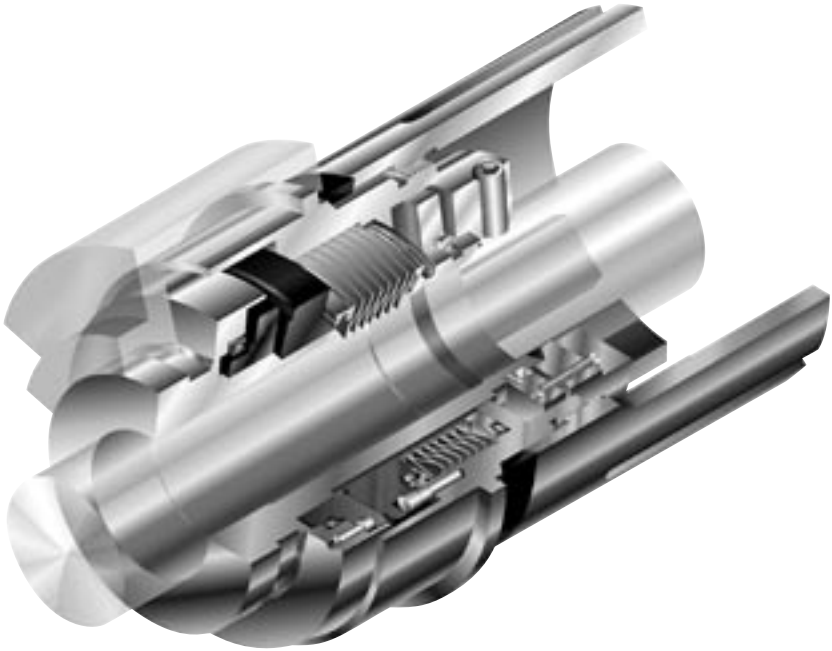
FLOWSERVE

Installation Instructions

GTS Series

Internally Mounted Steam Seal



Experience In Motion

Introduction

The GTS steam turbine seal is especially designed for operation in steam turbine applications. Successful operation relies on proper installation of the seal. These installation guidelines will cover the basic steps required to install the seal as well as additional factors to consider that will affect the installation. These steps are based on a cross section of turbines seen in actual installations and will cover all of the basics. There may be differences in your specific application.

A typical seal assembly is attached for **reference purposes only.** Refer to the job drawing for details on the actual seal assembly dimensions, correct part numbers, and the turbine configuration. The item numbers in the procedure refer to the item numbers on this typical drawing. Item numbers may differ slightly on the job assembly.

1 Tools

The GTS seal is designed around standard hardware with a minimum of tools required for installation. These include:

Needle nose pliers
5/16 Open end wrench
7/64 and 5/32 “Allen” wrenches
Set of adjustable OD spanner wrenches

2 Inspection of Steam Turbine in Operation

If possible, observe the turbine operating with the carbon rings installed prior to taking it out of service to install the GTS seals. Excessive steam leakage for carbon rings could indicate a problem with the turbine that should be addressed prior to seal installation

Investigate the following areas for excessive steam leakage:

2.1 Bad carbon rings or failed seal.

2.2 Cracked turbine case. Inspect the areas where steam leakage was present for signs of erosion, corrosion, etc.

2.3 Split line of turbine case or cover. Check for warpage that prevents effective sealing. Examine split line to see if steam leakage across the joint has eroded the case and cover.

2.4 Shaft damage, especially in the area of the carbon rings. Check the integrity of the overlay. It is possible for steam to leak beneath the overlay if improperly applied.

2.5 Check the turbine alignment. The shaft runout and the perpendicularity should meet normal pump standards. The concentricity may be much larger than that typically seen in a pump. The flange for internally mounted seals pilots on the turbine and requires a TIR < .020" for proper seal function.

Talk to the operations and maintenance personnel regarding the above concerns. Find out if there are any other issues regarding turbine reliability and performance.

3 Inspection of Steam Turbine Piping and Application of Steam Traps

Water is a problem for turbines in general, but poses some unique challenges for mechanical seals. Hot water under pressure at the OD of the seal faces will flash to form steam as it crosses to the atmospheric pressure at the ID of the faces. The expansion ratio when water is converted to steam is over 1600 to 1. This generates a large force that causes the faces to separate, resulting in high leakage. The GTS seal is robust and can recover from normal water slugs that occur during start up. However, operation in water will result in high leakage that is not generally acceptable for prolonged operation.

