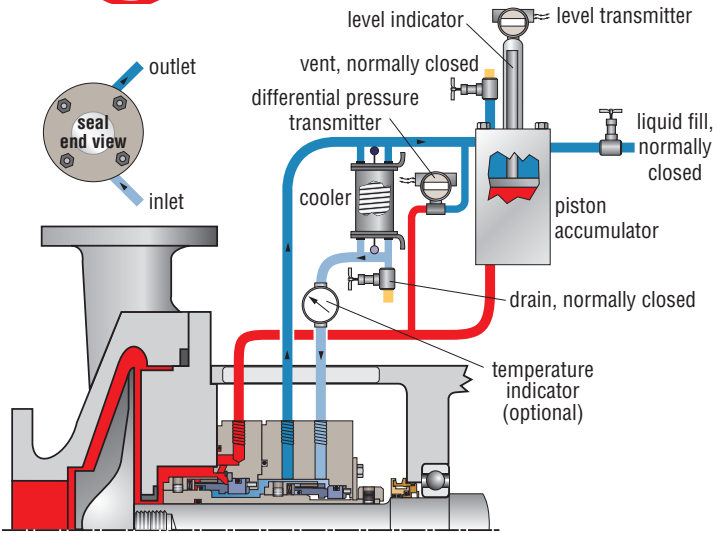
Plan 53C



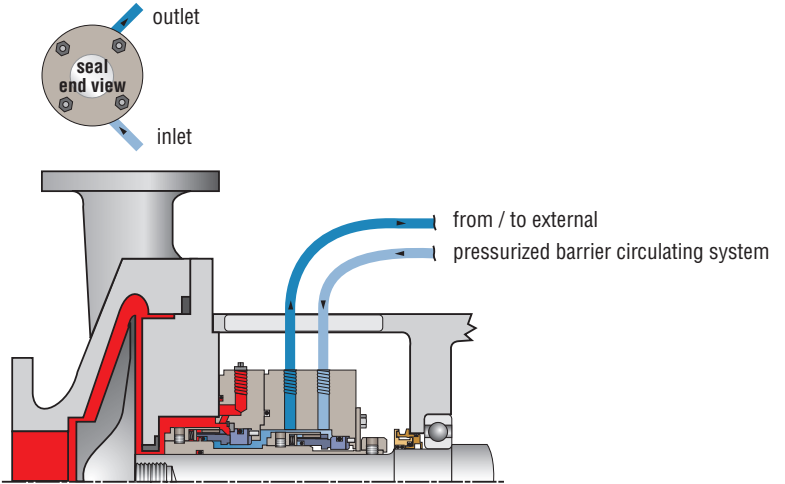
What
Pressurized barrier fluid circulation with piston accumulator.
Fluid is circulated by a pumping ring in the dual seal assembly.

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.

Plan 54


outlet
seal
end view
inlet
from / to external
pressurized barrier circulating system

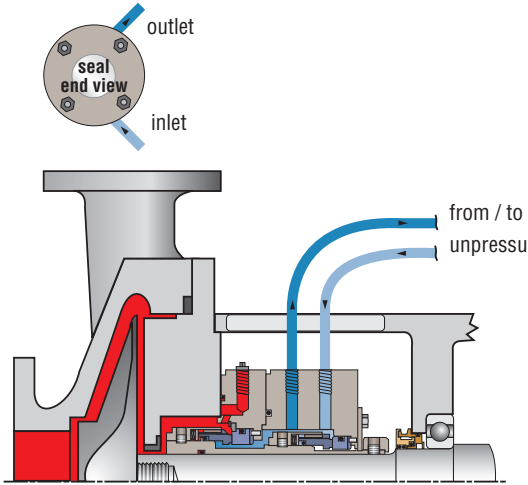
What
Pressurized barrier fluid circulation by external system.

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.

Plan 55


outlet
seal
end view
inlet
from / to external
unpressurized buffer circulating system

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.

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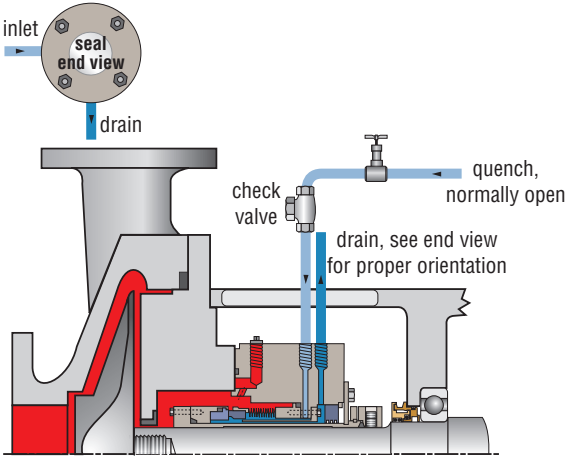
Plan 62



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.

