Action code: Immediately

Spark Erosion Update

August 2008
SL08-498/AAB

Concerns
Owners and operators of all MAN B&W two-stroke marine diesel engines.

Contents

Dear Sirs

This is an update on spark erosion, and how to discover and prevent it. Spark erosion can occur if electrical potential in the crankshaft discharges through the main or thrust bearings. If undiscovered, spark erosion can cause critical wear on the main bearings, and consequently severe crank train damage.

From practical experience and testing, we know that the best protection against spark erosion is to use a correctly installed and well-maintained shaftline earthing device.

Therefore, MAN Diesel now recommends all MAN B&W two-stroke engine operators to:

- Equip all newly ordered engines with a shaftline earthing device with specifications according to MAN Diesel specification No. 0792182-1.
- Equip all engines in operation without a shaft monitoring system with such a shaftline earthing device.
- Inspect and evaluate all existing shaft monitoring systems on engines in operation. Update and overhaul if necessary.

Please direct any questions about this service letter to our Operation Department: leo@mandiesel.com

Yours faithfully

Mikael C. Jensen
Vice President, engineering

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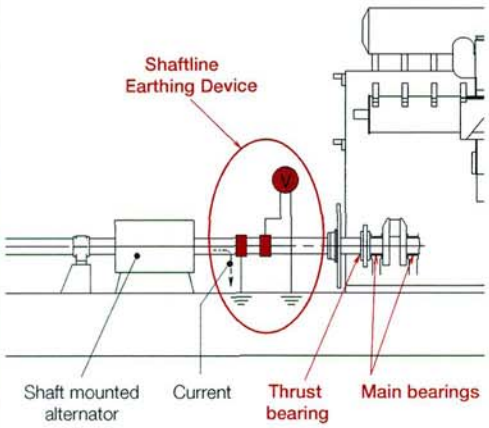
Senior Manager, operation



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About Spark Erosion

Unfortunately, spark erosion is still a problem on some vessels with two-stroke marine diesel engines. However; engine design and our recommendations for service and maintenance procedures have changed since our last service letter on spark erosion.

Former MAN Diesel service letters on spark erosion:
SL 83-193, SL 86-213, and SL 08-495

Engine Developments

To meet new market demands we continuously develop and improve our main bearing design, lining material, and service recommendations. As a consequence, particularly three recent developments have, unfortunately, also affected our engines' resistibility to spark erosion adversely:

Lining thickness

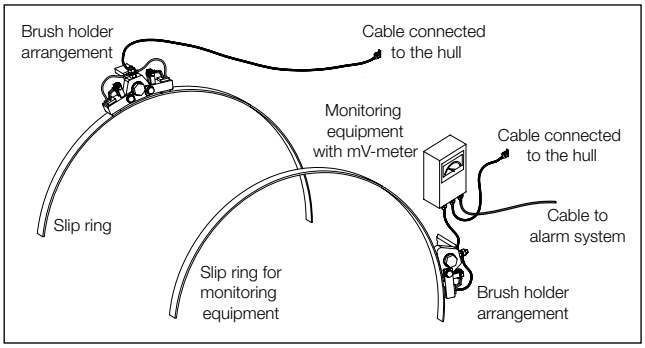
To improve lining fatigue strength, white metal bearing lining thickness has been reduced from about 2.5 mm to 1.5 mm. When lining thickness is reduced, the time from spark erosion onset until the situation becomes critical will also be reduced.

Tin/aluminium lining

A tin/aluminium lining is used on small and medium bore engines to improve lining fatigue strength.
A few case studies suggest that in case of spark erosion a tin/aluminium lining may wear through to the steel-back faster than a white metal lining.

Oil film thickness

Over the years, higher engine rating has led to a reduced minimum oil film thickness in our main bearings.
A reduced oil film thickness can make an engine more sensitive to spark erosion.



Shaftline earthing device parts

Shaftline Earthing Device

The best spark erosion cure is to prevent it. So, MAN Diesel still strongly recommends these precautionary measures against spark erosion:

- Correct installation of a shaftline earthing device.
- Follow maintenance instructions carefully.

A full and updated shaftline earthing device specification, including installation and maintenance instructions, is enclosed (see appendix).

Installation

We recommend installing the shaftline earthing device in as **dry, warm, well-ventilated**, and **easy-to-access** environment as possible, preferably close to the engine. If a shaft generator is installed, install the device forward of the generator, i.e. between the generator and the engine flywheel.

When installing and maintaining the device, remember:

- Install slip rings, brushes, brush holders, and cables that meet MAN Diesel's specifications.
- Install brushes to run on a slip ring, never directly on the shaft.
- Fit slip rings on a clean, polished shaft.
- Apply rust protection between shaft and slip ring.
- Adjust brush holders precisely.
- Install a monitoring voltmeter and connect output to the alarm system. Always use a separate and dedicated slip ring and brush system for the voltmeter.
- Follow installation and maintenance instructions.

Maintenance

Be particularly cautious with maintenance if the shaftline earthing device is located in the far aft end of the shaft or other exposed place.

Always overhaul and replace worn parts in due time:

- Replace the slip ring before the silver layer is worn through.
- Replace worn out brushes.
- Keep the slip ring clean and dry.

Corrosion between the slip ring and the shaft can be difficult to detect. We recommend these procedures:

- No monitoring voltmeter installed:
  Measure electrical contact between slip ring and shaft at least monthly to reveal any concealed corrosion.
  If resistance exceeds 5 mΩ: Overhaul the slip ring.
- Monitoring voltmeter installed:
  Check shaftline earthing device monitoring monthly.

