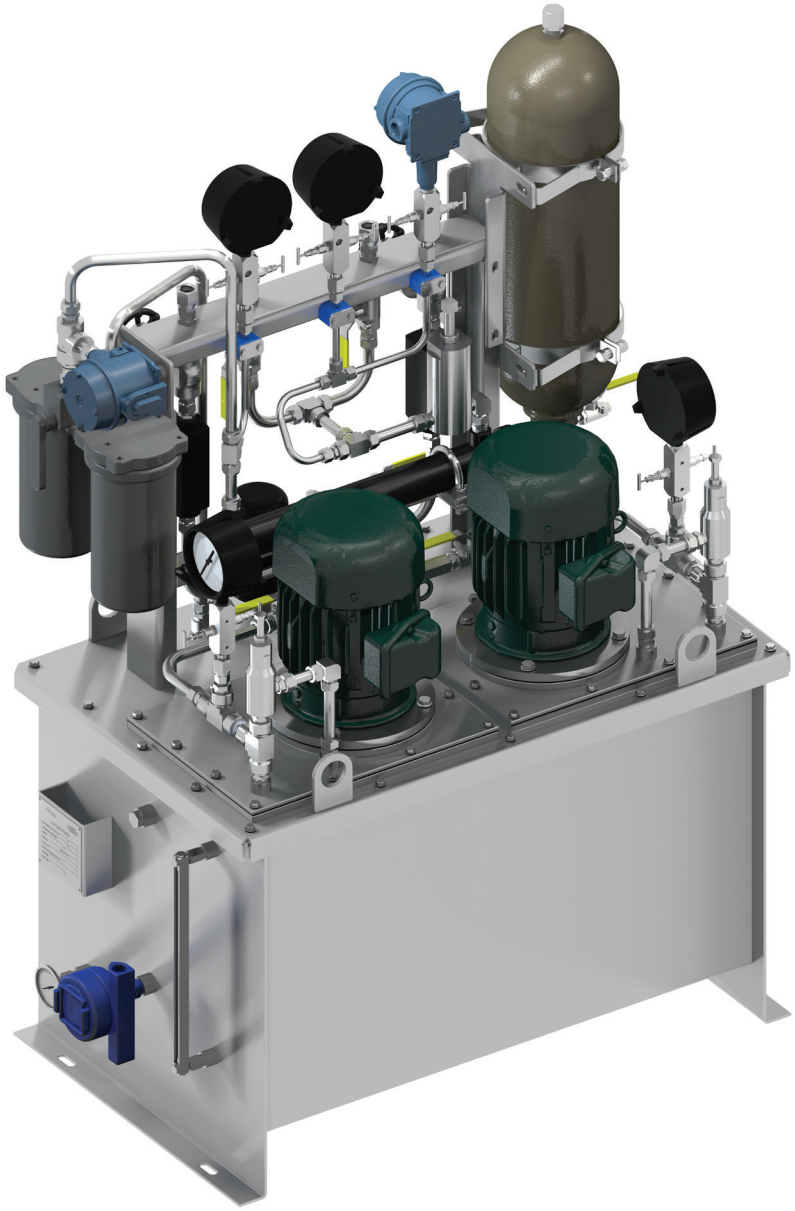
FLOWSERVE

USER INSTRUCTIONS

Installation
Operation
Maintenance

R54



Experience In Motion

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1. INTRODUCTION

1.1. About this manual

This manual provides information for the installation, operation, and recommended maintenance of the seal auxiliary system describe herein. It is intended for use by qualified personnel, trained and experienced with the seal auxiliary system and all associated equipment.

Operating features and some optional equipment covered here may not be included on every system. Refer to the detailed system drawing in the appendix to determine the exact system configuration.

1.2. How to use this manual

Before unpacking the equipment, fully read and understand the content of this manual and any referenced material. If any questions arise, contact your local Flowserve representative for assistance.

Use this manual to inspect the system upon delivery and ensure proper installation, operation, and maintenance. Refer to this manual and any application specific information from the system drawings attached when contacting Flowserve.

1.3. Other supplied documentation

The appendix of this manual includes system drawings such as Piping & Instrumentation Diagram (P&ID), General Arrangement (GA), Bill of Materials (BOM), Wiring Diagrams, and sub-component manuals. These documents are considered an integral part of this document and the information within must be followed.

1.4. Conformity with norms and directives

The seal auxiliary system conforms to the following norms and directives (as applicable):

- ASME B31.3
- ASME BPVC Section VIII Div. 1
- PED (2014/68/EU)

1.5. Use of Signal Words and Safety Alerts

The use of Signal Words and Safety Alerts are presented in this manual to alert personnel to potentially dangerous situations. Additionally, Notices are placed throughout the documents to communicate important information required for the successful operation of the system. These alerts (from the least severe to the most severe) are:

NOTICE: Indicates information considered important, but not hazard-related.

⚠	***CAUTION*** Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

⚠	***WARNING*** Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠	***DANGER*** Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

The above signal words and safety alerts are shown in their generic form. Specific alert symbols may be used to communicate the nature of the alert and the text will convey a concise message that includes the type of hazard, the consequence of not avoiding it, and direction for how to avoid the hazard.

2. SAFETY

The R54 has been manufactured to generally accepted engineering standards. There is still, however, a risk of personal injury or property damage if this chapter and the safety instructions in this documentation are not observed.

NOTICE: Read this documentation completely and thoroughly before working with the R54.

All operating and maintenance tasks need to be carried out in compliance with Health, Safety and Environmental (HSE) requirements as specified by company, local, government and regulatory agencies. Applicable HSE requirements may include the following:

- Equipment hazard reviews
- Hot work permits
- Personal Protective Equipment (PPE) requirements
- Lockout/Tagout procedures
- Handling and disposal of liquids and contaminants
- Incident reporting and investigation procedures
- Management of Change

2.1. R54 Hazards

An R54 seal system is designed to provide conditioned and pressurized fluid to a mechanical seal. The following hazards may be present:

- High pressure
- Electrical Shock
- Explosion
- Dangerous chemicals/process contamination
- High Temperature (hot surfaces)
- Pressurized Nitrogen (N2) in the accumulator
- Dangerous moving parts

2.2. Personal Protective Equipment (PPE)

At all times, when working at or in the vicinity of the system, observe the following minimum requirements for personnel.

The specific installation may require additional PPE.