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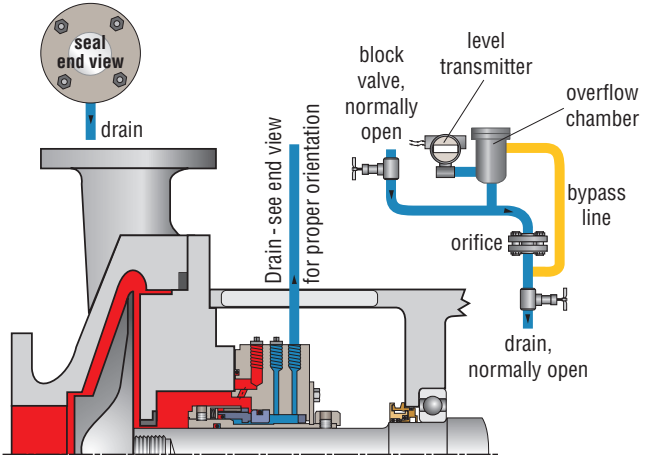
Plan 65A



Plan 65A

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.

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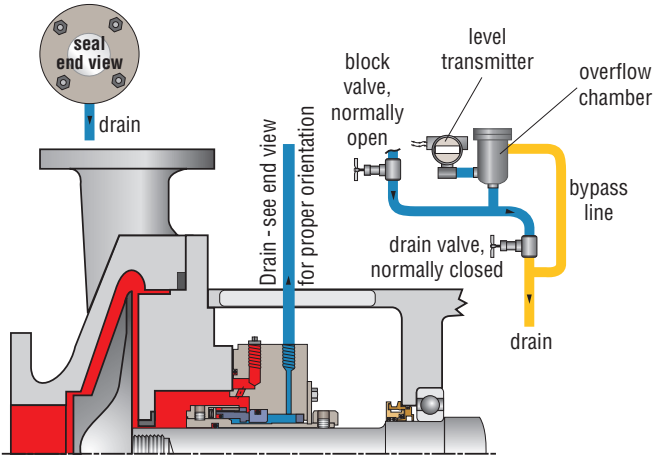
Plan 65B



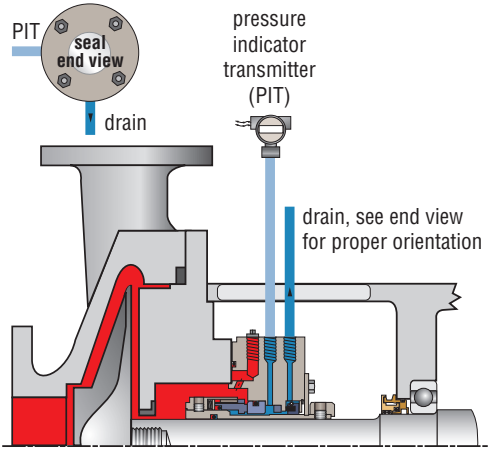
What
External drain with leakage detection on atmospheric side of seal.

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.

Plan 66A


PIT
seal
end view
drain
pressure
indicator
transmitter
(PIT)
drain, see end view
for proper orientation

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.

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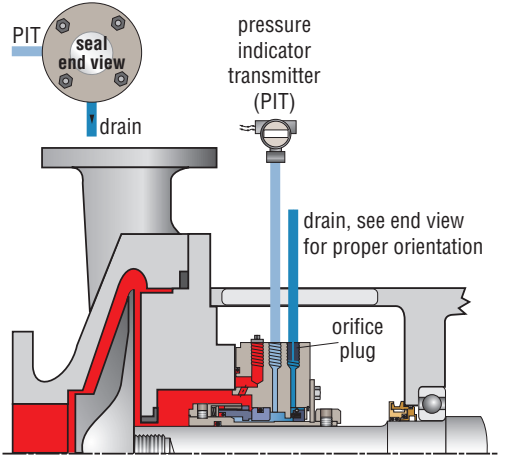
Plan 66B



Plan 66B

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.

