TECHNICAL MANUAL

FOR

TYPE MB SEAL

ManeSeal MB Inboard Seal

for Water Lubrication Systems

Based on Tabulated G.A. Drawings:

H 71601

CONTENTS

1. INTRODUCTION

1.1. The equipment described in this manual and the materials selected are the result of many years of research and experience in this field.

1.2. However, the care and attention paid during installation, testing, operations and maintenance, do to a large extent determine the long-term operational reliability of the equipment.

1.3. Thus, whilst it is our policy to allow the Installation and Maintenance of this equipment to be carried out by 3rd parties (in accordance with the guidance contained within this Technical Manual) we would always recommend that one of our Service Engineers is present to oversee any Installation or Maintenance.

1.4. **When using this manual refer to the general arrangement drawing(s) in Section 14**, which give the dimensions and data for the correct assembly and operation of the equipment.

1.5. There is no automatic provision to up-date this manual. However, the supply of a complete new assembly will be accompanied by the latest revision/issue Manual and Drawing(s).

1.1. For further assistance please contact your local Wärtsilä office or go to www.wartsila.com .

2. DESCRIPTION OF THE EQUIPMENT.

MB seals are members of the ManeSeal - M series family of wrapped Bellows - Radial Face Type seals.

The MB seal is a partially split inboard unit primarily for use with **closed sweet water** Lubrication Systems in Fixed Pitch or Controllable Pitch Propeller applications.

The MB seal can also be used in **open water systems**, however whether an open or a closed water system is used, the seal is specifically designed to accommodate high levels of shock loading.

The seal is provided by continuous rubbing contact between a rotating seat and a stationary face. This contact is sustained by spring pressure supplied through the flexible bellows assembly (mounted to the inboard end of the Sterntube) to the resilient mounted (removable) face. The seat (which is split) is fixed to and rotates with the propeller shaft.

In the MB design, the inside of the seal usually has a rubber lining (seal sizes over #670) and the drive clamp ring (which drives the seat) is positively fixed to the shaft with radial locking screws.

The seal unit is thus able to accommodate large axial and radial movements plus high frequency induced vibrations and shock loading.

On initial installation, the MB seal (which is partially split) is installed over the Propeller Shaft.

The MB main seal requires no adjustment between refits and seal components subject to wear are visible thus enabling inspection without dismantling.

Should repairs become necessary, these can be carried out without dry-docking the vessel.

The inflatable seal is housed behind the mounting ring of the stationary seal unit and provides an emergency sealing device. When the ship is afloat, this seal should be activated when it is necessary to remove or replace a seal component, or should the main seal be accidentally damaged. When inflated, it forms a liquid tight joint around the shaft.

Also the inflatable may, **in the event of an "extreme" emergency,** be run dynamically.

All wearing and working components of the MB seal can be removed and replaced with split components without disturbing either the shaft or the propeller.

3. STORAGE AND HANDLING.

3.1. All assemblies and components have been carefully inspected before shipment.

3.2. Each component is suitably packed and protected to prevent damage or deterioration during shipment, transit or storage. Any specific storage or handling requirements will be clearly identified on the package label(s).

3.3. Goods should be examined on receipt to verify the contents and their condition.

3.4. Wärtsilä UK Ltd. should be immediately advised of any damage or discrepancy in the scope of supply. Damage clearly due to handling in transit should be notified to the carrier (copy to us).

3.5. Keep goods in their original packing until just prior to installation in order to best protect them.

3.6. If goods have to be stored for long periods, they should be kept in their original packing, stored flat and unobstructed in a dry, cool and dark environment. To ensure a satisfactory life expectancy for any rubber components, exposure to sunlight, ultraviolet light and ozone should be prevented.

3.7. Care must be taken during handling to prevent any mechanical damage occurring due to dropping, crushing etc. Particular care and attention should be paid to the running/sealing surfaces of the face and seat.

4. PREPARATION

4.1. Remove all burrs and sharp edges over which the seal must pass. The surface of the shaft, local to the seal, should be clean and to the specified diameter and tolerance.

4.2. Ensure that all mating faces with the seal, i.e. the end face of the sterntube/housing is machined to the following parameters:

#				
#	Surface finish		- 1·6 µm Ra or finer - Shaft in way of "O" cords and Inflatable seal. - 6·3 µm Ra or finer - Sterntube/Housing	
#	Flatness		- 0·08 mm.	
#	Perpendicularly		Shaft Size < 500 500 - < 700 700 - < 1000 1000 – 1250	FIM - (Measured outside the bolting P.C.D.) 0·2 mm 0·3 mm 0·4 mm 0·5 mm
#	Concentricity		Shaft size 50 – 140 141 – 300 301 – 450 451 – 1500 451 – 1500	FIM – Sterntube Bore to Shaft 2mm (I.S. section H49249) 2mm (I.S. section H45421) 2mm (I.S. section H43874) 2mm (I.S. section H45202) 3mm (I.S. section H44700 for USA)

4.3. All mating surfaces should be clean with no debris or old gasket material, etc. present.

4.4. The sterntube mating surface must be prepared with holes machined and tapped as necessary to receive fasteners, as defined by the G.A. Drawing. If there is a sterntube recess into which the MB seal locates, it must be of the bore, depth and dimensional tolerances as specified on the G.A. Drawing.

4.5. The shaft must be of the diameter, tolerance and surface finish as defined by the G.A. Drawing. Further, holes in the shaft for the Drive Clamp ring radial locking screws must be provided dimensioned and positioned as defined by the G.A. Drawing, using the Drive Clamp ring as a machining template.

4.6. **It is essential that the running surfaces of the face and seat are protected at all times** during storage, transit and installation to promote correct operation of the assembled unit. Even minor damage to these surfaces can promote leakage.

5. HEAD TANK LOCATION/LUBRICATION SYSTEM

5.1. Basic Sweet Water Closed Loop System.

In a normal closed (Sweetwater) lubrication system, details should be as per the Technical Data Sheet TDS 1/002.

TDS 1/002 follows after Section 14– Attachments.

5.2. Basic Open Water system.

In a normal open water lubrication application, there will not be a "header tank" as such.

The flush water for the seal will normally be provided from a pumped system.

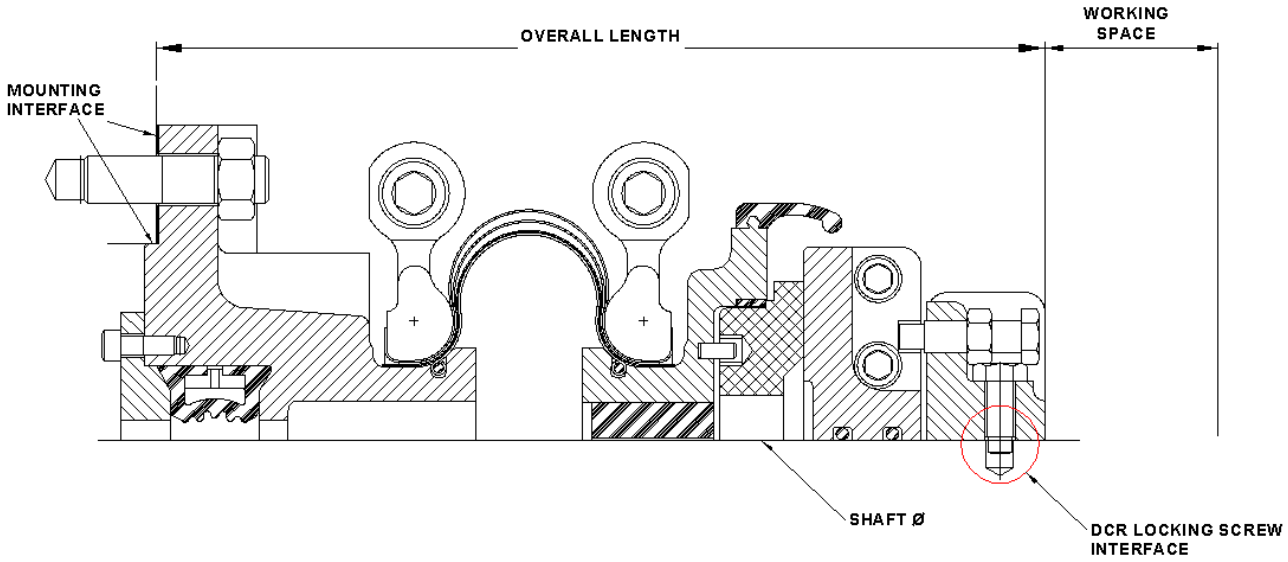
Details should be as per the Technical Data Sheet TDS 1/003.

TDS 1/003 follows after Section 14 – Attachments.

6. SPECIAL INTERFACING REQUIREMENTS.

When installed the MB Inboard seal interfaces with various elements and components around it.

Ensuring that the interfacing requirements are met is essential to the successful operation and performance of the seal.



Four areas of interfacing are relevant:

6.1. The Bore/I.D. of the seat and drive clamp ring assemblies to the shaft.

The seal will be supplied with the bore of the seat and drive clamp ring sized to suit the stated shaft diameter.

6.2. The Mounting ring/Carrier interface

The surface of the Sterntube to which the Mounting Ring is to be fitted must comply with the requirements of Section 4(Preparation).

The mounting surface must be prepared in accordance with the G.A. drawing with regard to tapped holes, studs etc. for the mounting of the MB seal to the Stern Tube.

The inner diameters of the mounting ring in way of the emergency/maintenance seal plus the mounting ring itself and the carrier (if it is rubber lined) are all directly related to the seal size in question. The shaft diameter must be as stated (ordered) and within the tolerance shown on the G.A. Drawing.

The concentricity of the mounting ring relative to the shaft is also important because of the inflatable seal. This is dependant on shaft size and the I.S. section specified. A centralising feature such as a spigot may, or may not be included in the design of a particular seal. In either case, after installation, the resulting concentricity between the mounting ring and the shaft must be within the values given below.

Shaft size	FIM - Mounting Ring to Shaft
50 – 140	2mm (I.S. section H49249)
141 – 300	2mm (I.S. section H45421)
301 – 450	2mm (I.S. section H43874)
451 – 1500	2mm (I.S. section H45202)
451 – 1500	3mm (I.S. section H44700 for USA)

6.3. Axial Space.

Though the Inboard MB seal does not require a "specific" Axial Space into which to fit, the space must be sufficient.

Check that inboard of the Sterntube forward surface (or the surface to which the seal is to be fitted) there is sufficient clear and unobstructed parallel shaft available to fit the seal.

The length required is the approximate Overall length of the seal (as shown on the G.A. Drawing for the particular seal size) **plus** the compression applied to achieve the working length and some additional space to build/fit the seal.

The compression will be shown on the Drawing.

Thus the Axial Space required to install the seal is the Approximate Overall Length (which includes the 1·0 mm / $^{1}/_{16}$" joint) plus the compression, plus a working space (of approximately 30 to 50 mm / 1¼" to 2").

6.4. The connection of services to the Mounting Ring.

All connections and services (water flush/vent and drain, plus air supply and vent/drain) as detailed on the relevant G.A. Drawing must be provided, ready for connection.

7. INSTALLATION.

(Refer to Drawing(s) - see Section 14.)

7.1. Supply

7.1.1. The MB seal is normally delivered fully assembled (including the compression tooling) and should not be dismantled.

7.1.2. The shaft must not be fully entered or connected so that and the seal can be threaded along the shaft then continue from 7.2 (Installation - Shaft Removed).

7.2. Seal Installation - Shaft Removed

IMPORTANT NOTE:

Please read Section 12.8. Maintenance - Seal Re-Assembly Procedure first.

The main seal is delivered fully assembled and should be mounted without dismantling if possible.

However - dependant upon the requirements of supply, the Inflatable seal may be supplied split and separate to the main seal. If this is the case it must first be joined and assembled to the Mounting Ring. (See Section 7.2.1).

If the Inflatable seal is already fitted, then only the seat and drive clamp ring need to be removed prior to assembly. These split components are fitted after installation of the tail shaft.

Referring to Section 12.8. Maintenance - Seal Re-assembly, lift the seal with the compression tooling still in place.

The seal should be threaded along the shaft, with its joint, as the shaft is installed in the vessel.

Note: If the MB seal has a rubber lined carrier (refer to the G.A. or the MB seal itself) then the rubber lining will be a close fit to the shaft. This should be taken into account when threading the seal along the shaft and possibly water may be required as a lubricant to assist in this process.

Once the shaft is in approximately the correct position the mounting ring can be secured to the stern tube with the studs and nuts (or screws), ensuring that the seal is orientated so that all the water and air connections are in their correct positions (refer to general arrangement drawing for positions). Lightly grease both sides of the joint and position it on the Mounting Ring (over the spigot location if one is provided). Tighten the mounting ring nuts (or screws) evenly in a diametrically opposite sequence to the torque shown on the G.A. Drawing.