- Hearing protection
- Respirator

2.3. General safety

When installing, operating, and maintaining the system, pay particular attention to safety:

- Obey all applicable safety laws and regulations.
- Obey all Plant regulations.
- Make sure that only trained and qualified personnel work on the system. Refer to section 2.4.
- Read and understand each part of this manual.
- Follow the installation, maintenance, and operating procedures exactly.
- Wear the relevant Personal Protective Equipment (PPE). Refer to section 2.2
- Never work alone.
- Make sure that adequate safety equipment is installed in and around the work area: first aid kits, safety showers (if applicable), fire extinguishers, escape routes, shut off valves, etc.
- Make sure that personnel are fully trained on how to use the safety equipment. A qualified first aid specialist must always be available for each shift.
- Read the Plant requirements for handling hazardous materials
- Check MSDS for relevant information

2.4. Trained and qualified personnel

Qualified personnel are people who have been authorized by those responsible for the safety of the Plant to perform the necessary work, and who can recognize and avoid possible dangers. The following aspects determine the qualification of personnel:

- Appropriate training
- Relevant experience
- Knowledge of relevant standards and specifications
- Knowledge of accident prevention regulations
- Knowledge of plant regulations and operating conditions

3. ENVIRONMENTAL CONSIDERATIONS

CAUTION
You are required by law to dispose of waste products and end of life equipment, according to local regulations.

3.1. Disposing of waste products

Any waste products resulting from the use or maintenance of the seal auxiliary system must be disposed of according to local environment laws and regulations.

3.2. End of life equipment

WARNING
DANGER CHEMICALS: Dangerous chemical might be released during removal of the system. Wear Personal Protective Equipment (PPE). Follow all safety regulations and Plant regulations.

WARNING
HIGH PRESSURE: High pressure might be stored in the system. Before removing or re-installing the system, make sure the entire system has been de-pressurized (and drained if required).

NOTICE: End of life equipment must be disposed of according to local environment laws and regulations.

4. DESIGN OVERVIEW

4.1. Purpose of the R54

The R54 is an independent hydraulic system designed to provide cool, clean, pressurized fluid to dual mechanical seals. The fluid circulating through the system provides a controlled environment for the reliable operation of the mechanical seal which lubricates the seal faces, cools the fluid and acts as a barrier between the process fluid and the environment (Barrier Fluid).

For successful operation of the R54, the barrier fluid pressure is required to always be greater than the pump seal chamber pressure. This positive differential pressure results in a small leakage of barrier fluid across the in-board seal face into the process and across the out-board seal face (typically to atmosphere).

4.2. Functional Description of the R54

The R54 is a packaged system consisting of various subsystems, as shown below, to support one or two mechanical seals. Variations of each subsystem are available.

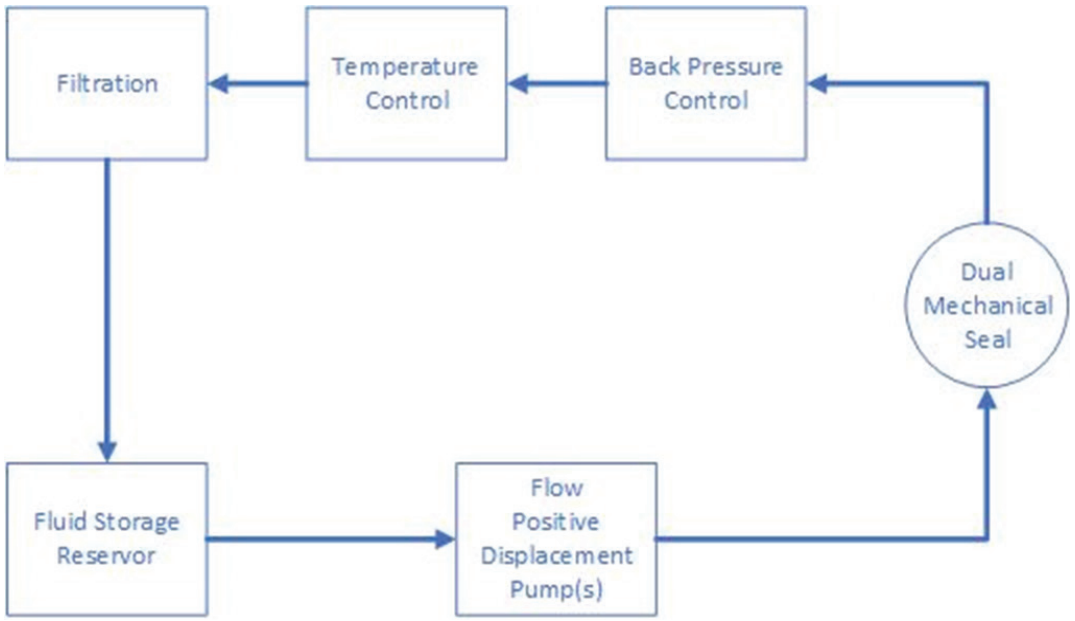


Figure 1 – R54 Sub Systems

4.2.1. Barrier Fluid

The Barrier fluid is an integral component of a R54 seal system. The circulating fluid not only serves the function of lubricating the seal faces but also must provide lubrication to the R54 pumps. It is important to maintain the fluid viscosity to provide adequate lubrication. The R54 is intended to operate with oil-based barrier fluids only. The following Flowserve products or equivalents are recommended.

Barrier Fluid	*ISO Viscosity Grade*	*Viscosity ASTM D-445*
DuraClear 5, DC-5-F	ISO VG 5	5.1 cSt @ 40°C 1.7 cSt @ 100°C
DuraClear 32, DC-32-F	ISO VG 32	31.4 cSt @ 40°C 6.0 cSt @ 100°C
A viscosity as high as 95 cSt is acceptable for a short period (i.e. Startup)		

Table 1 – Recommended Barrier Fluids

Consult with Flowserve for assistance with barrier fluid selection. The final selection of the barrier fluid depends upon many different factors and ultimately the system owner has the responsibility to approve the final selection.

4.2.2. Barrier Fluid Storage Reservoir

The R54 reservoir's purpose is to hold a volume of fluid, transfer heat from the system, allow solid contaminants to settle and facilitate the release of air and moisture from the fluid. The volume provides ample barrier fluid to circulate through the seal and make up for many months of run time at normal seal consumption.