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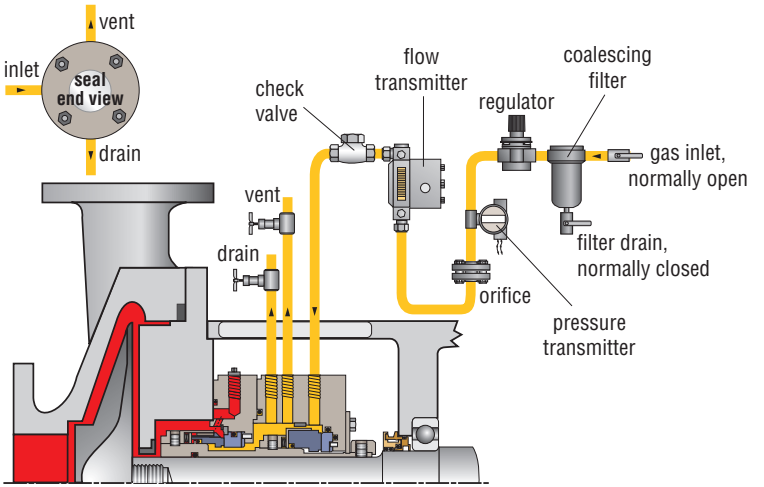
Plan 72



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.

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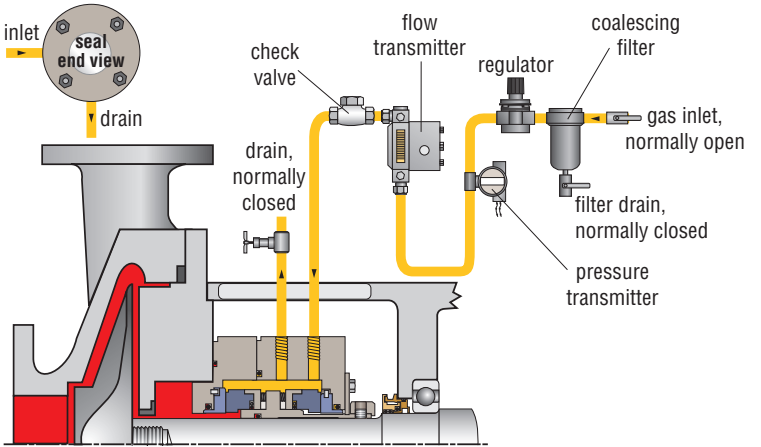
Plan 74



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.

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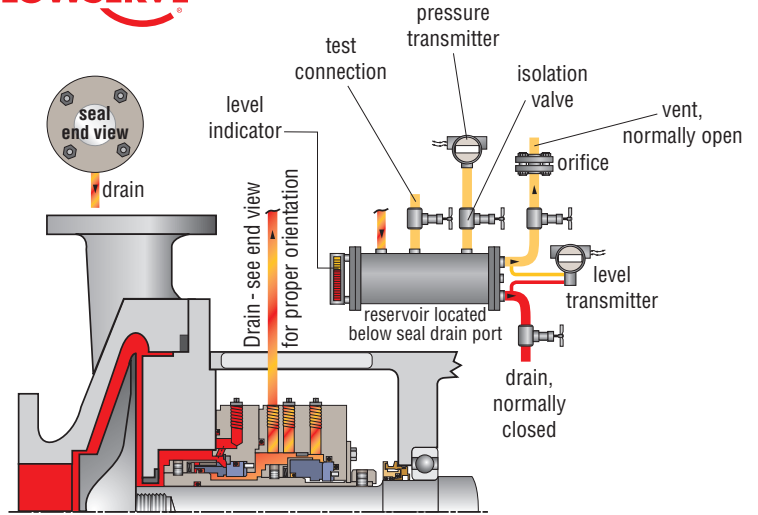
Plan 75



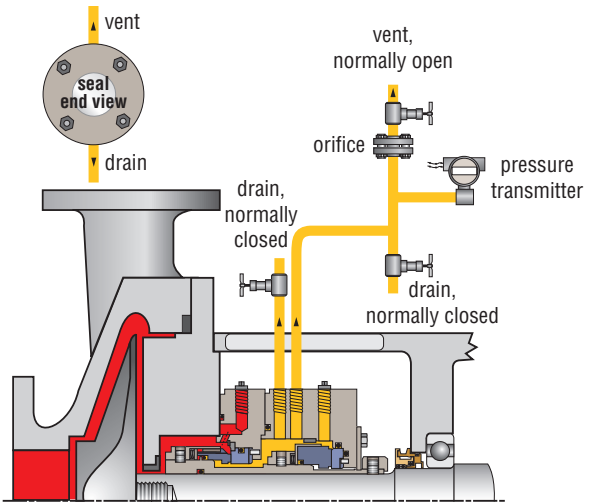
What
Drain from containment seal cavity to liquid collector and vapor recovery.

