

BALIÑO INNER STERN TUBE AND STERN TUBE BEARINGS

**Technical description
and
installation manual**

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1. INTRODUCTION

The aim of this document is to describe our product called “inner stern tube” that we supply completely assembled with bearings and all the necessary fixtures in it so that the shipyard receives it ready to install in the vessel.

Baliño also supply stern tube seals of lip type for which we have specific manuals for description and installation.

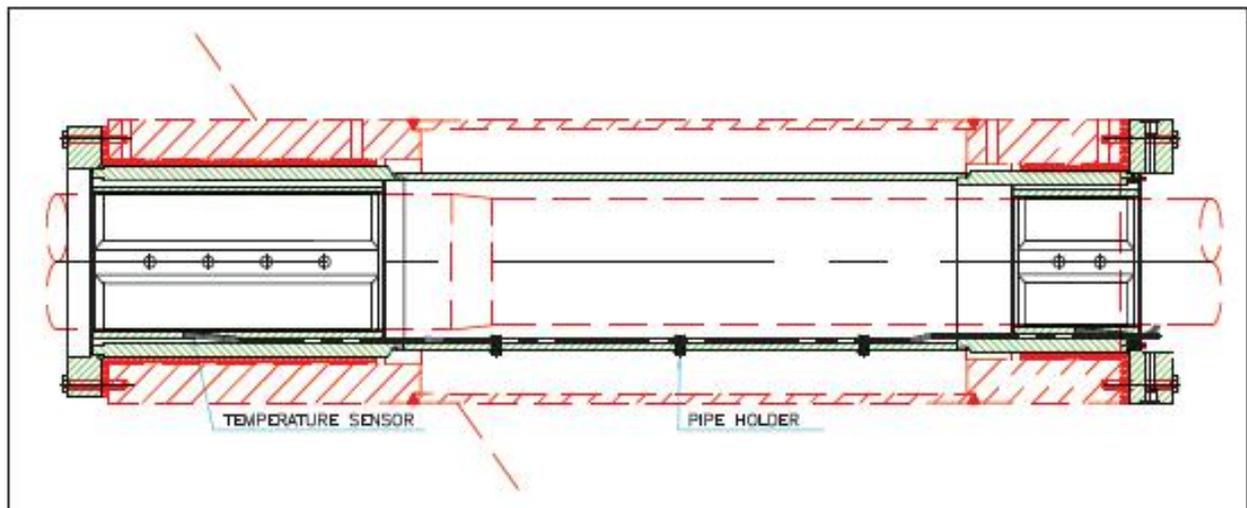
2. DESCRIPTION

The inner stern tube consists on a central tube with two thicker pieces (bearing sleeves) welded at the ends to give house to the bearings which are delivered already mounted and secured. The inner stern tube is intended to be installed with resin against the structural stern tube bosses therefore it facilitates the alignment procedure for the shipyard.

For oil lubricated stern tubes it may be also included temperature sensors for the white metal bearings and monitoring pipes for the stern tube seals.

The forward and aft flange fit in to the actual stern tube seals.

There are some particular cases on which the central tube doesn't exist and the sleeves with its corresponding bearing are independently fitted in with resin. With this arrangement the alignment rather difficult compared of that with central tube included.



3. INSTALLATION WITH RESIN

The inner stern tube is introduced inside the outer stern tube and supported by jacking screws inside the stern tube boss.

The annular clearance provides flexibility in positioning the bearing for alignment with the shafting center line. Once the bearing is positioned by the jacking screws, the annular area is dammed forward and aft and then filled with liquid epoxy which is either poured or pumped into the space through filling and venting connections in the outer part.

Detailed Instructions from the corresponding resin maker must be strictly followed.

4. TEMPERATURE SENSORS AND SEAL PIPES

Oil lubricated stern tubes, when required, can be fitted with temperature sensors for continuous monitoring of the bearing temperature.

Recommended temperature in the white metal bearing to set an alarm is 65°C

Temperature sensors are fitted inside a stainless steel pipe which runs through the stern tube into the bearing oil groove, in this way sensors can be easily exchanged with the ship afloat. The pipes are supported by pipe holders.

The pipes are plugged in the aft end, in order to prevent entering oil inside.