Reservoir Level	*Volume*	*Unit*
Minimum Operating	26 (100)	Gallon (liter)
Maximum Operating	80 (300)	Gallon (liter)
Usable	54 (200)	Gallon (liter)
Total Fill Volume	80 (300)	Gallon (liter)

Table 2 – Reservoir Volumes

Reservoir includes features to provide additional function to enhance the operations of the system. The standard reservoir supports the following features:

Feature	*Function*
Level Gauge	Provides visual indication of the fluid level.
Fill Cap	Easily removable, non-vented cap, for adding fluid to the reservoir.
Desiccant Breather	Provides a vent to prevent any pressure or vacuum build up and removes particles and moisture from the air entering the reservoir.
Temperature Indicator	Indicated the bulk fluid temperature within the reservoir.
Low Level Switch	Provides a remote alarm to signal when the reservoir level has fallen below the minimum operating level requiring fluid be added.
High Level Switch (Optional)	Provides a remote alarm to signal when the reservoir level has risen above the maximum operating level.
Level Transmitter (Optional)	Provides a 4 -20 mA remote alarm to signal when the reservoir level has risen above or fallen below the maximum and minimum operating level respectively.

Table 3 – Reservoir Features

4.2.3. Pump(s)

The base package includes a single pump. This fixed positive displacement pump determines the R54 flow rate. Two flow rate options are available.

Pump Capacity (nominal)	*Flow Rate*	*Unit*
Low Flow Option	4 (15)	GPM (l/min)
High Flow Option	8 (30)	GPM (l/min)

Table 4 – Pump Capacity

The actual pump capacity will depend on the application conditions. The chosen barrier fluid, operating temperature, and operating pressure will influence the volumetric efficiency of the pump and therefore the actual flow produced.

Each pump is equipped with the following:

- Back Pressure Valve
- Check Valve
- Isolation valve
- Pressure indicator

Optional Equipment:

Dual pumps and motors allow one pump to be running while the other is either on stand-by or removed for maintenance. Both pumps can be run at the same time during change over from one pump to the other to prevent loss of barrier fluid pressure and flow.

4.2.4. Flow meters

Optional equipment

When this option in included, indicating flow meters are installed on each seal supply line. They show the barrier fluid flow rate to the seal and help determine the status and health of the R54.

Flow Indication Range	*Flow Rate*	*Unit*
Flow Rate per Seal	1-10	GPM

Table 5 – Flow Indication Range

4.2.5. Back Pressure Monitor and Control

The barrier fluid pressure on the seal is controlled by an adjustable self-actuated back pressure regulator located in the return line.

The pressure set point of the regulator is read on the pressure indicator installed near the regulator.

The pressure switch provides a dry contact for a remote alarm to signal if the barrier fluid pressure is below the minimum operating pressure. When the switch is in the alarm state the differential pressure across the primary faces of the mechanical seal is below an acceptable level or possibly reversed. This poses a risk of damaging the seal and/or contaminating the R54.

Flow Indication Range	*Flow Rate*	*Unit*
Back Pressure Regulator	25-120 (1.7 – 8.3)	PSIG (BAR)
Back Pressure Regulator	120-450 (8.3 – 31.0)	PSIG (BAR)
Pressure Indicator	0 – 600 (0 – 40)	PSIG (BAR)
Pressure Switch (Single SPDT)	20-500 6-22 Dead band	PSIG
Pressure Transmitter	-14.5 to 800 (-1.0 to 55)	PSIG (BARG)

Table 6 – Pressure Monitor and Control Ranges

The pressure regulator and switch will be adjusted during the initial startup procedure. Guidelines for their setting are as follows:

- Back Pressure Regulator Set Point = Seal Chamber Pressure + 50 psig
- Pressure Switch Set Point = Seal Chamber Pressure + 20 psig

The values listed in Table 6 represent the adjustable spring range of the regulator. The pressure at the seal will be different and vary by application. Many variables, including piping length, flow rate, temperature, and fluid type effect this difference. Do not plan to operate at the extremes. If in doubt, contact your Flowserve representative for assistance.

NOTICE: It is the Owners responsibility to determine and take the appropriate action whenever a low-pressure alarm is indicated.

4.2.6. Temperature Monitor and Control

Significant heat can be added to the barrier fluid as it cools the seal. This heat, and any heat generated by the Plan 54 itself, must be removed from the system. Cooling the barrier fluid is accomplished with a water-cooled shell & tube style heat exchanger.

A dual setpoint temperature switch provides 2 independent SPDT contacts. The individual microswitches may be set to activate at different temperatures. This configuration allows the owner to implement a variety of temperature alarm or control scenarios.

Flowserve recommends that the dual setpoint temperature switch be used for indicating High temperature alarms at temperature listed in Section 9.2.

The front microswitch provides a dry contact for a remote alarm to signal that the barrier fluid temperature is above the normal range. When the switch is in the alarm state cooling is required. This could be used to open a water control valve.

The rear microswitch provides a dry contact for a remote alarm to signal that the barrier fluid temperature is above the maximum operating temperature. When the switch is in the alarm state could indicate:

- insufficient cooling water flow
- low water pressure
- fouling of the heat exchanger
- High cooling water temperature

NOTICE: The front (low) microswitch should never be set higher than the rear (high) microswitch. Refer to the manufacture's instruction manual.

NOTICE: It is the Owners responsibility to determine and take the appropriate action whenever a high-temperature alarm is indicated.

The heat exchanger is sized to maintain the barrier fluid temperature within the normal range

Temperature Control	*Temperature*	*Unit*
Normal Fluid Temperature Maximum Fluid Temperature	120 - 140 (49 - 60) 180 (82)	°F (°C)
Temperature Indicator	0 - 200 (-18 to 93)	°F (°C)
Temperature Switch (Dual SPDT)	0-225 (-18 to 107)	°F (°C)
Temperature Transmitter	-40 to 250 (-40 to 121)	°F (°C)

Table 7 – Temperature Control Range

4.2.7. Filtration

A duplex filter housing with an integral continuous flow transfer valve is installed in the system. The duplex arrangement provides continuous filtration and uninterrupted flow when either element is being replaced. An arrow cast into the valve handle indicate which element is in use.