Discover Spark Erosion

A few spark erosion situations have developed dramatically because severe main bearing wear was not discovered in time. The wear was discovered too late, because the main bearing top clearance and crankshaft deflection measures were compared to the maximum values in the manual, instead of the reference values for the particular engine.

Our minimum recommendation is to perform **yearly main bearing top clearance measurements and crankshaft deflection readings**. Store the values for future reference.

Measurement procedures and intervals are specified in the instruction manual. More frequent measurements will improve condition monitoring considerably.

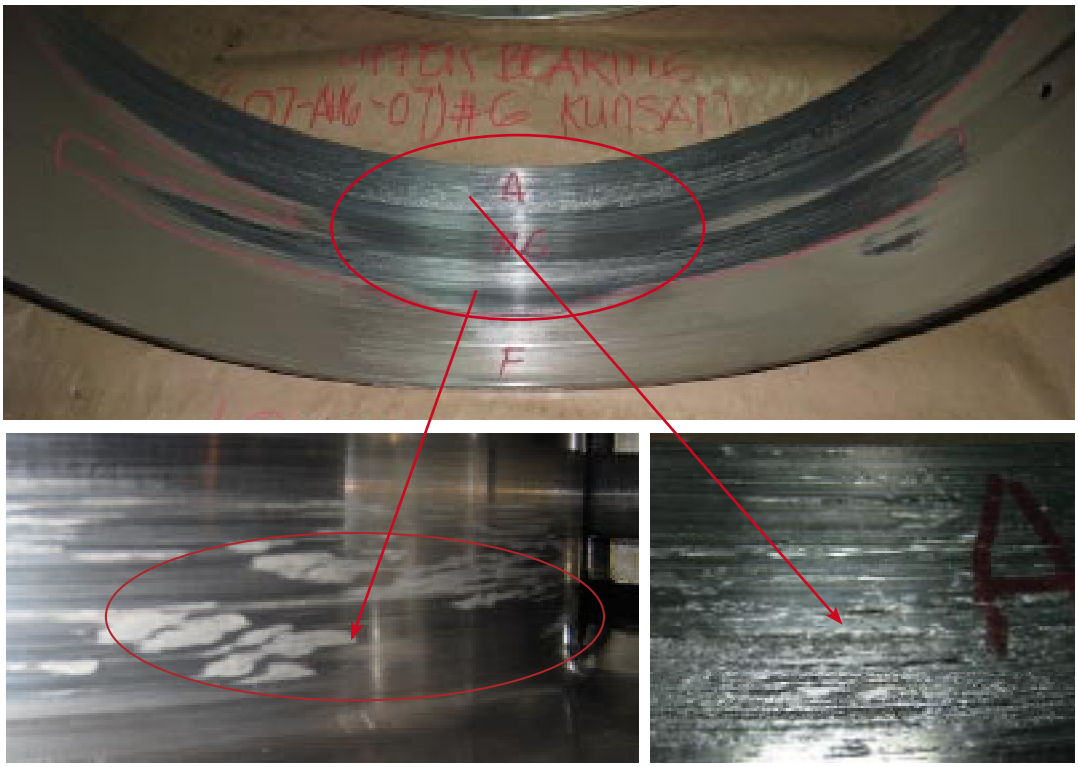
Signs of spark erosion can be difficult to discover and recognise, even during open-up inspections of main bearings and thrust bearing cam. To help you discover and recognise signs of spark erosion and spark erosion risk situations in time, we have prepared a series of photos showing where to look and what to look for.

AlSn40 Lining

This is a journal, main bearings and thrust collar with clear signs of spark erosion. Spark erosion signs are obvious, even in the upper main bearing shell.

The bearing damage is irreparable: This bearing cannot be re-used, it has to be replaced.

Upper main bearing shell

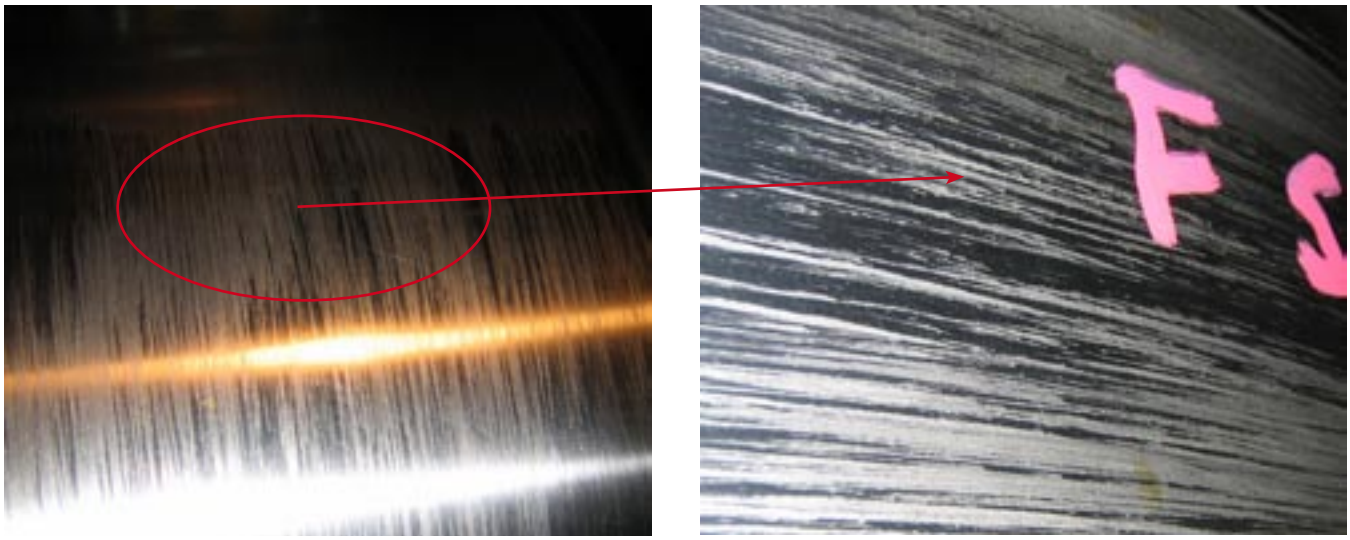


This journal MUST be polished to meet surface roughness specifications.