"DO NOT EXCEED THIS TORQUE"

Note: If there is no spigot location, the mounting ring should be centralised around the shaft before tightening the fasteners (see Section 6.2).

Now continue with Seal Compression (Section 7.2.3) onwards.

7.2.1. Inflatable Seal

The inflatable seal must be passed around the shaft, aft of the mounting ring and the ends joined with a suitable adhesive, ensuring that there is no **step** at the butts.

The inflatable seal depending on circumstances may be hot or cold bonded.

Hot bonding requires dedicated bonding equipment and as such can only be carried out by a Wärtsilä UK Ltd Propulsion Service Engineer.

The following procedure describes the cold bonding process in detail

PROCEDURE FOR COLD BONDING OF INFLATABLE SEAL

Please Note:

1. **A new inflatable seal is supplied to the correct length and must not be shortened.**

2. The butts of the inflatable seal have been suitably prepared for bonding prior to leaving the factory and require no further preparation other than cleaning using a suitable solvent cleaner (a suitable solvent cleaner being one that when applied evaporates leaving no oily residue).

3. A successful bond is easier to achieve with two people (i.e. one to hold the butts of the seal and form the bond, and one to apply the adhesive).

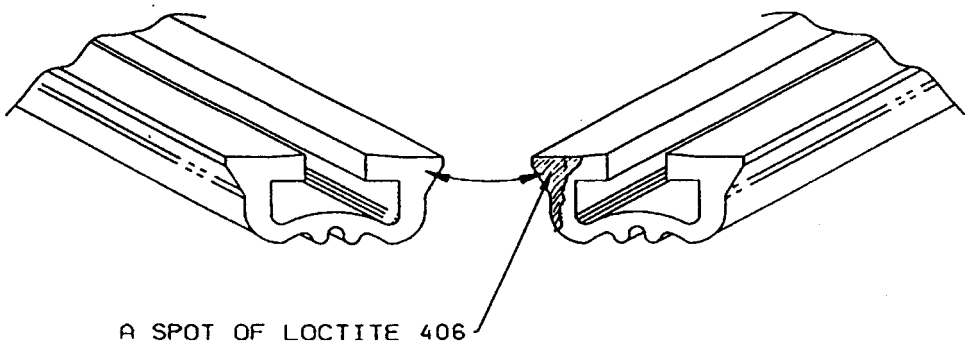
4. Do not try to achieve a complete cross sectional bond in one go; a progressive procedure should be adopted.

5. Providing the butts of the seal are clean and moisture free the nature of cyanoacrylate adhesive is such that a successful bond will occur within seconds. Therefore if a satisfactory bond is not instantaneously achieved, the application of additional adhesive is unlikely to correct the situation.

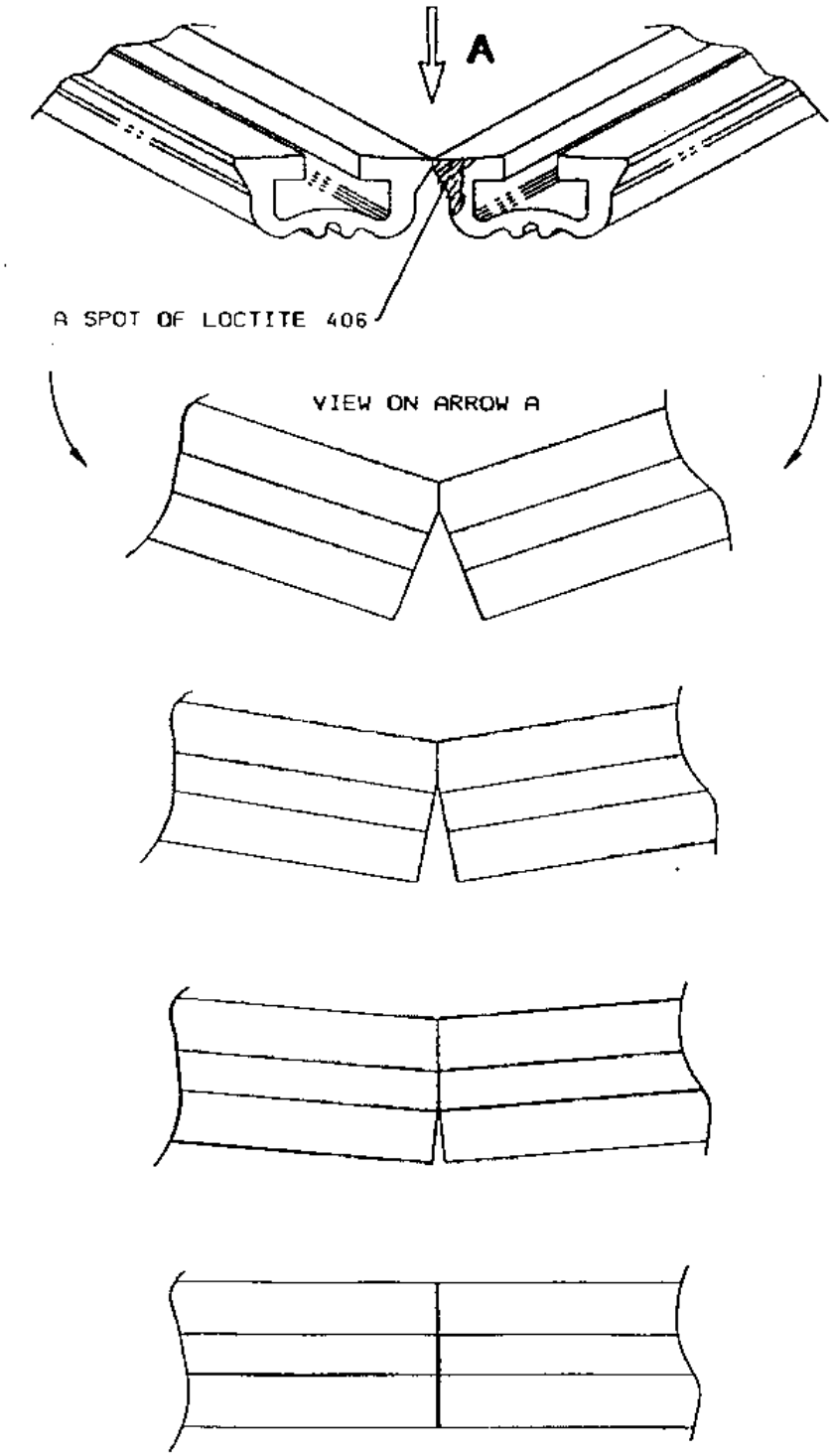
6. The inflatable seal and residue adhesive can be **worked** with suitable grade emery paper to correct the seal profile after the bond has been achieved.

BONDING PROCEDURE

1. Place the new inflatable seal around the shaft and starting at one edge apply a small amount of cyanoacrylate adhesive (e.g. Loctite 406) to one butt. Carefully join the butts together ensuring no step at the seal profile exists.



2. Continue applying adhesive to a small area and progressively join the butts until a successful bond has been achieved across the whole cross section of the seal.



3. If required correct the seal profile using a suitable grade emery paper (i.e. 120 grade) to remove any small steps or excessive adhesive.

Carefully insert the support ring into the joined inflatable seal using the minimum of grease.

Clean (removing any traces of butt sealant) and lightly grease the inflatable seal recess in the back of the mounting ring. Insert the inflatable seal, initially entering the leading edge of the rubber **all the way round** before pressing firmly and fully home into its recess. (The Inflatable seal and its Support ring may be fitted either way round).

Fit the adaptor ring - First thoroughly clean it, then locate it into the I.S. Housing recess up against the installed new inflatable and align the holes in the Adaptor Ring with the holes in the Housing. Apply Copper Based Anti-Seize Compound (supplied) to the Adaptor Ring screws, then tighten them evenly, progressively and in a diametrically opposite sequence to the torque specified on the G.A. Drawing.

"DO NOT EXCEED THIS TORQUE"

The mounting ring can now be secured to the stern tube as described in Seal Installation (Section 7.2) with its joint and nuts, (or screws) ensuring all pipe connections are in their correct positions. The joint will require to be cut if it has to be fitted around the shaft, a single dove tail or scarf cut **between** fastener holes is recommended - now lightly grease both sides of the joint.

The mounting ring can now be centralised around the shaft and the nuts (or screws) should be evenly and progressively tightened diametrically opposite sequence to the large specified on the G.A. Drawing.

"DO NOT EXCEED THIS TORQUE"

Now test the inflatable seal with air (or liquid).

Testing of Inflatable Seal

Refer to Air Supply - (Section 7.2.2.) first of all.

The inflatable air test is 5.0 Bar with an allowable leakage of 1.0 Bar/30 minutes/Metre of shaft diameter.

For example: - Shaft size = 727 mm diameter.

Allowable leakages would be 0.7 Bar in a 30-minute period or 0.35 Bar in a 15-minute period.

Test Procedure

(i) Close the vent/drain from the Inflatable Seal

(ii) Close the valve on the water supply to the Main Seal.

(iii) Open the air supply to the Inflatable Seal.

(iv) Open the drain valve from the Main Seal.

To revert to Normal Operation

(v) Close drain valve from the Main Seal.

(vi) Shut off the air supply to the Inflatable Seal.

(vii) Open the vent/drain from the Inflatable Seal.

(viii) Open the valve on the water supply to the Main Seal.

Note: Before connecting the air supply pipe to the Inflatable seal connection, blow the line through thoroughly to ensure that any debris/loose scale etc. has been removed.

Note: If a **liquid** is used as the inflation medium, it is advisable that the drain is fitted at bottom dead centre to ensure that the seal is properly drained.

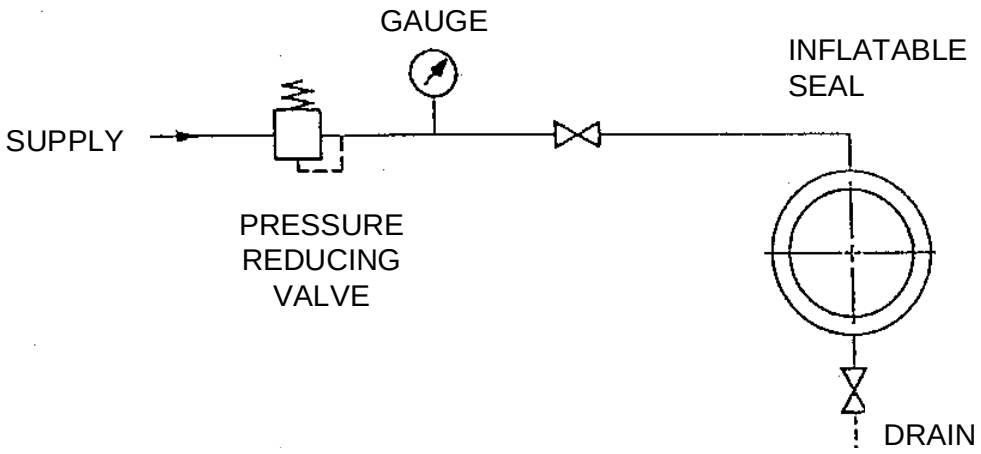
Note: When the inflatable seal is tested during Installation or Overhaul with the Bellows assembly disconnected from the Mounting Ring, the Inflatable seal is visible.

During tests in these circumstances the inflatable seal can be observed to confirm that it fully and evenly contacts the shaft when pressurised. Also the requirement to open and close water supply and drain valves to the main seal is not appropriate.

7.2.2. Air Supply

The air pressure required for the Inflatable seal should be stated on the G.A. Drawing.

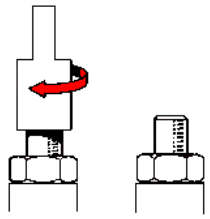
Normally, service air at a pressure of 5 Bar must be available, via a suitable control system, for the operation of the inflatable seal. A Typical, control system is indicated diagrammatically below.

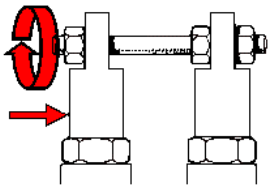


An air vent or drain must be provided in the operating system, which should be kept open whenever the Inflatable Seal is **not** in use.

Now continue with Seal Compression (Section 7.2.3).

7.2.3. **Compressing the Seal**.





At this stage in the seal assembly procedure the measured free length of the seal must be checked. If already fitted, release the compression tooling from the forward Clamp Ring in order to allow the Bellows to extend to its free length. If not already fitted, then screw the compression tools to the main clamp ring screws and fit studding into slots. Lock the studding in position on the Aft most tool with nuts either side. Fit nuts to the forward end of the studding but do not compress the seal yet.