As a practical matter, altering the turbine piping to remove water and improve performance of the turbine and mechanical seals is not an option for most end users. However, inspecting the piping can yield useful information about potential problems that may be reduced or eliminated through the application of mechanical free float actuated steam traps.

Check your piping system for the following:

3.1 Piping should slope downward 4 inches per 30 ft (10 cm per 10 m) in the direction of steam flow to aid condensate drainage.

3.2 Piping should be straight and free from sags where condensate could collect and create a slug of water.

3.3 Eccentric reducers should be used instead of concentric reducers, to prevent condensate from pooling upstream of the reducer and creating a slug of water.

3.4 Equipment supply lines should be connected to the top of steam mains, not the bottom, so that dirty condensate running along the bottom of the mains does not flow into the equipment.

3.5 Steam traps should be installed at regular intervals (every 100 to 150 ft or 30 to 50 m) in the steam main with correctly sized condensate pockets.

3.6 Steam traps should be installed upstream of isolation valves that are regularly closed.

3.7 Insulation of sufficient thickness should be installed on the piping to prevent excess radiation losses that result in condensate formation. Insulation should be dry, weatherproofed, and undamaged.

If your steam piping system lacks one or more of these features you may experience more problems with water slugs entering the turbine and with condensate collecting in the turbine. These problems will be further worsened if the steam main temperatures are near or at the saturation temperature of the steam. Typically, turbines that are distant from the source of the steam experience more problems because radiation losses have caused the steam temperatures to drop and condensate formation to increase. Also, condensate from upstream in the system will flow downstream if steam traps are not installed and functioning properly at regular intervals along the steam main.

To reduce problems caused by water in the turbine, the case drain of the turbine should be piped to a steam trap with the following features:

3.8 Mechanical free float actuation. There are a wide variety of steam traps on the market that fall into three basic categories: mechanical, thermostatic, and thermodynamic. A mechanical free float trap evacuates water immediately, whereas other types of mechanical traps and the thermostatic and thermodynamic traps operate intermittently. Intermittent operation can allow condensate to back up into the turbine and possibly the seals, which is undesirable.

3.9 Automatic air venting. This feature is necessary to prevent air present during start-up from locking the trap and preventing it from evacuating water.

3.10 Adequate size for condensate load. For instance, a turbine that is placed in hot standby will experience a much higher condensate load than a turbine that operates continuously or in slow roll. In hot standby, radiation losses from the exhaust pipe will cause condensate to form and run down into the turbine. If the exhaust line enters the bottom of the exhaust steam main, condensate running along the bottom of the main will enter the turbine as well. It will take a large trap to prevent condensate from flooding the turbine and the seals.

In continuous operation or slow roll, hot inlet steam will enter the turbine and flow out through the exhaust. This will usually keep the exhaust line much warmer than in hot standby, reducing the flow of condensate into the turbine. Of course, the steam trap must be sized for the worst case condition. If a turbine experiences both hot standby and continuous operation, the steam trap should be sized for hot standby.

3.11 Located as near the turbine as possible. Long piping distances between a steam trap and a turbine can cause the trap to steam lock. This occurs when the line to the trap is filled with superheated steam. Superheated

steam gets trapped in the line and prevents new condensate from actuating the trap. The condensate will back up into the turbine until the steam in the line condenses. If it is impossible to locate the steam trap near the turbine, use a trap that has a steam lock release valve.

3.12 Located below the turbine. The steam trap will not actuate until the condensate reaches the trap. If the steam trap is elevated this will not occur until the equipment is already partially flooded.

3.13 ***Important note:*** In most cases the bore of the turbine will be greater in diameter than the seal face OD until the throat expands into the case. This makes it easy for condensate that forms at the seals to drain back into the turbine case. However, in some cases the diameter steps down. This prevents condensate that forms at the seal faces from draining back into the case. Instead, it pools around the seal faces at bottom dead center. To prevent this from occurring the turbine geometry should be modified to provide drainage into the case or separate steam traps should be applied directly at the seals in addition to the trap provided at the case drain.