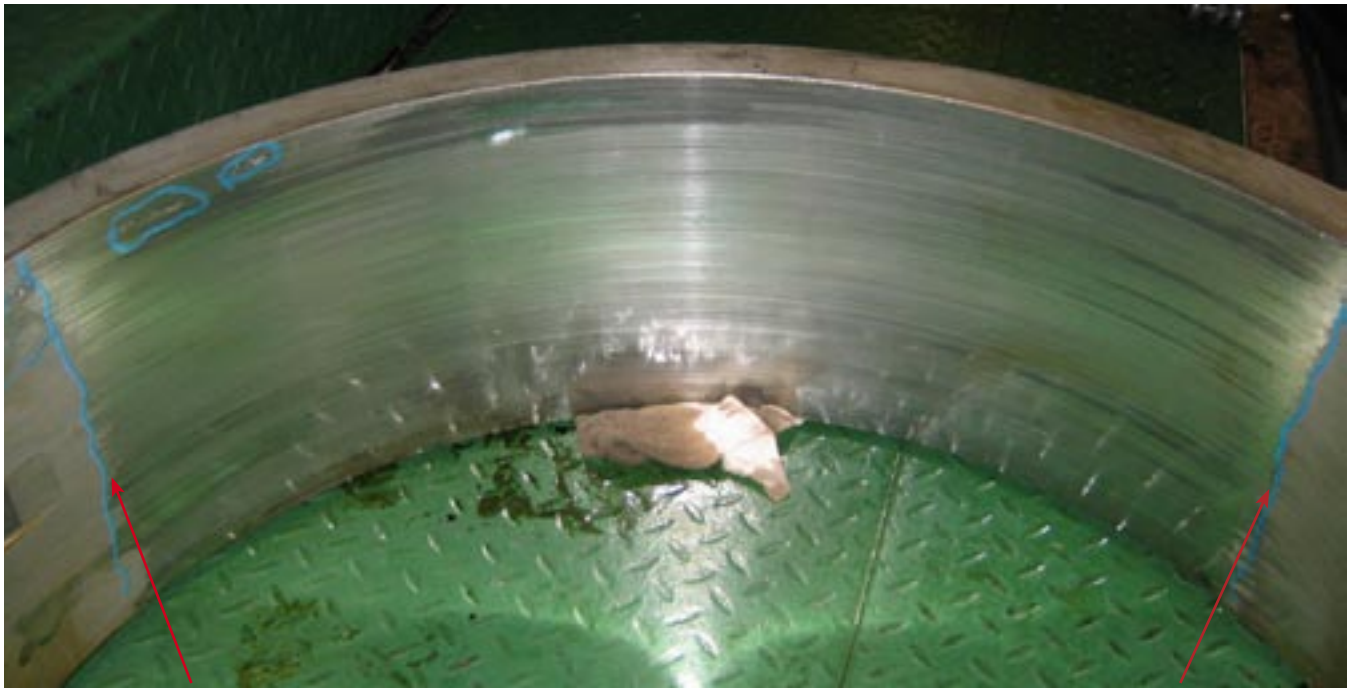
White Metal, Severe

Main bearing journal with signs of severe spark erosion. The condition was not discovered in time, so this main bearing cannot be saved; is has to be replaced. The journal can be-used, but has to be polished to meet surface roughness specifications.

The consequences of undiscovered spark erosion are shown below. The best protection against severe spark erosion incidents like this, is to use a correctly installed and well-maintained shaftline earthing device.



This journal MUST be polished to meet surface roughness specifications

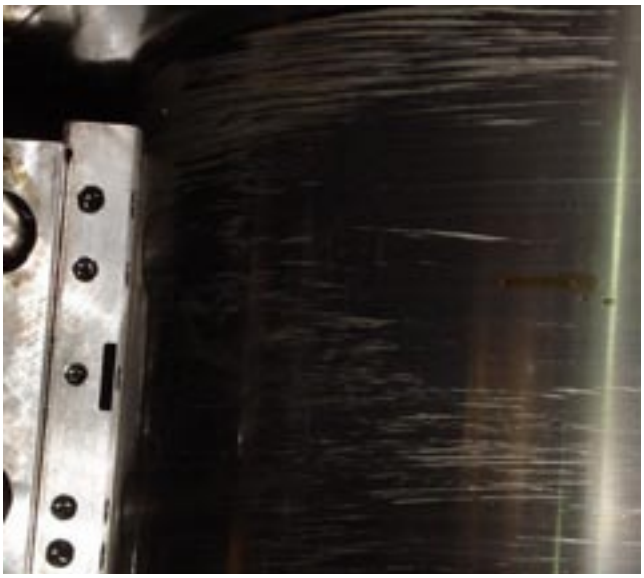


Corresponding main bearing lower shell with wide spread journal imprint. 0.5 mm of the shell is worn off between the two distinct, visible lines.

