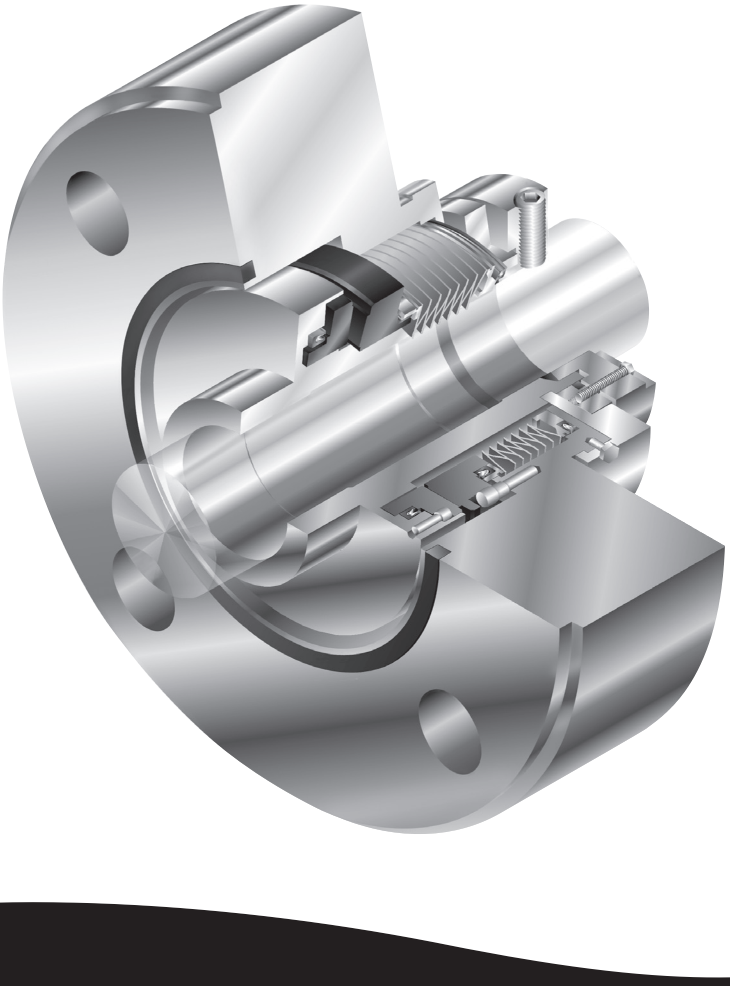
FLOWSERVE

Installation Instructions

GTS Series

Externally 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

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 Mismatch between the case and cover where the carbon ring box bolts to the turbine. Examine the carbon ring box, case, and cover for signs of erosion.

2.5 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.

2.6 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.

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 10 cm per 10 m (4 inches per 30 ft) 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 30 to 50 m or 100 to 150 ft) 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 startup 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 some cases the bore of the turbine will be greater in diameter than the seal face OD. This makes it easy for condensate that forms at the seals to drain back into the turbine case. However, in many cases the diameter of the turbine bore is less than the seal face OD. 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 all externally mounted seals should be provided with drain taps piped to separate steam traps. If the turbine has a large enough bore or if the turbine geometry has been modified to provide drainage into the case these drain taps can be plugged. A separate trap should be used for each seal, and should be applied as near the seal as possible. Pipe or tubing should be used to connect the drain to the steam trap if possible, otherwise use high pressure / high temperature steel braided hose.

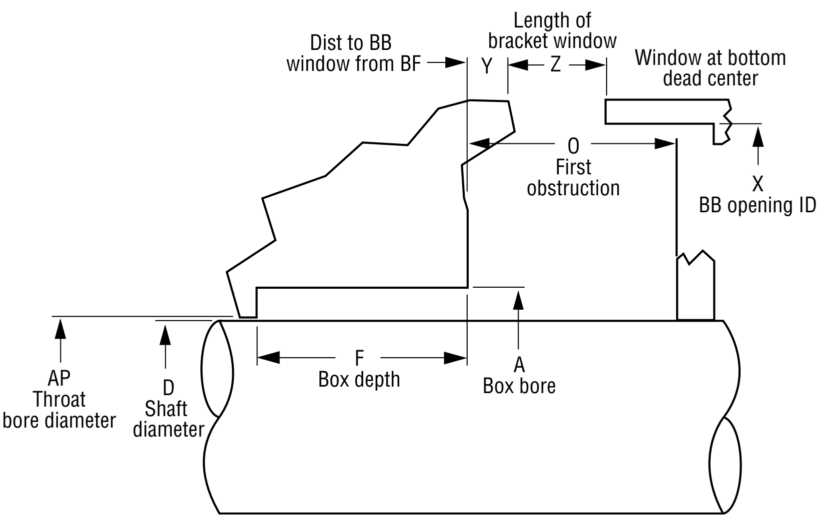
4 Inspection of Steam Turbine Components

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.

Seal Chamber Requirements 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 Mismatch on the face of the turbine at the split line should be less than 0.0127 mm (0.0005 inch). If not the surface should be stoned or machined to bring it into specification.

4.6 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.

5 Installation of Seal

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 and flange gaskets 18 for installation at step 5.4.