Check the free length of the seal, which is from the running surface (of a new face) back to the sterntube mounting surface.

The design free length is stated in the code in the top border of the G.A. drawing (The end part of the code shows as/FL – XXXX). The actual free length should be within this toleranced figure.

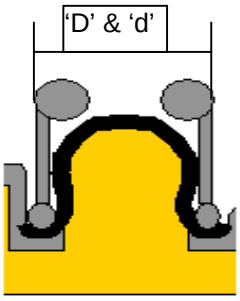
Over the bellows main clamp ring lugs check and make note of dimension 'D'. Now tighten the compression tools by applying the fitting compression stated on the installation drawing. **Do not over-compress the seal as this will result in damage to the bellows assembly.**

Check that the compression has been applied consistently by measuring across all main clamp ring lugs recording dimension 'd' for each lug in the table below.

These dimensions will be used for future comparative purposes. Lock off the compression tooling.

‘D’ = Bellows in free state

‘d’ = Bellows in compressed state



Date	Lug 1		Lug 2		Lug 3	
	D	d	D	d	D	d

7.2.4. Shaft Machining

Before fitting the seat, **if** the G.A. Drawings shows that the Drive Clamp Ring is fixed to the shaft using Drive Clamp Ring locking screws, then the shaft needs to be prepared at this stage.

Ensuring that the face of the MB seal is well protected, lightly join the Drive Clamp ring (correctly orientated) around the shaft using the butt screws. Position the Drive Clamp ring so that the forward edge is positioned at the overall length dimension as shown on the G.A. Drawing. Check that the Drive Clamp ring is square to the shaft, that any gap between the butts is even and then tighten the butt screws to grip the shaft.

Using the Drive Clamp ring as a template, mark off the shaft at the centre of each of the radially tapped holes, which take the locking screws.

Remove the Drive Clamp ring from the shaft and clean it. Using the marked positions, machine the shaft as detailed on the G.A. Drawing in order to accept the radial locking screws. Clean the shaft and newly machined holes, and then de-burr them to remove any sharp edges.

7.2.5. Seat Installation.

Ensure the shaft is clean as detailed in "Preparation".

Note: - The Seat and Drive Clamp Ring have to be aligned so that the alignment and drive screws can be fitted between them. The DCR. is located radially by the drive screws to the shaft/liner. In order to avoid rotating the Seat (to align it with the DCR) once the Seat has been fitted (which may cause the un-bonded Seat “O”-cords to separate), ensure that the Seat is orientated so that it will not require turning – before finally joining it around the shaft.

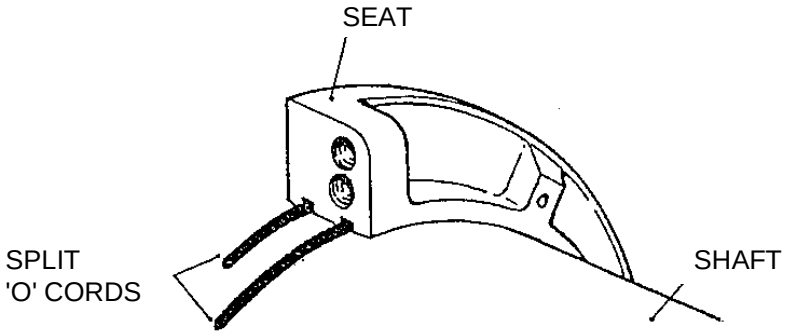
The seat is supplied assembled to protect the butt surfaces. Remove the screws at the butt and part the two halves. Clean any sealant compound from the butt surfaces. Ensure that the seat dowels and spring pins remain in position. Apply grease to both 'O' cord grooves visible in the bore of two halves. Press the split 'O' cords into one half of the seat with the ends hanging free. The' final 'O' cord joints must not align; therefore the free ends should be staggered. Lift this half off the seat complete with 'O' cords so that the butts are horizontal. Place this half over the shaft within 50 mm of the face, ensuring that 'O' cords remain in their grooves and do not become trapped.

Note: - The 'O' cords are supplied over length, to ensure their ends butt hard together.

Under no circumstances must the 'O' cords be shortened.

Pass the second half under the shaft and lift into position. Ensuring that the 'O' cords do not become trapped, carefully position them in the grooves in the second/lower half of the Seat (the ends of each O-Cord butts together) whilst raising the lower half of the Seat up towards the upper half. This operation requires extreme care and is more easily accomplished with assistance. Once correctly positioned apply Copper based anti-seize compound to the butt screw threads then insert the butt screws up to three full threads only. Clean the seat butt surface.

With the butts separated apply sealant to the butt surfaces. Double-check the radial position of the Seat vs the DCR. Adjust if necessary before tightening the Seat butt screws. Tighten the butt screws, ensuring the 'O' cords remain correctly sited and do not become trapped. Do not apply full torque to the screws at this time. Wipe any excess sealant from the seat face. Using a fingernail check that a step cannot be detected on the running surface at the butts. Fully tighten the butt screws to the torque specified on the installation drawing. Re-check the running surface at the butts, to ensure final alignment. Push the seat along the shaft until it contacts the face.



7.2.6. **Drive Clamp Ring**.

Ensure the shaft in the way of the drive clamp ring is clean and free from grease. Ensure that if required by the drawing, holes for the DCR locking screws have been machined in the shaft. Ensure that the holes machined in the shaft/liner have been de-burred to remove any sharp edges. Place the two halves of the drive clamp ring around the shaft. Apply Copper based anti-seize compound (supplied) to the butt screws and insert but do not tighten them.

Position the Drive Clamp Ring orientated correctly and aligned with the holes machined in the shaft (if required) as close to the seat as possible without actual contact. Engage the drive screws in the recess bosses on the Seat, and evenly tighten the butt screws to clamp the two halves of the DCR to the torque specified on the G.A. Drawing.

Fit the DCR radial locking screws (if applicable) through the DCR and into the holes in the shaft. These locking screws engage in the holes, but must not bottom out. They should be locked off against the DCR surface or with lock nuts if provided.

Tighten the alignment screws up until they contact the seat. Remove the compression studs and tools and return them to the toolbox.

7.2.7. **Seat Alignment**.

Mount a clock gauge to register against the face of the seat.

Rotate the shaft slowly and tighten up on the drive and alignment screws until the seat has been set to give a maximum of 0·25 mm total indicated reading.

On completion check that bellows compression is within 1 mm of the designed fitting compression (refer to General Arrangement Drawing) and tighten up the locknuts on the drive and alignment bolts.

Check and tighten, if necessary, the torque on the main clamp ring butt bolts.

Finally, re-check the compression and record the measurement of the gaps between each of the sets of main clamp rings lugs for the purpose of assessing seal wear. (Refer to Section 7.2.3).

7.2.8. **Splash Guard**.

Locate the splash Guard around the face carrier, ensuring that the drain hole is at bottom dead centre.

Now test the seal, as in Section 8 (Testing).

8. TESTING.

On completion of the Installation, static tests may be applied as follows:

8.1. Inflatable Seal Air Supply.

The air pressure required for the inflatable seal should be stated on the Installation drawing. An air vent or drain must be provided in the operating system, which must be kept open at all times when the inflatable seal is not in use. (Refer to Section 7.2.2. - Air Supply).

8.2. Inflatable Seal Air Test

The inflatable air test is 5.0 Bar with an allowable leakage of 1.0 Bar/30 minutes/Metre of shaft. (Refer to Section 7.2.1. - Testing of Inflatable Seal).

8.3. Face Seal Hydrostatic Test

Activate the inflatable seal to 0.3 bar min above the seal water test pressure.

Seal static test pressure is 1.5 bar.

The maximum acceptable leakage is 1.5-litres/100 mm of shaft/hour.

For example: -

Shaft size = 428 diameter

The maximum acceptable leakage is 6.4 litres/hour, or 1.6 litres in a 15-minute period.

9. NORMAL OPERATION.

During Normal Operation with the MB seal functioning within parameters, all conditions should be stable.

9.1. Stable Operating Conditions

9.1.1. Water ingress within acceptable limits.

9.1.2. No noticeable signs of the seal overheating.

9.1.3. Bearing Temperature(s) normal.

9.2. Routine checks that should be conducted.

9.2.1. Check for leakage regularly.

9.2.2. Check for signs of overheating regularly.

9.2.3. Check for Flush Water flow rate to the seal regularly.

9.2.4. Check the position (open/closed) of the Flush Water supply valve(s) daily.

9.2.5. Check the position of the Air Supply valve daily.

9.2.6. Check the bearing/stern tube temperature daily.

9.2.7. Check the operation of any supply pumps, filters etc. (if fitted) on a daily basis.

9.2.8. Check the Flush Water Flow Alarm (if fitted) weekly for correct operation.

9.2.9. Check the Seal overall length 3 monthly.

9.2.10. Check the Torque of the Clamp Ring Screws 3 monthly (Σ shaft stopped and locked).

9.2.11. Check Function and Performance of the Emergency Inflatable Seal on a routine basis (at least twice per year) (T Shaft Stopped and Locked).

9.3. Leakage rates.

Static (at Service pressure)

Static when fitted: - See Section 8.3

Static after run-in: - 0.5 litres/100 mm of shaft/hour.

For example: -

Shaft size = 428 diameter

Maximum acceptable leakage is 2.1 litres/hour, or 0.5 litres per 15-minute period.

Dynamic (at service pressure)

The maximum acceptable leakage is 1 litre/100 mm of shaft/hour.

For example: -

Shaft size = 428 diameter

Maximum acceptable 4.28 litres/hour, or 1.0 litre per 15-minute period.

9.4. Use of Inflatable seal as an emergency restrictor

In the event of an emergency the inflatable seal can be used as a restrictor. First close the vent valve at bottom dead centre. Open the air/liquid valve until the leak is reduced to approximately 2000 Litres per hour. **NOTE**: The maximum duration for running the vessel in this manner should not exceed 350 hours.

Note: The shaft speed **MUST NOT** exceed 50 revolutions per minute.

10. RECOMMENDED LUBRICANT LIST.

10.1. Closed/Sweet Water systems.

For MB seals used in a closed water lubrication system, refer to Technical Data Sheets 9/002.

TDS 9/002 refers to the additives normally used in conjunction with fresh water in the Closed Water (or Sweet Water) lubrication system along with recommendations regarding the concentrations of the mixture.

TDS 9/002 follows in Section 14– Attachments.

10.2. Open Water Systems.

For an MB Inboard seal used in an Open Water lubrication system there are obviously no recommended lubricants.

The MB Inboard Water lubricated seal is designed to work equally well on raw Sea Water or Fresh (River or Lake) Water or on a mixture (Estuarine) of these.

What is important is that the **flow** rate stated on the G.A. Drawing (which is a **minimum** figure) is maintained **whenever the shaft is dynamic**.

This figure (minimum flow rate) relates to the requirements of the MB seal alone unless specific reference is made to or shown relating to Bearing requirements.

Any requirement for the **Bearing,** which has to be supplied via the seal - **must** be considered as in addition to the seal flush rate!

11. PROBLEM SOLVING - Level 'a'.

11.1. Any problems with the MB Inboard seal will normally show themselves in one of two ways:

a) Water leakage from the seal.

b) Over heating of the seal.

(Refer to the associated causes and corrective actions in Section 11.4. and 11.5.).

11.2. Evidence that either of the above has occurred will be demonstrated in one of the following ways. (Also refer to the associated problem solving flow charts in Section 11.3 as indicated below).

a) Excessive Water leakage during routine inspection of the seal (Flow chart 11.3.2).

b) A high-level alarm warning from the Bilge Alarm (Flow chart 11.3.3).

c) A low flow in the Flush Supply activating the Low Flow alarm if one is fitted (Flow chart 11.3.4).

d) A high Bearing/Lubricant temperature alarm. (Flow chart 11.3.5).

e) A low-level alarm warning from a Sweet Water header tank (Flow chart 11.3.6.).