4 Inspection of Steam Turbine Components

4.1 Remove the rotor element from the steam turbine.

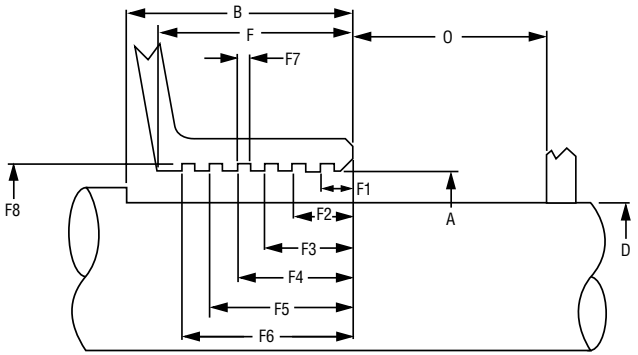
4.2 Remove coupling, thrust bearing, speed pickup, slinger, etc. from the rotor assembly.

4.3 Inspect the seal assembly drawing and confirm the turbine dimensions shown. See Figure 1.

4.4 Inspect the areas of all sealing surfaces. This includes the areas near the flange gaskets (18) and sleeve gaskets (19). See Figure 2. These areas must be free from any large pits, corrosion, or steam erosion. Any damage in these areas must be repaired to insure proper sealing of the static gaskets.

4.5 Hand polish the shaft to remove any burrs or buildup of deposits. Any damage in the seal areas should be repaired or the shaft replaced prior to seal installation.

Seal Chamber Requirements Figure 1



A	Turbine Bore	F2	Groove Location	F7	Groove Width
B	Shaft Step to Box Face	F3	Groove Location	F8	Groove Depth Diameter
D	Shaft Diameter	F4	Groove Location	O	First Obstruction
F	Turbine Depth	F5	Groove Location		
F1	Groove Location	F6	Groove Location		

5 Installation of Seal (Method 1)

5.1 Remove the seal assemblies from the box. Inspect for any obvious signs of mishandling or damage.

5.2 Set aside the sleeve gaskets (19), flange gaskets (18), and lock pins (5) for installation later.

5.3 Spin the spanner nuts (9) until there is a .375 inch gap between the retaining rings (54) and the flange shoulders. This simulates the installation of the .375 inch wide flange gaskets (18).

5.4 Lower the seal assemblies into the proper grooves in the turbine casing per the assembly drawing. The setting devices (103) should be oriented at the 12 O'clock position. Lower the bearing caps into place to insure proper fit of the assemblies. The spanner nuts should not interfere with the bearing caps.

5.5 The seals should seat fully in the turbine case. If they do not, the turbine will not seal at the split line. Measure the turbine bore diameters and the seal OD diameters to ensure adequate clearance. Compare with the information on the assembly drawing.

5.6 Mark the location of the lock pins (5). These lock pins will prevent the seal flanges from rotating in the turbine casing. A small slot must be milled or ground into the casing for each pin so that the pins do not interfere with the lowering of the top half of the casing. The slots should not be any larger than necessary to contain the pins and should not break into the adjacent gasket sealing areas.

5.7 Remove the spanner nuts (9), retaining rings (54), and drive collars (58) from the assemblies. Be careful not to dislodge the split rings (94).

5.8 Orient the seal so the drive collar end is facing away from the rotor. Carefully slide the seals onto the appropriate shaft diameter without the sleeve gaskets (19) and drive collars (58). If the split rings pop out, reinstall them.

5.9 Install the sleeve gaskets (19) and drive collars (58) onto the shaft and slide them into location against the sleeve end. Be careful not to damage the sleeve gaskets when sliding them onto the pilot diameter.

5.10 Lubricate the sleeve gasket compression screws (40) with anti-seize and install them into the adjusting collar (129) **finger tight**. Be careful not to dislodge the split rings when threading the screws into the adjusting collar.

Important Note: In some instances it may be difficult to get the screw started. In this case, use a longer screw in 1-3 locations to compress the gasket enough to get the shorter screws started. **Remove the longer screws** and start the remaining shorter screws, again only finger tight. If the longer screws are not removed, they will extend behind the adjusting collar after final installation. This reduces the allowable axial travel of the seal and **could cause failure** if the screws contact the flange.

5.11 Install the flange gaskets (18), retaining rings (54), and the spanner nuts (9). Use anti-seize on the nut threads. Thread the spanner nut onto the flange **but do not compress the gasket**. **Compressing the gasket at this time will result in a failure.**

5.12 Install the other turbine rotor components onto the shaft.

5.13 Temporarily secure the seals into position on the rotor.

5.14 Install the rotor assembly into the turbine. Take care not to damage the flange gaskets. Also, take care to locate the seals in the appropriate grooves.