5.3 Develop the piping or tubing for the steam traps. Take a seal assembly, minus gaskets, and place it in the lower half of the turbine case on the exhaust / coupling side. This side usually has the least space available between the case and bearing bracket. Hold the seal in place with two of the SHCS 40-2 . The pipe or tubing exiting the drain must not hit the case or bearing bracket. Tubing can be bent and cut with simple tools and provides a great deal of flexibility. Tube fittings make it easy to connect and disconnect the drain during installation. Check to make sure the configuration developed for the exhaust / coupling end will also work for the inlet / governor end.

5.4 Install the flange gaskets 18 into the grooves on the flanges. Apply a small dab of silicone grease to the gasket to hold it in the groove during assembly. **Wipe off any excess grease so that it will not get into the seals.** Grease contamination in the seal may compromise performance.

5.5 If the turbine has a sealant groove at the split line and on the turbine face it may interfere with the function of the flexible graphite gasket normally used. In this case, seal metal to metal, gland to turbine, with the same sealant used on the split line. Only use a very light coat of sealant on the turbine face. **Be careful not to get the sealant on the seal faces.**

5.6 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.

Note: The gland bolts will be installed after the turbine is assembled.

5.7 Install the sleeve gaskets (19) and drive collars 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.

5.8 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.

5.9 Install the other turbine rotor components onto the shaft.

5.10 Temporarily secure the seals into position on the rotor.

5.11 Install the rotor assembly into the turbine. Take care not to damage the flange gaskets.

5.12 Locate the seals and gaskets so they do not interfere with the lowering of the top half of the casing.

5.13 Install the turbine bearing caps.

5.14 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 into 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 and the face where the seals bolt on, the GTS flange gasket (18) will not seal this gap and will leave this gap and will leak.

5.15 Install the socket headed cap screws (40-2) to secure the seals to the turbine. Use the same torque as that specified by the turbine manufacturer for the carbon box.

5.16 Loosen the screws (40-1) securing the setting plates (103) by 1/2 turn. This will reduce the binding between the setting plate and the sleeve and make it easier to rotate the rotor as required in the following steps.

5.17 Tighten the sleeve gasket compression screws (40) in the drive collars (58). Tighten all screws evenly to insure uniform compression of the sleeve gaskets. Rotate the rotor assembly to access the screws.

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

5.19 Remove the setting plate screws (40-1) and remove the setting plates. **Keep the setting plates and screws for future use.**

5.20 Proceed to warm up the turbine slowly.

5.21 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 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.

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

6.2 Pressurize the turbine case to 344 kPa (50 psig) 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 69 -103 kPa (10 -15 psig). A slight hissing sound may be audible from the GTS seals.

6.3 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.

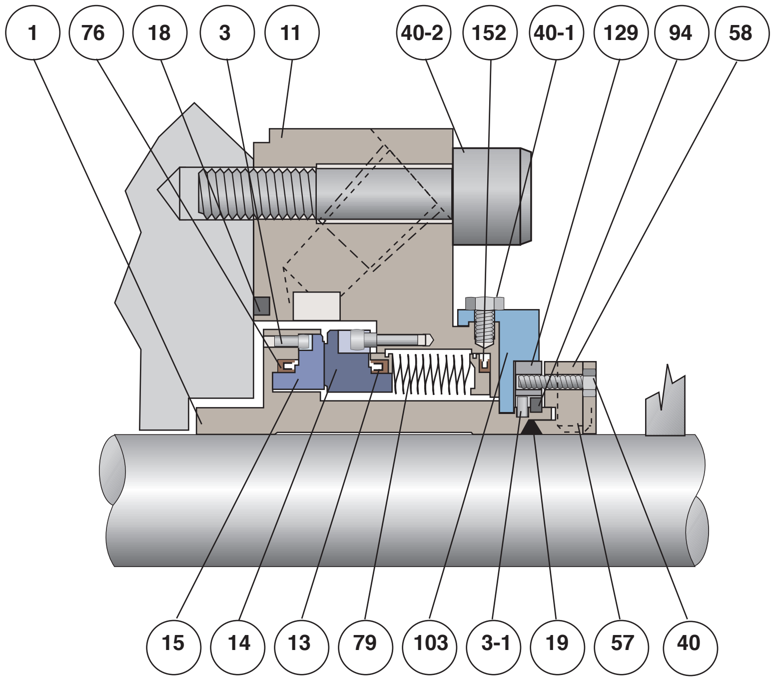
6.4 Conduct a rotational test of the turbine with back pressure on the seals set at minimum 345 kPa (50 psig). The shaft speed should be a minimum 800 rpm for this test. Do not conduct the rotational test at less than 345 kPa, this could result in seal face contact and damage. Rotational testing is generally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

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

7 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 seals are returned to Flowserve for repair, **decontaminate the seal assembly** and include 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.



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	Hex Head Cap Screw
76	Rotating Face Gasket	40-2	Socket Head Cap Screw
79	Bellows Assy	57	Cup Point Set Screw
152	Bellows Adapter Gasket	58	Drive collar
1	Shaft Sleeve	94	Split Ring
3-1	Drive Pin	103	Setting Plate
11	Gland	129	Adjusting Collar

TO REORDER REFER TO
B/M #________________
F.O. ________________

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