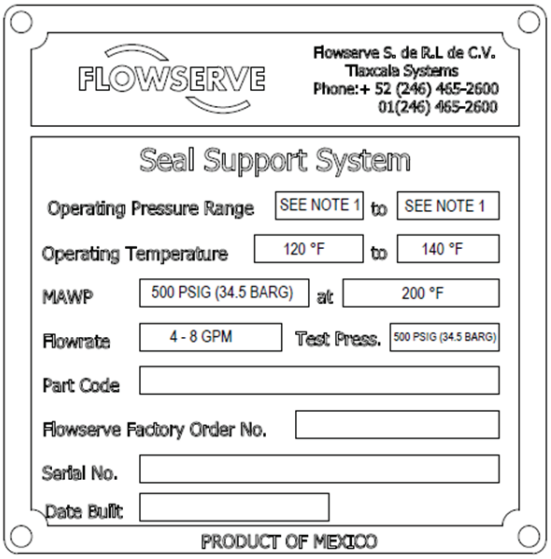
These filters remove small particulate debris and contamination from the seal oil. Each of the filter element can flow the maximum expected flow rate through the system.

A gauge pressure indicator located just upstream of the filter indicates the differential pressure across the element and provides an indication when the element needs to be replaced.

Filter	*Pressure*	*Unit*
Differential Pressure - Clean	<5 (< 0.34)	PSID (BARD)
Differential Pressure - Dirty	20 (1.38)	PSIG (BARD)
Filtration Efficiency	10 (nominal)	µm

Table 8 – Filter

4.3. Identifying the product (nameplate)



R54 Product Offerings

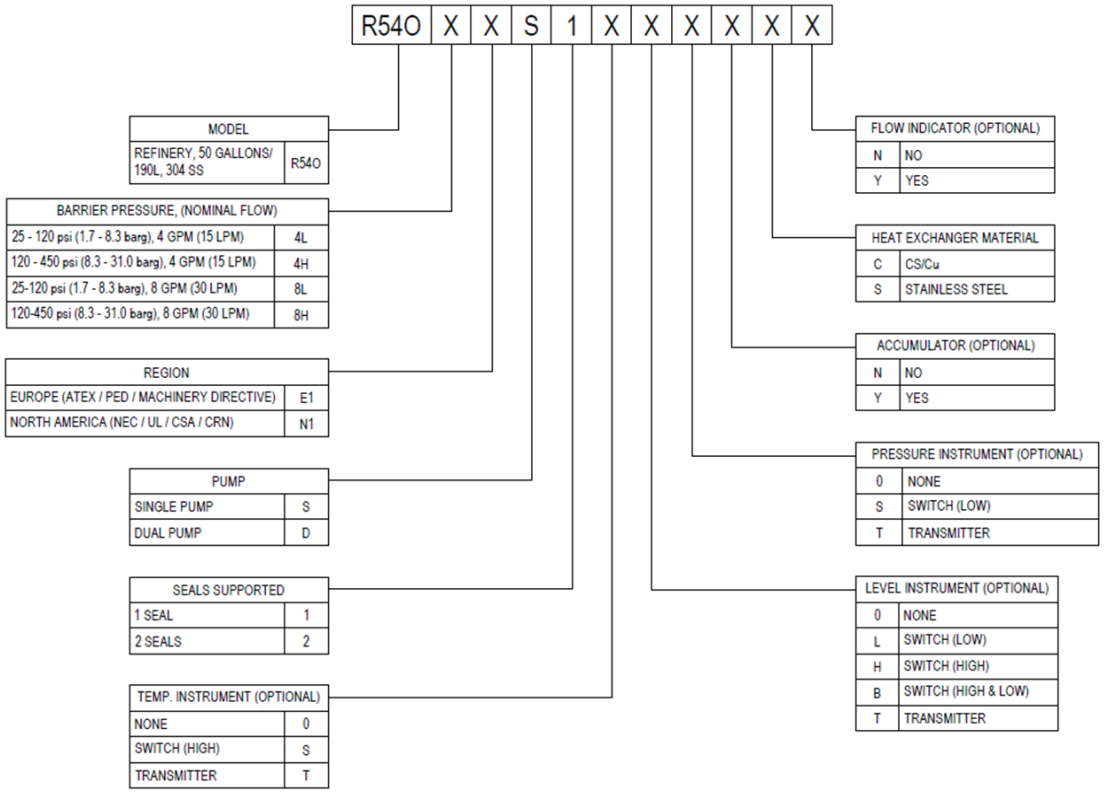


Table 9 – Part Number

5. TRANSPORT AND STORAGE REQUIREMENTS

5.1. Receiving and Unpacking

The R54 has been carefully prepared for shipment to protect and preserve it during transportation. The system requires careful handling and storage to ensure reliable operation.

The R54 and related equipment must be transported and stored in the original, unopened shipping container. Upon receiving the system, the user is responsible for inspecting the container for any signs of damage and for determining the status of any shipping damage indicator devices. If the container or any tattletale indicators show damage, the container should be opened for further inspected. An inspection by Flowserve or its appointed representative is strongly advised.

If the container is opened for inspection or other purpose and the system will not be immediately installed, the system must be repackaged and resealed in a manor equivalent to the original packing.

In addition to the original factory protective packaging, several preservation steps have been taken.

- Residual barrier fluid from the factory performance test remains in the system.
- All opening into the system have been blinded or plugged.
- All conduit connections to instruments are plugged.
- The nitrogen pre-charge pressure has been reduced to safe for shipping. Typically, less than 25 psig (1.7 barg).

While the original shipping container is suitable to protect the system from damage due to normal handling, it is not designed to protect from handling abuse or poor storage conditions. The system must be stored in a clean, dry, stable environment. In the original shipping container, the system may be stored for up to 3 months under the following environmental guidelines:

- Indoor storage only
- Temperature range 4°C to 37°C (40°F to 100°F). Avoid large fluctuations.
- Low humidity, less than 65% RH
- Atmosphere free from rain, dust, steam, chemicals, oils, radiation, and ozone
- Storage surface free from impact and vibrations
- No threat of water reaching above container bottom support (typically 3 ½ inches)
- No storage in the vicinity of where steel is processed or other dust/grit raising activities such as sandblasting are performed

Reference FIS222eng - Flowserve Mechanical Seal and Seal Support System Storage.

If system needs to be stored for an extended period before installation or commissioning, a specific inspection and maintenance schedule must be implemented. Contact your Flowserve representative for assistance.