Sensors are usually installed in the aft bearing and can be delivered with one or two elements. Sensors can also be provided in the fore bearing.

At the stern tube flange, the pipe is led to a connection box.

Depending on the type of seal installed, additional pipes might be installed inside the stern tube. These pipes typically run through the oil grooves, and connect to an intermediate chamber in between the lip seals. The pipes are usually made of stainless steel and will be supported by pipe holders.

5. BEARINGS

The bearings may be either of white metal type (antifriction) when the stern tube is oil lubricated or synthetic material when works in water lubricated stern tube. The bearings are installed with diametrical interference inside the stern tube housing.

In order to prevent the bearings from rotating, four anti-rotation locking pin are provided between the bearing and housing.

6. PROPELLER SHAFT SLOPE IN WAY OF BEARINGS

To avoid high local pressures on the aft bearing in the area where the propeller shaft contact the bearing, the recommendations from the shaft alignment calculations must be followed.

Classification Societies recommendations state that relative slope between propeller shaft and bearing in the contact area should not exceed 0,3 mm/m.

Misalignment in the aft stern tube bearing, increase significantly the risk of premature bearing failure.

7. INSERT AND EXTRACTION OF BEARING

7.1. Factory mounting of new bearings

When the stern tubes bearings are assembled in our workshops before the stern tube is sent to the shipyard, the diametrical interference is checked first, then the assembly is made by either heating the bearing housing (the common way in case of white metal bearing) or cooling the bearing (normal way in case of synthetic bearings).

7.2. Insert of bearing when the stern tube is installed in the vessel

When bearings are to be inserted in their housing at customer facilities, normally they are supplied oversized to be finished on site in order to get the interference needed to achieve a press-fitting insert.

Two ways are used to insert the bearings when the stern tube is already fitted in the vessel

Insert by using cooling system:

1. Secure that the measuring tools are calibrated.
2. Secure that during the measuring jobs the temperature of the bearing, stern tube housing and measuring tools will be approximately the same.
3. Measure the inside diameter of the housing at different positions both vertical and horizontal along the extension of the housing where the bearing should be fitted.
4. If the diameter is arranged in 1 mm steps one or two, see valid drawing, then it is also necessary to measure the position of that diametric change.
5. Calculate the correct diameter for the bearing according to grip instructions on the stern tube drawing or the drawing of the bearing.
6. Turn the bearing outer diameter on a lathe according to calculated dimensions from measurements and grip. Sometimes it is necessary to machine the oil channels and drill the lubrication holes.
7. Make sure that the stern tube housing is clean.
8. Cooling procedure:
 - 8.1 Preferably the cooling is done by introducing the bearing in a cylindrical case and applying the CO₂ ice or Nitrogen ice (N₂ ice) between the casing and the bearing. If this is not possible, it could do it by placing CO₂ ice or N₂ ice at the inside of the bearing and place the bearing horizontal in a box, but beware not to damage the surface.
 - 8.2 Lift the bearing into position and press it gently until it makes a mechanical stop at the diametric steps.
9. Secure the bearing by mounting the anti-rotation locking pins.

Insert by press-fitting system:

Following instruction is only valid for white metal bearing. To insert synthetic bearings intended for a water lubricated stern tube follow the cooling system explained previously.

A tool with a hydraulic jack is needed to insert the bearing. It is very important that the tool can take the estimated hydraulic jack capacity calculated using instructions below.

The insert shall be carried out according to the following procedure:

1. Check the required diametrical interference between bearing and the housing.
2. By means of the diagrams below, calculate the theoretical force required to insert the bearing:
 - Use the correct interference curve according to step 1.
 - Read estimated force at y-axis at correct outer bearing diameter on the x-axis.
 - Multiply the estimated force with the bearing length (please note that extraction forces are given for 1 meter length of bearing).

3. Use a hydraulic jack with at least 40% higher capacity.
4. Before applying the tool to the bearing, cover the bearing surface with clean textile fabric.
5. When applying the pressure with the hydraulic jack, check that the tool do not bend or twist. If so, align again and secure the bridge for the hydraulic jack better.
6. The bearings have diametrical steps, depending on diameter and length, none, one two or three, therefore press it until it makes a mechanical stop at the diametric steps.
7. Mount the anti rotation screws between the bearing and the housing.