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.

Plan 76


vent
seal
end view
drain
vent,
normally open
orifice
pressure
transmitter
drain,
normally
closed
drain,
normally closed

Plan 76

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.

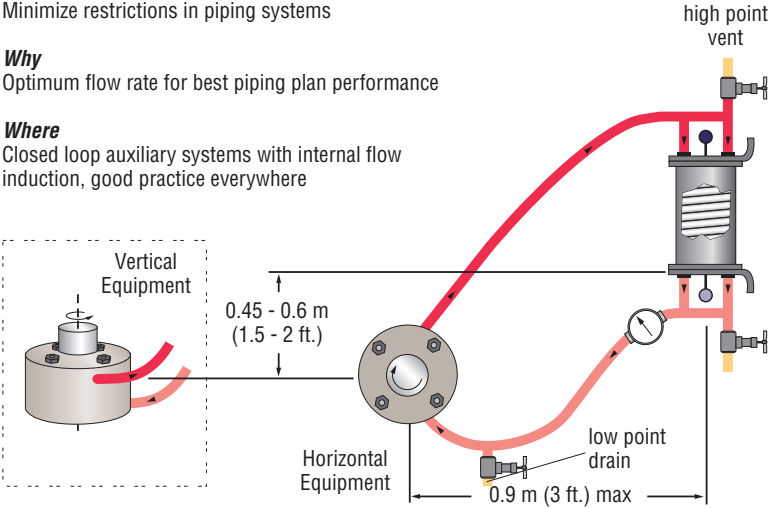
Preventative Maintenance
Continuously vent to low pressure vapor recovery/flare system.
Vent piping should include a condensate drain.
Primary seal leakage is indicated by increased vent pressure.
Monitor regularly for valve settings, blocked lines, and low vent pressure.

Single Seals - Plan 23 shown

What
Minimize restrictions in piping systems

Why
Optimum flow rate for best piping plan performance

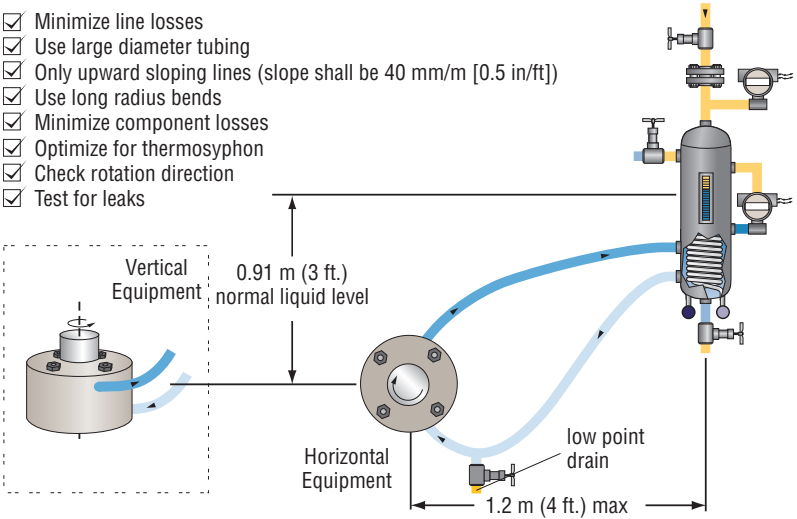
Where
Closed loop auxiliary systems with internal flow induction, good practice everywhere



Good Piping Practices

- ☑ 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

Dual Seals - Plan 53A shown



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Airfin Coolers

Forced air or natural convection seal coolers

Plans 21, 23 & 41

NX 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 52 & 53A

Bladder Accumulator	Piston Accumulator	Circulator	Gas Barrier Control Panel
Externally charged reservoir for dual seals	Hydraulically charged reservoir for dual seals	Standalone dual seal support system	Complete control system for dual gas seals
			
Plan 53B	Plan 53C	Plans 54	Plans 72 & 74

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Seal Gard I & II	Orifice	Magnetic Separator	Cyclone Separator
Combination flush flow regulator and meter	Plug and plate style flush line orifices	Iron particle separator for seal flush	Solid particle separator used in dirty flush stream
			
Plan 32	Plans 11, 13, 14, & 21	Plan 23	Plans 31 & 41

Refill Cart

Mobile cart to manually fill liquid reservoirs

Plan 52 & 53

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

Bearing isolators

Notes

Notes

Notes

Notes

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