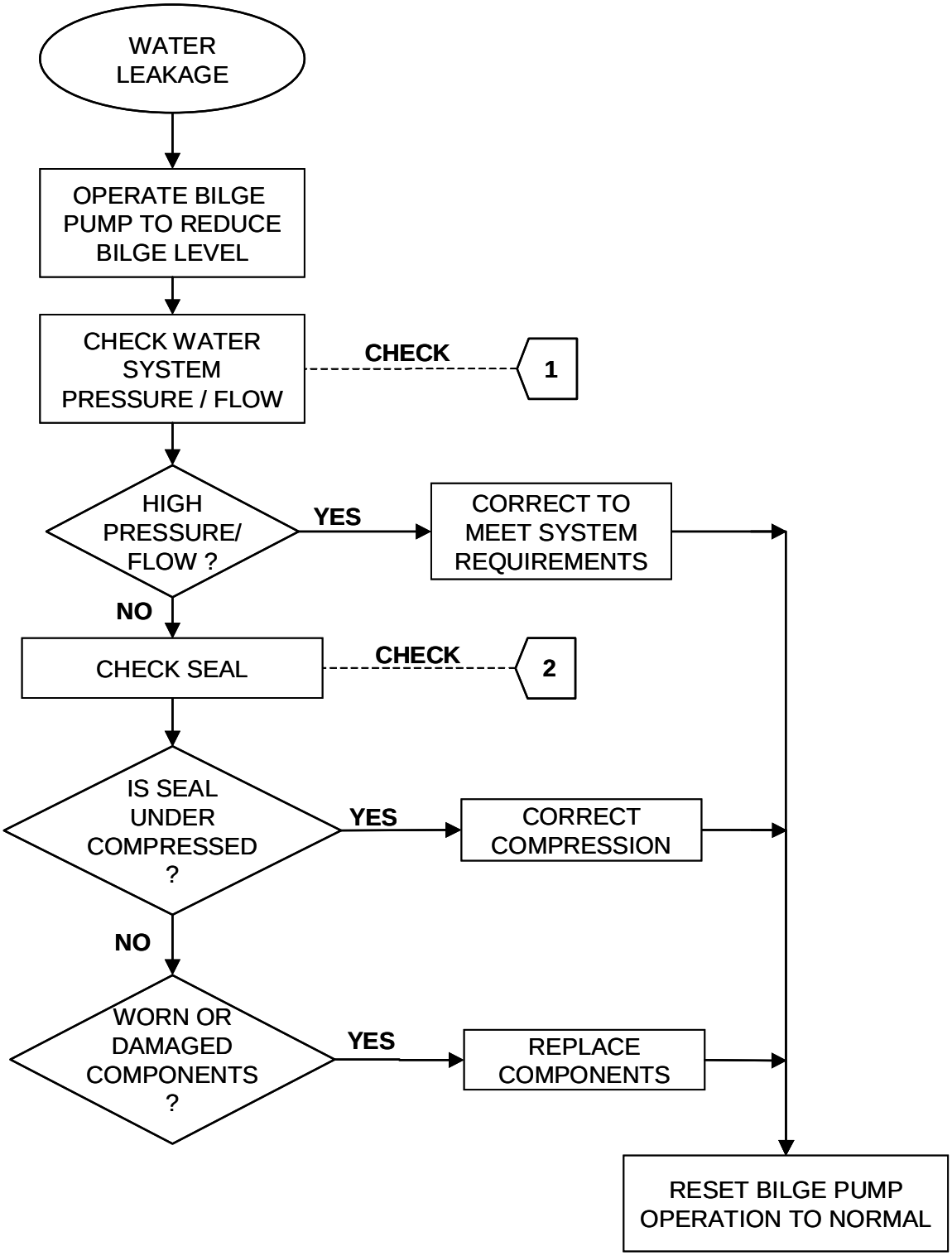
11.3. Flow Charts.

Explanations of the above, including cause, affect and corrective actions now follow:

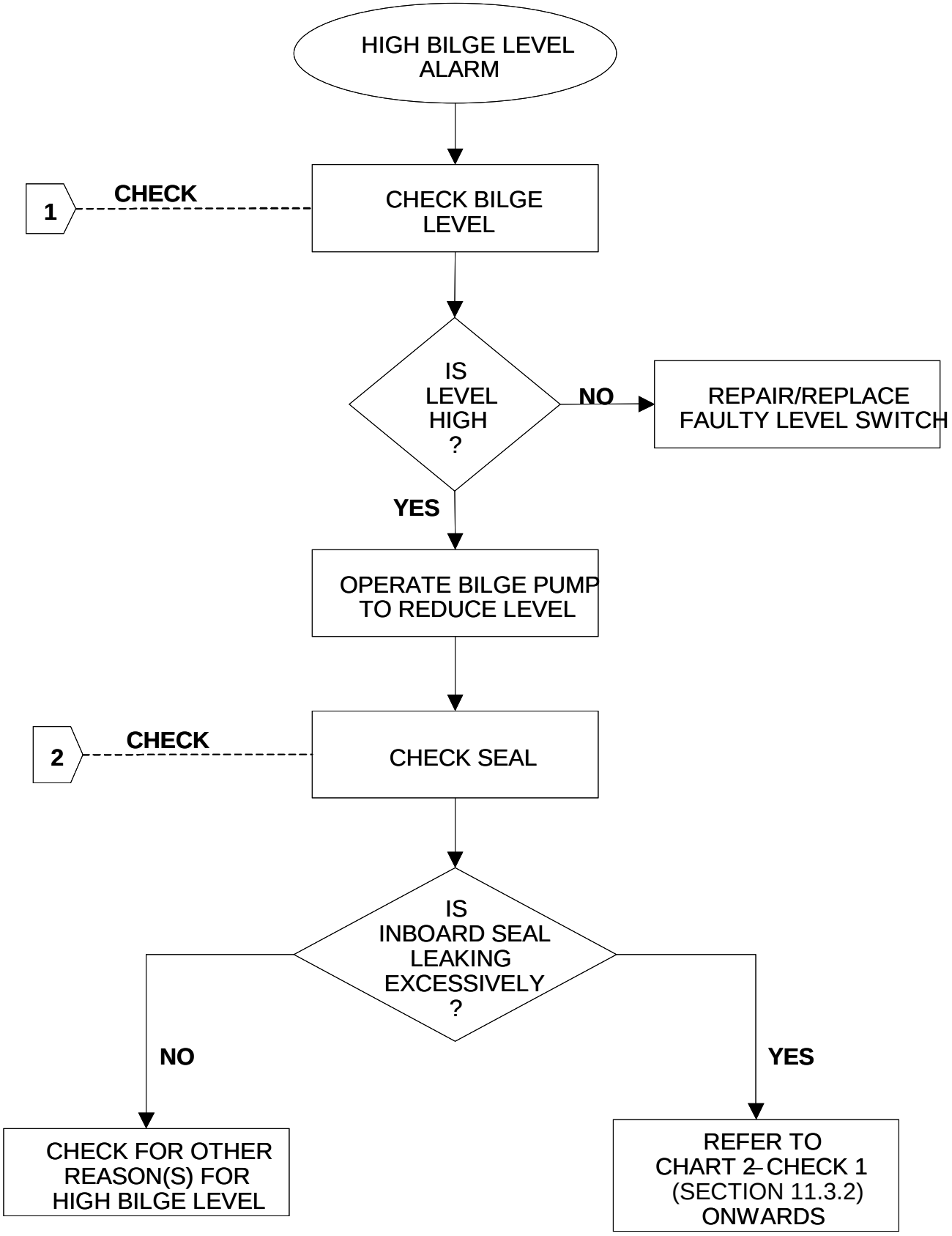
11.3.1. Normal Operation

For Normal Operating Conditions, refer to Section 9 (in conjunction with Heat Tank location/Lubrication Systems as referenced in Section 5).

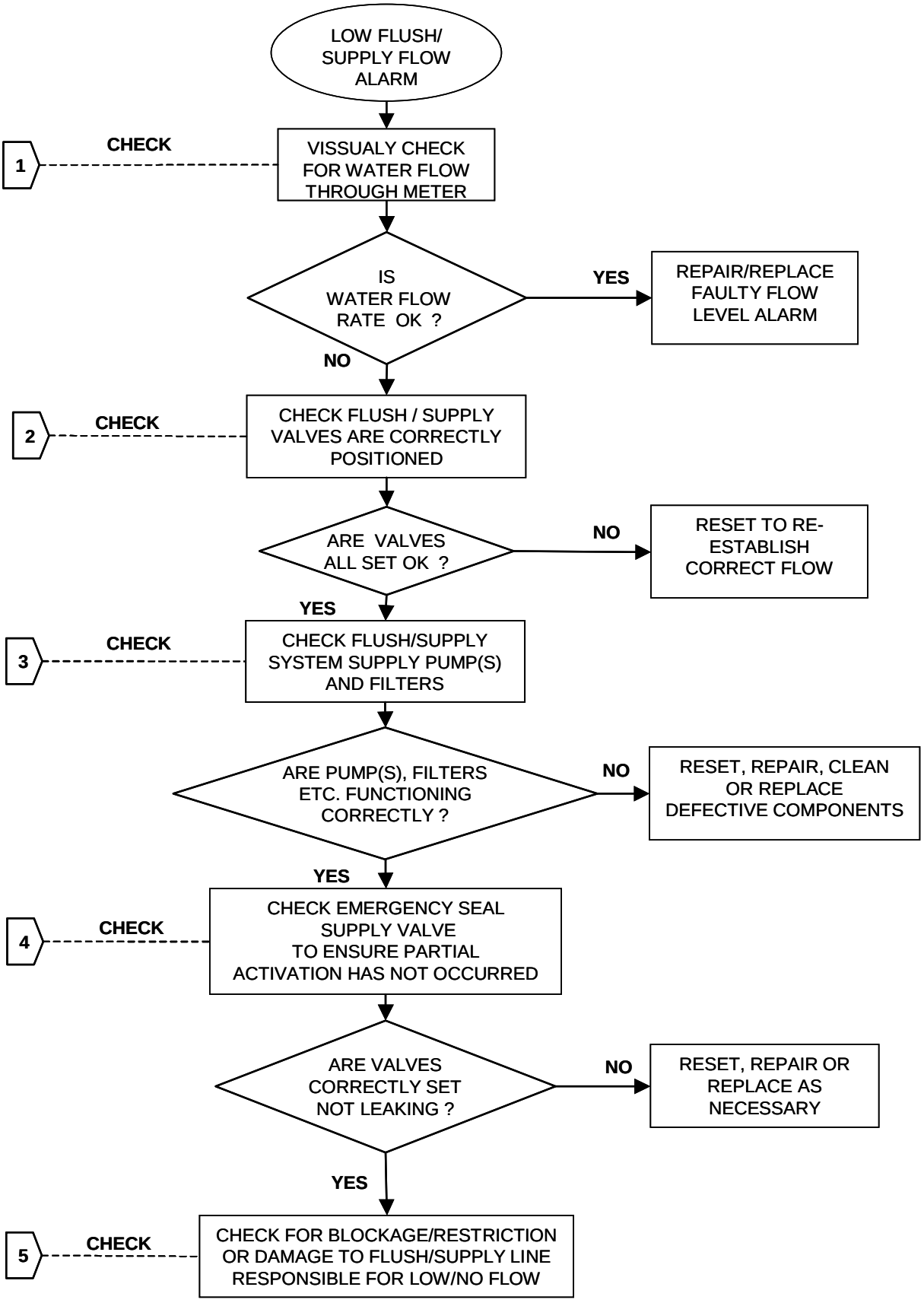
11.3.2. WATER LEAKAGE.