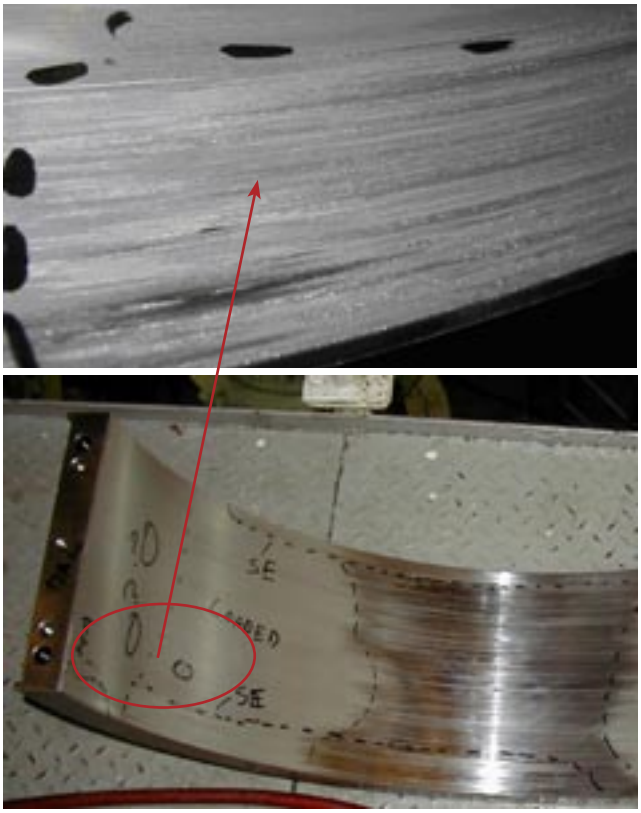
White Metal, Moderate

Main bearing with moderate spark erosion, discovered in time to save the bearing shell.

This bearing can be re-used after dressing up. The journal must be polished to meet surface roughness specifications.



Main bearing journal

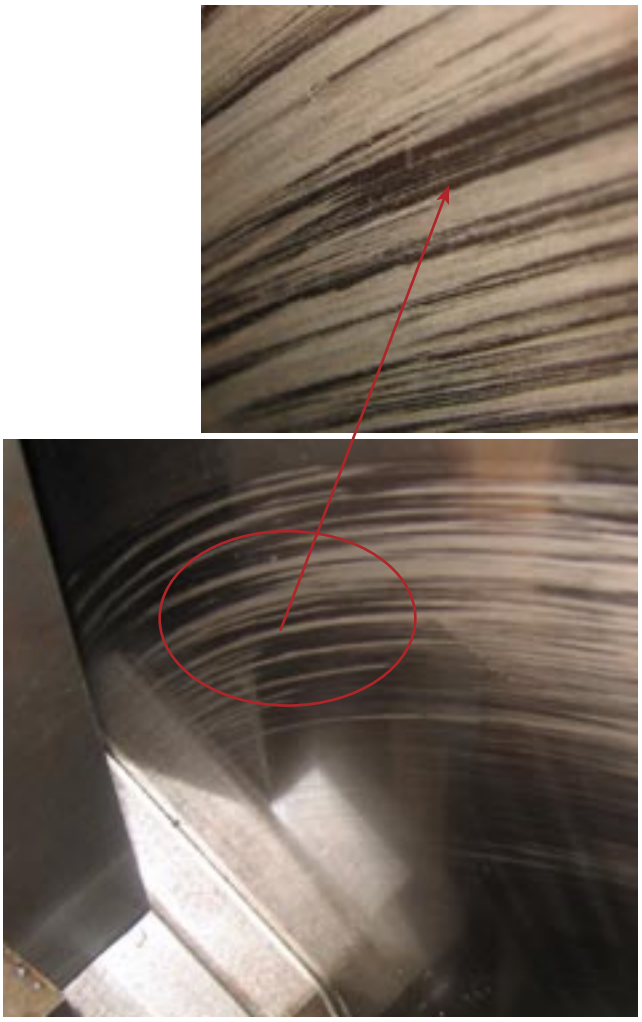


Corresponding lower bearing shell. Visible spark erosion, but no or limited wear can be measured.

Thrust Collar Face

This is a thrust collar face with clear signs of spark erosion. Spark erosion may not be visible on the entire surface.

When inspecting the thrust collar surface or the main bearing journal, remember:
Slowly turn the engine 360°/1 revolution, and inspect the entire surface very carefully.



The greyish stripes on this thrust collar face indicate spark erosion

Incorrect installation

Incorrect shaftline earthing device installation can increase the risk of spark erosion dramatically. The photos on this page show how incorrect installation has increased the risk of spark erosion.

DO NOT copy these incorrect installations!
Correct installation and maintenance procedures are described in specification No. 0792182-1.

No Slip Ring

2-year-old vessel, incorrect installation.

Here, the carbon brushes run directly on the propeller shaft, and so electrical contact between brushes and shaft is reduced.

Note:

- Install a silver covered slip ring between the brushes and the shaft to ensure sufficient electrical contact
- Replace the slip ring before the silver layer is worn through.
- Inspect brushes regularly, and re-adjust brushes when necessary.

No seperate slip ring installed

Poor Hardware Quality

3-year-old vessel, incorrect installation.

These pictures show a severe rust attack causing poor contact between the slip ring and the shaft. The installed cables are incorrectly dimensioned. Cables, Ag/carbon brushes, and slip ring are of poor quality that do not meet MAN Diesel specifications.

ALWAYS install slip ring, cables and brushes that meet MAN Diesel specifications (see appendix for details).

Poor hardware quality

Brushes and cables that do not meet MAN specifications

Insufficient Maintenance

Insufficient maintenance is a severe spark erosion risk factor. The pictures on this page show how incorrect maintenance can increase the risk of spark erosion.

ALWAYS follow maintenance instructions carefully. See enclosed MAN Diesel specification No. 0792182-1 for details.