7.3. Extraction of old bearing

A extractor tool with a hydraulic jack as per below sketch is needed to withdraw the bearing. It is very important that the tool could take the estimated hydraulic jack capacity calculated using instructions below.

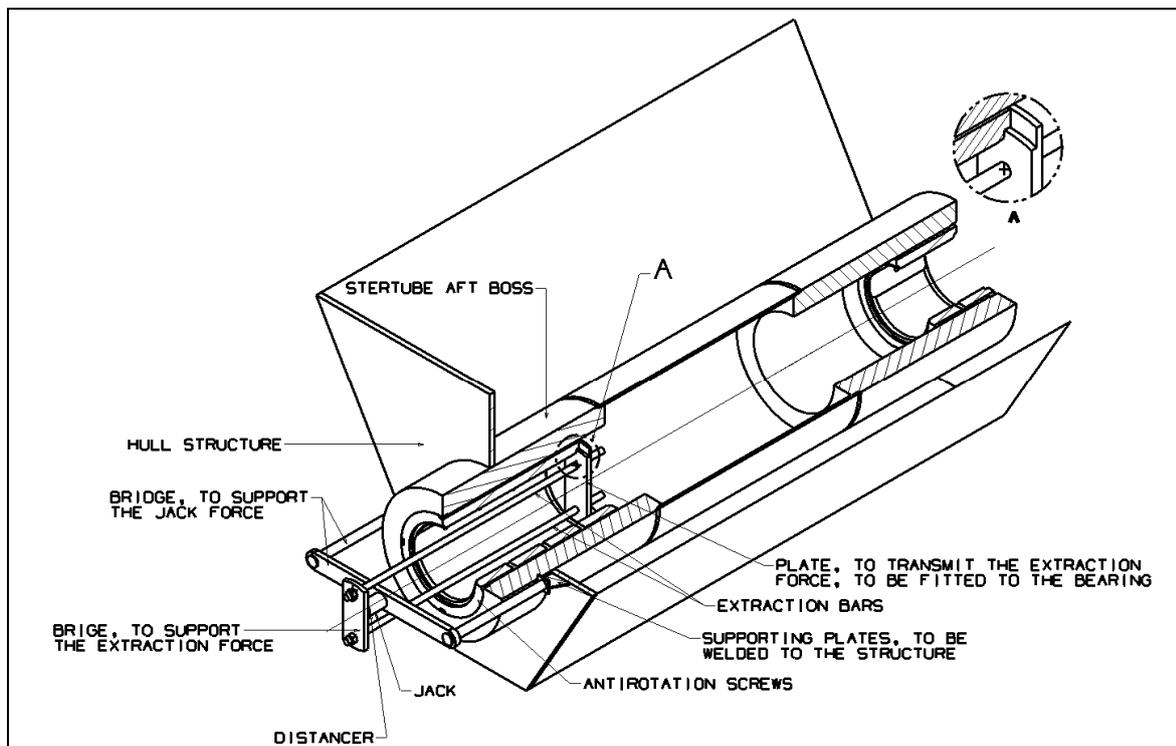


Fig. 1 Bearing extraction tools arrangement

The withdrawal shall be carried out according to the following procedure:

1. Check the used diametrical interference between bearing and the housing.
 - For white metal bearings the theoretical force required to extract the bearing may be calculated by using the diagrams below. Use the correct interference curve according to step 1.
 - Read estimated extraction force at y-axis at correct outer bearing diameter on the x-axis.

- Multiply the estimated extraction force with the bearing length (please note that extraction forces are given for 1 meter length of bearing).

For synthetic bearings, the information from the supplier has to be followed to know the theoretical force.

2. Use a hydraulic jack with at least 40% higher capacity.
3. Dismount the anti rotation screws mounted between the bearing and the housing.
4. Before applying the tool to the bearing, cover the bearing surface with clean textile fabric.
5. When applying the pressure with the hydraulic jack, check that the tool do not bend or twist. If so, align again and secure the bridge for the hydraulic jack better.
6. The bearings have diametrical steps, depending on diameter and length, none, one two or three, therefore it will loose when is pushed the corresponding step distance of the bearing length

Quick dismantling of a scrapped bearing can be carried out just by cutting the bearing along the longitudinal oil groove with a grinding machine.