5.15 Install the turbine bearing caps. Make sure there is no interference with the seal spanner nuts. Note that the nuts will move farther in when tightened to compress the flange gasket.

5.16 Install the lock pins into the flanges. Rotate the flanges so that the lock pins are in the slots in the lower casing. Make sure the pins rest below the split line in the turbine.

5.17 Remove the screws (40-1) that secure the setting plates (103) to the sleeves. Do not remove the screws (40-2) that secure the setting plates to the flanges at this time.

5.18 Tighten the sleeve gasket compression screws (40) in the drive collars through the access window in the spanner nut (9). Be sure to tighten all

screws evenly to insure uniform compression of the sleeve gasket. Rotate the rotor assembly to access screws below the split line. The #10-32 HHCS should be tightened to about 50 in-lbf (5.65 N-m). As a practical matter, this torque is frequently difficult to measure. Use the following guideline as an alternative. As the gasket is compressed the torque required to tighten the screws will steadily increase. When the gasket is almost solid, the torque will begin to climb much more rapidly. In practice this is very near the 50 in-lbf guideline.

5.19 Tighten the drive collar set screws (57) to secure the seal assemblies to the shaft. Use a torque of 156 in-lbf (17.6 N-m).

5.20 Remove the remaining setting plate screws (40-2) and remove the setting plates. Store the (40-1) and (40-2) screws in the setting plate storage holes. **Keep the setting plates and screws for future use.**

5.21 Install the top half of the turbine casing. Refer to the turbine manufacturer's recommendation for use of split-line sealant and torque values for case bolts. Ensure that split line sealants do not come in contact with the seal faces.

Important note: Be very careful if using any sort of flat gasket or "string" gasket to seal the case split line. Either of these gaskets will create a gap between the turbine cover and the case. Unless the flat gasket is flush with the bore of the turbine, the GTS flange gasket (18) will not seal this gap and will leak.

5.22 Tighten the spanner nuts (9) using the notches on the OD. An adjustable OD spanner wrench is recommended. Tighten using the spanner wrench until you cannot turn the nuts.

5.23 Proceed to warm up the turbine slowly. The flange gaskets may begin to leak as the turbine casing expands. Tighten the spanner nuts until all leakage stops.

5.24 Start the turbine. Usually, there should not be any visible leakage past the seals during normal operation. In a cold climate, some steam leakage may be visible.

6 Installation of Seal (Method 2)

An alternate method can be used to install internally mounted seals that may make installation easier in some cases. This method can work very well to remove and reinstall a set of seals that are already on the machine.

6.1 Slide the seal assemblies into place on the shaft as described in Method 1 above.

6.2 Install the thrust bearing. Do not install the other rotor components.

6.3 Lower the rotor into the bottom half of the turbine case and onto the journal bearings. Make sure the seals are located in the correct groove in the turbine case. The thrust bearing should axially locate the rotor correctly in the case. Verify that the nozzle clearance meets the manufacturers specification.

6.4 Use machinist's blue or a scribe to mark the location of the sleeve end nearest the wheel (setting plate side of the seal, opposite the drive collar). If seals were installed using Method 1, marking the location of the sleeve end as described here will simplify reinstallation.

6.5 Remove the rotor from the case.

6.6 At least one threaded hole, usually #8-32, is provided in the end of the sleeve in addition to the one required to screw the setting plate to the sleeve. Find a #8-32 set screw and use this hole to secure the end of the sleeve to the shaft at the location marked in step 6.4.

6.7 Tighten the sleeve gasket compression screws (40) and the set screws (57). Make sure the seal stays in the correct location. The drive collar should draw up on the sleeve. It is usually much easier and faster to tighten these screws when access is not restricted by the case, as is the situation with Method 1. Also, it is possible to measure the torque used to tighten the sleeve gasket compression screws.

6.8 Remove the screw installed in 6.6 to hold the seal in the proper location. Steam corrosion could cause the screw to seize. Also, if later forgotten during disassembly damage to the shaft could occur during disassembly.

6.9 Build up the rotor and install it into the turbine.

6.10 Remove the setting plates and finish assembly of the turbine.

7 Testing of Turbine with Seals

After installing GTS seals in a turbine, static and dynamic testing under air or steam pressure is recommended. Safety precautions for pressurized equipment should be followed at all times. Note that if GTS seals are exposed to a slug of water they will leak more until the water has dissipated.