Poor Brush Adjustment

This picture shows a set of incorrectly adjusted brushes. The brushes have slipped out, and so the distance between brushes and slip ring is too long.

Poorly adjusted brushes

Note:

- Inspect the brushes if the voltmeter reads more than 50 mV.
- Re-adjust the brushes if they have insufficient contact with the slip ring.

Corroded Slip Ring

Here, the voltmeter readings were ok, so the shaftline earthing device appeared to be in an acceptable condition.

However: High electrical resistance was measured between the slip ring and the shaft, indicating insufficient electrical contact between slip ring and shaft. Removing the slip ring revealed heavy corrosion on the shaft and on the back side of the slip ring.

Corrosion hiding behind the slip ring

Heavy corrosion on the back side of the slip ring

Note:
ALWAYS polish the propeller shaft carefully and apply rust protection (e.g. **Dinitrol 300**) between the Ag band and the shaft when assembling and overhauling.

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300155	Shaftline earthing device	0792182-1

Scale:	Size:	Type:	Page No.:
	A4	Specification	1 (11)

Similar Drwg.:	Replacement for Ident No.:

Date	Des.	Chk.	Appd.	A.C.	Change / Replacement	C. No.
20080609	IBB	TOB	OLS			0
20080610	IBB	TOB	OLS	Z4	Pictorial correction.	1
20080702	IBB	TOB	NBC	Z4	Text added in paragraph 5.	2
						3
						4
					Replaced by Ident. No.:	5

Suppl. Drwing. No.:				

This document is valid for following engine types:

All engine types

This MAN Diesel Specification should be regarded as a guideline. Further design details are to be taken from the drawings for the actual plant concerned.

Contents:

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20080702	IBB	TOB	NBC	Z4	Text added in paragraph 5.	2

1. Scope and field of application:

A difference in electrical potential between the hull and the propeller shaft will be generated due to the difference in materials and to the propeller being immersed in sea water.

In some cases, the difference in the electrical potential has caused spark erosion on the thrust and main bearings and journals of the crankshaft of the engine.

In order to reduce the electrical potential between the crankshaft and the hull and thus prevent spark erosion, there must be installed a highly efficient shaftline earthing device.

The shaftline earthing device should be able to keep the electrical potential difference below 50 mV DC, and there must be installed a shaft to hull monitoring equipment with a mV-meter and with an output signal to the alarm system so that the potential and thus the correct function of the shaftline earthing device can be monitored.

Please note that only one shaftline earthing device is needed in the propeller shaft system.

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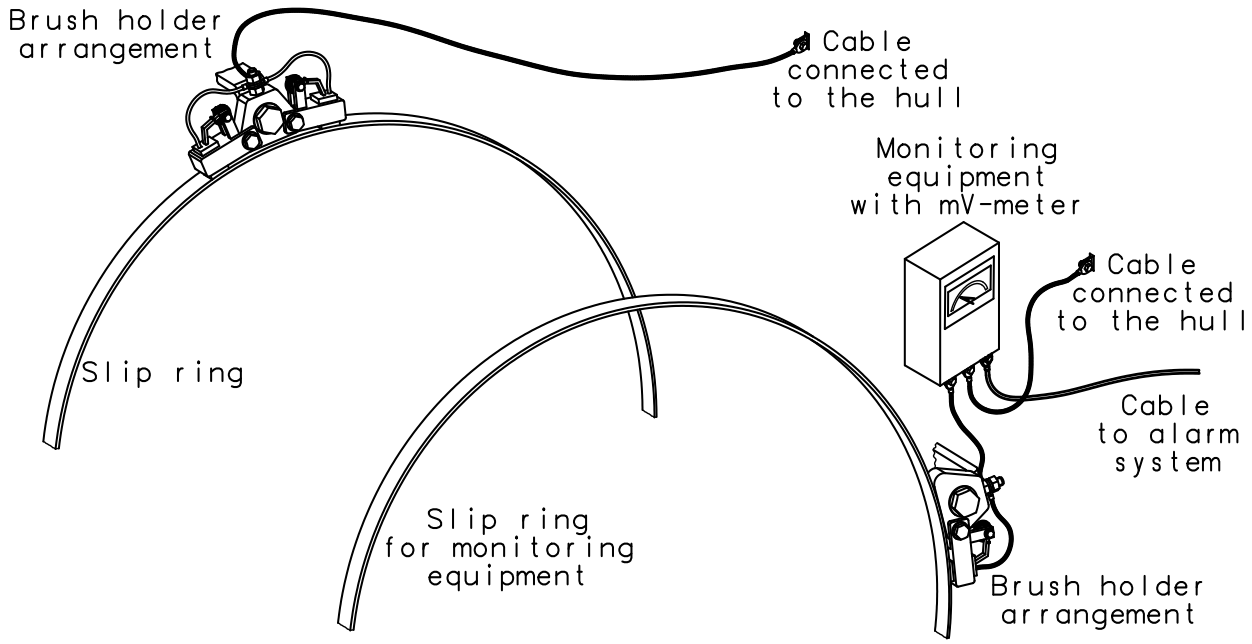
2. Design description of the shaftline earthing device:

The shaftline earthing device consists of two silver slip rings, two arrangements for holding brushes including connecting cables and monitoring equipment with a mV-meter and an output signal for alarm.

Figure 1.



The slip rings should be made of solid silver or back-up rings of cobber with a silver layer all over. The expected life span of the silver layer on the slip rings should be minimum 5 years.

The brushes should be made of minimum 80% silver and 20% graphite to ensure a sufficiently electrically conducting capability.