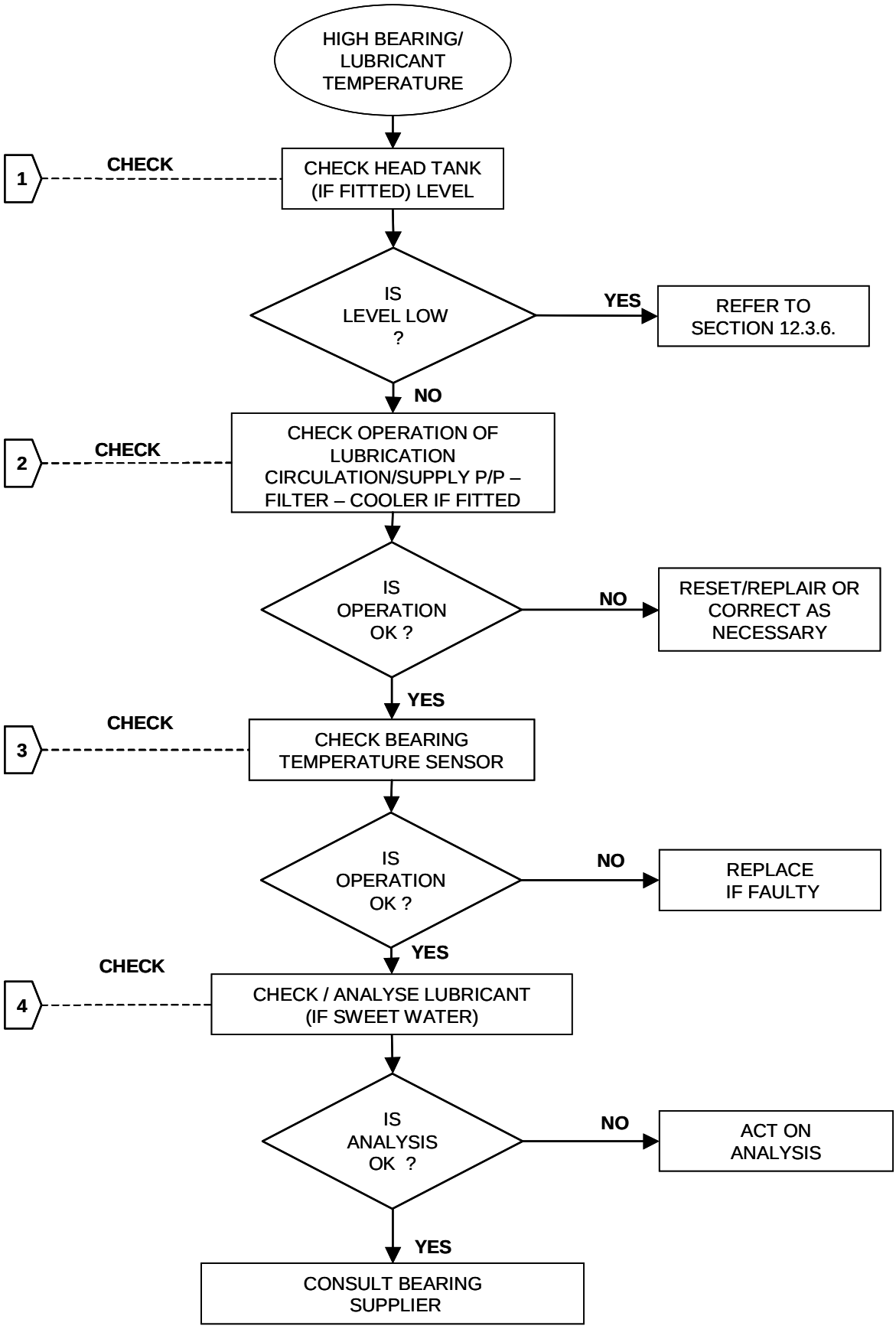
11.3.3. BILGE HIGH LEVEL ALARM



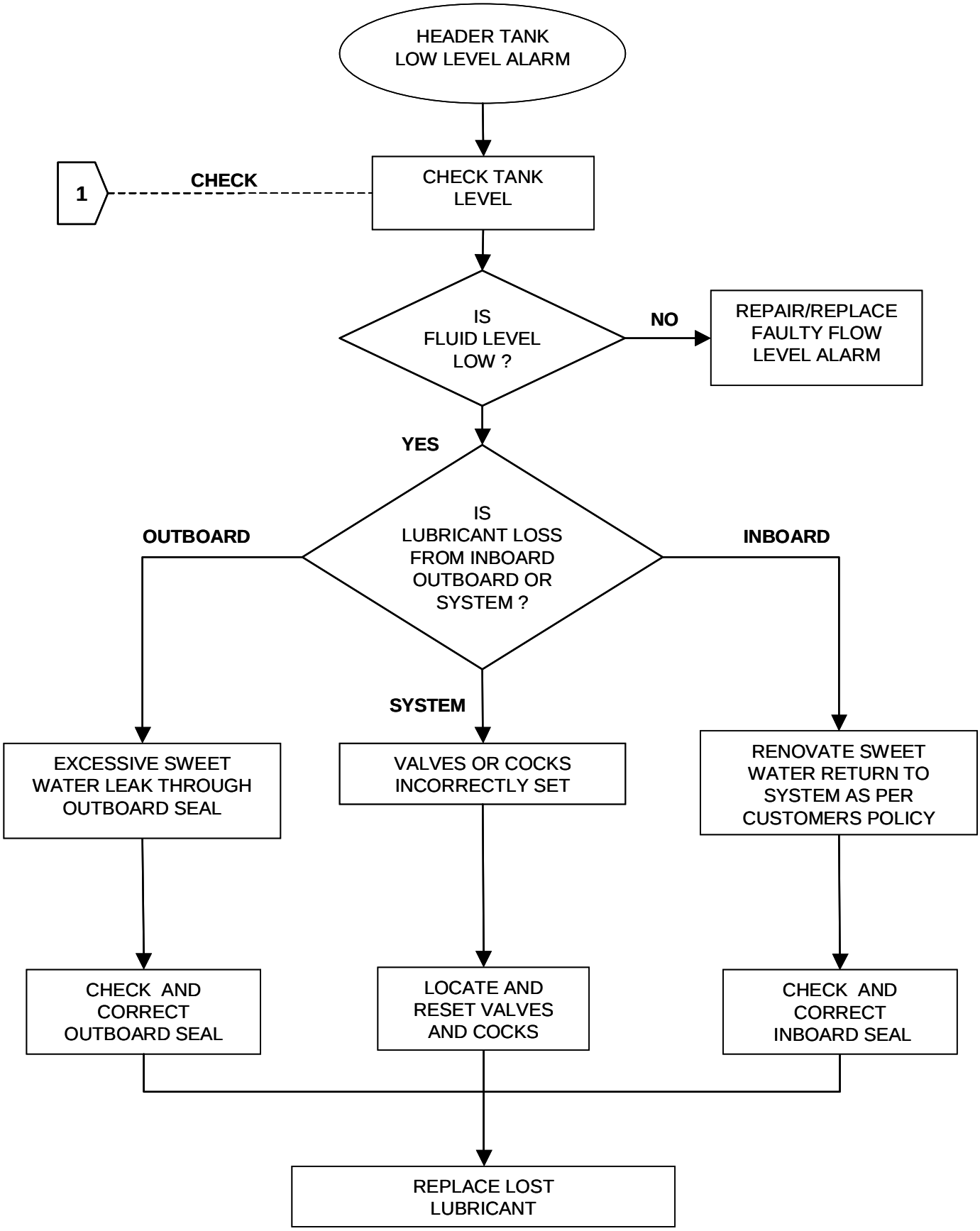
11.3.4. LOW FLUSH/SUPPLY FLOW ALARM



11.3.5. HIGH BEARING/LUBRICANT TEMPERATURE



11.3.6. SWEET WATER – HEADER TANK LOW LEVEL ALARM.



11.4. SECTION "A" - WATER LEAKAGE FROM THE SEAL

Water leakage from the Inboard seal may be due to one or more causes. For each, a suggested course of corrective actions follows:

CAUSE		CORRECTIVE ACTION	
A1	Water pressure/flow too high	a	Reduce to that stated in the Technical Manual.
A2	Loss of seal compression due to age or wear	a	As a temporary measure, reset the fitting compression by using compression tooling until components can be replaced.
		b	Replace the component(s) responsible for the loss of compression.
A3	Insufficient compression due to installation or axial shaft movement	a	Establish the correct compression by resetting - the seat and clamp ring using the compression tooling.
		b	Determine and rectify the causes of excessive shaft movement.
A4	Debris between the Face and Seat.	a	Carefully remove any debris. If no damage has occurred a good seal should be re-established. If damage has occurred - refer to "A5".
A5	Damage to the inboard seal.	a	If the seal is damaged and is leaking then proceed as for 2a. having first checked and carefully removed any debris.
		b	Run dynamically on the Inflatable Seal.
		c	Replace damaged components as soon as is possible.

11.5. SECTION "B" - EVIDENCE OF OVERHEATING OF THE SEAL

As for Water Leakage, Overheating may be due to one or more causes.

For each, a suggested course of corrective actions follows:

CAUSE		CORRECTIVE ACTION	
B1	Water pressure/flow too low.	a	Increase to that stated in the Technical Manual.
B2	Loss of Water Flush/ Circulation.	a	Check and re-set all flush supply valves to correct position/operation.
		b	Check supply pump(s) and filters etc. for correct operation.
		c	Check Emergency seal supply valve to ensure it is correctly positioned and the Inflatable seal has not become partially inflated.
		d	Check for blockage/restriction or damage to the Flush supply line(s) causing low/no flow.
		e	Where a Header Tank is used – confirm that the level is not low.
B3	Excessive compression due to installation or axial shaft movement.	a	As for "A" 3a.
		b	As for "A" 3b.

NOTE: Where corrective actions involving material replacement refurbishment or adjustment have rectified a situation, then any "temporary" measures taken such as changes in lubricant pressures should be reverted to normal.

NOTE: If these Problem Solving measures fail to rectify a situation, then assistance and further advice should be sought via one of the contact addresses given in the front of the Technical Manual.

12. MAINTENANCE.

(Refer to relevant Drawing(s) - Section 14)

12.1. The need for Maintenance

This may be determined by several factors, which are performance related. Alternatively, though the performance of the equipment may be perfectly satisfactory, maintenance may be carried out as part of a planned/preventative schedule. Overhaul of the equipment may also be carried out because it is part of a system or assembly that is itself needing or due for maintenance!

For example:

- ❑ Each time the vessel is alongside with the shaft stopped and locked the seal should be viewed externally for signs of wear, deterioration or damage.
- ❑ Each time the tailshaft (screw shaft) is withdrawn the face assembly comprising face and sealing strip should be replaced and the seat refurbished as per Section 12.7.1. Whilst the shaft is out, the seal should be viewed internally for possible support spring damage.
- ❑ Every 4/5 years the seal should be thoroughly inspected both inside and out. Should a major loss of free length or any signs of damage be found, the bellows assembly must be replaced.
- ❑ At the same time, the opportunity should be taken to replace the Neoprene Inflatable Seal.
- ❑ The bellows assembly comprising support spring assembly, bridging spring assembly, backing spring assembly and interlayer should be replaced at intervals not exceeding 10 years regardless of apparent condition.
- ❑ The measurement of the "Free Length" of the seal or the distance between each of the main clamp ring lugs as described in Section 7.2.3 will help in the assessment of the Bellow spring condition and overall wear (Face & Seat) by comparison with the original Installation figures (See Section 7.2.3).
- ❑ If the vessel is out of the water, there is no need to operate the Inflatable Seal, except for a Sweet Water System, where (for whatever reason), it is decided not to drain the lubricant from the system.

12.2. Factors that normally determine the need for Maintenance are:

12.2.1. Performance: -

Excessive water ingress into the vessel.

12.2.2. Wear: -

Normally associated with the fibre face of the seal, though it does to a lesser degree affect the Ph. Bronze seat.

Wear is important as the loss of material means a loss of compression in the bellows assembly, which can lead to leakage.

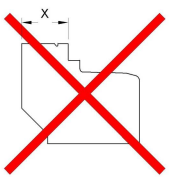
The following Maintenance Procedures are based on a condition where the Propeller Shaft is still installed (stopped and locked). If the vessel is in the water or with a sweet water system, the lubricant is not being drained, then shut the valve(s) supplying water to the Stern Tube bearing and the main seal. Operate the Inflatable Seal and open the drain on the main seal. Wait for all water to drain, the absence of further water verifies that the Inflatable Seal is tight.

T IMPORTANT: BEFORE COMMENCING ANY MAINTENANCE PROCEDURE - "ENSURE" THAT THE SUITABLE REPLACEMENT SPARES ARE AVAILABLE.

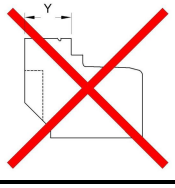
12.3. Face

12.3.1. Face Wear.

Wear the MB" face can be determined by measuring the length of the nose of the face. When new this dimension is typically about 15 mm. If the measurement is less than the value indicated below, the face assembly should be replaced in order to re-establish the correct compression on the seal.



Condition (Plain Face)	Status
X = 15 (approx.)	"as new"
X > 5	OK
X < 5	Replace



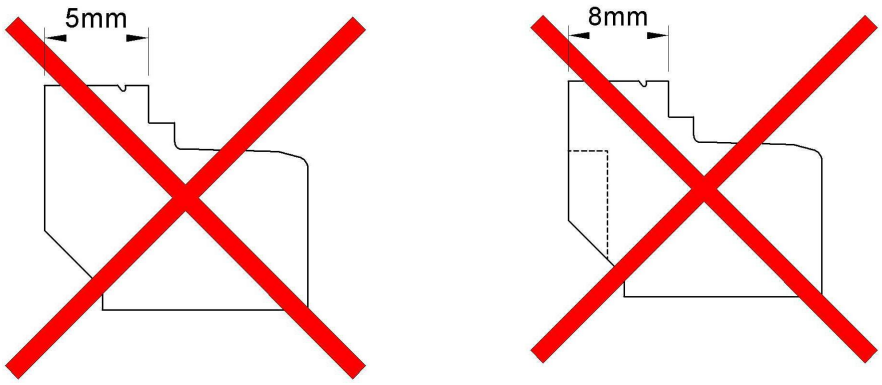
Condition (Slotted Face)	Status
Y = 15 (approx.)	"as new"
Y > 8	OK
Y < 8	replace

Normally on a vessel operating deep sea or using a Sweet Water Lubrication system the MB seal experiences low levels of wear. However, an open water system operating in abrasive water conditions may experience higher wear rates then when operating in clean water.