7.1 Seal the turbine case exhaust and inlet with flanges rated for at least 50 psig (345 kPa) or the desired back pressure. Connect a pressure source and provide a pressure indicator rated for 50 psig or the desired back pressure.

7.2 Pressurize the turbine case to 50 psig (344 kPa) with no shaft rotation to test static leakage. GTS seals faces lift off with pressure so some leakage

is normal. Isolate the turbine case from the pressure source and monitor the pressure decay. Typical pressure decay over a minute is 10-15 psig (69-103 kPa). A slight hissing sound may be audible from the GTS seals.

7.3 If the turbine operates at a higher back pressure, the turbine can be pressurized accordingly if there is sufficient pressure source and the test flanges, etc. are rated as such. It is normal for the pressure to decay more quickly at higher pressures.

7.4 Conduct a rotational test of the turbine with back pressure on the seals set at minimum 50 psig (345 kPa). The shaft speed should be a minimum 800 rpm for this test. Do not conduct the rotational test at less than 50 psig, this could result in seal face contact and damage. Rotational testing is generally a short duration to check overall equipment assembly.

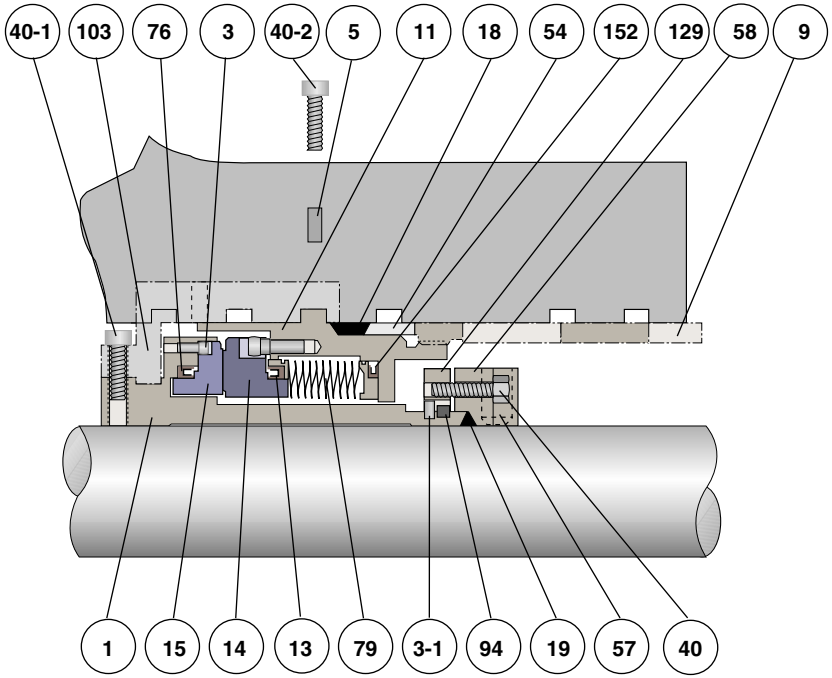
7.5 After rotational testing, repeat step 6.2 and compare pressure decay results. Pressure decay results should be equal.

8 Repairs

This product is a precision sealing device. The design and dimension tolerances are critical to seal performance. Only parts supplied by Flowserve should be used to repair a seal. To order replacement parts, refer to the part code and B/M number. A spare backup seal should be stocked to reduce repair time.

When repairs are not conducted on site, **decontaminate the seal assembly** and return it to Flowserve, with an order marked **"Repair or Replace"**. **A signed certificate of decontamination** must be attached. **A Material Safety Data Sheet (MSDS) must be enclosed** for any product that came in contact with the seal. The seal assembly will be inspected and, if repairable, it will be rebuilt, tested, and returned.

Seal Nomenclature Figure 2



No.	Description	No.	Description
3	Drive Pin	18	Gland Gasket
13	Seat Gasket	19	Sleeve Gasket
14	Stationary Face	40	Hex Head Cap Screw
15	Rotating Face	40-1	Socket Head Cap Screw
76	Rot Face Gasket	40-2	Socket Head Cap Screw
79	Bellows Assy	54	Retaining Ring
152	Bellows Adapter Gasket	57	Cup Point Set Screw
1	Shaft Sleeve	58	Drive collar
3-1	Drive Pin	94	Split Ring
5	Lock Pin	103	Setting Plate
11	Gland	129	Adjusting Collar
9	Spanner Nut		

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