Resistivity of the silver should be less than 0.1μ Ohm x m. The total resistance from shaft to hull must not exceed 0.005 Ohm. For a well-functioning shaftline earthing device it is expected that the resistance is approximately 0.001 Ohm.

Cabling of shaftline earthing device to hull must be with a cable with a cross section not less than 45mm² and the length of the cable to the hull must be as short as possible.

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Monitoring equipment should have a 4-20 mA signal for alarm and a two range mV-meter with switch for changing range. Primary range from 0 mV to 50 -150 mV DC and secondary range from 0 mV to 300-1500 mV DC.

When the shaftline earthing device is working correctly, the electrical potential will normally be within the range of 10-50 mV DC. The alarm set-points should be 5 mV for low alarm and 80 mV for high alarm. The alarm signals with alarm delay of 30 seconds and alarm cut-off, when engine is stopped, must be connected to the alarm system.

Connection of cables as shown on the sketch, Figure 1.

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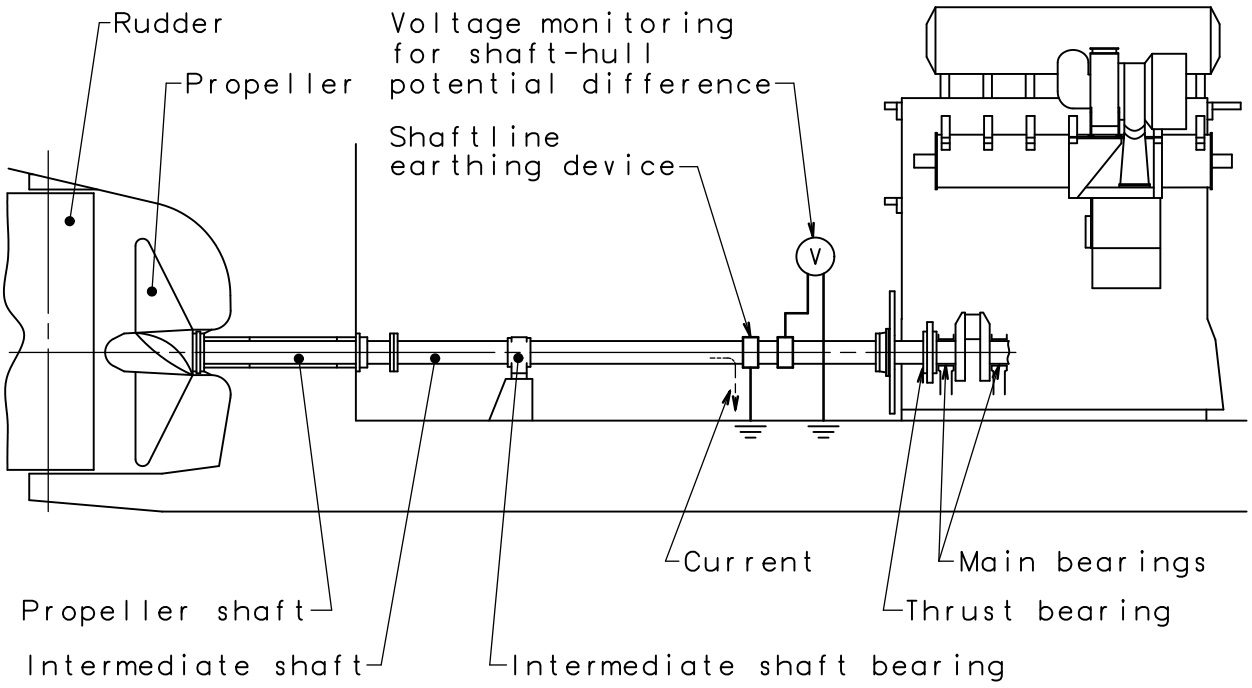
20080702	IBB	TOB	NBC	Z4	Text added in paragraph 5.	2

3. Mounting of shaftline earthing device:

The shaftline earthing device slip rings must be mounted on the foremost intermediate shaft as close to the engine as possible, Figure 2.

Figure 2.



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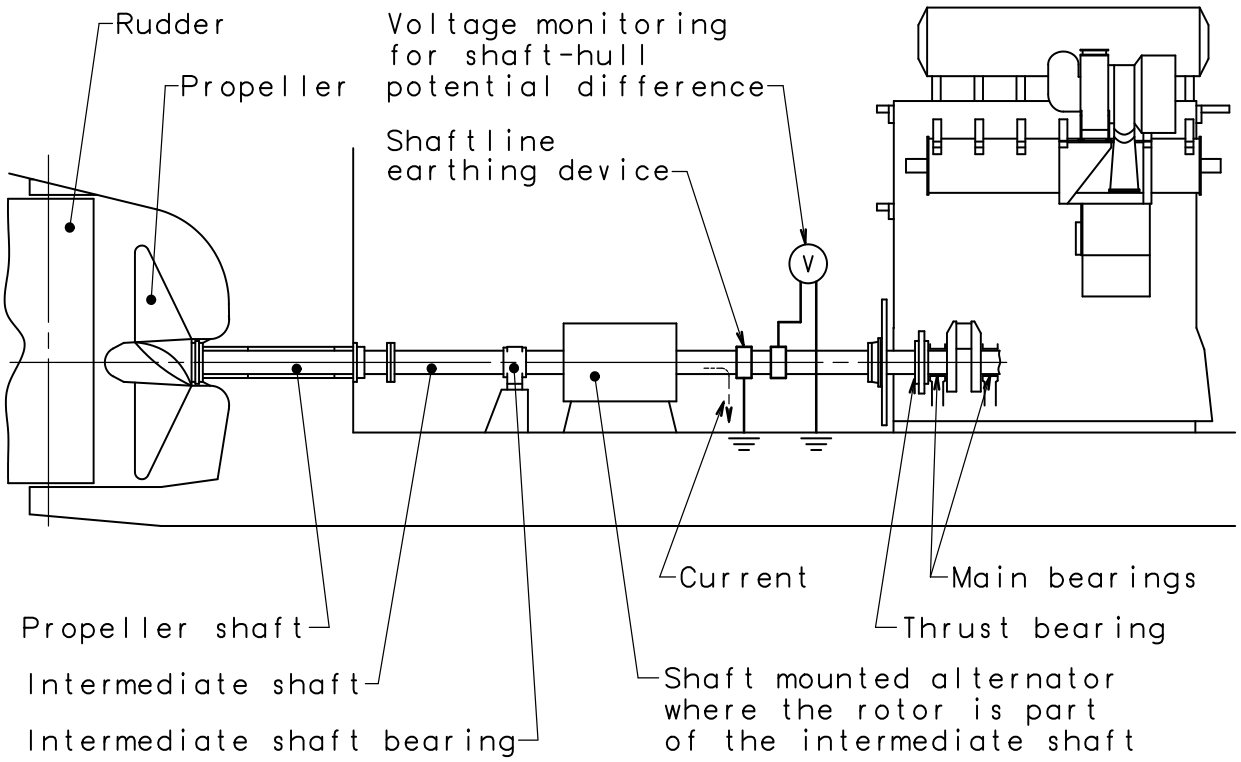
20080702	IBB	TOB	NBC	Z4	Text added in paragraph 5.	2