12.3.2. Face maintenance procedure.

The face is not normally considered to be refurbishable. However, in certain circumstances it is possible to re-use the face after it has been machined. It is mandatory that re-machining of the face is only carried out under the supervision of Wärtsilä UK Ltd.

Note: A face with a nose length of less than the value shown below is not considered to be recoverable.



Plain Face **Slotted Face**

Installation procedure is as described in Section 12.8.5. and 12.8.6. (Re-Assembly).

12.4. Seat

The seat is designed to be a component that can be refurbished. Whenever the seat is dismantled or new face is to be fitted the running surface of the seat must be re-machined to remove the existing wear track. Re-machining can only be carried out with the two halves of the seat secured together.

To replace/refurbish the Face and Seat requires only partial dismantling of the MB seal. The Mounting Ring, Bellows and Carrier assemblies may remain undisturbed on the shaft if Maintenance is restricted to the Face and Seat only.

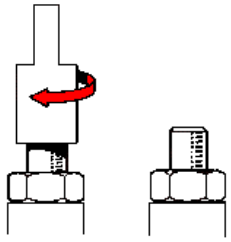
12.5. Inflatable Seal

The only maintenance requirement for the Inflatable seal is a regular test preferably not in excess of 6 months to ensure that the pipe system is clear and that the Inflatable seal operates satisfactorily as described in Section 7.2.1

12.6. Seal Dismantling Procedure

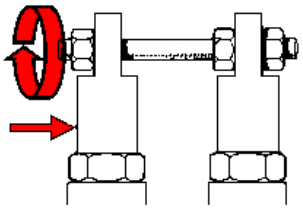
12.6.1. Isolation

Close the valve supplying water to the stern bearing and main seal and operate the inflatable seal. Open the drain on the main seal and drain off any remaining fluid.



12.6.2. Seal Compression

Screw the compression tools to the main clamp ring screws and fit studding into the slots. Lock the studding in position on the forward most tool with nuts either side. Compress the seal (evenly and progressively) so that a gap of 5 mm maximum exists between face and seat.



Do not over compress seal as this will result in damage to bellows assembly.

12.6.3. Splash Guard removal

Undo or unclip the Splash Guard from around the Carrier - retain for reuse if not being renewed.

12.6.4. Drive Clamp Ring Removal.

Slacken the locking nuts on the Drive and Adjusting screws, and then undo the screws until they are clear of the seat.

Slacken, and remove the Drive Clamp Ring Locking Screws.

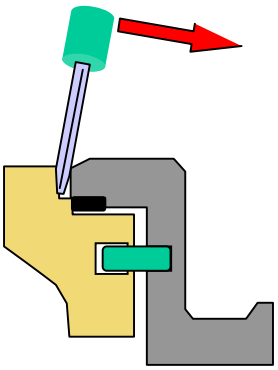
Slacken, then undo the Drive Clamp Ring Butt screws and carefully remove the Drive Clamp Ring from the shaft.

12.6.5. Seat Removal

If possible turn the shaft on turning gear so that the seat butts are horizontal. Loosen the seat butt screws and pull the seat forward clear of the face and secure lifting equipment to the top half. Remove the butt screws, separate the butts and lower the bottom half clear of the shaft. Remove and retain the seat dowels and spring pins for future use. Secure lifting equipment to the top half, and lift it clear of the shaft. Remove and discard the two 'O' cords.

In order to best protect the Seat, especially the butt surfaces, it is recommended that once removed from the shaft, the seat is joined back together using the dowels/spring pins and butt screws.

12.6.6. Face Removal

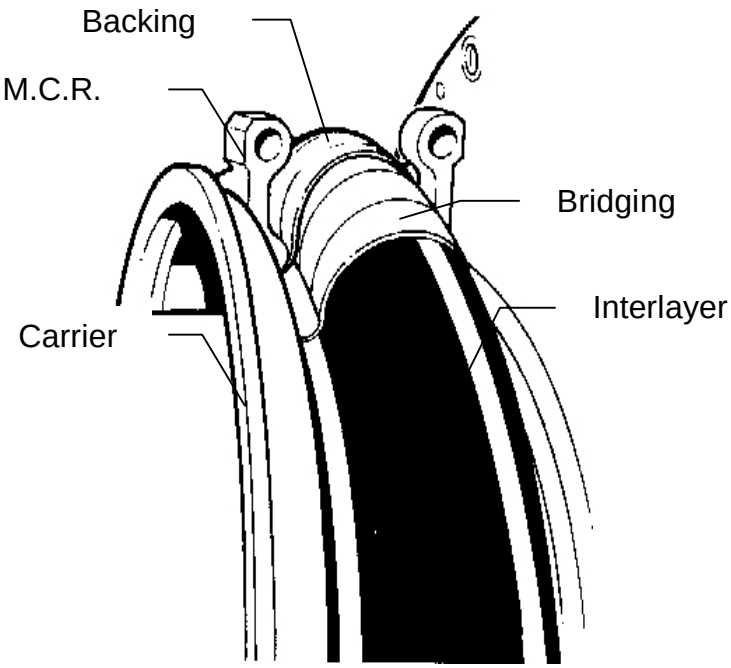


Insert a lever into the gap between face and carrier, gently lever working around the circumference until the face begins to move.

Note: Do not use excessive force or the face will be damaged.

Fully remove the face, remove and discard the sealing strip.

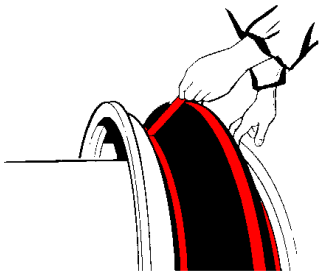
12.6.7. Backing Spring Removal



At this stage remove the compression tooling allowing the bellows to expand to its natural free length. Return the Compression tooling to the toolbox for future use. Support the carrier with wooden chocks and loosen the main clamp ring screws. Remove the screws from one segment at a time and carefully ease the main clamp rings and backing springs away from the seal. Remove the short bridging springs.

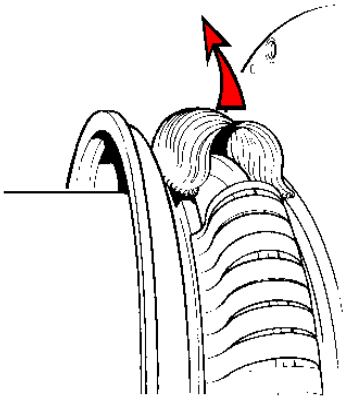
Note: Care should be taken when removing backing and bridging springs if they are to be reused.

12.6.8. Interlayer



Remove the PVC tape from the interlayer and starting at the loose end unwind interlayer. This item **must always be renewed** on rebuilding the seal.

12.6.9. Support Spring Removal



First remove any PVC tape from around the support spring. The support spring assembly is connected by 'O' cords. Find the ends of the assembly and gently pull so that springs unclip from slots in carrier and mounting ring.

Note: Care should be taken if the support spring assembly is to be reused.

12.6.10. Carrier and Mounting Ring Removal

With the MB seal, at this stage of seal dismantling, only the Carrier and Mounting Rings will be left fitted around the shaft.

If **necessary** to **remove** them, then this must be done by de-coupling the shaft in order to remove these non-split components. Otherwise they may be left in position undisturbed/over the shaft until the seal is re-assembled.

Carrier Removal

Sling the carrier to a suitable lifting arrangement using reinforced fibre strops. With the carrier secured, carefully remove it from the shaft.

Mounting Ring Removal

To remove the Mounting Ring, the vessel **must** be out of the water and all services (air and water) must be disconnected from the Mounting Ring. If the lubrication system is a closed Sweet Water one, it must first be drained before the seal is disassembled.

To access and replace the Inflatable seal, the Mounting Ring must be separated from the Sterntube, though it need not be removed from the shaft. Remove the Nuts or Screws securing the Mounting Ring to the Sterntube.

Separate the mounting ring from Sterntube/joint. (The Mounting ring has 4 off tapped through holes for fitting the compression Tooling - jacking screws may be inserted in these holes to assist in the removal from the Sterntube). Secure and sling the Mounting ring with lifting strops as for carrier. Move the Mounting ring forward on the shaft, clear of the Sterntube.

Undo and remove the Inflatable Seal Adaptor ring screws from the back of the Mounting ring followed by the split Adaptor ring itself.

Carefully ease the Inflatable seal and its Support ring out of the recess in the back of the Mounting ring, then remove the Split support ring and cut and discard the old Inflatable seal.

Remove the Mounting Ring from the de-coupled shaft if necessary.

12.7. Refurbishment.

With the MB seal, the majority of any maintenance requirement is by re-use of existing parts or replacement with new components.

When considering the assemblies/components, the following is applicable.

(a) Major Wearing Components.

- Face - not refurbishable - replace.
- Seat - refurbishable - re-use (replace if necessary).

(b) Major Working Components.

- Bellows Assembly - not refurbishable - reuse - replace if necessary.

(c) Elastomers.

- Inflatable/Interlayer/Seat 'O' Cords - not refurbishable - replace if necessary or whenever disturbed.
- Rubber lining inside carrier – not refurbishable – If seriously damaged or deteriorated – return the carrier for refurbishment/ replacement if necessary.

(d) Major metal components (excluding the Seat).

- I.S. Adaptor Ring
- I.S. Support Ring
- Mounting Ring
- Main Clamp Ring
- Carrier *
- Drive Clamp Ring

} Not refurbishable - re use (replace only if necessary)

***** See (c) if damage is restricted to only the rubber lining.

From the above it will be noted that only the seat is Refurbishable and the Procedure for seat refurbishment is as follows.

12.7.1. Seat Refurbishment Procedure

The seat is designed to be a refurbishable component. Whenever the seat is dismantled or a new face is to be fitted, the running surface of the seat must be re-machined to remove the existing wear track. Re-machining can only be carried out with the two halves of the seat secured together.

Procedure

(i) Transport the seat to the workshop ensuring that all machined surfaces are adequately protected.

(ii) Carefully remove butt screws, retain with the seat dowels and spring pins for future use.

(iii) Thoroughly clean the two halves, especially all machined surfaces and the butt surfaces to remove all traces of sealing compound.

(iv) Place each half of the seat, butts down on a clean surface table. Using a feeler gauge check for flatness by ensuring that a gap of no greater than 0.025 mm (≈0.001") exists. Should a gap in excess of 0.025 mm (≈0.001") be found then Wärtsilä UK Ltd. must be contacted to obtain machining instructions. Alternatively, if a suitable surface table is not available, bolt the two halves of the seat together (clean and dry, without sealant). Using this method, if a gap in excess of 0.05 mm (≈0.002") is found then Wärtsilä UK Ltd. must be contacted.

(v) Once the butts have been found to be satisfactory, the seat dowels and spring pins can be refitted and the halves of the seat carefully reassembled without butt sealant. Ensure that the screws are tightened to the torque value specified.

(vi) Mount the assembled seat on a suitable machine table and align vertically and horizontally. Care must be taken when clamping the seat to prevent distortion.

(vii) Machine across the full running surface to remove all signs of any existing running track and generate a surface finish of 1.6μm. Using grade 600 grit abrasive paper, polish to achieve a final surface finish of 1.2 μm.

12.8. Seal Re-assembly Procedure

This procedure is based on the Propeller and Shaft remaining in situ during re-assembly. If the Propeller shaft is removed or de-coupled, assemble the seal as follows and install it as a unit as per Section 7.2 (Seal Installation - Shaft Removed).

12.8.1. Carrier and Mounting Ring Re-Assembly.

If these items were removed as described in 12.6.10., then they need to be replaced as follows.

Mounting Ring:

Ensure that all components of the Mounting Ring Assembly are available, in good condition and thoroughly cleaned.