Once the maximum storage time has elapsed, it is recommended that you have the system inspected by a Flowserve representative.

6. INSTALLATION

6.1. Introduction

Before installing the system, make sure you have read and understood the Installation requirements in this section. If you have any questions regarding the installation of your system, contact your local Flowserve representative.

6.2. Installation requirements

The following sections outline the scope of the R54 installation and the items to be prepared for installation.

NOTICE: Any design, construction, or materials required by Section 6.2 are the Owners responsibility.

6.2.1. Safety considerations

The preferred location on the R54 installation is as close as practical to the seal(s) being served and at a similar elevation. In all cases, ensure there is sufficient allowances for:

- Evacuation of the Plant in case of an emergency. Do not block walkways or impede emergency egress.
- Reliable operation of the system. Do not install the system near sources of excessive heat, vibration, or particulates.
- Safe operation and maintenance of the system. Ensure there is adequate clearances are maintained to allow safe access to and around the equipment.
- Hazardous Areas. Ensure that all equipment and installation methods meet or exceed the hazardous area requirements.

	DANGER RISK OF EXPLOSION: If the system is being installed in a hazardous area, there could be an explosion risk. Make sure all instrumentation has the adequate explosion protection.

If the system is being installed in a confined area, make sure there is adequate ventilation.

	DANGER SUFFOCATION HAZARD: Breathing N2 in a confined space can result in sudden unconsciousness or death. Take extra care when working in confined areas.

Adequate ventilation is required for:

- Safe filling of the accumulator with Nitrogen (N2).
- Correct cooling of the system.

6.2.2. Foundation

The R54 requires a firm stable foundation. Either steel base or concrete pad. The foundation should be flat and level, with anchor bolts set firmly in place. If a steel baseplate is used, it shall have sufficient rigidity to prevent distorting or movement of the system after it is bolted down.

NOTICE: The design and construction of the foundations is the Owners responsibility.

6.2.3. Interconnecting Piping - Barrier Fluid

The R54 requires piping to be installed to and from the mechanical seal.

1. From the Seal Supply connection on the R54 to the Barrier In (BI) connection on the seal gland.
2. From the Barrier Out (BO) connection on the seal gland to the Seal Return connection on the R54.

Figure 2 - Minimum Barrier Fluid Piping

General guidelines for the design and installation of this barrier fluid piping should be followed to minimize pressure losses.

- Pipe or tubbing is acceptable.
- Stainless steel is preferred.
- Choose a size and wall thickness to meet the application requirements.
- Design goal should be to limit the fluid velocity to 7-10 ft/sec and limit the total equivalent length so the frictional loses do not exceed 10% of the normal operating pressure.
- The preferred size is either.
- ¾"x 0.095" tubing
- ¾" schedule 80 pipe (NPS).
- Minimize the number flow restrictive components such as fittings, valves.
- Keep the total pipe length and number of bends to a minimum.
- Smooth, large radius bends are preferred over elbows, tees, and other restrictive fittings.
- Pipe runs should be sloped continuously up or down to allow for good draining.
- The pipes must be clean and free of burrs.
- Do not use Teflon tape on threaded connections. Loctite 577 thread sealant or a similar product is preferred.

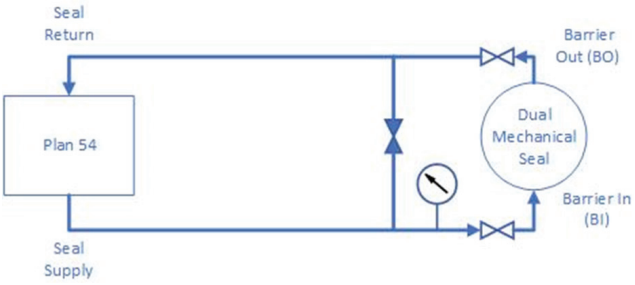


Figure 3: Recommended Barrier Fluid Piping

NOTICE: If isolation valves are part of the interconnecting piping, these valves shall be full bore and "locked open" during operation.

6.2.4. Interconnecting Piping - Cooling Water

The R54 requires piping to be installed in and out the heat exchanger.

1. From the plant cooling water source to the R54 heat exchanger connection (CWI).
2. From the heat exchange connection (CWO) to the plant cooling water return.

General guidelines for the design and installation of the cooling water piping should be the same as for the barrier fluid piping.

The minimum recommended cooling water piping is shown in Figure 4.

Figure 4: Minimum Cooling Water Piping

The recommended piping should include a valve for back flushing and a relief valve to protect the cooling system from over pressurization as shown in Figure 5.

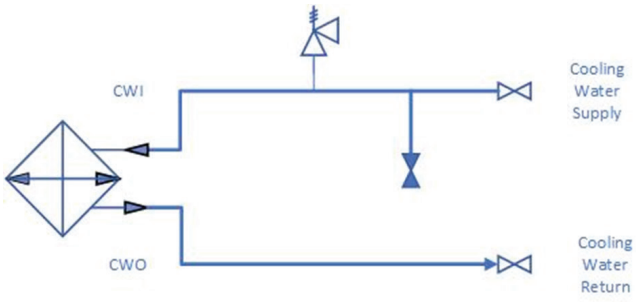


Figure 5: Recommended Cooling Water Piping

NOTICE: It is the Owners responsibility to protect the R54 and cooling water system over pressurization and freezing.

6.2.5. Power Wiring

The R54 is equipped with an

- Electric motor driver for the main pump
- Optional electric motor driver for the auxiliary pump

6.2.6. Instrument Wiring

The R54 is equipped with the following electrical instruments that must be wired to the owners DCS

- Level Switch – Low
- Level Switch – High (Optional)
- Pressure Switch – Low
- Temperature Switch - High

6.3. Installation procedure

Use the following step-by-step procedure to install or reinstall the system.

1. Before installing the system, inspect all components for damage. If any of the components are damaged, it shall be reported to the Flowserve representative.
2. Use an appropriate lifting device and set the system on the foundation. Secure in place with anchored bolts.

NOTICE: It is the Owners responsibility to mount the system securely to its prepared foundation.

3. Manufacture the interconnection piping as describe in Section 6.2.
4. Flush the interconnection piping prior to installation.
5. Wire the electric motors.
6. Wire the provided instrumentation.
7. Make sure the installation is correctly grounded
8. Make a final check to ensure that the unit has been properly connected according to the system schematic.

7. OPERATION

7.1. Initial Start-up

Use the following procedure to prepare the R54 for operation under these conditions:

- Initial start-up
- Return to service after maintenance
- Return to service after being idle for more than 30 days

NOTICE: It is important to circulate the barrier fluid and purge all air from the system components and piping before applying significant pressure.

1. Fill the system with Barrier fluid to a level greater than the minimum operating level. Filling to the maximum operating level is preferred.
2. The pressure limiting valve(s) have been factory set to the design pressure of the Plan 54 and should not require any adjustment. It must not be set to a higher value. However, if the factory setting is determined to inappropriate for the application an adjustment is necessary. The preferred method is to remove the valve from the system and set it independently.
3. If possible, install a temporary strainer in the return line to filter the fluid as it returns to the tank. This will protect the system from any construction debris in the interconnecting piping.
4. Ensure that all block valves are set per the P&ID. All gauge block valves should be open, and vent valves should be closed.

5. If the interconnecting piping was installed as show in Figure 3, bypass each seal serviced by this system. This will reduce any construction debris from entering the seal.
6. Confirm proper pump rotation by jogging the main motor. Refer to markings on the motor for correct direction.
7. If the system has been out of service for more than 30 days it is likely that the pump(s) have not retained a quality oil film on the internal parts. It is recommended that they be primed to ensure an easy start with minimum wear. To prime the pump, remove the discharge pressure gauge and gauge valve and fill the piping with barrier fluid. Approximate 250 ml is sufficient.
8. Start the pump and allow the system to run for about 30 minutes to allow the system to stabilize and purge any air. Open the instrument bleed valves to purge air any trapped air.
9. It is likely that a significant volume of barrier fluid will be required to fill the components and piping. If at any time the fluid level reached the minimum operating level, add additional fluid.
10. Fill the auxiliary filter with fluid by slowly switch the filter change over valve.
11. If equipped, repeat steps 6) through 9) of this procedure for the auxiliary pump. It is acceptable to start the auxiliary pump prior to shutting off the main pump.
12. With normal flow establish from either the main or auxiliary pump, set the back pressure to the required value. A single back pressure regulator controls the pressure on each seal and was factory set to its minimum setting. It must now be set to the value required by the seal, 25-50 psi (2-4 barg) above the seal chamber pressure. Slowly increase the pressure by turning the adjusting screw clockwise until the pressure on the seal reaches the designed value.
13. If the seal(s) were bypassed in Step 5) switch the valve to flow through the seal(s). If the system includes two seal supply lines, each is equipped with a globe valve. These globe valves should normally be fully open. Their function is to balance the available flow between each seal and not to restrict the flow to any specific value. Restricting the flow from the positive displacement pump will cause an unnecessary rise in pressure and potentially bypass through the pressure limiting valve.
14. Once the barrier pressure has been set, lock the adjustment screw using a wrench.
15. At this point the system is operational. Follow the Normal Start-up steps in section 7.2 to place the system into service.

7.2. Normal Start-up

Use this procedure to start the system.

NOTICE: Startup and pressurization of the seal must precede pressurization of the pumps.

1. Verify that the temperature of the oil in the tank is at 65 °F.
2. Start the main or auxiliary pump. After a few minutes the flow and pressure at each seal should stabilize.
3. Verify the barrier fluid pressure and flow match the expected values.
4. Verify the outlet temperature of the heat exchanger. The oil temperature will be less than normal until the pump seals are in operation.
5. Verify that the normal filter element differential is less than 15 psi. Switch housings and replace elements if necessary.
6. After all pump seals are in operation, verify that the temperature downstream of the cooler is normal and stable as per the P&ID.
   a. If the temperature is higher than anticipated, verify the operation of the heat exchanger by ensuring cooling water is being supplied.

7.3. Operating

During Normal operation the R54 will provide barrier fluid to the seal(s) at a steady pressure, flow rate, and temperature. Monitoring and recording specific information can provide valuable data on the operation and assist in troubleshooting in the event a malfunction.

To ensure long term operation, manually log the operating conditions listed below and note any variation from previous days. On a daily basis, log the following information:

- Fluid level (LG-101)
- Bulk Fluid Temperature (TI-101)
- Pump Discharge pressure (PI-100 and/or PI-101)
- Flow rate to each seal (FI-200 and/or FI-300) (Optional Equipment)
- Barrier fluid pressure (PI-102)
- Filter Pressure (PI-103)

The following instruments should be monitored continuously through the owners DCS or similar system where each instrument can provide immediate notification of an abnormal condition.

- Barrier Fluid Level (LS-101)
- Barrier Fluid Pressure (PS-100)
- Barrier Fluid Temperature (TS-101)

7.4. Shut down

Use the following procedure to remove the R54 from operation.

NOTICE: It is the owner's responsibility to ensure that the process pump(s) being supported by the R54 are safely shutdown, isolated, and depressurized to atmospheric pressure prior to shutting down the R54

NOTICE: It is the owner's responsibility to ensure that any alarms that might be trigger when shutting down the R54 are safely managed.

1. Shutdown, isolate, and depressurize to atmospheric pressure the process pump(s) being supported by the R54. Ensure that the seal chamber pressure does not exceed the barrier fluid pressure at any time during the shut-down
2. Stop the active circulating pump, main or auxiliary.
3. Ensure that the R54 is isolated from other equipment that may create a hazard.
4. Ensure that the lock-out/tag-out of the R54 is complete.
5. Prior to servicing any component, ensure that there is no stored energy in the accumulator and temperatures are at ambient conditions.

	***WARNING*** HIGH PRESSURE: The cooling water circuit of the R54 system is not protected against overpressure. If the return line is closed, a water line could burst. Make sure a pressure relief valve is installed in the cooling water circuit.

	***WARNING*** HOT SURFACES: The system and surrounding surfaces might be hot. Take care when touching components. Wear the appropriate Personnel Protection Equipment (PPE), according to plant regulations.

	***WARNING*** DANGER CHEMICALS: Dangerous chemical might be released during removal of the system. Wear Personal Protective Equipment (PPE). Follow all safety regulations and Plant regulations.

8. MAINTENANCE

8.1. Introduction

Proper maintenance is critical to ensuring that the R54 system fulfils its required function. Maintenance must be done at regular intervals and should be part of the facility's overall maintenance plan. The following paragraphs provide important maintenance requirements for the R54 system. Addition information on the major components can be found within the supplied vendor documentation.

8.2. Barrier Fluid

The quality of the barrier fluid can greatly affect the performance and life of the mechanical seal system. The fluid not only provides lubrication and cooling for the seal but for all components on the R54 system.

The service life of the barrier fluid can vary dramatically in different applications. In general, fluids operating at high temperatures will have a shorter life than fluid operating at lower temperatures. When operating the R54 within the conditions outline in Section 4.2 it is recommended that periodic fluid sampling and analysis should be performed.

Check the fluid each month for changes in the following:

- pH
- Color
- Viscosity
- Particulate Contamination
- Water Contamination
- Process Contamination

Any significant changes require a fluid change and further analysis.

8.2.1. Check barrier-fluid Level

The barrier fluid level in the reservoir must be maintained between the minimum and maximum parting levels as indicated on the level gauge. Operating the system below the minimum level risk damage to the system and seal.

During normal operation, the mechanical seal will consume barrier fluid an a very low rate. However, over time this will result in a falling liquid level in the reservoir. A low-level alarm will be indicated by the level switch when it falls to the minimum acceptable level. Immediate action is required to replenish the reservoir level. It is not necessary to wait for an alarm before refilling. It is recommended that the level be checked and replenished as required monthly.

8.2.1.1. Adding barrier-fluid

Safety is the primary concern when performing this function. In some instances, the system will need to be refilled while in operation.

- Use only new fluid from a clean container.
- Ensure that the area around the fill port is clear of debris.
- Remove the fill cap.
- Add barrier fluid by simply pouring the fluid through the open fill port.
- Fill to the Maximum level as indicated on the level gauge. (typically, approximately 1" below the top of the gauge).
- Close the fill cap.

8.2.1.2. Changing barrier-fluid

- Shut down the entire system and ensure barrier fluid is at room temperature.
- Drain the oil from the tank.
- Follow the procedures in 8.2.1.1 for adding barrier fluid to the tank.

8.3. Accumulator (Optional)

When the optional hydraulic accumulator is installed in the systems it will help absorb pressure spikes that may occur when changing from the main to auxiliary pumps, smooth out pulsations from the pump, and store energy during a brief power loss. To provide these functions, the accumulator must be pre-charged with nitrogen to the proper pressure.

For detail instructions on safety, pre-charging, and checking the accumulator pre-charge pressure refer to the following document located in the Appendix.

Parker Hannifin Corporation Pre-Charging Instructions HY10-1632-M2.2/US

The following additional guidelines apply.

- The accumulator is shipped with only a minimum pre-charge only required to maintain the bladder shape. Use dry nitrogen only to pre-charge the accumulator.
- Use the charging assembly recommended in accumulator manufacturers manual.
- The accumulator must be hydraulicly isolated from the system and drained
- Set the nitrogen pressure to 80%-90% of the normal operating pressure.
- After charging, check the charging valve for leaks using snoop or soap water.
- Tighten the protective cap on the gas valve stem to hand tight.

Check the nitrogen pre-charge pressure periodically. This must be done after all the hydraulic system pressure is removed. The pre-charge must be checked after one week of operation, and then every six months during normal operation.

8.4. Filters

The filter is the primary component used to keep the barrier fluid free of particulate contamination. The life of the filter can be checked by observing the differential pressure. This pressure should be checked daily, and the dirty element replace whenever it reaches its terminal differential pressure or after one full year of service, whichever occurs first.

For detail instructions on safety, replacing the filter elements, and repairing the transfer valve refer to the document located in the Appendix.

Instructions - Installing and Operating NUGENT Duplex Filters and Strainers Sizes 1R and 1S

Notice: Allowing the differential pressure to exceed it maximum rating may cause the filter elements to collapse or break apart and contaminate the seals and system.

8.5. Heat Exchanger

Required maintenance of the heat exchanger is highly dependent on the quality of cooling water. One indication of fouling will be a reduction of cooling capacity. Performance of the cooler can be judged by monitoring the bulk fluid temperature in the reservoir or by a high temperature alarm.

Normal operating temperatures should be noted and recorded on newly installed units so that any reduction in effectiveness can be detected. Any loss in efficiency, indicated by higher temperatures, can normally be traced water scale.

For maintenance and other recommendations see the manufactures document located in the appendix.

Thermal Transfer - Shell & Tube Recommendations

If the cooling water had been pipe as shown in Figure 5, the heat exchanger can be back flushed by closing the water supply and opening the vent valve. Cooling water will flow backwards through the shell of the heat exchanger and out the vent.

NOTICE: It is the owner's responsibility to properly dispose of any cooling water and debris flushed from the heat exchanger.

8.6. Level Switch

The R54 reservoir is equipped with an ultrasonic level switch to detect low liquid level. Optionally, a second ultrasonic level switch can be installed to detect high liquid level.

For detail instructions on safety, wire, operating, and servicing refer to the manufacturers document located in the Appendix.

8.7. Level Switch

An optional level transmitter can be provided in place of a Temperature Switch to provide visual confirmation of the barrier fluid oil level including providing remote monitoring and alarms.

8.8. Pressure Switch

The seal return piping on the R54 is equipped with pressure switch to detect low liquid pressure and provide an alarm to indicate the minimum operating level has been reached.

For detail instructions on safety, wire, operating, and servicing refer to the manufacturers document located in the Appendix.

8.9. Pressure Transmitter

An optional Pressure transmitter can be provided in place of a Pressure Switch to provide visual confirmation of the barrier fluid oil pressure including providing remote monitoring and alarms.

8.10. Temperature Switch

The R54 is equipped with a temperature switch located in the barrier fluid stream at the heat exchanger outlet. The switch will detect high liquid temperature and provide an alarm to indicate the maximum operating temperature has been reached.

For detail instructions on safety, wire, operating, and servicing refer to the manufacturers document located in the Appendix.

8.11. Temperature Transmitter

An optional temperature transmitter can be provided in place of a Temperature Switch to provide visual confirmation of the temperature of the oil including providing remote monitoring and alarms.

8.12. Pump

The R54 one of two different capacity positive displacement pumps.

For detail instructions on safety, operating, and servicing refer to the manufacturers document located in the Appendix.