When a generator is mounted in the propeller shaft system, where the rotor of the generator is part of the intermediate shaft, the shaftline earthing device must be placed between the generator and the engine, Figure 3.

Figure 3.



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Before mounting the two silver slip rings, the intermediate shaft has to be cleaned and polished with emery paper. It is recommended to keep a distance between the two slip rings of approximately 100 – 200 mm.

To protect the shaft and slip rings from corrosion, a preservation oil has to be applied to the shaft surface before mounting the slip rings.

Information of recommended preservation oils are to be found in paragraph 4.

After mounting the slip rings excessive preservation oil has to be cleaned off with a clean cloth leaving the surface of the slip rings clean and dry. **Do not** use a solvent which can penetrate and remove the coat of the preservation oil between the shaft and slip rings.

Verification of the electrical resistance between the slip rings and the shaft should be conducted by measuring, as descriped in paragraph 5.

Mounting of the holders for the brushes should be as close, to the slip rings as possible. For adjustment of the arrangement see the makers recommendation.

It is recommended to place the monitoring equipment near the shaftline earthing device and at an easy accessible location for inspection and for reading the mV-meter.

A simple cover can be applied in case protection of the arrangement of brush holders is needed. The cover must be easy to remove for inspection of the shaftline earthing device.

4. Preservation oil recommended for assembly:

As preservation oil we recommend to use one of the following products listed in Table 4.1.

Table 4.1 Preservation oils:

Dinitrol	ML300
Tectyl	472
Rust Ban	393
Mobilarma	245
Chevron Water Displacing Fluid	
Rust Veto	266

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5. Verification of the electrical resistance between the slip rings and the shaft.

For the verification equipment is needed:

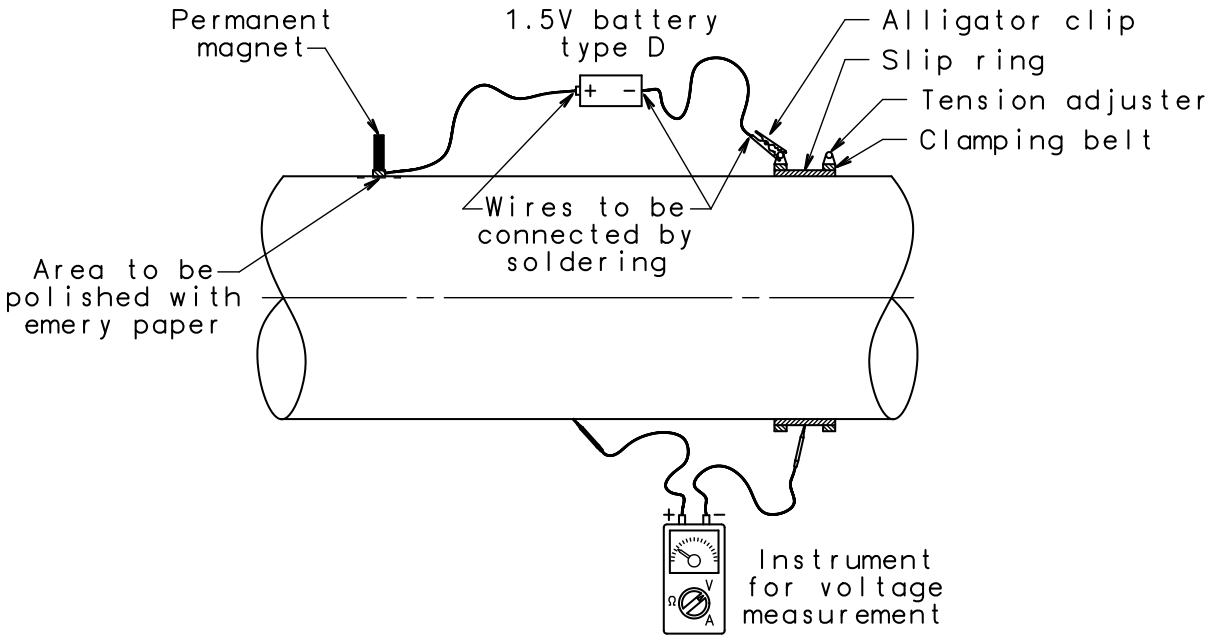
One new high quality 1.5 V battery of D type. An electrical wire with a cross section of 0.75mm² has to be mounted on each pole of the battery by soldering. Length of the wire should be approximately 200mm.