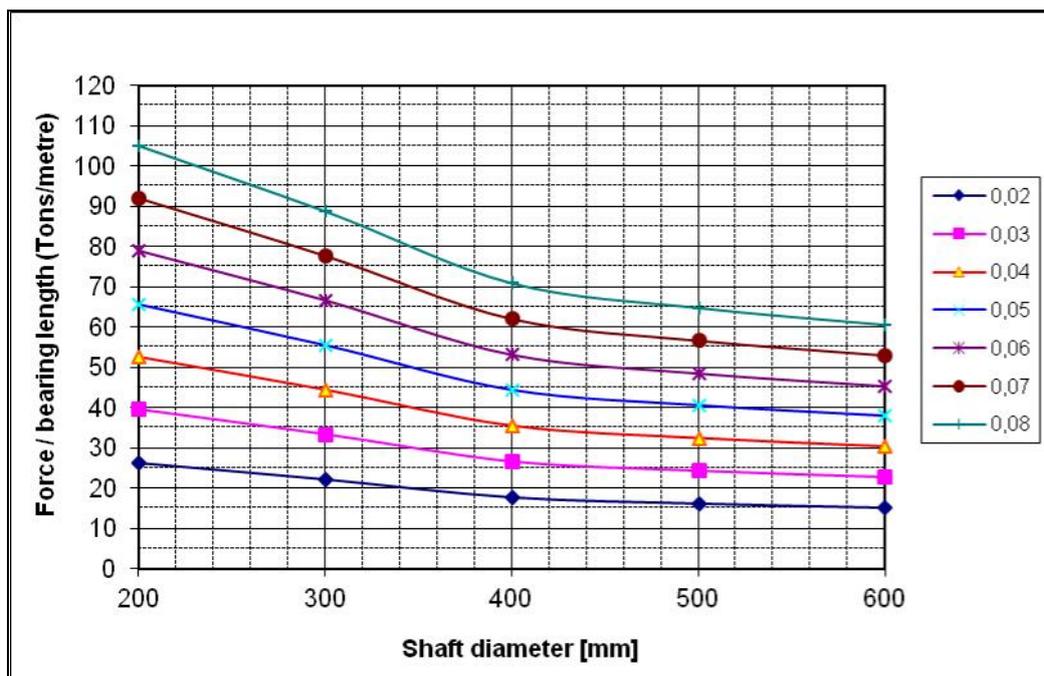


Fig. 1 Insert or Extraction force diagram for bearing mounted.

8. OIL LUBRICATED STERN TUBE

Stern tube is oil filled for lubrication and cooling purposes.

During the normal rotation of the shaft over the bearings, fluid film lubrication is established, and a certain amount of heat is generated due to friction, and must be removed. This task is carried out by the stern tube oil which circulates through the system and ascends to the tank by a natural convection process. At the same time, cooled oil is fed to the stern tube through the corresponding pipe.

Heat is also exchanged from the stern tube to aft peak and surrounding areas.

Considerations should be given to the oil heat dissipation when air is in the camera between the inner and outer stern tube because the high isolation capacity of air. In some cases the central tube is provided with holes to permit the oil to fill in the said camera so that the total oil capacity is increased. In this case care should be taken to avoid oil leakage to the sea.

8.1. STERN TUNE LUBRICATION DIAGRAM

Typical lubrication consists of a header tank connected to the stern tube by means of two pipes, one for feeding the oil and one for returning.

The header tank is usually fitted with several connections and accessories:

- Filling plug, in the upper side. This plug is of the breathing type.
- Level switch.
- Return pipe, connected to the upper side of the forward stern tube flange. It connects the header tank through a valve. This pipe discharges the heated oil inside the tank at a certain height.
- Feed pipe, connected to the lower side of the forward stern tube flange. It connects the header tank through a valve. A three way valve is provided in the lower part of this pipe for draining the oil from the system.
- Drain valve in the tank bottom.
- Sight glass in the tank front for oil level checking.