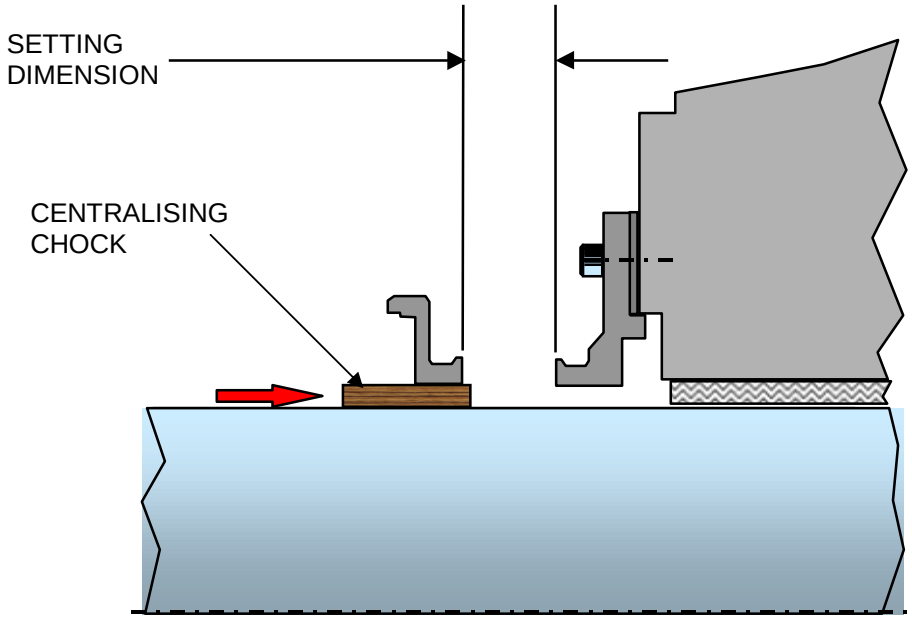
A new mounting ring joint should be fitted over the shaft, between the sterntube and the mounting ring, having been greased on both sides.

Next a new Inflatable seal must fitted to the Mounting Ring and the Mounting Ring then fitted to the Sterntube as described in Section 7.2.1

Carrier:

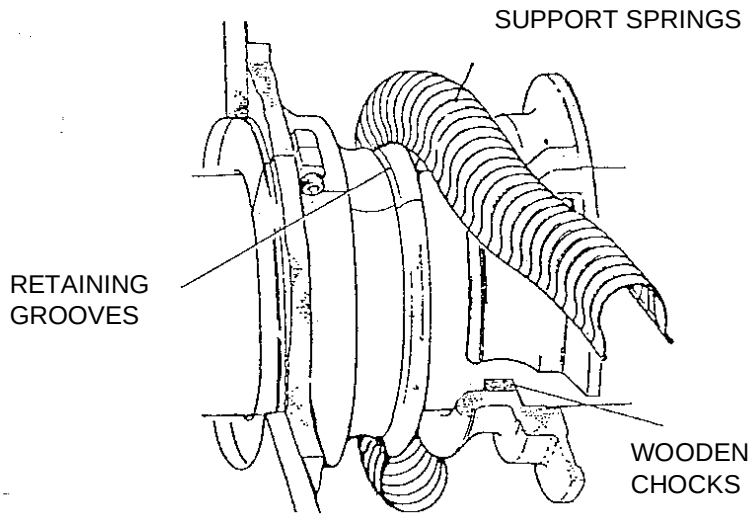
Ensure that all components of the Carrier Assembly are available, in good condition and thoroughly cleaned.

Using suitable wooden chocks, centralise the carrier on the shaft.

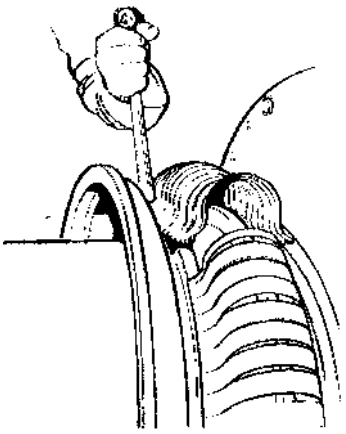


The setting distance between the carrier and the mounting ring should be adjusted to the dimension specified on the G.A. drawing.

12.8.2. **Support Spring**.



Starting at bottom dead centre, lay the support spring in position across the carrier and mounting ring. Using a suitable wooden shaft, tap the ends of the springs so they clip into the grooves. Work around the seal ensuring that each spring **butts** up to the next until all springs are fitted as shown.

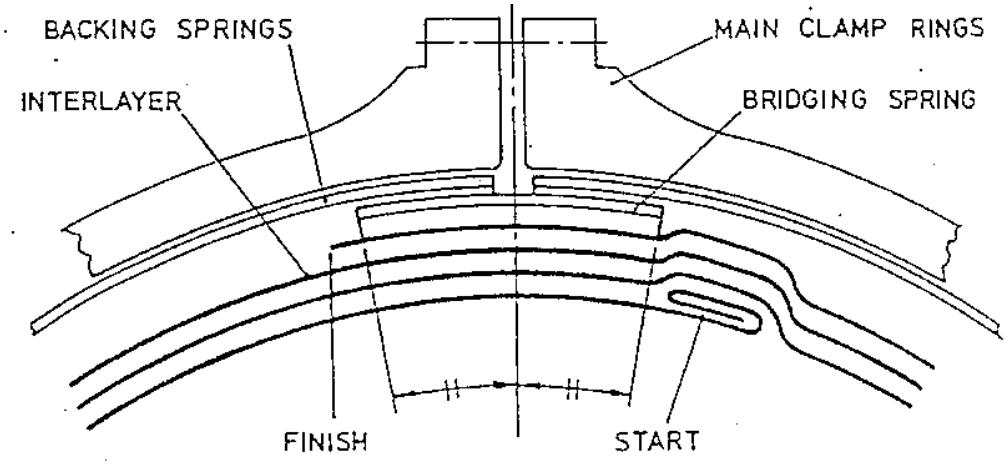


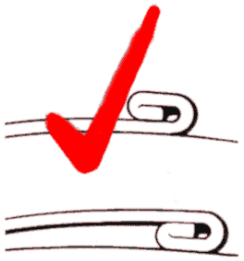
To ensure the join, use PVC tape across four springs (i.e. 2 springs either side of the join) in several places (e.g. in both grooves - at the top of the Omega Spring and either side).

12.8.3. Interlayer Wrapping.

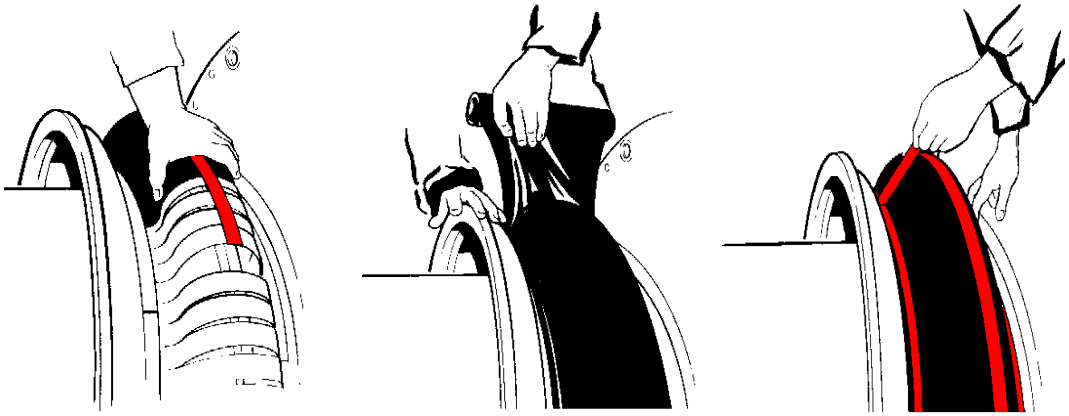
Roll the interlayer, starting at the plain end, into a tight coil, with the fabric backing outwards.

The start of the interlayer, the folded end determines the position of the main clamp ring butts as shown below.





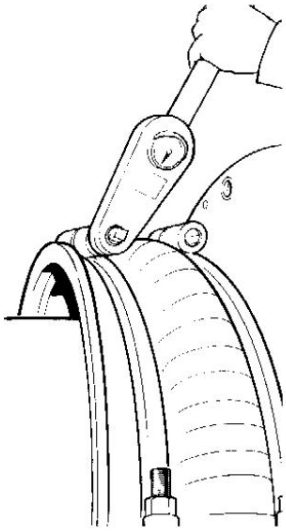
Position the folded end of the interlayer so that it is offset from TDC by approximately 15º. Using PVC tape, fix three lengths of approximately 500 mm in the centre and at the edges of the springs. Two men are required to perform the next operation. With one holding the end of the interlayer, the other pulls the roll so that the rubber is tightly stretched over the springs. The interlayer must be central, free from creases and go around the seal between 3¼ - 3½ times. The interlayer is then retained in position by running three lengths of PVC tape around the seal in the same positions as above.



12.8.4. Backing Spring Assembly.

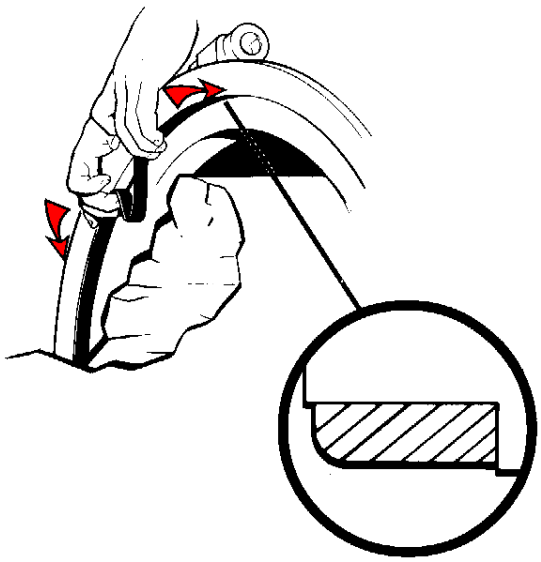
First lightly grease the Inner surfaces of the Bridging and Backing Spring where they will fit into the Carrier and Mounting ring grooves.

Place the first bridging spring at TDC alongside the bulge created by the start of the interlayer. The other bridging springs must be equally spaced around the interlayer and can be adjusted as the backing springs are fitted.



The backing spring segments must be positioned so that the gaps between the main clamp ring butts are even and that a bridging spring is centrally positioned under each gap. Before the main clamp ring screws and nuts are fitted, ensure that the numbers stamped on the main clamp ring butts are **matched**. Next, apply Copper based anti-seize compound (supplied) to the butt screw threads. The screws can now be tightened, maintaining an **even** gap at all main clamp ring butts. Once tight the screws must be progressively torque to the value specified on the General Arrangement Drawing. **DO NOT EXCEED THIS TORQUE.** Support chocks should then be removed.

12.8.5. Face Sealing Strip Assembly.

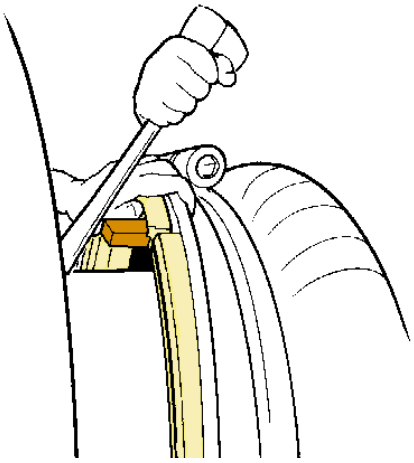


The recess in the carrier in which the sealing strip locates should be cleaned and greased. The sealing strip should be fitted into the groove so that the radiused edge forms a lead in for the face as shown. The two ends should be fitted together and a loop formed at 180° to the join. This loop is 'smoothed' into the carrier. The sealing strip is supplied in this manner in order that the face is correctly loaded.

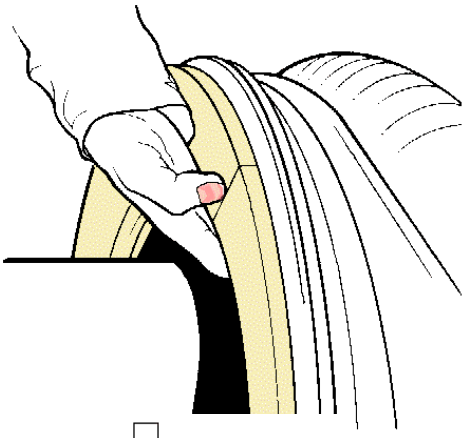
Under no circumstances shorten the sealing strip.

Note: Observe the position of the Anti Rotation pins in the carrier and estimate where the two butt joins of the face will be. Ensure that the face sealing strip join will not coincide with the join in the face.

12.8.6. Face Insert Assembly.



Grease the **new** sealing strip taking care not to dislodge it. Lightly grease the area of the face that engages into the sealing strip ensuring that no grease migrates to the raised running surface or the butts. Fit one half of the face ensuring that the anti rotation pin holes in the back of the face engage with the pins fitted into the carrier. Push the second half of the face into position, if necessary lever the face using a wooden block and hammer shaft as shown, in order to avoid damage to the face insert.

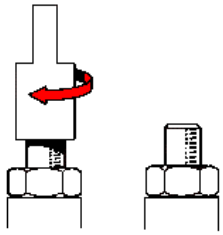


Care must be taken not to damage the face otherwise seal leakage will occur.