8.13. Driver

The R54 driver is an electric motor of 3HP or 5HP, depending on the system capacity.

For detail instructions on safety, wire, operating, and servicing refer to the manufacturers document located in the Appendix.

9. ALARMS

9.2 Level Switch / Transmitter

Tank				
Tank	***Description***	***Permissive***	***Latch***	***Delay***
LT-101	Seal Oil Tank Level Switch / Transmitter	Yes	***No***	***No***

LAL - Level Alarm Low

Initiation of a Low alarm indicates the following:

- Low Barrier Fluid in tank
- Leakage within the circulator oil system
- Seal failure

The rate of drop in barrier fluid should be monitored as a more frequent than usual initiation of this alarm could indicate a failing seal.

LAH - Level Alarm High

Initiation of a high alarm indicates the following:

- Too much barrier fluid during refill
- Process fluid entering tank
- Seal failure

Tank Fill levels

Value	***Units***	***Description***
7.5 (30%)	Inches	Minimum Operating Level
22.5 (90%)	Inches	Maximum Operating Level

9.3 Temperature Switch / Transmitter

Monitoring Devices				
Tag #	***Description***	***Permissive***	***Latch***	***Delay***
TS-101	Temperature Switch / Transmitter	No	***No***	***No***

TAH – Temperature Alarm High

Initiation of a high alarm indicates the following:

- No cooling water supplied to Heat Exchanger
- Contaminated barrier oil
- Extremely low flow rate
- insufficient cooling water flow
- low water pressure
- fouling of the heat exchanger
- High cooling water temperature

High Barrier fluid temperatures at or above 180°F (82°C) damage seal compounds and cause further oil degradation.

Tag	*Normal*	*Recommended High Alarm*	*Units*
TS-101	120 °F (49 °C)	160 °F (71 °C)	Inches

Definition of Control Terms

The following abbreviations are used when describing equipment control loops:

Term	*Definition*
AUTO	The control is implemented as an automatic control loop in a PLC.
MANUAL	The control is implemented as requiring manual operator intervention
CV	The tag number of the instrument that provides the process value or feedback in the control loop.
SP	If the control loop is identified as “MANUAL”, this is the process value that requires operator intervention to achieve. If the loop is “AUTOMATIC”, this identifies either the normal set point of the controlled device, or the proposed control logic to be implemented in the PLC if more complex control is required.
PERMISSIVE	This alarm must be cleared prior to start of compressor operation
LATCH	This alarm should not be automatically cleared by the PLC/DCS and instead requires manual acknowledgement.
DELAY	Time delay, in seconds, between exceeding the alarm set point and triggering of the alarm.

10. TROUBLESHOOTING

Use the following table to troubleshoot the system. Once you have identified the problem, use the procedures in this manual to maintain the system. If you are not sure how to troubleshoot or maintain your system, please contact your local Flowserve representative.

Issue	*Common Causes*
Unable to maintain Pressure (Low Pressure)	Pressure Control Valve setting Low: The PCV may be set lower than desired. • Follow the procedure in Section 4.2.5 to adjust the pressure as required. Pressure Relief Valve setting Low: The PRV may be set lower that required and allowing fluid to bypass back to the reservoir. • The relief valves have been set and should not require any adjustment. However, if adjustment is necessary, the preferred method is to remove the relief valve from the system and set it independently. Ensure the relief valve is set to a value above the maximum barrier pressure required but below the MAWP of any instruments.
Unable to maintain Pressure (High Pressure)	Pressure Control Valve setting High: The PCV may be set lower than desired. • Follow the procedure in Section 4.2.5 to adjust the pressure as required. Poor supply and return line piping: The supply and return line piping should be sized and constructed to eliminate as much pressure loss as practical. • For interconnecting piping, use the same size as shown in P&ID. Fluid Temperature Low / Viscosity High: Low temperature can cause the barrier fluid to have a too high of viscosity, creating high pressure loss on the seal supply and return lines. • Insulate and heat trace the lines to maintain temperature. • Reduce cooling water flow rate.
Unable to maintain Flow	Low pressure relief valve setting. A low setting may allow partial flow to leak back to the reservoir. • The relief valves have been set and should not require any adjustment. However, if adjustment is necessary, the preferred method is to remove the relief valve from the system and set it independently. Ensure the relief valve is set to a value above the maximum barrier pressure required but below the MAWP of any instruments. Worn Pump: If the circulator pump wears the discharge flow rate will decrease. This will be more apparent at higher pressures. • Measure the flow rate at normal operating pressure and again at 1/2 normal operating pressure. If the flow increases more than 20% then the pump may need to be replaced. **Note**: pump wear can be accelerated by poor quality barrier fluid and/or failure to maintain system filtration and contaminant prevent ingression.
Unable to maintain Level	Low Reservoir Level. Normal seal leakage consumes barrier fluid and will cause the level to drop. • Refill the reservoir to the normal level or greater. Do not excess the High Level.
High Level Alarm	The reservoir has been overfilled. • Lower the reservoir level by draining fluid using the drain port. The seal is or has been reverse pressurized and process has entered the reservoir. • Take an oil sample and check for process contamination.
Filter Differential Pressure	

The following notes apply to the above table:

1. An indicator or alarm is used for the Indication.
2. Pressure drops should be monitored over time. If the pressure drops too fast compared to previous readings, this could be caused by one of the listed causes. Slow reduction of pressure is normal over time.

11. SPARE PARTS

- The system is designed to provide reliable operation under a wide range of operating conditions. However, repairs will be necessary when system components reach the end of their normal life expectancy or when the system has been operated outside of its design capabilities.
- All liabilities and warranties to Flowserve FSD for damage incurred through the use of non-original replacement parts and accessories will be rendered null and void.
- Please note that special manufacturing and delivery specifications exist for all parts of our products manufactured or produced by ourselves and the replacement parts are always offered in accordance with the latest technology and with the most current regulations and laws.
- Flowserve uses SPIR lists with parts to be procured at Flowserve, that can be used for exchange when defect. Contact a Flowserve representative for a SPIR list of the system.

12. APPENDIX

12.1. System logbook

Copy and use this logbook to record periodic or corrective maintenance done on your system. Use the following codes and enter remarks, the date, and your name:

Code	*Remarks*	*Date*	*Name*

Maintenance	W = weekly M = monthly Y = yearly A = adjust R = replace

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