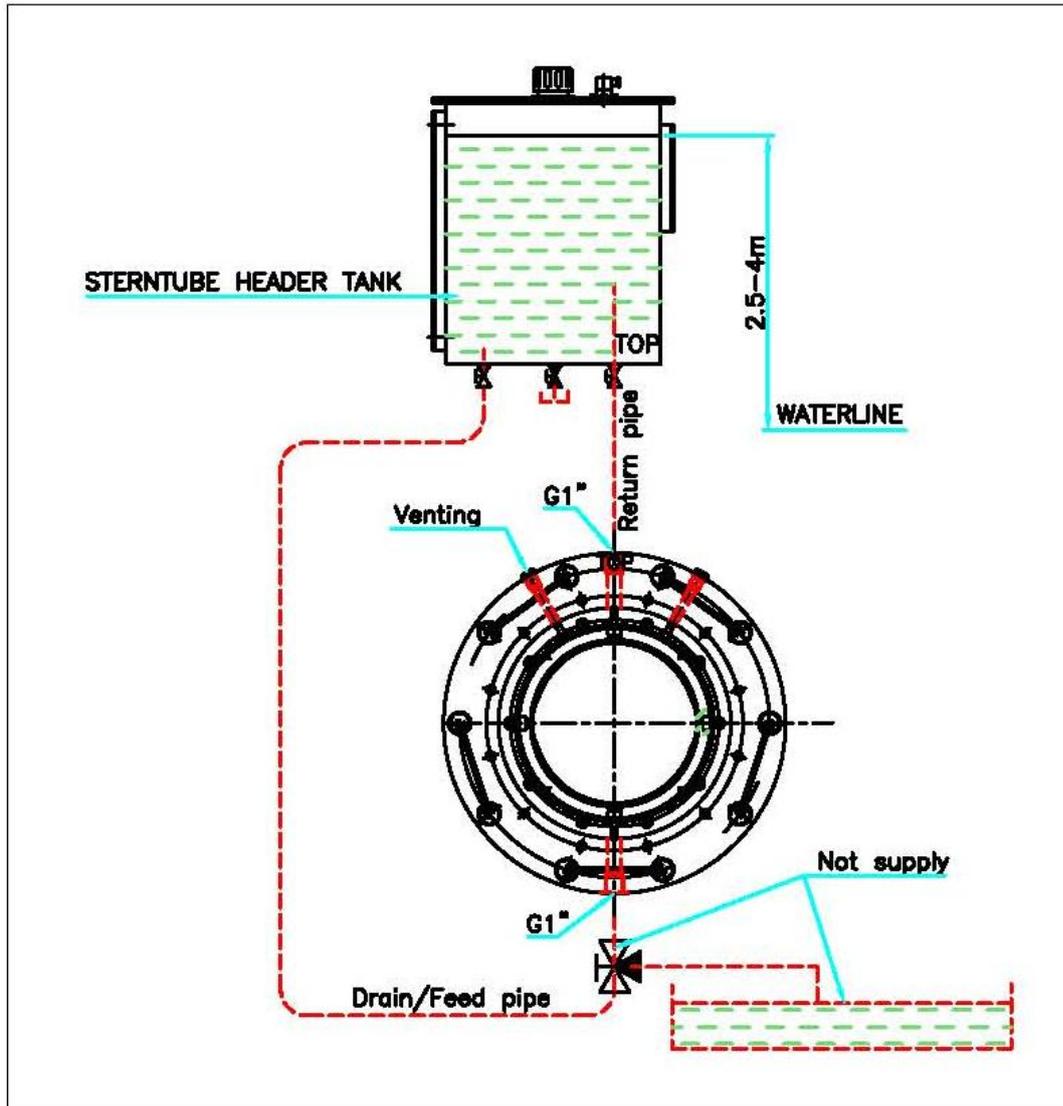


Fig. 4 Oil lubrication system

8.2. HEADER TANK INSTALLATION HEIGHT

The header tank height represents the static oil pressure inside the stern tube. This pressure must be enough to compensate the external sea water pressure over the aft seal. The sea water density is approximately 20 % higher than the oil density; therefore, the oil height must be above the ship loaded waterline in order to compensate static pressure.

An oil level drop inside the header tank is an indication of possible oil leakage from the stern tube through the seals.

If the ship has two loading conditions with very different drafts, two header tanks can be provided, each installed at a different height. The crew must manually shift from one tank to the other on each sailing condition.

Installation height is shown in the fig 4.

8.3. STERN TUBE OIL

Information and recommendations of oils used for lubrication of stern tube white metal bearings and seals, see our document 0074