At the end of the wire end of the positive pole a length of 20 mm of the insulation has to be removed and encapsulated by soldering. At the end of the wire of the negative pole an alligator clip should be mounted by soldering.

Before the battery is connected to the shaft, a small area of the shaft must be polished with emery paper in order to ensure a good connection for the end of the wire of the positive pole. One of the poles of a horseshoe shaped permanent magnet is placed on top of the wire end to keep it in place on the polished area. It is recommended that the horseshoe shaped magnet has a pull force of 80 to 120 N.

The wire end of the negative pole with the alligator clip should be placed on the tension adjuster of the clamping belt.

Figure 4.



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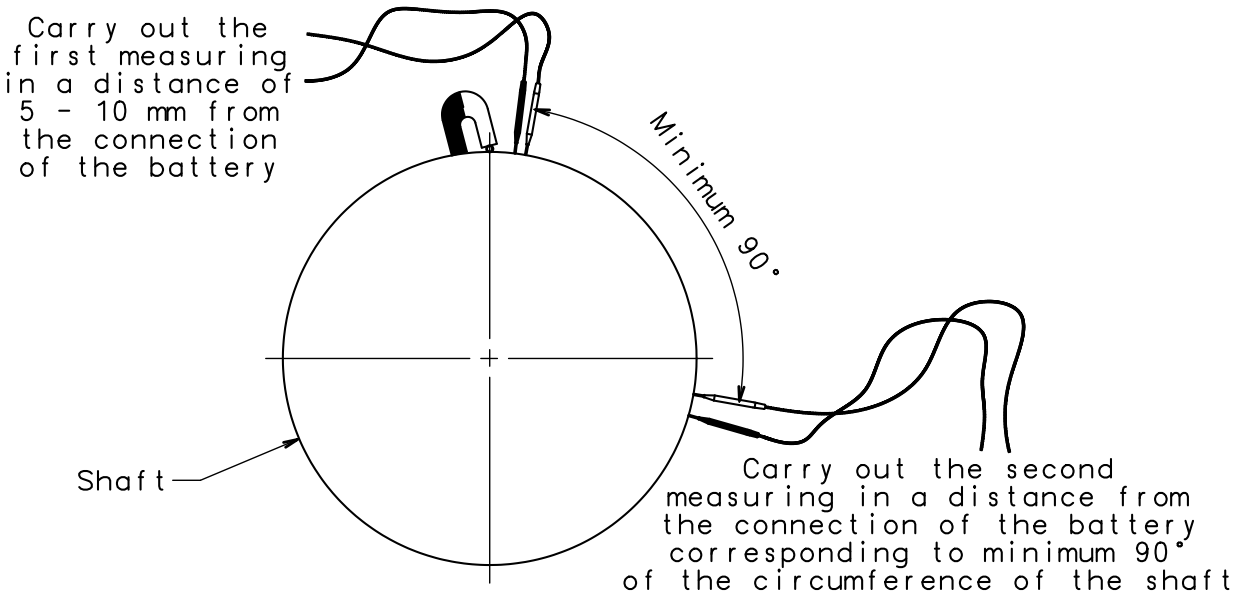
For the first measurement place the positive touch needle of the instrument for Voltage measurement 5 to 10mm from the positive wire end and the negative touch needle on the silver layer of the slip ring as near as possible to the tension adjuster where the alligator clip is placed and note the reading.

For the second measurement place the touch needles at a distance corresponding to minimum 90° of the circumference of the shaft. Place the positive touch needle on the shaft and the negative touch needle on the silver layer of the slip ring and note the reading. It is expected that the second measurement should be 0 V.

A high short-circuit current from the 1.5 V DC battery will only last for a short time. To ensure reliable measuring results it is important to carry out the two measurements within 30 seconds after the battery has been connected. The battery should be disconnected and removed after the last measurement. The battery must only be used once and should be renewed if another measurement is to be carried out later.

Figure 5.



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To verify the electrical resistance the following formula is to be used:

$\frac{U}{I} = R$, Where the short-circuit current is set to be 15 A.

$$\frac{\text{The voltage reading V}}{15\,\text{A}} = \text{R}\Omega$$

Example:

$$\frac{0{,}015\text{V}}{15\,\text{A}} = 0{,}001\Omega$$

For a well functioning shaftline earthing device it is expected that the resistance is approximately 0.001 Ohm and must not exceed 0,005 Ohm.

6. Maintenance:

It is recommended to keep the shaftline earthing device clean and dry at all times and to make a visual inspection of the shaftline earthing device on a regular basis.

Cables and cable connections are to be checked. Damaged cables or connectors have to be replaced.

If the brushes are worn-out, they have to be replaced with new brushes.

If the silver layer on the slip rings is worn-out or if the silver layer is partly missing the slip rings have to be replaced with new ones. Follow the mounting procedure described in paragraph 3.

If the mV-meter on the monitoring device indicates more than 80 mV DC after the inspection of the mechanical parts of the earthing device and all parts have been found in good condition, it is recommended to dismount the slip rings and clean and polish the shaft and apply new preservation oil (Paragraph 4. Table 4.1). The slip rings back side should be cleaned and polished, if they are not replaced with new before remounting.

When maintenance work of the earthing device has been carried out, it must be checked that the monitoring equipment is working properly.

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7. Suppliers:

Supplier ref. no. 1386

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