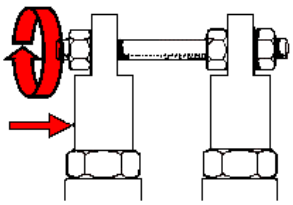
Once the face is fully positioned adjust the butts so that no step can be detected with a fingernail across running track.

Important: Any detectable step left in the running surface will result in seal leakage.

12.8.7. Compressing the Seal.



At this stage in the seal assembly procedure the measured free length of the seal must be checked. If already fitted, release the compression tooling from the forward Clamp Ring in order to allow the Bellows to extend to its free length. If not already fitted, then screw the compression tools to the main clamp ring screws and fit studding into slots. Lock the studding in position on the Aft most tool with nuts either side. Fit nuts to the forward end of the studding but do not compress the seal yet.



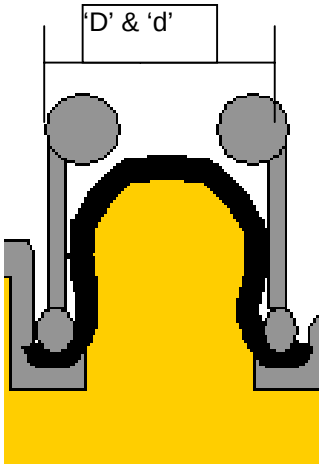
Over the bellows main clamp ring lugs check and make note of dimension 'D'. Now tighten the compression tools by applying the fitting compression stated on the installation drawing. **Do not over-compress the seal as this will result in damage to the bellows assembly.**

Check that the compression has been applied consistently by measuring across all main clamp ring lugs recording dimension 'd' for each lug in the table below.

These dimensions will be used for future comparative purposes. Lock off the compression tooling.

'D' = Bellows in free state

'd' = Bellows in compressed state



Date	Lug 1		Lug 2		Lug 3	
	D	d	D	d	D	d

12.8.8. Seat Assembly.

Ensure the shaft is clean as detailed in "Preparation".

Refer to Section 7.2.5 (Seat Installation) re. aligning the seat, before fully joining it around the shaft.

The seat is supplied assembled to protect the butt surfaces. Remove the screws at the butt and part the two halves. Clean any sealant compound from the butt surfaces. Ensure that the seat dowels and spring pins remain in position. Apply grease to both 'O' cord grooves visible in the bore of two halves. Press the split 'O' cords into one half of the seat with the ends hanging free. The' final 'O' cord joints must not align; therefore the free ends should be staggered. Lift this half off the seat complete with 'O' cords so that the butts are horizontal. Place this half over the shaft within 50 mm of the face, ensuring that 'O' cords remain in their grooves and do not become trapped.

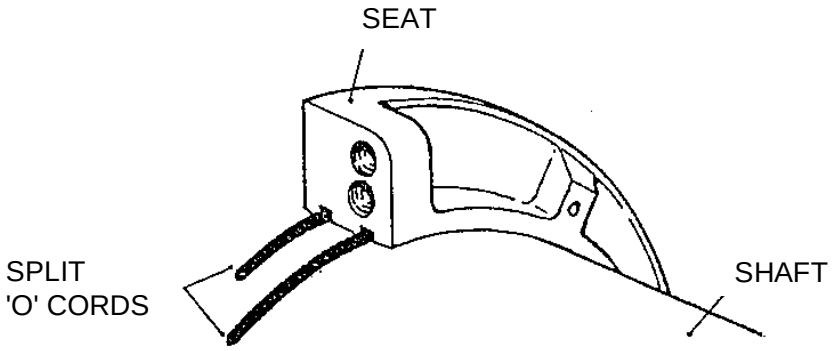
Note: - The 'O' cords are supplied over length, to ensure their ends butt hard together.

Under no circumstances must the 'O' cords be shortened.

Pass the second half under the shaft and lift into position. Ensuring that the 'O' cords do not become trapped, carefully position them in the grooves in the second/lower half of the Seat (the ends of each O-Cord butts together) whilst raising the lower half of the Seat up towards the upper half. This operation requires extreme care and is more easily accomplished with assistance.

Once correctly positioned apply Copper based anti-seize compound to the butt screw threads then insert the butt screws up to three full threads only. Clean the seat butt surface.

With the butts separated apply sealant to the butt surfaces. Tighten the butt screws, ensuring the 'O' cords remain correctly sited and do not become trapped. Do not apply full torque to the screws at this time. Wipe any excess sealant from the seat face. Using a fingernail check that a step cannot be detected on the running surface at the butts. Fully tighten the butt screws to the torque specified on the installation drawing. Re-check the running surface at the butts, to ensure final alignment. Push the seat along the shaft until it contacts the face.



12.8.9. Drive Clamp Ring Assembly.

Ensure the shaft in the way of the drive clamp ring is clean and free from grease, and that the holes in the shaft/liner for the DCR drive screws are clean and de-burred as detailed in Section 7.2.6. Place the two halves of the drive clamp ring around the shaft. Apply Copper based anti-seize compound (supplied) to the butt screws and insert but do not tighten them.

Position the drive clamp ring oriented correctly and aligned with the holes machined in the shaft (if required) and as close to the seat as possible without actual contact. Engage the drive screws in the recess bosses on the seat, and evenly tighten the butt screws to clamp the two halves of the drive clamp ring to the torque specified on the General Arrangement Drawing.

Fit the DCR radial locking screws (if applicable) through the DCR and into the holes in the shaft. These locking screws must engage in the holes, but must not bottom out. They should be locked off against the DCR surface or with lock nuts if provided.

Tighten the alignment screws up until they contact the seat. Remove the compression studs and tools and return them to the toolbox.

12.8.10. Seat Alignment.

Mount a clock gauge to register against the face of the seat.

Rotate the shaft slowly and tighten up on the drive and alignment screws until the seat has been set to give a maximum of 0·25 mm total indicated reading.

On completion check that bellows compression is within 1 mm of the designed fitting compression (refer to General Arrangement Drawing) and tighten up the locknuts on the drive and alignment bolts.

Check and tighten, if necessary, the torque on the main clamp ring butt bolts.

Finally, re-check the compression and record the measurement of the gaps between each of the sets of main clamp rings lugs for the purpose of assessing seal wear. (Refer to Section 7.2.3).

12.8.11. Splash Guard Assembly.

Locate the splash Guard around the face carrier, ensuring that the drain hole is at bottom dead centre.

Now test the seal, as indicated below.

12.8.12. Testing

On completion of the Installation, static tests may be applied as follows:

Inflatable Seal Air Supply.

The air pressure required for the inflatable seal should be stated on the Installation drawing. An air vent or drain must be provided in the operating system, which must be kept open at all times when the inflatable seal is not in use. (Refer to Section 7.2.2. - Air Supply).

Inflatable Seal Air Test

The inflatable air test is 5.0 Bar with an allowable leakage of 1.0 Bar/ 30 minutes/Metre of shaft. (Refer to Section 7.2.1. - Testing of Inflatable Seal).

Face Seal Hydrostatic Test

Activate the inflatable seal to 0.3 bar min above the seal water test pressure.

Seal static test pressure is 1.5 bar.

The maximum acceptable leakage is 1.5 litres/100 mm of shaft/hour.

For example: -

Shaft size = 428 diameter

The maximum acceptable leakage is 6.4 litres/hour, or 1.6 litres in a 15-minute period.

12.8.13. Where the Propeller Shaft is removed and the seal may be installed in an assembled condition, the following lifting advice should be considered.

The seal should be lifted using a suitable chain block, strops and shackles. Note, the weight of seal with the seat assembly and drive clamp ring assembly is normally stated on the G.A. Drawing. The assembly less the seat and DCR will be approximately 75% of the total seal weight.

The shackles should be inserted into the mounting holes as shown in Fig 1.

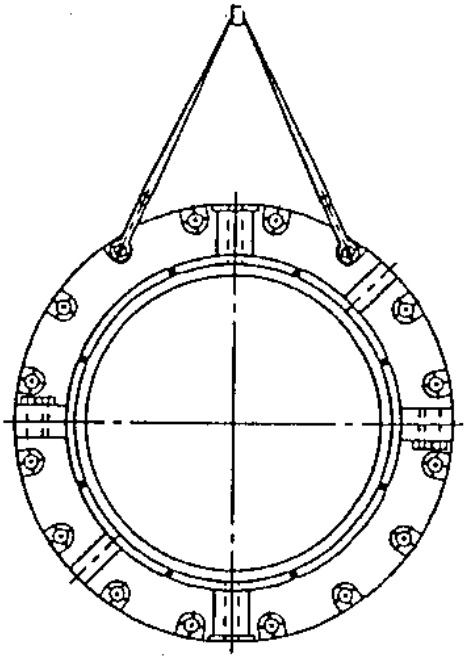


FIG. 1

The shackles should be fitted as shown in Fig 2, in order that they can be removed once the seal is closed to the sterntube/bulkhead.

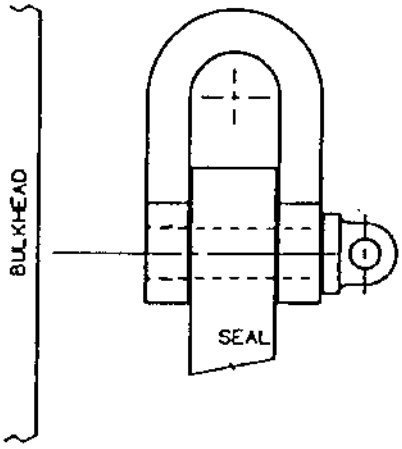


FIG. 2

Once suspended the seal will have a tendency to hang as shown on Fig. 3. It should be offered to the sterntube/bulkhead so that the bottom studs engage. Nuts should be fitted to these studs and tightened at the same time as removing some load from the chain block. This will square the seal and more studs will engage, the process can then be removed, and the seal pulled into its final position.

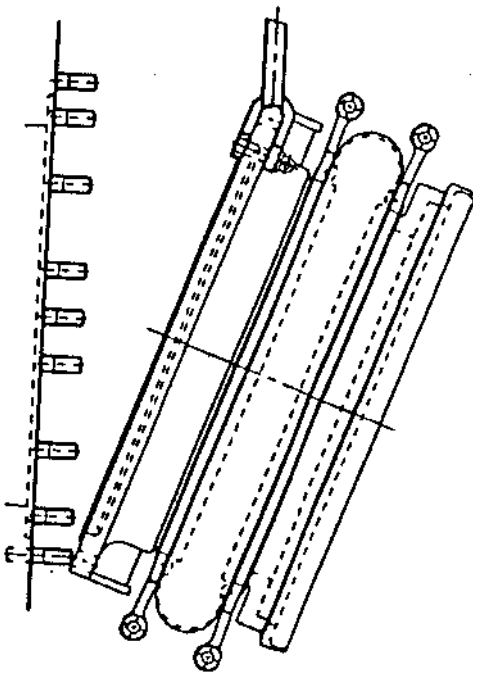


FIG. 3

13. SPARE PARTS AND THEIR STORAGE.

13.1. For MB seals, the spares recommended to be held can be grouped into two categories:

- ❑ Onboard Spares.
- ❑ Spares for scheduled dockings.

13.1.1. For onboard it is recommended that a split face assembly (face plus sealing strip), a bellows interlayer and seat 'O' - cords are held.

13.1.2. For a scheduled docking the face assembly, bellows assembly (which contains and interlayer) Seat 'O' - cords and an Inflatable seal should be available.

13.1.3. The seat assembly is considered to be a refurbishable item using a simple machining process as described in Section 12.7.1.

13.2. All parts held as spares should be kept in their original packing as they will have been inspected and packed prior to despatch as described in Section 3 (Storage and Handling).

13.3. All components must be protected from damage or deterioration by maintaining their original packing and careful storage to prevent physical damage (with special care being taken of any fine machined surfaces or critical components).

All spares should be stored flat and unobstructed in a dry, cool and dark environment, as described in Paragraph 3.6.

14. ATTACHMENTS.

The following attachments are covered by this Technical Manual (TM–MB-01)

- Tabulated or Specific General Arrangement Drawing(s)*.

- TDS 1/002 - for Closed Sweet Water systems.
- TDS 1/003 - for Open Raw Water systems.
- TDS 9/002.

***Note:** This manual is written based on the “Tabulated” General Arrangement Drawings listed on the front cover.

However: MB Seals with a **specific** General Arrangement drawing are derived from one of the listed “Tabulated” General Arrangement drawing are also covered by this Technical Manual.

In all instances the Drawing(s) specific to the application must be included after this attachment page and referenced in conjunction with this manual.

All pertinent drawings should appear on the relevant Works Order.

The attachments referenced above, now follow: