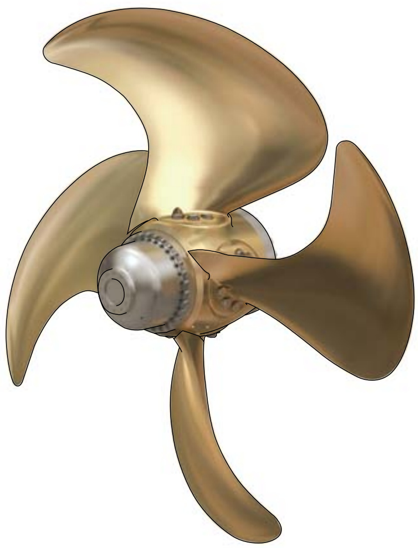
49334-E

Rolls-Royce



Installation Manual
Kamewa™ CP-A D

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Introduction

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Purpose

The purpose of the Installation Manual is to provide the necessary information to plan and perform a safe and correct installation of the delivered system, as well as verify the functionality of the equipment.

Included are also the instructions for handling the goods after deliverance at yard. It is of great importance that these instructions are followed to avoid problems during outfitting and commissioning.

Furthermore, this manual shall provide instructions for all activities necessary for preparing the commissioning.

Target Groups

The target groups for this Installation Manual is the following:

- Yard supervisor
- Yard engineers
- Yard mechanics
- Operator representatives
- Rolls-Royce service personnel

Reading this Installation Manual

This installation manual contains installation descriptions for the main propeller system and is intended as a complement to the appended installation drawings.

The installation descriptions are intended for dockyard personnel which have experience of propulsion system installation. The manual does not contain detailed instructions to guide inexperienced dockyard personnel through the installation procedure. If the personnel on the dockyard are uncertain of how to perform an installation task consult Rolls-Royce Marine Global Support Network before proceeding.

The installation descriptions are divided into chapter Before Launching, chapter After Launching and chapter Control System. The descriptions in each chapter are divided in chronological working order. Chapter Before Launching contains the installations tasks that must performed before launching of the vessel and chapter After Launching contains the installation tasks that must be performed after launching. The installation of the control system is performed after launching of the vessel.

Note that the installation order in the installation manual is a general recommended working order, some yards may have different routines.

This manual covers the installation descriptions of the propulsion system parts which are manufactured by Rolls-Royce. The sub suppliers' documentation is appended in part Sub Supplier Manuals. Rolls-Royce recommends that the user of this manual reads the whole installation manual before planning and starting the installation. Make sure to read the installation instructions from the sub supplier carefully.

If there are any questions in how to perform the installation of any part of the propulsion system supplied by Rolls-Royce, please consult Rolls-Royce Marine Global Support Network before proceeding.

Please note that all illustrations in this manual are schematically correct but they may not be an exact copy of the corresponding equipment on your vessel. For detailed information see part Drawings.

Writing Conventions

When referring to information within a part, the word "section" is used. When referring to information found in another part, the word "part" is used.

All cross references regarding parts, sections, and figures are shown without page numbers. See the table of contents for page numbers to parts and sections.

The titles of any referred drawings are spelled with capital letters, for example, the Hydraulic Diagram drawing.

Acronyms and Abbreviations

The following acronyms and abbreviations are used in the manual:

As Req. - As required

CAN - Controller area network

CanMan - Controller area network manoeuvering system platform

CCN unit - CanMan control node circuit board

DP - Dynamic positioning

Drw - Drawing

ECR - Engine control room

EMI - Electro magnetic interference

ESD - Electrostatic discharges

FPS - Fuel pump setting

HPP - Hydraulic power pack

I/I - Current in put/ current out put

I/O - In/Out

I/U - Current in put/ voltage out put

LED - Light emitting diode

LIC - Load increase control

LLS - Load limit settings

O.D. - Oil distribution

OD-box (M0) - Oil distribution box type M0

OD-box (FA) - Oil distribution box type FA

PC - Printed circuit

PC Board - Printed circuit board

PTI - Power Take In

PTO - Power Take Off

RPM - Revolutions per minute

SLIO unit - Serial linked input/output circuit board

VDR - Voyage data recorder

Qty - Quantity

Safety

Introduction

Read the safety precaution chapter very carefully. It concerns your safety as well as the safety of others and of the propulsion system.

This introduction describes how the safety information is presented in the manual and it gives a general information of which safety precautions to take when working on the propulsion system.

Warning: The warning sign indicates that there is a great risk of personal injury as well as serious damage to the product if the warning text is ignored.

Caution: The caution sign indicates that minor personal injury as well as damage to the product or major operating faults can occur if the caution text is ignored.

Note: The note text draws attention to important information which facilitates the reading of the instructions.

General Statement

Undertaking any work envisaged by this document may either directly or indirectly create risks to (1) the safety and health of the person undertaking the work or (2) the propulsion system and/or its components whilst the work is being undertaken.

It is the responsibility of the user to ensure that appropriate controls and precautions are identified and applied in relation to the work envisaged by this document in accordance with relevant statutory, legal and industry requirements to protect the health and safety of the persons undertaking the work.

Neither this document, nor its use, in any way absolves the user from their responsibility to ensure that the controls and precautions referred to above are implemented.

If, whilst undertaking any work envisaged by this document, you become aware of any Rolls-Royce product design related feature which could create risk to a person undertaking work or to the propulsion system and/or its components please contact Rolls-Royce Marine Global Support Network (GSN) immediately.

It is the user's responsibility to make all relevant hazard identifications and risk assessments of all the activities associated with the use of this document.

It is the user's responsibility to design and implement safe systems of work and to supply safe equipment (including, without limitation, safety equipment) and training (including, without limitation, health and safety training) to anyone using this document to work on products to which it relates.

A user without the relevant experience of working in accordance with this document or with products, or similar products, to which it relates should seek appropriate advice to enable them to identify the appropriate health and safety controls and precautions and controls and precautions to protect against risks to the propulsion system and/or its components whilst work is being undertaken. Technical assistance can be sought from Rolls-Royce and will be subject to Rolls-Royce's terms and conditions.

Safety Instructions

General Safety Precautions

Warning: PPE (personal protection equipment) must be used according to local regulations. Examples of PPE are hard boots, overall, protective glasses, ear protectors, hard hat, and gloves.

Warning: All rotating parts between the main engine and the stern tube must be permanently covered by adequate protective equipment. After installation and maintenance make sure to install all protective equipment before start up.

Warning: As a general rule, make sure to perform installation and maintenance work with the engine stopped.

Warning: All adjustments in close connection with the shafts must be performed with the engine stopped and the shafts secured.

Warning: Make sure that the propeller has enough room to rotate before rotating the shaft in a dry dock. Make sure to communicate with the operator on board the vessel.

Warning: Make sure that the personnel who are lifting the Rolls-Royce equipment have studied the appended lifting instructions

Warning: Always use Rolls-Royce lifting tools if such have been provided by Rolls-Royce.

Warning: Never work alone while lifting heavy components. Most lifting devices require two persons, one to operate the lifting device and one to ensure that the components do not get damaged.

Warning: Most chemicals intended for the propulsion system are harmful to your health. Always read the warning label on the packaging of the chemical and act according to its instructions.

Warning: Using other hydraulic oil than recommended by Rolls-Royce can cause malfunctions when manoeuvring the vessel. The malfunctions can cause personal injury and equipment damage.

Warning: All fuels and many chemicals are flammable. Do not allow naked flame or smoking during installation and maintenance. Make sure that the work area has got good ventilation and to always have a fire extinguisher at hand.

Caution: Make sure that the warning or information decals are always visible on the propulsion system. Replace decals that are damaged or painted over.

Caution: Make sure that there is enough room for mounting and dismantling before any work is performed on the propulsion system

Caution: It must not be possible to come in contact with rotating components, hot surfaces or sharp edges, while working on the propulsion system. Take proper measures of precaution.

Caution: Shut off the electric voltage before any work is performed concerning electricity.

Caution: Prior to welding, make sure that the electrical system of the propulsion system is disconnected. If the electrical system is not disconnected the supply filters and the control system can be damaged.

Caution: During welding the earthing must be connected as close as possible to the object on the propulsion system which is being welded. If earth leakage current passes through, for example a bearing, it can be damaged.

Caution: In orde to prevent corrosion please take care of the propulsion system’s parts immediately at arrival. All parts must be unpacked and inspected. The corrosion prevention must be renewed, since the parts have been treated with corrosion prevention for transport only.

Caution: All disassembled parts of the propulsion system such as shafts, hydraulic components and control system components must be protected against moist, sand and dirt in an adequate way during installation and maintenance.

Caution: Before assembly the disassembled parts must be clean and dry.

Special Safety Precautions

Propeller Hub

Warning: The engine must be stopped and the shaft secured, while work is being performed on the propeller hub or blades

Warning: The torque tool must be dimensioned with consideration taken to the torque values. This also includes the power socket which must have correct dimension for the width across flats.

Caution: The propeller and blade are machined to great accuracy and smoothness. Handle them with care.

Caution: Do not clean the blade flange with a high-pressure jet cleaning unit, because it can damage the blade sealing ring.

Caution: Make sure to handle the torque tool with care to prevent personel injuries due to the massive forces used.

Shafting

Warning: The engine(s) must be stopped and the shaft secured, while work is being performed on the shafts and couplings.

Warning: Read the appended sleeve coupling manual carefully before any work is performed on the sleeve coupling.

Caution: The corrosion prevention must be renewed immediately at spots where it may have been removed.

Hydraulic System and Oil Distribution Box

Warning: The hydraulic system uses high pressurized oil for functioning. The pressure might be high even when the engine is not running. Always take great care when, for example, opening nipples.

Warning: Depressurize the hydraulic system before performing any installation or maintenance work.

Warning: Hydraulic oil is harmful to your health. Always read the warning label on the hydraulic oil packaging and act according to its instructions.

Warning: The pressurized oil in the hydraulic system can be hot! Damage on hoses, pipes or couplings can lead to serious personal injuries.

Warning: Air mixed with oil may explode if the oil comes in contact with hot machine parts. There is also a risk of fire.

Caution: Mineral oil and additives can cause eczema or allergic reactions. Oil mist can cause irritation, headaches and nausea if inhaled.

Caution: Always use protective gloves while handling hydraulic pipes and hoses.

Caution: Oil mist spread into work areas or oil dripping onto walkways increases the risk of slipping.

Caution: Use only oil in the hydraulic system which meets the hydraulic oil standards recommended by Rolls-Royce. Using other hydraulic oil might damage the propulsion system.

Caution: It is highly important to prevent dirt and particles to enter the hydraulic system. Always use clean equipment when working with the hydraulic system. Clean the working area and the parts before assembly and disassembly.

Remote Control / Closed Loop System for Main Propeller

Warning: Radio waves from for example walkie-talkies and mobile phones can interfere with the signals from the feed back unit and the central unit. Be cautious when using such equipment when the propulsion system is running, since this can disturb the control system.

Warning: **Only trained personnel are allowed to operate the main propellers using the main propeller control system.**

Warning: **Make yourself familiar with the emergency systems before starting to operate the propellers.**

Warning: **Do not open the control system cabinet doors and do not touch the wiring during operation.**

Warning: **Never allow water to enter inside the cabinets or control panels. Like with other electrical equipment, water may cause danger for electrical shocks and serious damages on the equipment.**

Warning: **Test the back-up system regularly.**

Warning: **Do not stop the pitch control hydraulics while the main engine(s) is/are running and is/are engaged.**

Warning: **Do not start and engage the main engines until the pitch control hydraulics are running.**

Caution: The pitch feed back box and the central unit cabinet contain components that are sensitive to Electrostatic Discharges (ESD). To prevent damage to the equipment, always use a grounded ESD bracelet while work is performed inside the feed back box and inside the central unit cabinet.

Remote Control System for Main Propeller

Warning: Test the emergency clutch out (if included) regularly.

Caution: Use emergency clutch out solely in emergency situations. Do not use it for regular clutch out as it will wear on the clutches.

Caution: The possibility to override the load limit and the LIC function is intended for temporarily risen power requirements and should not be used in regular operation.

Caution: In back-up mode no automatic load control will take place. Observe the “ENGINE OVERLOAD” lamp on the control panel, and reduce the pitch immediately if the lamp is lit.

System Description Mechanical and Hydraulic

General

The following information describes the scope of supply of the Kamewa controllable pitch propeller type A. It includes descriptions of the different sub system.

The characteristic of the Kamewa controllable pitch propeller is that the propeller blades can be turned about their own axis. The blade axis is perpendicular to the propeller shaft. The propeller blades can be controlled from the bridge or the engine room. The blades turn simultaneously by means of hydraulic pressure which is controlled by a hydraulic system.

This propulsion system gives the possibility to set the pitch angle in any position between full power ahead and full power astern, which makes it unnecessary to reverse the rotation of the propeller shaft when going from ahead to astern direction. This provides for quicker, more responsive manoeuvring and improved operative economy.

The advantage of changing the angle of the propeller blades is maintaining engine speed and making full use of the propulsion power. For example, in case of an emergency situation, the stopping distance and stopping time are much shorter than with a fixed pitch propeller. However, the efficiency ratio is slightly lower when going astern, than with a fixed pitch propeller.

Each Kamewa propeller is supplied with blades designed specifically for the particular vessel. Consideration is given to factors such as:

- Power
- Shaft speed
- The hull wake field
- Draught
- Clearance between propeller and hull
- Rules of the classification societies

If any of these factors are changed, the performance (efficiency, noise, and vibration) could be influenced. Thanks to the flexibility of the controllable pitch propeller a re-optimization is simple. The modifications are normally limited to revision of the relationship between shaft speed and pitch.

Main Components

The main components in the propulsion system are described in figure 1. The dashed poses in the figure means that the components are optional Rolls-Royce delivery.

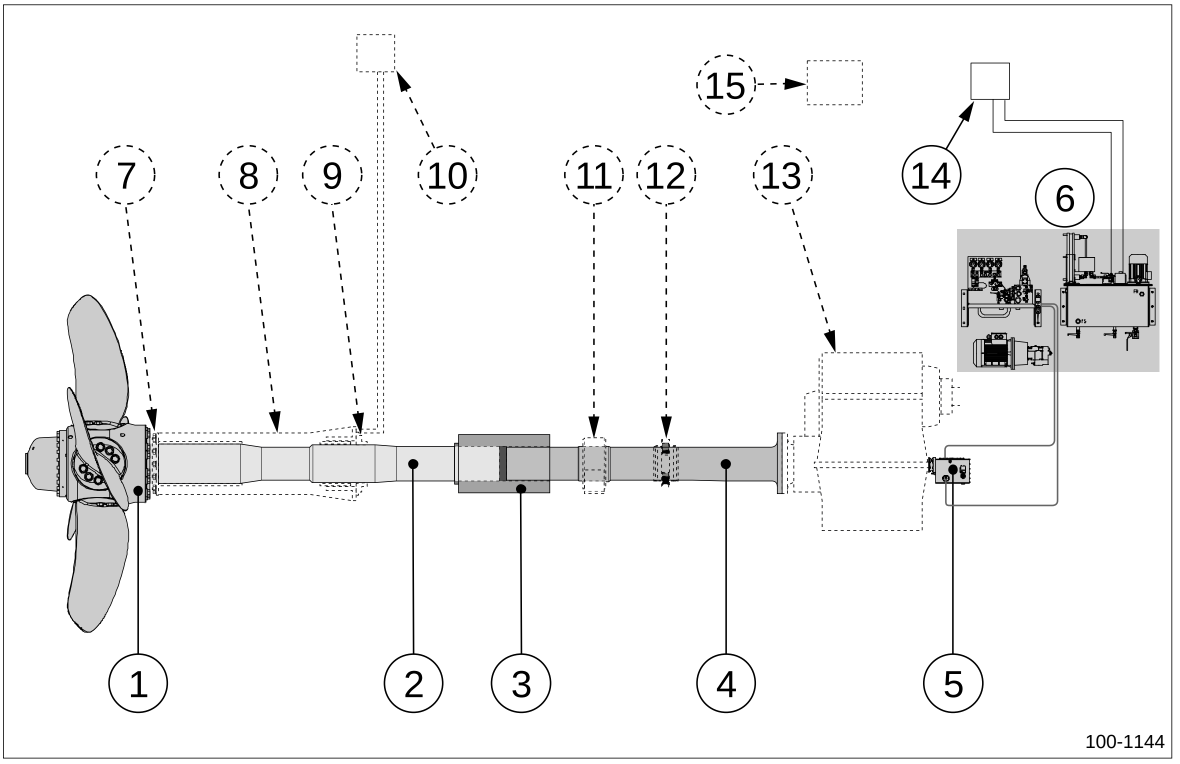

Figure 1 An overview of a propulsion system with an OD-box type FA.

1. Propeller hub with blades
2. Propeller shaft
3. Sleeve coupling
4. Intermediate shaft
5. Oil Distribution Box (FA)
6. Hydraulic power pack
7. Stern tube aft sealing (Optional Rolls-Royce delivery)
8. Stern tube (Optional Rolls-Royce delivery)
9. Stern tube forward sealing (Optional Rolls-Royce delivery)
10. Stern tube header tank (Optional Rolls-Royce delivery)
11. Support bearing (Optional Rolls-Royce delivery)
12. Earthing device (Optional Rolls-Royce delivery)
13. Gear box (Optional Rolls-Royce delivery)
14. Gravity tank
15. Remote control system or closed loop system (Optional Rolls-Royce delivery)

Functional Description

The propulsion system uses pressurised hydraulic oil to control the pitch angle of the propeller blades. The pressurised oil is guided to the propeller hub through a twin tube which runs through a hollow bored shaft line. The twin tube is connected in the forward end to an oil distribution box (OD-box) and in the aft end it is bolted to the piston in the propeller hub. The turning of the propeller blades is managed by applying hydraulic oil pressure to either side of the piston, which in turn moves the piston rod back and forth. It is by means of the OD-box that the hydraulic oil pressure is applied to the desired side of the piston. When the piston rod is pushed forward this turn the propeller blades to an ahead pitch. For astern pitch setting, the piston rod is pushed aft ward.

The twin tube, propeller shaft, and bearings are installed in a stern tube which is filled with oil for lubrication purposes. The stern tube header tank contains the oil at a certain height above sea level to achieve a static pressure from the gravity force. The stern tube, together with shaft bearings and seals, can be delivered as a complete unit from Rolls-Royce or other manufacturers on the market.

The lubrication of the propeller hub is maintained by static pressurised hydraulic oil, guided to the propeller hub by the hollow bored shaft line. The oil is contained in the hydraulic power pack, which could be equipped with a supplementary gravity tank. The static pressure is achieved by a pump unit on the power pack. Pressurised oil is necessary to prevent ingress of water in the propeller hub and to maintain sufficient blade bearing lubrication. To prevent the hydraulic system from over pressure, safety valves are included in the hydraulic system.

The mounting of a supplementary gravity tank must be at a specified height above sea level (maximum draught) to ensure sufficient oil pressure. It is also possible to achieve sufficient oil pressure by applying pneumatic pressure in the gravity tank which enables lower mounting height. The gravity tank can be delivered as a complete unit from Rolls-Royce or other manufacturers on the market.

Sub Systems (FA)

Propeller Hub and Blades

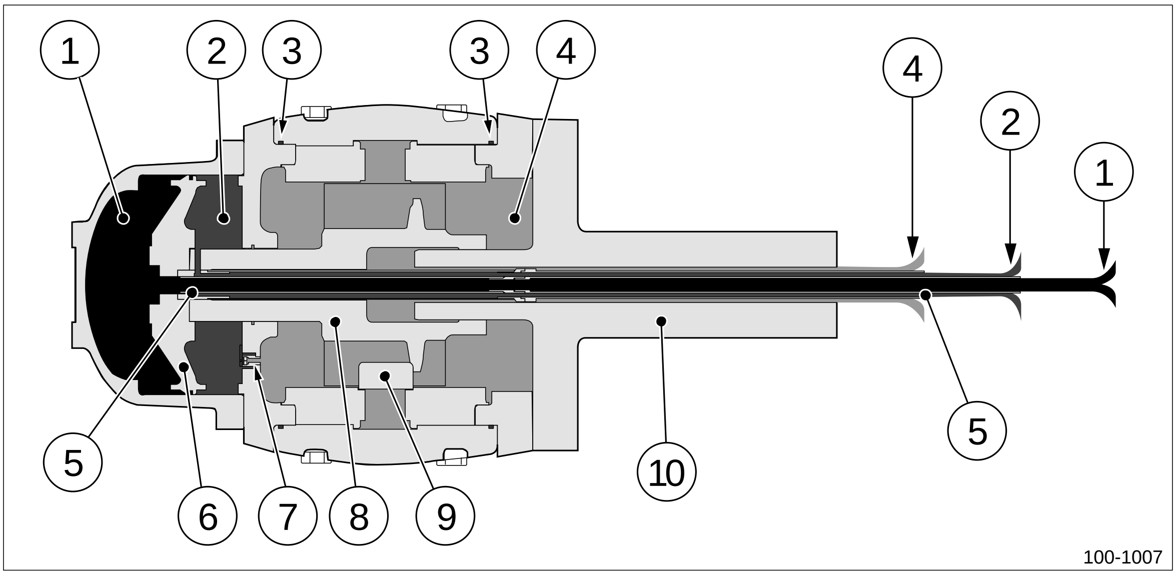

Figure 2 The propeller and propeller shaft.

1. Pressurised hydraulic oil for Ahead setting
2. Pressurised hydraulic oil for Astern setting
3. O-ring
4. Low pressurised oil for static hub pressure
5. Twin tube
6. Piston
7. Oil circulation valve
8. Piston rod
9. Sliding shoe
10. Propeller shaft

The propeller is manufactured with integrated blade bearings and O-rings (3) for sealing off sea water at each blade. The lubrication of the propeller hub is provided by the static pressurised hydraulic oil (4).

Inside the hub body, the twin tube (5) is bolted to the piston (6) and piston rod (8), which are the components that mechanically turn the propeller blades around their axis.

When hydraulic pressure is applied through the twin tube on either the aft side (1) or the forward side (2) of the piston, the piston rod moves forth and back, thus forces the sliding shoes (9) to move as well. As the sliding shoes move with the piston rod they describe a circular movement in their guiding trails. Each propeller blade is turned around by a crank pin, which is guided by the sliding shoe.

The propeller hub is equipped with a hub oil circulation system. The oil circulation system allows a constant flow of oil from the highly pressurised oil (2) through the oil circulation valve (7) into the static pressure parts (4) of the hub.

Propeller Shaft

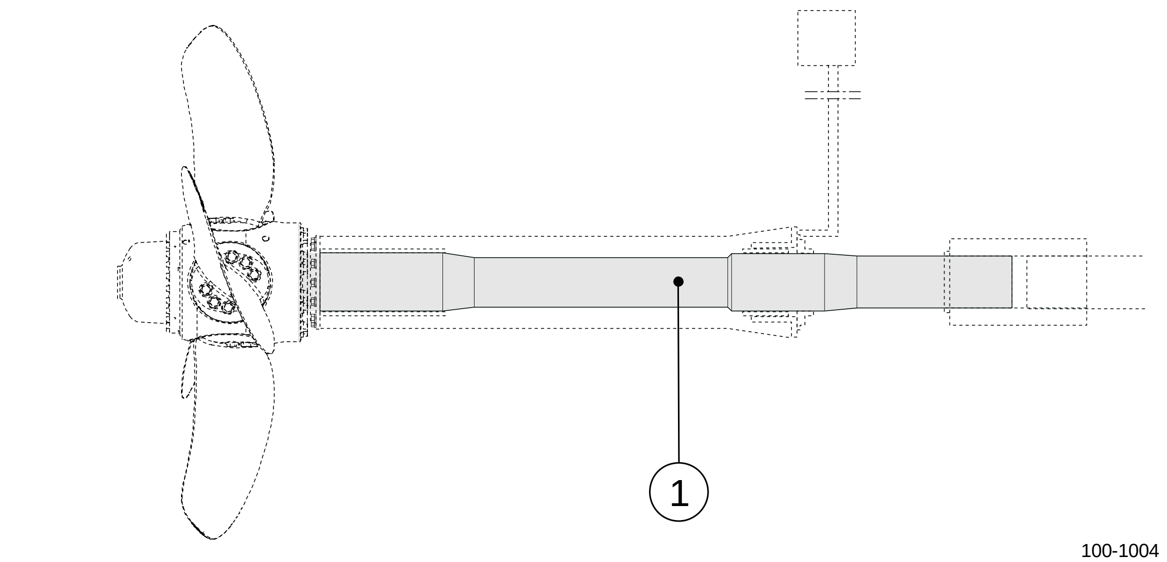

Figure 3 The propeller shaft.

1. Propeller shaft

The propeller shaft is hollow bored to allow the twin tube to run through it. The shaft line can be split in parts of manufacturing reasons and connected by sleeve couplings.

Sleeve Coupling

Two types of friction couplings can be used in the shaft line. A sleeve coupling can be used to connect two shaft parts if the shaft is split into more than one part. And a flange coupling can be used for the flanged connection towards the gear box.

The couplings consist basically of two sleeves of high quality steel, a thin inner sleeve and a thick outer sleeve. The couplings are mounted by driving the outer sleeve up on the taper of the inner sleeve using the hydraulic unit incorporated in the couplings. The inner sleeve is compressed onto the shaft and thus creating a powerful interference fit.

For more information concerning sleeve couplings, please see the Sub Supplier Manuals part in this manual.

Intermediate Shafts

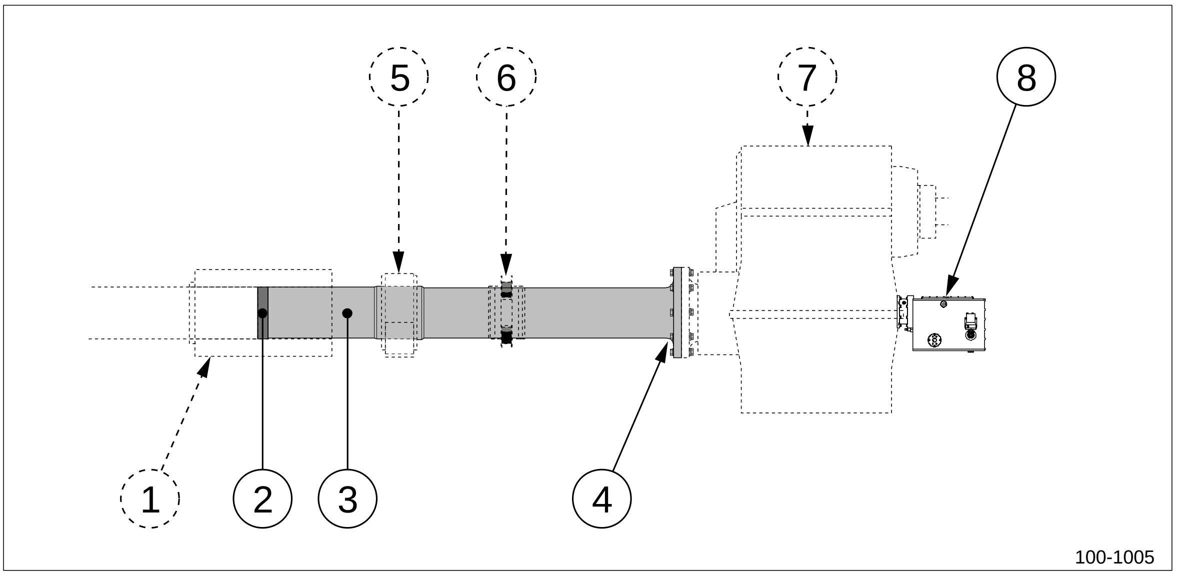

Figure 4 Intermediate Shaft.

1. Sleeve coupling (Optional Rolls-Royce delivery)
2. Split distance ring
3. Intermediate shaft
4. Flange with fitting bolts
5. Bearing (Optional Rolls-Royce delivery)
6. Earthing device (Optional Rolls-Royce delivery)
7. Gear box (Optional Rolls-Royce delivery)
8. OD-box (FA)

The intermediate shafts are hollow bored to allow the twin tube to run through them. The shaft line can be split in parts of manufacturing reasons and connected by sleeve couplings and flange connections.

Twin Tube and OD-box FA

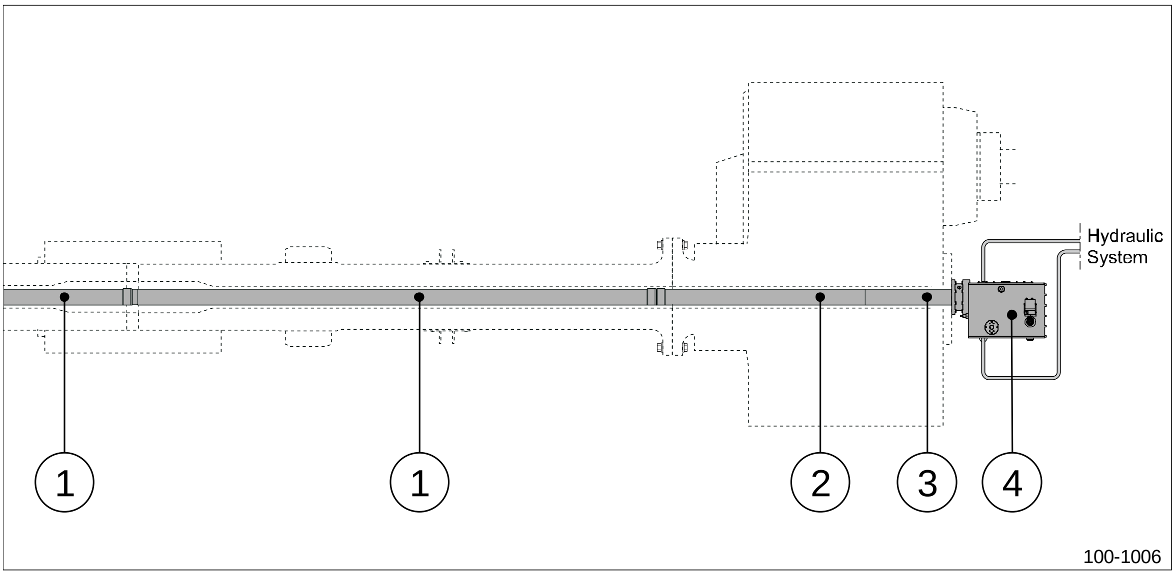

Figure 5 OD-box (FA).

1. Intermediate twin tube
2. Forward twin tube
3. Oil transfer tube
4. OD-box (FA)

The OD-box is located on the forward side of the gear box and is the component which mechanically guides the pressurised hydraulic oil to the twin tube for the desired pitch setting. The twin tube is fastened to the OD-box by a bolted connection and passes through the gear box into the hollow bored shaft line. In the propeller hub, the twin tube is fastened to the piston. When the piston moves back and forth depending on the pitch setting, the twin tube also moves together with the piston and the movement is fed back to the control system by a feed back box.

Oil Distribution Box, Type FA

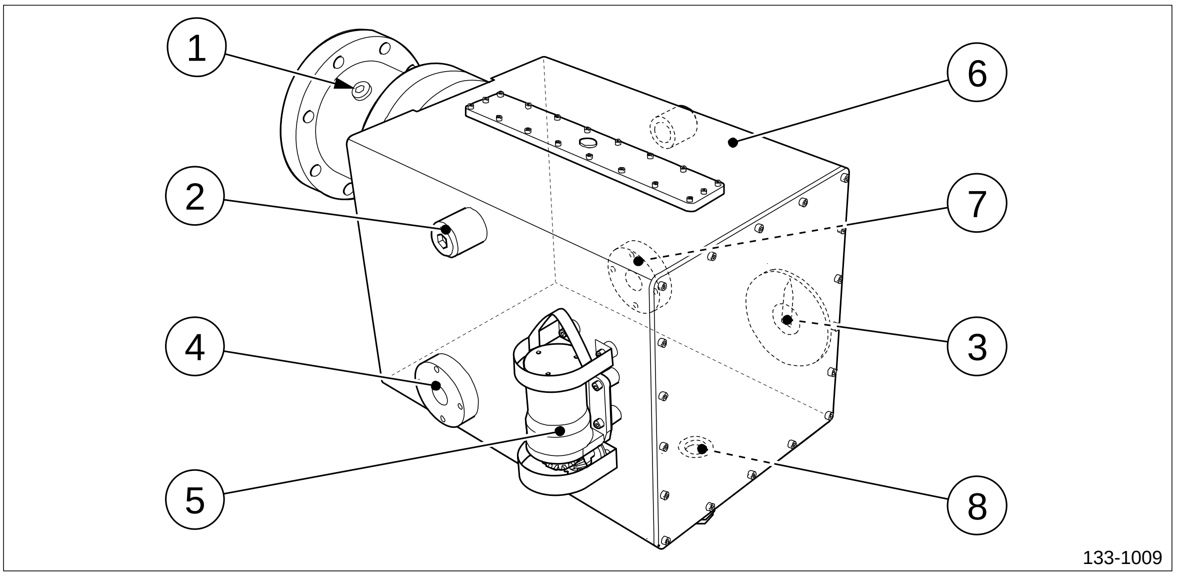

Figure 6 OD-box FA.

1. Connection for static pressure, SP
2. Connection R
3. Pointer and scale
4. Connection A
5. Feed back box
6. Box housing
7. Connection B
8. Shut-off valve (Yard supply)

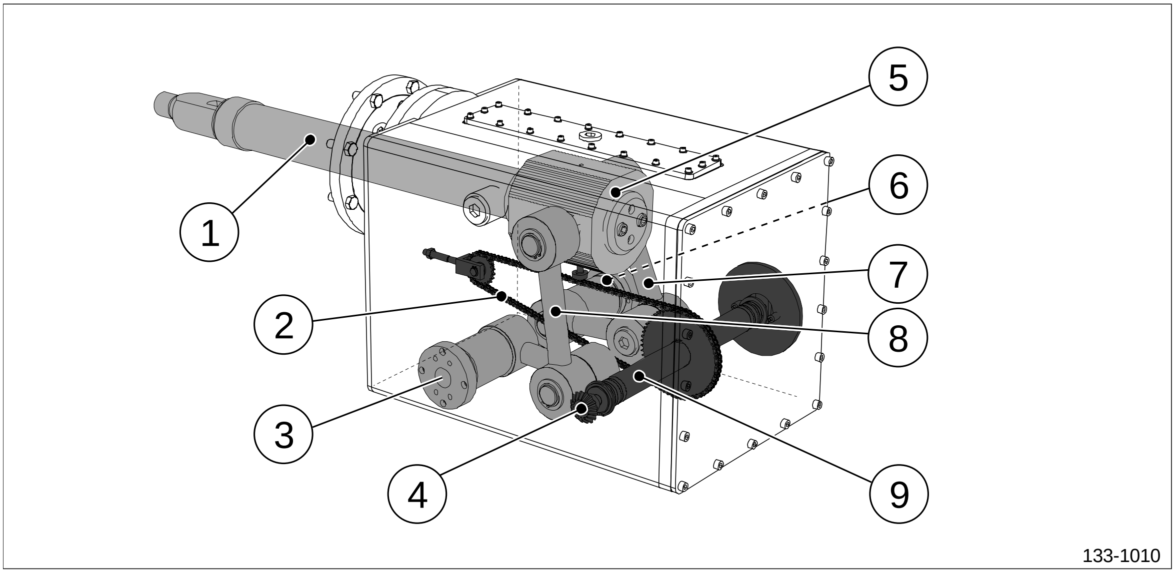

Figure 7 OD-box, type FA.

1. Oil transfer tube
2. Feed back chain
3. Connection A
4. Connection to feed back box
5. OD-box ring and stub shaft
6. Connection B
7. Swivel B
8. Swivel A
9. Feed back shaft

The oil distribution box is an arrangement that feeds two different oil pressures; low pressurised oil and a high pressurised oil.

The low pressurised oil in the box housing is guided to the propeller hub by the hollow bored shaft line.

The high pressurized oil is feed into the twin tube for ahead (6) or astern (3) pitch setting in the propeller hub. The pressurised oil is transferred through two separate swivels (7 and 8) into a stub shaft (5), which is connected to an oil transfer tube (1).

As the high pressurised hydraulic oil is lead into the propeller hub, this causes the twin tube and stub shaft to move back and forth. When the stub shaft moves, the feed back shaft (9) is turned by the feed back chain (2). The feed back box translates the mechanical turning of the feed back shaft into an electrical signal which is used by the electric remote control system to verify the actual pitch setting. The pitch position can also be read (in millimetres) directly from the mechanical scale (pos 3, figure 6) on the OD-box.

Hydraulic System

General Description

The hydraulic system pressurises hydraulic oil which enables the turning of the propeller blades. It consists of a hydraulic power pack system, hydraulic oil, and piping. Note that the piping is not part of the Rolls-Royce delivery. The system can also be equipped with PTO-driven pump unit and a gravity tank as optional equipment.

The main components in the hydraulic system are the hydraulic oil tank, control panel, pump unit and connection box. The hydraulic system provides two different pressure levels; a high oil pressure used for the pitch setting and a low oil pressure used for the lubrication of the propulsion system and for static pressure in the propeller hub.

Main Components

Note that the illustrations may not be an exact copy of the actual hydraulic power pack system on board the vessel. For more specific scope of supply see part Design Drawings.

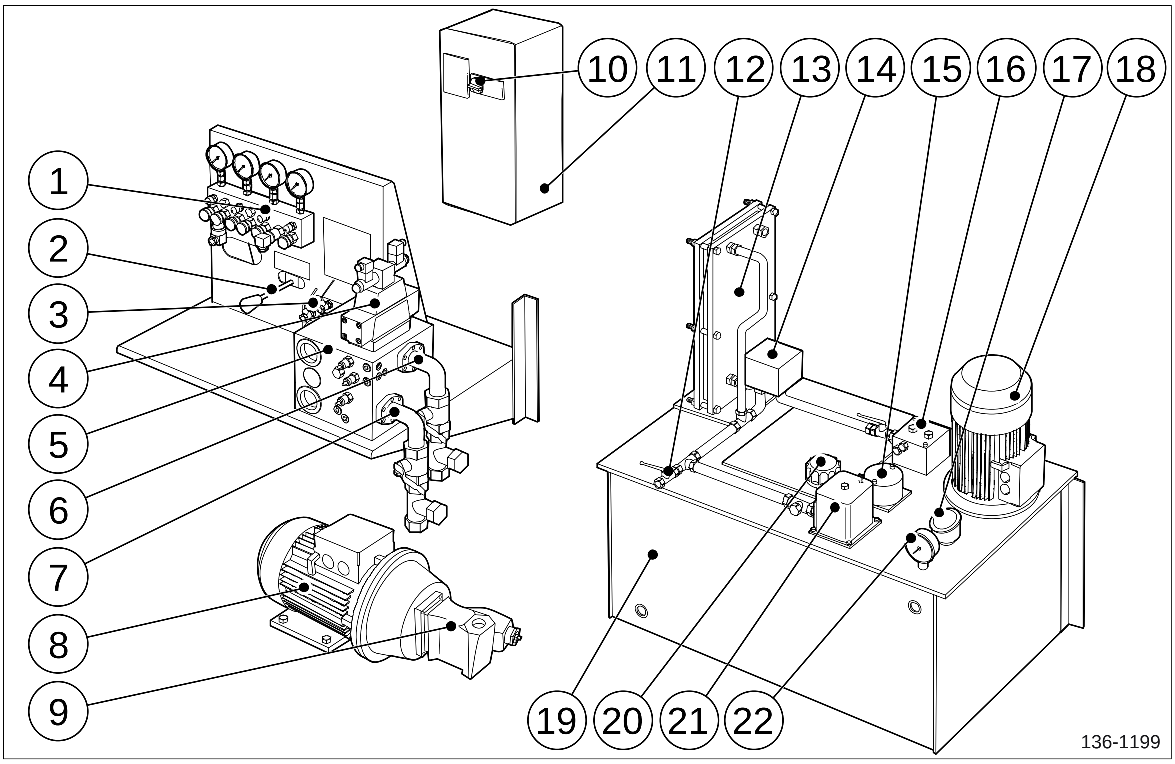

Figure 8 Hydraulic system.

1. Control panel
2. Selector for control valve V12
3. Emergency control panel
4. Proportional control valve V3
5. Valve manifold
6. Connection A
7. Connection B
8. Electric motor M1
9. Pump unit P1
10. Remote/local switch
11. Connection box
12. Connection Z (shut-off valve)
13. Oil cooler C1
14. Temperature control valve TV1
15. Level switch LS1
16. Valve manifold
17. Temperature transmitter
18. Static pressure circulation pump unit P3
19. Hydraulic oil tank
20. Air breather filter
21. Circulation filter
22. Temperature gauge

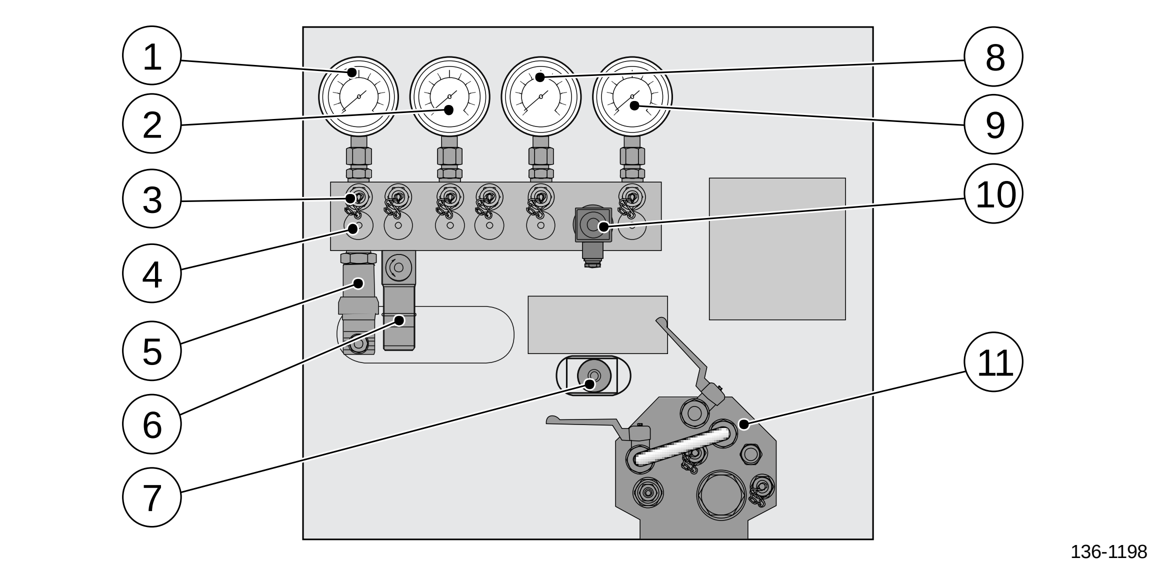

Figure 9 Control panel with emergency manoeuvre block and gauge panel.

1. Pressure gauge, system pressure, G1
2. Pressure gauge, astern pitch, G3
3. Test nipples
4. Shut off valves
5. Pressure transmitter PT2
6. Pressure switch PS1
7. Emergency control valve V12
8. Pressure gauge, ahead pitch, G4
9. Pressure gauge, static pressure, G5
10. Pressure transmitter PT3
11. Emergency valve manifold

The hydraulic power pack unit

The hydraulic power pack system is equipped with electrical motor driven pumps, oil tank, and all the necessary valves, oil filters, and sensors are integral parts of the unit.

The electrically driven pump (pos 9, figure 8) is used as main pump and supplies oil pressure for the pitch control.

The electrical pump is of load sensing variable displacement type. Its special feature is to give flow and oil pressure to the hydraulic system only when needed and when not needed it is in idle mode. This feature minimizes not only noise and vibrations but it also makes the pump power-saving.

Two pressure levels

The hydraulic power pack provides two different pressure levels; a high oil pressure part used for the pitch setting and a low oil pressure part used for the lubrication of the propulsion system and for static pressure in the propeller hub. A number of control valves and safety valves, which are controlled by the electric remote control system, manage the oil flow in both the high and low oil pressure parts.

The manoeuvring of the pitch is controlled by the proportional control valve V3 (pos 4, figure 8) located on the valve manifold.

The low oil pressure is maintained by a continuously running pump unit P3 (pos 18, figure 8) during operation. The pump is an electrical motor driven double pump and both pump units are run simultaneously. One of the pump units supplies the pressure to the lubrication and static pressure system and the other one runs the oil cooler system and the oil filtration system. The pump unit P3 should always be running to make sure that the oil in the hydraulic system is filtrated even though the main pump units are stopped.

Gravity tank

The hydraulic power pack unit can be equipped with an supplementary gravity tank. The gravity tank will maintain the static pressure in the propeller hub if the pump unit P3 and the main pumps are stopped. When the oil level in the gravity tank decreases the level switch in the tank starts the pump unit P3 and when the tank is full the level switch stops the pump.

Oil cooler

The hydraulic system is equipped with an oil cooler (pos 13, figure 8). The current oil temperature are shown on a gauge on the control panel (pos 22, figure 8).

The cooling water to the oil cooler can be controlled by a thermostat control valve as an optional feature. The thermostat control valve only opens when the oil temperature rises above a pre-set value.

Filtration

The filter (pos 21, figure 8) in the filtration system is equipped with electrical and visual indication. The filter has a by-pass function and the filter element can be replaced during operation.

Operating Modes

The hydraulic system can be operated in three different ways:

• The vessel’s remote control system.

• The vessel’s back-up control system.

• Manually by the pushing the buttons on the proportional control valve V3.

For more information about how to operate the hydraulic system see Part Operating Instructions.

Emergency operating

In case of an emergency situation, such as OD-box failure or complete loss of pressure in the high oil pressure part, it is possible to control the pitch setting by using the pump unit P3 and an emergency manoeuvre block on the hydraulic power pack unit. For more information about the emergency operating instructions please see Part Operating Instructions.

System Description
G-design Blade Flange

General

The following information describes the scope of supply of the G-design propeller blade. It includes functional and technical descriptions of the design.

The characteristic of the G-design blade flange is that each propeller blade can be replaced under water since the blade flanges is environmental friendly sealed off - no oil leakage occur from the hub to the sea water and all excess oil used when flushing the blade flange is collected.

Blade Foot, G-design

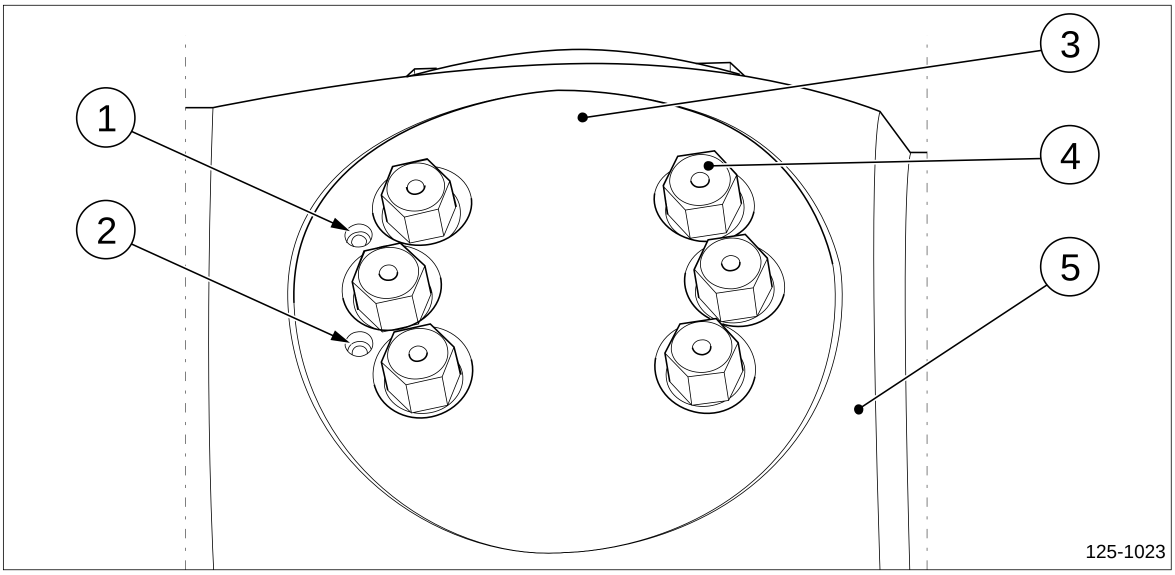

Figure 1 Blade foot, G-design.

1. Oil connection hole marked “OUT”
2. Oil connection hole marked “IN”
3. Blade flange
4. Blade bolts
5. Hub body

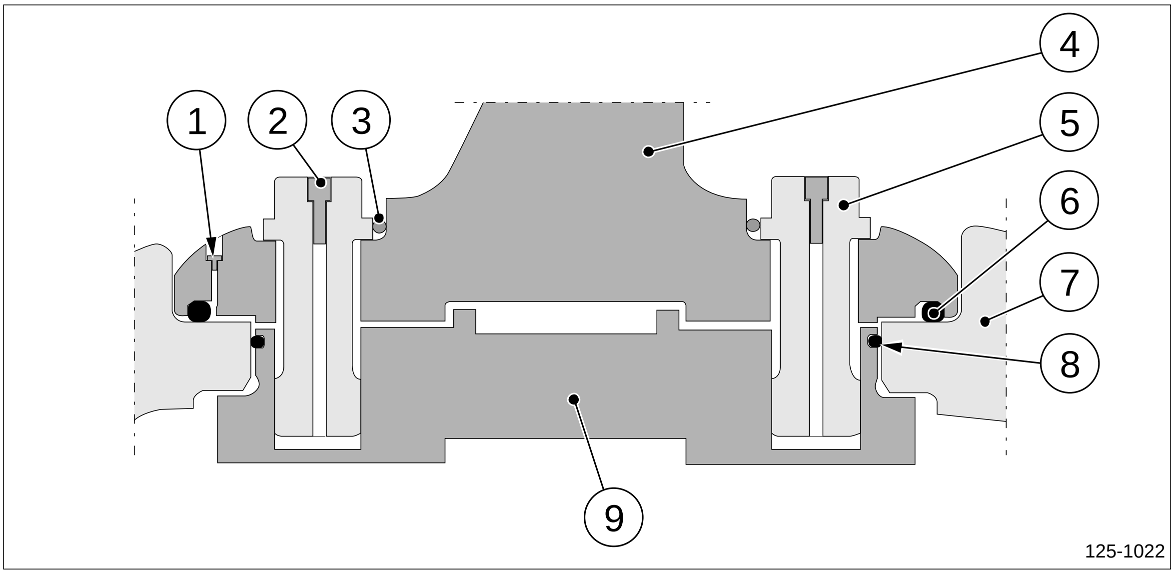

Figure 2 Cross-section of blade foot, G-design.

1. VSTI plugs for oil connection IN/OUT
2. Sealing screws
3. Locking pins
4. Propeller blade / blade flange
5. Hollow bored blade bolts
6. Blade sealing O-ring
7. Hub
8. O-ring
9. Crank pin ring

Technical and Functional Description

Each propeller blade (pos 4, figure 2) is mounted to the hub body (pos 7, figure 2) by the blade bolts (pos 5, figure 2) which are fastened to the crank pin ring (pos 9, figure 2). The crank pin ring seals off the blade flange with an O-ring (pos 8, figure 2).

Each propeller blade is manufactured with integrated blade bearings and a blade sealing O-ring (pos 6, figure 2) for sealing off sea water at each blade. The lubrication of the propeller blade flange is provided by oil injected through the blade flange using the oil connections (pos 1 and 2, figure 1). The oil connections are marked with “IN” and “OUT”. When replacing the blades an oil pump is connected to the “IN” connection hole and an oil container is connected to the “OUT” connection hole. The excessive oil used for flushing the blade flange is collected so no oil leakage will occur.

The G-design blade flange is manufactured with oil channels which connects the blade sealing ring, the blade bolt holes and the space between the blade flange and the crank pin ring.

Technical Description Pump Motor Starter

Introduction

This technical description describes all pump motor starters which can be supplied by Rolls-Royce and if your vessel is not equipped with for example a pump unit P5 or a gravity tank please disregard the descriptions regarding those features.

Pump Motor Starter P1 and P2

This instruction is valid for a vessel equipped with two electrically driven main pumps.

Introduction

This chapter describes the main components and functions of the main pump motor starters which control the hydraulic main pump units in the propulsion system.

Use the pump motor starter drawings as reference material and the Remote Supervision drawing, see part Drawings.

If the vessel is not equipped with a pump motor starter control panel from Rolls-Royce, equivalent functionality must still be available.

Main Components

In Engine Room

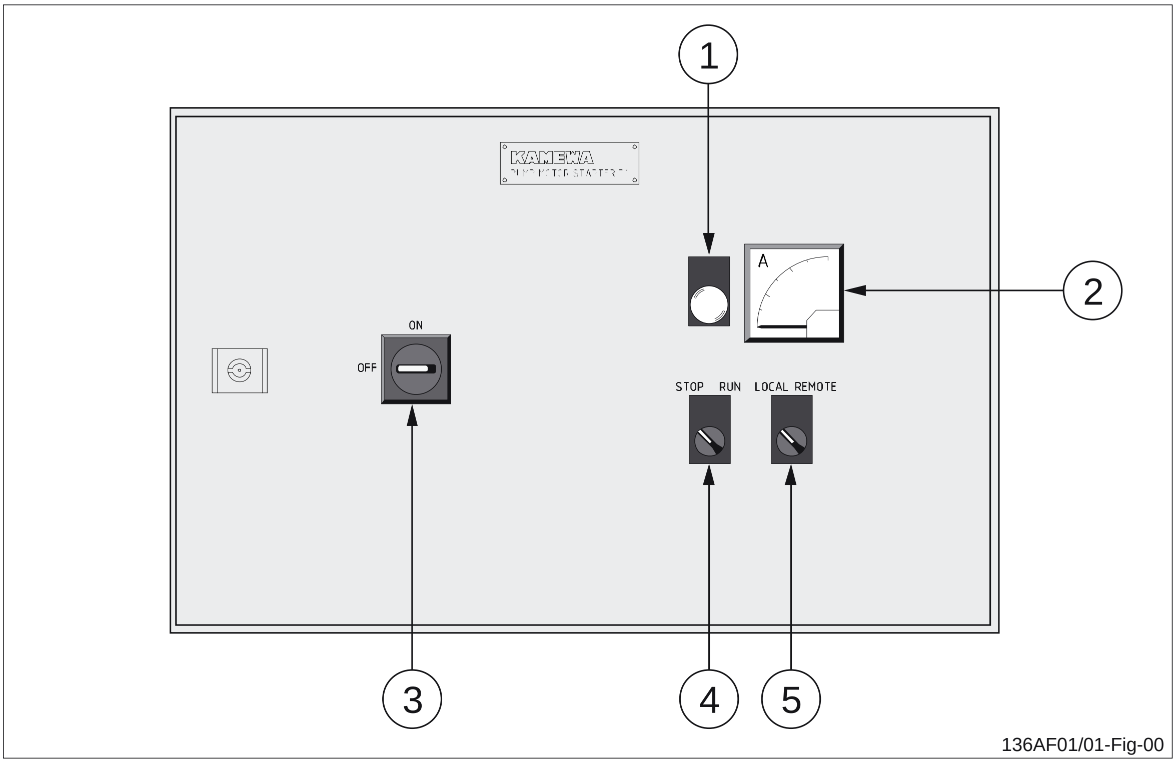

Figure 1 Front view of pump motor starter cabinet P1 or P2.

1. Run indicator lamp, H1
2. Ampere meter, P1 or P2
3. Main switch, Q1
4. Stop/run switch, S1
5. Local/remote switch, S2

The following pump motor starter equipment is located in the engine room:

• A pump motor starter cabinet for each main pump unit

• A pressure switch PS1.X for each main pump stand-by-start

Each pump motor starter cabinet includes a stop/run switch S1 and a selector switch local/remote S2, see position 4 and 5 in figure 1.

In Control Room/Bridge (Optional Equipment)

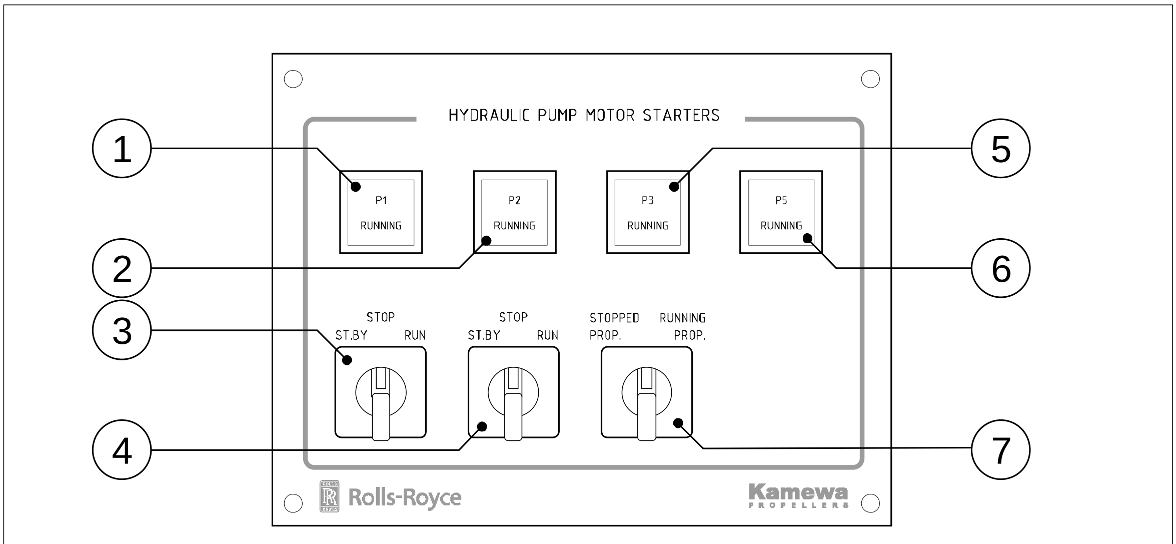

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Figure 2 Example of a pump motor starter control panel.

1. Run indicating lamp, pump unit P1
2. Run indicating lamp, pump unit P2
3. Selector switch, pump unit P1
4. Selector switch, pump unit P2
5. Run indicating lamp, pump unit P3 (optional)
6. Run indicating lamp, pump unit P5 (optional)
7. Selector switch, pump unit P3

The following pump motor starter equipment is located on the control panel:

• A selector switch for each main pump unit which has three positions:

- ST-BY (stand-by)
- STOP
- RUN

• A lamp indicating RUN

Note that each main pump unit has a separate selector switch.

Functional Description

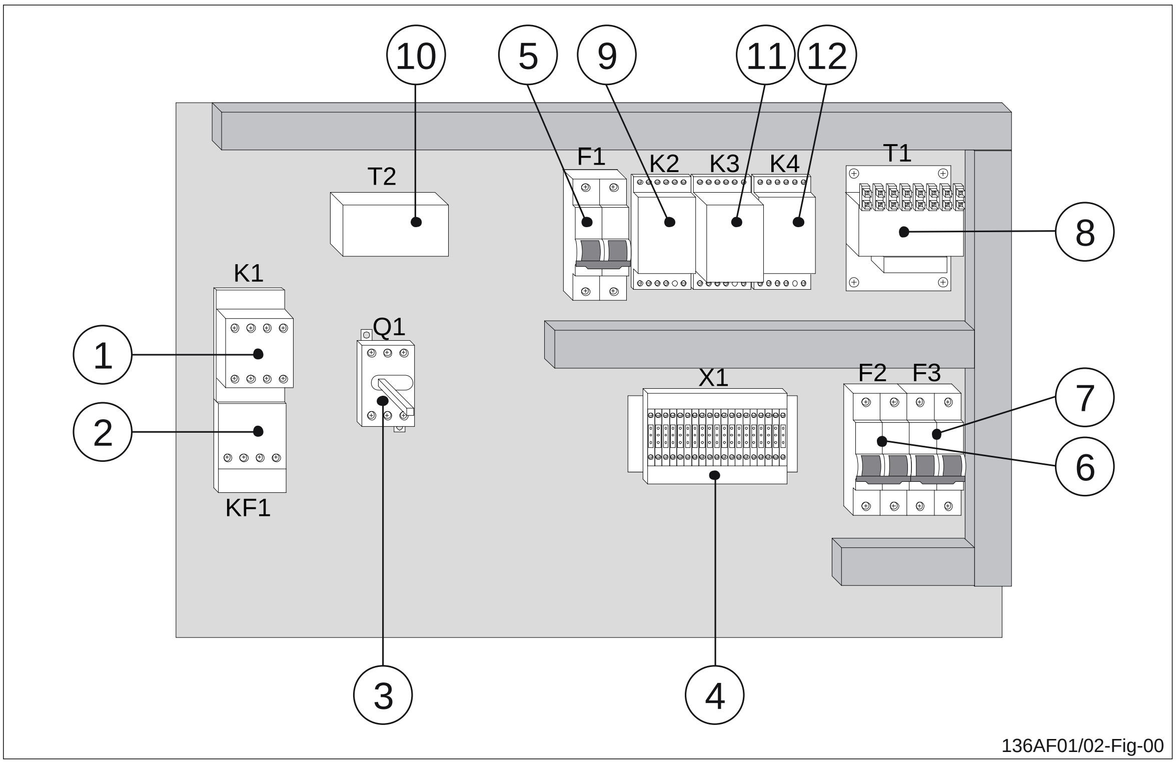


Figure 3 Internal equipment of pump motor starter P1 and P2.

1. Contactor, K1
2. Overcurrent relay, KF1
3. Main switch, Q1
4. Terminal strip, X1
5. Automatic fuse, F1
6. Automatic fuse, F2
7. Automatic fuse, F3
8. Transformer, T1
9. Relay, K2
10. Current transformer, T2
11. Time relay, K3
12. Time relay, K4

• Automatic fuse F1 is feeding the transformer T1.

• Automatic fuse F2 is feeding the operation circuits.

• Automatic fuse F3 is feeding indication lamps with 24 volt.

If the selector switch for one of the main pump units is in ST.BY (stand-by) position and the selector switch for the other pump unit is in RUN position, the pump unit in stand-by position will start automatically if the pump unit in RUN position fails.

After a voltage failure, the pump motor with the selector switch to RUN position will start automatically.

The pump motor starter P1 and P2 give voltage-free closed contacts for example running indication to the alarm system.

Pump Motor Starter, Local Mode

If the local/remote switch S2 (pos 5, figure 1) on the pump motor starter is in LOCAL position the pump unit is controlled from the switches on the pump motor starter cabinet in the engine room.

With the remote/local switch S2 in LOCAL position and switch stop/run S1 (4, figure 1) in RUN position the main contactor K1 (pos 1, figure 3) is activated and the pump motor will run.

The local mode deactivates the stand-by mode and the pump unit in stand-by has to be started manually.

Pump Motor Starter, Remote Mode

If the local/remote switch S2 on the pump motor starter is in REMOTE position the pump unit is controlled from the control panel in the control room or on the bridge.

With the local/remote switch S2 in REMOTE position and the selector switch on the control panel in RUN position the main contactor K1 is activated and the pump motor will run.

With the local/remote switch S2 in REMOTE position and the selector switch on the control panel in ST-BY position, time relay K3 is activated. If the pump unit in run mode fails and the hydraulic pressure drops, the pressure switch PS1.X is closed and time relay K4 is activated after a preset period. This will activate contactor K2 which connects main contactor K1 and the pump motor in stand-by will run.

For time adjustment of the time relays see the Remote Supervision drawing in part Drawings.

Operating Settings

Settings at Narrow Waters and Harbour:

Both selector switches, on the control panel, for each main pump units must be turned to RUN position.

Settings at Open Sea:

The selector switch, on the control panel, for one main pump unit is turned to RUN position and the selector switch for the other main pump unit can be turned to stand-by position.

Pump Motor Starter P1 (PTO)

This instruction is valid for a vessel equipped with a PTO driven main pump and an electrically driven main pump unit P1.

Introduction

This chapter describes the main components and functions of the main pump motor starters which control the hydraulic main pump units in the propulsion system.

Use the pump motor starter drawings as reference material and the Remote Supervision drawing, see part Drawings.

If the vessel is not equipped with a pump motor starter control panel from Rolls-Royce, equivalent functionality must still be available.

Main Components

In Engine Room

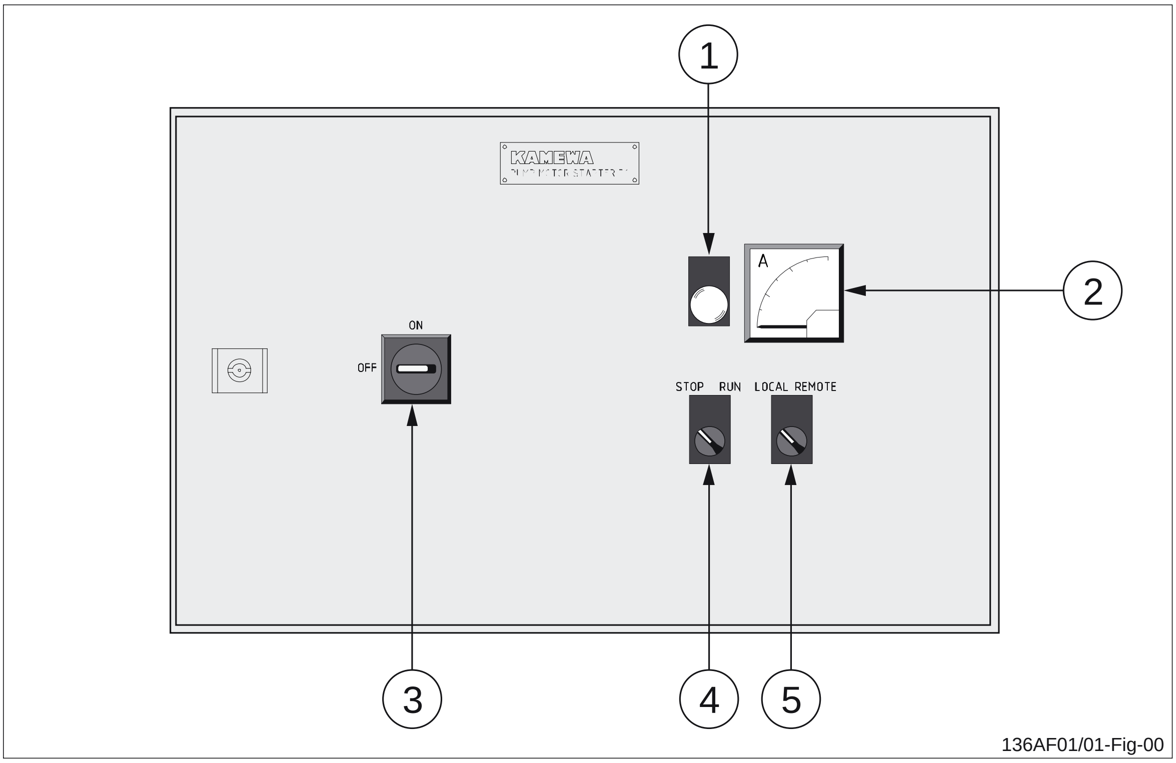


Figure 4 Front view of pump motor starter cabinet P1.

1. Run indicator lamp, H1
2. Ampere meter, P1
3. Main switch, Q1
4. Stop/run switch, S1
5. Local/remote switch, S2

The following pump motor starter equipment is located in the engine room:

• A pump motor starter cabinet for main pump unit P1

• A pressure switch PS1.X for the PTO driven main pump

The pump motor starter cabinet includes a stop/run switch S1 and a local/remote S2 switch (pos 4 and 5, figure 1).

In Control Room/Bridge (Optional Equipment)

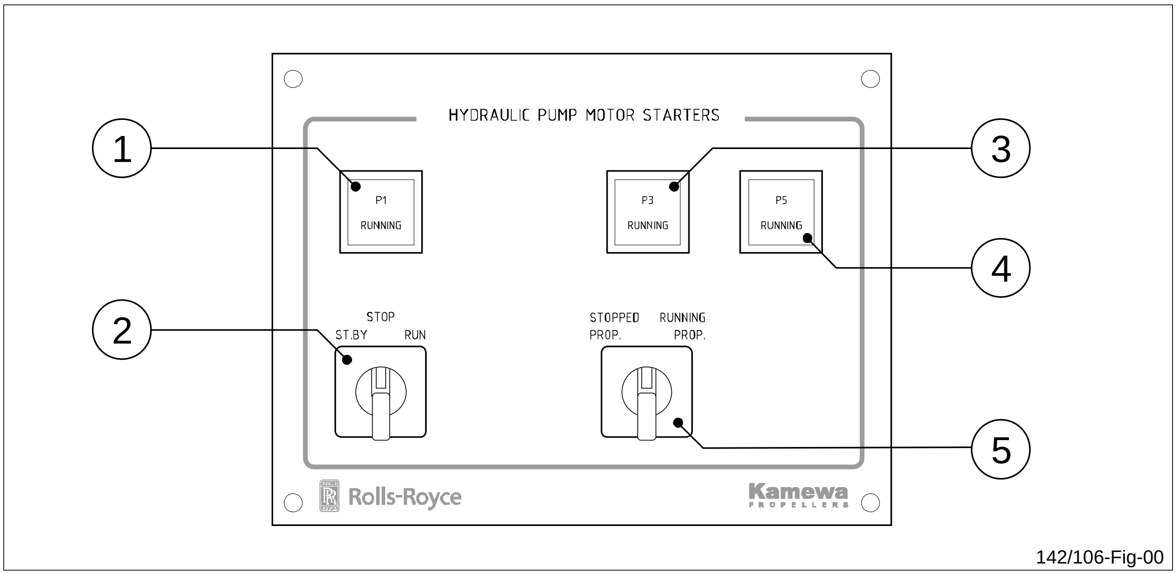


Figure 5 Example of a pump motor starter control panel.

1. Run indicating lamp, pump unit P1
2. Selector switch, pump unit P1
3. Run indicating lamp, pump unit P3 (optional)
4. Selector switch, pump unit P3 (optional)
5. Run indicating lamp, pump unit P5 (optional)

The following pump motor starter equipment is located on the control panel:

• A selector switch for the main pump unit P1 which has three positions:

- ST-BY
- STOP
- RUN

• A lamp indicating RUN

Functional Description

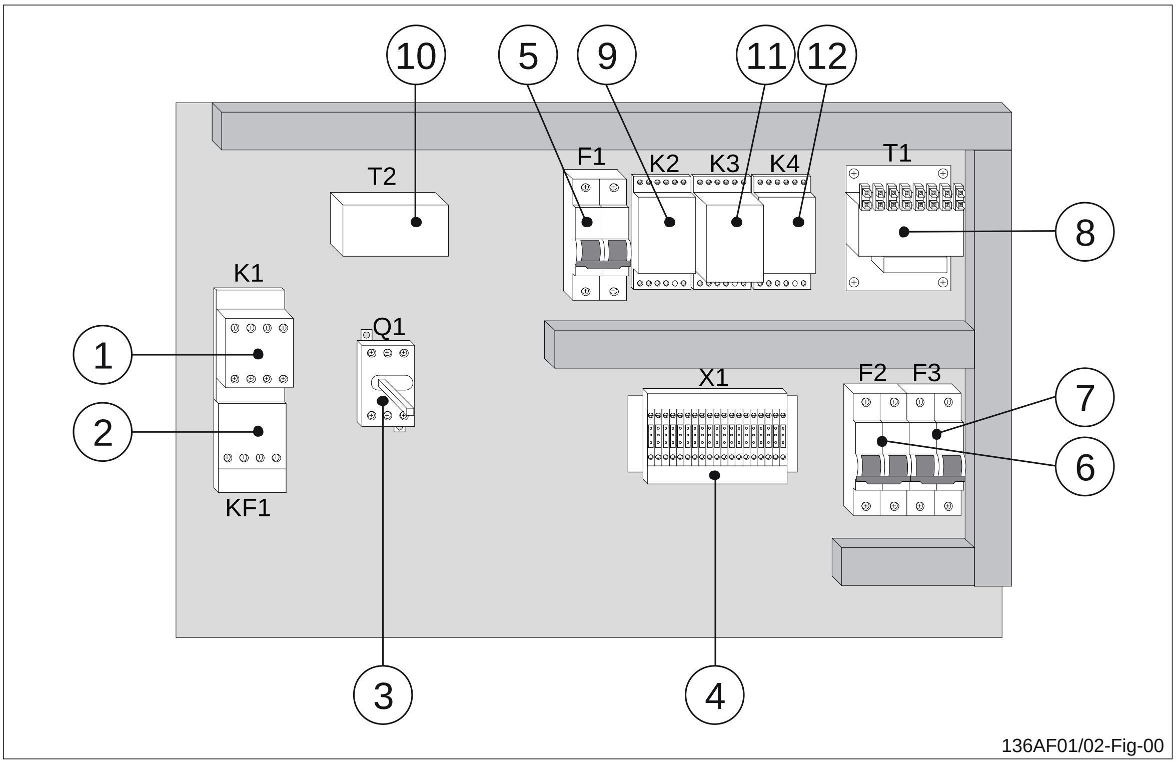


Figure 6 Internal equipment of pump motor starter P1.

1. Contactor, K1
2. Overcurrent relay, KF1
3. Main switch, Q1
4. Terminal strip, X1
5. Automatic fuse, F1
6. Automatic fuse, F2
7. Automatic fuse, F3
8. Transformer, T1
9. Relay, K2
10. Current transformer, T2
11. Time relay, K3
12. Time relay, K4

• Automatic fuse F1 is feeding the transformer T1.

• Automatic fuse F2 is feeding the operation circuits.

• Automatic fuse F3 is feeding indication lamps with 24 volt.

If the selector switch for main pump unit P1 is in ST.BY (stand-by) position, the pump unit P1 will start automatically if the PTO driven pump fails and the hydraulic pressure drops.

After a voltage failure, the pump motor P1 will start automatically if the selector switch is in RUN position.

The pump motor starter P1 gives voltage-free closed contacts for example running indication to the alarm system.

Pump Motor Starter, Local Mode

If the local/remote switch S2 (pos 5, figure 1) on the pump motor starter is in LOCAL position the pump unit is controlled from the switches on the pump motor starter cabinet in the engine room.

With the remote/local switch S2 in LOCAL position and switch stop/run S1 (pos 4, figure 1) in RUN position main contactor K1 (pos 1, figure 3) is activated and the pump motor will run.

The local mode deactivates the stand-by mode and the pump unit in stand-by mode has to be started manually.

Pump Motor Starter, Remote Mode

If the local/remote switch S2 on the pump motor starter is in REMOTE position the pump unit is controlled from the control panel in the control room or on the bridge.

With the local/remote switch S2 in REMOTE position and the selector switch on the control panel in RUN the main contactor K1 is activated and the pump motor will run.

With the local/remote switch S2 in REMOTE position and the selector switch on the control panel in ST.BY (stand-by) position, time relay K3 is activated. If the PTO driven pump fails and the hydraulic pressure drops, the pressure switch PS1.X is closed and time relay K4 is activated after a preset period. This will activate contactor K2 which connects main contactor K1 and pump unit P1 in stand-by will run.

For time adjustment of the time relays see the Remote Supervision drawing in part Drawings.

Operating Settings

Settings at Narrow Waters and Harbour:

The selector switch for the pump unit P1 must be turned to ST.BY (stand-by) position and the PTO driven pump must be running.

Settings at Open Sea:

The selector switch for the pump unit P1 must be turned to ST.BY (stand-by) position and the PTO driven pump must be running.

Pump Motor Starter P3 (without Gravity Tank)

Introduction

This chapter describes the main components and functions of the pump motor starter for the static pressure pump unit P3. This description is valid for a vessel which is not equipped with a gravity tank.

Use the pump motor starter drawings as reference material and the Remote Supervision drawing, see part Drawings.

If the vessel is not equipped with a pump motor starter control panel from Rolls-Royce equivalent functionality must still be available.

Main Components

In Engine Room

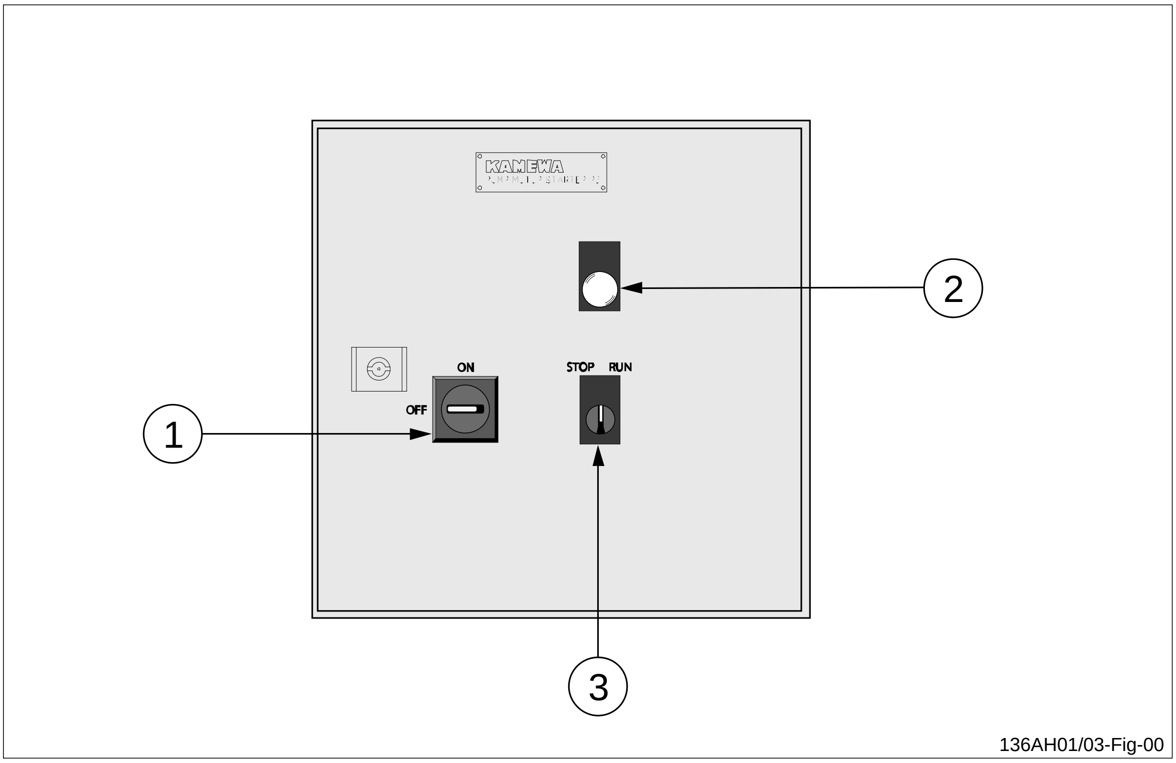


Figure 7 Front view of pump motor starter cabinet P3.

1. Main switch, Q1
2. Run indicator lamp, H1
3. Stop/run switch, S1

The following pump motor starter equipment is located in the engine room:

• A pump motor starter cabinet

The pump motor starter cabinet includes a stop/run switch S1 (see position 3, in figure 7).

In Control Room/Bridge (Optional Equipment)

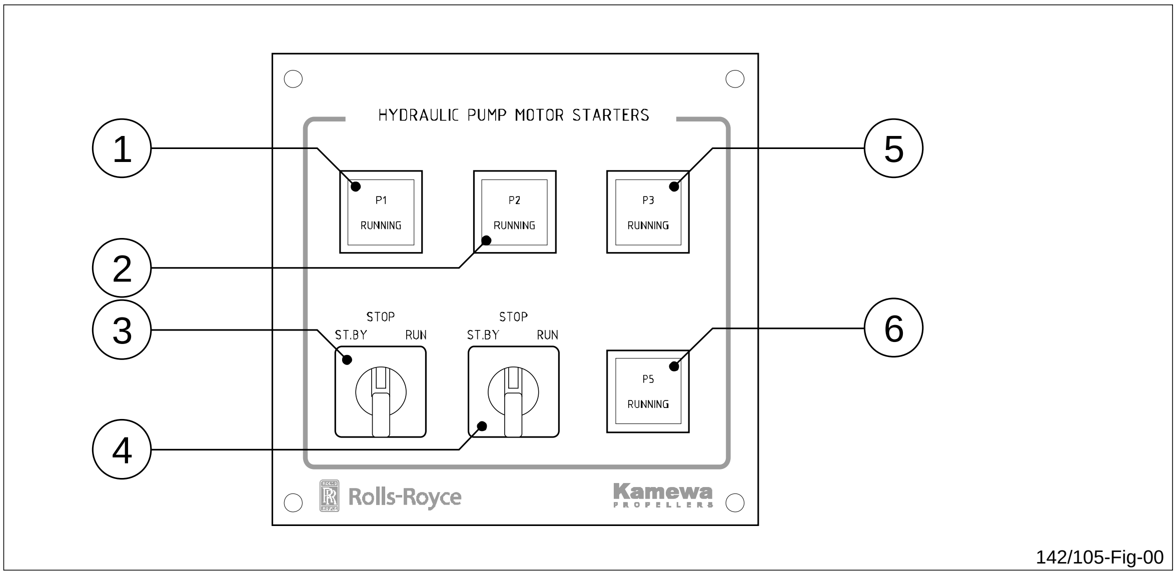


Figure 8 Example of a pump motor starter control panel.

1. Run indicating lamp, pump unit P1
2. Run indicating lamp, pump unit P2 (optional)
3. Selector switch, pump unit P1
4. Selector switch, pump unit P2 (optional)
5. Run indicating lamp, pump unit P3
6. Run indicating lamp, pump unit P5 (optional)

The following pump motor starter equipment is located on a control panel:

• A lamp indicating RUN.

Functional Description

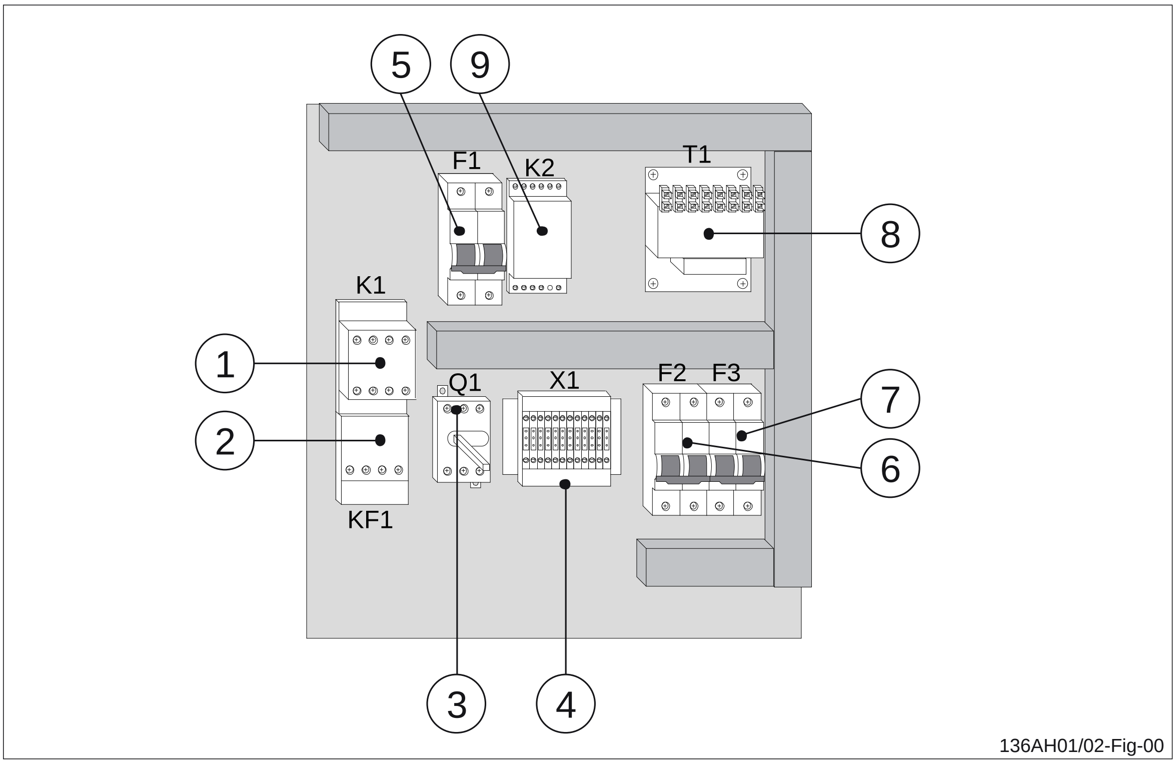


Figure 9 Internal equipment of pump motor starter cabinet P3.

1. Contactor, K1
2. Overcurrent relay, KF1
3. Main switch, Q1
4. Terminal strip, X1
5. Automatic fuse, F1
6. Automatic fuse, F2
7. Automatic fuse, F3
8. Transformer, T1
9. Relay, K2

• Automatic fuse F1 is feeding the transformer T1.

• Automatic fuse F2 is feeding the operation circuits.

• Automatic fuse F3 is feeding indication lamps with 24 volt.

It is also possible to connect an external emergency stop to the pump unit. If the external emergency stop is not used, strap terminal connection X1:25 to terminal connection X1:26.

The static pressure pump P3 must run continuously regardless if the propeller is running or stopped.

• The pump unit P3 runs continuously if the stop/run switch S1 (pos 3, figure 7) is turned to RUN position.

• The pump unit P3 stops if the stop/run switch S1 (pos 3, figure 7) is turned to STOP position.

If start/stop switch S1 is in STOP position or if the external emergency stop is ordered, the pump unit P3 stops. Note that the pressure maintaining pump P3 must normally be continuously running.

After a voltage failure, the pump motor P3 must be manually restarted.

Pump Motor Starter P3 (with Gravity Tank)

Introduction

This chapter describes the main components and functions of the pump motor starter for the static pressure pump unit P3. This description is valid for a vessel which is equipped with a gravity tank.

Use the pump motor starter drawings as reference material and the Remote Supervision drawing, see part Drawings.

If the vessel is not equipped with a pump motor starter control panel from Rolls-Royce equivalent functionality must still be available.

Main Components

In Engine Room

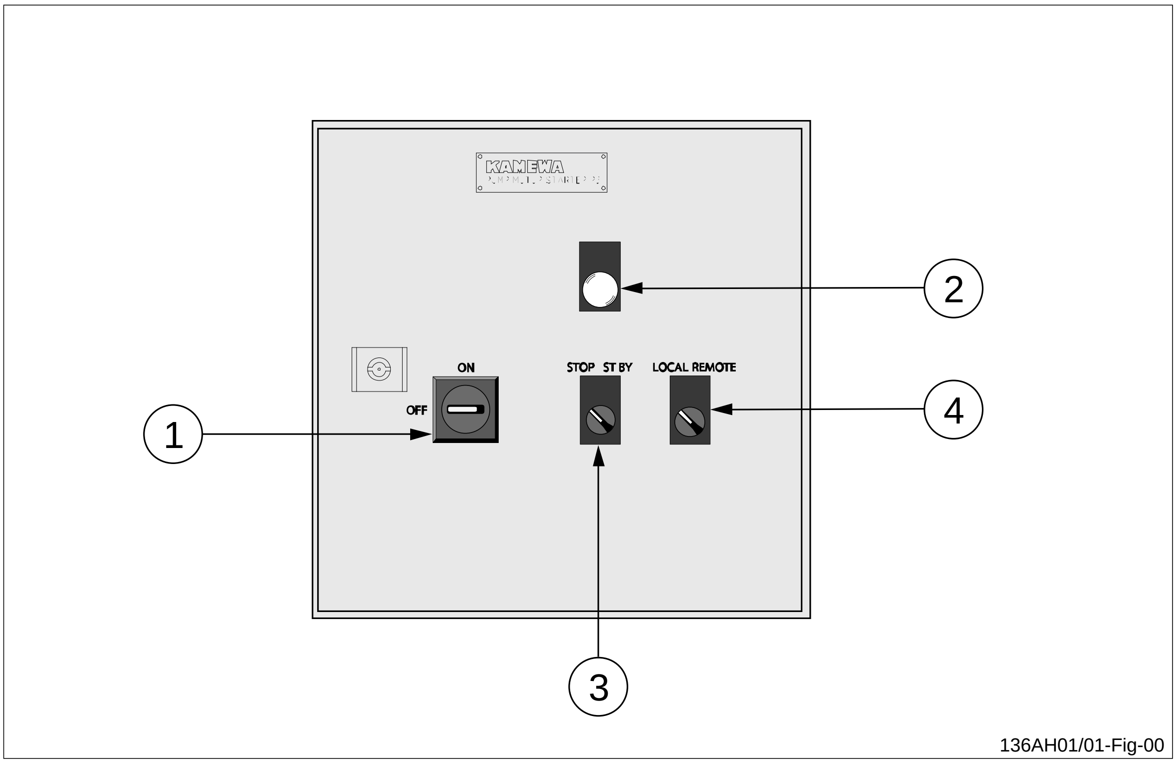


Figure 10 Front view of pump motor starter cabinet P3.

1. Main switch, Q1
2. Run indicator lamp, H1
3. stop/stand by switch, S1
4. Local/remote switch, S2

The following pump motor starter equipment is located in the engine room:

• A pump motor starter cabinet

The pump motor starter cabinet includes a stop/run switch S1 and local/remote switch S2, (pos 3 and 4, figure 10).

In Gravity Tank

The following pump motor starter equipment is located in the gravity tank:

• A level switch

The level switch in the gravity tank gives voltage-free closed contacts to the pressure maintaining pump P3 unit indicating high or low oil level in gravity tank. This function starts and stops pump unit P3 automatically.

Note that the function of the level switch is only valid if the pump unit is in stopped propeller mode. If the pump unit is in running propeller mode this mode will override the function of the level switch, see section Pump Motor Starter, Remote Mode.

In Control Room/Bridge (Optional Equipment)

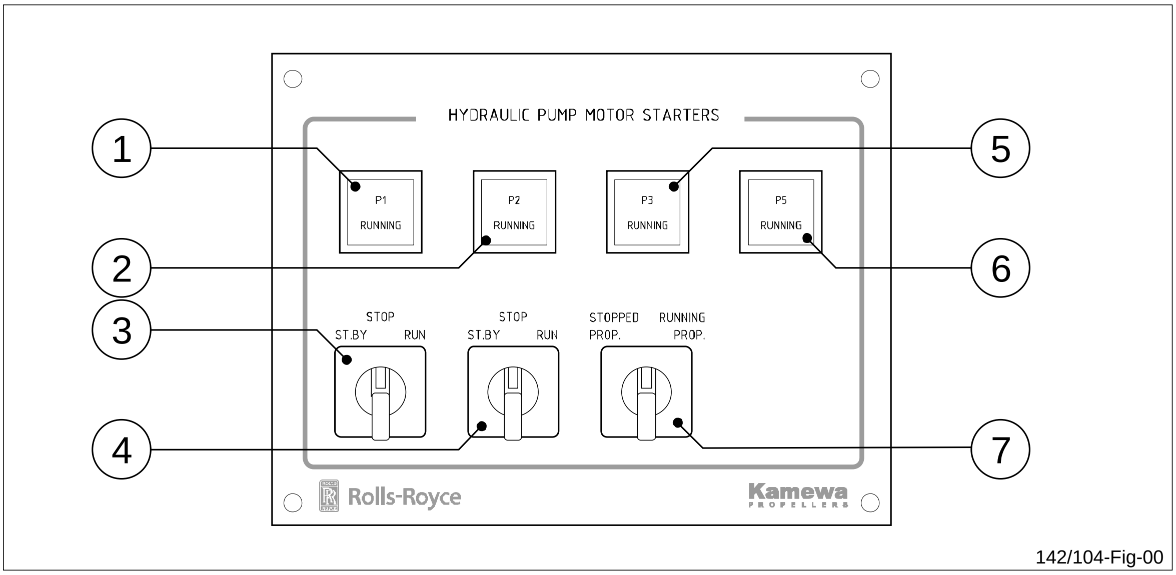


Figure 11   Example of a pump motor starter control panel.

1. Run indicating lamp, pump unit P1
2. Run indicating lamp, pump unit P2
3. Selector switch, pump unit P1
4. Selector switch, pump unit P2
5. Run indicating lamp, pump unit P3 (optional)
6. Run indicating lamp, pump unit P5 (optional)’
7. Selector switch, pump unit P3

The following pump motor starter equipment is located on a control panel:

• A selector switch which has two positions:

- RUNNING PROPELLER

- STOPPED PROPELLER

• A lamp indicating RUN.

Functional Description

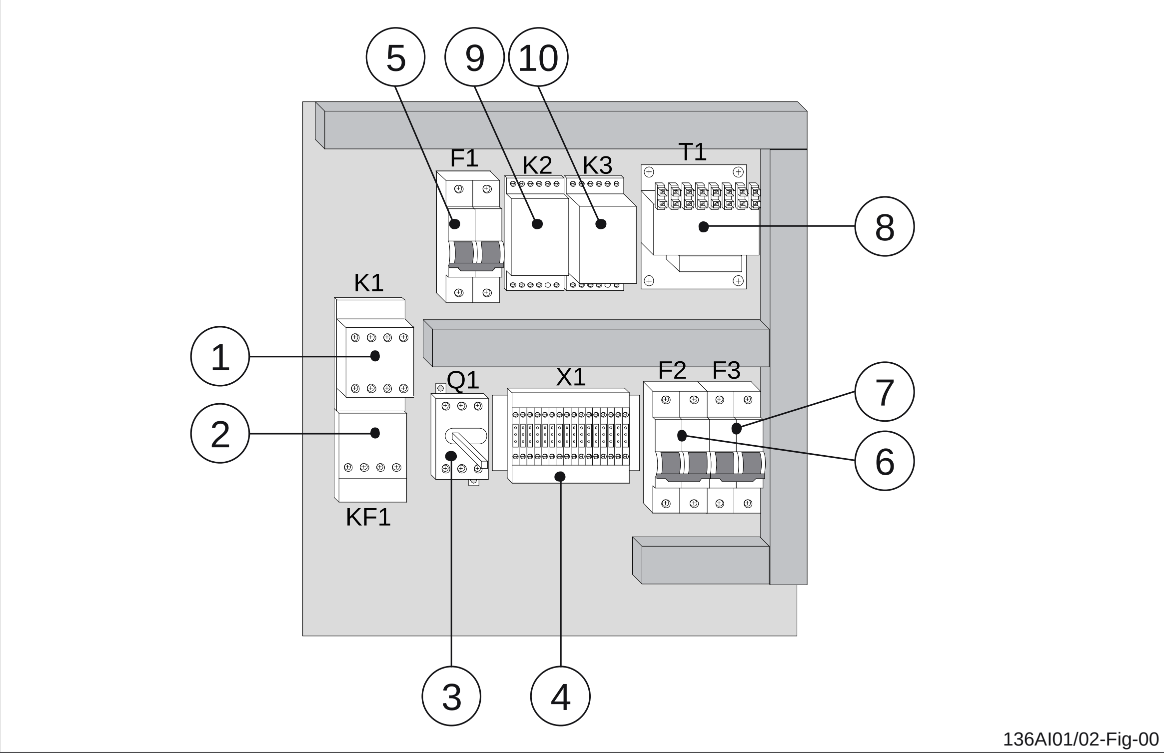


Figure 12 Internal equipment of pump motor starter P3.

1. Contactor, K1
2. Overcurrent relay, KF1
3. Main switch, Q1
4. Terminal strip, X1
5. Automatic fuse, F1
6. Automatic fuse, F2
7. Automatic fuse, F3
8. Transformer, T1
9. Relay, K2
10. Time relay, K3

• Automatic fuse F1 is feeding the transformer T1.

• Automatic fuse F2 is feeding the operation circuits.

• Automatic fuse F3 is feeding indication lamps with 24 volt.

It is also possible to connect an external emergency stop to the pump motor starter. If the external emergency stop is not used, strap terminal connection X1:25 to terminal connection X1:26.

Pump Motor Starter, Remote Mode

In remote mode the pump unit P3 must be able to be set in two modes, to make full use of the benefits of the gravity tank:

• Running propeller mode:
It is important to note that when the propeller is running the pump unit P3 must be running continuously even though a gravity tank is installed.

• Stopped propeller mode:
When the vessel is equipped with a gravity tank the pump unit P3 can be stopped when the hydraulic system is shut off and the propeller is stopped. Due to internal leakage it can be necessary to fill up the gravity tank by starting pump unit P3. A level switch in the gravity tank is used to automatically start and stop the pump unit P3.

Running Propeller Mode

The pump unit P3 must be running continuously if the propeller is running, even though the hydraulic system is equipped with a gravity tank.

When the propeller is running, the selector switch (pos 7, figure 11) for the pump unit P3 must be turned to RUNNING PROP. position.

This mode enables the pump unit P3 to run continuously without being influenced by the level switch in the gravity tank.

Stopped Propeller Mode

When the propeller is stopped, the selector switch (pos 7, figure 11) for pump unit P3 can be turned to STOPPED PROP. position.

During this mode, the pump unit will automatically be started and stopped by the level switch in the gravity tank, depending on the oil level in the tank.

Pump Motor Starter, Local Mode

If the local/remote switch S2 on the pump motor starter cabinet P3 is in LOCAL position, the pump unit P3 can be manually operated by the switches on the pump motor starter cabinet:

• The pump unit P3 runs continuously if the stop/stand by switch S1 (pos 3, figure 10) is turned to RUN position.

• The pump unit P3 stops if the stop/stand by switch S1 (pos 3, figure 10) is turned to STOP position.

Pump Motor Starter P5

Introduction

This chapter describes the main components and functions of the pump motor starter for drain pump unit P5.

Use the pump motor starter drawings as reference material and the Remote Supervision drawing, see part Drawings.

If the vessel is not equipped with a pump motor starter control panel from Rolls-Royce equivalent functionality must still be available.

Main Components

In Engine Room

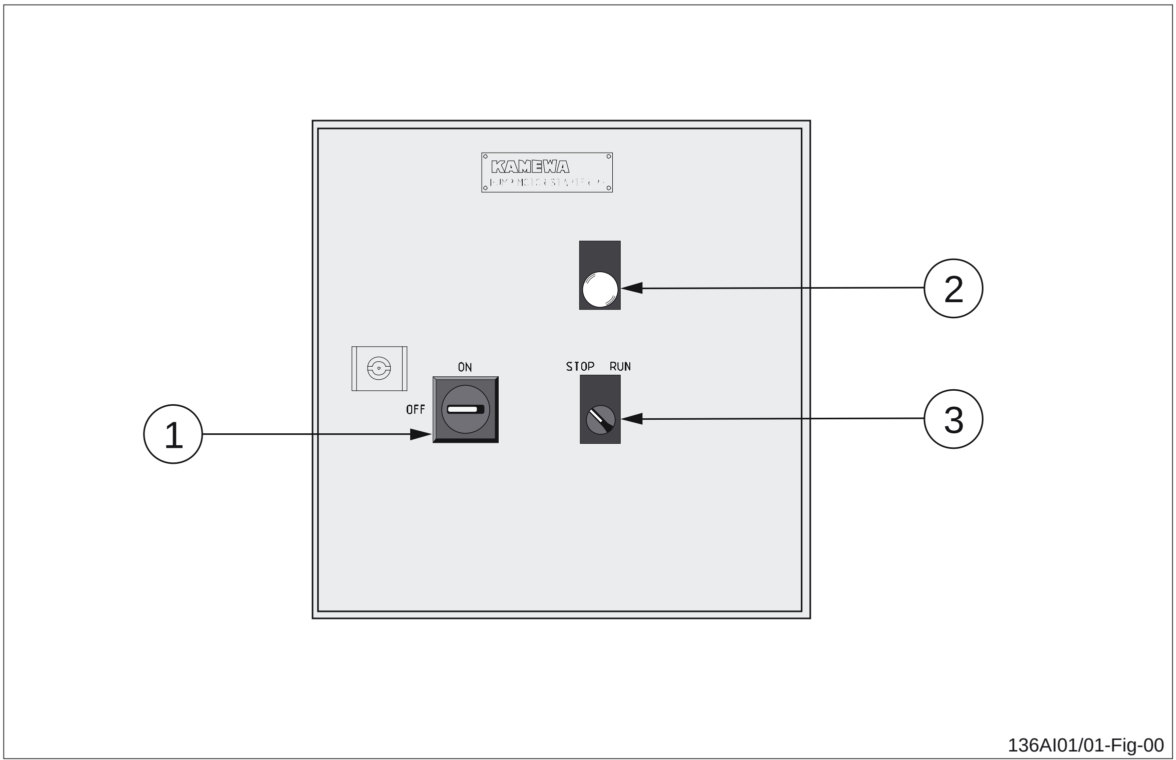


Figure 13 Front view of pump motor starter P5.

1. Main switch, Q1
2. Run indicator lamp, H1
3. Stop/run switch, S1

The following pump motor starter equipment is located in the engine room:

• A pump motor starter cabinet.

The pump motor starter cabinet includes a stop/run switch S1 (pos 3, figure 13).

In Drain Pump Unit Tank

The following pump motor starter equipment is located on a control panel:

• A level switch.

The level switch in the drain pump unit tank gives voltage-free closed contacts to pump unit P5 unit indicating high or low oil level in the tank. This function starts and stops pump unit P5 automatically.

In Control Room/Bridge (Optional Equipment)

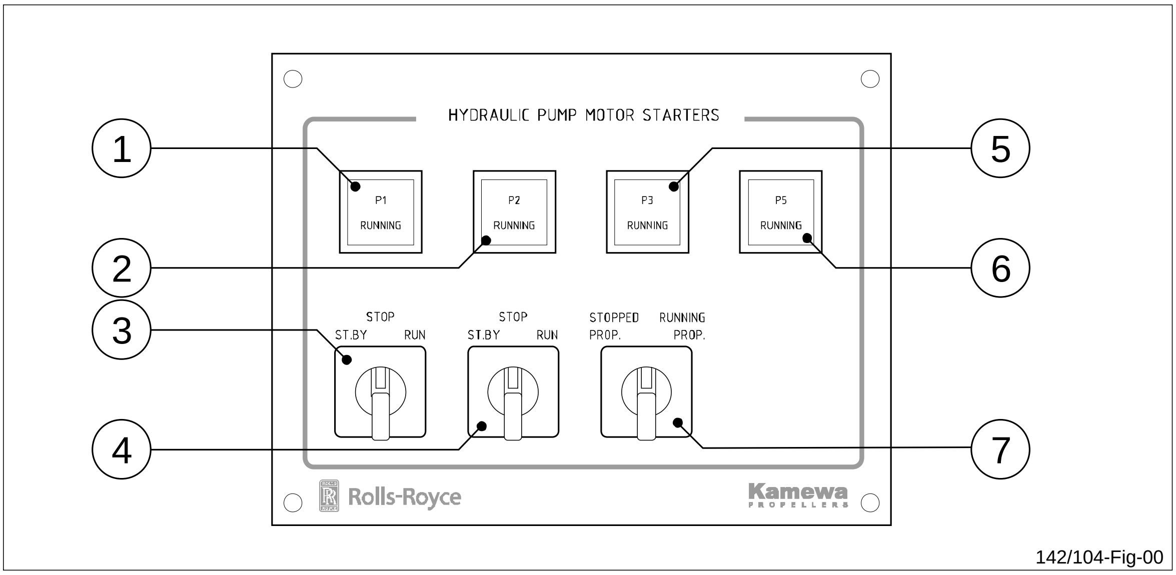


Figure 14 Example of a pump motor starter control panel.

1. Run indicating lamp, pump unit P1
2. Run indicating lamp, pump unit P2
3. Selector switch, pump unit P1
4. Selector switch, pump unit P2
5. Run indicating lamp, pump unit P3 (optional)
6. Run indicating lamp, pump unit P5
7. Selector switch, pump unit P3 (optional)

The following pump motor starter equipment is located on a control panel:

• A lamp indicating RUN.

Functional Description

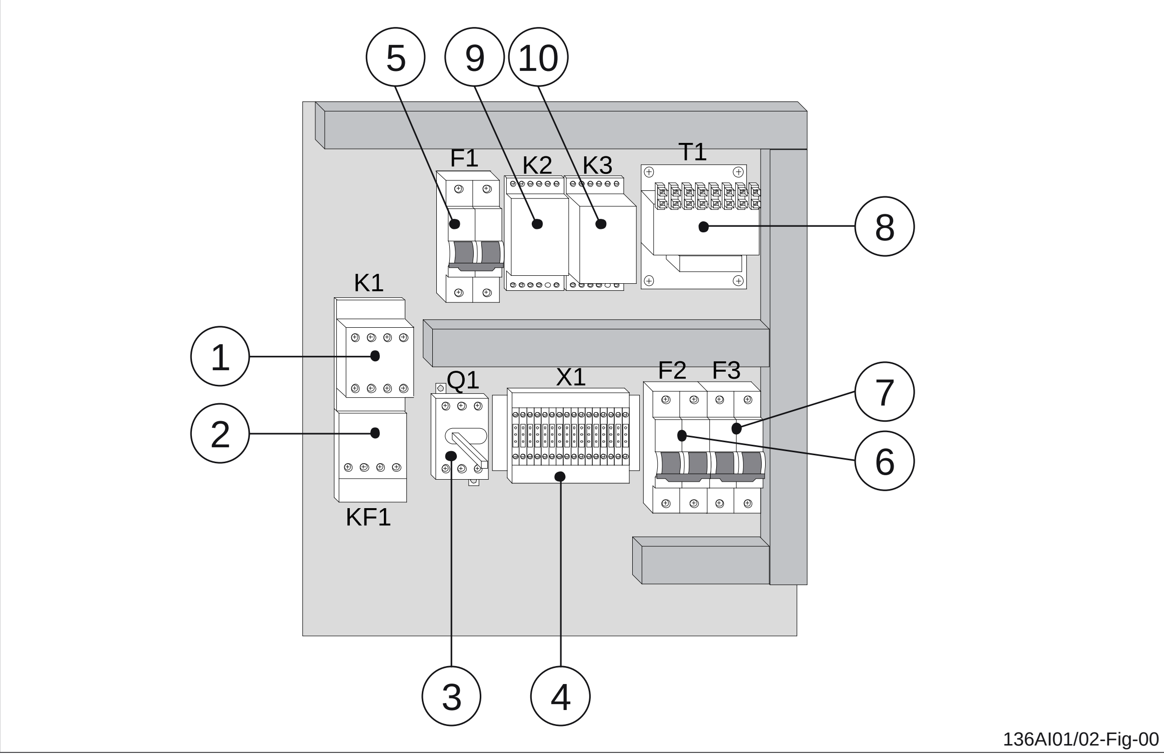


Figure 15   Internal equipment of pump motor starter P5.

1. Contactor, K1
2. Overcurrent relay, KF1
3. Main switch, Q1
4. Terminal, X1
5. Automatic fuse, F1
6. Automatic fuse, F2
7. Automatic fuse, F3
8. Transformer, T1
9. Relay, K2
10. Time relay, K3

• Automatic fuse F1 is feeding the transformer T1.

• Automatic fuse F2 is feeding the operation circuits.

• Automatic fuse F3 is feeding indication lamps with 24 volt.

It is also possible to connect an external emergency stop to the pump motor starter. If the external emergency stop is not used strap terminal connection X1:25 to terminal connection X1:26.

The stop/run switch S1 (pos 3, figure 13) is in RUN position. The level switch in the drain oil tank will start and stop the pump unit P5.

After a voltage failure, the time relay K3 (pos 10, figure 15) will be activated after 5 seconds and it activates main contactor K1 (pos 1, figure 15) and the drain oil pump motor starts automatically.

System Description, Kamewa CPP-BASIC

Introduction

The Kamewa CPP-BASIC remote control system is a microprocessor based remote control system, used to control the pitch setting of the Kamewa Controllable Pitch Propeller (CPP).

The system can, with maintained rotation direction of the propeller, order both ahead and astern manoeuvres by changing the pitch setting.

The manoeuvring is performed from a control station. The system can be equipped with up to three control stations on bridge and one control station in control room.

When there is more than one control station, there is also a responsibility system included which allows only one control station at a time to be "In command".

The RPM of the Main engine, driving the propeller, can also be controlled from the Kamewa system (optional function). When ordering a pitch setting, the system simultaneously generates a main engine RPM command. The relationship between pitch setting and main engine RPM is determined from the "combinator curve".

When manoeuvring the pitch (and RPM), the load of the main engine is controlled by the load control system (optional function) which automatically regulates the pitch. The max allowed load/pitch, corresponding to the actual engine RPM, is determined from the "load curve".

A back-up system, which is a complement to the main system, is included. The back-up system is of "non follow up" type and controls the pitch by direct activation of the hydraulic control valve. The back-up system is electrically separated from the main system.

There is also a pitch indication system included which is electrically separated from both the main and back-up systems.

The indication system continuously shows (on each control station) the actual pitch setting of the propeller.

As option, a shaft (propeller) RPM indication system can be included.

The system is available in a basic version to which different options can be added.

Below is a list over the basic and optional functions.

Basic equipment/functions of the "CPP-BASIC" system:

- One control station, main bridge
- Pitch control (not RPM control)
- Back-up control, on main bridge
- Pitch indication (on each control panel)
- Engine overload protection system
- Slowdown/Shutdown (inputs)
- Failure supervision of main control, back-up and indication system.
- 24V DC system supply

Optional equipment/functions of the "CPP-BASIC" system:

- Bridge wing control stations (one or two)
- Control station in control room
- RPM control (combinator)
- Separate RPM control panel, in control room
- Remote/Local RPM take over panel/function
- E/P converter, for engine RPM setting
- Load control
- Additional pitch indicators, "Panama type"
- Shaft RPM indication
- Hand terminal (for calibration / adjusting)
- Signals for VDR/manoeuvre recorder
- Signals to Manoeuvre recorder
- Signals to wrong way alarm system
- Shaft generator interface
- 115/220VAC power supply
- Emergency stop
- Clutch control

Equipment and Basic Functions

Signal Routing

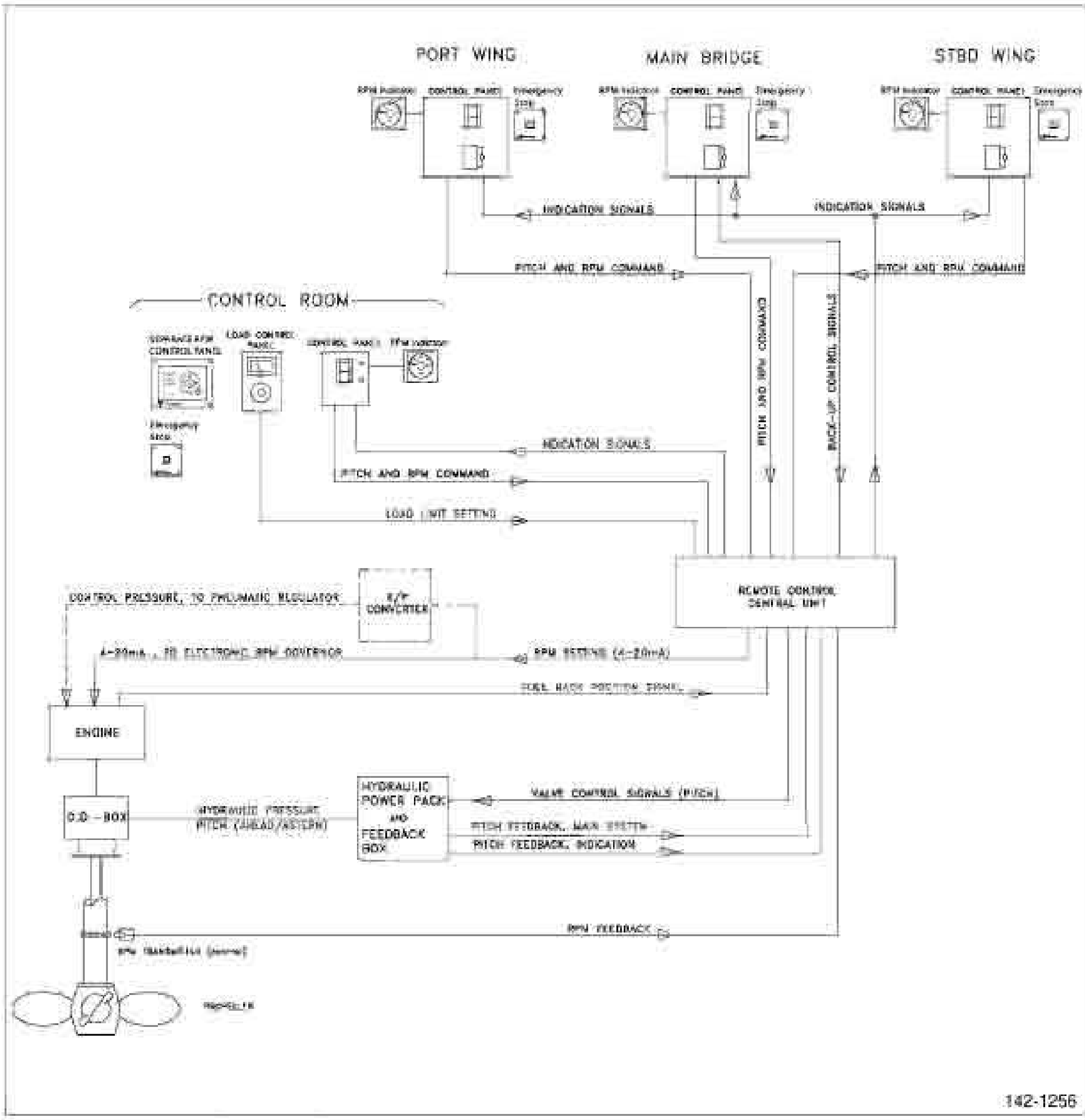


Figure 1 Signal routing.

Main Bridge, Control Station

Control modes (if RPM control is included)

Combinator Mode

Simultaneous control of pitch and RPM, with the control lever.

Constant RPM-mode

Pitch is controlled with the control lever.

A constant RPM is generated by the control system.

Back-up Mode

Control of pitch, using the push buttons ahead/astern (non follow up control). A constant "back up RPM" is activated.

Control modes (if RPM control is not included)

Pitch control-mode

Pitch is controlled with the control lever.

RPM is controlled from an external system (not Kamewa).

Back-up Mode

Control of pitch, using the push buttons ahead/astern (non follow up control).

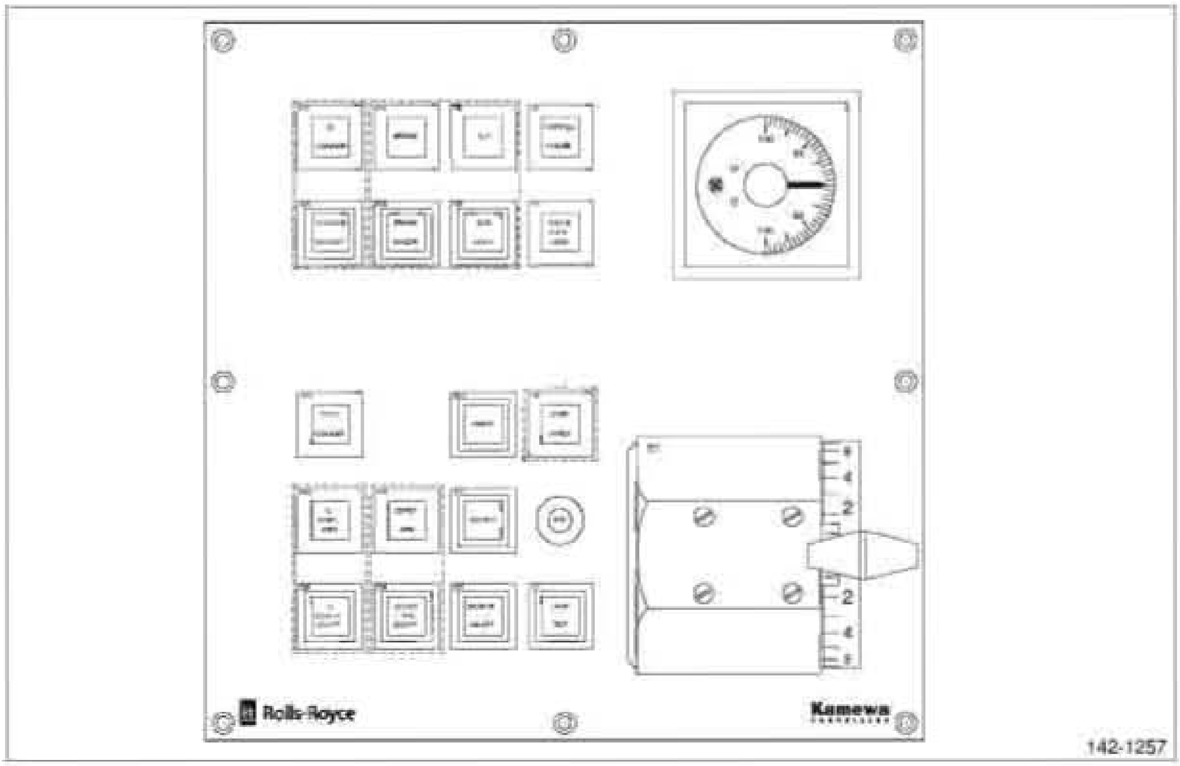


Figure 2 Control panel, main bridge (all options included).

Bridge Wing, Control Station(s)

Control modes (if RPM control is included)

Combinator Mode

Simultaneous control of pitch and RPM, with the control lever.

Constant RPM-mode

Pitch is controlled with the control lever.

A constant RPM is generated by the control system.

Control modes (if RPM control is not included)

Pitch control-mode

Pitch is controlled with the control lever.

RPM is controlled from an external system (not Kamewa).

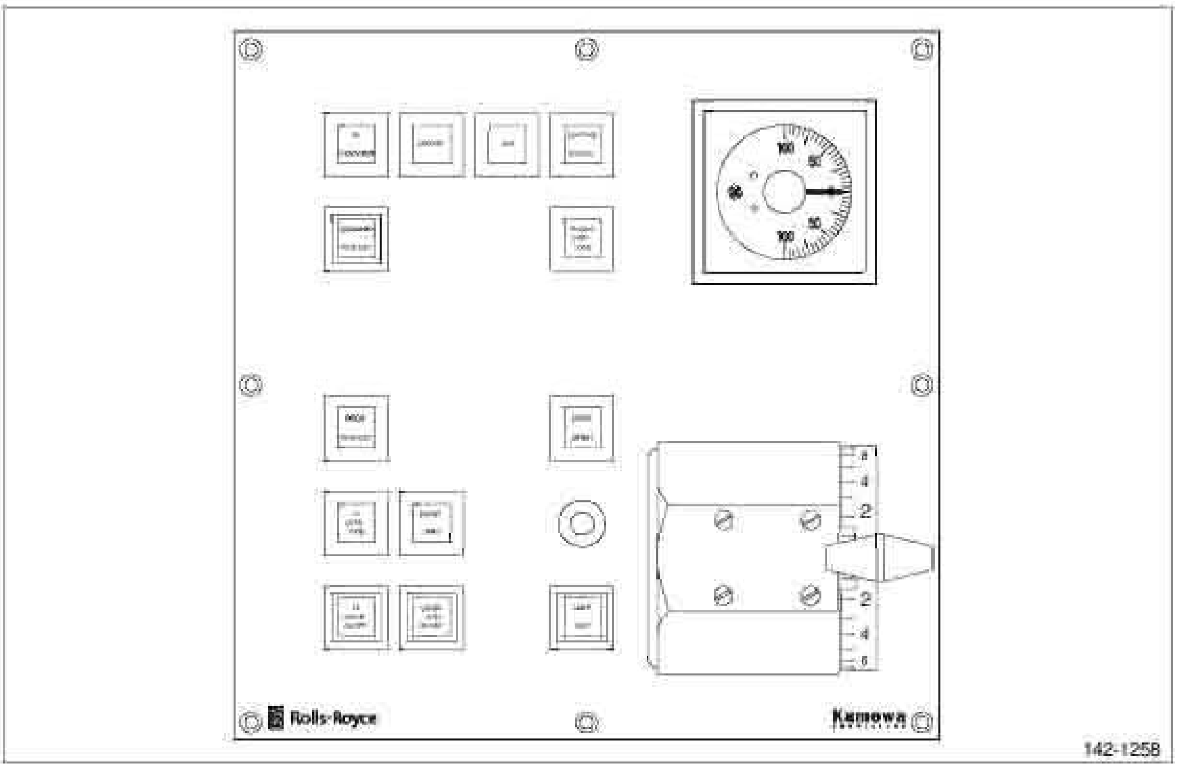


Figure 3 Control panel, bridge wing (all options included).

Control Room (ECR), Control Station

Control modes

Pitch control-mode

Pitch is controlled with the push buttons "ahead" and "astern" (follow up control).

RPM is controlled from a separate control device.

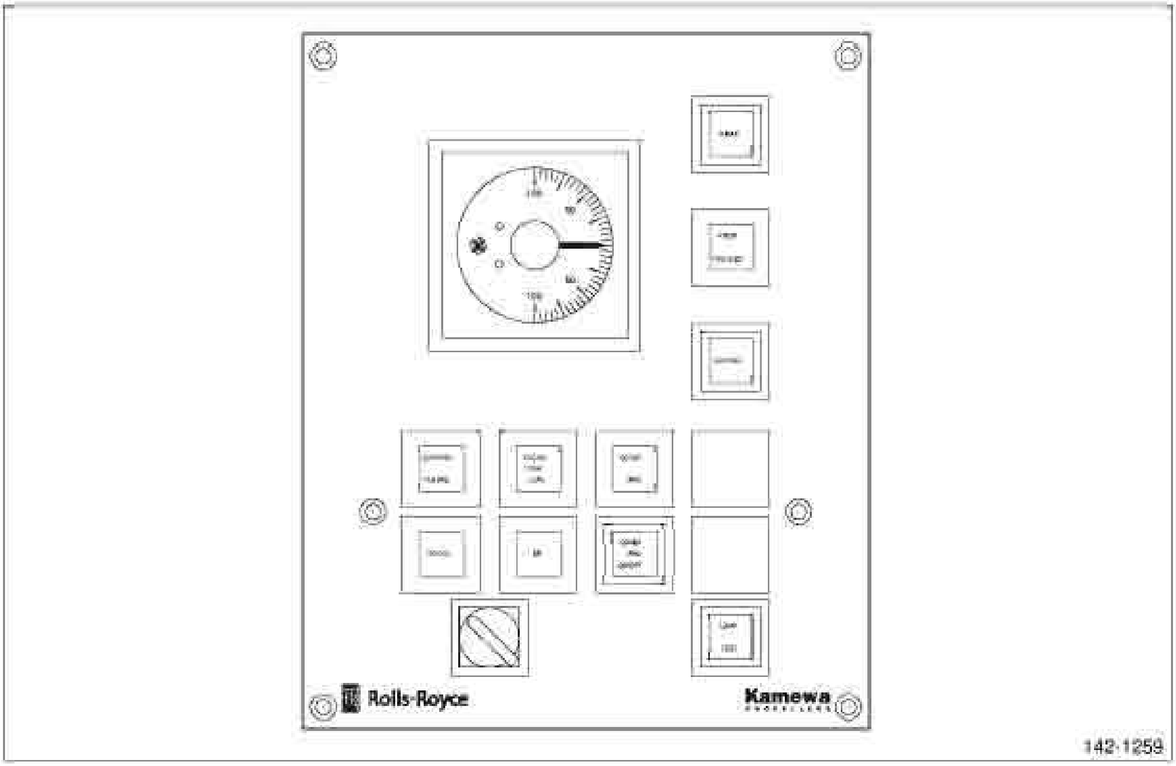


Figure 4 Control panel, control room.

The separate RPM control device can be supplied by Rolls-Royce AB or other supplier.

When supplied from Rolls-Royce AB (optional function), we deliver a "separate RPM control panel".

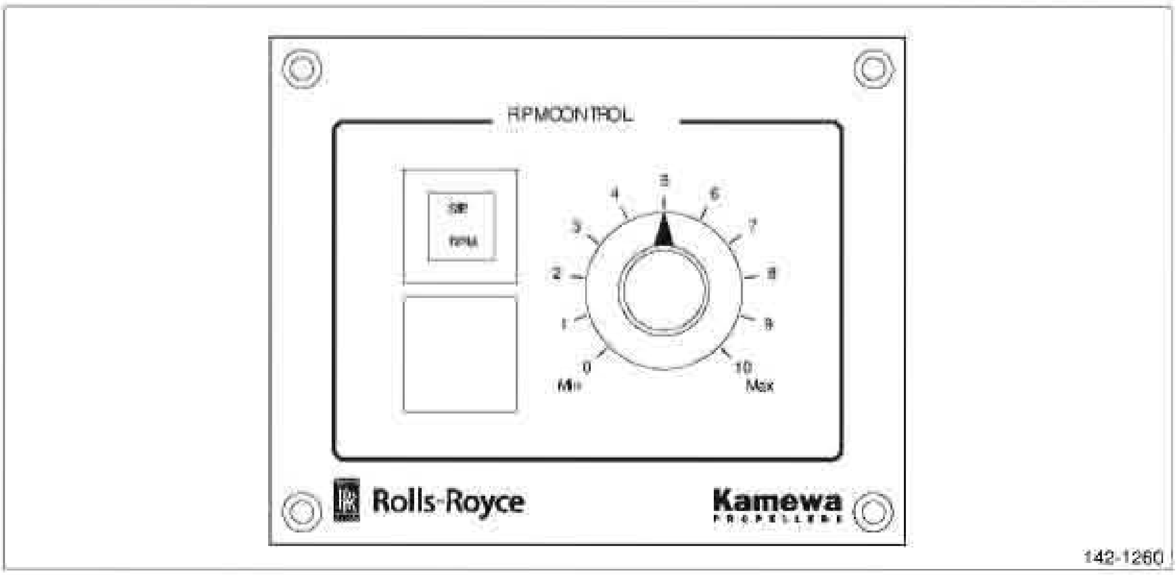


Figure 5 Separate RPM control panel, control room.

When remote/local take over function is included (optional function), we supply a "Remote/Local RPM control panel".

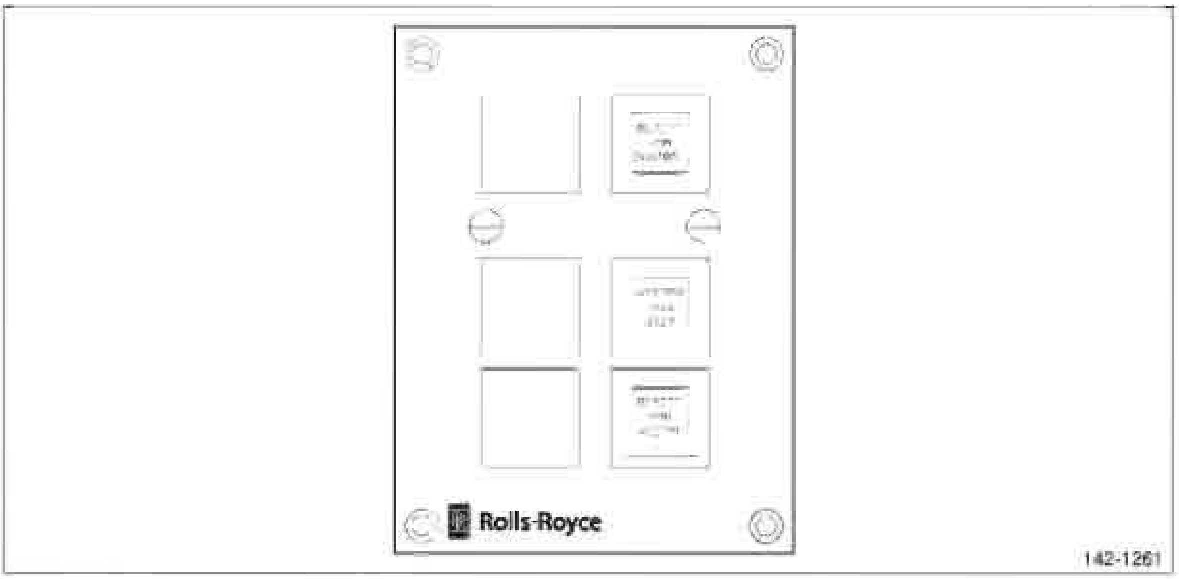


Figure 6 Remote/local RPM control panel, control room.

When load control is included (optional function), we supply a "Load control panel".

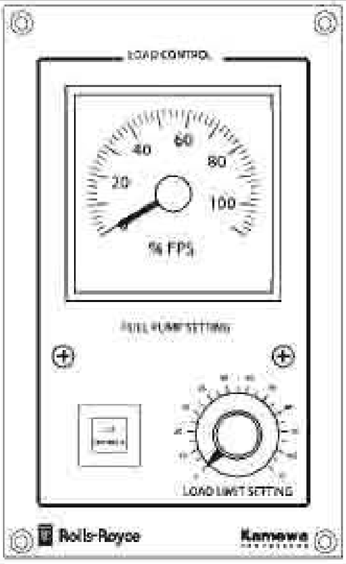


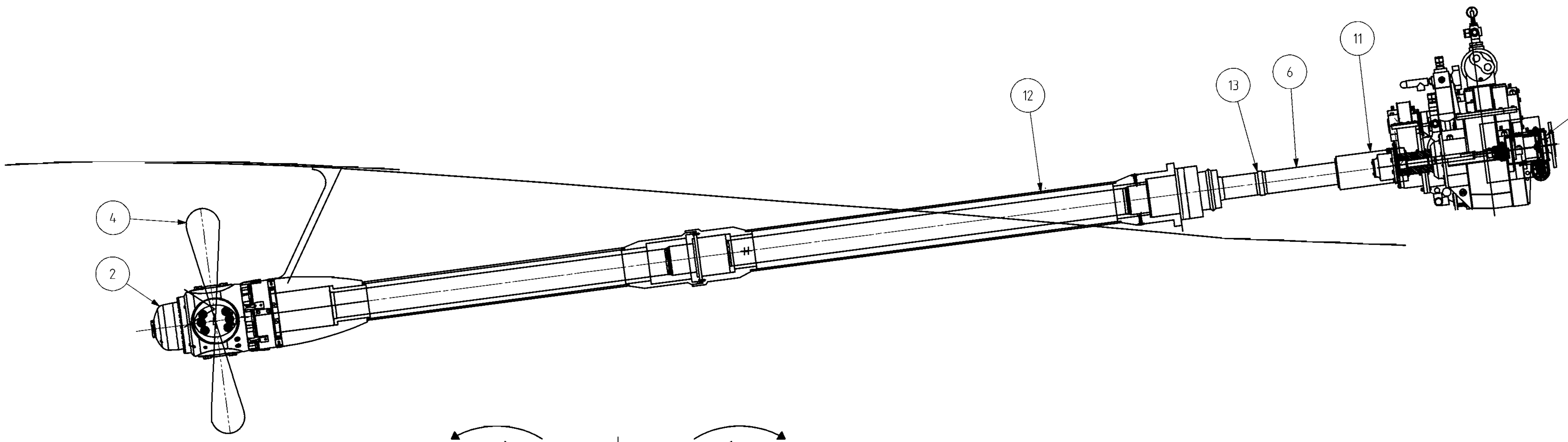
Figure 7 Load control panel, control room.

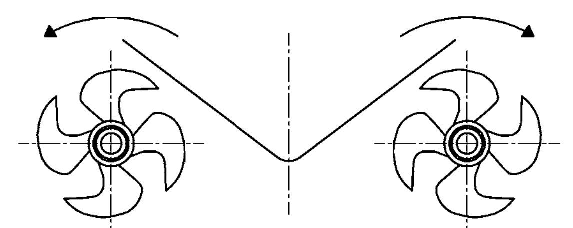
Produced by: SS Approved by: Nna
Creation date: 2005-05-31

Revision: Sign:
Revision date:

Delivery Specification

PORT SIDE SHOWN





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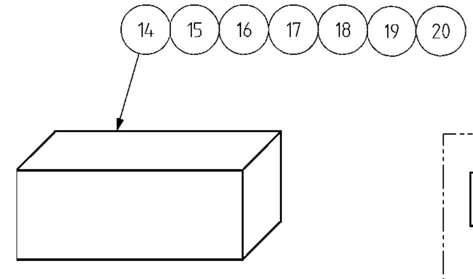

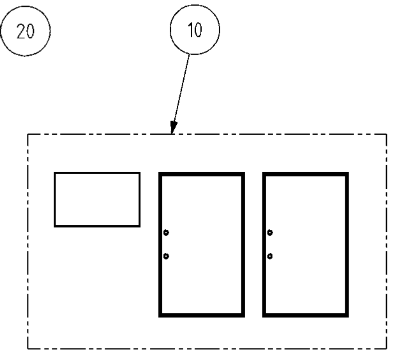

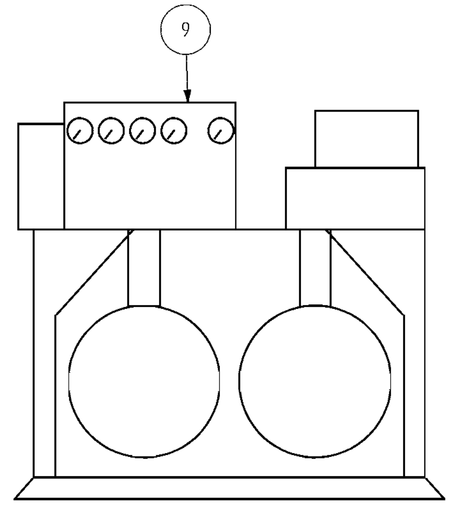

MÄRKNING AV DETALJER

DETAILS TO BE MARKED

		BABORD PORT	STYRBORD STARBOARD
		VÄNSTER-ROTERANDE LEFT HAND TURNING	HÖGER-ROTERANDE RIGHT HAND TURNING
ORDER NO.	NYB. NR. YARD NO.	RR MÄRKNING RR MARKING	RR MÄRKNING RR MARKING
10S000239	K-200-1	16514	16515
10S000240	K-200-2	16516	16517
10S000241	K-200-3	16518	16519
10S000242	K-200-4	16520	16521
10S000243	K-200-5	16522	16523
10S000244	K-200-6	16524	16525
10S000245	K-200-7	16526	16527
10S000246	K-200-8	16528	16529
10S000247	K-200-9	16530	16531

HYDRAULIC SYSTEM	9	1	HYDRAULIKSYSTEM	RRM200007036	---	---
O.D.-BOX ASSY LEFT	7	1	T.O.-BOX SMST VÄNSTER	RRM200009766	---	Note 1
PROPELLER SHAFT ASSY.	6	1	PROPELLERAXEL SMST	RRM200005966	---	Note 1
PROPELLER BLADE	4	4	PROPELLERBLAD, VÄNSTER	RRM200005946	---	---
PROPELLER HUB	2	1	PROPELLERNAV, VÄNSTER	RRM200009345	---	---
	Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark

9	1	HYDRAULIKSYSTEM	RRM200007036	---	---
8	1	T.O.-BOX SMST HÖGER	RRM200005985	---	Note 1
6	1	PROPELLERAXEL SMST	RRM200005966	---	Note 1
5	4	PROPELLERBLAD, HÖGER	RRM200005943	---	---
3	1	PROPELLERNAV, HÖGER	RRM200009225	---	---
Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark

Note 1: Shaft and O.D.-BOX assemblies includes the twin tube

TOOLS EMERGENCY CONTROL	20	1	VERKTYG NÖDMANÖVER	940832A
TOOLS SHAFTING	19	1	VERKTYG AXELLEDNING	104500A
TOOLS HUB	18	1	VERKTYG NAV	---
SPARE PARTS STARTERS	17	1	RESERVDELAR STARTERS	RRM200007041
SPARE PARTS HYDRAULIC	16	1	RESERVDELAR HYDRAULIK	RRM200007040
SPARE PARTS O.D.-BOX	15	1	RESERVDELAR T.O.-BOX	214017A
INSTALLATION SPARE KIT HUB	14	1	INSTALLATIONSSATS NAV	---
EARTHING DEVICE	13	2	JORDNINGSUTRUSTNING	RRM200005977
STERNTUBE ASSY	12	2	AXELHYLSA SMST	RRM200006467
SHAFT COUPLING	11	2	KOPPLING	RRM200005975
CONTROL SYSTEM ASSY	10	1	MANÖVERSYSTEM SMST	RRM200005995
SHAFTING ARRANGEMENT	1	1	AXELARRANGEMANG	DMN200000864
DESCRIPTION	ITEM NO.	NO. OF	SWEDISH DESCRIPTION	REFERENCE

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	-

Drawing, Assembly
55A/4D -35FA
Main assy & Mark drawing

Rolls-Royce

Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin./Date:		Scale:	Format:	Sheet:
Wkg	2010.07.15	1:20	A1	1 of 1
Drawing no: DMN200001313				Revision: A

Access List:

RR AB's Info class

Produced by: KK295 Approved by: anl
Creation date: 6 september 2010

Revision: Sign:
Revision date:

Technical Data

General

Building yard:	Halifax Shipyard
New building number:	6094-6099, 6101-6103
RRAB manufacturing number (Port):	16514, 16516, 16518, 16520, 16522, 16524, 16526, 16528, 16530
RRAB manufacturing number (Starboard):	16515, 16517, 16519, 16521, 16523, 16525, 16527, 16529, 16531
RRAB file number:	10s000239

Propeller

Hub size:	55A DBG
Propeller diameter:	1700 mm
Number of blades:	4
Material in hub:	NiAl Bronze
Material in blades:	NiAl Bronze

Shaft Coupling

Make:	OKCAX 160
Type:	SKF Couplings

Weights (approximation)

Propeller hub with blades:	932 kg
Propeller blade (each):	102 kg
Propeller shaft:	1770 kg

Hydraulic Oil

See the document Requirements for Lubricating Oil in either part Maintenance (User Manual) or part Installation (Installation Manual).

Oil volume in hub and shaft line:	Approx. 62 litres
Oil volume in hydraulic power pack tank:	Approx. 120 litres
Total oil volume for the system:	Approx. 182 litres

Hydraulic Pumps with Electric Motors

See drawing Hydraulic diagram in part Design Drawings.

Tightening Torques

For information of tightening torques see the applicable drawing in the Installation Manual part Design Drawings.

Safety Valves

The safety valve in the hydraulic system must be set on a pressure according to hydraulic diagram (can be inspected by reading the pressure gauge when the propeller pitch is in its mechanical end position).

Produced by: SS Approved by: Nna Revision: f Sign: Nna
Creation date: 2005-05-31 Revision date: 2009-07-24

Requirements for Lubricating Oil

Lubrication of Hub and Hydraulic System

The oil used in the CPP system must be of type mineral gear oil with EP additives (Extreme Pressure) single grade oil. The oil must fulfill the requirements stated in DIN 51517 part 3 for CLP lubricating oils.

Viscosity Grade

The viscosity grade must meet the requirements of ISO VG 68 (68 cSt at 40^{o}C). If other viscosity grade is to be used an approval from Rolls-Royce must be granted.

Degree of Cleanliness

We know from experience that gear oils are sensitive to contamination. That can deteriorate the filterability. It is therefore of utmost importance that the oil is clean at first filling of the system and therefore the following directions must be followed:

- New gear oil must not be mixed up with other oils, even in very small quantities.
- Equipment used to fill the oil must be clean.
- External piping of the hydraulic systems must be carefully cleaned before connection to the hydraulic system.
- New gear oil must be filtered before filling. Rolls-Royce AB recommends as a minimum requirement a cleanliness level of 18/16/13, according to ISO 4406:1999. This is an approximate equivalent of contamination classes NAS 1638 class 7 and SAE AS 4059 class 8. This cleanliness grade will normally be obtained when using a 6 to 8 micron filling filter.

Example of Oil Types

The lubricants in this chapter are typical products only and should not be construed as exclusive recommendations. Example of oils that fulfil Rolls-Royce’s requirements are as following:

- AGIP Blasia 68
- Amoco Permagear EP LUB 68
- BP Energol GR-XP 68
- Caltex Meropa 68
- Castrol Alpha SP 68
- Chevron NL Gear Compound EP 68
- Elf Epona Z 68

• Esso Spartan EP 68

• Fina Pontonic N 68

• Mobil Gear 626

• SERVO, Servomesh SP 68

• Shell Omala oil 68

• Statoil Loadway EP 68

• Statoil Loadway Marine 68

• Texaco Meropa 68

Lubrication of Sterntube

The lubricating oil used in the sterntube must be of type mineral gear oil with EP additives (Extreme Pressure) single grade oil.

The oil must fulfill the requirements stated in DIN 51517 part 3 for CLP lubricating oils. A special oil intended for sterntube systems can also be used. In that case the oil must be tested to make sure that it suits both the bearings and the sterntube sealings.

Viscosity Grade

The viscosity grade must meet the requirements of ISO VG 100 (100 cSt at 40^{o}C). If other viscosity grade is to be used an approval from Rolls-Royce must be granted.

Degree of Cleanliness

Rolls-Royce AB recommends as minimum requirement a cleanliness level of 18/16/13 according to ISO 4406:1999. This is an approximate equivalent of the contamination classes NAS 1638 class 7 and SAE AS 4059 class 8. This cleanliness grade will normally be obtained when using a 10 micron filling filter.

Example of Oil Types

The lubricants in this chapter are typical products only and should not be construed as exclusive recommendations.

Example of oils that fulfil Rolls-Royce’s requirements are as following:

• AGIP Blasia 100

• BP Energol GR-XP 100

• Castrol Alpha SP 100

• Chevron NL Gear Compound EP 100

• Esso Spartan EP 100

• Mobil Gear 627

• Shell Omala 100

• Statoil Loadway Marine 100

Produced by: KK174 Approved by: Fnl Revision: a Sign: SJ
Creation date: 2008-01-04 Revision date: 2011-03-07

Location of Manufacturing Number

Finding the Manufacturing Number

Propeller Blade

The manufacturing number is placed at the blade flange, above the classification number, see figure 1.

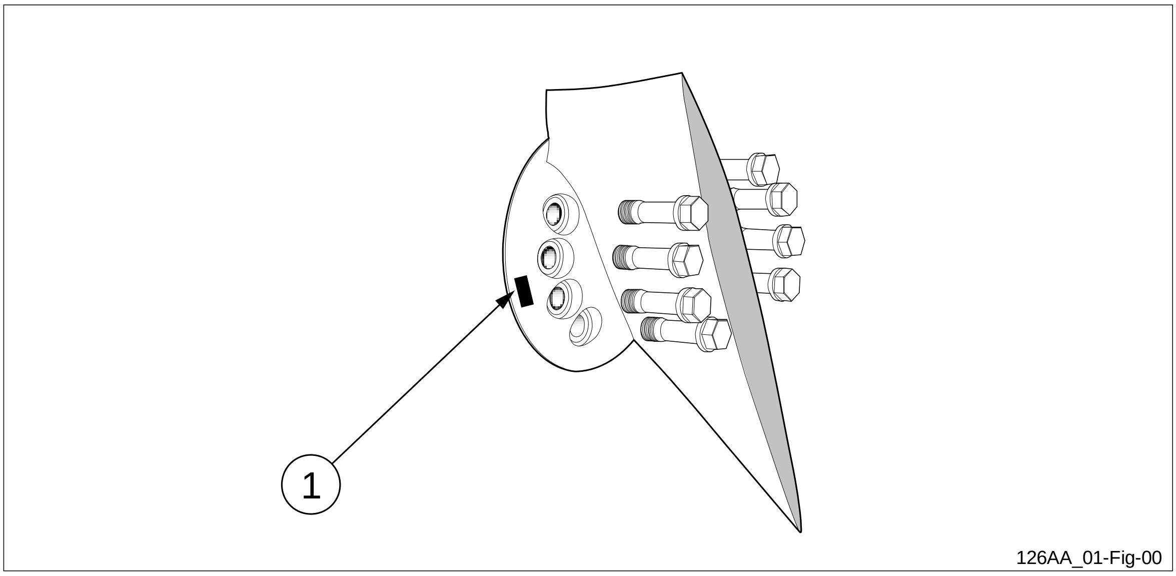

Figure 1 Propeller blade.

1. Manufacturing number

OD-box type F0

The manufacturing number is placed at the flange, see figure 2.

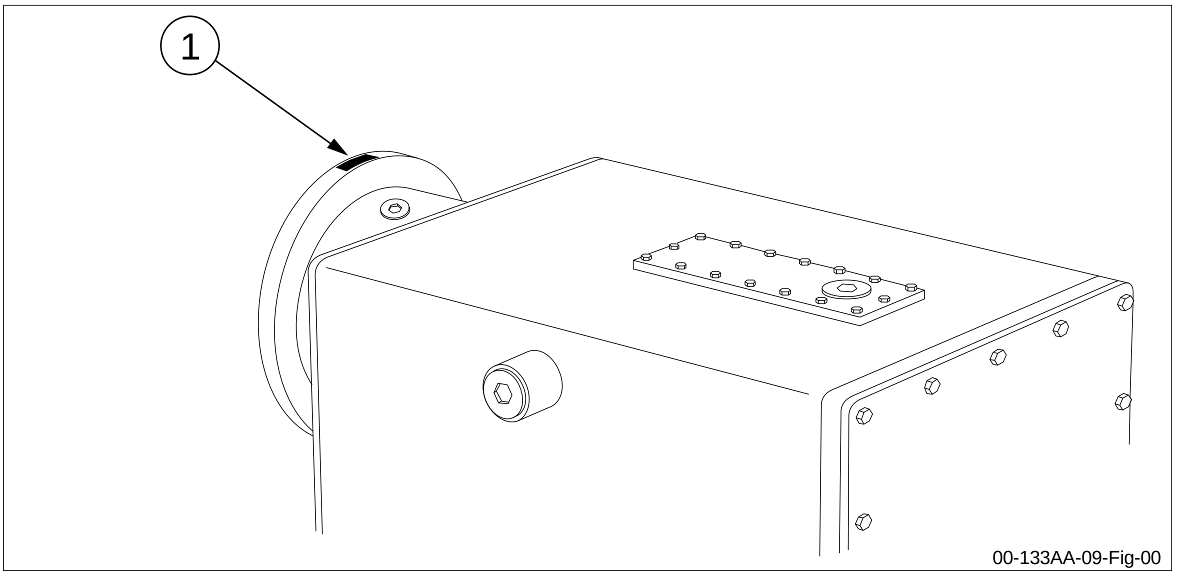

Figure 2 OD-box type FA.

1. Manufacturing number

OD-box Type M0

The manufacturing number is placed on the shaft flange, see figure 3.

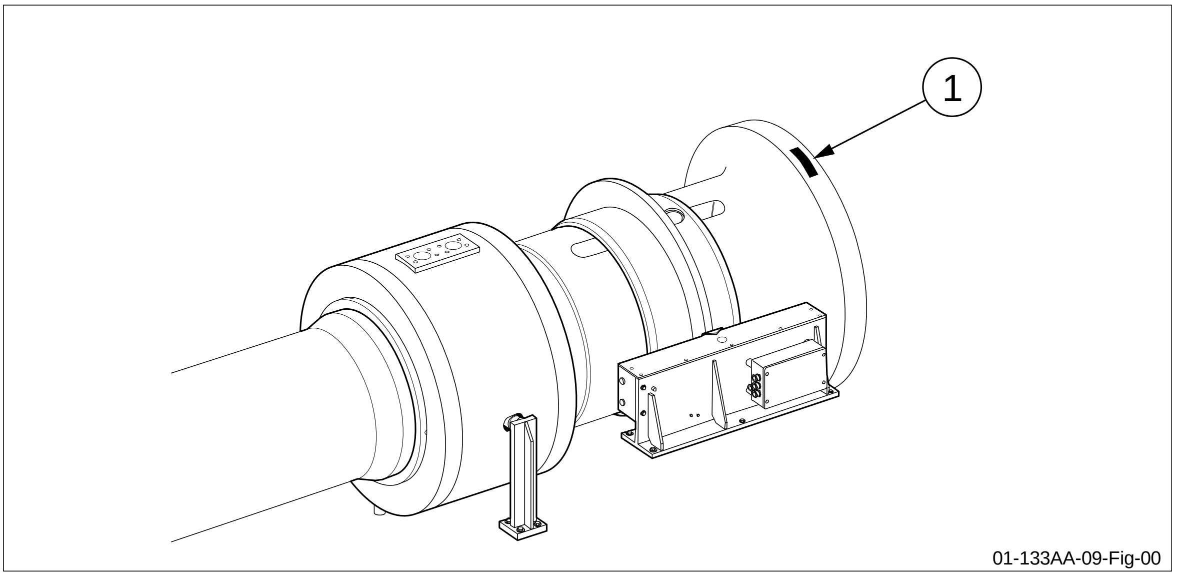

Figure 3 OD-box type M0.

1. Manufacturing number

Twin Tubes

The manufacturing number is placed at the stern end of each twin tube, at the female muff, see figure 4.

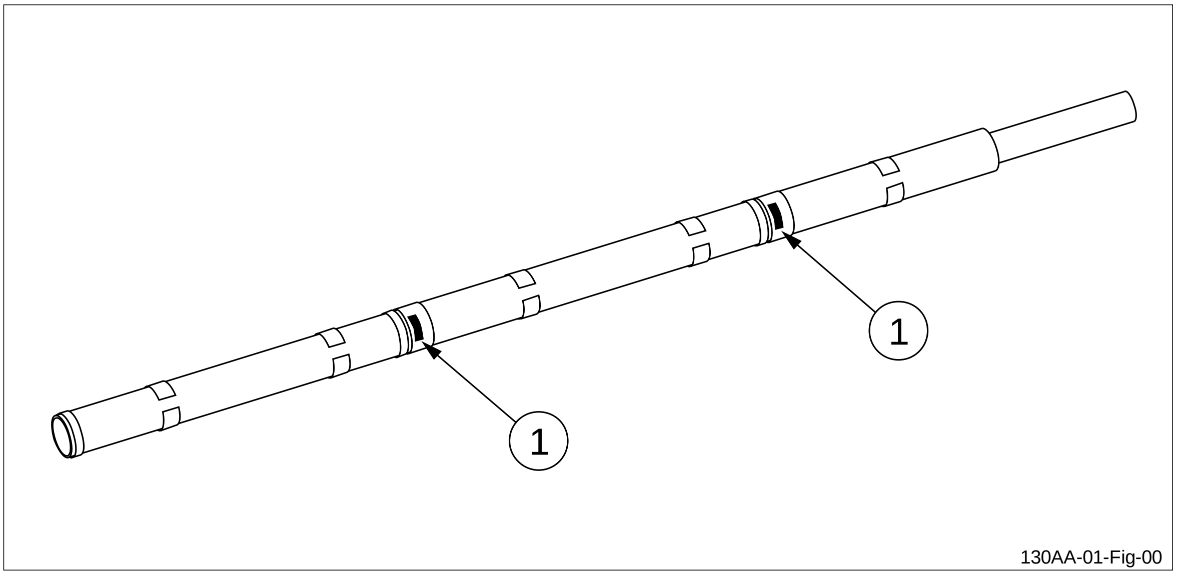

Figure 4 Twin tubes without flanges.

1. Manufacturing number

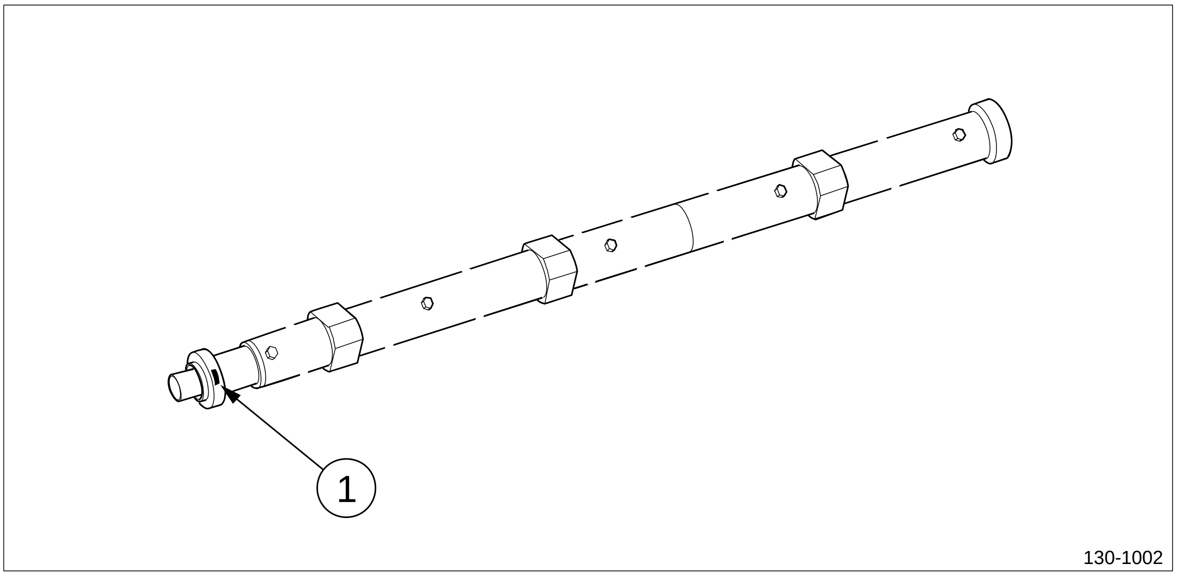

Figure 5 Twin tube with flanges.

1. Manufacturing number

Shaft

For shafts without a flange, the manufacturing number is placed at the end of the shaft, above the classification number, see figure 6.

For shafts with one or several flanges, the manufacturing number is placed on the flange above the classification number, see figure 7.

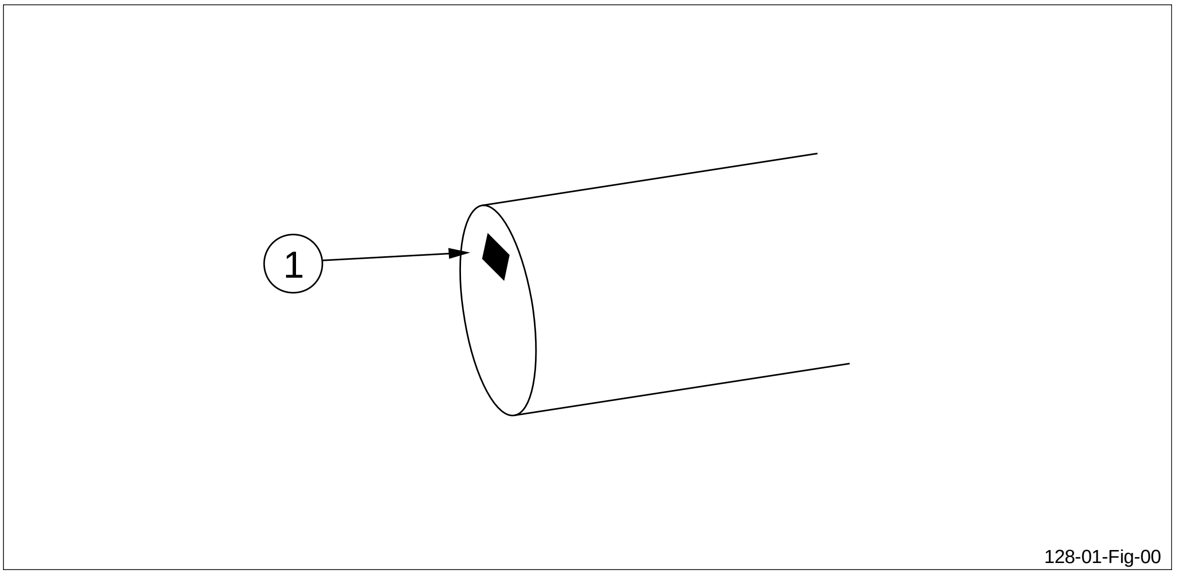

Figure 6 Shafts without a flange.

1. Manufacturing number

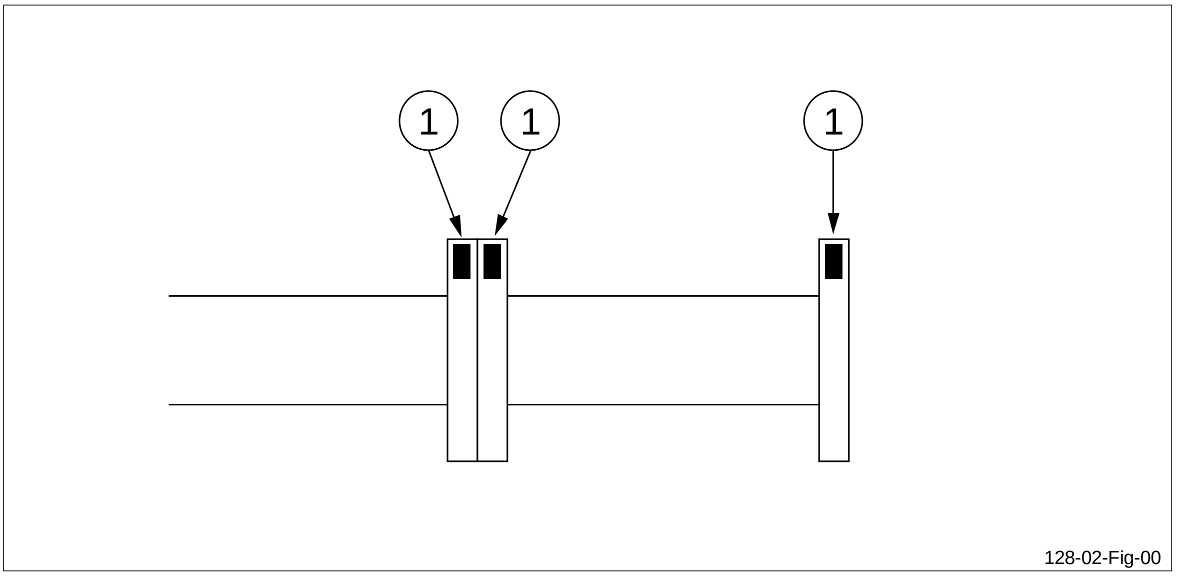

Figure 7 Shafts with one or several flanges.

1. Manufacturing number

Hub Body

The manufacturing number is placed in the forward end of the Hub Body face and next to the propeller shaft, together with the classification number, see figure 8.

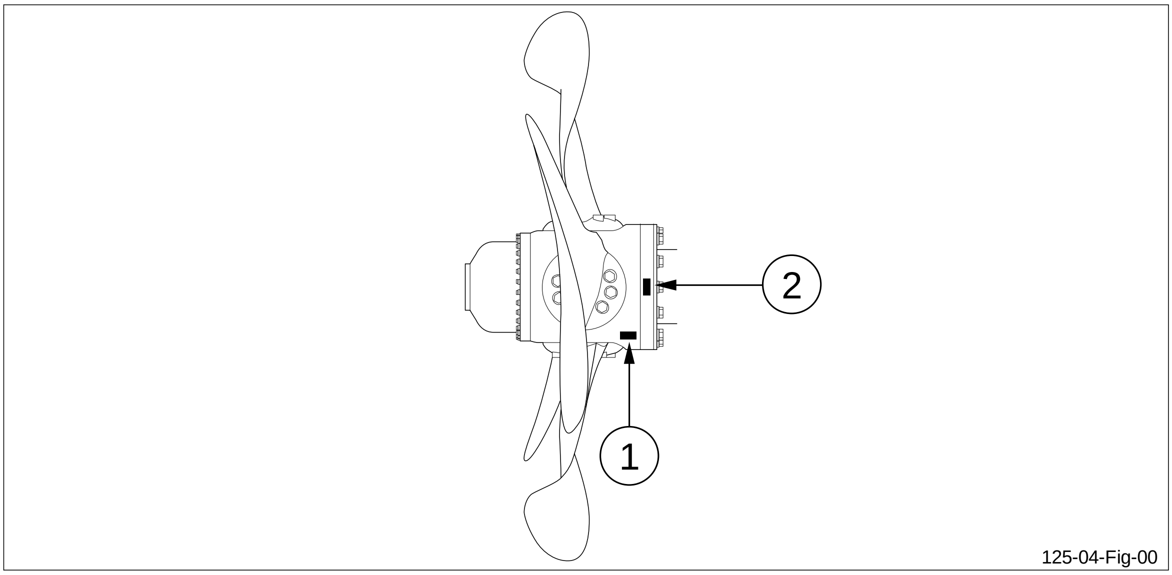

Figure 8 Hub body.

1. Manufacturing number and classification number at hub body
2. Manufacturing number and classification number at propeller shaft

Hydraulic System

The manufacturing number is placed on a sign on the front side of the hydraulic power pack tank, see figure 9.

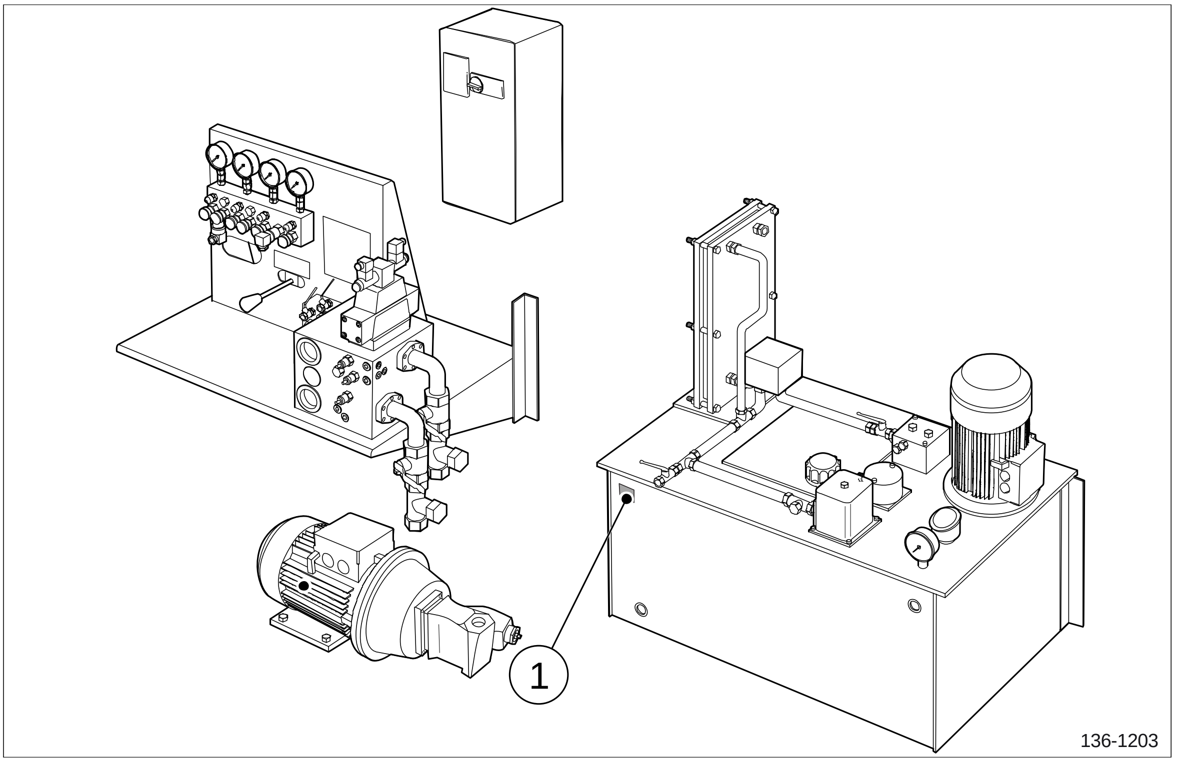

Figure 9 Hydraulic system.

1. Manufacturing number

Produced by: KK174 Approved by: Fnl Revision: a Sign: Nna
Creation date: 2008-05-05 Revision date: 2009-07-22

Handling and Preservation

Introduction

The Handling and Preservation contains information about the following:

Delivery Inspection

All parts of the propeller system must be immediately unpacked and inspected at delivery. For easy identification all of the propeller system parts are marked with a number. Store the parts in original wrap.

If the delivered goods have suffered any damage due to the transport, such as impact damage, scratches, cracks, and so on, it must be reported to the transport insurance company according to Incoterms 2000.

Storage Recommendations

Introduction

These storage recommendations apply to how to store the propeller system before installation, how to store spare parts, and to long time storage of the propeller system.

General Requirements

All parts must be adequately protected during transit and storage against mechanical damage, corrosion, and from long term exposure to aggressive atmospheric conditions.

Parts which are not protected against corrosion at delivery, such as fitting bolts and machine-finished surfaces, must be treated with an anti corrosive agent. Rolls-Royce recommend oil type such as Dinitrol 3641-E or similar.

The propeller system parts that are kept in storage before installation must be inspected weekly and stored spare parts must be inspected twice a year. Any damage found on the parts must be remedied at once.

All parts, such as the hydraulic power pack, OD-box, electronic control system, couplings, propeller blades, spare parts, tools and lifting tools are preferably kept in an indoor warehouse. However, spare parts such as propeller blades, can be stored onboard the vessel. The parts of the propeller system must be stored according to the following conditions:

- The temperature must be between +10 ^{o}C and +55 ^{o}C. Note that temperatures above +35^{o}C will accelerate aging of rubber materials.
- Storage conditions must be such that condensation does not occur.
- Until assembly, store the parts in original wrap in a dry and clean place, that protect parts from moisture, sunlight, mechanical damages, dust and dirt.
- Do not use storage areas with ozone generating equipment.
- Do not use forced circulated air in the storage area.

Specific Requirements

Hydraulic Power Pack

If the storage period exceeds three months, all connections on the hydraulic power pack must be sealed off and the pump units, valves etc. to be filled with oil. The oil must meet the recommendations in document Requirements for Lubricating Oil.

Propeller Hub

If a storage period exceeds three months special treatment of the propeller hub is necessary. The propeller hub, without blades, must be fully submerged in oil during storage. A suitable tank, which is not part of the Rolls-Royce delivery, must be provided by the customer.

The oil must meet the recommendations in section Requirements for Lubrication Oil. The container with the propeller hub is preferably stored in a warehouse.

Propeller Blade

The blades must be handled with care to prevent damage on the blade edges and the blade foot sealing surfaces.

If spare propeller blades are part of the delivery, the blades are preferably stored below deck, but they can be stored on deck, see figure 1 for attachment instruction.

Apply an anti corrosive agent on the blade. When the coating has dried it should be approximately 70-100µm. Secure the blades according to figure 1.

Make sure to inspect and apply new anti corrosive agent on the spare blade once a year. It is important to inspect the underside of the blade carefully since it is especially exposed to the weather conditions.

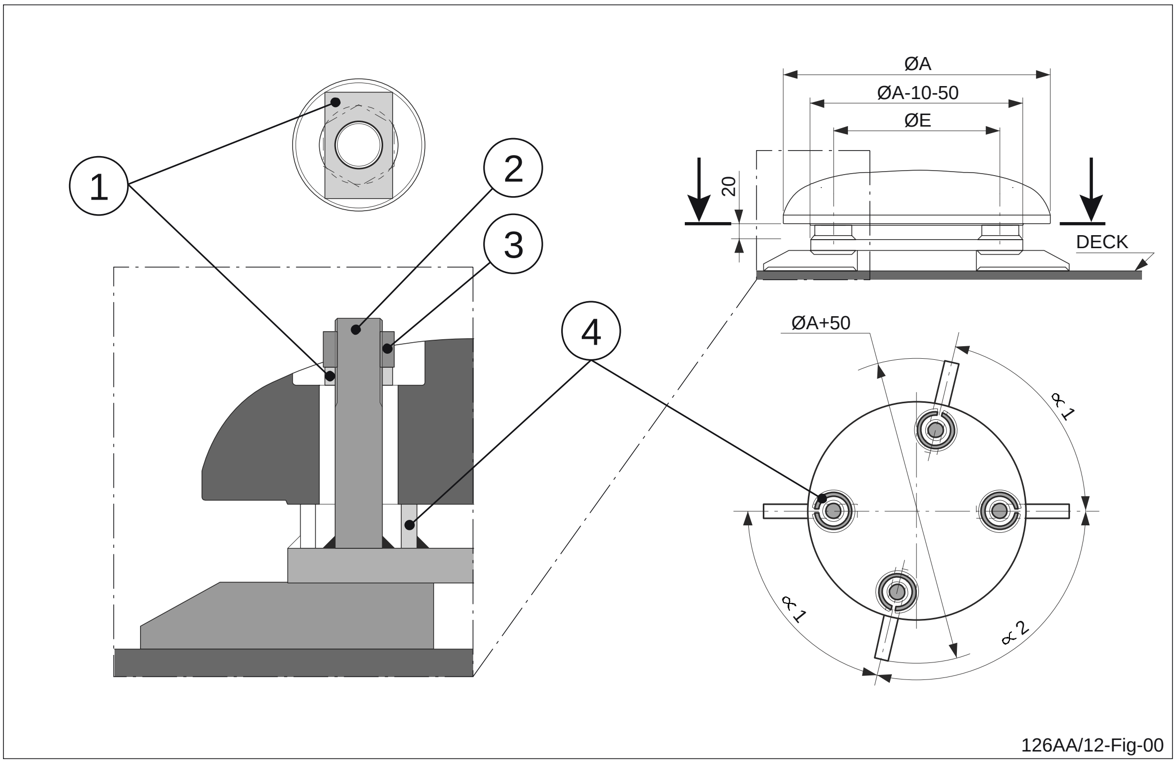

Figure 1 Storage of spare propeller blade.

1. Washer (Galvanized)
2. Stud Bolt (Stainless Steel)
3. Nut (Stainless Steel)
4. Supports (Mild Steel), groove for water drain

Shaft Line Components

Couplings must be stored and handled according to the instructions from the Sub Supplier, see Part Sub Supplier Manuals.

The shafts have been treated with an anti corrosion agent for transport only.

The shafts must be unpacked immediately upon arrival for inspection and treated with an anti corrosive agent. Rolls-Royce recommend an oil type such as Dinitrol 3641-E or similar with a minimum thickness of 120 micron. New anti corrosive agent must be applied at regular intervals according to the manufacturer specification. This is done to prevent corrosion until the time the shafts will be installed in the ship. All parts must be inspected weekly and any damage found must be remedied at once.

The shafts must be stored in a ventilated warehouse with a solid roof of sufficient extent and must be protected against moisture and dust. If an indoor storage is not possible an alternative outdoor storage as described in figure 2 is recommended.

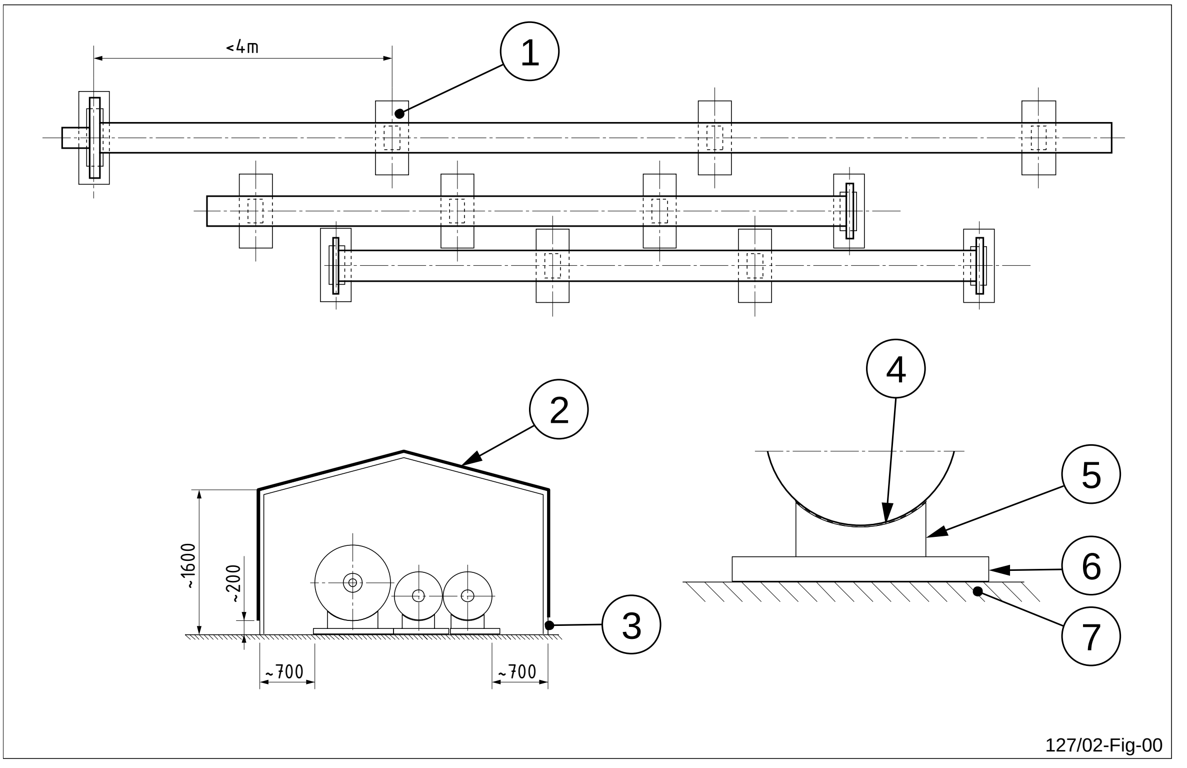

Figure 2 Example of weather-protected, ventilated outdoor storage.

1. Support. Avoid bearing journals and coupling surfaces
2. Tarpaulin or equal
3. Ventilation opening all around
4. Lead plate, thickness approx. 3 mm
5. Wood support
6. Beam
7. Stiff ground

The shafts must be placed on supports with maximum 4 metres distance in between. The support surface must be covered by a non-water absorbing material, for example a lead plate (see figure 2 for more information).

The shafts must be unwrapped and treated with an anti corrosive agent. The supports must be placed on a stiff ground and be well aligned, to ensure the straightness of the shafts.

The shafts must be lifted once a month to inspect the contact surface of the supports. It is possible to partially lift the shaft close to a support by means of a hydraulic jack. A pad must be placed between the hydraulic jack and the shaft when lifting the shaft to prevent it from getting damaged.

The oil tubes must be fitted into the shafts and the hollow boring must be filled with oil which meets the recommendations in document Requirements for Lubrication Oil. This procedure requires blanking flanges, which are not part of the Rolls-Royce delivery, see figure 3 for more information.

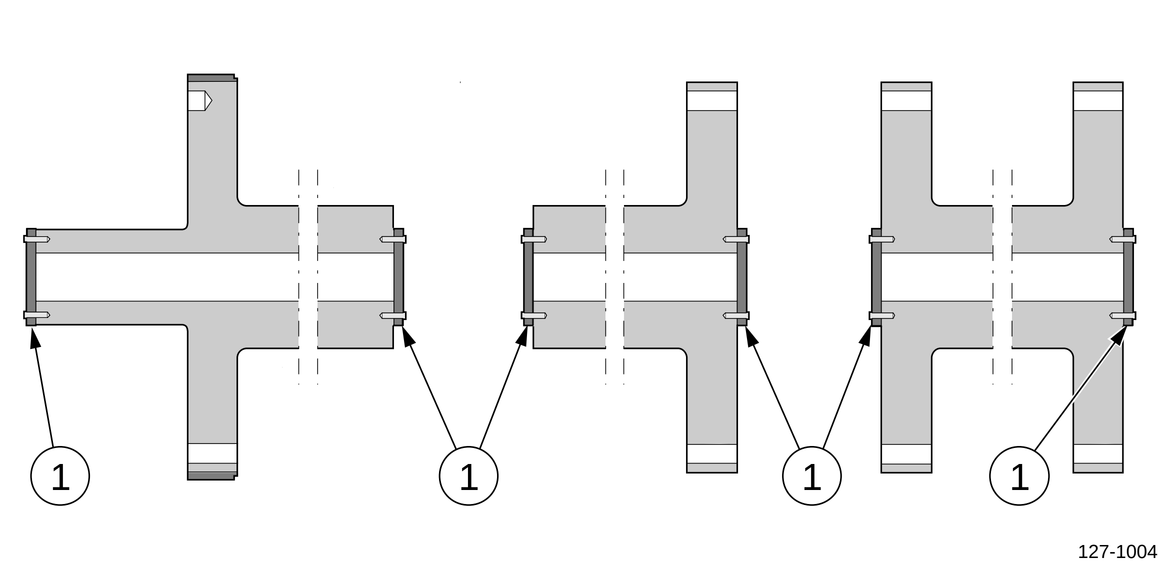

Figure 3 Examples of blanking flanges for propeller shafts and intermediate shafts.

1. Blanking flanges

Storage During Outfitting Time on Board

General Requirements

The general requirements stated in Section Storage Recommendations must be fulfilled.

All parts must be protected against damage from handling and outfitting work, such as grinding and welding spray, impact damage, rain and other weather conditions, long term exposure to aggressive atmospheric conditions, and so on.

During welding on board, the propeller and the shaft line must be carefully earthed to the hull, the contact in the stern tube is not sufficient. Furthermore, the hull must be carefully earthed to the quay. The earthing must be inspected daily during welding periods. It is most important to prevent leaking currents to go through the propeller and shaft line. Leaking current causes cathodic corrosion.

Before starting up, the Harbour Acceptance Test (HAT) must be completed. The underwater parts of the supply must be thoroughly inspected and remedied. Make sure that propeller blades, hub, and propeller shaft are free from marine growth and other foreign objects which can damage the equipment.

Specific Requirements

Propeller Hub

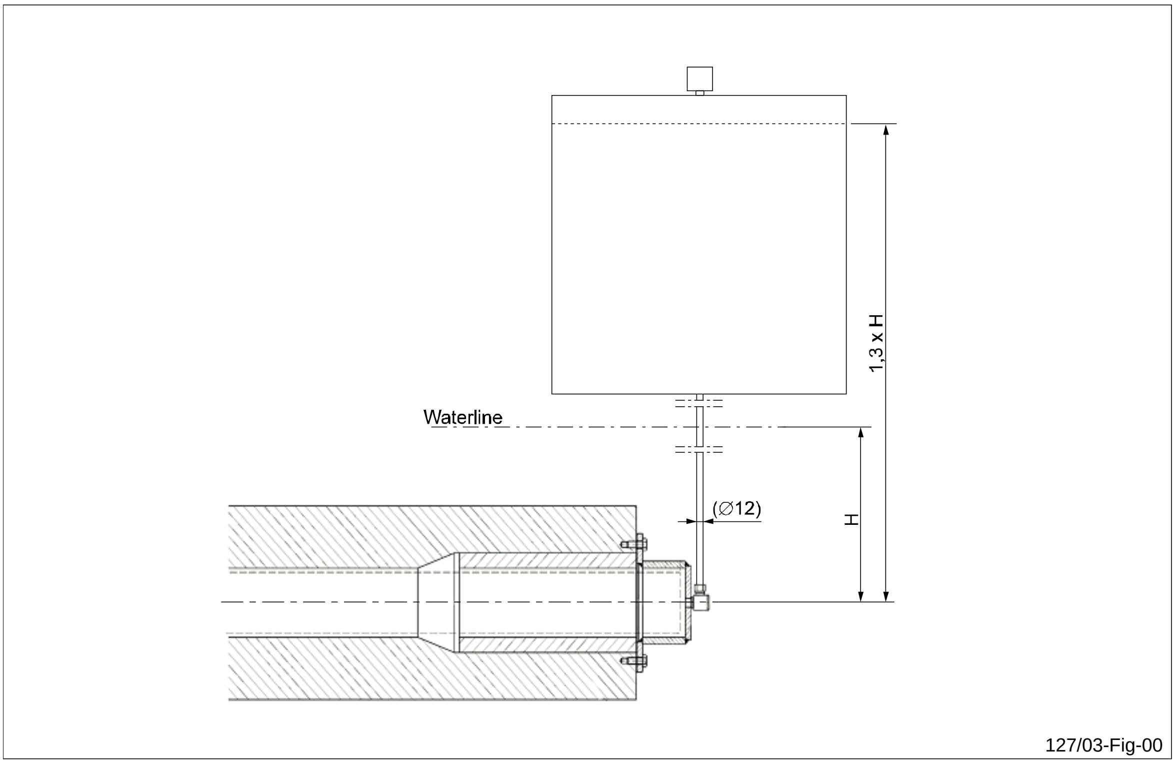

Figure 4 Example of a temporary oil tank.

For corrosion prevention by water entering into the internal parts of the hub it must be filled with oil before launch and a pressure test has to be performed, see part Installation Description. A static over pressure must be maintained during the whole outfitting period. If the hydraulic system cannot be connected, a temporarily tank must be arranged, which is not part of the Rolls-Royce delivery, see figure 4 for an example. The oil must meet the recommendations stated in the section Requirements for Lubrication Oil. As soon as the hydraulic power pack unit has been connected and set to work the pitch must be manoeuvred from full ahead to full astern weekly.

Propeller

Bronze Propellers

To prevent corrosion of sea water exposed parts of the hub and shafts, the following instructions must be followed regarding bronze propellers:

1. The propeller shaft must be earthed to the hull with a special earthing device, designed to be used during the whole life of the vessel. The earthing device function must be inspected weekly. The contact in the stern tube is not sufficient. If the permanent system is not installed, a temporary earthing device, which is not part of the Rolls-Royce delivery, must be arranged during the outfitting period.

2. During welding on board, the hull must be carefully earthed to the welding equipment. To prevent cathodic corrosion this must be inspected daily during periods that welding is in progress on board.

3. The cathodic protection system, zinc or aluminium anodes, must be inspected every second month.

Stainless Steel Propellers

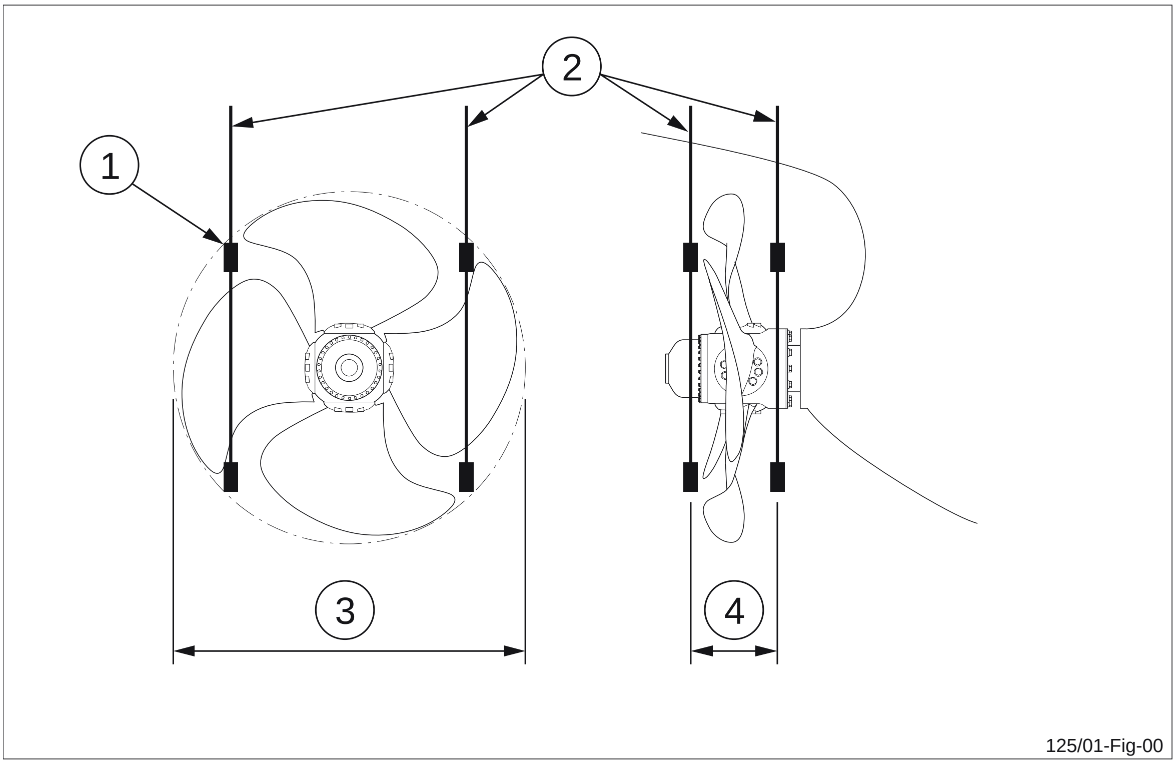

Figure 5 Placement of temporary zinc anodes after launching.

1. Zinc anodes
2. Insulated cables (15-20 mm^2) connected to the hull.
3. Propeller diameter
4. Length of hub body

To prevent corrosion on the parts of the hub and shafts that are exposed to sea water, the following instructions must be followed regarding stainless steel propellers:

1. The propeller shaft must be earthed to the hull with a special earthing device, designed to be used during the whole life of the vessel. The earthing device function must be checked weekly. The contact in the stern tube is not sufficient. If the permanent system is not installed, a temporary earthing device, which is not part of the Rolls-Royce delivery, must be arranged during the outfitting period.

2. During welding on board, the hull must be carefully earthed to the welding equipment. To prevent cathodic corrosion this must be checked daily during periods that welding is in progress on board.

3. After launching, eight zinc anodes must be placed around the propeller, see figure 5. The distances are adjusted according to figure 5. The cathodic protection system, zinc or aluminium anodes, must be inspected monthly. The anodes are to be suspended by insulated electrical cables that are earthed to the hull. It is recommended that warning signs are to be placed at the engine control stand informing that the anodes must be lifted before turning the propeller.

Cathodic Protection for Nozzle Propellers

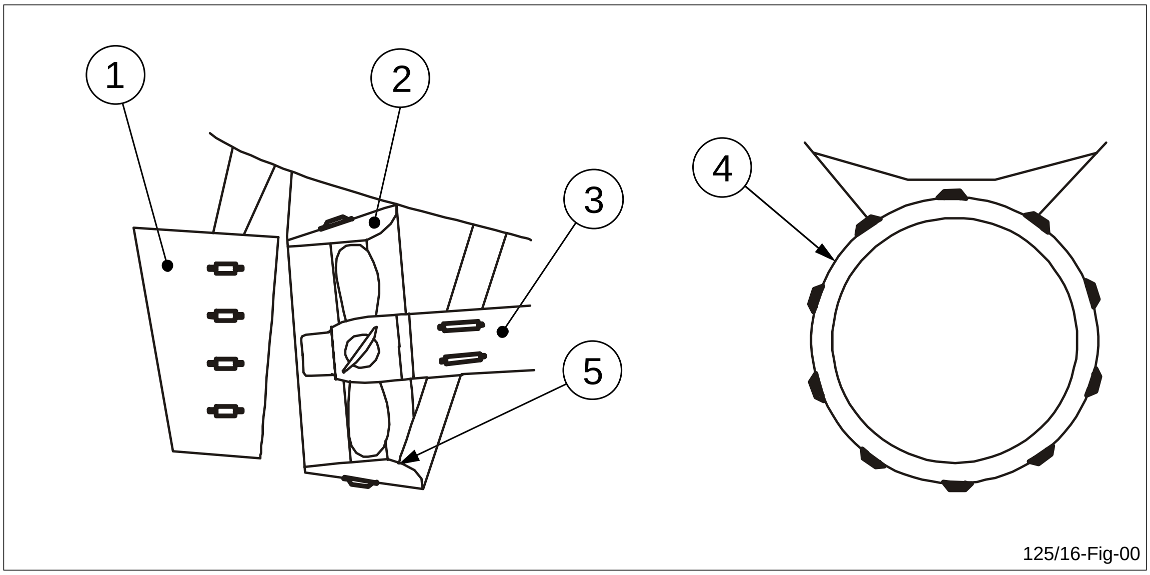

Figure 6 The positions of the sacrificial anodes on the rudder, nozzle, and shaft carrier.

1. Rudder with anodes
2. Nozzle (cut away view)
3. Shaft carrier with anodes
4. Nozzle with anodes
5. Stainless steel cladding

Sacrificial anodes installation

The sacrificial anodes should be made of zinc and may be of either tank type or oblong type. If the anodes are dimensioned to the recommended weight they are calculated to last for about three year.

All anti-corrosion painting should be finished before fitting the anodes. However, the anodes must be in place before launching of the vessel and be effective during the fitting-out period.

Anodes on the nozzle

Sacrificial anodes must be installed on the outside of the nozzle. The total weight of the anodes should be about 14 x D x D in kilograms. Where D is equal with the propeller diameter in meter. This formula is only valid for anodes made out of zinc.

Anodes on the rudder

Standard rudder anodes must be installed on the rudder. The total weight of the sacrificial anodes should be 1/3 of the weight of the anodes installed on the outside of the nozzle.

Anodes on the shaft carrier

Four sacrificial anodes must also be installed on the shaft carrier. The total weight of all four of the anodes should be 1/3 of the weight of the anodes installed on the outside of the nozzle.

Shaftline Components

After installation, open areas between bearings on inboard shafts, must be treated with an anti corrosive agent such as Dinitrol, Tectyl, painting, or similar protection.

The shafts must be inspected for corrosion and be rotated approximately a half turn at least once a month.

Pump Motor Starter Cabinets

The main switch on the pump motor starter cabinet must be turned to off during the outfitting period onboard.

The cables should be connected as late as possible and after that all welding work is finished.

The cabinets must be tight, that is, the doors must be closed and the flanges mounted to prevent moisture and dust to enter the unit.

When grinding work is carried out the starters must be protected against grinding flares and grinding dust.

The pump motor starter equipment should also be covered when painting work is performed near the control system.

Where there is a risk of mechanical damage, special protection equipment must be arranged to protect the pump motor starter parts.

After mounting the pump motor starter unit must be inspected and cleaned before start-up.

Control System

When the components are installed they should be disconnected electrically where possible until the system is to be started up, that is:

• The automatic fuses should be disconnected.

• The PC-boards should be disconnected.

• The terminals should be disconnected.

• The cable connections should be disjointed, etc.

The cables should be connected as late as possible and after that all welding work is finished.

The cabinets must be tight, that is, the doors must be closed and the flanges mounted to prevent moisture and dust to enter the unit.

When grinding work is carried out the control panels must be protected against grinding flares and grinding dust.

The control system equipment should also be covered when painting work is performed near the control system.

Where there is a risk of mechanical damage, special protection equipment must be arranged to protect the control system parts.

After mounting the control system units must be checked and cleaned before start-up.

Permanent Protection of the Propeller Against Corrosion

The propeller must be provided with an effective protection against corrosion. When designing the cathodic protection for the hull the current absorption of the propeller must also be considered.

For a cathodic protection system about 250 mA/m^2 propeller surface is needed. If sacrificing anodes are used the supplier of these must dimension the anodes so that required life span and current density is obtained.

If an impressed current system is used the supplier of this system must locate and dimension the anodes so that required current density is obtained. The system must always be connected even when the vessel is at quay.

Even if the hull is protected against corrosion by means of a modern painting system, for example two-component Epoxy, cathodic protection of the propeller is necessary. On vessels where such painting systems are used the current density (250 mA/m^2) must be increased by 25-50% as the hull cannot protect the propeller in the same way as when the hull is painted with standard paint.

The cathodic protection does not only protect the propeller but also the hull, which due to potential differences between hull and the propeller can be exposed to corrosion attacks if the hull plating is damaged.

Procedures during Long Period of Inactivity

Preparation of the Vessel

The following conditions must be fulfilled if the vessel is to be in harbour for a long period of time (idle in harbour for more then two weeks).

- The general requirements stated in Section Storage Recommendations must be fulfilled.
- The static pressure pump unit P3 must not be shut off. If the vessel is equipped with a gravity tank the pump unit P3 is started and stopped by a level switch in the gravity tank. If the vessel is not equipped with a gravity tank the pump unit P3 must be running constantly to prevent water from entering the hub.
- If the vessel is equipped with a propeller made of stainless steel, eight temporary zinc or aluminium anodes must be placed around the propeller, see figure 5. The anodes are suspended by insulated electrical cables that are earthed to the hull. It is recommended that warning signs are to be placed at the engine control stand informing that anodes must be lifted before turning the propeller.
- Switch off the remote control system by the switches in the central unit cabinets placed on the bridge, in the control room, and close to the hydraulic power pack unit.

Inspections and Procedures

Weekly Inspection

- Turn the shaft approximately 1.5 rotations once a week. Use the turning equipment on the gear if the vessel is equipped with such. The rotation of the shaft is necessary to prevent the shaft from being curved and to lubricate the contact surfaces in bearings and sealings.

- Start pump unit P1 and P2 and manoeuvre the pitch from full ahead to full astern and back to zero position. This manoeuvre must be done in order to lubricate the blade sealing rings under each blade foot. If the blade sealing ring is not lubricated they may get damaged during start-up. This procedure will also allow the valves in the hydraulic system to move, which prevents them from getting stuck.

- Inspect the propeller system. Make sure that there are no oil leakage, no signs of corrosion or other damage caused by for example noxious animals. If the coating of anti corrosive agent is damaged or if other damage is found it must be remedied immediately.

Every Second Month Inspection

- Inspect the cathodic protection system, zinc or aluminium anodes, every second month. Replace the anodes before they are consumed.

Before Start-up of the Vessel

- The propeller shaft, propeller hub, and blades must be cleaned from marine growth before start-up of the propeller system. Any other foreign objects, which may damage the propeller equipment during the start-up, must also be removed.

- If the vessel is equipped with a stainless steel propeller, lift the zinc anodes up prior to take off.

Lifting Instructions

General Information

If lifting tools are part of Rolls-Royce delivery these must be protected with an anti-corrosion agent after use.

Propeller Shaft

Warning: It is important that only qualified personnel perform the lifting.

Caution: Make sure to insert the shaft in a straight line so that pipes and other equipment in the stern tube do not get damaged.

Caution: The propeller shaft must be thoroughly cleaned from dust and dirt, otherwise it might get scratched during insertion. It must also be well lubricated to allow it to run smoothly through the stern tube bearings.

Caution: Protect the propeller system parts from dust and dirt during the lifting and installation procedure. Cover the parts in a proper way.

Caution: Use only clean soft slings when lifting to prevent damage on the propeller shafts.

The propeller shaft can be inserted into the stern tube either with or without the propeller hub mounted. If the propeller hub is to be mounted later, all fittings concerning the hub installation must be placed on the shaft before insertion into the stern tube.

Note the placement of the soft slings when lifting.

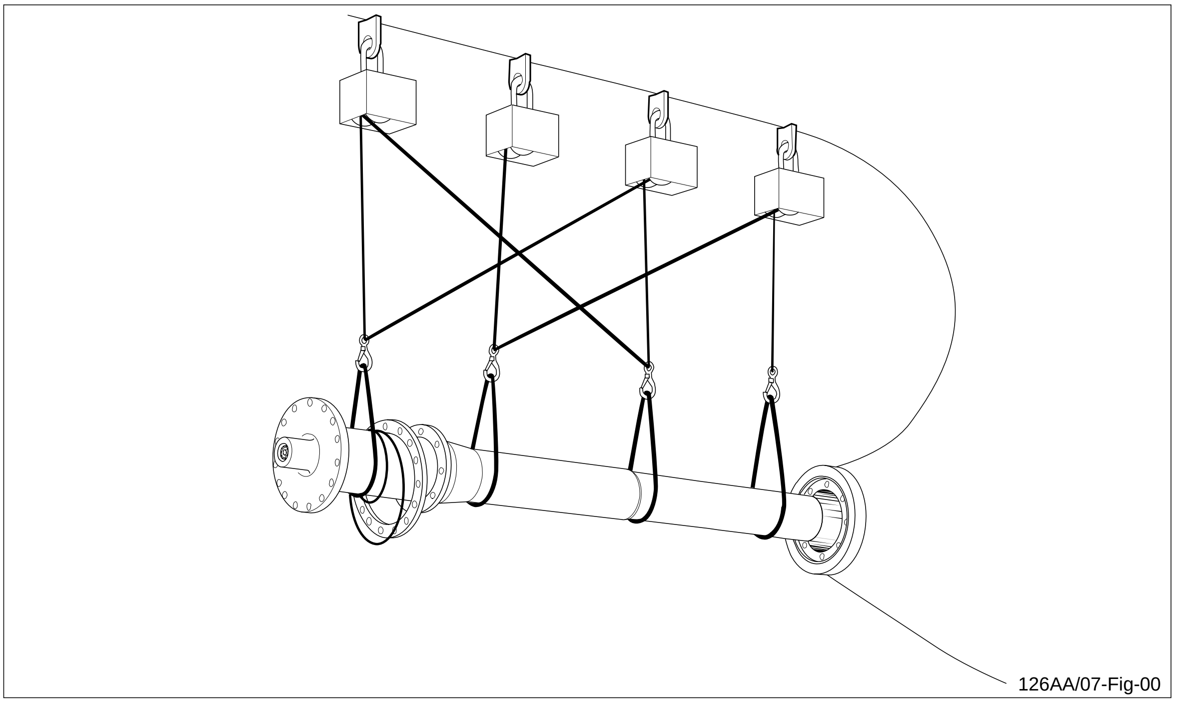

Figure 7 Lifting of propeller shaft with necessary hub mounting equipment.

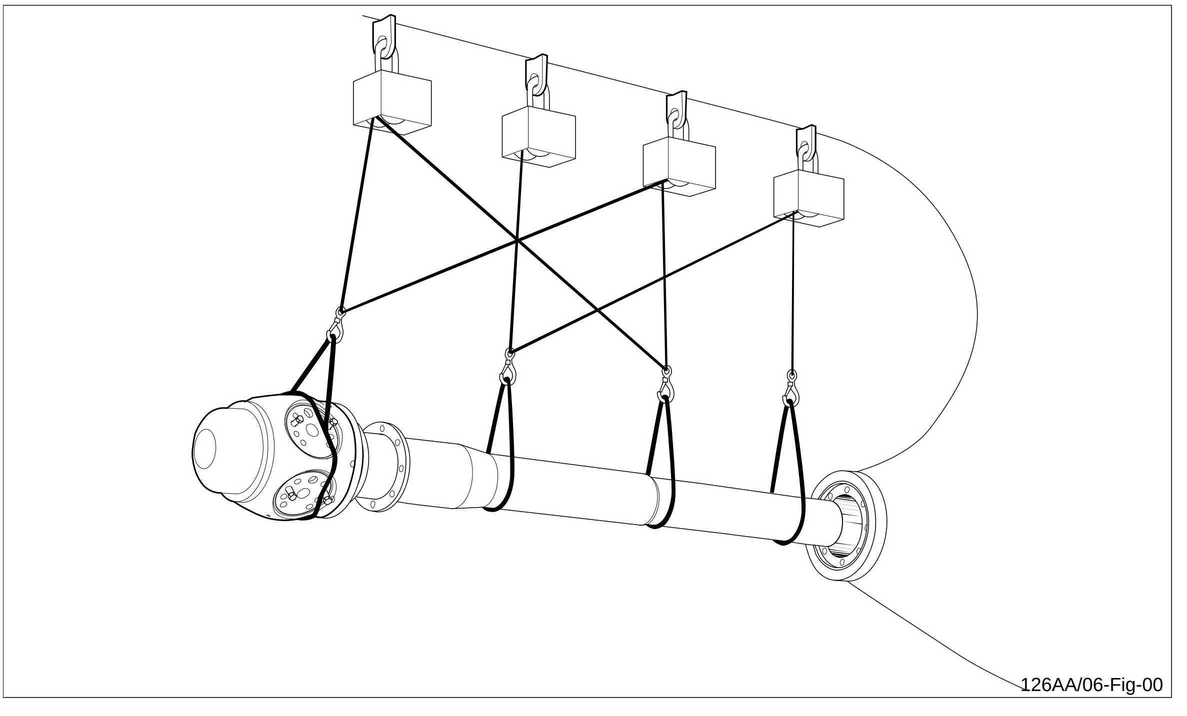

Figure 8 Lifting of propeller shaft with propeller hub mounted.

- Lift the propeller shaft in chain blocks just in front of the stern tube hole as shown in figure 7 and figure 8.
- Prepare for the stern tube sealing.

Twin/Single Tube

The twin/single tube is normally mounted in its respective shaft at delivery. This lifting instruction is applicable if the twin tube is delivered separately.

Warning: It is important that only qualified personnel perform the lifting.

Caution: Use only clean soft slings when lifting to prevent damage on the twin/single tube.

Caution: Take care during the installation to prevent the twin/single tube from getting damaged. Support the twin tube in several places during installation.

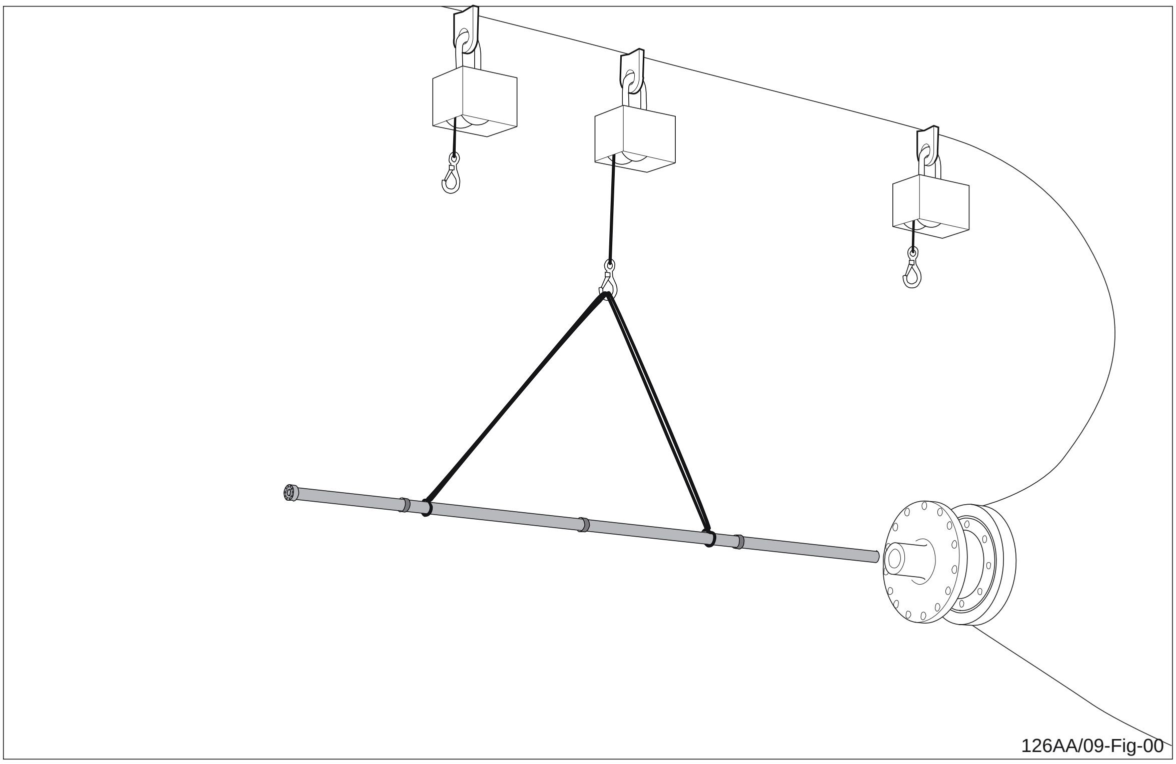

Figure 9 Lifting of the twin/single tube.

• Lift the twin tube assembly in front of the propeller shaft as shown in figure 9.

Propeller Hub

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one who operates the lifting device and one who prevents the components from getting damaged.

Warning: It is important that only qualified personnel perform the lifting.

Caution: The lifting tools from Rolls-Royce is dimensioned to lift the weight of the propeller hub only. Do not use the lifting tools if the lift includes the propeller blades or if the hub is attached to the propeller shaft.

Caution: Protect the propeller system parts from dust and dirt during the lifting and installation procedure. Cover the parts in a proper way.

Caution: Use only clean soft slings when lifting to prevent damage on the propeller hub.

Lifting the propeller during installation can be performed by using one of the following methods depending on the size of the propeller hub:

• Using lifting yokes

• Slinging around the hub

• Slinging around the blades

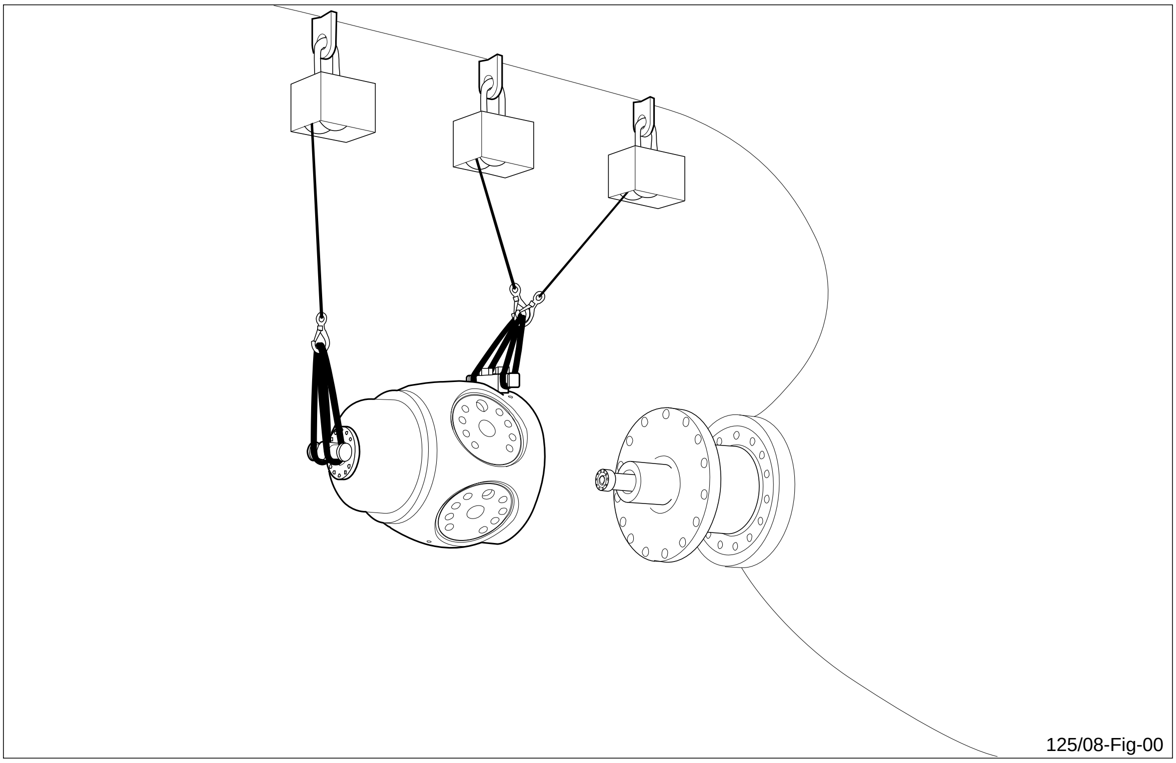

Figure 10 Lifting a large hub using lifting yokes.

Using Lifting Yokes

For propeller hubs size 102 and larger, lifting yokes are included in the delivery from Rolls-Royce. The lifting tools from Rolls-Royce are dimensioned to lift the weight of the propeller hub. Do not use the lifting tools if the lift includes the propeller blades or if the hub is attached to the propeller shaft.

Mount one of the yokes in the lifting holes on the hub cylinder and one in the lifting holes on the hub body. Fit soft slings according to figure 10.

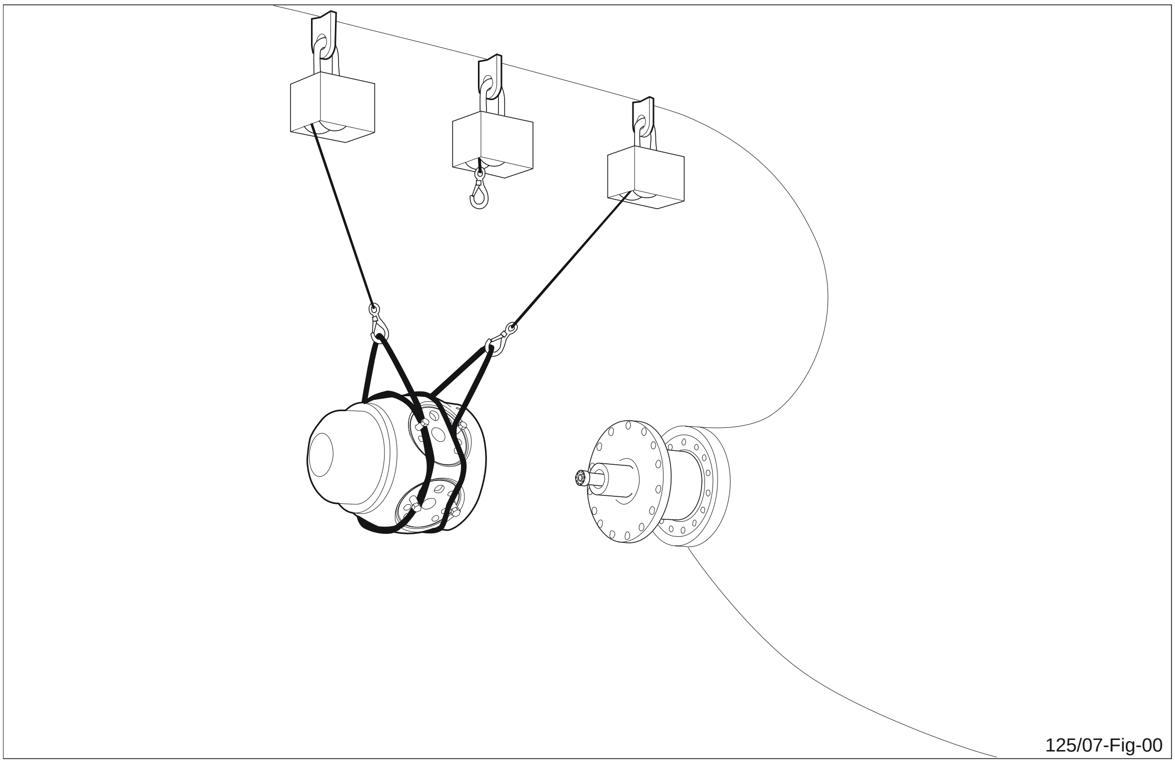

Figure 11 Lifting of propeller hub without blades.

Slinging around the hub

For medium sized propeller hubs, the hub can be lifted by slinging soft slings around the hub. To prevent the soft slings from sliding off the hub, a sufficient number of blade bolts are threaded into position, see figure 11.

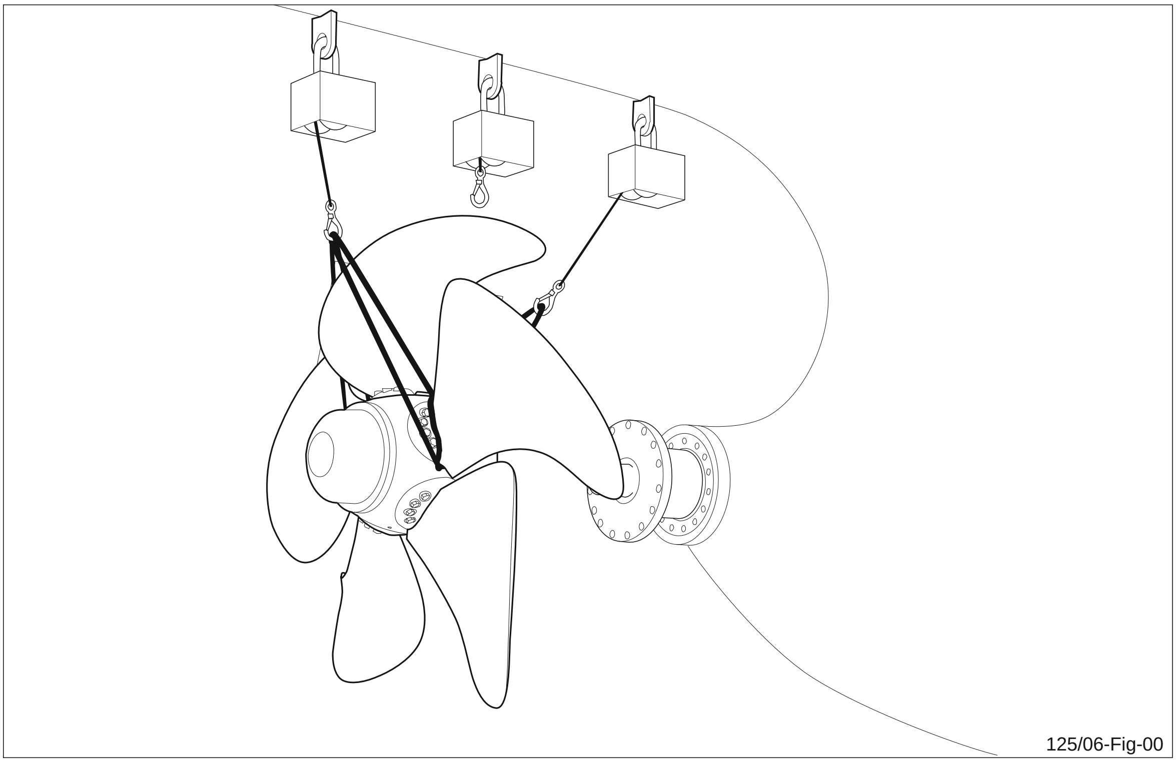

Figure 12 Lifting of propeller hub with mounted blades.

Slinging around the blades

For small sized propellers it is many times sufficient to lift and install them by slinging the propeller around the blades during the lifting and installation process, see figure 12. This method can be considered if the weight is below five tons.

Propeller Blade

Lifting Instruction using the Lifting Hole in the Propeller Blade

Description

This task describes how to lift the propeller blades using the lifting hole in the blade. To be able to use the lifting hole a plug must be removed and a protection sleeve fitted in the lifting hole. This instruction also describes how to reinstall the plug in the lifting hole.

Support Items

Spare Part Name	Cross Ref. No.
Crack bolt	4002

Special/Additional Tools and Test Equipment	Qty
Standard welding machine	1
Standard grinding machine	1
Standard lithe	1

Reference Documents
Hub Assembly drawing

Consumables	Qty
Grinding disks	As req.
Electrodes, ISO E 23.12.2	As req.
Kamewa bolt head sealing compound	As req.
Linen rags	As req.

Instruction

Remove Lifting Hole Plug and Lift the blade

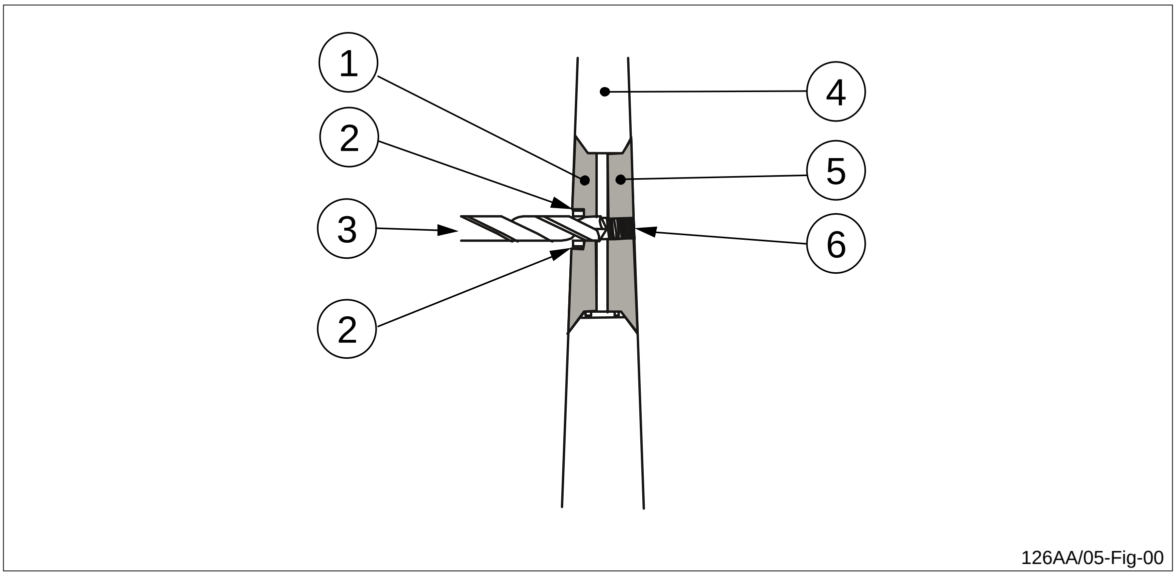

Figure 13 The crack bolt head must be drill out before removing the lifting hole plug.

1. Lifting hole plug half, pressure side
2. Spot welding
3. Drill
4. Propeller blade
5. Lifting hole plug half, suction side
6. Crack bolt

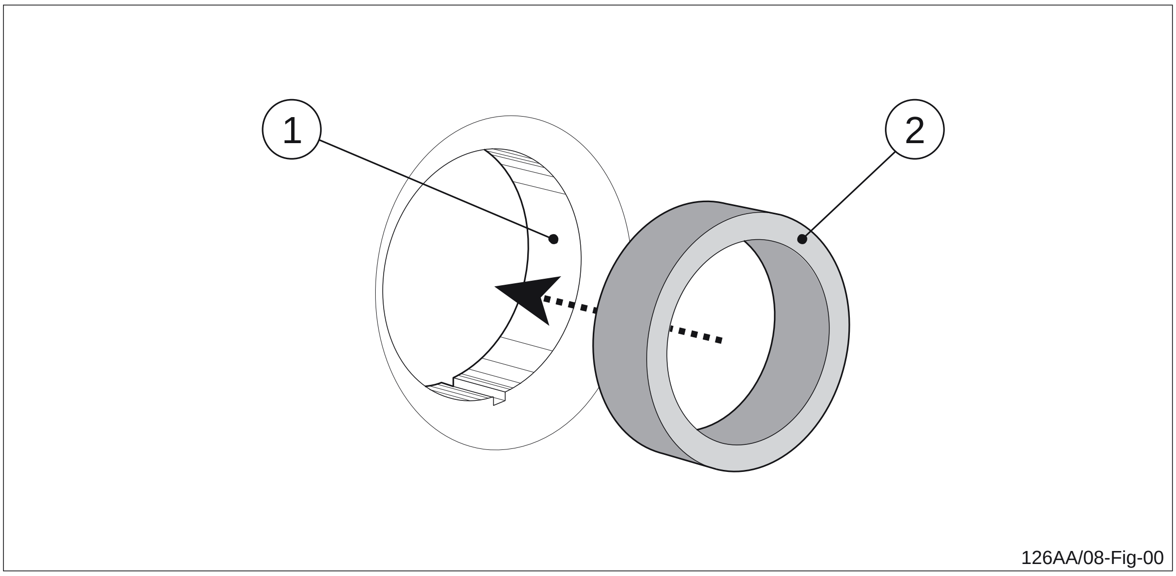

Figure 14 The protection sleeve for the blade lifting hole.

1. Lifting hole
2. Protection sleeve

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one operate the lifting device and one ensure that the components do not get damaged.

Caution: It is important that only qualified personnel perform the lifting.

Caution: Use only clean soft slings when lifting to prevent damage on the blades.

Note: The plug halves have the same manufacturing number as its respective propeller blade.

Make sure that proper lifting equipment are available. Weld brackets onto the ships hull or use a mobile crane to lift the propeller blades.

The lifting hole plug is fasten with a crack bolt and the crack bolt head has to be drilled out before removing the plug.

Remove the lifting hole plug

1. Use a drill with a diameter of 6 mm to pre-drill a hole in the centre of the crack bolt head.
2. Use a drill with a diameter of 13.5 mm or 18 mm and drill, to a depth of approximately 10 mm, until the head loosens from the crack bolt (see figure 13). When the head has loosened do not drill any deeper.
3. Remove the plug half on the pressure side of the propeller blade.
4. Unthread the remaining part of the crack bolt and remove the plug on the suction side.

Fit protection sleeve and lift the blade

5. Attach clean soft slings to the propeller blade using the lifting hole. Use soft slings suitable to lift the weight of the propeller blade. Make sure that the lifting is performed by qualified personnel.
6. Unscrew and remove the blade bolts (for more information see Task: Remove Propeller Blade in part Maintenance).
7. Lift the propeller blade. The blade must be lifted straight upwards and be kept in horizontal position until the blade has come off the guide pins.

8. Place the blade with the blade flange down on a clean wooden foundation.

When the protection sleeve is not used it must be lubricated and treated with corrosive preventive agent. It must then be stored together with other lifting tools or spare parts.

This task is now completed.

Plug the Lifting Hole

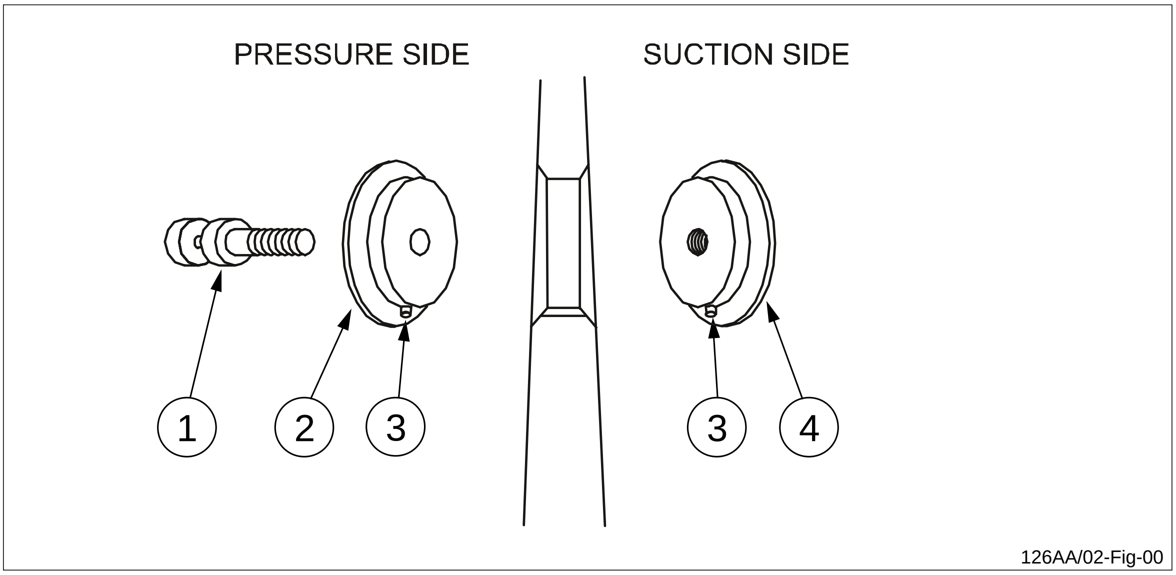

Figure 15 The two plug halves are pre-machined to fit in its propeller blade.

1. Crack bolt
2. Lifting hole plug half, pressure side
3. Position pin
4. Lifting hole plug half, suction side

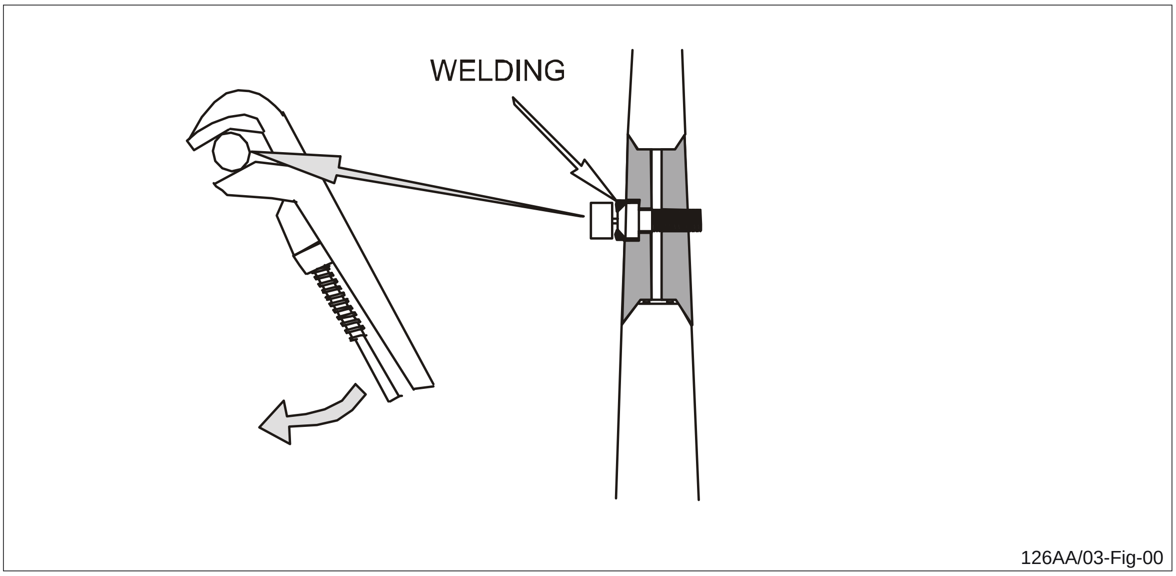

Figure 16 The crack bolt is secured by welding.

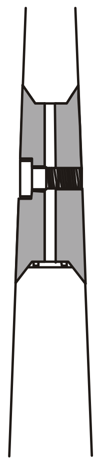

Figure 17 The installed plug in the lifting hole.

Caution: Do not grind on the propeller blade.

Note: The lifting hole plug halves have the same manufacturing number as its respective propeller blade.

The plug halves is pre-machined to fit the lifting hole perfectly. Make sure to fit the suction side plug half on the suction side of the propeller blade and vice versa. Each plug has to be fitted in the correct blade, note that the blade and the plug halves are marked with the same manufacturing number. The plug halves are marked on the inside.

Install the lifting hole plug

1. Use a lathe or a facing cutter to turn out the spot welds that fastens the remaining part of the crack bolt head to the plug (see position 2, in figure 13). Remove the crack bolt head.
2. Make sure that the existing plug halves are intact and can be reinstalled. The position pins (see figure 15 position 3) must be intact.
3. Lubricate the lifting hole and the plug with Kamewa sealing compound or similar corrosion protection before installing the plug.
4. Insert the plug halves in the lifting hole according to figure 17.
5. Use a new crack-bolt and tighten the crack-bolt until the crack bolt head breaks off (see figure 16).
6. Lock the crack-bolt by spot welding.

7. Grind down the crack-bolt on both sides of the blade until the bolt is levelled with the surface of the lifting plug. Do not to grind on the propeller blade.

For more detailed instructions on how to install the lifting hole plug, please contact Rolls-Royce Global Support Network.

Lifting Instruction for Blades without Lifting Hole

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one operate the lifting device and one ensure that the components do not get damaged.

Caution: It is important that only qualified personnel perform the lifting.

Caution: Use only clean soft slings when lifting to prevent damage on the blades.

Make sure that proper lifting equipment are available. Weld brackets onto the ships hull or use a mobile crane to lift the propeller blades.

1. Fit clean soft slings around the blade and the blade foot. Use soft slings and lifting equipment that are suitable to lift the weight of the propeller blade. Note that the lifting of the propeller blade must be performed by qualified personnel.
2. Unscrew and remove the blade bolts (for more detailed information see Task: Remove Propeller Blade in part Maintenance).
3. Lift the propeller blade. The blade must be lifted straight upwards and be kept in horizontal position until the blade has come off its guide pins.
4. Place the blade with the blade flange down on a clean wooden foundation.

OD-box (FA)

Use soft slings as shown in figure 18 and figure 19.

Depending on the OD-box size there are two ways of lifting the OD-box, see figure 18 and figure 19.

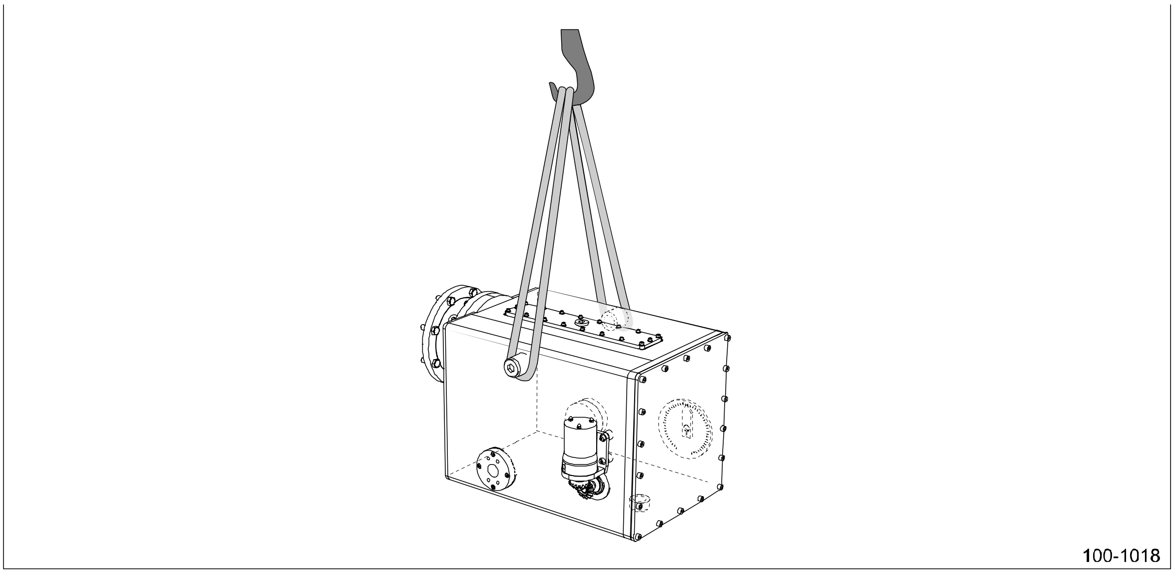

Figure 18 Lifting of OD-box (FA) size 70, 100 and 140.

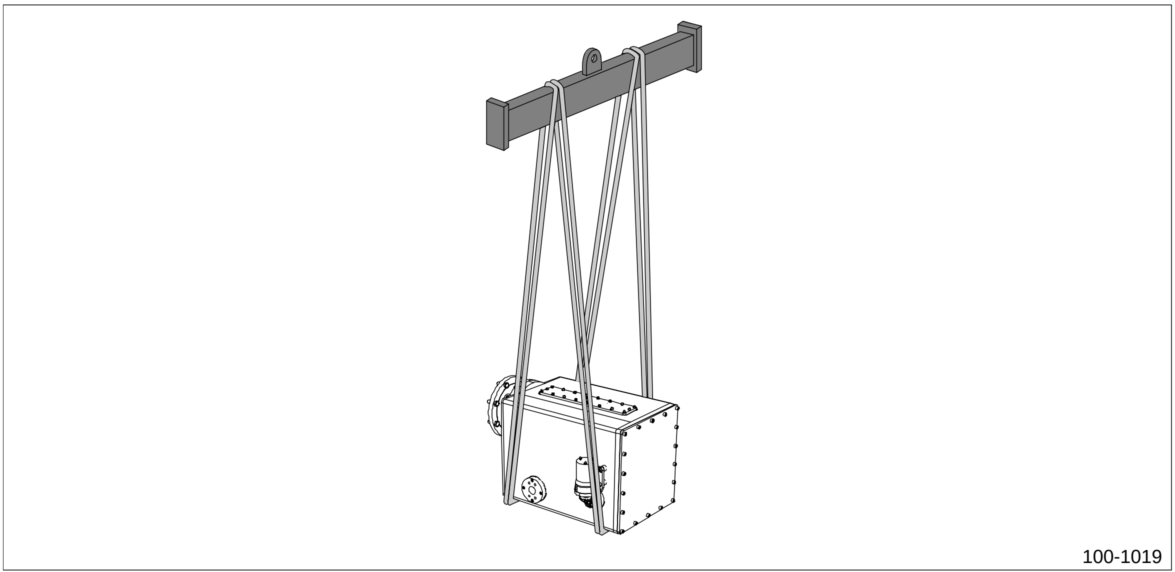

Figure 19 Lifting of OD-box (FA) size 35, 50 and 70.

OD-box (M0)

Caution: Use clean soft slings to prevent the OD-box from getting damaged.

Caution: Do not lift in box housing or feed back sleeve.

The lifting of the OD-box (M0), is performed as when lifting an intermediate shaft, but it is not permitted neither to lift in the box housing, nor in the feed back sleeve.

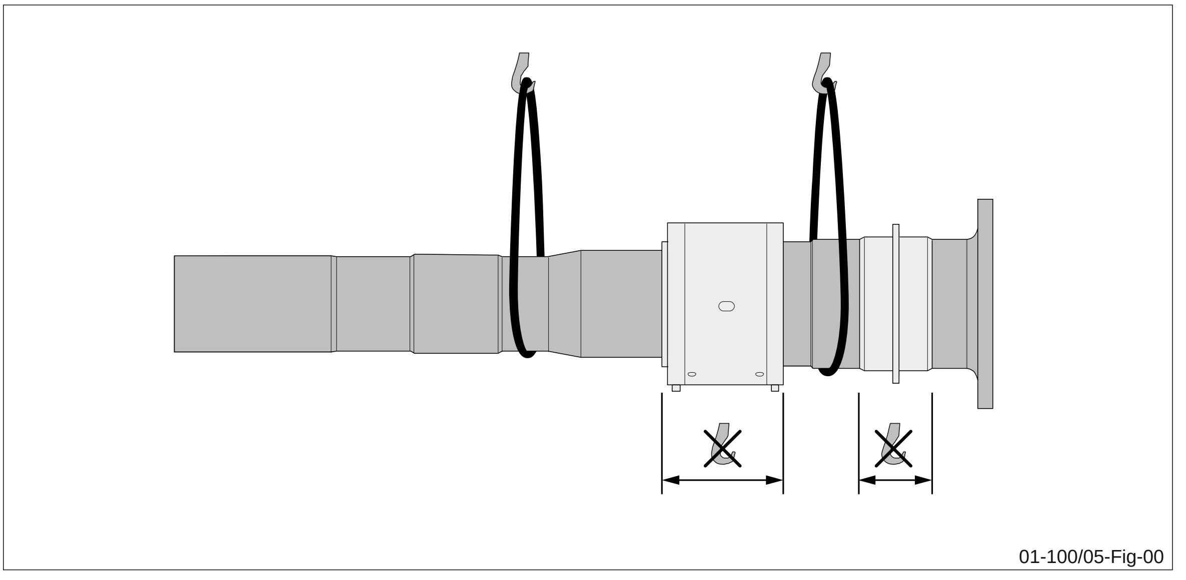

Figure 20 Lifting of OD-box (M0).

Hydraulic Power Pack

Use soft slings and a lifting device as shown in figure 21. The lifting device is not part of the Rolls-Royce delivery.

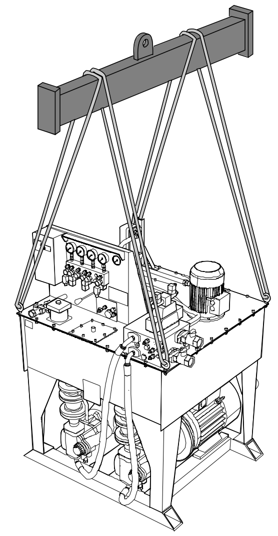

Figure 21 Lifting of hydraulic power pack.

Planning the Installation

General

This installation manual contains installation descriptions for Kamewa propulsion system and are intended as a complement to the appended installation drawings in part Design Drawings.

Plan the installation of the propulsion system with care. Make sure that there is enough room for safe installation, dismantling, and reinstallation of the propulsion system parts. All service points must be accessible and there must be sufficient space around the propulsion parts for safe installation, commissioning, and maintenance. The minimum working and dismounting space is found on the appended installation drawings. Note that some of the values given in the drawings are minimum working and dismounting space and considerations must be taken regarding the service personnel.

Before starting the installation of the propulsion system, make sure that concerned personnel have read and understood the content of the Installation Manual and that the information in the following chapters has been considered.

Always make sure that correct approved propulsion parts, tools and consumables, such as oil, are available before starting the installation

When your installation plan of the propulsion system is finished, please fill in and send the Document Yard Installation Plan for Rolls-Royce Equipment within the date and to the address stated in the coordination plan.

Inspection and Cleaning of Propulsion System Parts

Thoroughly clean the propulsion parts before installation. Use only clean linen rags not twist when cleaning. Make sure that all dust and dirt are removed, use a degreaser if necessary. Non painted areas, for example the shafts, should be degreased and all dust and dirt must be thorougly removed. After the installation procedure the non painted areas must be treated with an anti corrosion agent.

It is important to inspect the equipment for any damage or faults before installation. Please see Part Handling and Preservation for more detailed information.

Lifting Instructions

When lifting Rolls-Royce equipment it is necessary to pay attention to lift it in a correct and safe way. Only qualified personnel are to perform the lifting, for more detailed information please see Part Handling and Preservation and the appended lifting tool user manual in part Tools.

Storing of Propulsion System Parts

If the propulsion parts must be stored during installation, keep it in a dry area with uniform temperature in order to avoid moisture and prevent condensation. The equipment must also be well protected against damage, dust and dirt. Please see Part Handling and Preservation for more detailed information.

Special Tools

All recommended tools and necessary special tools are found in part Tools.

Drawings

All appended drawings are found in part Design Drawings.

Torque Values

All necessary torque values are found on the appended installation drawings, see part Design Drawings.

Tightening and Locking of Bolts

See Instruction for tightening of screws, in part Design Drawings, for detailed instructions on how to tighten screws. For torque values see adequate installation drawing.

See drawing Instruction for locking of screws, in part Design Drawings, for detailed instructions on how to lock screws.

Oil Requirements

For information regarding oil to use in the propulsion system see section Requirements for Lubricating Oil in part Installation Description and the sub supplier documentation in part Sub Supplier Manuals.

Installation Working Order

The described installation order of the propulsion system is only a general recommendation from Rolls-Royce and the installation routines may differ between yards.

Before Launching of the Vessel

- Install stern tube
- Stern tube air pressure test
- Install propeller shaft and twin tube
- Pre-install support bearings
- Install propeller hub and connect the twin tube

- Install propeller blade
- Install intermediate shaft and twin tube
- Pre-install brake device pre-installation (if applicable)
- Pre-install earthing device (if applicable)
- Pre-install bulk head seal
- Preliminary shaft alignment
- Fill stern tube, propeller hub, and propeller shaft with oil
- Install propeller shaft end cover and temporary gravity tank (if applicable)
- Pressure test the propeller hub
- Pressure test the stern tube (using oil)
- Inspect the plastic protection coating (if applicable)
- Inspect locking of all screws
- Secure the shaft line before launching of the vessel

After Launching of the Vessel

- Final shaft alignment
- Final support bearing installation
- Final twin tube installation
- Final installation intermediate shaft
- Final sleeve coupling installation
- Inspect maximum run out of shaft and twin tube
- Final installation of brake device (if applicable)
- Final installation of earthing device (if applicable)
- Final installation of bulk head seal
- Install shaft locking device (if applicable)
- Install switches, sensors and transmitters
- Install OD-box and feed back system
- Install hydraulic system and piping
    - Hydraulic power pack unit
    - Gravity tank (if applicable)
    - Piping
    - Pump motor starters (if applicable)
    - Switches/sensors and transmitters
- Fill support bearings with oil or grease

- Fill gear couplings with oil or grease
- Fill hydraulic system with oil
- Start up and flush hydraulic system
- Inspect twin tube axial movement ratio
- Adjust OD-box scale
- Inspect the OD-box ring axial play (applicable for OD-box type F0 and FA)
- Inspect function of all alarms

Remote Control System or Closed Loop System

- Install all electric equipment
- Install the cables
- Inspect the cabling
- Inspect the control system for earth faults before power up
- Inspect supply voltage

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Installation Description Before Launching

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Propeller Shaft Installation

Installation Work Order

The work order and the procedure for installation of the propeller shaft is described in the bullet list below.

- Make sure that all equipment is clean.
- Lubricate the stern tube bearings.
- Lubricate the propeller shaft.
- Protect the bearing surfaces on the shaft by using a rubber cloth.
- Place hub fittings and aft stern tube seal on the shaft.
- Insert the shaft carefully through the stern tube. Make sure to insert the shaft in a straight line so that pipes and other equipment in the stern tube do not get damaged.
- Install forward stern tube seal.
- Mount the sleeve coupling parts on the propeller shaft to the position stated on the Shafting Arrangement drawing. For more information on how to install the sleeve coupling, please see the documentation in part Sub Supplier Manuals.

Propeller Shaft Insertion

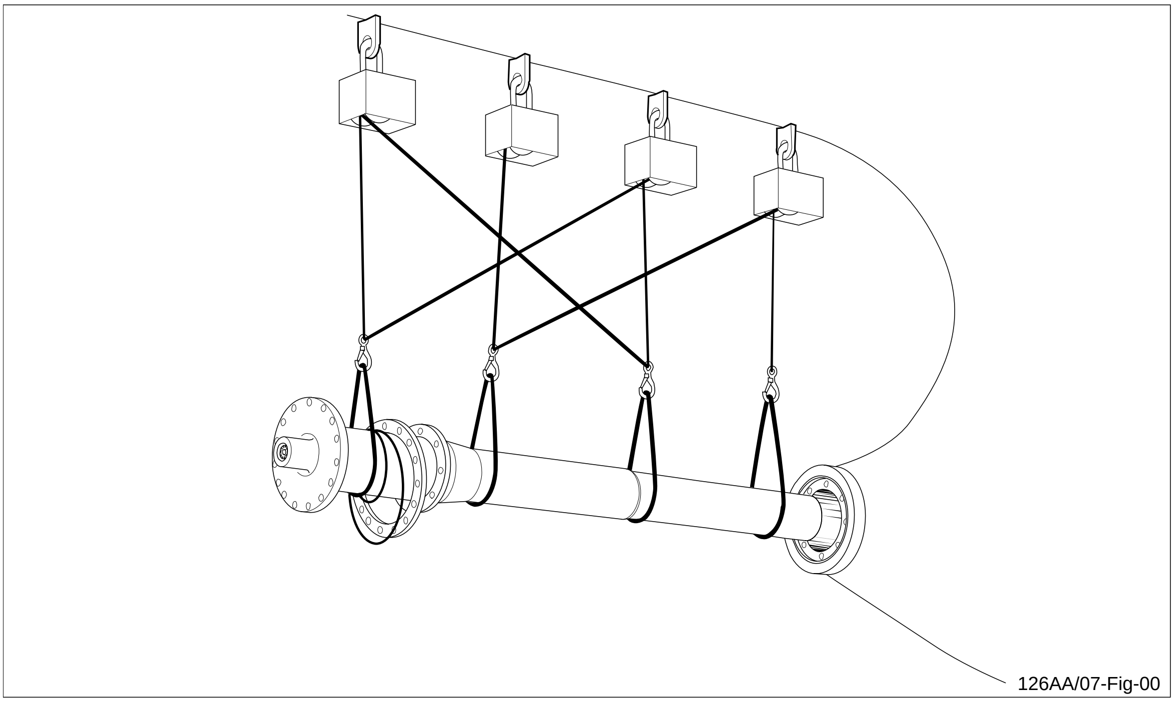

Figure 1 Insertion of propeller shaft with necessary hub fittings and aft stern tube seal placed on the shaft.

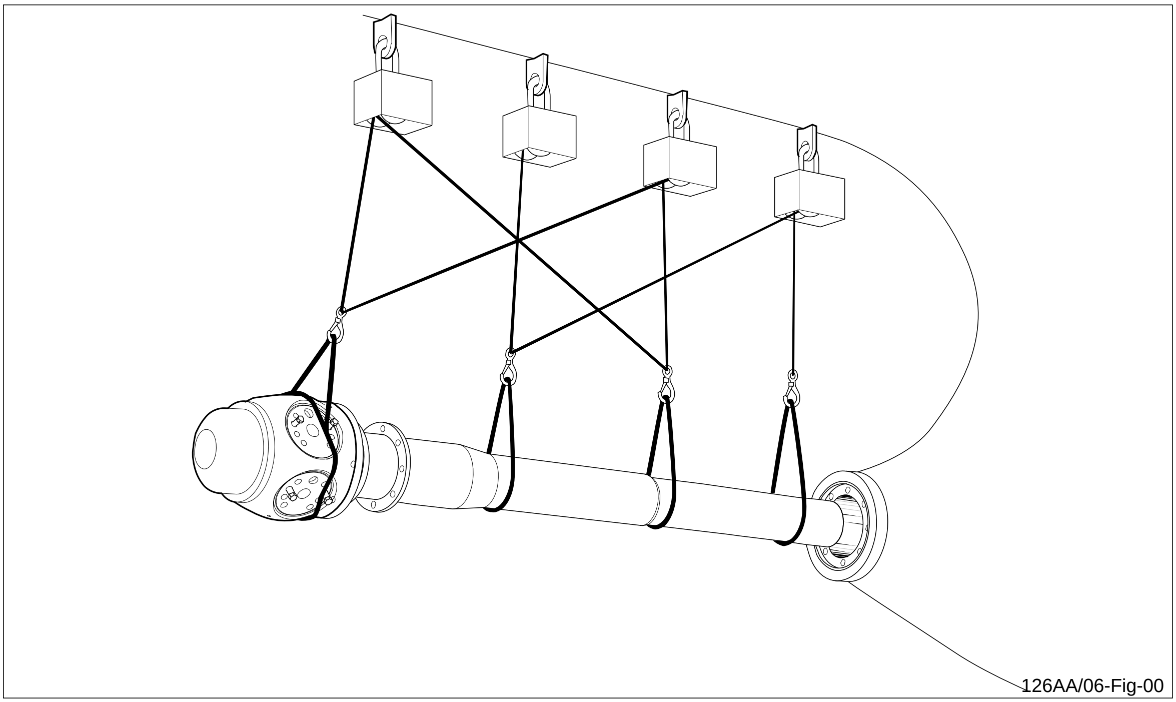

Figure 2 Insertion of propeller shaft with propeller hub mounted and aft stern tube seal placed on the shaft.

Warning: It is important that only qualified personnel perform the lifting.

Caution: Make sure to insert the shaft in a straight line so that pipes and other equipment in the stern tube do not get damaged.

Caution: The propeller shaft must be thoroughly cleaned from dust and dirt, otherwise it might get scratched during insertion. It must also be well lubricated to allow it to run smoothly through the stern tube bearings.

Caution: Protect the propulsion parts from dust and dirt during the lifting and installation procedure. Cover the parts in a proper way.

Caution: Use only clean soft slings when lifting to prevent damage on the propeller shafts.

Note: Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.

Use the following documents as reference material during the installation:

• Hub Assembly drawing (see part Design Drawings)

• Propeller Shaft Assembly drawing (see part Design Drawings)

• Lifting instructions (see part Storage and Handling)

The propeller shaft can be inserted into the stern tube either with or without the propeller hub mounted. If the propeller hub is to be mounted later, all fittings concerning the hub installation must be placed on the shaft before insertion into the stern tube.

• Hang the propeller shaft in front of the stern tube hole as shown in figure 1 and figure 2.

• Clean the shaft thoroughly from dust and dirt. Use a degreaser if necessary.

• Lubricate the stern tube bearings using stern tube oil.

• Lubricate the shaft using stern tube oil.

• Place hub fitting equipment and the shaft flange protection cover on the shaft before insertion.

• Place the aft stern tube sealing parts on the shaft before insertion.

• Let the shaft enter the stern tube carefully and then push it almost to its final position.

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Propeller Hub Installation

Lifting Description

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one who operates the lifting device and one who prevents the components from getting damaged.

Warning: It is important that only qualified personnel perform the lifting.

Caution: The lifting tools from Rolls-Royce are dimensioned to lift the weight of the propeller hub and blades. Do not use the lifting tools if the propeller hub is attached to the propeller shaft during the lift.

Caution: The lifting yoke is constructed to lift Rolls-Royce propeller hubs together with an aft lifting yoke. All other use is prohibited.

Caution: Protect the propulsion parts from dust and dirt during the lifting and installation procedure. Cover the parts in a proper way.

Caution: Use only clean soft slings when lifting to prevent damage on the propeller hub.

Use the Hub Assembly drawing as reference material during this procedure.

Lifting the propeller hub during installation can be performed by using one of the following methods depending on the size of the propeller hub:

- For hub sizes 102 and larger, use the lifting yokes included in the delivery from Rolls-Royce.
- For hub sizes below 102, fit slings around the hub or around the blade feet. The lift of small sized propeller hubs can be performed with or without the propeller blades mounted.

Lifting Yokes

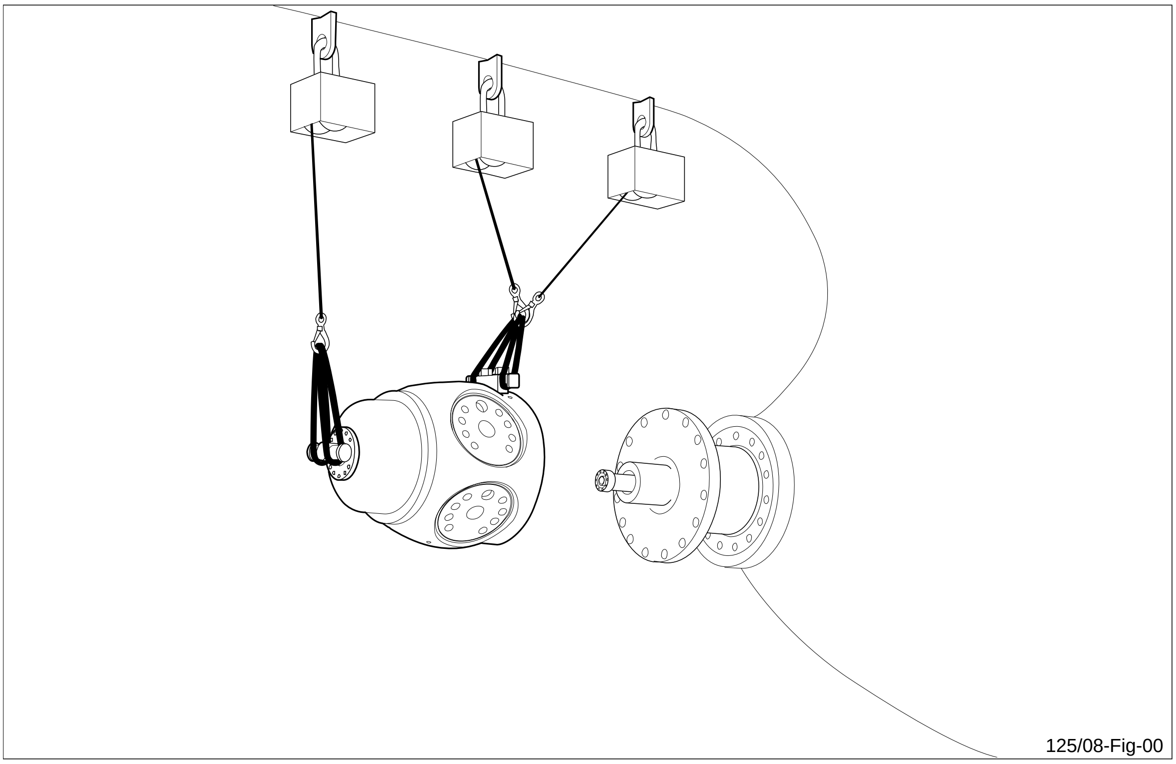

Figure 1 Lifting a large sized hub using lifting yokes.

For propeller hubs size 102 and larger, lifting yokes are included in the delivery from Rolls-Royce. The lifting tools from Rolls-Royce are dimensioned to lift the weight of the propeller hub and its blades. Do not use the lifting tools if the propeller hub is attached to the propeller shaft during the lift.

Mount the aft yoke in the lifting holes on the hub cylinder and the forward yoke in the lifting holes on the hub body. Fit soft slings according to figure 4.

For more information see the User Manual for the lifting yoke in part Tools.

Slinging Around Hub or Blade Feet

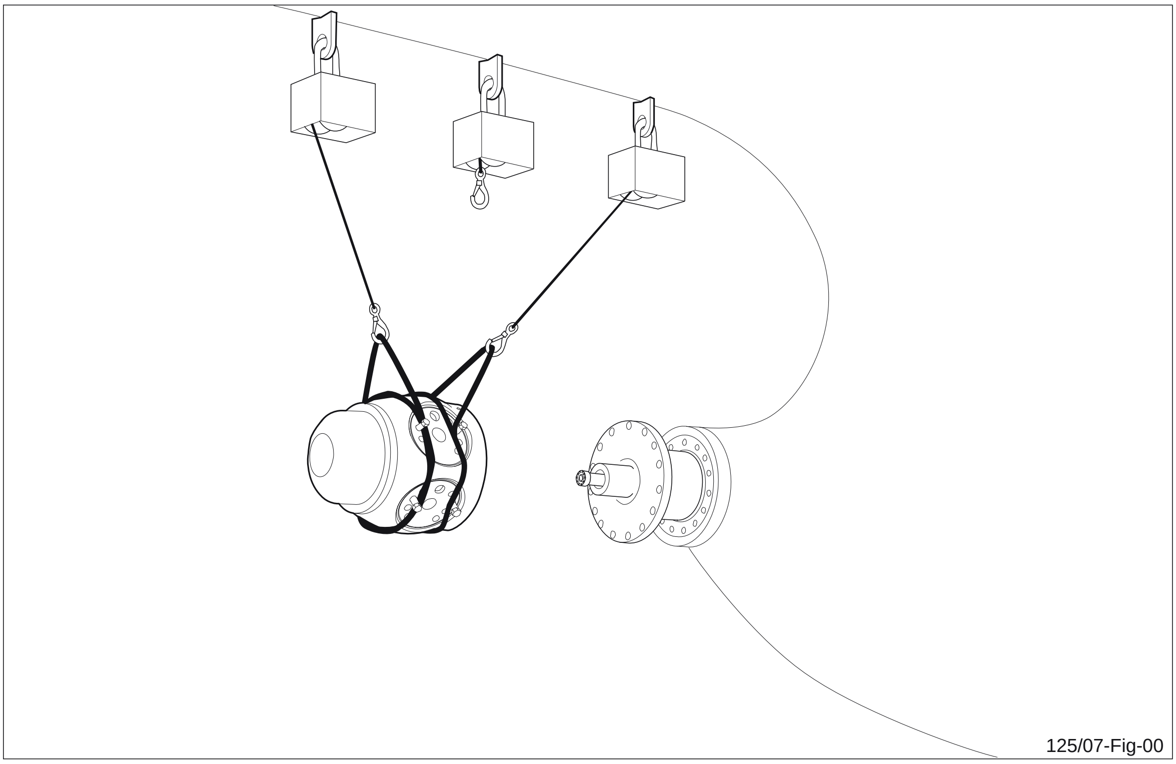

Figure 2 Lifting a small sized propeller hub without blades using soft slings.

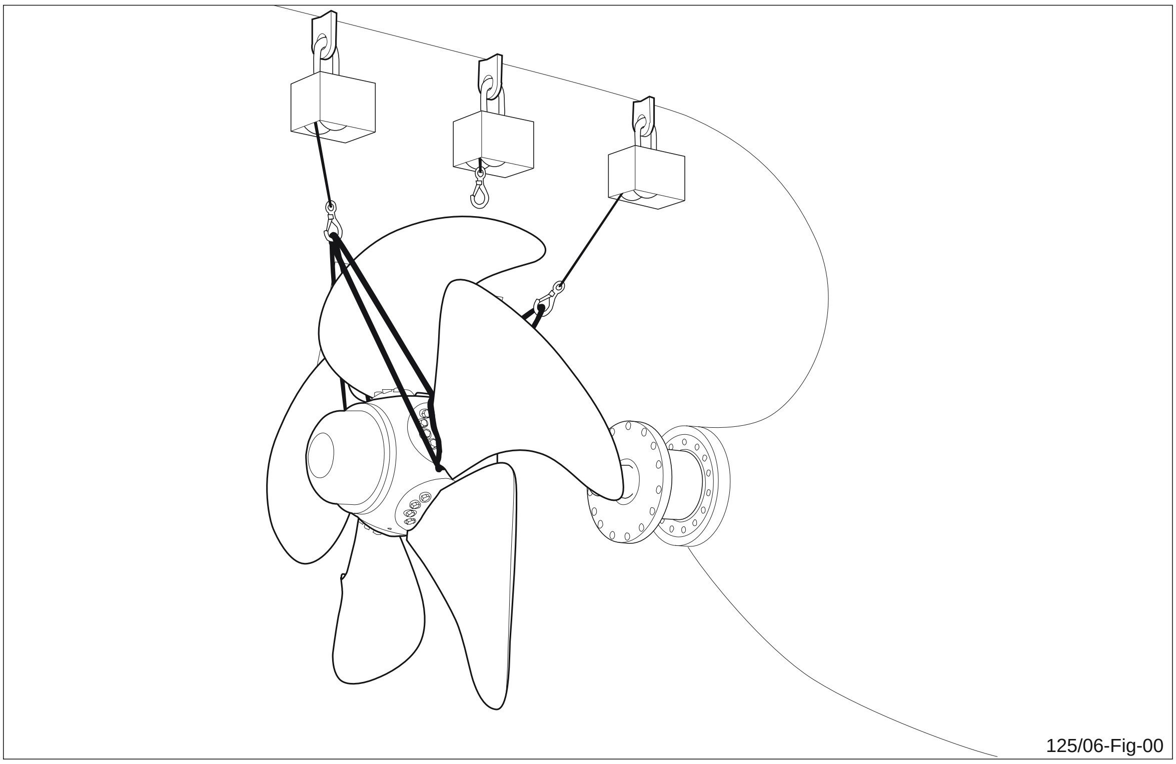

Figure 3 Lifting a small sized propeller hub with mounted blades using soft slings.

For propeller hubs smaller than size 102, there are no lifting yokes included in the Rolls-Royce delivery.

- The small sized hubs are lifted by fitting soft slings around the hub. To prevent the soft slings from sliding off the hub, a number of blade bolts must be screwed into position, see figure 2.
- It is also possible to lift and install the hub with the propeller blades mounted. Soft slings are fitted around the blade feet to keep the soft slings in place during the lifting and installation process, see figure 3.

Mount Propeller Hub on Propeller Shaft

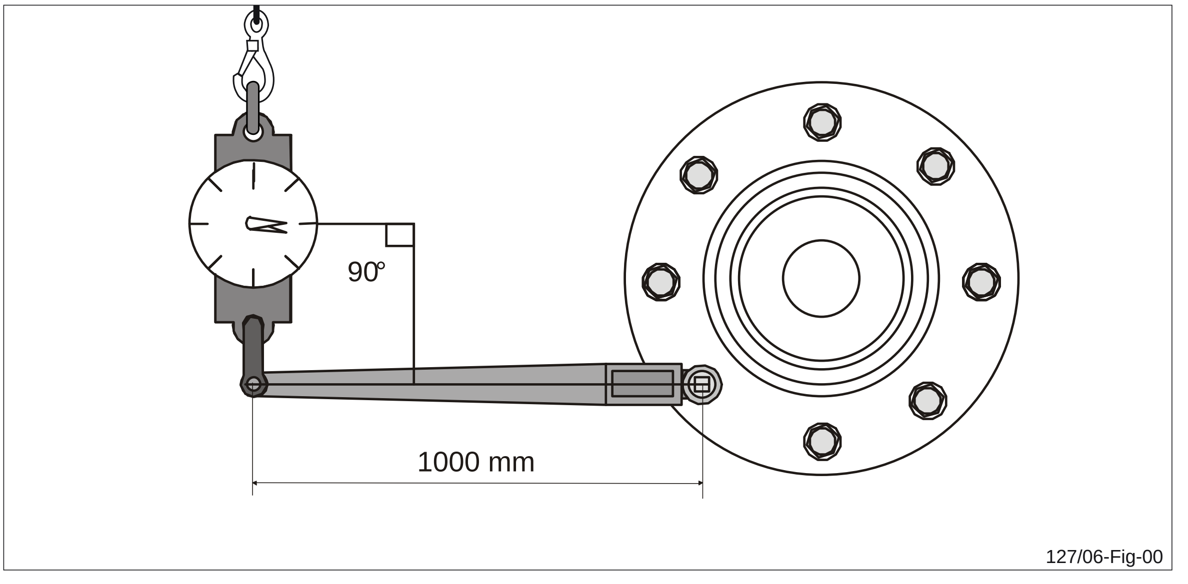

Figure 4 Alternative 1: Dynamometer and torque wrench attached to a shaft flange screw.

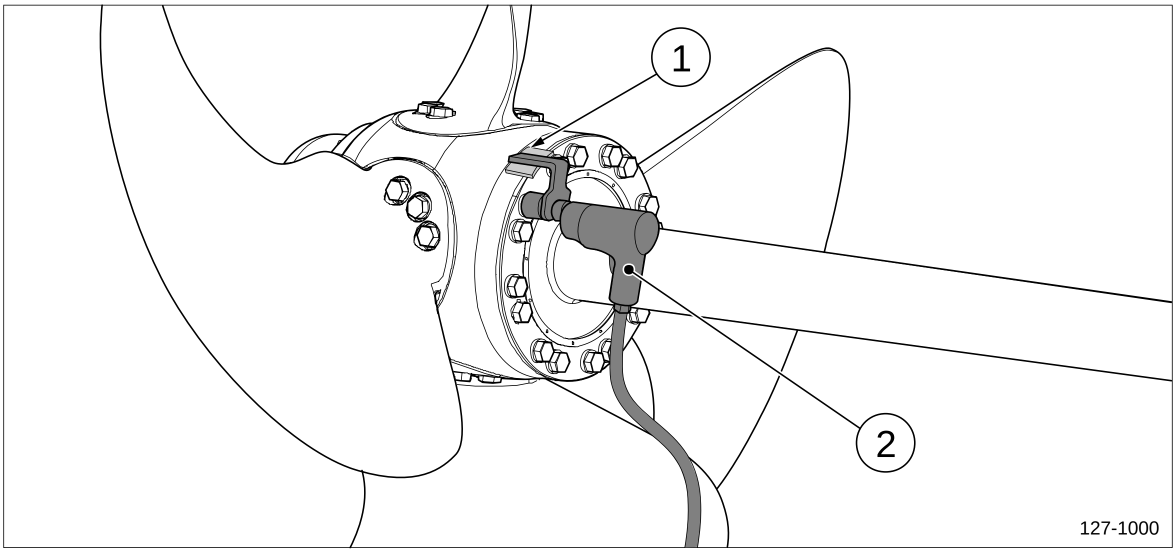

Figure 5 Alternative 2: Tighten shaft flange screws.

1. Protection plate
2. Example of torque tool

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one operate the lifting device and one ensure that the components do not get damaged.

Warning: The torque tool must be dimensioned with consideration taken to the torque values. This also includes the power socket which must have correct dimension for the width across flats.

Caution: It is important that only qualified personnel perform the lifting.

Caution: Make sure to handle the torque tool with care to prevent personel injuries due to the massive forces used.

Note: **Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.**

Note: **Make sure to have a up to date certificate regarding torque calibration of the torque tool.**

Use the Hub Assembly drawing as reference material during the installation.

Before starting this procedure , make sure that all parts are clean and dry. It is very important that no dust or water are left inside the twin tube, the hub or in between the shafts.

Make sure that proper lifting equipment is available. Weld brackets onto the ships hull or use a mobile crane to lift the propeller hub.

To be able to perform a safe installation with satisfied outcome the following prerequisites must be fulfilled.

- Make sure that all equipment is clean.
- Mount lifting yokes or fit soft slings to the propeller hub depending on hub size.
- Lift and hang the hub into position in front of the shaft.
- Fit the shaft flange O-ring and the O-ring on the hub front face before connecting the twin tube parts.
- Connect the twin tube aft part to the connection piece in the hub. Pull the twin tube out of the propeller shaft enough to connect the two ends.
- Carefully tackle the hub against the shaft flange and make sure that the O-rings are in place. Make sure that the hub guide pins fit into the shaft flange while measuring that the hub and the flange are parallel.
- Lubricate the shaft flange screws and apply sealing compound underneath their head. Fit four shaft flange screws and tighten lightly.
- Dismantle and remove the lifting equipment.
- Fit the remaining shaft flange screws and make sure that their threads are lubricated and their heads have sealing compound underneath.
- There are two alternatives for final tightening the screws, see figure 4 or figure 5. For torque values and locking of the screws, see Hub Assembly drawing and Instruction for Locking of Screws drawing in part Design Drawings.
- When using a torque tool according to pos 2 in figure 5, the tool’s support part must be adjusted (the angle) towards the shaft to obtain a steady torque force on the screws. To protect the surface on the shaft use a thick aluminium, copper or brass plate (pos 1, figure 5) between the tool’s support and the blade/shaft. The plate must be bent with a similar radius as the surface to avoid damages to the surface.

Propeller Blade Installation, G-design

Description

This task describes how to install the propeller blades on the propeller hub.

Support Items

Spare Part Name	Qty

Special/Additional Tools and Test Equipment	Qty
Mobile crane or other suitable lifting equipment such as chain falls.	1
Dynamometric wrench or torque tool	1
Tension tester	1
Standard welding machine	1
Feeler gauge	1
Soft lifting slings	1

Reference Documents
Hub Assembly drawing
Lifting instructions in Part Handling and Preservation

Consumables	Qty
PTFE-compound	As req.
Sealing compound	As req.
Loctite 648 or similar	As req.
Teflon grease	As req.
Molycote or similar	As req.
Degreasing solvent	As req.
Flushing oil of type: Statoil SL 07-201	20 litres

Installation Procedure

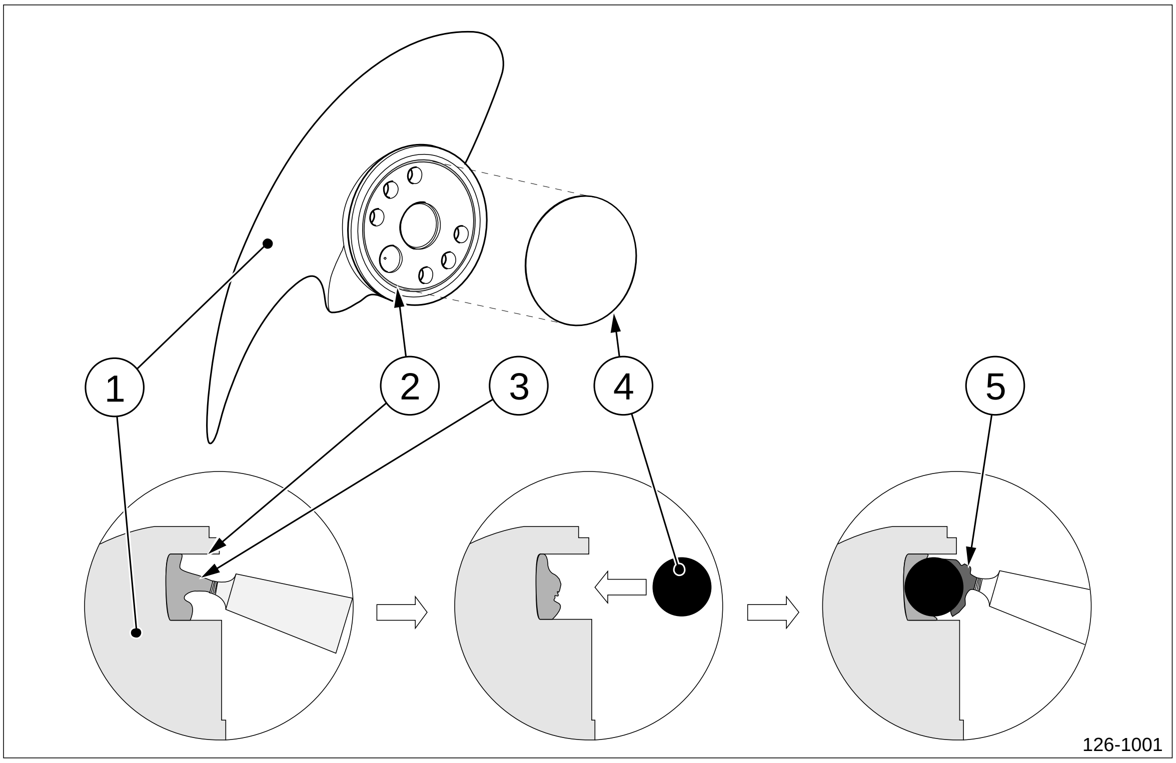

Figure 1 Mounting of blade sealing ring on blade flange.

1. Propeller blade
2. Blade sealing groove
3. Grease or similar
4. Blade Sealing Ring
5. PTFE-compound

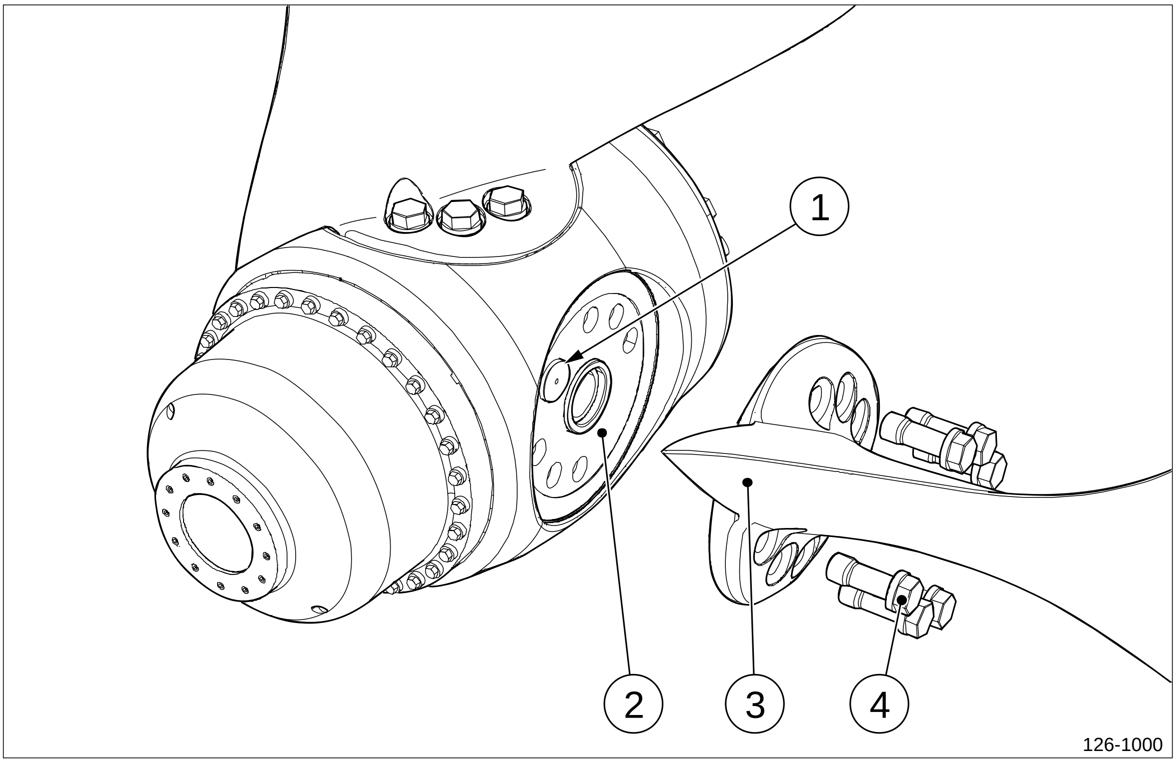

Figure 2 Mount the propeller blade on the hub.

1. Guide Pin
2. Crank Pin Ring
3. Propeller Blade including Blade Sealing Ring
4. Blade Bolts

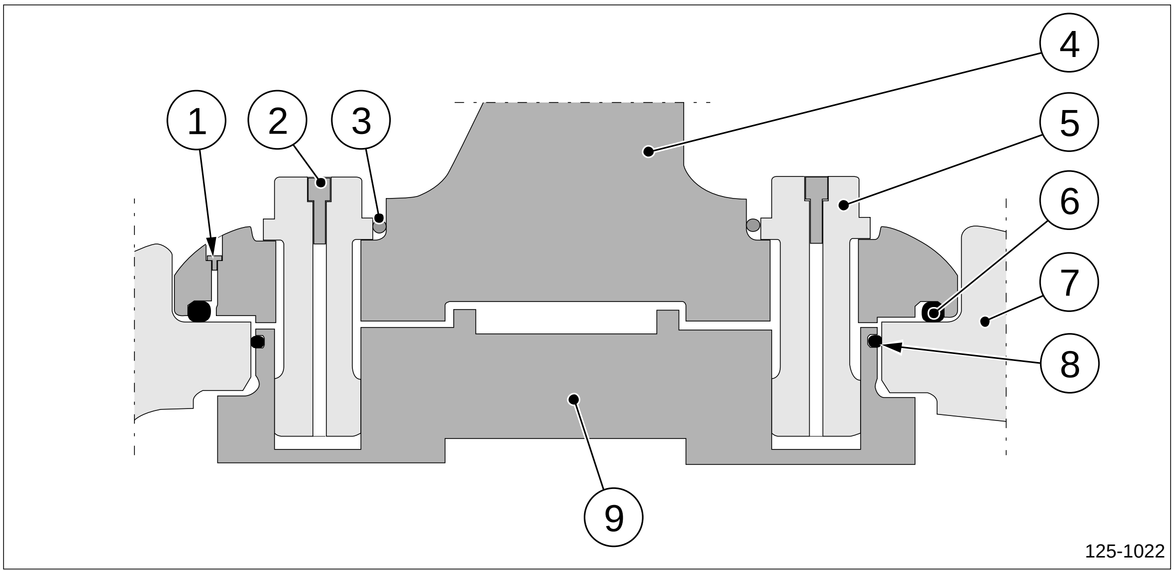

Figure 3 Cross-section of blade foot, G-design.

1. VSTI plugs for oil connection IN/OUT
2. Sealing screws
3. Locking pins
4. Propeller blade / blade flange
5. Hollow bored blade bolts
6. Blade sealing O-ring
7. Hub
8. O-ring
9. Crank pin ring

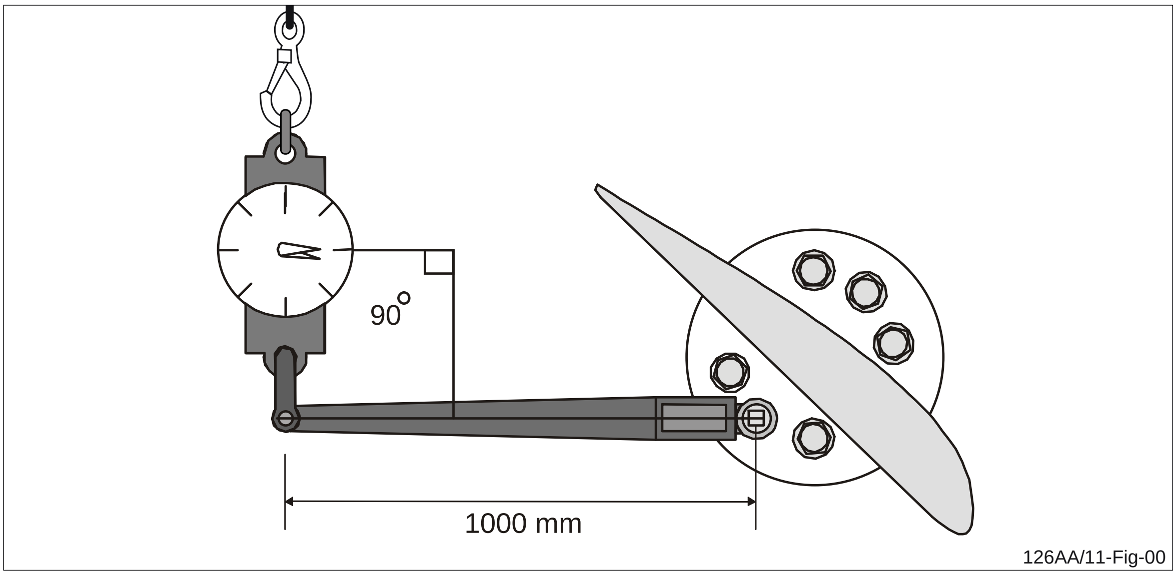

Figure 4 Final tightening of the blade bolts alternative 1: Dynamometer and torque wrench attached to a blade bolt.

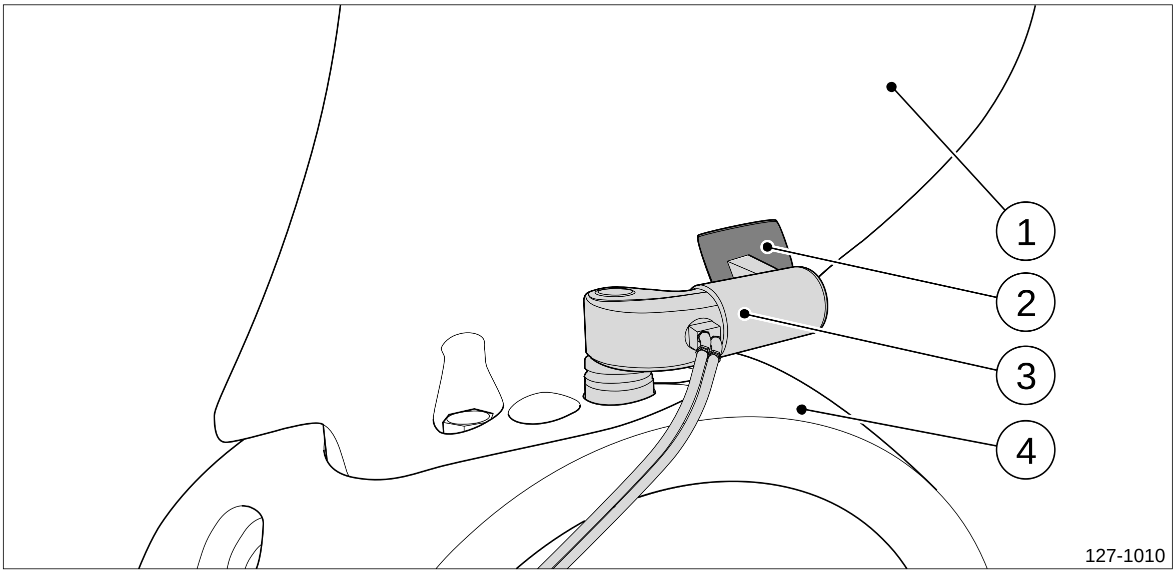

Figure 5 Final tightening of the blade bolts alternative 2: Torque tool used..

1. Propeller blade
2. Protection Plate
3. Example of a Torque Tool
4. Hub body

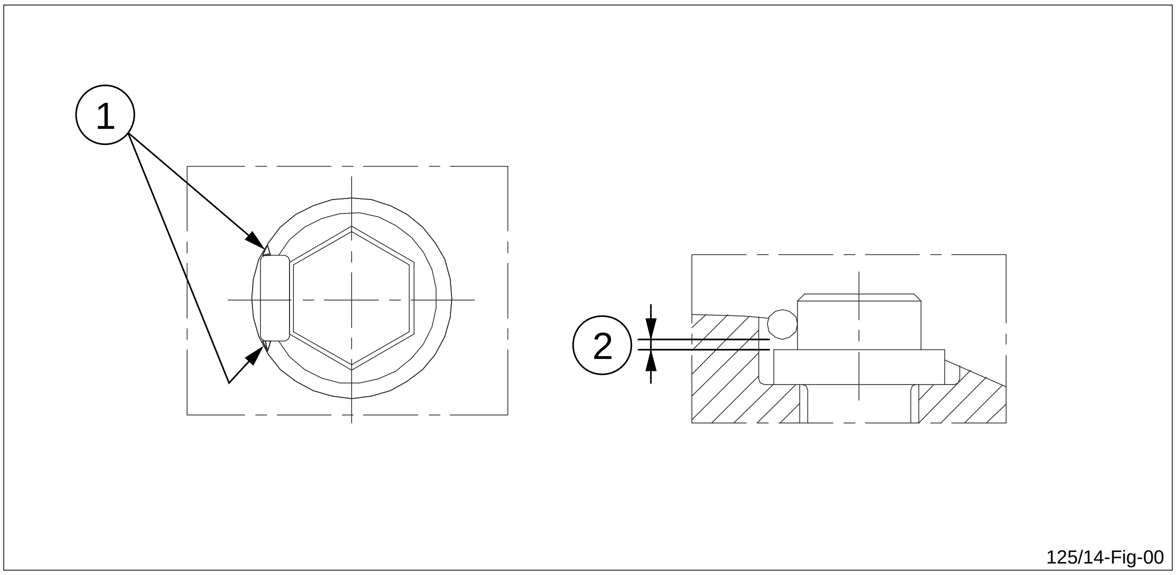

Figure 6 Lock the blade bolts by fastening a steel rod by spot welding.

1. Spot welding
2. Space between the locking pin and the screw head

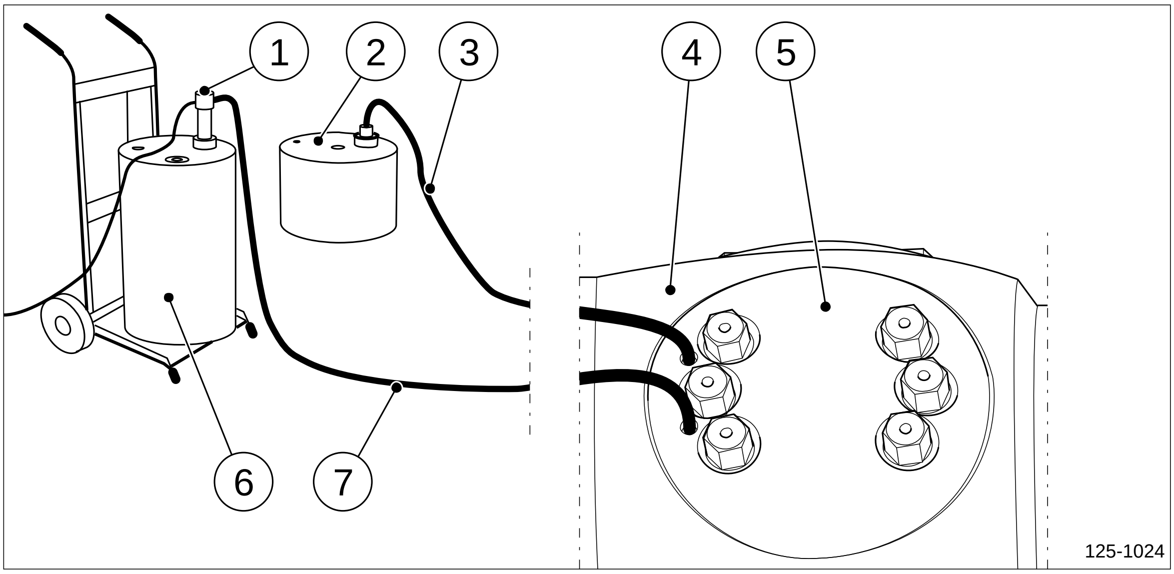

Figure 7 Example of flushing equipment.

1. Air driven pump unit
2. Container for excessive flushed oil
3. Hose connected to the connection “OUT” on the blade flange
4. Hub body
5. Blade flange
6. Flushing oil container
7. Hose connected to connection “IN” on the blade flange

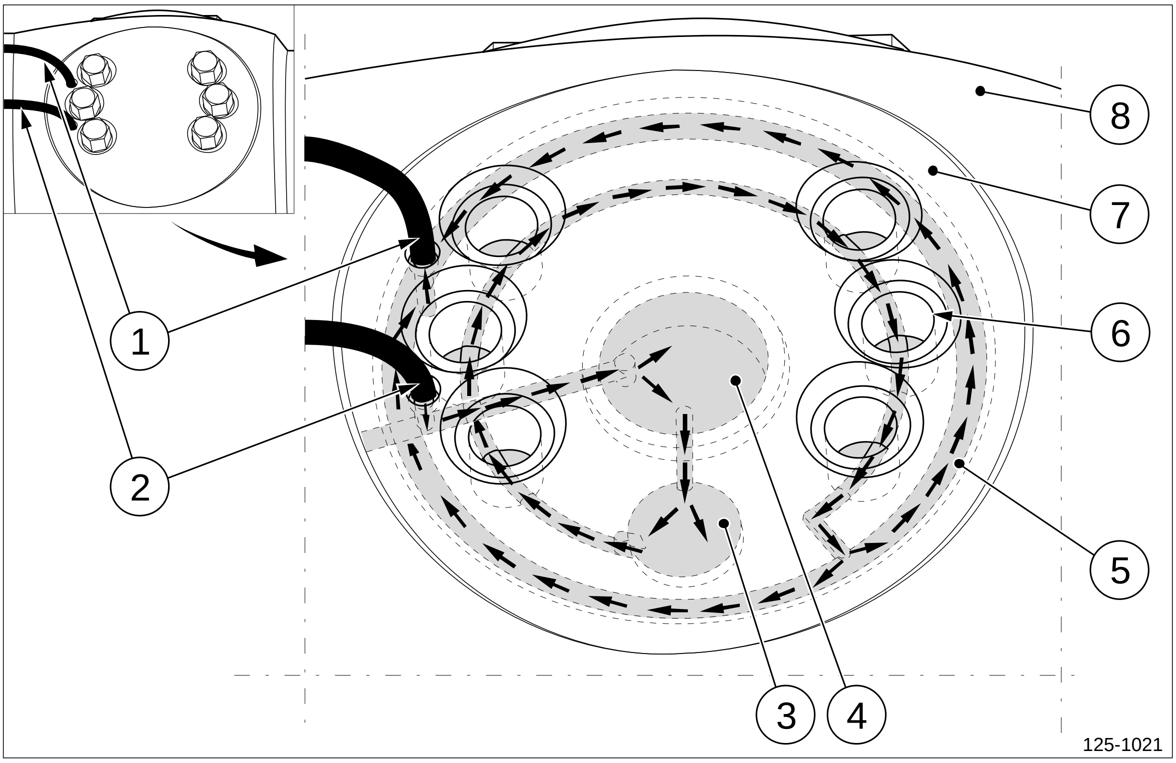

Figure 8 Flushing direction through the blade flange, G-design.

1. Oil connection marked “OUT”
2. Oil connection marked “IN”
3. Guide pin
4. Space between blade flange and crank pin ring
5. Blade sealing ring groove
6. Blade bolt holes
7. Blade flange
8. Hub body

Warning: Never work alone when lifting heavy components. Most lifting operations require two persons, one operate the lifting device and one ensure that the components do not get damaged.

Warning: The torque tool must be dimensioned with consideration taken to the torque values. This also includes the power socket which must have correct dimension for the width across flats.

Caution: It is important that only qualified personnel perform the lifting.

Caution: Use only clean soft slings when lifting to prevent damage on the blades.

Caution: The parts that are to be assembled must be cleaned and dry before the assembly.

Caution: Make sure to apply PTFE-compound or similar on the blade sealing ring or it will get damaged at the start up.

Caution: Make sure to handle the torque tool with care to prevent personel injuries due to the massive forces used.

Note: Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.

Note: Make sure to have an up to date certificate regarding torque calibration of the torque tool.

This instruction describes how to install propeller blades.

Before Starting this Procedure:

To be able to perform a safe installation with satisfied outcome the following prerequisites must be fulfilled.

Make sure that all parts are clean and dry. It is very important that nothing comes in between the blade foot and crank pin ring.

Make sure that proper lifting equipment are available. Weld brackets onto the ships hull or use a mobile crane to lift the propeller blades.

Make sure that all equipment is clean.

Preparations before the blade is installed

1. Clean the blade flange, screw holes, blade seat and crank pin ring.

2. Wash the blade screws using a de-greasing solvent.
3. Inspect that the guide pins are properly secured. If the guide pins are loose, tighten and lock the screws that are keeping the guide pins in place.
4. Apply thread lubricant, according to Hub Assembly drawing, on the blade guide and on the guide pin.
5. Clean the blade sealing groove.
6. Prepare the flushing equipment (see figure 7). Make sure all hoses are properly connected to the pump and collecting container.

Install the blade and level it with the crank pin ring

7. Apply grease or similar (pos 3, figure 1), in the blade sealing groove (pos 2, figure 1) on the blade flange in order to keep the blade sealing ring (pos 4, figure 1) in place when the blade flanges are mounted to the hub.
   Place a new blade sealing ring in its groove (see figure 1) and apply PTFE-compound on the top surface of the blade sealing ring (pos 5, figure 1).
8. Apply oil (the same as in the hydraulic system) on the bearing surface. Make sure that no grease is applied on the mating surface between the crank pin ring and the blade flange.
9. Apply sealing compound
10. Lift the blade in position. Use clean soft slings and lifting equipment suitable to lift the whole weight of the blade (for more information see the lifting instructions in section Storage and Preservation).
11. Use a level to make sure that the foot of the blade and the crank pin ring are absolutely parallel.
12. Lubricate the blade bolt heads and the threads according to the Hub Assembly drawing.
13. Make sure that the holes in the blade bolts are unplugged.
14. Fill the blade bolt holes in the crank pin ring (pos 9, figure 3) up to a third with grease according to the Hub Assembly drawing.
15. Mount the blade to the crank pin ring with two blade bolts positioned opposite to each other.
16. Use a ring key and a hammer to slightly tighten two blade bolts. Tighten the bolts at the same time as a person is “rocking” the blade to assure that the blade will enter its guides.
17. Inspect by means of a feeler gauge that the gap between the blade and the crank pin ring is a maximum of 0,05 mm. Measure the gap through one of the empty blade bolt holes.

Fasten the blade

18. Screw in all blade bolts. Excessive grease is evacuated through the hollow bored blade bolts.
19. Use a hand tool to prestress all the blade bolts in a cross pattern.
20. There are two alternatives for final tightening the blade bolts, see figure 4 or figure

5.
When using a torque tool according to pos 3 in figure 5, the tool's support part must be adjusted (the angle) towards the blade to obtain a steady torque force on the screws.
To protect the surface on the blade use a thick aluminium, copper or brass plate (pos 2, figure 5) between the tool's support and the blade. The plate must be bent with a similar radius as the surface to avoid damages to the surface.
For torque values see Hub Assembly drawing in part Design Drawings.
Tighten the blade bolts in a cross pattern to the torque vale stated on the Hub Assembly drawing. For more information on how to tighten the blade bolts see Instructions for tightening of screws, 586431.

Flush the blade flange

21. Connect the oil injection pump flushing nipple and hose (pos 2, figure 8) to connection marked “IN”.
22. Connect the excessive oil container flushing nipple and hose (pos 1, figure 8) to oil connection marked “OUT”.
23. Start to flush the blade flange with the oil pump unit (pos 1, figure 7). Use minimum pressure value at first. Slowly increase the pressure until grease and then flushing oil starts to evacuate through the open blade bolt holes.
24. When only flushing oil evacuates through the blade bolt holes, plug the hole in each blade bolt head using a sealing screw (see position 2, figure 3). Tighten the screws to the torque value stated on the Hub Assembly drawing.
25. When flushing oil starts to evacuate to the excessive oil container (pos 2, figure 7) the flushing of the blade flange is complete.
26. Disconnect both hoses with nipples at the “IN” and “OUT” connections on the blade flange.
27. Install the VSTI plugs (see position 1, figure 3) and tighten to the torque value stated on the Hub Assembly drawing and by using Loctite.
28. Install the blade lifting hole plug (if applicable), see instruction in section Storage and Handling.
29. Perform a propeller hub pressure test according to Task: Propeller Hub Pressure Test.
30. Fit stainless steel locking pins between the hexagon part of the blade bolt and the hub. Spot weld the locking pin to the recess on the propeller blade according to figure 6. Make sure to leave a space between the locking pin and the screw (see position 2, figure 6).
31. Clean and store the oil injection pump and excessive oil container in a proper storage.

This task is now completed.

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Twin Tube Pre-installation

1 Introduction

Use the following documents as reference material during this procedure:

• Intermediate Shaft Assembly drawing

• Twin Tube Assembly drawing

• Lifting instructions and recommendations in Part Handling and Preservation

The twin tube parts are normally mounted inside the shafts at delivery and the twin tube must be assembled when the shafts are mounted inside the vessel. Make sure to connect the twin tube to the connection piece in the propeller hub before the vessel is launched. The final connection of the twin tube parts must be at the sleeve coupling and is performed when the final shaft alignment has been completed.

If the twin tube parts are delivered separately, outside the shafts, they are mounted and connected from the aft, through the propeller shaft. The twin tube can also be mounted from the OD-box if the desired working space is available.

2 Mounting Options

The twin tube can be mounted in the following ways:

• Each twin tube pipe part is inserted in its shaft before the shaft line is mounted and the joints of the twin tube are connected before the shafts are lined up.

• The twin tube is inserted from the aft into the shaft. This procedure must be performed before the propeller hub is mounted. The joints of the twin tube must be connected before inserting into the shaft line.

3 Lifting Instruction

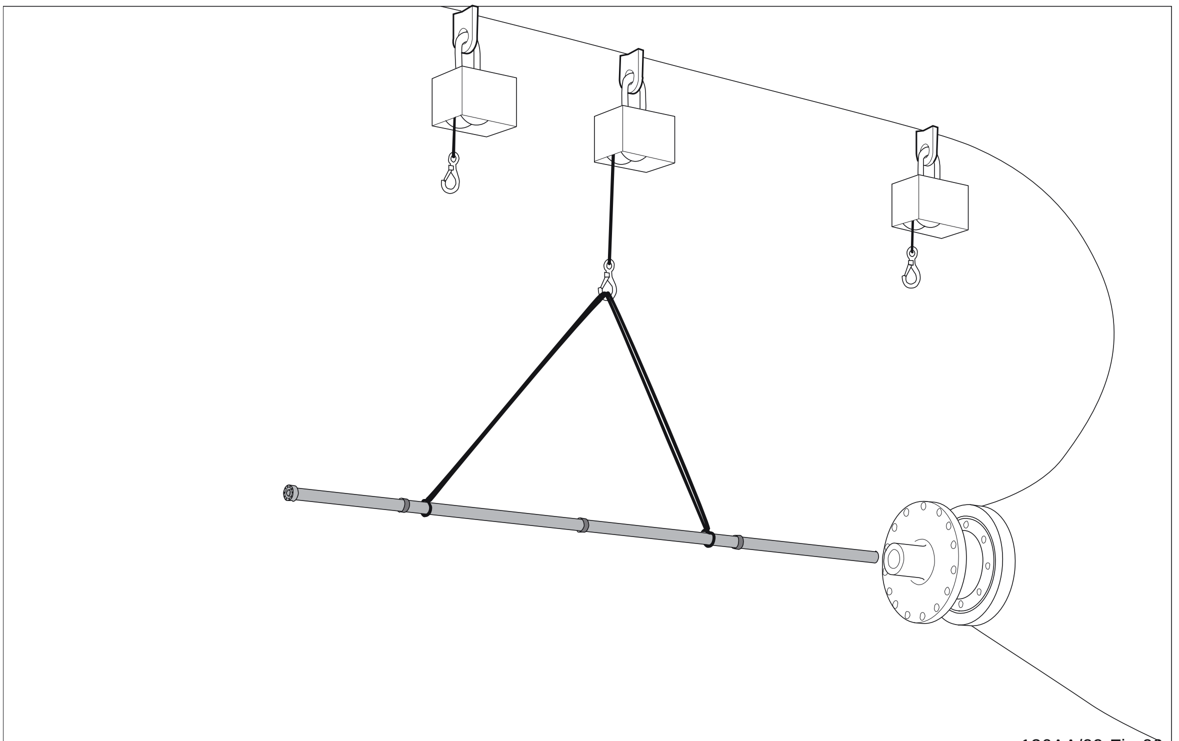

Figure 1 Lifting of the twin tube.

Caution: Take care during the installation to prevent the twin tube from getting damaged. Support the twin tube in several places during installation.

Caution: Use clean soft slings to prevent the twin tube from getting damaged.

Note: Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.

The twin tube is normally mounted in its respective shaft at delivery. This lifting instruction is applicable if the twin tube is delivered separately.

- Lift the twin tube assembly in front of the propeller shaft as shown in figure 1. Make sure to support the twin tube in several places during the installation.

Earthing Device Pre-installation

The shaft line must be provided with an effective slip ring device for earthing to the hull.

If an earthing device is included in Rolls-Royce AB supply, please see the documentation in part Sub Supplier Manuals for information on how to install the earthing device.

During welding on board, the propeller and the shaft line must be carefully earthed to the hull, the contact in the stern tube is not sufficient. Furthermore, the hull must be carefully earthed to the quay. In addition to the earthing device delivered by Rolls-Royce AB, a mechanical supplementary earthing connection between the shaft and the hull must be installed.

The earthing must be inspected daily during welding periods. It is most important to prevent leaking currents to go through the propeller and shaft line. Leaking current can cause corrosion and damage the bearings.

Information about cathodic protection is found in Part Handling and Preservation.

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Preliminary Shaft Alignment

For information on shaft alignment requirements, see the documentation from your supplier of the shaft alignment calculation.

Stern tube bearings and inboard support bearings must be aligned on Line of Sight before the installation of the shaft. For more accurate calculations see the datum line (reference line) in the shaft alignment calculation documents.

End Cover and Temporary Gravity Tank Installation

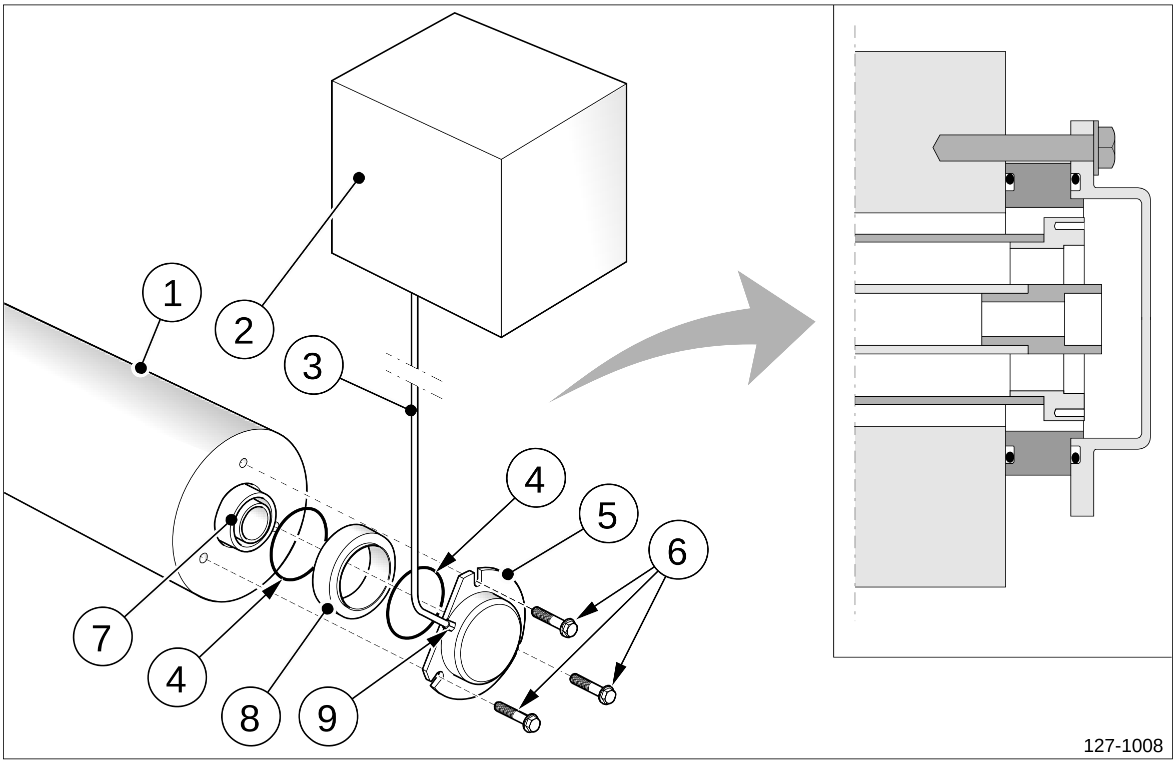

Figure 1 Temporary solution for providing static oil pressure in hub.

1. Propeller shaft
2. Temporary gravity tank (yard supply)
3. Oil pipe (yard supply)
4. O-rings
5. Cover
6. Screws and washers
7. Twin/single tube
8. Distance piece
9. Pipe connection

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

During installation, before launching:

The propeller hub and propeller shaft must be filled with oil and connected to a temporary gravity tank via an end cover installed on the propeller shaft end (see figure 1). The gravity tank will maintain an oil pressure in the hub and prevent water ingress.

During maintenance, with vessel afloat:

If the propeller shaft needs to be disconnected from the intermediate shaft during maintenance of the vessel, the propeller hub and propeller shaft must still be filled with oil. A temporary gravity tank to be connected to an end cover installed on the propeller shaft end (see figure 1). The gravity tank will maintain an oil pressure in the hub and prevent water ingress.

The cover consists of:

- Cover
- Pipe connection
- Distance piece
- 3 screws with washers
- 2 o-rings

The gravity tank must be located 1.3 times higher than the distance between the centre of the shaft and water line, or minimum 2 m above the water line, in order to keep the oil pressure in the hub. If the gravity tank is placed 10 meters above the propeller centre line the pressure will be enough when pressure testing the propeller hub.

The oil used must meet the requirements in chapter Requirements for Lubricating Oil.

Installation procedure

1. Disconnect the coupling between the propeller shaft and intermediate shaft. Make sure to have a container below the two shaft ends for collecting bleeding oil.
2. Place the o-rings (pos 4, figure 1) in the grooves in the distance piece (pos 8, figure 1) and cover (pos 5, figure 1).
3. Insert and loosely tighten one screw, with washer, (pos 6, figure 1) in the hole closest to the bottom of the propeller shaft (in order to use the screw as a support for the distance piece and cover).
4. Slide the distance piece (pos 8, figure 1) over the twin/single tube end (pos 7, figure 1) and use the screw as a support.
5. Fit the cover to the distance piece and turn the cover until the pipe connection hole is pointing upwards (pos 5, figure 1).
6. Fit and tighten the screws and its washers (pos 6, figure 1).
7. The tank (yard supply) shall be provided with an air breather on top and a valve for drain in the bottom. The connection to the pipe can be provided with a shut-off

valve but it must be secured in open position after oil filling.

8. Connect a pipe or hose between the cover and the temporary gravity tank.
9. Fill the gravity tank with oil that meets the recommendations in section Requirements for Lubricating Oil.

Disconnection procedure

1. Close the shut-off valve on the pipe between gravity tank and connection to cover (if installed). Make sure to have a container below the shaft ends for collecting bleeding oil.
2. Remove the screws and washers.
3. Remove the distance piece and cover including the o-rings.
4. Reconnect the twin/single tube and the propeller shaft to the intermediate shaft in reversed order as when disconnected.
5. Fill up the complete propeller system with oil that meets the recommendations in section Requirements for Lubricating Oil.
6. Make sure that the static pressure system is working normally.

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Fill Oil and Flush Propeller Hub

Description

Fill oil to and flush the propeller hub using an external filling unit. Also, purify the oil using an external filter before filling oil to the propeller hub. The oil must meet the recommendations in section Requirements for Lubricating Oil.

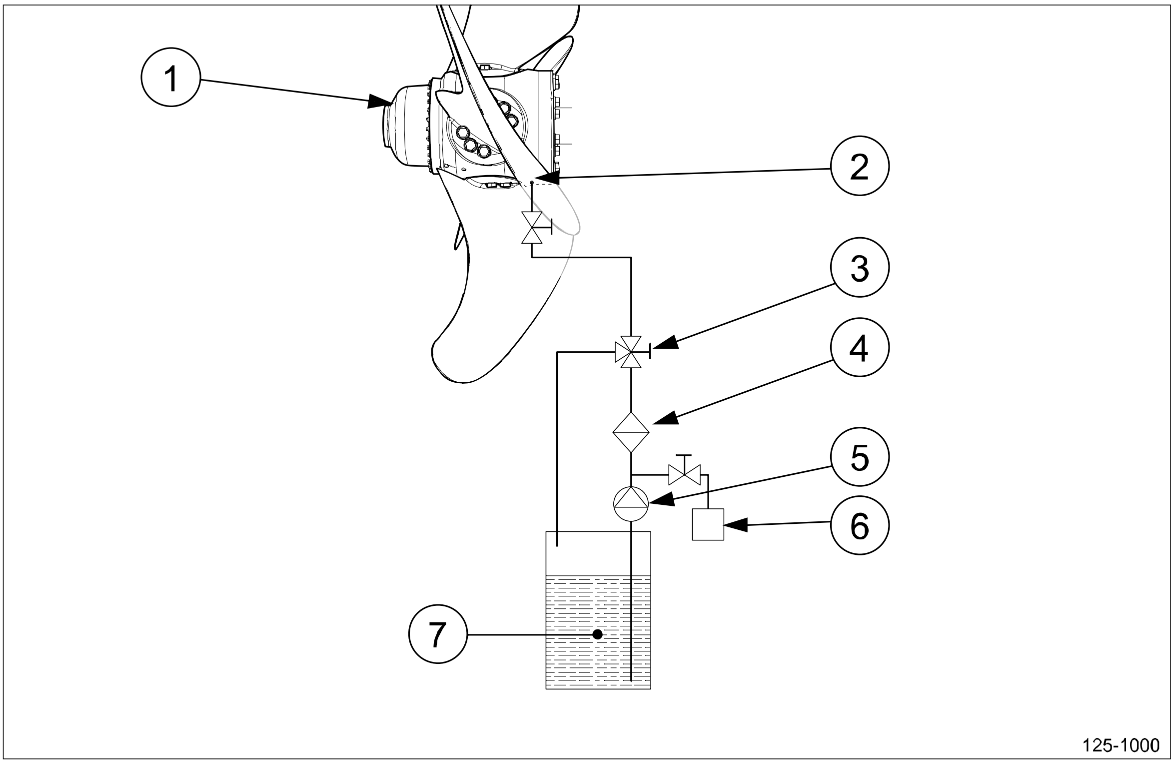

Figure 1 Initial position of the hub when purifying and filling the oil.

1. Aft plug
2. Forward plug
3. Three way valve
4. External filter
5. Pump
6. Particle counter
7. Oil container

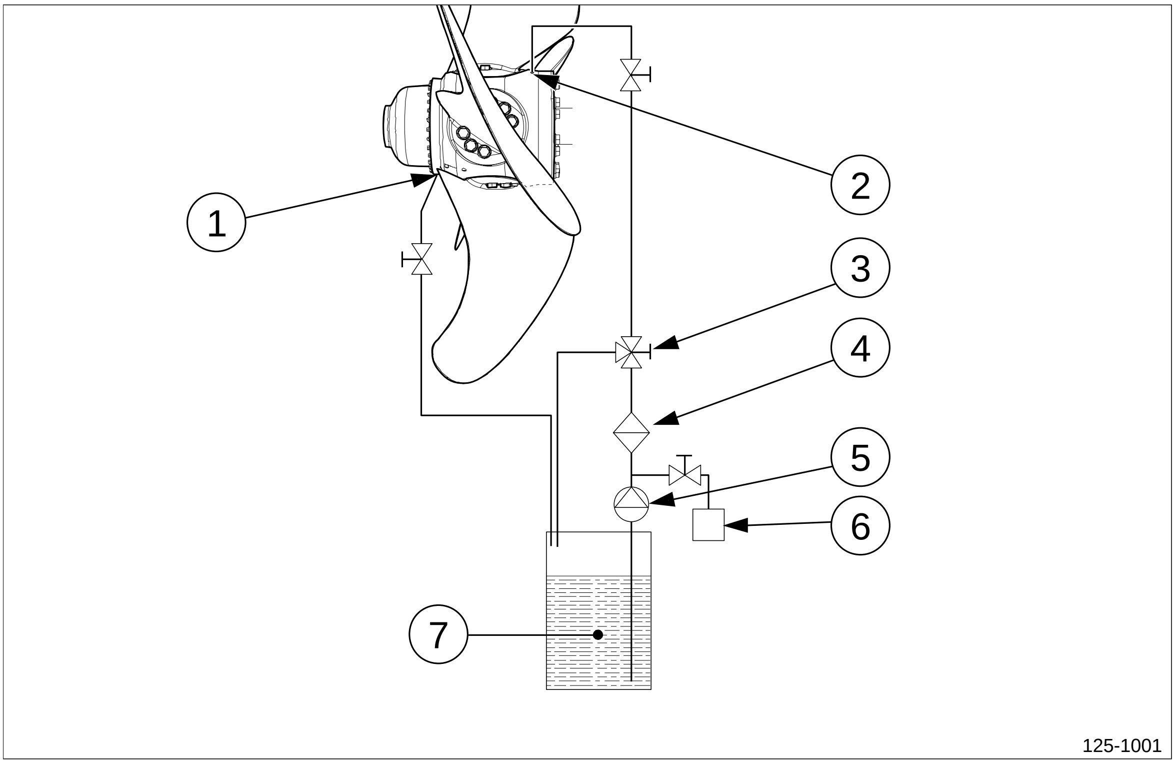

Figure 2 The hub is turned half a turn when flushing the hub.

1. Aft plug
2. Forward plug
3. Three way valve
4. External filter
5. Pump
6. Particle counter
7. Oil container

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

Pressure Recommendations

Completely installed shaftline

If the shaftline is completely installed; the SKF coupling is mounted and the piping is connected to the OD-box, a pressure of maximum 0.30 Mpa can be used during the flushing procedure.

Not completely installed shaftline

If the SKF coupling and the piping to the OD-box are not installed a pressure of maximum 0.13 Mpa can be used during the flushing procedure.

Completely installed shaftline and plugged OD-box

If the shaftline is completely installed and the piping to the OD-box is not installed, the pipe connections to the OD-box can be plugged. If the vessel is equiped with a OD-box of type M0, the drain connections in the bottom end covers have to be connected to a drain tank.

With completely installed shaftline and a plugged OD-box a pressure of maximum 0.30 Mpa can be used during the flushing procedure.

Fill Oil and Flush Propeller Hub Procedure

- Turn the propeller hub until the forward plug is directed straight downwards and the aft plug is directed straight upwards, see figure 1.
- Remove both plugs.
- Use an external oil filling unit and filter to purify the oil and to fill the hub. Attach the external oil filling unit and filter according to figure 1.
- Manoeuvre the three way valve (see position 3, figure 1) to enable the oil flow to return directly to the oil container (see position 7, figure 1) without passing through the hub.
- Purify the oil by circulating it until the desired particle value is noted by the particle counter (see position 6, figure 1).
- Manoeuvre the three way valve to enable the oil flow to fill the hub from bottom to top. The air trapped inside the hub is allowed to evacuate through the aft plug hole (see position 1 in figure 1).
- When oil is coming out of the plug hole (see position 1 in figure 1), turn off the filling unit and fit a valve and hose to the plug hole.
- Start the filling unit again and turn the propeller hub half a turn (180^{o}) (see figure 2).
- Flush the propeller hub. Let the oil circulate inside the propeller hub and through the external filter. Use the particle counter to make sure that the oil meets the recommendations in section Requirements for Lubricating Oil.
- Turn the propeller hub until the text “Hole” (stamped into the forward part of the hub) is directed straight downwards (6 o’clock position).

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Propeller Hub Pressure Test

Use the Hub Assembly drawing as reference material.

The hub pressure test must be performed in presence of a surveyor from the classification society.

The propeller blades must be mounted before the pressure test is performed.

Prior to launching the propeller hub is filled with oil and a pressure test must be performed to verify that no leakage occur.

Pressure test the propeller hub to a pressure value between 0.10 to 0.15 MPa.

During the pressure test the locking of screws and plugs should also be inspected. The pressure test can be made by using the pressure from the gravity oil tank or using an external pressure pump connected to the venting and oil filling holes see the following description:

- Install the end cover in the propeller shaft (see instruction “End Cover and Temporary Gravity Tank Installation”) and insert a plug in the hole in the blanking flange.
- Fill the low pressure part (static pressure) of the propeller hub with oil, see section Fill Oil and Flush Propeller Hub.
- Leave the external filling unit connected to the forward venting/filling hole.
- Insert a plug in the aft venting/filling hole and start the external pump. Let the pressure rise to 0.10 to 0.15 MPa. Retain the pressure for 1 hour.
- Inspect the blade seal seats, the bolt head seats and the shaft flange screws for leakage.

For more information about pressure testing the propeller hub, please contact the nearest Rolls-Royce Marine Global Support Network.

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Plastic Coated Shafts

Plastic Coating Inspection

Warning: The protection coating shall only be repaired by experienced personnel or an authorized workshop, because the protection coating is made of epoxy and it is allergenic and cancerous.

Use the Propeller Shaft Assembly drawing and Intermediate Shaft Assembly drawing as reference material.

If the vessel is equipped with plastic coated shafts, they must be painted with anti-fouling paint before launching. If this is not performed, marine growth will harm the plastic coating after the vessel has been launched.

The protection coating protects the shaft against corrosion.

- Use the spark tester to check for defects in the protection coating.
- Follow the instructions in the spark tester's documentation to turn it on and how to adjust it.
- Move the spark tester's brush electrodes over the whole protection coating area. If there is damage in the coating a spark will jump from the brush electrode to the damage in the coating.
- All damage that is found with the spark tester must be repaired by experienced personnel or an authorized workshop, for more information please consult the Rolls-Royce Marine Global Support Network.
- If no defects on the protection coating are found, paint the shaft with antifouling paint, see section Antifouling Painting Procedure.

Antifouling Painting Procedure

Caution: The antifouling paint is injurious to the health. Use proper protective equipment.

Use the Propeller Shaft Assembly drawing and Intermediate Shaft Assembly drawing as reference material.

Before launching the vessel, if the vessel is equipped with plastic coated shafts, the shafts must be painted with antifouling paint. If this is not done, marine growth might harm the plastic coating.

We recommend the following painting procedure:

- Use some rubbing to prepare the surface for the painting procedure.
- Apply antifouling paint to the propeller shafts and the intermediate shafts that are in contact with water. Use proper protective equipment when applying the paint.
    - Apply adhesive premier to a thickness 50-100 µm.
    - Apply a top coat of paint to a thickness of minimum 300 µm. Use an antifouling paint. Your local supplier will recommend a suitable type.

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Screws Locking Inspection

Inspect the locking of all screws concerning the propulsion system, both the outboard components and the components onboard the vessel. Make sure that the locking is performed according to the Locking of Screws drawing and Tightening of Screws drawing.

All necessary torque values are found on the appended installation drawings, see part Design Drawings.

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Revision date:

Secure Shaft Line Before Launching

Warning: There is a great risk of personal injury and equipment damage if the vessel is launched without securing the shaft line both from rotation and axial movement.

The shaft line must be secured from rotation and axial movement in a proper way before the vessel is launched. If the vessel is launched without securing the shaft line there is a great risk of personal injury and equipment damage.

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Installation Description After Launching

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Creation date: 2005-05-31 Revision date: 2007-12-27

Final Shaft Alignment

Note: All the final measurements must be recorded and approved by the supplier of the shaft alignment calculation and the classification society.

For information on shaft alignment requirements, see the documentation from your supplier of the shaft alignment calculation.

Note that the jack load measurement must be recorded and approved by the supplier of the shaft alignment calculation and the classification society.

Shaft bearings, gearbox, main engine, etc. must be aligned both vertically and horizontally according to the alignment calculation. They must also be axially positioned according to the Shafting Arrangement drawing.

Gearbox and main engine must be aligned to the propeller shafting after launching of the vessel.

Bearing loads must be measured when the complete shaftline has been connected and the vessel is afloat in the vessels most frequent sailing conditions, the design conditions.

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Twin Tube Final Installation

Flange Connections

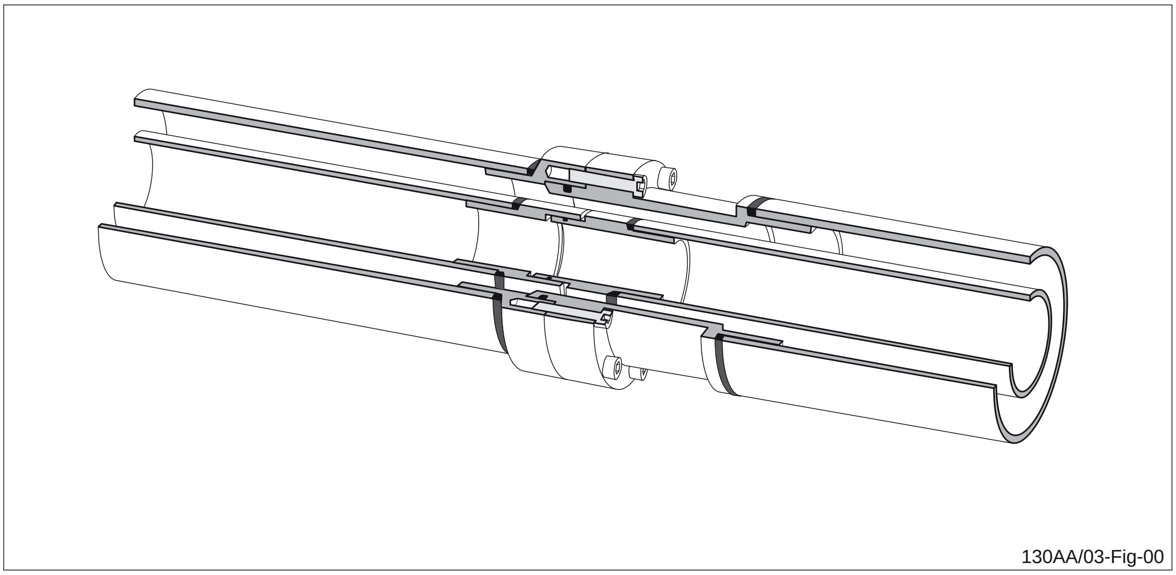


Figure 1 The twin tube flanges are bolted together and the bolts are locked by loctite.

Caution: The twin tube can get damaged if it is not supported in several places during the mounting.

Caution: The joints of the twin tube must be thoroughly cleaned before assembly.

Caution: It is important that only qualified personnel perform the lifting.

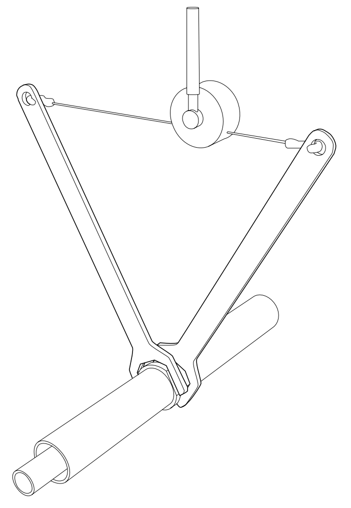
Note: **The twin tube must be connected to the connection piece in the propeller hub before launching of the vessel.**

Use the Twin Tube Assembly drawing as reference material during the final installation. The twin tube must be installed according to the assembly drawing.

- The flange connections of the twin tube joints (valid for hub sizes 86 and larger) are bolted together and sealed by O-rings. Each joint is marked with a number, beginning from the aft.
- All joints must be cleaned and the flange bolts tightened in a cross-pattern, see figure 1.
- The twin tube installation procedure is completed after the vessel has been launched. The twin tube joint at the sleeve coupling must be connected before the sleeve coupling is mounted.
- This step is only valid for vessels equipped with a OD-box of type F0/FA. After the final twin tube installation, the stub shaft and the OD-box ring are to be fitted to the twin tube inside the OD-box housing. See section OD-box and Feed Back System Installation for more information.

If the shaft line is delivered with length adjustment ring, follow the instructions given in the Twin Tube Assembly drawing.

Screw Connections



130AA/04-Fig-00

Figure 2 Two U-spanners and a chain fall are used to tighten the twin tube connection.

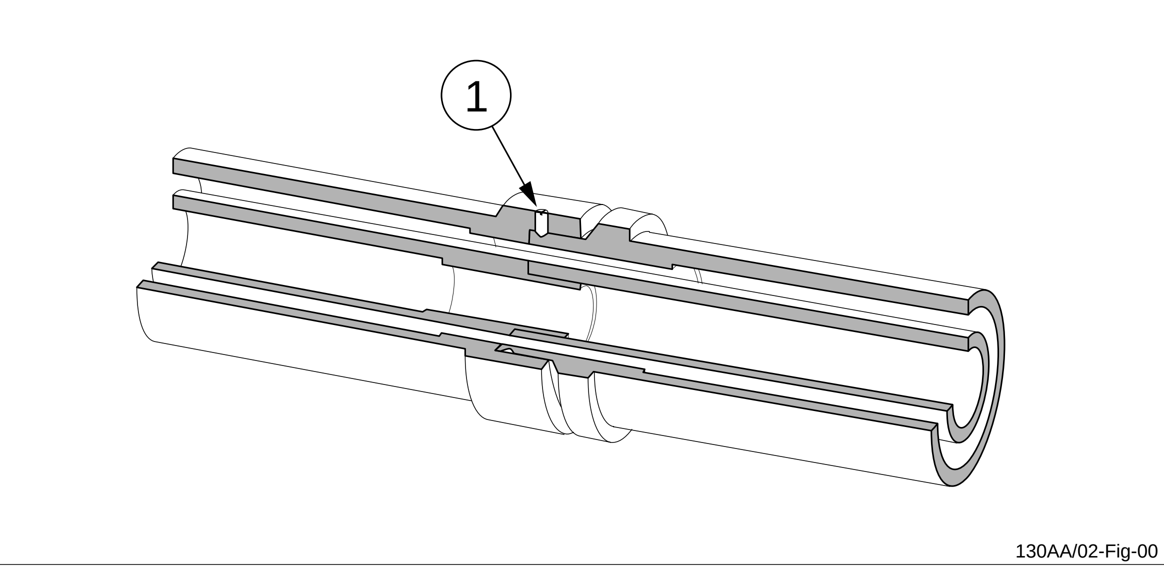


Figure 3 The twin tube joint is screwed together and locked into position by a set screw.

1. The twin tube joint set screw.

Caution: Take care during installation to prevent the twin tube from getting damaged. Support the twin tube in several places during the lifting and mounting.

Caution: The joints of the twin tube must be thoroughly cleaned before assembly.

Caution: Do not over tighten the threaded twin tube joints. If the twin tube joints are over-tighten the sealing capacity will be reduced. Tighten only until the set screw can be inserted.

Caution: It is important that only qualified personnel perform the lifting.

Note: The twin tube must be connected to the connection piece in the propeller hub before launching of the vessel.

Use the Twin Tube Assembly drawing as reference material during the final installation. The twin tube must be installed according to the assembly drawing.

- The screw connections of the twin tube joints (valid for hub sizes 66 and 79) are screwed together and sealed by means of mechanical face sealing. Each joint is marked with a number, beginning from aft.
- All joints must be cleaned and tightened until the set screw can be installed in the pre-drilled holes, see figure 2 and figure 3. Use loctite to secure the set screw.
- The twin tube installation procedure is completed after the vessel has been launched. The twin tube joint at the sleeve coupling must be connected before the sleeve coupling is mounted.
- This step is only valid for vessels equipped with a OD-box of type F0/FA. After the final twin tube installation, the stub shaft and the OD-box ring are to be fitted to the twin tube inside the OD-box housing. See section OD-box and Feed Back System Installation for more information.

If the shaft line is delivered with length adjustment follow the instructions given in the Twin Tube Assembly drawing.

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Sleeve Coupling Final Installation

Caution: Make sure that the shafts are aligned and concentric before mounting the sleeve coupling.

If the vessel is equipped with a distance ring, it must be mounted between the shaft ends before the sleeve coupling is installed. For positions of the distance ring, see the Propeller Shaft Assembly drawing or the Intermediate Shaft Assembly drawing in part Design Drawings.

For information on how to install the sleeve coupling, please see part Sub Supplier Manuals.

Installation Description

Maximum Run out of Shaft and Twin Tube Inspection

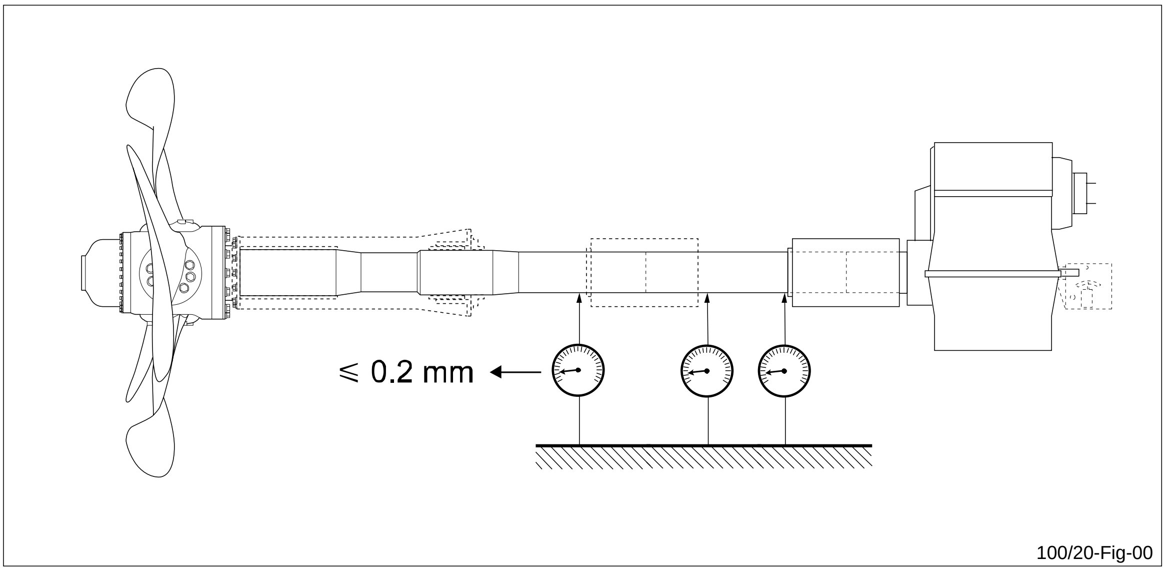

Figure 1 OD-box FA, mounted on the forward side of the gear-box.

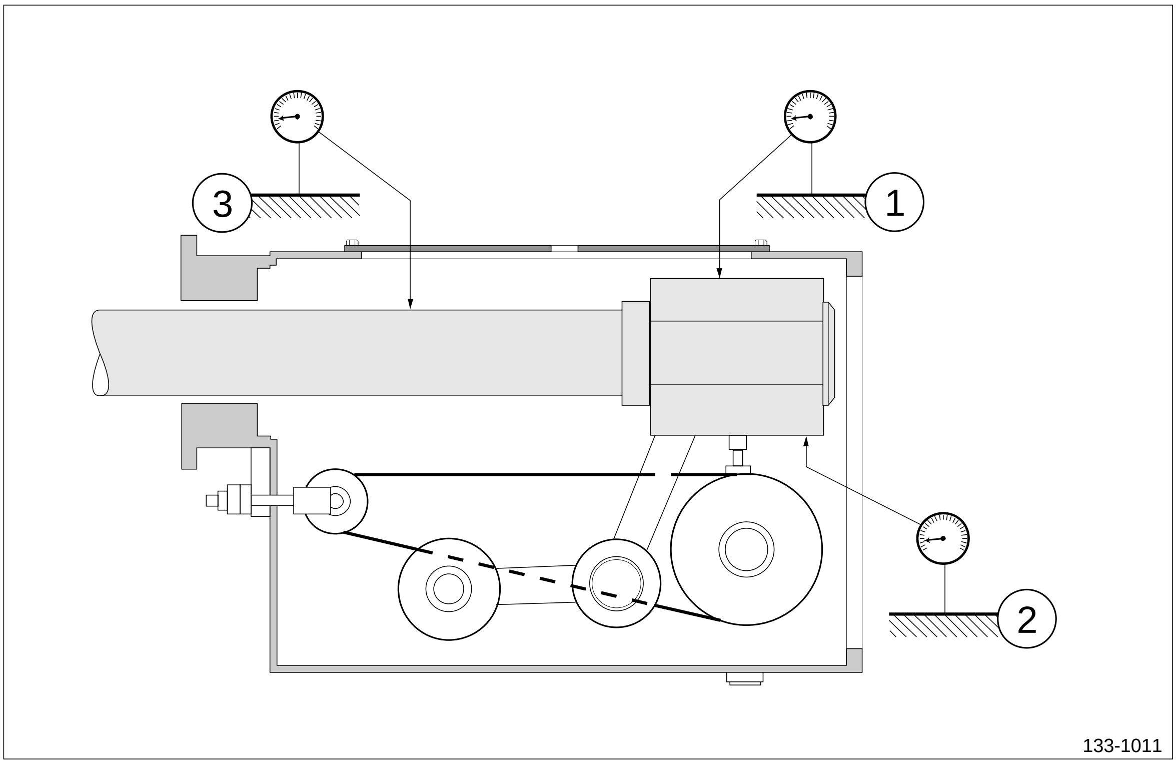

Figure 2 Use one of 3 alternative positions to measure the maximum run out of the twin tube.

1. Alternative 1
2. Alternative 2
3. Alternative 3

Note: The values stated in figure 1 are only valid for the Rolls-Royce equipment, other parts on the shaft line may require other tolerances.

Inspect and record the maximum run out of the shaft, sleeve coupling, and the twin tube according to figure 1. The values given in figure 1 are valid for all sleeve couplings.

Note that the values stated in figure 1 is only valid for the Rolls-Royce equipment, other parts on the shaft line may require other tolerances.

The values, given in millimetres, in figure 1 are maximum values taken from a dial gauge reading during a 360^{o} rotation of the shaft. It is necessary to keep within the stated values, because deviations will cause vibrations in the shaft line which will reduce the lifetime of seals and bearings in, for example, the gear box and the stern tube.

Inspect the Run Out of Twin Tube

There are three possible positions to measure the maximum run out at the twin tube, figure 2.

- Alternative 1: can be used on OD-box size 70, 100, and 140 during service inspections. When using alternative 1 the OD-box does not have to be drained completely from oil.

- Alternative 2: can be used on OD-boxes of all sizes. Requires that the OD-box is completely drained from oil.

- Alternative 3: is used when the OD-box is not mounted.

Alternative 1

This alternative can be used on OD-box size 70, 100, and 140 during service inspections. Use this alternative when the OD-box is mounted and the hydraulic system is started up.

- It is preferable that the pitch is set as close as possible to the mechanical end position ahead.
- Drain the OD-box from oil until it is possible to open the plug on the top cover of the OD-box without spilling oil.
- Remove the plug.
- Place an indicating gauge on the OD-box ring, through the plug hole, see position 1, in figure 2.
- Use the turning gear to slowly rotate the shaft 360^{o}. Inspect and record the values given by the indicator gauge. The value may differ maximum 0.3 mm.
- Reinstall the plug in the plug hole.
- If applicable, fill oil to the OD-box.

Alternative 2

- It is preferable that the pitch is set as close as possible to the mechanical end position ahead.
- Drain the OD-box from oil, if applicable.
- Remove the OD-box end cover.
- Place an indicating gauge on the OD-box ring, see position 2, in figure 2.
- Use the turning gear to slowly rotate the shaft 360^{o}. Inspect and record the values given by the indicator gauge. The value may differ maximum 0.3 mm.
- Assemble the OD-box end cover.
- If applicable, fill oil to the OD-box and start the hydraulic system and inspect the oil level in the hydraulic power pack tank. Refill oil to the hydralic power pack tank if necessary.

Alternative 3

- It is preferable that the pitch is set as close as possible to the mechanical end position ahead. If not possible the pitch can remain in its position close to zero pitch.
- Place an indicating gauge on the oil transfer tube, see position 3, in figure 2.
- Use the turning gear to slowly rotate the shaft 360^{o}. Inspect and record the values given by the indicator gauge. The value may differ maximum 0.2 mm.

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Revision date:

Earthing Device Final Installation

The final installation of the earthing device must be performed after the inspection of the maximum run out of the shaft.

For information on how to install the earthing device please see the documentation in part Sub Supplier Manuals.

Switches/Sensors and Transmitters Installation

Note: It is the yard's responsibility that all cables and connections are performed correctly towards the alarm system of the vessel, it is not part of the Rolls-Royce delivery.

Make sure to connect the following switches/sensors and transmitters to the vessel's alarm system:

- All sensors for stern tube bearings, see the documentation from the sub supplier, in part Sub Supplier Manuals.
- All sensors for radial bearings, see the documentation from the sub supplier, in part Sub Supplier Manuals.
- All temperature switches or sensors.

OD-box Installation Instruction (FA)

OD-box and Feed Back System

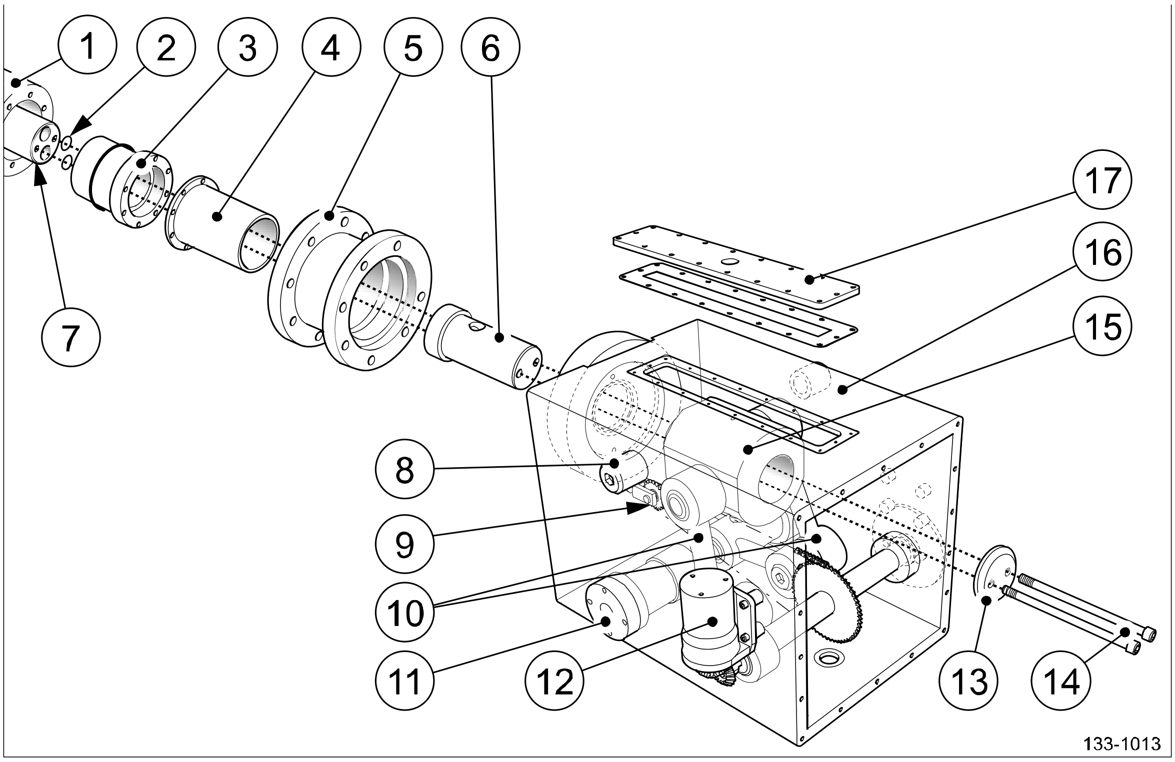

Figure 1 Assembly of the OD-box.

1. Gear shaft
2. O-rings
3. Bushing
4. Sleeve
5. Connection flange with sealings
6. Stub shaft
7. Forward twin tube
8. Plug, connection R
9. Adjustable chain wheel
10. Swivels
11. Connection A (connection B on opposite side)
12. Feed back box
13. Washer
14. Screws
15. OD-box ring
16. OD-box housing
17. Inspection cover

Note: **Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.**

Note: **The internal parts in the OD-box are to be considered as hydraulic components and therefore cleanliness is of great importance.**

Use the following documents as reference material during the installation:

• OD-box Assembly drawing

• OD-box Dimension drawing

• Connection to Gear drawing

• Lifting instructions in Part Handling and Preservation

Plan the installation of the OD-box with care. Make sure that all service points are accessible and that there is sufficient space around the OD-box for safe installation and maintenance of the OD-box and feed back unit. There must also be sufficient space for emergency pitch operating of the OD-box. The minimum working and dismantling space is found on the OD-box Dimension drawing and Shaft Arrangement drawing. Note that the values given in the drawings are minimum working and dismounting space and considerations must be taken regarding the service personnel.

The hydraulic piping must be connected to the OD-box with expansion bends and the connections to the OD-box must be easy to dismantle.

• Disassemble the reduction nipple mounted between the cover (pos 17, figure 1) and the OD-box ring (position 15, figure 1). Replace the reduction nipple with a plugg supplied in the delivery. For more information see the OD-box Assembly drawing.

• Insert the forward twin tube (pos 7, figure 1) in the gear box. For more information se installation instructions from the supplier of the gearbox.

• Mount the bushing (position 3, figure 1) and sleeve (position 4, figure 1) in the gear shaft (position 1, figure 1). Make sure that the diameter and the drilled holes in the gear shaft and the bushing are in accordance before installing the bushing and sleeve, see the Connection to Gear drawing for dimensions.

• Mount the OD-box housing (see position 16, figure 1). Make sure that the diameter and the drilled holes in the gear housing are in accordance with the OD-box ring. See the Connection to Gear drawing for dimensions.

• Mount the sealing package (see position 5, figure 1) on the twin tube forward end. The outside liner and the inside of the sealing rings must be greased with Lithium grease before mounting. Make sure that the sealing package is held in line with the liner during mounting, or the seals might get damaged.

• Fit the two O-rings (see position 2, figure 1) in their groove on the forward twin tube. Lift the stub shaft and OD-box ring (see position 6 and 15, figure 1) and mount them on the forward twin tube.

• Connect the guide rod to the OD-box ring.

- Assemble the OD-box covers.
- Fill the OD-box housing with filtered oil through the inspection cover (pos 17 figure 1) or the plug (pos 8, figure 1) before start-up of the hydraulic system. It is most important that the oil meets the oil recommendations in section Requirements for Lubricating Oil in part Technical Data. The OD-box must be completely filled to secure lubrication and cooling of vital internal components, such as, the OD-box ring, stubshaft, and sealing arrangement.

The following tasks are normally performed by Rolls-Royce service personnel during commissioning. If the task is not performed by Rolls-Royce, Rolls-Royce's personnel must approve the task after completion.

- Assemble the linkage in the feed back box.
- Adjustment of the pointer on OD-box scale.
- Adjustment of the cams and micro switches.
- Adjustment of the feed back potentiometer.

Hydraulic System Installation

Hydraulic System

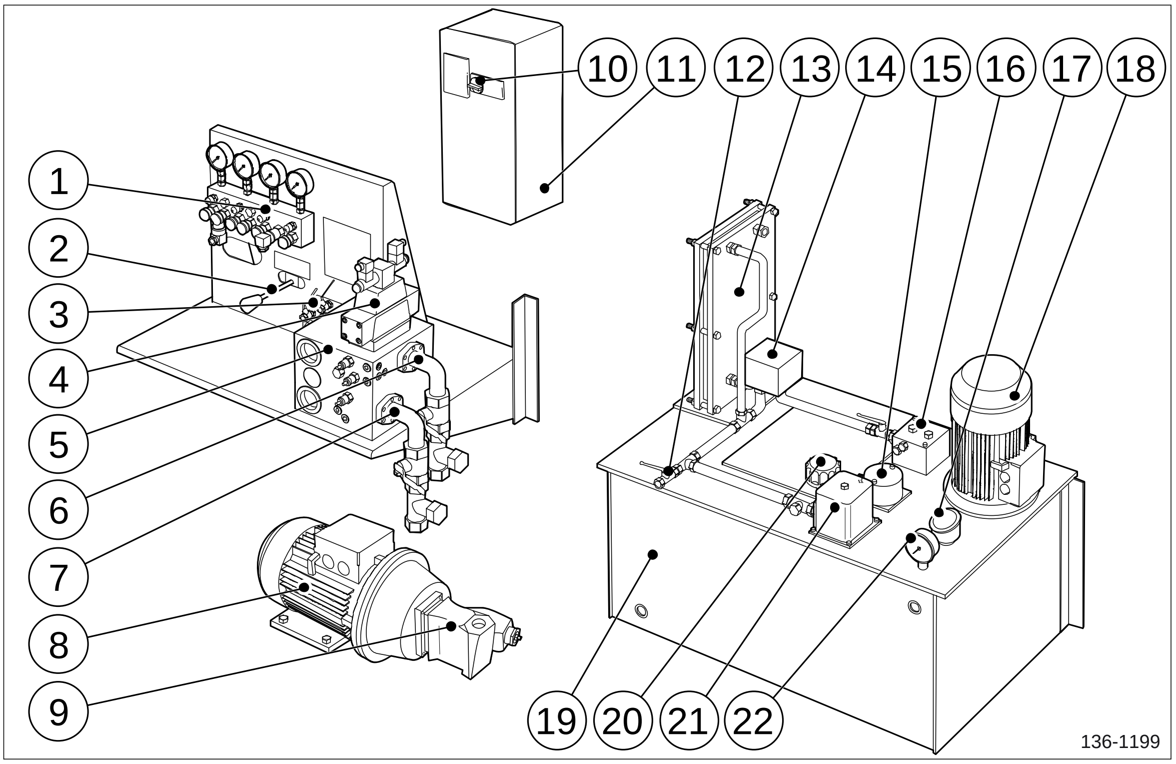

Figure 1 Hydraulic system.

1. Control panel
2. Selector for control valve V12
3. Emergency control panel
4. Proportional control valve V3
5. Valve manifold
6. Connection A
7. Connection B
8. Electric motor M1
9. Pump unit P1
10. Remote/local switch
11. Connection box
12. Connection Z (shut-off valve)
13. Oil cooler C1
14. Temperature control valve TV1
15. Level switch LS1
16. Valve manifold
17. Temperature transmitter

18. Static pressure circulation pump unit P3
19. Hydraulic oil tank
20. Air breather filter
21. Circulation filter
22. Temperature gauge

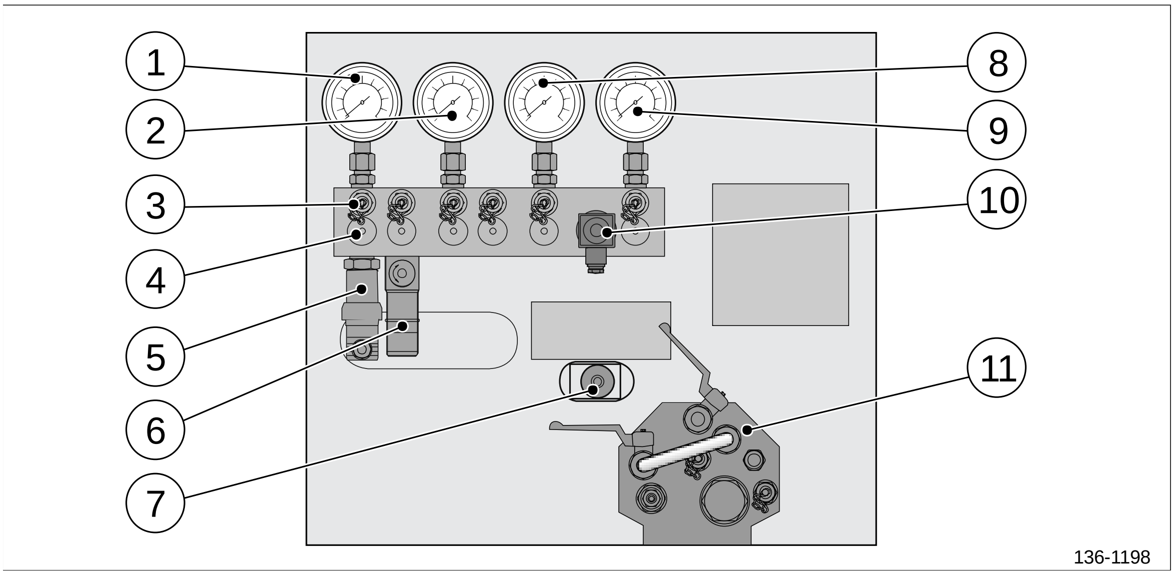

Figure 2 Control panel with emergency manoeuvre block and gauge panel.

1. Pressure gauge, system pressure, G1
2. Pressure gauge, astern pitch, G3
3. Test nipples
4. Shut off valves
5. Pressure transmitter PT2
6. Pressure switch PS1
7. Emergency control valve V12
8. Pressure gauge, ahead pitch, G4
9. Pressure gauge, static pressure, G5
10. Pressure transmitter PT3
11. Emergency valve manifold

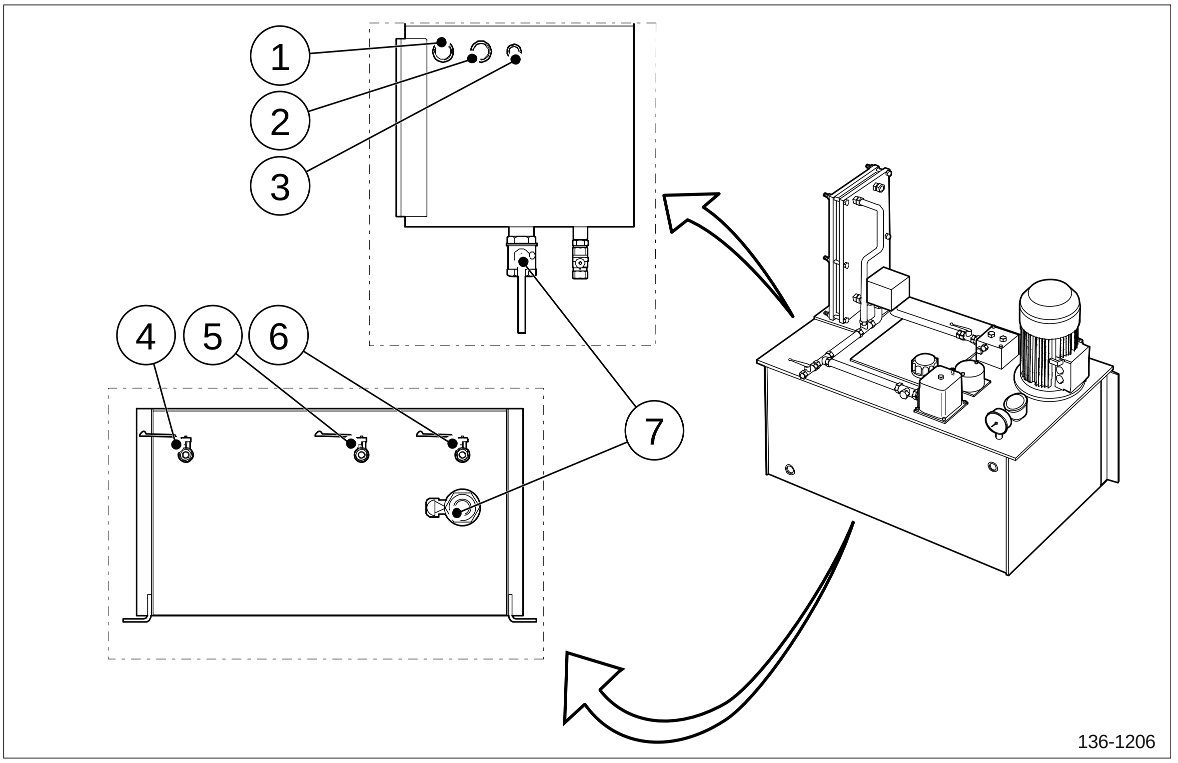

Figure 3 View from under and side of the hydraulic oil tank.

1. Connection H7
2. Connection H6
3. Connection H3
4. Connection X1
5. Connection X2
6. Connection X3
7. Connection H4

Note: **Make sure to read the lifting instructions in part Handling and Preservation before starting the installation.**

Use the following documents as reference material during the installation:

• Hydraulic System drawing

• Hydraulic Diagram drawing

• Lifting instructions in Part Handling and Preservation

Note that the illustrations above may not be an exact copy of the actual hydraulic system on board the vessel.

In addition to Rolls-Royce installation recommendations the installation of the hydraulic tanks must also meet the requirements of the classification society. The hydraulic system has been pressure tested and approved by the classification society before delivery.

Plan the installation of the hydraulic system units with care. Make sure that all service points and test points are accessible and that there is sufficient space around the separate parts of the hydraulic system for safe installation and maintenance. The pressure gauges must be clearly visible and the emergency manoeuvre block and valve manifold must be easy to access.There must also be sufficient space for emergency pitch operating of the OD-box.

The hydraulic system units should be located close to the OD-box and must be placed with a vertical deviation of 0-2 meters above the propeller shaft centre line. The point of measure on the hydraulic system units is the bottom plate of the hydraulic oil tank.

The hydraulic system units must be placed at least 200 mm from the nearest wall, due to air circulation.

The hydraulic system units and the pipes to and from the units must not be placed close to warm objects (for example the exhaust line from the engine) as the oil in the hydraulic system can be heated up.

Make sure that there is enough dismantle space around the hydraulic system units. If the pump unit P3 is damaged it must be enough space above it. See the Assembly, Dimension Drawing Hydraulic System for minimum service space for pump units P1 and P3.

If the vessel is equipped with a PTO driven pump, connect it to the gear box according to sub supplier documentation in part Sub Supplier Manuals. Rolls-Royce recommends that the bottom of the hydraulic system oil tank unit is placed about 0.5 meters above the PTO driven pump. However, if this is not possible the maximum suction height for the pump is when the bottom of the hydraulic system oil tank is placed at maximum 1 meter below the PTO driven pump.

The suction lines to the main pump must not be longer than 4 meters. However, if it is necessary to exceed the maximum suction length, please consult Rolls Royce Global Support Network (GSN).

Fasten the hydraulic system units and lock the screws in a proper way using the intended holes in the units, see Hydraulic System drawing. Some units are equipped with vibration absorbers at delivery, see the documentation from the sub supplier for fastening instructions. For these units the hydraulic system oil tank must be earthed to the vessel´s hull.

Connect all transmitters and other electric devices to the vessel’s monitoring and alarm system. Use the Remote Super Vision drawing as reference.

Information of the oil cooler mounted on the hydraulic oil tank is found in the part Sub Supplier Manuals. It is important that the water flow to the oil cooler is not exceeded, because high water velocity in the cooler will cause internal erosion damage and leakage.

Piping

Note: **The external piping is the responsibility of the yard and is not included in Rolls-Royce delivery.**

Note: **The hydraulic piping must not be installed close to hot objects (for example the exhaust line from the engine) as the oil in the hydraulic system can be heated up.**

Use the following documents as reference material during the installation:

• Hydraulic System drawing

• Hydraulic Diagram drawing

In addition to Rolls-Royce installation recommendations the installation of the external piping must also meet the requirements of the classification society.

The hydraulic piping must not be placed close to warm objects (for example the exhaust line from the engine) as the oil in the hydraulic system can be heated up.

The piping installation must be carried out with a minimum of bends. Do not exceed the minimum bending ratio, see the Hose Assembly drawing for minimum values.

The pipes must be dimensioned for the maximum working pressure stated on the Hydraulic Diagram drawing. When the installation of the hydraulic piping is finalized the piping must be pressure tested at 1.5 times the maximum working pressure.

The pipes must not exceed the maximum pipe length stated on the Hydraulic Diagram drawing. If the maximum pipe length has to be exceeded, consult Rolls-Royce before proceeding.

Pipes and the piping components must be manufactured out of steel. Recommended steel quality is stated on the Hydraulic Diagram drawing.

The pitch setting piping (connection A and B) must be connected with flanges, while other piping can be connected with flare tube fittings or equal.

Note that the diameters given for pipes on the Hydraulic Diagram drawing are minimum acceptable inner diameters.

Pipes must not be installed in the dismounting space area of the OD-box and the hydraulic system units, see the OD-box Dimension drawing for minimum dismounting space. Make sure that the connections to the OD-box are easy to dismantle considering the emergency pitch procedure, see part Operating Instructions.

Before the hydraulic system is put into operation, pipes and tanks must be thoroughly cleaned and the hydraulic installation must be approved by a superintendent from the shipyard. The system must be properly cleaned as even small quantities of oil, which do not meet RRAB requirements, or other liquids can contaminate the gear oil. Phosphatized precision steel pipes that have neither been welded nor bent hot, must not necessarily be pickled. If the pipes have to be fabricated or welded a method which minimise the cleaning procedure should be used. In those cases when such a method for practical reasons cannot be used or if, for example, formation of scales have occured on the internal bore of the pipe, the piping must be cleaned in the following or similar way:

1. Remove all welding slag and clean the piping carefully.
2. Wash the piping with water.
3. Pickle the pipes in 10-15% sulphuric acid at a temperature of 50-60 ^{o}C. Let the piping remain in the solution for one or one and a half hour. The exact time is

determined by test pickling one of the pipes.

4. Dip the pipes twice in water to neutralise the sulphuric acid. The pH value of the water should exceed 7. The preferred pH value is 9-10.

5. Oil the inside of the pipes to prevent corrosion.

If the pipes are not to be fitted to the hydraulic system immediately, the ends of the pipes must be properly sealed.

Switches and Sensors

Install Switches/Sensors and Transmitters

Note: **It is the yard's responsibility that all cables and connections are installed correctly towards the alarm system of the vessel, it is not part of the Rolls-Royce delivery.**

Use the following drawings as reference material when connecting the transmitters, switches or sensors:

• Electric Connection Diagram drawing (hydraulic system)

• Cable Connection drawing (hydraulic system)

• Remote Supervision drawing (hydraulic system)

See the Remote Supervision drawing for information about type, set value, and location of the switch/sensor and transmitters.

Make sure to connect all switches/sensors, and transmitters in the hydraulic system to the vessel's alarm system. It is the yard's responsibility that all cables and connections are installed correctly towards the alarm system of the vessel, it is not part of the Rolls-Royce delivery.

Pump Motor Starters Installation

Warning: The pump motor starters and the panel in the control room are supplied by high voltage.

Caution: The installation of the pump motor starters must be performed by an electrician.

Use the following document and drawings as reference material during the installation of the pump motor starters:

- Pump Motor Starter Technical Description (See part System Description)
- Pump Motor Starter drawing
- Hydraulic Diagram drawing
- Cable drawing (hydraulic system)
- Cable Connection drawing (hydraulic system)
- Cable Connection Diagram (remote control system)

In addition to Rolls-Royce installation recommendations, the installation of the pump motor starters must also meet the requirements of the classification society.

Plan the installation of the pump motor starters with care. Make sure that all service points are accessible and that there is sufficient space around the pump motor starter cabinet for safe installation and maintenance. Place the pump motor starter cabinet as close to the hydraulic power pack unit as possible. If possible the service personnel should be able to see the pitch indicator on the hydraulic power pack unit from the position of the pump motor starter cabinet.

The pump motor starter cabinets must not be placed close to warm objects (for example the exhaust line from the engine).

Fasten the cabinet and lock the screws in a proper way using the intended holes in the cabinet, see Pump Motor Starter drawing.

Connect all transmitters and other electric devices to the vessel’s monitoring and alarm system. Use the Cables for Hydraulic System drawing, Cable Connections for Hydraulic System drawing and Remote Super Vision drawing as reference.

If the pump motor starter cabinets must be stored during the installation please follow the instructions in part Storage and Handling.

Fill Gear Coupling with Oil or Grease

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

Caution: Make sure to use the recommended type of oil or grease and the recommended amount.

This instruction is only valid if the vessel is equipped with shafts of high speed type.

Fill the gear couplings with oil or grease. Make sure to use the recommended type and amount. For more information see the documentation from your sub supplier in part Sub Supplier Manuals.

Fill Hydraulic System with Oil

Fill Hydraulic System with Oil

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

Caution: Only oil that meets the recommendations in the document Requirements for Lubricating Oil can be used in the hydraulic system.

Note: If oil is filled through another connection then connection Z the filter function is by-passed.

Before the hydraulic system is filled with oil, an evaluation of the quality of the hydraulic installation must be performed by a superintendent from the shipyard.

The piping and tanks must be thoroughly cleaned, before filling the hydraulic system with oil. For more information see section Piping.

Fill the hydraulic power pack tank to its maximum level with oil that meets the recommendations in section Requirements for Lubricating Oil in Part Technical Data. Make sure to use the filling connection Z on the hydraulic power pack unit to fill the oil. The filters in the hydraulic power pack unit will ensure that clean, filtered oil is used in the hydraulic system. Note that if the oil is filled through another connection the filter function is by-passed.

- Make sure that the remote/local switch on the connection box on the hydraulic power pack unit is turned to LOCAL position.
- Connection Z must be used to fill oil to the hydraulic power pack tank. If an external oil filling and filtration unit is used, the filling pressure from it must not exceed 0.3 MPa.
- Start an electrically driven main pump and let it run, close valve V39 and turn valve V3 to Full forward (B) until the oil temperature has reached about 40^{o}C. Inspect the filter indicator on the hydraulic power pack unit and replace the filter element when

required. Open valve V39 and turnt valve V3 back to Neutral.

Start-Up and Flushing of Hydraulic System

Prerequisites

Warning: Make sure that the propeller has got sufficient space to rotate.

Warning: Make sure that no personnel gets in the way of the rotating propeller.

Caution: Radio waves, from for example walkie-talkies, can interfere with the signals from the feed back unit and the central unit. Be cautious when using such equipment near the central unit, when the propulsion system is running. The radio waves can disturb the remote control system.

Caution: The start-up of the hydraulic system must be performed by authorized Rolls-Royce service personnel.

Make sure that the propeller has got sufficient space to rotate. Remove for example scaffolds that might be too close to rotating parts of the propulsion system.

Make sure that one person bears the main responsibility of the start-up from the bridge and that there is an assistance outside the vessel. These persons should have radio contact with each other. The assistant must make sure that nobody gets too close to the rotating parts of the propulsion system.

The start-up and flushing of the hydraulic system must be performed by authorized Roll-Royce service personnel.

Instruction

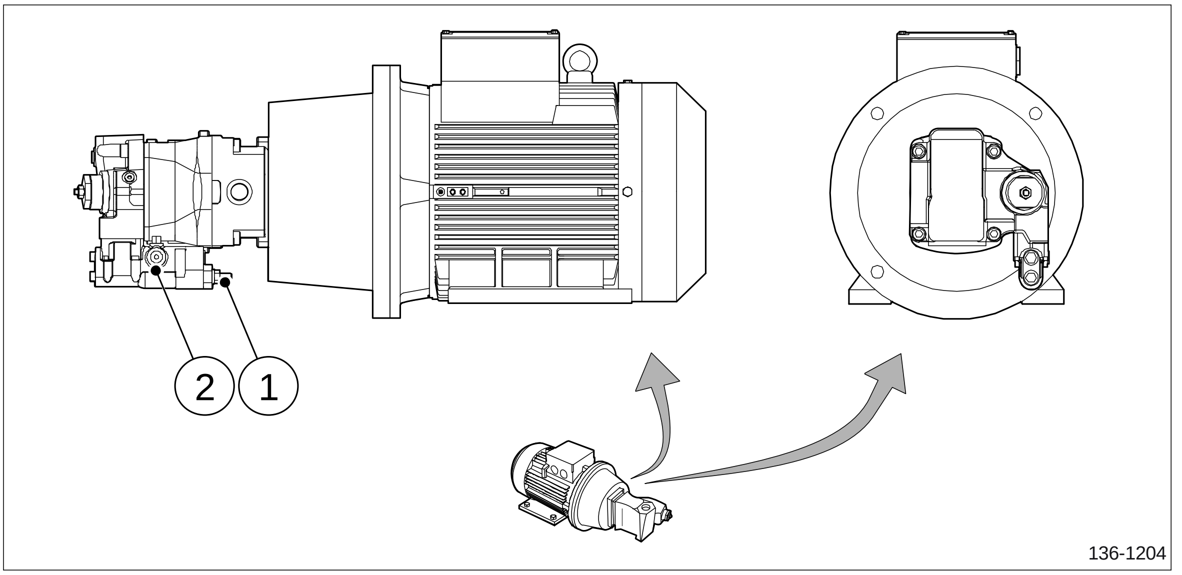

Figure 1 Electric motor M1 with pump unit P1

1. Pressure regulator
2. Load sensing regulator

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

Note: It is important that this procedure is performed before the start-up of the shaft.

Use the following drawings as reference during this procedure:

• Hydraulic Diagram drawing

• Hydraulic Power Pack drawing

Preparations

1. Inspect the hydraulic piping and make sure that they are installed according to the Hydraulic Diagram drawing.
2. Make sure that the pump unit P1 is filled with oil. If not, fill the pumps with oil that meets the recommendations in document Oil Requirements.
3. Make sure that the shut-off valves P1V is open.

Start-up the pump unit P3

4. Turn the pump unit P3 on and quickly off. Inspect the pump unit's direction of rotation. The correct direction of rotation is marked on the pump unit with an arrow.
5. Start the pump unit P3.
6. Inspect the static pressure on the gauge G5. The pressure should normally be 0.15 MPa, but depending on the oil temperature a value between 0.1 and 0.2 MPa is acceptable.
7. Let the pump unit P3 run during the whole start-up and flushing procedure.

Start-up the pump unit P1

8. Turn the pump unit P1 on and quickly off. Inspect the pump unit's direction of rotation. The correct direction of rotation is marked on the pump unit with an arrow.
9. Start pump unit P1
10. Inspect gauges G1 to make sure that the pump unit P1 gives pressure. The gauge G1 should show a pressure value at approximately 2.0 MPa (adjusted load sensing pressure in idle mode).
11. Let pump unit P1 run during the whole start-up and flushing procedure.
12. Inspect the mechanical filter indicator on the circulation filter during the start-up and flushing procedure and change filter element when required.
13. Shut of pump unit P1

Function test of the safety valve V1

14. Close shut-off valve V39 and shut-off valve V40.
15. Start pump unit P1.
16. Manoeuvre the proportional valve V3 by hand to ahead.
17. Inspect the oil pressure on gauge G1, make sure that the value is in accordance with the value stated on the Hydraulic Diagram drawing.
18. Increase the pressure on the pump units by adjusting the pressure regulator (clockwise) (see figure 1) until the safety valve V1 is actuated.
19. During the test of the safety valve V1 inspect pressure on the gauge G1. The oil pressure must not exceed the maximum oil pressure for the safety valve V1, see Hydraulic Diagram drawing.
20. If the maximum oil pressure is exceeded the safety valve V1 is not adjusted properly. Decrease the pressure setting on valve V1 to the pressure stated on the Hydraulic Diagram drawing.

Connect flushing filter and flushing hose

21. Connect the flushing filter to the connection Z and F on the hydraulic power pack unit.
22. Rotate the propeller shaft slowly until one of the air-venting plugs is directed downwards and one is directed upwards.

23. Connect the flushing hose to the air-venting holes A and B on the propeller hub.

Flush the hydraulic system

24. Open shut-off valve V39.
25. Make sure that the shut-off valve V40 is closed.
26. Start pump unit P1.
27. Manoeuvre the directional valve V3 by hand to full ahead.
28. Inspect the oil pressure on gauge G4. Make sure that the oil pressure do not exceed 4 MPa.
29. Make sure that no oil is leaking from the hydraulic piping or from the propeller hub.
30. Let pump unit P1 run for approximately 4 hours.
31. During the flushing procedure inspect the oil temperature, oil pressure, and both the flushing filter and the circulation filter F3.
32. Change the oil filters if required.

Reset the hydraulic system

33. Stop pump unit P1.
34. Make sure that directional valve V3 is in neutral position (de-actuated.)
35. Close shut-off valve V39.
36. Disconnect the flushing filter and plug connection Z and F.
37. Disconnect the flushing hose and plug the air venting holes A and B. Replace the o-ring on the plug before fastening. Lock the plug using spot welding.

Test the pitch function

38. Close shut-off valves V39 and V40.
39. Manoeuvre the proportional valve V3 by hand to full ahead. Keep the valve V3 actuated during the adjustment of the pressure regulator.
40. Adjust the pressure regulator to its lowest possible value. Turn the pressure regulator counter clockwise.
41. Manoeuvre the proportional valve V3 by hand to neutral position (not actuated).
42. Open shut-off valves V39 and V40.
43. Manoeuvre the proportional valve V3 by hand, until zero position is reached and then manoeuvre back to mechanical end position ahead. If the pitch does not move, carefully increase the pressure by adjusting the pressure regulator. Inspect the actual pressure on the gauge G1.

Inspect the axial movement ratio

44. Inspect the axial movement ratio for more information see section Twin Tube Axial Movement Ratio Inspection.

Bleed the hydraulic system from air

45. Close shut-off valve V39 and valve V40.
46. Manoeuvre the proportional valve V3 by hand to ahead. Keep the valve V3 actuated during the adjustment of the pressure regulator.
47. Adjust the pressure regulator to the pressure stated on the Hydraulic Diagram drawing and inspect the oil pressure on gauge G1.
48. Manoeuvre the proportional valve V3 by hand to neutral position (not actuated).
49. Open shut-off valve V39 and shut-off valve V40.
50. Turn the remote/local switch on the hydraulic power pack to LOCAL position.
51. Manoeuvre the proportional valve V3 by hand using the ahead and astern attendance button. Give 15 full strokes between mechanical end position ahead and mechanical end position astern.
52. Wait an hour.
53. Give 15 full strokes between mechanical end position ahead mechanical end position astern.
54. Wait 15 minutes.
55. Give 15 full strokes between mechanical end position ahead mechanical end position astern.
56. Inspect the mechanical filter indicator on the circulation filter during the air bleeding procedure. Replace the filter if required.
57. Inspect the static hub pressure on gauge G5 during the manoeuvres. The pressure should normally be 0.15 Mpa, but depending on the oil temperature a value between 0.1 and 0.2 MPa is acceptable.

Take an oil sample

58. Locate the connection X3.
59. Clean connection X3 and connect a clean hose.
60. Carefully open the shut-off X3 and drain at least two litres of oil. This oil to be discarded.
61. Drain two litres of oil and use a suitable particle counting instrument to inspect the purity of the oil. Make sure that the oil meets the recommendations stated in section Requirements for Lubricating Oil.
62. If the test result does not meet the recommendations let the oil circulate using pump unit P3 until the desired particle value is noted by the particle counting instrument.
63. Inspect oil level in the hydraulic power pack tank and refill oil if necessary.

Set the pressure setting of the pressure regulator

64. Set the pressure setting of the pressure regulator to the valve stated in the Hydraulic Diagram drawing.

Inspect the automatic start of the pump unit P3

If the vessel is equipped with a gravity tank, inspect the function of the automatic start of the static pressure pump unit P3.

1. Turn the selector switch for pump unit P3, on the panel in the control room, to STOPPED PROP. position.
2. Simulate low oil level in the gravity tank. Make sure that the level switch LS3 starts pump unit P3.
3. Simulate high oil level in the gravity tank. Make sure that the level switch LS3 stops pump unit P3.

The start-up and flushing procedure of the hydraulic system is now completed.

Start Up and Flushing of Hydraulic System (Under water)

Prerequisites

Warning: Make sure that the propeller has got sufficient space to rotate.

Warning: Make sure that no personnel gets in the way of the rotating propeller.

Caution: Radio waves, from for example walkie-talkies, can interfere with the signals from the feed back unit and the central unit. Be cautious when using such equipment near the central unit, when the propulsion system is running. The radio waves can disturb the remote control system.

Caution: The start-up of the hydraulic system must be performed by authorized Rolls-Royce service personnel.

Make sure that the propeller has got sufficient space to rotate. Remove for example scaffolds that might be too close to rotating parts of the propulsion system.

Make sure that one person bears the main responsibility of the start-up from the bridge and that there is an assistance outside the vessel. These persons should have radio contact with each other. The assistant must make sure that nobody gets too close to the rotating parts of the propulsion system.

The start-up and flushing of the hydraulic system must be performed by authorized Roll-Royce service personnel.

Instruction

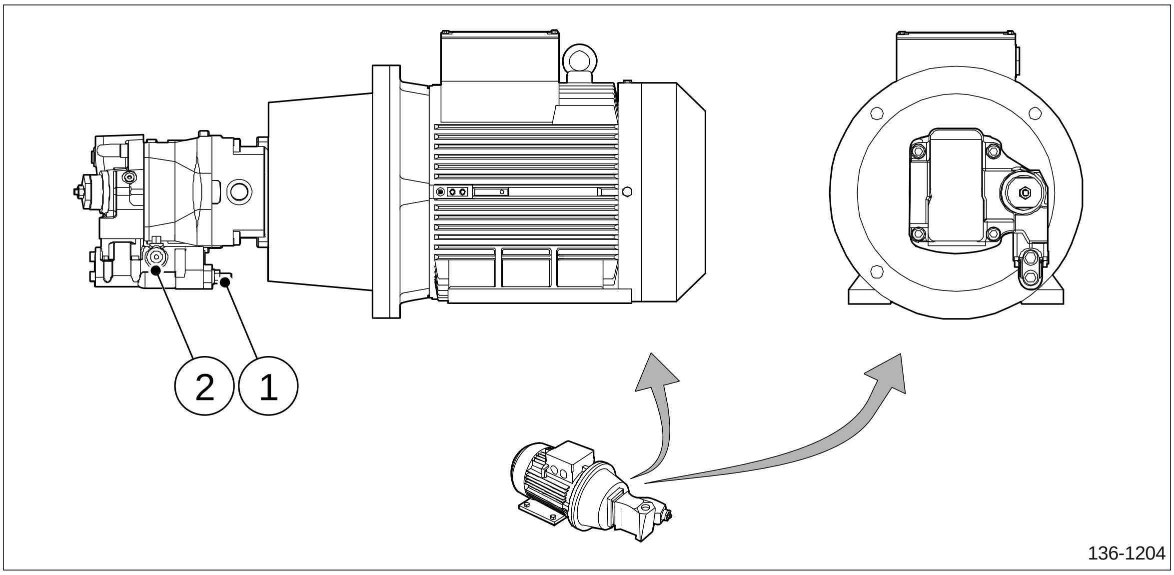

Figure 1 Electric motor M1 with pump unit P1.

1. Pressure regulator
2. Load sensing regulator

Caution: Oil is injurious to your health. Always read the warning label on the oil packaging and act according to the instructions.

Note: It is important that this procedure is performed before the start-up of the shaft.

Use the following drawings as reference during this procedure:

• Hydraulic Diagram drawing

• Hydraulic Power Pack drawing

Preparations

1. Inspect the hydraulic piping and make sure that they are installed according to the Hydraulic Diagram drawing.
2. Make sure that the pump unit P1 is filled with oil. If not, fill the pump with oil that meets the recommendations in document Oil Requirements
3. Make sure that the shut-off valve P1V is open.

Start-up the pump unit P3

4. Turn the pump unit P3 on and quickly off. Inspect the pump unit's direction of rotation. The correct direction of rotation is marked on the pump unit with an arrow.

5. Start the pump unit P3.

6. Inspect the static pressure on gauge G5. The pressure should normally be 0.15 MPa, but depending on the oil temperature a value between 0.1 and 0.2 MPa is acceptable.

7. Let the pump unit P3 run during the whole start-up and flushing procedure.

Start-up the pump unit P1

8. Turn the pump unit P1 on and quickly off. Inspect the pump unit's direction of rotation. The correct direction of rotation is marked on the pump unit with an arrow.

9. Start pump unit P1.

10. Inspect gauges G1 to make sure that the pump unit P1 gives pressure. The gauge G1 should show a pressure value at approximately 2.0 MPa (adjusted load sensing pressure in idle mode).

11. Let pump unit P1 run during the whole start-up and flushing procedure.

12. Inspect the mechanical filter indicator on the circulation filter during the start-up and flushing procedure and the change filter element when required.

13. Shut of pump unit P1

Function test of the safety valve V1

14. Close shut-off valve V39 and shut-off valve V40.

15. Start pump unit P1.

16. Manoeuvre the proportional valve V3 by hand to ahead.

17. Inspect the oil pressure on gauge G1, make sure that the value is in accordance with the value stated on the Hydraulic Diagram drawing.

18. Increase the pressure on the pump units by adjusting the pressure regulator (clockwise) (see figure 1) until the safety valve V1 is actuated.

19. During the test of the safety valve V1 inspect pressure on the gauge G1. The oil pressure must not exceed the maximum oil pressure for the safety valve V1, see Hydraulic Diagram drawing.

20. If the maximum oil pressure is exceeded the safety valve V1 is not adjusted properly. Decrease the pressure setting on valve V1 to the pressure stated on the Hydraulic Diagram drawing.

Test the pitch function

21. Close shut-off valves V39 and V40.

22. Manoeuvre the proportional valve V3 by hand to ahead. Keep the valve V3 actuated during the adjustment of the pressure regulator (pos 1, figure 1).

23. Adjust the pressure regulator to its lowest possible value. Turn the pressure

regulator counter clockwise.

24. Manoeuvre proportional valve V3 by hand to neutral position (not actuated).
25. Open shut-off valves V39 and V40.
26. Manoeuvre the directional control valve V3 by hand, until Zero pitch is reached and then back to mechanical end position ahead. If the pitch does not move, carefully increase the pressure by adjusting the pressure regulator. Inspect the actual pressure on gauge G1.

Inspect the axial movement ratio

27. Inspect the axial movement ratio. For more information see section Twin Tube Axial Movement Ratio Inspection.

Bleed the hydraulic system from air

28. Close valve V39 and valve V40.
29. Manoeuvre the proportional valve V3 by hand to ahead. Keep the valve V3 actuated during the adjustment of the pressure regulator.
30. Adjust the pressure regulator to the pressure stated on the Hydraulic Diagram drawing and inspect the oil pressure on gauge G1.
31. Manoeuvre the proportional valve V3 by hand to neutral position (not actuated).
32. Open shut-off valve V39 and shut-off valve V40.
33. Turn the remote/local switch on the hydraulic power pack to LOCAL position.
34. Manoeuvre the directional control valve V3 by hand using the ahead and astern attendance button. Give 15 full strokes between mechanical end position ahead and mechanical end position astern.
35. Wait an hour.

36. Give 15 full strokes between mechanical end position ahead and mechanical end position astern.
37. Wait 15 minutes.
38. Give 15 full strokes between mechanical end position ahead and mechanical end position astern.
39. Inspect the mechanical filter indicators on the circulation filters during the whole air bleeding procedure. Replace the filter elements if required.
40. Inspect the static hub pressure on gauge G5 during the manoeuvres. The pressure should normally be 0.15 MPa, but depending on the oil temperature a value between 0.1 and 0.2 MPa is acceptable.

Take an oil sample

41. Locate the connection X3.
42. Clean connection X3 and connect a clean hose.
43. Open and drain at least two litres of oil from connection X3. This oil to be

discarded.

44. Drain two litres of oil and use a suitable particle counting instrument to inspect the purity of the oil. Make sure that the oil meets the recommendations stated in section Requirements for Lubricating Oil.

45. If the test result does not meet the recommendations let the oil circulate using pump unit P3 until the desired particle value is noted by the particle counting instrument.

46. Inspect oil level in the hydraulic power pack tank and refill oil if necessary.

Set the pressure setting of the pressure regulator

47. Set the pressure setting of the pressure regulator to the value stated in the Hydraulic Diagram drawing.

Inspect the automatic start of the pump unit P3

If the vessel is equipped with a gravity tank, inspect the function of the automatic start of the static pressure pump unit P3.

1. Turn the selector switch for pump unit P3, on the panel in the control room, to STOPPED PROP. position.

2. Simulate low oil level in the gravity tank. Make sure that the level switch LS3 starts pump unit P3.

3. Simulate high oil level in the gravity tank. Make sure that the level switch LS3 stops pump unit P3.

The start up and flushing procedure of the hydraulic system is now completed.

Twin Tube Axial Movement Ratio Inspection

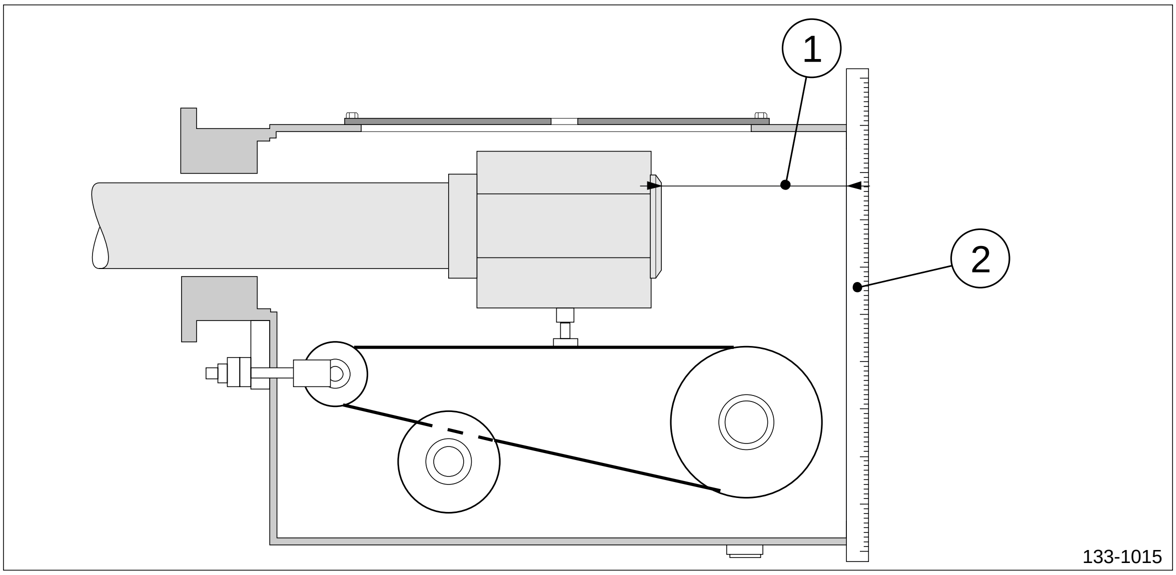

Figure 1 Position of the OD-box ring in mechanical mean position.

1. Mechanical mean position measurement
2. Ruler

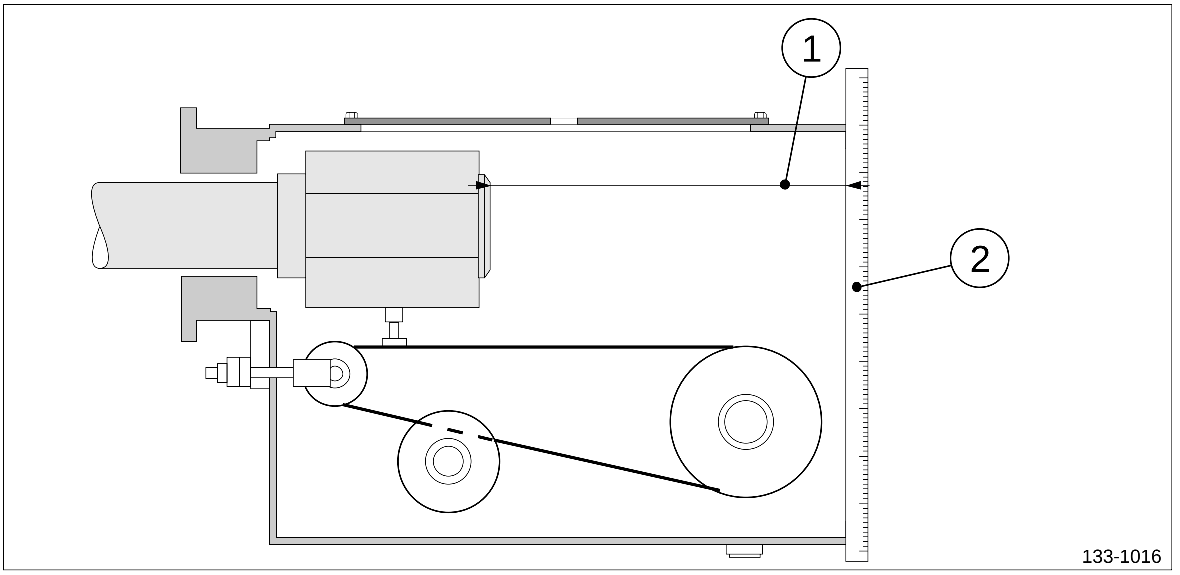

Figure 2 Position of the OD-box ring in mechanical end position astern.

1. Mechanical end position astern measurement
2. Ruler

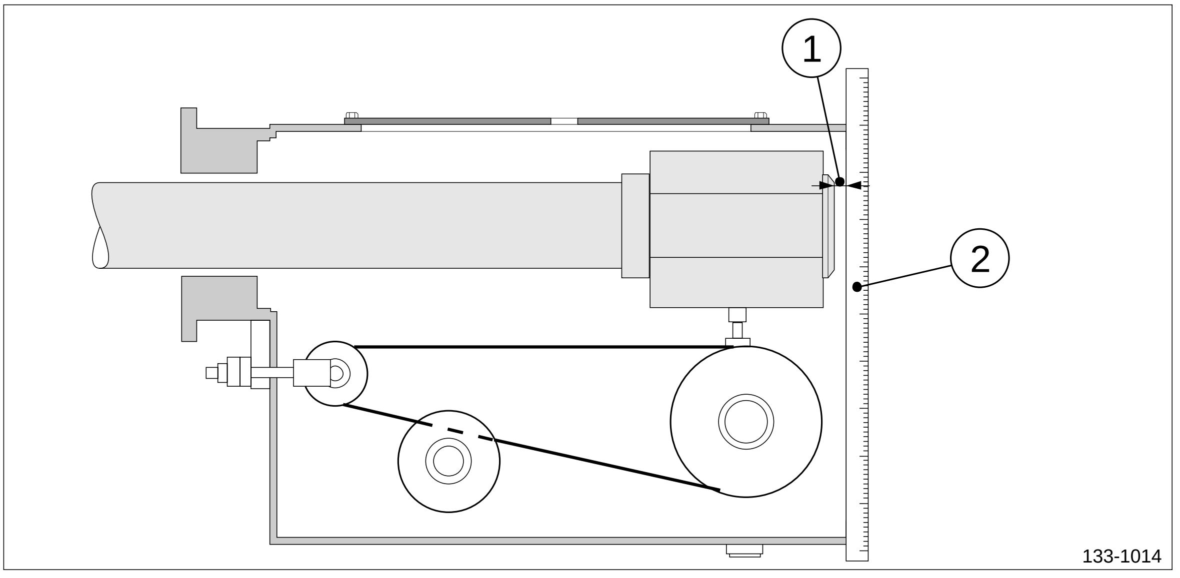

Figure 3 Position of the OD-box ring in mechanical end position ahead.

1. Mechanical end position ahead measurement
2. Ruler

Warning: The OD-box ring must not exceed the mechanical end position astern or mechanical end position ahead. If the mechanical end positions are exceeded the OD-box and/or twin tube can get seriously damaged.

Warning: Make sure to use as low hydraulic pressure as possible when setting the pitch. Use low hydraulic pressure until the inspection of the axial movement is completed and approved, otherwise the twin tube and/or the OD-box can get seriously damaged.

Caution: The twin tube axial movement ratio inspection must be performed by authorized Rolls-Royce service personnel.

The twin tube axial movement ratio inspection must be performed by authorized Rolls-Royce service personnel.

Use the following documents as reference material during the installation:

• OD-box Assembly drawing

• Combinator Diagram drawing

The axial movement must be inspected before the hydraulic system is put under full hydraulic pressure, the inspection must be performed using as low hydraulic pressure as possible.

1. Use the push buttons on directional valve V2 on the hydraulic power pack to manoeuvre the pitch to mean position. See the OD-box Assembly drawing for mean position value.

2. Check that the OD-box ring is in mean position by removing the end cover of the OD-box and measure the distance from the OD-box ring to the forward end of the OD-box housing. Put a ruler over the opening and use it as a straight-edge to measure against. Note: do not measure from the washer, see figure 1.

3. Set the pitch to mechanical end position ahead. Make sure to use as low hydraulic pressure as possible during the manoeuvre. If low pressure is not used, the twin tube and the OD-box can get seriously damaged.

4. Unscrew the pointer on the OD-box scale and adjust the pointer to the value for mechanical end position, according to the Combinator Diagram drawing.

5. Inspect that the position of the OD-box ring does not exceed the maximum ahead position, see value stated on the OD-box Assembly drawing and in figure 2. Measure the distance from the OD-box ring to the forward end of the OD-box housing. Put a ruler over the opening and use it as a straight-edge to measure against. Note: do not measure from the washer, see figure 2.

6. Set the pitch to mechanical end position astern. Make sure to use as low hydraulic pressure as possible during the manoeuvre. If low pressure is not used, the twin tube and the OD-box can get seriously damaged.

7. Inspect the OD-box scale and compare that value on the OD-box scale with the calculated mechanical end position astern value stated on the Combinator Diagram drawing. The value on the OD-box scale must not exceed the calculated mechanical end position astern value stated on the Combinator Diagram drawing.

8. Inspect that the position of the OD-box ring does not exceed the maximum astern position, see value stated on the OD-box Assembly drawing and in figure 3. Measure the distance from the OD-box ring to the forward end of the OD-box housing. Put a ruler over the opening and use it as a straight-edge to measure against. Note: do not measure from the washer, see figure 3.

If the axial movement for any reason does not coincide, please contact Rolls-Royce Marine Global Support Network (GSN) immediately.

Produced by: KK174 Approved by: Fnl
Creation date: 2008-05-05
Revision: Sign:
Revision date:

OD-box Scale Adjustment (FA)

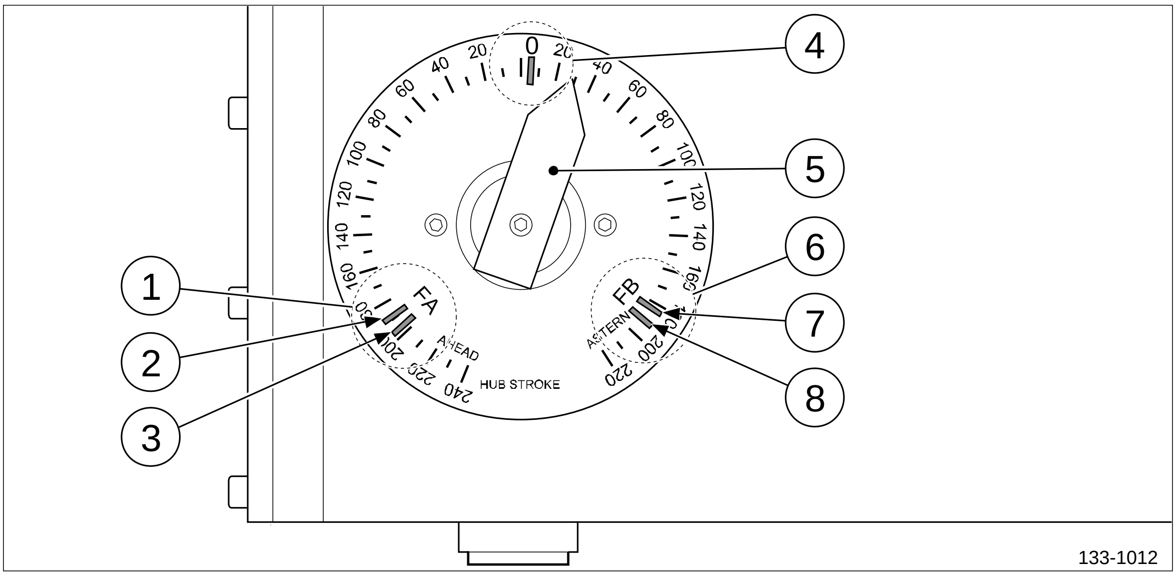

Figure 1 The mechanical scale on the OD-box.

1. Full Ahead, FA
2. Max command pitch ahead
3. Mechanical end position ahead
4. Actual zero pitch thrust marked with “0”
5. Pointer
6. Full Astern, FB
7. Max command pitch astern
8. Mechanical end position astern

Note: This procedure must be performed by an authorized Rolls-Royce service personnel.

The adjustment of the OD-box scale must be performed by Rolls-Royce service personnel. This will be done during the commissioning.

Before first start-up the OD-box and pointer must be adjusted according to the drawing Combinator Diagram.

• Set the switch on the connection box to LOCAL or disconnect the electrical wires for the solenoids.

- Set the pitch to mechanical end position Ahead. Check the gauge G1 and G4 on the hydraulic power pack unit to see when the safety valve opens.
- Adjust the pointer to mechanical end position Ahead according to drawing Combinator Diagram and lock the pointer.
- Set the pitch to calculated zero thrust according to drawing Combinator Diagram.
- Start the propeller shaft. Find the preliminary zero thrust by moving the pitch. The final zero pitch position is adjusted at the sea trial at open sea.

The following reference markings to be stamped onto the OD-box scale:

- FB = Full Astern (pos 1, figure 1)
  - One reference mark for mechanical end position
  - One reference mark for max command astern from control system
- FF = Full Ahead (pos 8, figure 1)
  - One reference mark for mechanical end position
  - One reference mark for max command ahead from control system
- 0 = Zero thrust (pos 4, figure 1)

If for some reason, the propeller hub, twin tube, or the OD-box have been overhauled the OD-box scale and pointer must be reinspected.

Produced by: KK174 Approved by FnI Revision: Sign:
Creation date: 2008-05-05 Revision date:

Installation Description

OD-box Ring Axial Play Inspection

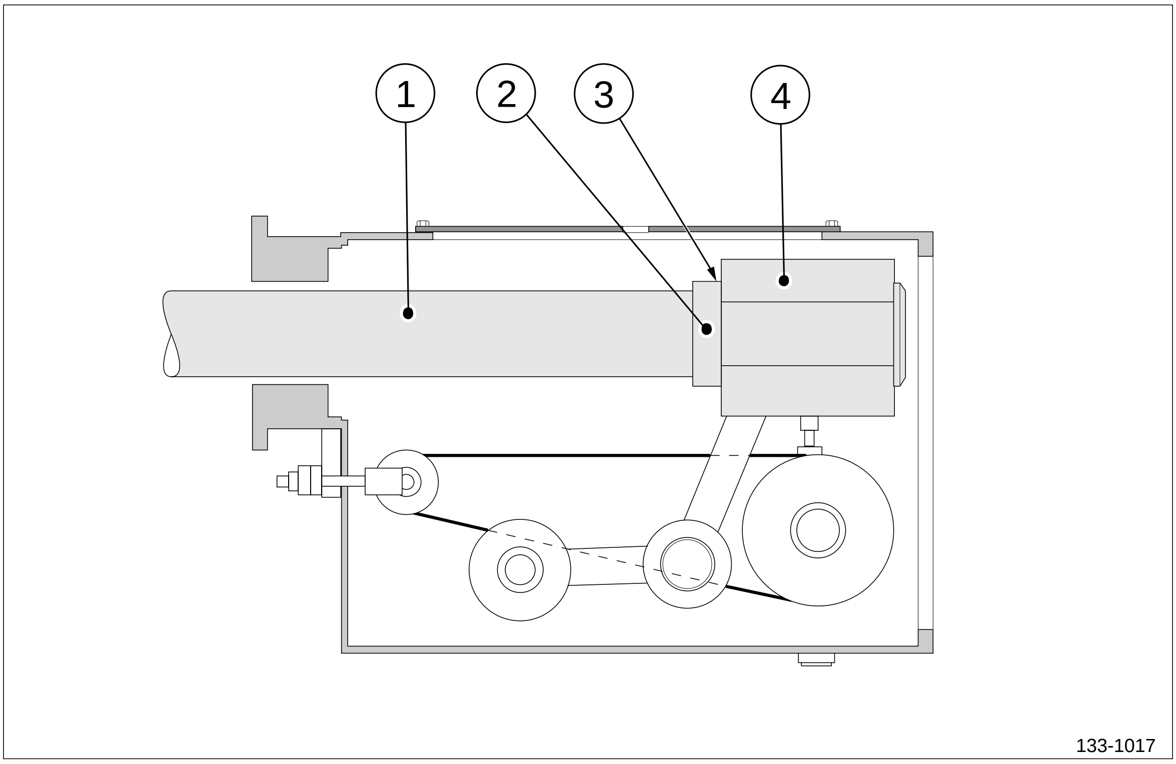

Figure 1 The OD-box - inside view.

1. Oil transfer tube
2. Stub shaft
3. Position to measure the axial play
4. OD-box ring

Box Size	Minimum play	Maximum Play
35	0.05	0.30
50	0.05	0.30
70	0.05	0.30
100	0.1	0.35
140	0.1	0.40

Acceptance criteria for the axial play.

Note: **The internal parts in the OD-box are to be considered as hydraulic components and therefore cleanliness is of great importance.**

Inspect and record the axial play of the OD-box ring according to figure 1. See the table "Acceptance criteria for axial play" for maximum and minimum values.

It is most important to keep within the given values to prevent high loads and heat releases in the OD-box ring. Misalignment or lack of play between the OD-box ring and the stub shaft can lead to excessive wear or breakdown of the white metal bearing surface in the OD-box ring. A damaged OD-box ring can lead to loss of pitch control.

1. Set the pitch to full ahead position or as close to full ahead as possible.
2. By hand, pull the OD-box ring (pos 4, figure 1) in ahead direction. Measure the axial play (pos 3, figure 1) between the OD-box ring and the stub shaft (pos 2, figure 1) using a filler gauge.
3. The minimum and maximum values for the axial play are found in the table "Acceptance criteria for axial play".

If there are any deviations from the acceptance criterias please contact Rolls-Royce Marine Global Support Network (GSN).

Produced by: SS Approved by: Nna Revision: a Sign: Nna
Creation date: 2005-05-31 Revision date: 2009-12-10

Alarms Functional Description

Verify the function of all alarms on the propulsion system. Use the Remote Supervision drawing as reference material.

Make sure to inspect the following temperature sensors/switch:

- All temperature sensors in all bearings.
- Temperature switch on the OD-box of type M0. This temperature switch is only installed on a vessel equipped with an OD-box type M0 for controllable pitch propeller (CPP) installations.

Installation Description, Control System

General

At delivery all control system units are marked with the control system assembly drawing number and item number.

When the units are installed, disconnect them electrically where possible, that is, remove fuses, disconnect PC-boards and terminals, disjoin cable connections, etc, and leave them disconnected until system start-up.

It is important that no power supply be switched on to the control system until Rolls-Royce service personnel has checked the installation.

Caution: **When welding closer than 10 m from the Rolls-Royce control equipment, all power supplies must be disconnected before welding starts. Supply filters might be damaged and the control system function can be jeopardised.**

Cabinets/Cubicles

- All control units (degree of protection IP55) for the remote control system must be placed on the bridge and in the control room environment with a maximum environmental temperature of 55°C and a maximum allowed non condensing humidity of 100%.
- Placing of control units:
  - Place the bridge unit on the bridge.
  - Place the Engine Control Room (ECR) units in the ECR.
  - Place the Hydraulic Power Pack (HPP) unit(s) close to the HPP.
  - Place the station I/O units underneath each control stand.
- In order not to expose the electronics to abnormal temperatures, do not mount the units in areas where higher environmental temperature than 55°C can be expected, for instance close to exhaust pipes and so on.
- Do not mount the control units close to radio transmitters or radio aerials or in places where high intensities of field from radio signals or disturbing electric equipment can

be expected, for instance in the transmitter room. In case of doubt, please contact Rolls-Royce.

- Connect the control units to the hull or the ship grounding system, that is, metal clean corrosion protected surfaces in nipples to the hull. If an earth-wire is used for connection to the hull it should be as short as possible. Use a multi-wire plate. Use toothed plate connectors in the connections.
- Place the control units so that the door can be opened 90° as a minimum.
- Place the control units so that they are exposed to a minimum of vibrations. If there is a risk for vibrations exceeding the levels stated in IEC 60068-2-6 damping elements should be fitted.

Cabling

- Rolls-Royce supplies the cables and connectors that connect the control system panels with the station I/O units. The cable connections in the bridge unit and in all propeller node units are of screwless tension clamp type.
- Ship cabling and cable glands are not supplied by Rolls-Royce. All cables must be intended for marine use and approved by the classification society.
- Rolls-Royce cable drawing and cable connection drawing for electronic control contain detailed cable specifications. The cables must correspond to these specifications.
- Cable cross sections must correspond to the cable drawing specifications as a minimum or to the classification society requirements.
- Separate cables with different signal levels or voltage levels well in order to avoid disturbances. This means that cables for systems with 110 V or higher voltage or cables with high Electro Magnetic Interference (EMI) generating signals should not be placed together with the Rolls-Royce control signal cables.
- Install all electric cabling so that mechanical damage is prevented.
- Avoid splicing of cables.
- Use screened cables for connecting the units. Coverage area of the screen should preferably be minimum 85%.

Cables with one screen:

- Connect the cable screen to the hull at least at both ends of the cables.

Double screened cables:

- Connect the outer screen to the hull at both ends (Faraday screen).
- Then connect the inner screen the shortest way to hull connection at the central unit end.

Cable Connections to the System Units

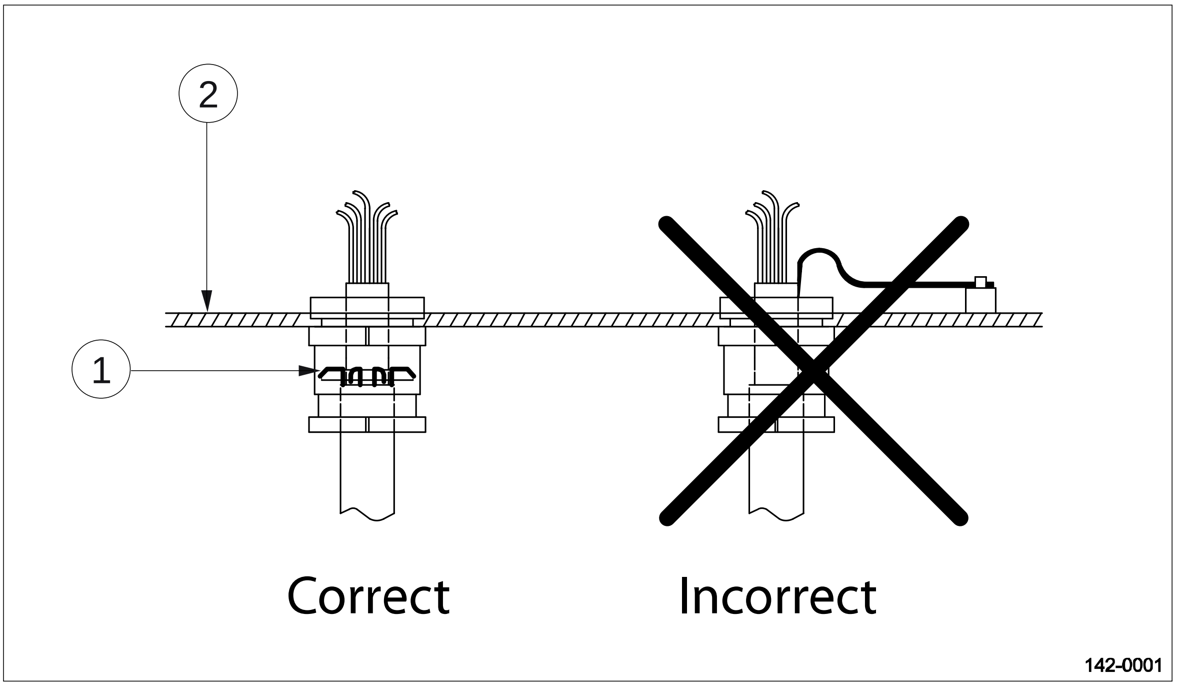

Figure 1 Mounting of cable screen.

1. Correctly mounted cable screen
2. Mounting flange

Caution: Cable screens on external equipment cables must never be laid into the units.

- The control unit and the station I/O unit are equipped with a flange for external cable cable inlet. The inlets must be performed with screen bonding glands of EMC type, that is, the cable screens must be connected concentrically to the covering of the units.
- Cable glands must be watertight and stress relieved. The cable glands are not included in the Rolls-Royce delivery since the cable dimensions vary greatly from one shipyard to another.
- Cut off the cable parts in the control unit nodes in suitable lengths, that is, not longer than necessary. Cable looms at control panels must be sufficiently long to enable removal of the panel for maintenance purposes without disconnecting the cables.
- Strip the cables carefully so that all cores in the conductors are intact and all insulation material removed. Use end splices if possible. If not, twist all cores carefully to avoid contact between terminals.

A follow up check of the cable has to be done before the delivery of the ship.

CAN Cable Specification for Bus-A, Bus-B and Bus-S

Note: The redundant bus cables for the CAN-A network and CAN-B network must be well separated.

- Can bus cable, ISO 11898
- 125 kBit/sec
- Maximum cable length 300 metres
- Shielded
- Twisted pair, 2 x 2 x 0.5 mm^2 shielded pair (AWG20)
- Nominal impedance 120 Ohm
- Capacity maximum 70 nF/km
- Resistance maximum 160 Ohm/km (loop resistance)

Power Supply

Warning: Do not connect any power supply to the control system until Rolls-Royce service personnel has checked out the installation.

Warning: All power supplies must be disconnected before welding works starts within 10 m from the control equipment. Otherwise the supply filters might be damaged and the control system function can be jeopardised.

- The power supply must always be made according to the classification society regulations.
- The power supply to the different systems has to be 24 V DC (18-32 V, ripple <=200 mV RMS) and must be taken from sources with high priority so that the supplies are not jeopardised. For each power supply the power consumption is specified in the cable diagram.
- All Rolls-Royce systems should be free floating, that is, have no negative connection to the hull.
- Connect the redundant control system supply to two different uninterrupted sources with high priority.
- Provide separate circuit breakers and/or fuses for each feeding line to the control system.

• Connect the back-up control system and indication system to emergency source separated from the main supply.

Control Panels Outdoor Installation

• All control panels are supplied for desk mounting. They are designed according to the degree of protection IP 65 as a standard. Upon request, special silicon covers can be supplied for the control panels according to the degree of protection IP 66 (splash water proof) for outdoor installation. Please inform Rolls-Royce when applicable.

• The panels are not designed for continuous exposure to water and strong sunshine. If control panels are mounted outdoors in bridge stands not supplied by Rolls-Royce, the stand must be equipped with a protecting cover that covers the panel when the control station is not used. The covers must be designed so that the movement of the lever is not obstructed.

• Ensure that the stand is built tight enough to prevent dampness from penetrating.

• Arrange heating and venting in the desk to avoid condensation.

FPS Transmitter Installation (Optional)

• The Fuel Pump Setting (FPS) transmitter transmits response values for the load control. Great care must be taken as regards its fitting to the machinery.

• It must be possible to adjust the transmission from the fuel regulating shaft to the FPS transmitters. The lever placed on the shaft of the FPS transmitter has adjustable radius. The coupling rod has left hand and right hand tread so that the length can be varied. The engine manufacturer, or the shipyard, only has to supply a linear movement corresponding to the fuel pump setting from stopped engines to maximum setting. The movement must be within 35-110 mm.

• For example, the Rolls-Royce FPS transmitter can be mounted directly at the speed governors actuator. Preferable a spring linkage has to be fitted between the speed governor and the fuel rack shaft. That means that the transmitter is able to measure overload, also if the fuel rack is stopped at nominal load

• Place the transmitters so that they are exposed to a minimum of vibrations. The delivered vibration absorbers must be applied.

• A fuel pump setting of at least 103% must be possible to make the system work satisfactory.

RPM Transmitter Installation

Use the RPM transmitter drawing as reference material during the installation.

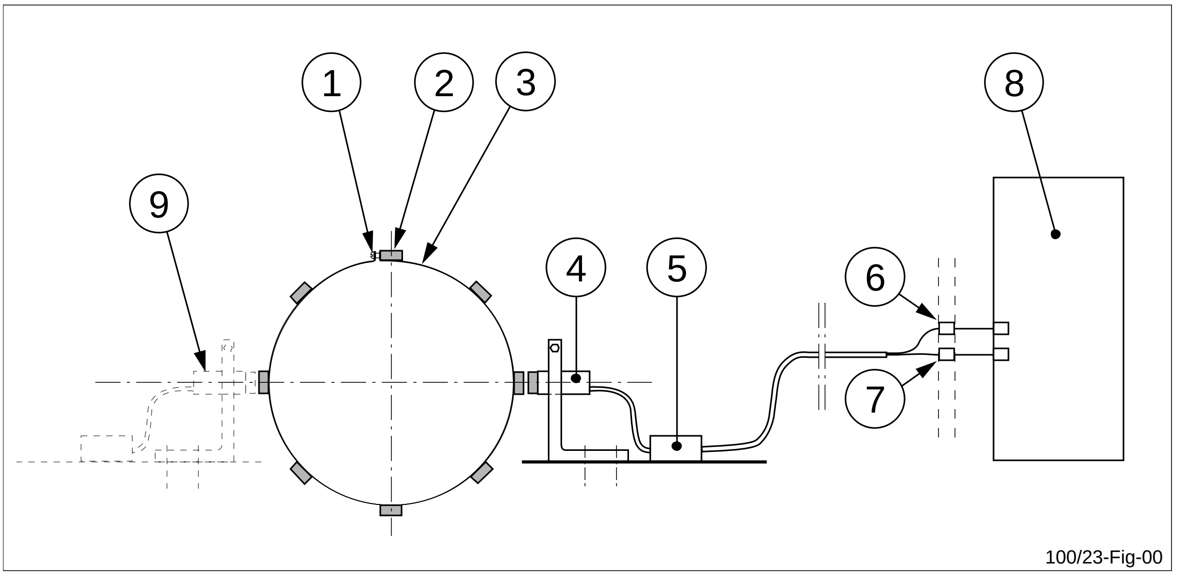

Figure 2 RPM transmitter indication system hardware installation.

1. Screw (Non magnetic)
2. Peg
3. Peg band
4. RPM pick-up
5. Switch box (Not Rolls-Royce Delivery)
6. Brown cable, 24 volt
7. Blue cable, 0 volt
8. Indication system
9. Alternative placement of the RPM transmitter

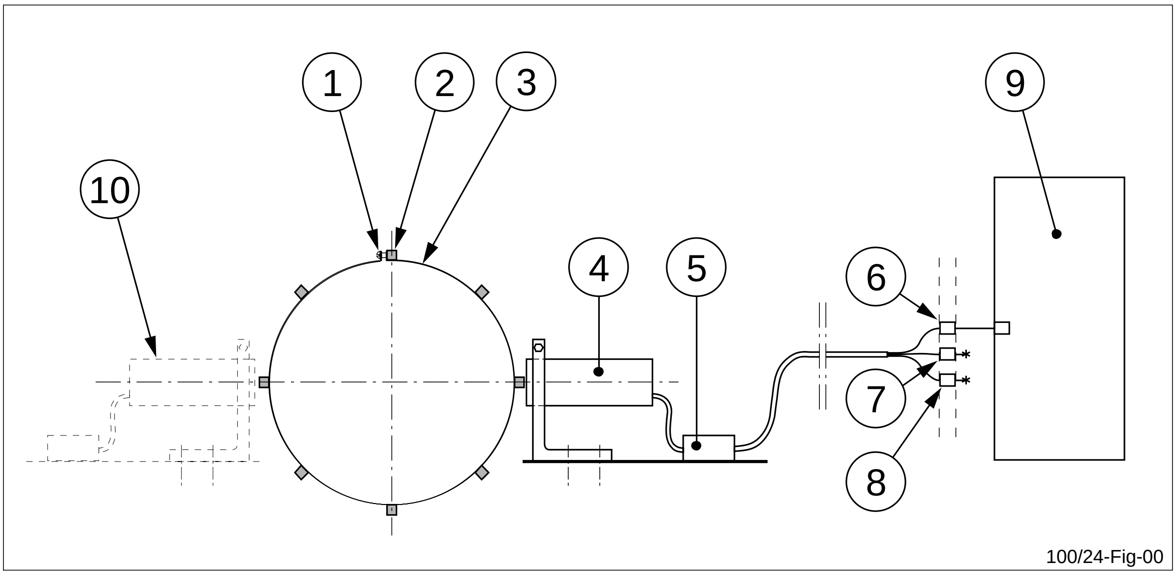

Figure 3 RPM transmitter remote control system hardware installation.

1. Screw (Non magnetic)
2. Peg
3. Peg band
4. RPM pick-up
5. Switch box (Not Rolls-Royce Delivery)
6. Black cable, Signal
7. Brown cable, 24 volt
8. Blue cable, 0 volt
9. Control system
10. Alternative placement of the RPM transmitter

The Revolutions Per Minute (RPM) transmitter transmits the response value of the propeller rpm. Each RPM transmitter consists of a peg band and an RPM pick-up.

- Fasten the peg band around the propeller shaft with the non-magnetic screws included in the delivery.
- Fasten the pick-up using the non-magnetic holder included in the delivery.
- The distance between the pegs and the pick-up has to be within 2 to 6 mm for the remote control system pick-up and 2 to 3 mm for the indication system pick-up.

The RPM transmitter software is installed by Rolls-Royce service personnel.

Interface Description

Interface: General

For Analogue Signals

- For input signals to the Rolls-Royce system, we provide galvanic isolation of the signal.
- For output signals to other suppliers, the galvanic isolation has to be provided in the receiving system.

For Digital Signals

- For input signals, Rolls-Royce requires voltage-free contacts.
- For output signals, Rolls-Royce provides voltage-free contacts.
- Contacts rated 250V AC, 2A, (applied voltage preferably max 50V).

Interface: Rolls-Royce Main Engine

RPM Setting

- One Pneumatic RPM command signal for each engine, from Rolls-Royce, within the range 1,3 to 6,3 bar.

The E/P-converter is to be fed with an air pressure of about 7 bars.

The air supply manifold is not included in our delivery.

Back-up RPM is set by means of a reducing valve in the E/P-converter and has to be set at trial.

Please inform Rolls-Royce about:

- Any blocked RPM operating range.
- Which signal levels that correspond to idling resp. full RPM.

RPM Setting

- One RPM command signal for each engine, from Rolls-Royce,
- Current signal within 4-20mA DC, max resistance 500 ohm.

Alternative

- Voltage signal within 0-10V DC, min resistance 2k ohm.

Please inform Rolls-Royce about:

- Any blocked RPM operating range.
- Which signal levels that correspond to idling resp. full RPM.

Back-up RPM

- One voltage free contact for each engine, from Rolls-Royce, "Back-up RPM"

OR

- One analogue signal (4-20mA or 0-10V) for each engine, from Rolls-Royce.

Please inform Rolls-Royce witch type of back-up signal that is required.

Separate RPM

- One voltage free contact for each engine, from Rolls-Royce, when "Separate RPM" is selected.

See also general description 52020-E.
(Closed contact = Separate RPM control).

Externally Controlled RPM

- A voltage free contact is needed, to Rolls-Royce, if the RPM is not controlled by Rolls-Royce, for instance "Local mode".
(Closed contact = External RPM control).

Fuel Pump Setting

- One FPS-signal from each engine, to Rolls-Royce, current signal within the range 4-20 mA DC. The FPS signal must represent up to at least 103% load.

The signal, including all reasonable overload conditions must never exceed 20mA.

Fuel Pump Setting

- One FPS transmitter for each engine, delivered by Rolls-Royce, for converting of mechanical movement of the fuel rack to an electric signal for the remote control system.

Mechanical installation: see Installation Description 49680-E.

Engine Overload

- Two voltage free contact from each engine, to Rolls-Royce, Overload >100 % load.
(Overload = closed contact)

Engine Start Blocking

- One voltage free contact, from Rolls-Royce, "zero pitch" for start blocking of the main engine when the pitch is not in zero position.
(Zero pitch = closed contact.)

Alternatively the "zero pitch"-contact can be used for "clutch in" interlocking. See interface Rolls-Royce - Clutch control system.

Main Engine Running

If the actual installation doesn't have a clutch between main engine and propeller shaft Rolls-Royce need an "engine running" signal fed to the "clutch in" input.

- One voltage free contact "engine running"
  (Running = closed contact)

If clutch is available, see interface Rolls-Royce Clutch control system.

Interface: Rolls-Royce Main Engine Safety System

Slow Down

- One voltage free contact from each engine safety system, to Rolls-Royce, for automatic slow down. When slow down signal is received the load is reduced down to a preset load limit value.
  (Slow down = closed contact)

Shut Down

- One voltage free contact from each engine safety system, to Rolls-Royce, for automatic shut down. When shut down signal is received the pitch is set to zero position and the engine RPM is set to idling speed.
  (Shut down = closed contact)

The above two inputs slow down and shut down are included for all installations. If not connected the functions will be inactive.

Low Scav. Air

- One voltage free contact, to Rolls-Royce, from each engine from each engine "Low scavenging air", for momentary stop of pitch increase.
  (Closed contact = Low scav. air).
- One analog input, to Rolls-Royce, from each engine from each engine “Low scavenging air”, for momentary stop of pitch increase.
  Current signal within the range 4-20 mA DC.

The input is included for all installations. If not used the function will be inactive.

Interface: Rolls-Royce Clutch Control System

Clutch In

- One voltage free contact from each clutch, to Rolls-Royce, "clutch in".
  (Clutch in = closed contact)

(If engine is direct coupled, we need "engine running" information, see interface Rolls-Royce - Main engine).

Zero Pitch

- One voltage free contact, from Rolls-Royce, "zero pitch" for clutch in interlocking when the pitch is not is zero position.
  (Zero pitch = closed contact.)

Alternatively the "zero pitch"-contact can be used for engine start blocking, see interface Rolls-Royce - Main engine.

Interface: Rolls-Royce Shaft Generator

Shaft Generator RPM

- One voltage free contact, to Rolls-Royce, "Shaft generator RPM". Shaft generator system must still verify that actual RPM is reached.
  (Shaft generator RPM = closed contact)

Interface: Rolls-Royce Shaft Generator

Shaft Generator Connected

- One voltage free contact, to Rolls-Royce, "Shaft generator connected", e.g. the shaft generator is electrically connected to its load.
  (Shaft generator connected = closed contact)
- One voltage free contact, from Rolls-Royce, "Shaft generator RPM" selected. Shaft generator system must still verify that actual RPM is reached.
  (Shaft generator RPM = closed contact)

Interface: Rolls-Royce Alarm System

The following alarms outputs are available from the electronic systems in form of voltage free contacts, (alarm=open contact).

From Bridge Unit

- “System warning”, which includes alarm for power failure, transmitter failure, I/O failure and computer error, (open contact = alarm).
  System warning is an indication for loss of redundancy.
- "Joystick system failure" which includes Power supply failure and Cable break.
- "Off course alarm" which includes regulating "failure" of the automatic heading control in the Joystick system.
- "Hand responsibility failure" which includes Power supply failure.

From each ECR Unit

- "Control system failure" which includes Power supply failure, Computer error, Cable break and Remaining control error in the main system. The "Control system failure" is also indicated with buzzers and alarm lamps on all control stations.

From each HPP Unit

- “Back-up supply failure”, which includes alarm for power failure to the back-up system, (open contact = alarm).

Interface: Rolls-Royce Wrong Way Alarm System

- One voltage free contact, from Rolls-Royce pitch feedback box, "PITCH AHEAD" (Ahead = closed contact)
- One voltage free contact, from Rolls-Royce pitch feedback box, "PITCH ASTERN" (Astern = closed contact)

In "zero pitch" both contacts are open.

Interface: Rolls-Royce Voyage Data Recorder/ Manoeuvre Recorder

NMEA 0183 including signals for, see specification 52073-E.

- Station in command
- Lever position
- Actual pitch setting
- Propeller shaft RPM

Alternative

- One voltage free contact for each control station, from Rolls-Royce, "station in command".
  (In command = closed contact).
- One "lever position" signal (within ±10V or 4-20mA), for station in command.
- One "actual pitch setting" signal (within ±10V or 4-20mA).
- One "shaft RPM feedback" signal (within 0-10V or 4-20mA).

Please inform us soonest.
The signals are available in Bridge unit.

Interface: Rolls-Royce Joystick Rudder Control System

The steering gear must be equipped with a control system of following-up type. Individual control of the rudders is preferred.

Furthermore, the steering gear must be arranged with a control change over system designed so that it is subordinated the Rolls-Royce Joystick responsibility system, (when the steering gear mode selector is set in position "HAND/JOYSTICK", i.e. not in position non follow up or autopilot etc....)

Signals for each Rudder

- One voltage free contact, to Rolls-Royce, "in service".
  (In service = closed contact).

In service means no alarms, hydraulic pump motor running, rudder mode selector switch in pos. "HAND/JOYSTICK".

- One voltage free contact, from Rolls-Royce, "Joystick in command request", for automatic change over from hand to joystick control.
  (Joystick IC req. = closed contact.)

Note that change over to joystick may take place only with the rudder mode selector switch in pos. "HAND/JOYST."

- One voltage free contact, to Rolls-Royce, “Joystick in acknowledge
  (Joystick IC acknowledge = closed contact.
- One rudder command signal ±10 V DC, from Rolls-Royce. The signal ±10 V represents tight starboard to tight port.

When returning from joystick control to hand control Rolls-Royce will give information to the rudder system, so that the rudder hand command can be transferred to the station where hand mode was selected.

- Three voltage free, momentary closing contacts, from Rolls-Royce, "Hand control request". One for each control station, main bridge, port and stbd wing.

The contacts should be connected in parallel with the "command request push buttons" (or equal function) in the rudder control panels.

Interface: Rolls-Royce Joystick Tunnel Thrusters

The tunnel thrusters must be equipped with a control system of follow-up type.

Furthermore, the tunnel thruster system must be arranged with a control change over system designed so that it is subordinated the Rolls-Royce Joystick responsibility system.

Signals for each Tunnel Thruster

- One voltage free contact, to Rolls-Royce, "in service",
  (In service = closed contact).
  In service means no alarms, hydraulic pump motor running etc.
- One voltage free contact, from Rolls-Royce, "Joystick in command request", for automatic change over from hand to joystick control.
  (Joystick IC req. = closed contact.)
- One voltage free contact, to Rolls-Royce, "Joystick in command acknowledge", when change over to joystick has been carried out.
  (Joystick IC acknowledge = closed contact).
- One tunnel thruster command signal ±10 V DC, from Rolls-Royce. The signal ±10 V represents tight starboard to tight port.

When returning from joystick control to hand control Rolls-Royce will give information to the tunnel thruster system, so that the tunnel thruster hand command can be transferred to the station where hand mode was selected.

Above functions requires following interface signals

- Three voltage free, momentary closing contacts, from Rolls-Royce, "Hand control request". One for each control station main bridge, port wing and stbd wing.

The contacts should be connected in parallel with the "command request push buttons" (or equal function) in the tunnel thruster panels.

Interface: Rolls-Royce Joystick Gyro Compass Manufacturer

Required Information

For information of actual heading we need a serial NMEA 0183 signal from the gyro with following data:

- Gyro-Compass sentence

$HEDT,x.x,T*hh<CR>>LF>

Checksum
Degrees true
Heading
Talker identifier gyro compa

- Preferable baud rate: 9600
- Input rate: 10Hz
- Alternative baud rate: 4800

Alternative 1

For information of actual heading we need a separate voltage free sin cos potentiometer on the gyro with following data:

Type:	**360o conductive plastic**
Resistance:	10 kohm +/-10 %
Peak to peak conformity:	<0,5 %
Output smoothness:	Should meet MIL-R-39023 grade 0,1%
Rotation life:	20,000,000 shaft revolutions
Vibration, acceleration, shock and altitude:	Should meet MIL-R-39023

Alternative 2

If the gyro manufacturer cannot provide suitable potentiometer, we can supply a potentiometer with following data:

Mounting:	2 inch diameter servo mount
Shaft diameter:	1/4 inch
Shaft length:	15 mm +/-1

Please inform us soonest.

Produced by: BI Approved by: Jnj Revision: b Sign: Mnm
Creation date: 2006-05-18 Revision date: 2007-08-21

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Korea			

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Dubai			
United Arab Emirates			

1 Harbour Acceptance Test Record

1.1 Data

Yard/New building no……………………………………………………………………………

Rolls-Royce AB file no: ………………………………………………………………………

Order no: ………………………………………………………………………………….. ……....

Date: …………………………………………………………………………………………...

Rolls-Royce representative: …………………………………………………………………

Customer representative: ……………………………………………………………………

1.2 Introduction

This document is a record of the harbour acceptance test that is filled in by a Rolls-Royce service engineer during a harbour acceptance test. After each completed task the belonging box has to be checked and a signature written on the dotted line.

The document is a general document and all tests might not be applicable for the vessel.

1.3 First Inspection

1.3.1 Installation Check list	
Verify that the items in the document Installation Check list (see part Commissioning) has been carried out and that the form is filled in and signed.	☐ …………
1.3.2 Visual Inspection	
Check that all delivered items of the propulsion system are undamaged and correctly installed according to the installation descriptions.	☐ …………
1.3.3 Earth Fault Test	
Check the resistance between each negative supply and chassis. The correct value is < 10 ohm.	☐ …………
1.3.4 Power Supplies	
Check that all units, in the remote control system, are supplied with correct power supplies, according to specifications and wiring diagrams. 24VDC or 220VAC 24VDC, (18-32VDC) ripple < 200mV RMS	☐ …………
1.3.5 Shaft Alignment	
The shaft alignment is verified and approved by the classification society.	☐ …………
1.3.6 Hydraulic Installation	
Verify that the hydraulics (including piping) is treated and installed according to the installation instructions.	☐ …………

1.3.7 Hydraulic Valve Settings	
Verify that all hydraulic valves are adjusted according to the hydraulic diagram.	☐ …………
1.3.8 Pitch Manoeuvre Time	
Check and note the pitch manoeuvre time, in seconds, from full astern to full ahead (with stopped shaft). Manoeuvre time, one pump (sec.) Port Starboard .... Manoeuvre time, two pumps (sec.) Port Starboard	☐ …………
1.3.9 Pitch Indication, Mechanical Scale	
Verify the adjustment of the mechanical pitch indicator according to the pitch or combinator diagram.	☐ …………

1.3.10 Remarks on “First Inspection”

1.4 Function Test

1.4.1 Transmitter Signals		
Verify and if necessary calibrate the command and response signals (levers, FPS-transmitter, pitch feedback, etc.).	☐	…………
1.4.2 Manoeuvre Responsibility, Bridge/ECR		
Verify the function of the manoeuvre responsibility system between the bridge and the ECR.	☐	…………
1.4.3 Manoeuvre Responsibility, Bridge/Annex		
Verify the function of the manoeuvre responsibility system between the main bridge station and the control station(s).	☐	…………
1.4.4 Electrical Shaft		
Verify the function of the electric shaft between all installed control stations.	☐	…………
1.4.5 Pitch Indication		
Verify the function of the pitch system: • Function of all indicators • Adjustment of full ahead, zero pitch and full astern	☐	…………
1.4.6 RPM Indication		
Verify the function of the RPM indication system: • Function of all indicators • Adjustment of zero and full RPM	☐	…………
1.4.7 Pitch/RPM Control		
Verify the function of the “combinator control” of pitch/RPM. • Pitch and RPM control from lever • Curves according to combinator diagram	☐	…………
1.4.8 Load Curve(s)		
Verify the load curves according to the “load curve diagram”.	☐	…………

1.4.9 Constant RPM	
Verify the function constant RPM: • ON/OFF activation • (ON) indication • RPM level	☐ …………
1.4.10 Separate RPM	
Verify the function of the separate RPM mode (in Engine Control Room): • Pitch from lever and RPM “separate” control device	☐ …………
1.4.11 Back-up System	
Verify the function of the back-up system: • ON/OFF activation • (ON) indication • Pitch control (ahead/astern) • Constant RPM	☐ …………
1.4.12 Alarms	
Verify the function of the alarms: • Control failure: power failure, cable break, control error (check indication and reconnect function) • Back-up failure: power failure (Check indication) • Illumination failure: power failure (Check indication)	☐ …………
1.4.13 Load Increase/Decrease Program	
Verify the function of the LIC: • ON/OFF activation • (ON) indication • Pitch reduce indication • Override by 100% power function • Up/Down curves according to specification	☐ …………

1.4.14 Zero Pitch	
Verify the zero pitch. Adjust if necessary: • Zero pitch = zero thrust • Verify and adjust the mechanical scale and the electronic feedback	☐ …………
1.4.15 Clutch Control	
Verify the function of the clutch control: • Interlocks for “Enable” • Clutch IN sequence • Clutch OUT sequence • Sequence failure (detection and indication) • Emergency clutch out (function, indication, EM clutch out reset)	☐ …………
1.4.16 Joystick Test (Static)	
Verify the system of the manoeuvre responsibility system between main system and the joystick control station(s). Verify the function of manoeuvring from joystick (lever and rotation knob). Verify the function/control of all propulsion units and rudders: • In service indications • Control of thrust, main propeller(s) and tunnel thrusters(s) • Control of rudder(s) • Direction of thrust and rudder angles	☐ …………

1.4.17 Remarks on “Function Test”

1.5 Interface

Calibration and function test.

1.5.1 Engine	
Verify the engine interface: • FPS-signal/Overload contact/Scav. air signal • RPM command • Back-up/Separate RPM • Safety signals (slow-down, shut-down)	☐ …………
1.5.2 Gearbox	
Verify the gearbox interface: • Clutch IN/OUT (command and feedback) • Oil and air pressure • “Ready” and other interlock signals	☐ …………

1.5.3 Manoeuvre Recorder	
Verify the recorder interface: • Station "in command" signals • Pitch/Power/RPM signals • Other signals	☐ …………
1.5.4 Speed-Pilot	
Verify the speed-pilot interface: • Command request/enable/acknowledge signals • Pitch control from speed-pilot	☐ …………
1.5.5 DP-system	
Verify the DP-system interface: • Command request/enable/acknowledge signals • Pitch control from DP	☐ …………
1.5.6 Joystick	
Verify the joystick interface to main propellers: • Command request/enable/acknowledge signals • Pitch control from Joystick	☐ …………
1.5.7 Gyro	
Verify the gyro interface: • Correct heading information	☐ …………
1.5.8 Rudder(s)	
Verify the rudder interface: • Command request/enable/acknowledge signals • Rudder control from joystick	☐ …………

1.5.9 Tunnel Thruster(s)	
Verify the thruster interface: • Command request/enable/acknowledge signals • Rudder control from joystick	☐ …………
1.5.10 Monitoring System	
Verify the monitoring system interface: • Signals according to specification Example: Pitch/RPM/station in command etc.	☐ …………
1.5.11 Power Management System	
Verify the power management system interface: • Signals according to specification Example: Constant RPM/Shaft generator connected/PTO/PTI mode.	☐ …………

1.5.12 Remarks on “Interface (calibration and function test)”

1.6 Safety Precautions

1.6.1 Warning, Possible Danger!	
The design, calculations, and class approvals have been made to assure a safe and reliable function of the shaft line. The safety and reliability however, also depends on a correct installation and alignment of all components. Should any of the above mentioned not been done properly, it may result in parts coming loose or bursting due to unpredictable loads. In case personnel are in the vicinity, it may lead to severe injuries or in the worst-case fatal accidents.	☐ …………
1.6.2 Procedures	
Check that there is a yard step-by-step procedure, with checkpoints between each step, in place for the shaft line run-up. There must be responsible personnel appointed to monitor important parameters such as temperature, pressure etc.	☐ …………
1.6.3 Communication	
Check that the above procedure also includes a reliable method of communication between the monitoring and the operating personnel. In case of an emergency situation it should be completely clear to all personnel involved how to make an emergency stop and how to find safe escape ways, if necessary. Considerations must also be taken regarding escape ways in case of a black-out situation.	☐ …………

1 Seatrial Acceptance Test Record

1.1 Data

Yard/New building no……………………………………………………………………

Rolls-Royce AB file no: ……………………………………………………………………

Order no: ……………………………………………………………………………….. ……....

Date: ……………………………………………………………………………………………...

Rolls-Royce representative: ………………………………………………………………….

Customer representative: …………………………………………………………………….

1.2 Introduction

This document is a record of the seatrial acceptance test that is filled in by a Rolls-Royce service engineer during a harbour acceptance test. After each completed task the belonging box has to be checked and a signature written on the dotted line.

The document is a general document and all tests might not be applicable for the vessel.

1.3 Zero-Thrust Adjustment

1.3.1 Zero-Thrust Adjustment	
Final value for zero-thrust to be marked on OD-box scale: Value................	☐ …………

1.3.2 Remarks on “Zero-Thrust Adjusment”

1.4 Hydraulic Tests

1.4.1 Working Pressure, Maximum	
Inspect and note the (maximum) required hydraulic pressure for pitch control at full shaft RPM: Port:...................MPa Starboard:...................MPa	☐ …………
1.4.2 Working Pressure, at Design Pitch	
Inspect and note the hydraulic pressure in A and B at design pitch and at full shaft RPM (with no hydraulic control-valves activated). Port:...............MPa Starboard:...............MPa	☐ …………

1.4.3 Remarks on "Hydraulic Tests"

1.5 Function Test, Main Control

1.5.1 Main Engine Load	
Verify/calibrate 100% load on the main engine(s) (signal from FPS transmitter).	☐ …………
1.5.2 Combinator Control	
Verify the function of the "combinator control" of pitch/RPM. The test must be performed with Load Limit Settings (LLS) in 100% position. • Pitch and RPM control from lever • Curves according to combinator diagram	☐ …………
1.5.3 Load Control	
Check of load control function: • Load regulated, according to the load curve • FPS indicator(s) • Overload indication • Load limit setting (adjustment by LLS-knob) • Override of LLS, with 100% power function	☐ …………

1.5.4 Load Sharing	
Check of load sharing function: • Load sharing setting (adjustment by load sharing-knob) • Load sharing regulation (check FPS indicators) • Auto/Manual mode (function and indication)	☐ …………
1.5.5 Load Increase/Decrease Program	
Check of load increase function: • Load increase/decrease regulated according to Curves • Pitch reduced indication • Override by 100% power function	☐ …………
1.5.6 Wind Milling Protection	
Check of wind-milling function: • Stop of pitch reduction when over speed • RPM feedback exceeds RPM command by 4% (parameter)	☐ …………

1.5.7 Remarks on “Function Test, Main Control”

1.6 Function Test, Joystick (Dynamic)

Make dynamic test and adjustment of joystick.

1.6.1 Weight Factors	
Verify/adjust the weight factors.	☐ …………
1.6.2 Harbour Mode	
Verify/adjust the harbour mode: • Heading balance, when side movement • Dynamic heading test • Bow/Mid/Stern rotation centre • Manoeuvring test (combined rotation and sideways manoeuvres	☐ …………
1.6.3 Sea Mode	
Verify/adjust the sea mode: • Dynamic heading test at half speed • Dynamic heading test at full speed	☐ …………

1.6.4 Remarks on “Function Test, Joystick”

1.7 Speed Trials

1.7.1 Mile Run	
During mile run, check and note values below: Port / Stbd Power (KW) .... Shaft RPM (rev/min) .... Pitch (P/D) .... Pitch on OD-box (mm) .... Ship speed (Knots)	☐ …………
1.7.2 Mile Run (100%)	
During mile run, at 100% engine power, check and note values below: Port / Stbd Power (KW) .... Shaft RPM (rev/min) .... Pitch (P/D) .... Exhaust temp (℃) .... Scav. air pressure (MPa)............ .... Ship speed (Knots)	☐ …………

1.7.3 Remarks on “Speed Trials”

1.8 Bullard Pull

1.8.1 Bullard Pull	
During bullard pull test, check and note values below: Port / Stbd Pull (kN) .... Power (KW) .... Shaft RPM (rev/min) .... Pitch (P/D)	☐ …………

1.8.2 Remarks on “Bullard Pull”

1.9 Crash Stop Test

1.9.1 Crash Stop Test	
Make a crash stop (from full speed) and note the result below: Time..............Stop distance................	☐ …………

1.9.2 Remarks on “Crash Stop Test”

1.10 Data Dump

1.10.1 Data Dump	
When the tests are successfully carried out and adjustments and calibrations have been performed, the parameter settings and function curves should be saved using the data dump function.	☐ …………

1.10.2 Remarks on “Data Dump”

Tools

Introduction

Every task in the installation and maintenance parts includes a section with recommended equipment called Support Items. The Special Tool and Test Equipment table in the Support Items section covers the special tools and additional tools needed to perform the task, it does not include standard tools. Rolls-Royce presumes that standard tools are available on board the vessel, see section Standard Tools for recommended standard tools.

Standard Tools

Rolls-Royce presumes that standard tools are available on board the vessel. Rolls-Royce recommends that at least the following standard tools are available (note that the illustrations may not be an exact copy of the tools on board the vessel):

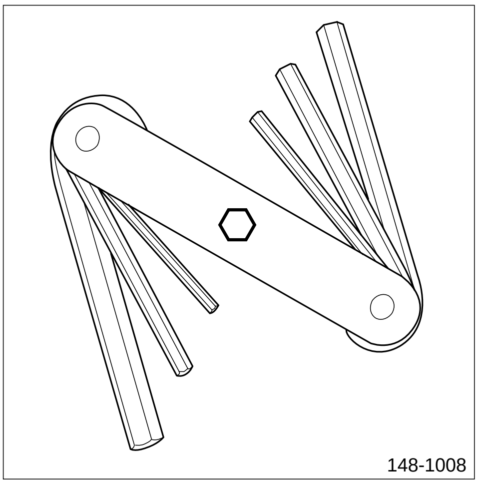


Figure 1 Allen key kit.

Figure 2 Socket wrench kit (including ratchet wrench, ratchet wrench extension and sockets).

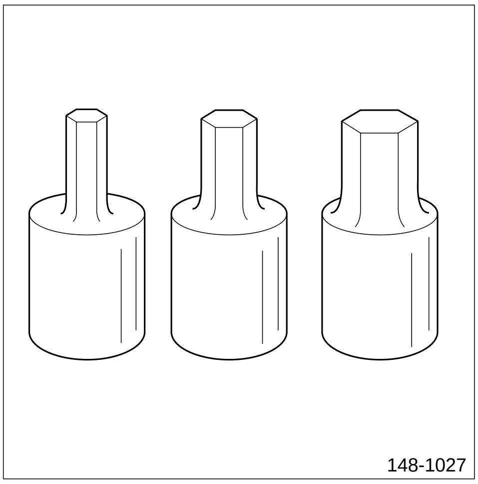


Figure 3 Hexagon wrench kit fitting ratchett wrench .

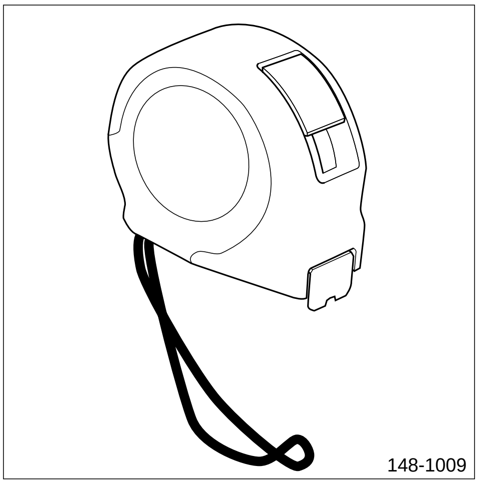


Figure 4 Measure tape.

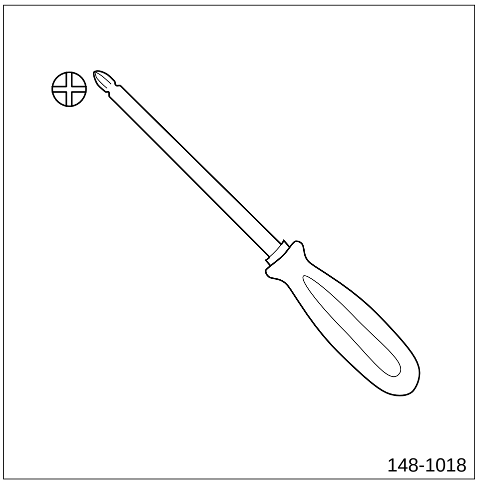


Figure 5 Screw driver (Philips type).

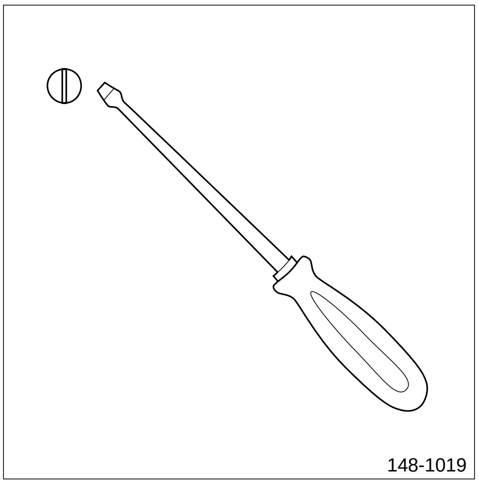


Figure 6 Screw driver (slotted).

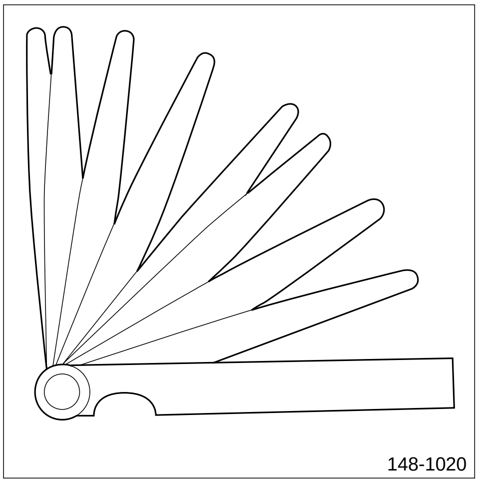


Figure 7 Feeler gauge.

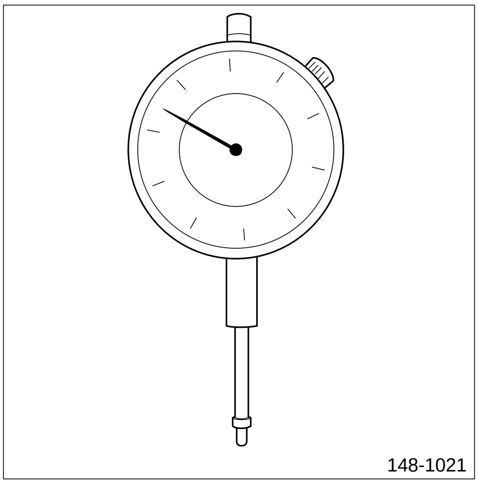


Figure 8 Dial indicator.

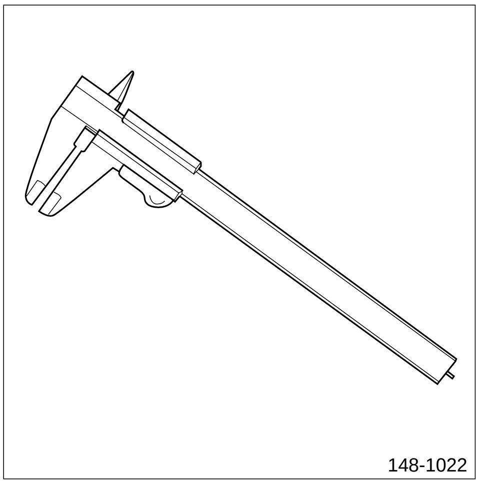


Figure 9 Sliding caliper.

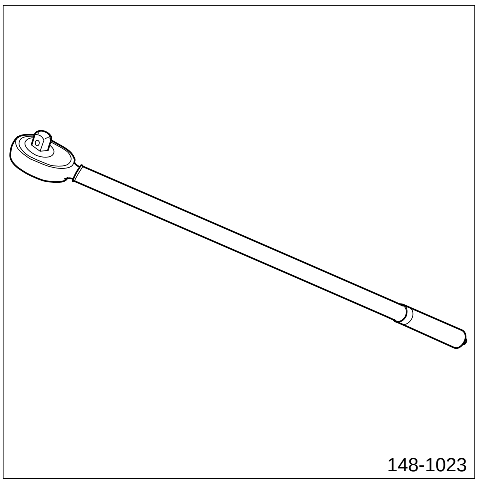


Figure 10 Torque wrench.

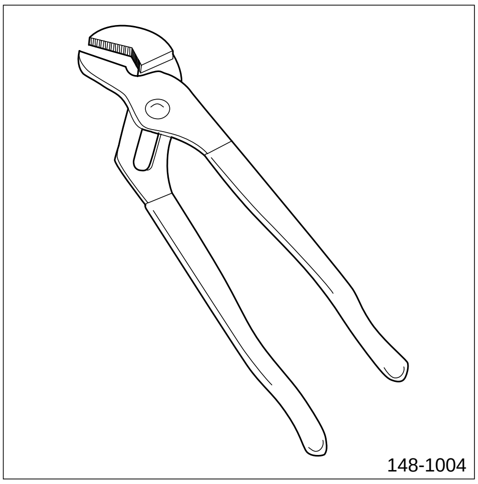


Figure 11 Universal plier.

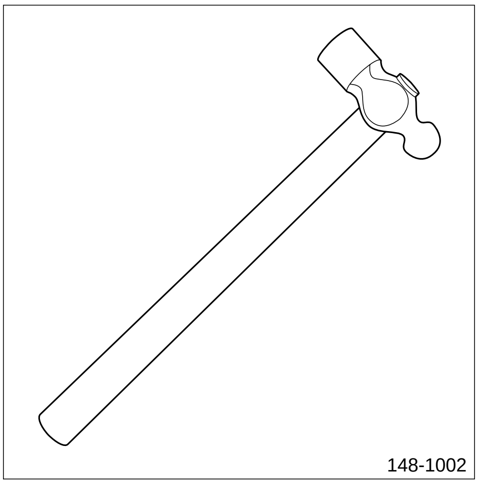


Figure 12 Ball hammer.

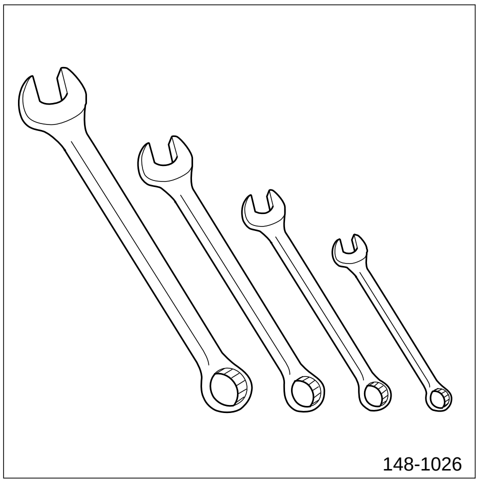


Figure 13 Spanner kit.

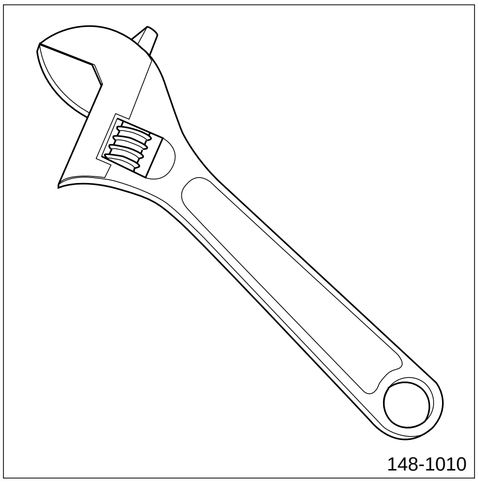


Figure 14 Adjustable wrench.

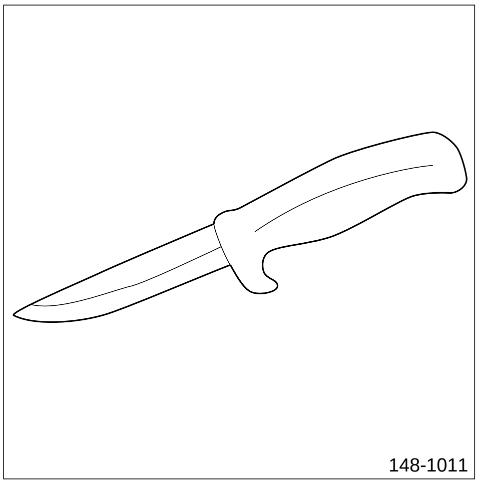


Figure 15 Knife.

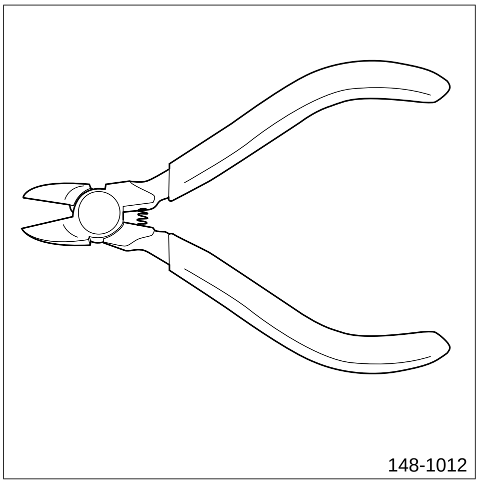


Figure 16 Side cutting plier.

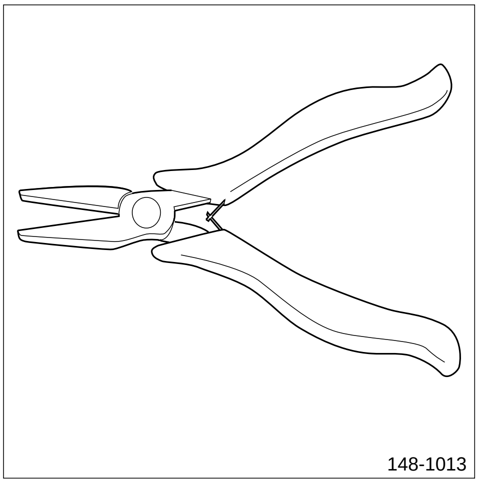


Figure 17 Flat plier.

Lifting Tools

All Rolls-Royce lifting tools are tested and approved according to 2A 98/37/EG Machinery Directive. For more information see the appended user manual for lifting tools in part Tools.

Special Tools

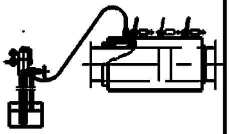
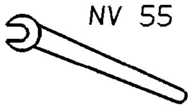
If special tools are part of the Rolls-Royce delivery they are listed in part Design Drawings. The special tools are tools that are manufactured by Rolls-Royce and included in the delivery of the propulsion system. To order special tools, please contact nearest Rolls-Royce Marine Global Support Network.

Additional Tools

Additional tools are not part of the Rolls-Royce delivery but are mentioned in the support items table to facilitate the maintenance of the propulsion system.

.

B

Nr. No.	Benämning Description	Skiss Sketch	Material Material	Ant. No of	Märkning Marking Ritning Drawing	Märkning Marking Det. Item	Placering Location
1	MONTAGEVERKTYG MOUNTING TOOLS			1	943587□	1-2	SKF KOPPLING SKF COUPLING
2	U-NYCKEL U-SPANNER	NV 55  STAHLVILLE 4004-55	STÅL STEEL	2	-	2	DUBBELRÖR TWIN TUBE
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

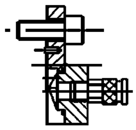
KaMeWa
A Vickers P.L.C. company

AXELLEDN. HÅLBORRN. Ø65
SHAFTING (60-66XF5/4)
VERKTYG
TOOLS

Uppgj.	Kontr.	Godk.	
Sdb	Lnr	JÅN	
Datum 970715	Föreg. ritn. _	Skala –	A4

104500

B

Nr. No.	Benämning Description	Skiss Sketch	Material Material	Ant. No of	Märkning Marking: Ritning Drawing	Märkning Marking: Det. Item	Placering Location
1	NÖDMANÖVER-PLUNGE EMERGENCY-PLUNGER		STÅL STEEL	1	948427	1-7	OLJEINFÖRNINGS-RÖR OIL DISTRIBUTION PIPE
2	NÖDMANÖVER-SLANG EMERGENCY-HOSE	7m	GUMMI RUBBER	1	961214	1-6	PLUNGE PLUNGER
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

KAMEWA
A Vickers P.L.C. company

VERKTYG NÖDMANÖVER
TOOLS EMERGENCY CONTROL

TO-BOX
OD-BOX
ø35

Uppgj.	Kontr.	Godk.
JA	Lnr	Nna
Datum 920115	Föreg. ritn. –	Skala – A4

940832

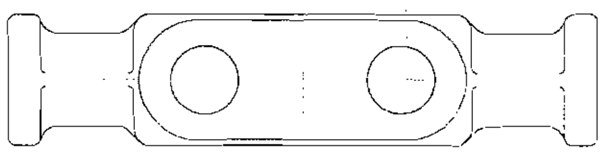
Rolls-Royce AB
PO Box 1010
S-681 29 Kristinehamn, Sweden
Tel:+46 550 84000,
Fax:+46 550 18190

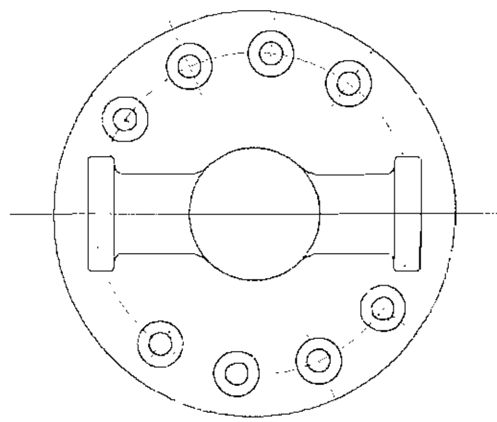
Users manual

For lifting yoke,

Instruction no: 49517-E

Utfärdare/Author	Referens/reference	Datum/date	Sida/page
L-G Andersson PM 12 Leif Mörk P 41		27/9-2002	1/3





1.Information

Purpose of use

Forward lifting yoke that together with aft lifting yoke is constructed to lift Rolls-Royce hubs with or without blades.

Technical data

Maximum load:	See data on lifting yoke
Tightening torque:	See data on lifting yoke

2.Safety information

General

Make sure that the load doesn't exceed the maximum load. **Caution!!! Never stand under or next to the propeller when lift is in progress.**

Danger

When lifting, moving or lowering of the hub, pay attention that no person is in the immediate area or under the hub unit.

Prohibited action

The yoke is constructed to lift only Rolls-Royce propeller hubs together with an aft lifting yoke. All other use is prohibited.

3. Instruction

Preparations

Only persons that have good knowledge in the use of the tool shall handle the application. The manual should also be read carefully before use.
Check that the parts are free from wear and cracks, if wear or cracks are visible replace part before using. In any problem, contact the manufacturer.

User instruction

1. Make sure that preparations are correct.
2. Check that the yoke is properly mounted and that the bolts are tightened with proper torque.
3. Fit the hoisting sling on to the yoke. Make sure that you use the hoisting sling that is made for the weight you lift.
4. Connect the sling to the lifting crane hook.
5. Make a test lift.
6. If there is necessary to make some adjustments, do it before you make the actual lift.

Caution

Lift in a smooth and steady move, avoid snatching that causes heavy stresses in slings and yoke, and also avoid the hub to rocking or swinging witch may cause overload.

Final action

When operation is finished demounts the yoke and check for wear and cracks, before storage.

4.Maintenance

Storage

The tool should be kept in a dry place to avoid corrosion. The tool should be protected with an anticorrosion or oil after use.

Maintenance

Check that the tool is free from corrosion, wear and cracks. Make sure that the bolt threads run smoothly and that the threads are undamaged on the bolt. Maintenance should be made according to SS 7685006 or similar standard within EU.

Modifications

The manufacturers guarantees are not valid if any modification or changes are made to the tool components without written permission from Rolls-Royce AB (Production Development).

Rolls-Royce AB
PO Box 1010
S-681 29 Kristinehamn,
Sweden
Tel:+46 550 84000,
Fax:+46 550 18190

Users manual

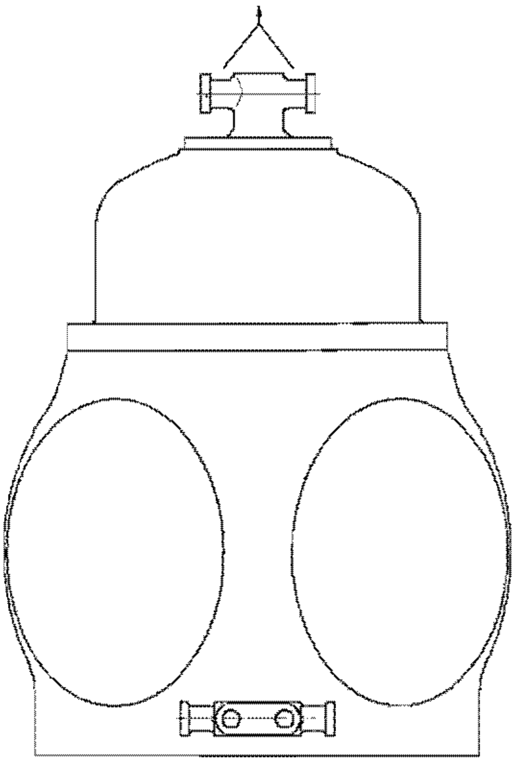
For lifting yoke,

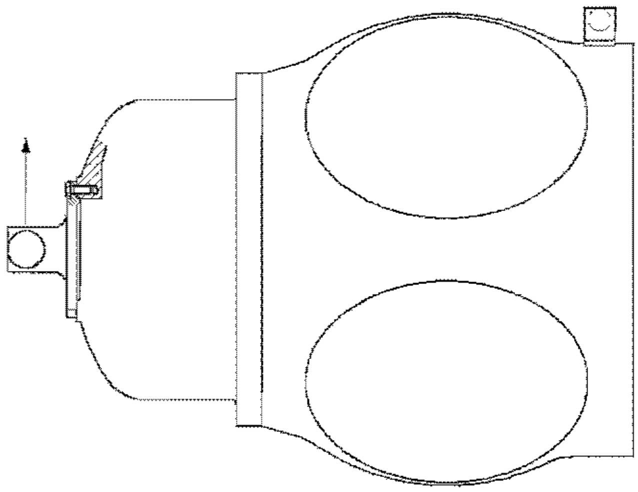
Instruction no:	
49517-E	

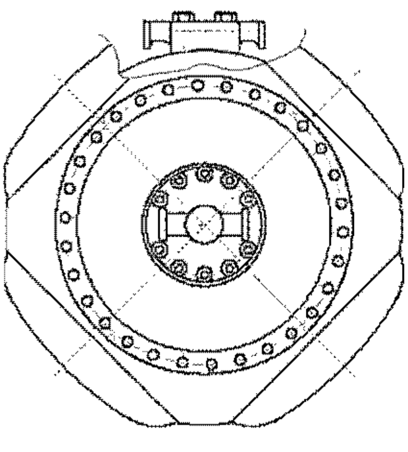
Utfärdare/Author	Referens/reference	Datum/date	Sida/page
L-G Andersson PM 12 Leif Mörk P 41		27/9-2002	3/3

Assembly instructions

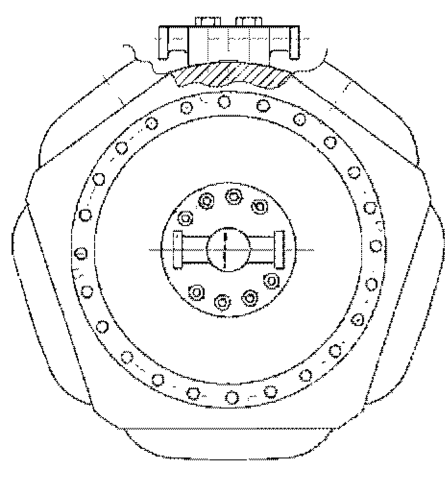
Forward lifting yoke and aft lifting yoke assembled together according to these instructions.







4 blade propeller



5 blade propeller

Rolls-Royce AB
PO Box 1010
S-681 29 Kristinehamn, Sweden
Tel:+46 550 84000, Fax:+46 550 18190

Rolls-Royce

DECLARATION OF CONFORMITY

According to 2A 98/37/EG Machinery Directive

Ensures that

Lifting equipment: Lifting yoke

Testing load is 150% of maximum load

Drawing number	Maxload	Testing load
F01-943941-1	12000 kg	18000 kg
F01-935470-1	20000 kg	30000 kg
F01-943952-1	30000 kg	45000 kg
F01-943958-2	40000 kg	60000 kg
F01-943944-1	12000 kg	18000 kg
F01-935461-1	20000 kg	30000 kg
F01-943953-1		
F01-943959-1	32000 kg	48000 kg
F01-987096-1	40000 kg	60000 kg

- Fulfil the regulation AFS 1993:10 "Machines and other technical Equipments" or similar national regulation in EG country witch transforms 98/37/EG.

Referring to standards used for construction or other technical specifications for this item.

-
-

Date and Place

Kristinehamn 2004-11-09

Authorized signers

Stefan Elm

Anders Björe

Produced by: KK297 Approved by: Revision: Sign:
Creation date: 31 August 2010 Revision date:

Design Drawings

1.1 Mechanical and Hydraulic Drawings

Drawing Title	Drawing Number	Design
Shafting		
Shafting Arrangement	DMN200000864 rev E	
Main Assembly and Marking Drawing	DMN200001313 rev A	
Propeller Unit Drawing with Marking, Port	RRM200005971 rev B	
Propeller Unit Drawing with Marking, Starboard	RRM200005972 rev B	
Propeller Shaft Assembly	RRM200005966 rev B	
Twin tube	RRM200008623 rev A	
Stern Tube Assembly	RRM200006467 rev A	
Stern Tube Bearing Aft	RRM200006474 rev B	
Stern Tube Intermediate Bearing	RRM200006475 rev B	
Stern Tube Bearing forward	RRM200006476 rev B	
SKF Coupling Assembly	RRM200005975 rev A	
PDn Diagram	10S000239/42061-O	
Propeller Hub		
Hub Assembly Left	RRM200009345 rev A	
Blade Outline	10S000239/R185033-O	
Tightening and Locking of Screws		
Instruction for Tightening of Screws	586431 rev A	
Instruction for Locking of Screws	998174 rev A	
Plug for Lifting Hole Assembly	144 112 rev –	
Oil Distribution Box		
OD-box Assembly	214 000 rev A	
OD-box Dimension	154 903	
OD-box Connection to Gear	214740	
Feed Back Box Assembly (F0/FA)	RRM200000128 rev C	

Drawing Title	Drawing Number	Design
Hydraulic System		
Hydraulic System Assembly	RRM200007036 rev B	
Hydraulic Diagram	DMN200000689 rev D	
Gravity Tank Assembly	RRM200011521 rev A	
Hydraulic Power Pack	RRM200007037 rev D	
Connection Diagram Power Pack	DMN200000981 rev B	
Pump Motor Starter P1/P2	RRM200007038 rev B	
Pump Motor Starter P3	RRM200007039 rev B	
Cable drawing	DMN200000983 rev B	
Cable Connection drawing	DMN200000984 rev B	
Remote Supervision Hydraulic	DMN200000982 rev B	

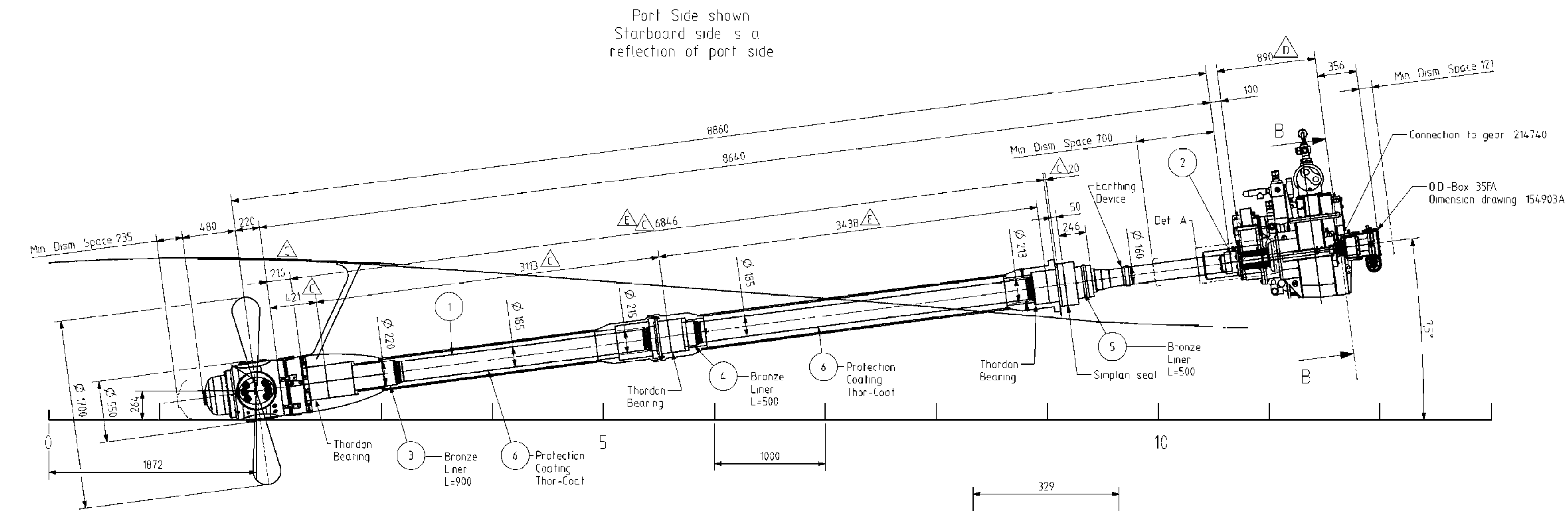
Design Drawings

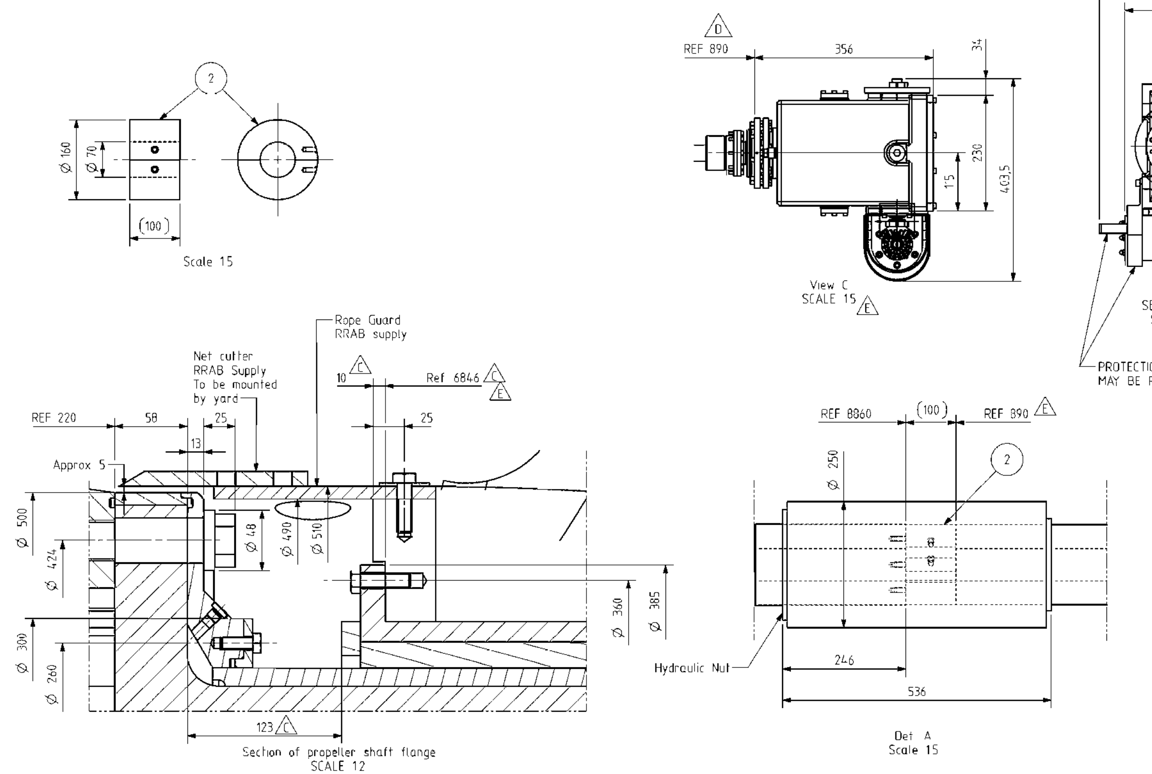
Yard: Halifax Shipyard

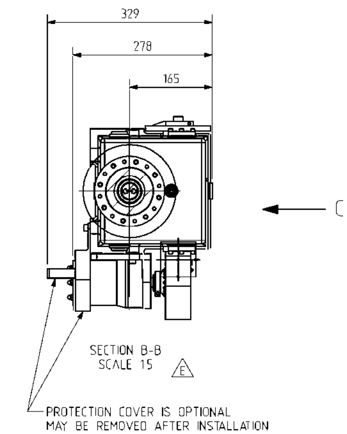
Yard number: 2603

Remote Control System

Drawing Title	Drawing Number	Revision
Main drawing	RRM200005995	A
Bom Report	RRM200005995	A
Cable drawing	DMN200001162	A
Cable connection drawing	DMN200001162	A
Load curve	-	-
Combinator diagram	-	-
Control panel Main bridge PORT	RRM200005922	A
Control panel Main bridge STBD	RRM200005925	A
Control panel Wing stations (PORT propeller)	RRM200005949	A
Control panel Wing stations (STBD propeller)	RRM200005950	A
Control panel ECR	RRM200005951	A
Load control panel	RRM200001864	A
Sep. RPM control panel	RRM200002414	A
Clutch Control panel Main bridge	RRM200005928	A
Clutch Control panel ECR	RRM200005952	A
RPM indicator	128 952	-
RPM indicator ECR	128 967	-
Impulse band	107 127	b
RPM transmitter for indication	510 800	c
RPM transmitter for control system	107 009	c
Central unit	129 066	b
Clutch Control unit	129 066	b







HOLE DIAMETER Ø65

DATA OF PROPELLER

Diameter:	1700 mm
Weight:	932 kg
Mass moment of inertia at MCR condition, J:	184 kgm² in water
Mass moment of inertia, J:	111 kgm² in air
Material:	NiAl Bronze
Direction of rotation, seen from aft:	Outwords over the top
Propeller speed:	491.9 r/min
Numbers of blades:	4

DATA OF MAIN ENGINE PER SHAFT

Number: 1	Type:	MTU 12V4000M93L
Cycles: _	No of cyl: _	
Brake power, P_B at max.cont. rating:		2500 kW
Engine speed:		2100 r/min
Make and type of engine coupling:		_
Make and type of reduction gear:		_

CLASSIFICATION SOCIETY

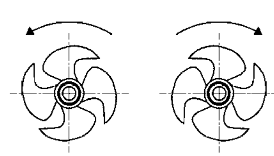
LRS

Ice class:	No ICE

TVC SCHEME DRAWING: DMN200000945

MATERIAL PROPERTIES

Item	Min tens.strenght N/mm	Min yield point N/mm	Min elongation % on 5.65+√So	Impact test, min. KV (J) at -10°C	Weight kg
1	600	300	18	_	1630
2	_	315	_	_	13
3	270	130	16	_	74
4	270	130	16	_	31
5	270	130	16	_	42
6	Protection Cooting				



SEEN FROM AFT

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	-

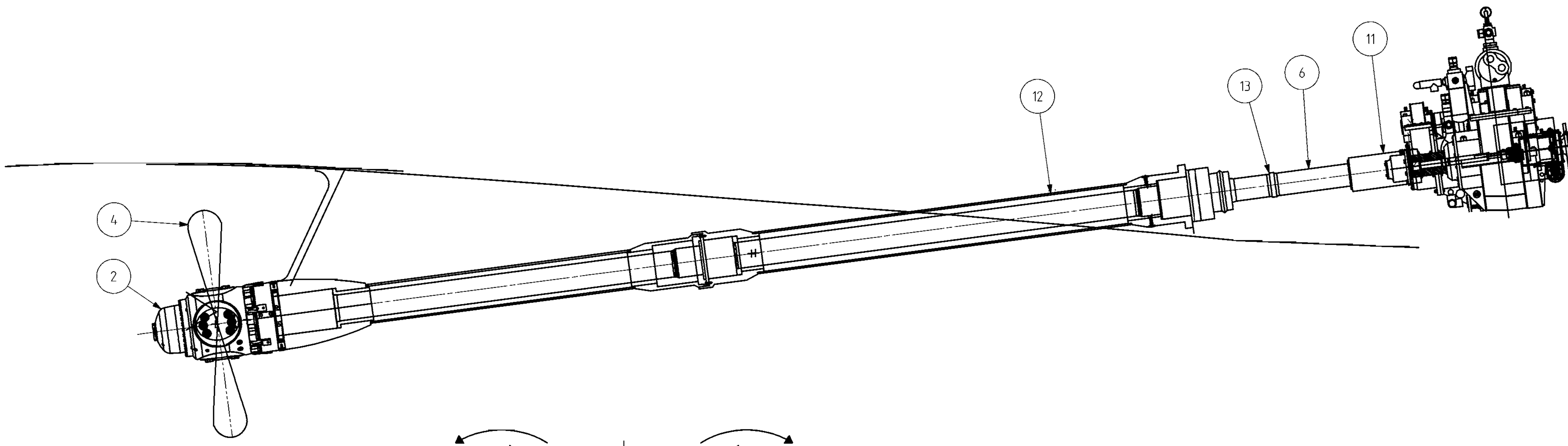
Drawing, Arrangement
2x 55A/4D-B-G - 35FA
Axelarrangemang K-200

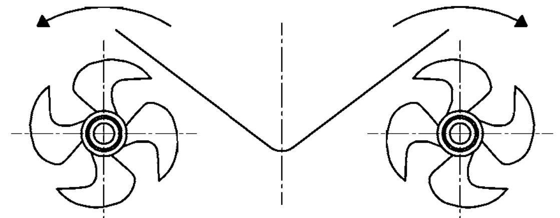
Rolls-Royce
Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin/Date	Scale	Format	Sheet
JH 2010.03.23	1:20	A1	1 of 1

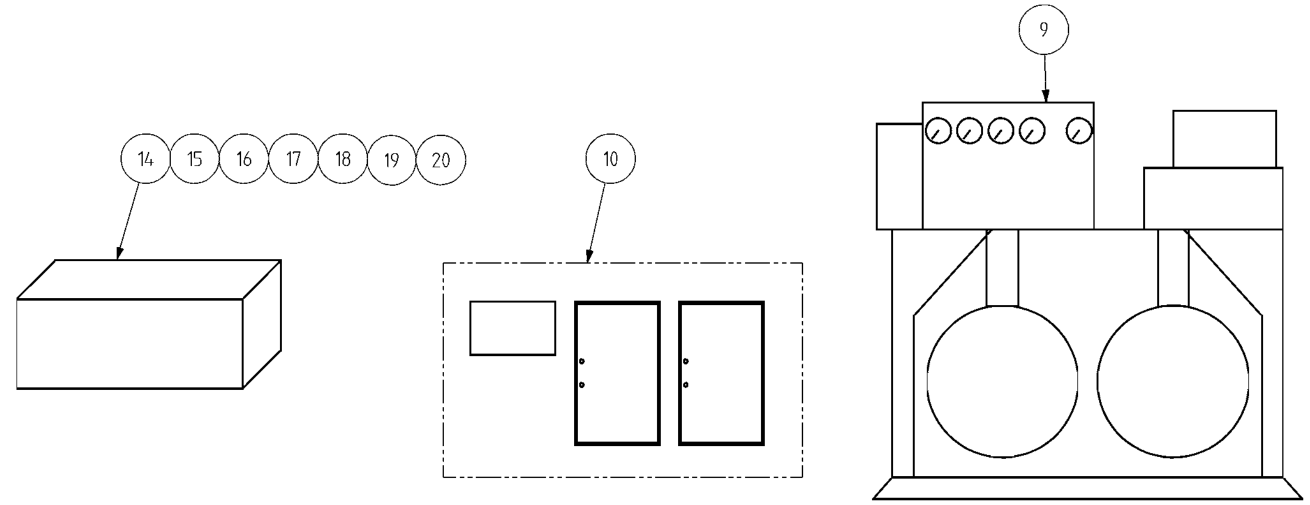
Drawing no: DMN200000864
Revision: E

PORT SIDE SHOWN





SEDD AKTERIFRAN
SEEN FROM AFT



MÄRKNING AV DETALJER

DETAILS TO BE MARKED

ORDER NO.	NYB. NR. YARD NO.	BABORD PORT – VÄNSTER-ROTERANDE LEFT HAND TURNING – RR MÄRKNING RR MARKING	STYRBORD STARBOARD – HÖGER-ROTERANDE RIGHT HAND TURNING – RR MÄRKNING RR MARKING
10S000239	K-200-1	16514	16515
10S000240	K-200-2	16516	16517
10S000241	K-200-3	16518	16519
10S000242	K-200-4	16520	16521
10S000243	K-200-5	16522	16523
10S000244	K-200-6	16524	16525
10S000245	K-200-7	16526	16527
10S000246	K-200-8	16528	16529
10S000247	K-200-9	16530	16531

	Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark
HYDRAULIC SYSTEM	9	1	HYDRAULIKSYSTEM	RRM200007036	---	---
O.D.-BOX ASSY LEFT	7	1	T.O.-BOX SMST VÄNSTER	RRM200009766	---	Note 1
PROPELLER SHAFT ASSY.	6	1	PROPELLERAXEL SMST	RRM200005966	---	Note 1
PROPELLER BLADE	4	4	PROPELLERBLAD, VÄNSTER	RRM200005946	---	---
PROPELLER HUB	2	1	PROPELLERNAV, VÄNSTER	RRM200009345	---	---

Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark
9	1	HYDRAULIKSYSTEM	RRM200007036	---	---
8	1	T.O.-BOX SMST HÖGER	RRM200005985	---	Note 1
6	1	PROPELLERAXEL SMST	RRM200005966	---	Note 1
5	4	PROPELLERBLAD, HÖGER	RRM200005943	---	---
3	1	PROPELLERNAV, HÖGER	RRM200009225	---	---

Note 1: Shaft and O.D.-BOX assemblies includes the twin tube

DESCRIPTION	ITEM NO.	NO. OF	SWEDISH DESCRIPTION	REFERENCE
TOOLS EMERGENCY CONTROL	20	1	VERKTYG NÖDMANÖVER	940832A
TOOLS SHAFTING	19	1	VERKTYG AXELLEDNING	104500A
TOOLS HUB	18	1	VERKTYG NAV	---
SPARE PARTS STARTERS	17	1	RESERVDELAR STARTERS	RRM200007041
SPARE PARTS HYDRAULIC	16	1	RESERVDELAR HYDRAULIK	RRM200007040
SPARE PARTS O.D.-BOX	15	1	RESERVDELAR T.O.-BOX	214017A
INSTALLATION SPARE KIT HUB	14	1	INSTALLATIONSSATS NAV	---
EARTHING DEVICE	13	2	JORDNINGSUTRUSTNING	RRM200005977
STERNTUBE ASSY	12	2	AXELHYLSA SMST	RRM200006467
SHAFT COUPLING	11	2	KOPPLING	RRM200005975
CONTROL SYSTEM ASSY	10	1	MANÖVERSYSTEM SMST	RRM200005995
SHAFTING ARRANGEMENT	1	1	AXELARRANGEMANG	DMN200000864

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	-

Drawing, Assembly
55A/4D -35FA
Main assy & Mark drawing

Rolls-Royce

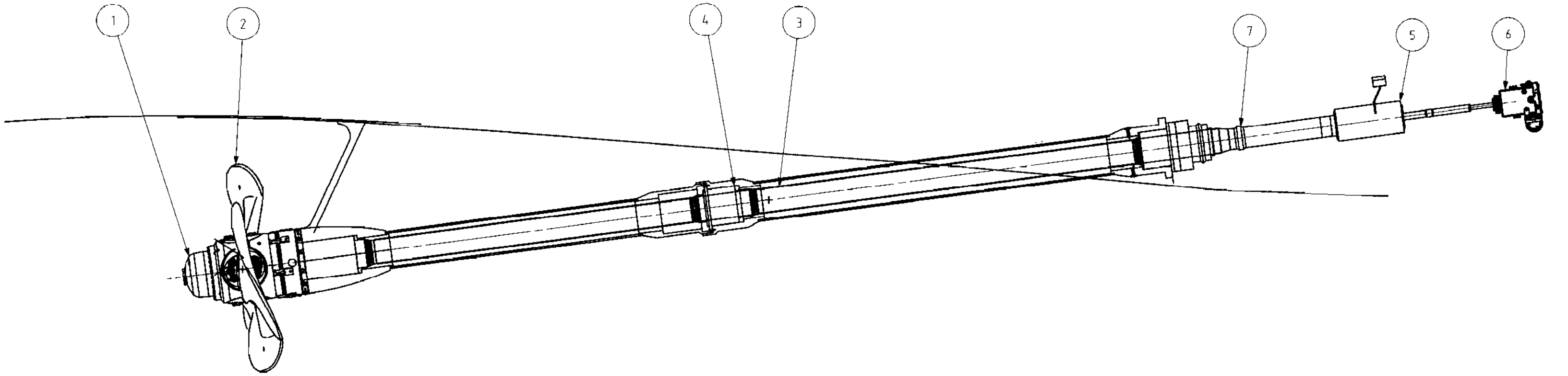
Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin./Date:	Scale:	Format:	Sheet:
Wkg 2010.07.15	1:20	A1	1 of 1

Drawing no: DMN200001313 — Revision: A

Access List:

RR Affis info class



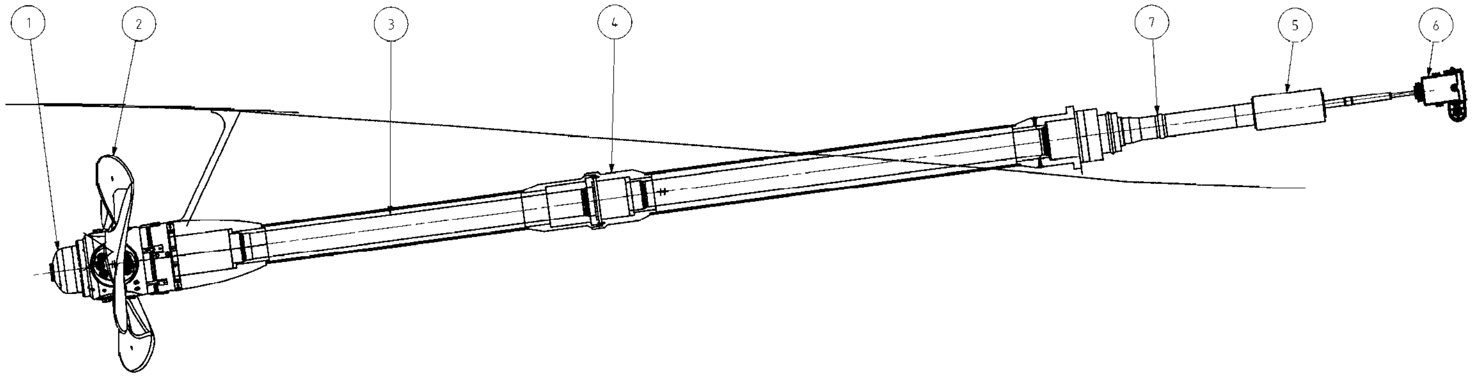
General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO1302 Ra µm	R 0,8 - 1,6	3140

Propeller Unit, CPP
55A/4-DBG
Propellerenhet, Babord

Rolls-Royce

Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin./Date:		Scale:	Format:	Sheet:
JH	2010.12.09	1:20	A1	1 of
Drawing no:	RRM200005971			Revision: B



General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO1302 1302 Ra µm	R 0,8 - 1,6	3140

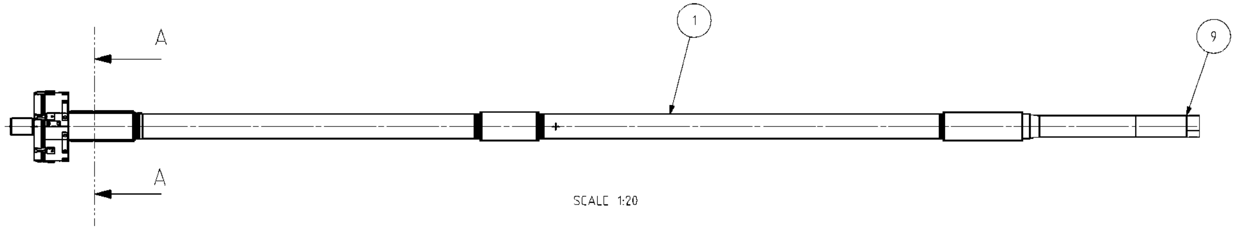
Propeller Unit, CPP
55A/4-DBG
Propellerenhet, styrbord

Origin./Date:		Scale:	Format:	Sheet:
JH	2010.12.09	1:20	A1	1 of 1

Drawing no:	Revision:
RRM200005972	B

Rolls-Royce

Rolls-Royce AB
S-681 29 KRISTINEHAMN



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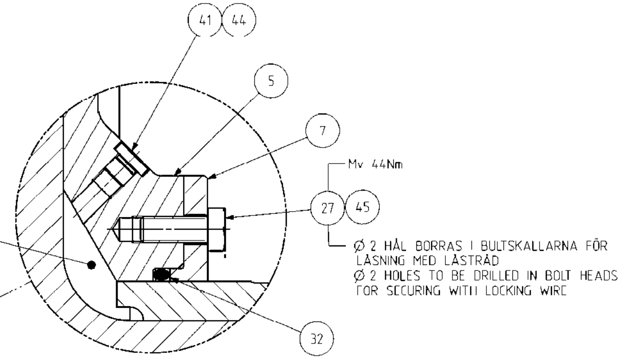
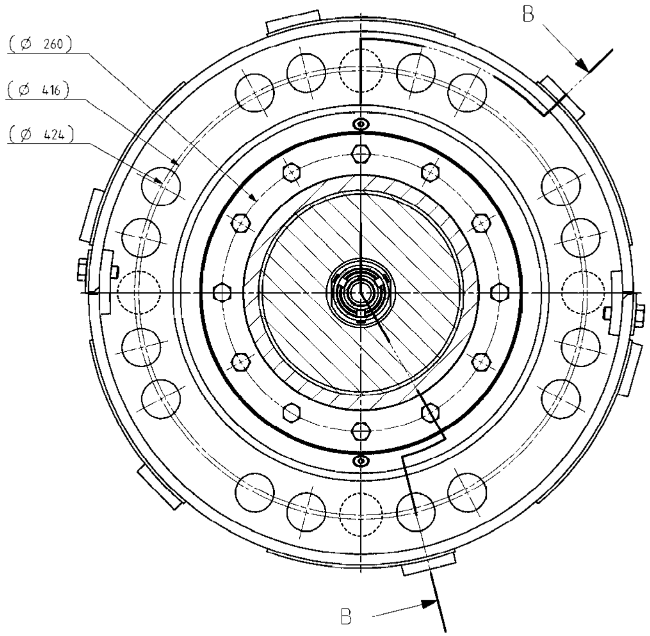
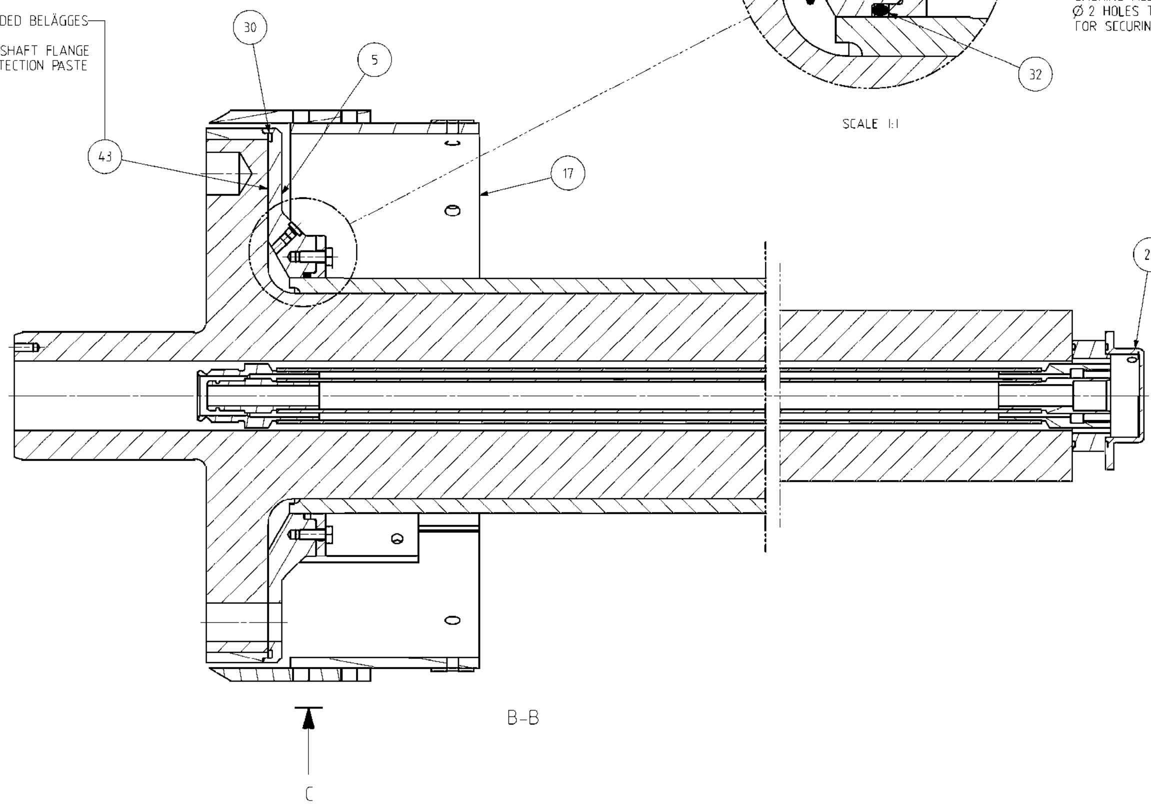


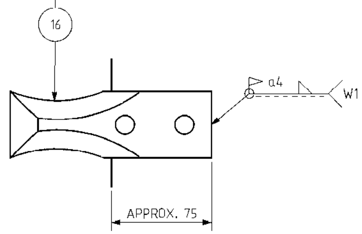
SCALE 1:1



A-A
SKALA / SCALE 2:5



B-B



VY / VIEW C
SCALE 1:2

SVETSBESTÄMMELSER WELDING RULES	SVETSSTANDARD FÖR ROLLS-ROYCE AB WELDING STANDARD FOR ROLLS-ROYCE AB
GRUNDMATERIAL PARENT METAL	—
AVSPÄNNINGSGLÖDGNINGSTEMPERATUR STRESS-RELIEVING HEAT TREATMENT AT	SE SVETSDATABLAD SEE WELDING PROCEDURE SPECIFICATION (WPS)
SVETSPLAN SEQUENCE OF WELDING	SE SVETSDATABLAD SEE WELDING PROCEDURE SPECIFICATION (WPS)
TÄTHETSKRAV SEALING REQUIREMENTS	— —
SVETSTOLERANS WELDING TOLERANCE	EN ISO 13920-BE

			PROVNINGSOMFATTNING EXTENT OF EXAMINATION				
SVETS NR WELD NO	SVETSKLASS WELDING CLASS	SVETSMETOD WELDING PROCESS	RÖNTGEN UNDERSÖKNING RADIOGRAPHIC EXAMINATION	ULTRALJUD UNDERSÖKNING ULTRASONIC EXAMINATION	MAGNETPULVER UNDERSÖKNING MAGNETIC PARTICLE EXAMINATION	PENETRANT UNDERSÖKNING LIQUID PENETRANT EXAMINATION	ANMÄRKNING REMARK
W1	C	—	—%	—%	—%	—%	

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO 1302 Ra µm	R 0,8 - 1,6	1850

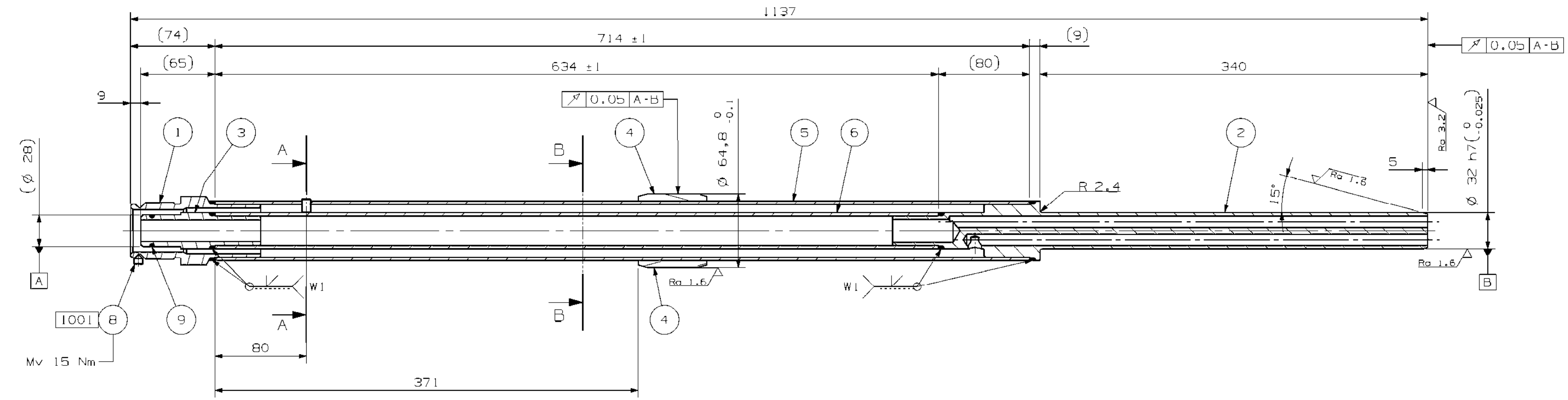
Propeller Shaft
55A/4-DBG
PROPELLER SHAFT ASSY

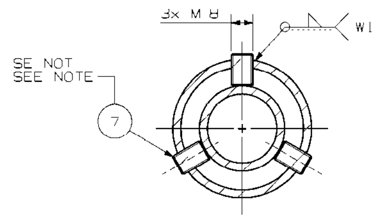
Rolls-Royce

Rolls-Royce AB
S-681 29 KRISTINEHAMN

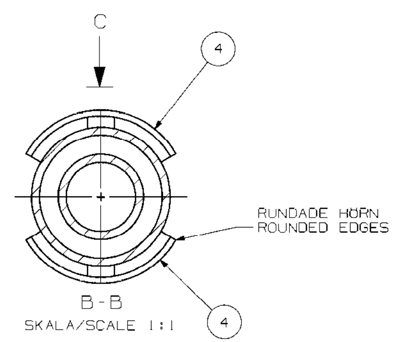
Origin./Date:		Scale:	Format:	Sheet:
Wkg	2010.06.10	1:2.5	A1	1 of 1

Drawing no:	Revision:
RRM200005966	B

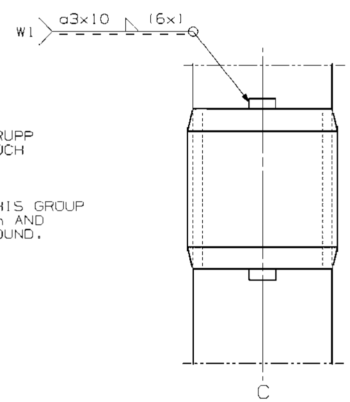




A-A
SKALA/SCALE 1:1



B-B
SKALA/SCALE 1:1



SKALA/SCALE 1:1

FÖR VERKSTAD

DUBBELRÖREN RENGÖRES NOGGRANT IN OCH UTVÄNDIGT FÖRE MONTAGE.

VARJE KOMPLETT DUBBELRÖRSDEL MÄRKES MED RÖRETS RITNIGNSNUMMER SAMT TILLV.NR. ENLIGT HUVUDSMST OCH MÄRKRITNING.

FOR WORKSHOP

BEFORE MOUNTING, THE TWIN TUBES ARE TO BE CLEANED CAREFULLY IN AND OUTWARDS.

EACH COMPLETE PART OF THE TWIN TUBE TO BE MARKED WITH DRAWING NO. AND MANUFACTURING NO. ACC. TO MAIN ASSY AND MARK DRAWING.

SVETSBESTÄMMELSER WELDING RULES	SVETSSTANDARD FÖR ROLLS-ROYCE AB WELDING STANDARD FOR ROLLS-ROYCE AB
GRUNDMATERIAL PARENT METAL	St35BK, EN S355JR
AVSPÄNNINGSGLÖDGNINGSTEMPERATUR STRESS-RELIEVING HEAT TREATMENT AT	SE SVETSDATABLAD SEE WELDING PROCEDURE SPECIFICATION (WPS)
SVETSPLAN SEQUENCE OF WELDING	SE SVETSDATABLAD SEE WELDING PROCEDURE SPECIFICATION (WPS)
TÄTHETSKRAV SEALING REQUIREMENTS	SE TÄTHETSPROV SEE PREASURE TEST
SVETSTOLERANS WELDING TOLERANCE	EN ISO 13920-BE

			PROVNINGSOMFATTNING EXTENT OF EXAMINATION				
SVETS NR WELD NO	SVETSKLASS WELDING CLASS	SVETSMETOD WELDING PROCESS	RÖNTGEN UNDERSÖKNING RADIOGRAPHIC EXAMINATION	ULTRALJUD UNDERSÖKNING ULTRASONIC EXAMINATION	MAGNETPULVER UNDERSÖKNING MAGNETIC PARTICLE EXAMINATION	PENETRANT UNDERSÖKNING LIQUID PENETRANT EXAMINATION	ANMÄRKNING REMARK
W1	C	_	_%	_%	_%	_%	

TÄTHETSPROV PRESSURE TEST

☐ Före bearbetning
Before machining

☒ Efter bearbetning
After machining

Kontrollmedium PROVTR. VÄTSKA
Test medium PRESSURE TEST LIQUID

Kontrolltryck 135 bar
Test pressure

Kontrolltryck i pilens-T→riktning
Test pressure applied in directio. of →

Tid 10 min.
Time

NOT
SKRUVARNA I DENNA GRUPP ANSÄTTES MED 10 Nm OCH TÄTSVETSAS RUNTOM.

NOTE
THE SET SCREWS IN THIS GROUP TO BE SET WITH 10 Nm AND WELDED TIGHT ALL AROUND.

[1001] LOCTITE 243

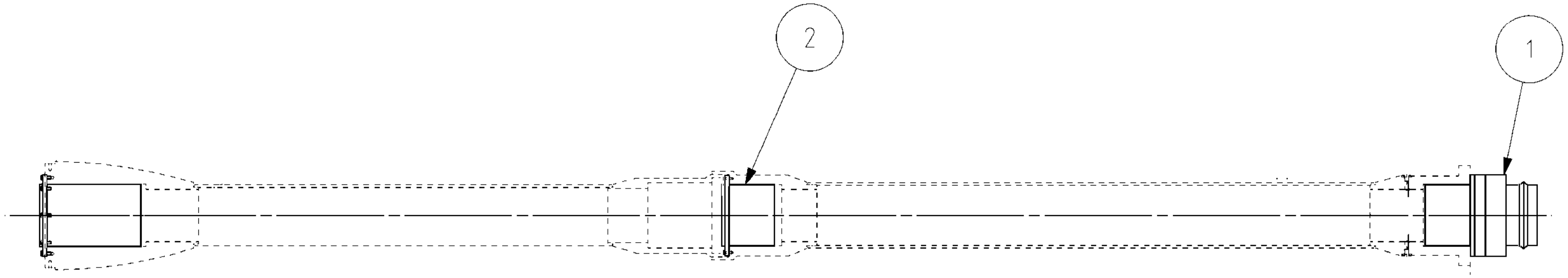
General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,1 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	8

Twin Tube
55A/4D-B -35FA
DUBBELRÖR; FÖRLIG DEL

Rolls-Royce
Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin/Date	Scale	Format	Sheet
Wkg 2010.07.08	1:2	A1	1 of 1

Drawing no: RRM200008623
Revision: A



General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	201

Stern Tube
55A/4-DBG
AXELHYLSA

Rolls-Royce

Rolls-Royce AB
S-681 29 KRISTINEHAMN

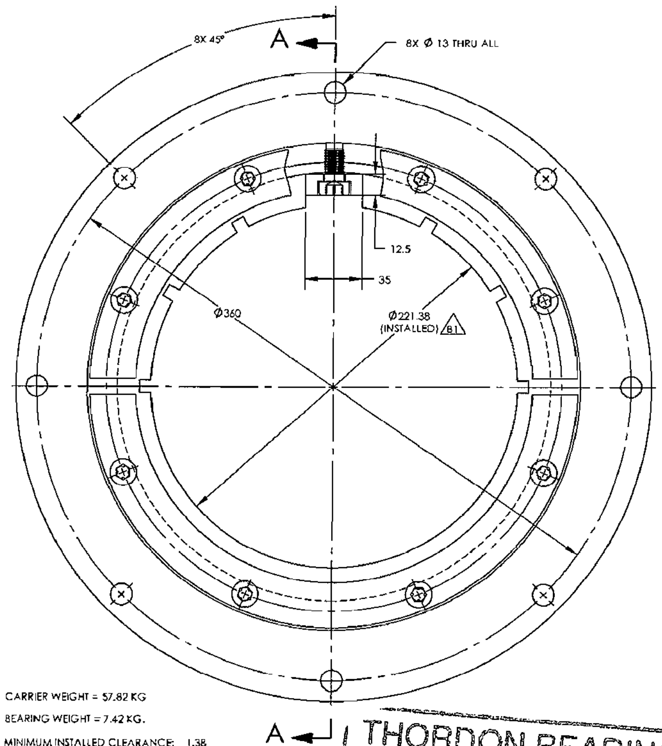
Origin./Date:		Scale:	Format:	Sheet:
Wkg	2010.07.12	1:1	A3	1 of 1
Drawing no:				Revision:
RRM200006467				A

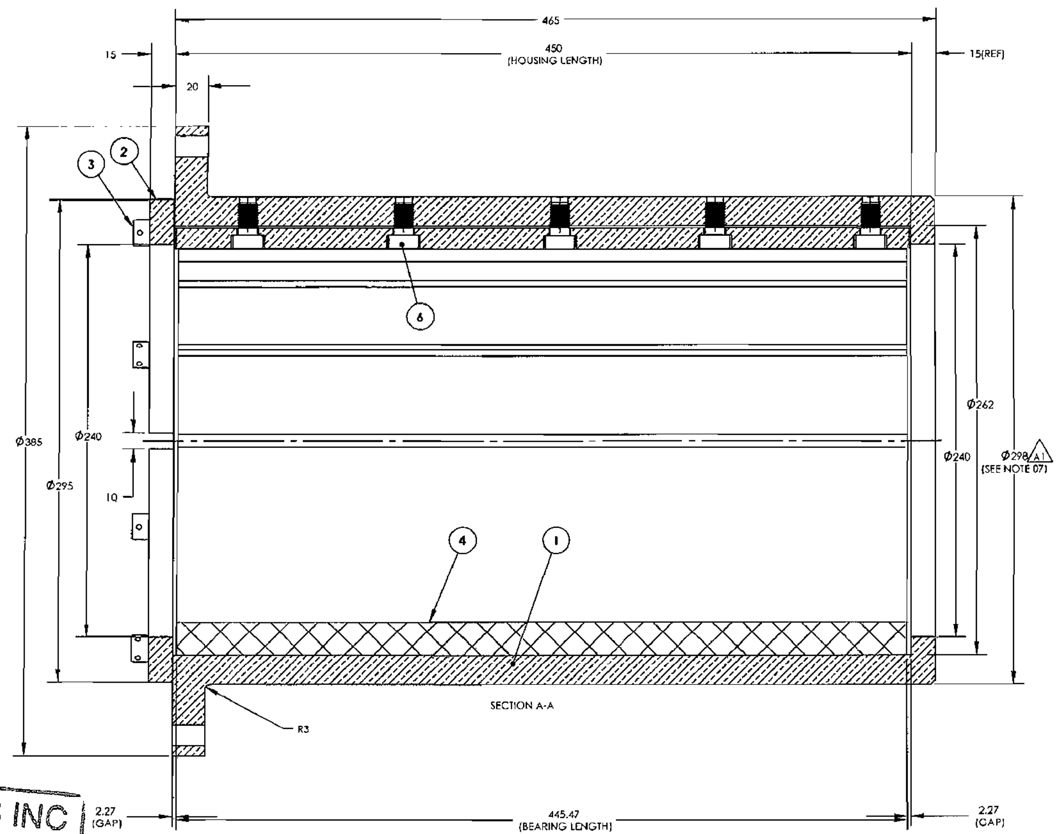
Acess List:

RR AB's Info class: Limited

ALL DIMENSIONAL INFORMATION IS BASED ON A MACHINING TEMPERATURE OF 21°C, UNLESS STATED OTHERWISE. MACHINE GROOVES ONLY WHERE SHOWN

ITEM NO.	QTY.	PARTNO	DESCRIPTION	Material	REMARKS	DRAWING NUMBER
1	1	F________	COMPAC BEARING	THORDON COMPAC		TG-21126
2	1	F________	RETAINING RING	BRONZE	SPLIT	TG-21128
3	1	F________	KEY	BRONZE		TG-21129
4	5	F________	CAPSCREW, LOW PROFILE HEX SOCKET HEAD	BRONZE C95400	DIN 6912-M12X20	TG-21130
5	8	F________	CAPSCREW, HEX SOCKET HEAD	AISI 316 ST. STEEL	DIN 912-M10 X 30	PURCHASE
6	1	F________	CARRIER	BRONZE		TG-21127





CARRIER WEIGHT = 57.82 KG
BEARING WEIGHT = 7.42 KG.
MINIMUM INSTALLED CLEARANCE: 1.38
RUNNING CLEARANCE: 0.88
THERMAL EXPANSION ALLOWANCE: 0.19
WATER SWELL ALLOWANCE: 0.31
TEMPERATURE RANGE: -2°C TO 45 °C
SHAFT DIA.: = 220
HOUSING DIA.: = 262
HOUSING LENGTH = 450

THORDON BEARINGS INC
APPROVED
FOR
PRODUCTION
29 Oct 2010
APPROVED BY

GENERAL NOTES:

01. MATERIAL: SEE PARTS LIST
02. DIMENSIONS ARE EXPRESSED IN MM UNLESS NOTED OTHERWISE.
03. DO NOT SCALE THIS DRAWING WORK TO DIMENSIONS SPECIFIED.
04. TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
05. BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
06. ALL FILLET AND RADII DIMENSIONS ARE NOMINAL UNLESS NOTED OTHERWISE.
A1 07. SHIPSETS #1 THRU 4 SUPPLIED AT Ø295

ROLLS ROYCE Rolls-Royce | Date. 2010-11-10 | Approved. JH
Sheet 1 of 1 | Drawing no RRM 200 006 474 | Revision: C

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED

UNLESS SHOWN OTHERWISE, MACHINING TOLERANCES ARE:
LINEAR UP TO 1m(40") +/-0.5 mm(±0.020")
OVER 1m(40") +/-1.0 mm(±0.040")
ANGULAR ±/0.25°
SURFACE FINISH 3.2μmRa (125μinch)
THORDON MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPARATOR

REV	DESCRIPTION	DATE	DWN	CKD	APPV
B1	ADDED DIMENSION	10/29/2010	GL	GA	GA
A1	WAS Ø295 & ADDED NOTE 07	10/18/2010	GL	GA	GA

THORDON BEARINGS INC.
BURLINGTON, ONTARIO, CANADA

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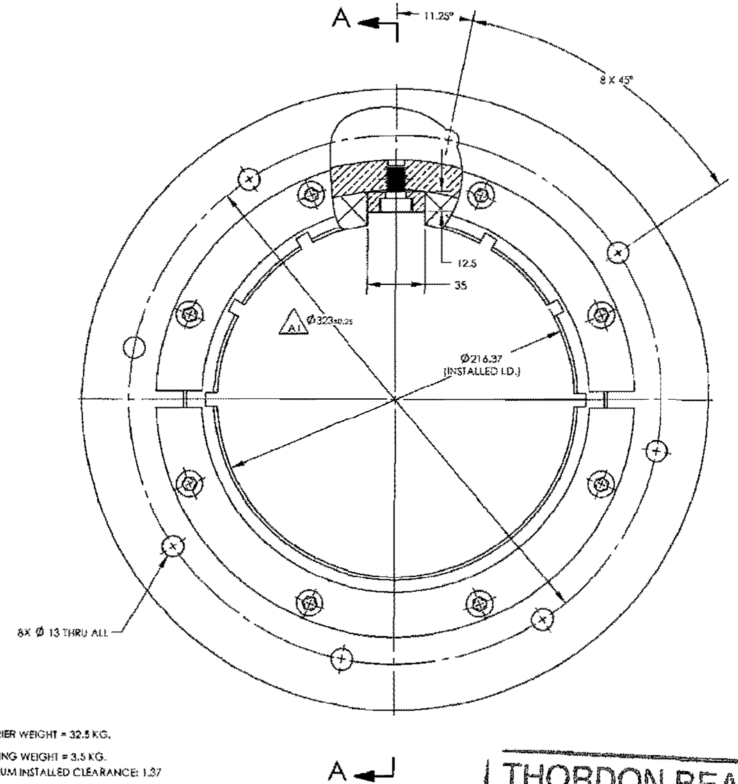
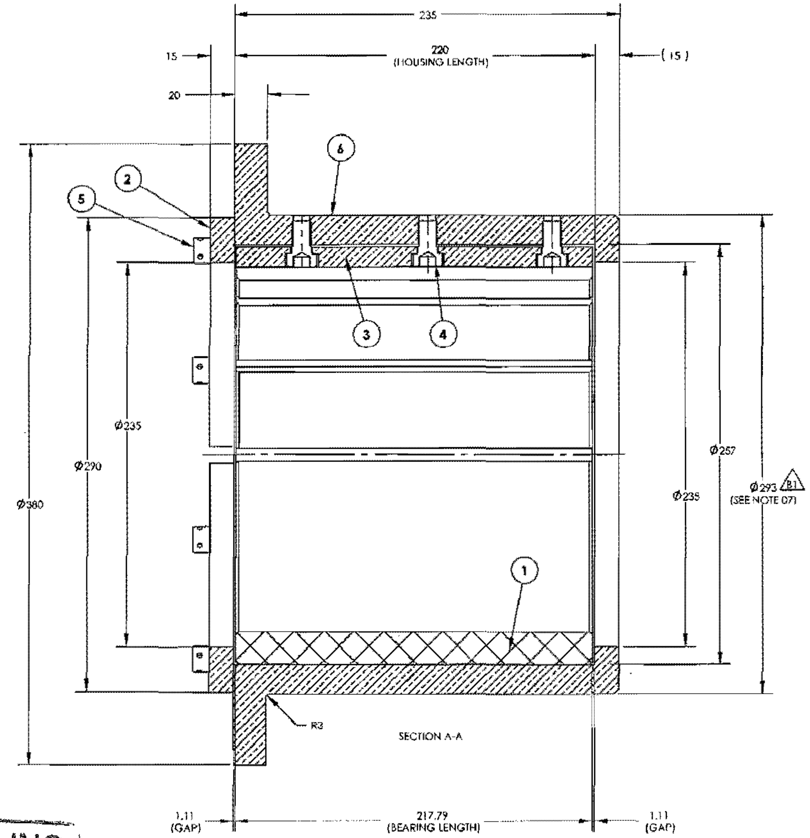
CET DESSIN EST DE PROPRIETE OF THORDON BEARING INC. TOUTE USAGE C'EST STRICTEMENT INTERDIT SAUF PERMISSION ECRIT PRECEDENT.

DWN/DESS: C.PREDOI | CKD/VER: G.AUGER | APPVL/APP: G.AUGER
CUSTOMER/CLIENT: DUWEL TECNO ROLLS ROYCE | DRAWING DATE / DATE OU DESSIN: 04-08-2010 | MRP NO: FA7750330 | SIZE: C
TITLE/TITRE: THORDON COMPAC AFT. BEARING ASSEMBLY | DRAWING NO OU DESSIN: TG-20843 | REV: B
SHEET/FEUILLE 1 OF/DE 1

ALL DIMENSIONAL INFORMATION IS BASED ON A MACHINING TEMPERATURE OF 21 °C, UNLESS STATED OTHERWISE. MACHINE GROOVES ONLY WHERE SHOWN

ITEM NO.	QTY.	PARTNO	DESCRIPTION	Material	REMARKS	DRAWING NUMBER
1	1	F________	BEARING	THORDON COMPAC		TG-21133
2	1	F________	RETAINING RING	BRONZE		TG-21138
3	1	F	KEY	BRONZE		TG-21136
4	3	F________	CAPSCREW, LOW PROFILE HEX SOCKET HEAD	BRONZE C95400	DIN 6912-M12X20	TG-21130
5	8	F________	CAPSCREW, HEX SOCKET HEAD	AISI 316 ST. STEEL	DIN 912-M10 X 30	PURCHASE
6	1	F________	CARRIER	BRONZE		TG-21134





CARRIER WEIGHT = 32.5 KG.

BEARING WEIGHT = 3.5 KG.

MINIMUM INSTALLED CLEARANCE: 1.37

RUNNING CLEARANCE: 0.87

THERMAL EXPANSION ALLOWANCE: 0.19

WATER SWELL ALLOWANCE: 0.31

TEMPERATURE RANGE: -2°C TO 45 °C

SHAFT DIA.: = 215

HOUSING DIA.: = 257

HOUSING LENGTH = 220

THORDON BEARINGS INC
APPROVED
FOR
PRODUCTION

18Oct 2010

APPROVED BY

GENERAL NOTES:

01. MATERIAL: SEE PARTS LIST
02. DIMENSIONS ARE EXPRESSED IN MM UNLESS NOTED OTHERWISE.
03. DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
04. TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
05. BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
06. ALL FILLET AND RADII DIMENSIONS ARE NOMINAL UNLESS NOTED OTHERWISE.
B1 07. SHIPSETS #1 THRU 4 SUPPLIED AT Ø290

Rolls-Royce — Date: 2010-11-10 — Approved: JH
Sheet: 1 of: 1 — Drawing no.: RRM 200 006 475 — Revision: C

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED

UNLESS SHOWN OTHERWISE, MACHINING TOLERANCES ARE:

LINEAR UP TO 1m(40") +/-0.5 mm(±0.020")

OVER 1m(40") +/-1.0 mm(±0.040")

ANGULAR +/-0.25°

SURFACE FINISH 3.2μmRa (125μinch)

THORDON MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPARATOR

REV	DESCRIPTION	DATE	DWN	CKD	APPV
B1	WAS Ø290 & ADDED NOTE 07	10/18/2010	GL	GA	GA
A1	B.C. WAS Ø350	10/5/2010	CP	GA	GA

THORDON BEARINGS INC.
BURLINGTON, ONTARIO, CANADA

DWN/DESS: C.FREDOI — CKD/VER: G.AUGER — APPVL/APP: G.AUGER

CUSTOMER/CLIENT: ROLLS ROYCE DUWEL TECHNO — DRAWING DATE / DATE DU DESSIN: 06-AUG-2010 — MRP NO.: F________ — SIZE: C

TITLE/TITRE: THORDON COMPAC INTERMEDIATE BEARING ASSEMBLY — DRAWING NO. / NO. DU DESSIN: TG-20844 — REV: B — SHEET/FEUILLE: 1 OF/DE 1

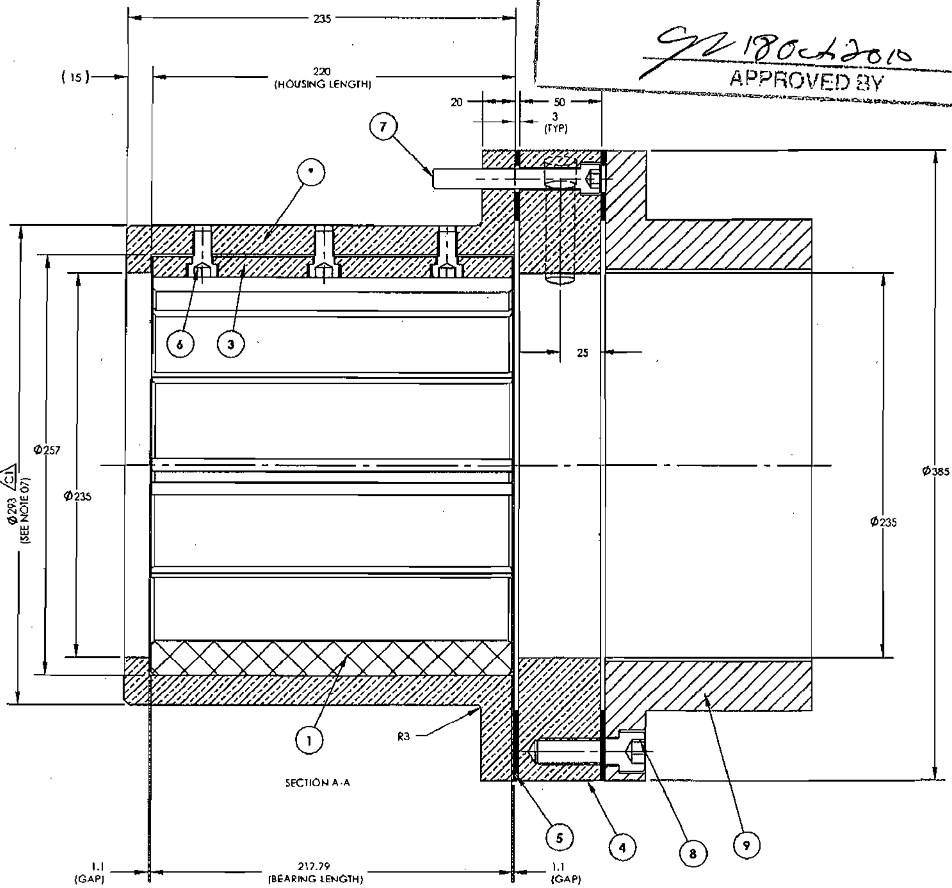
F19775033

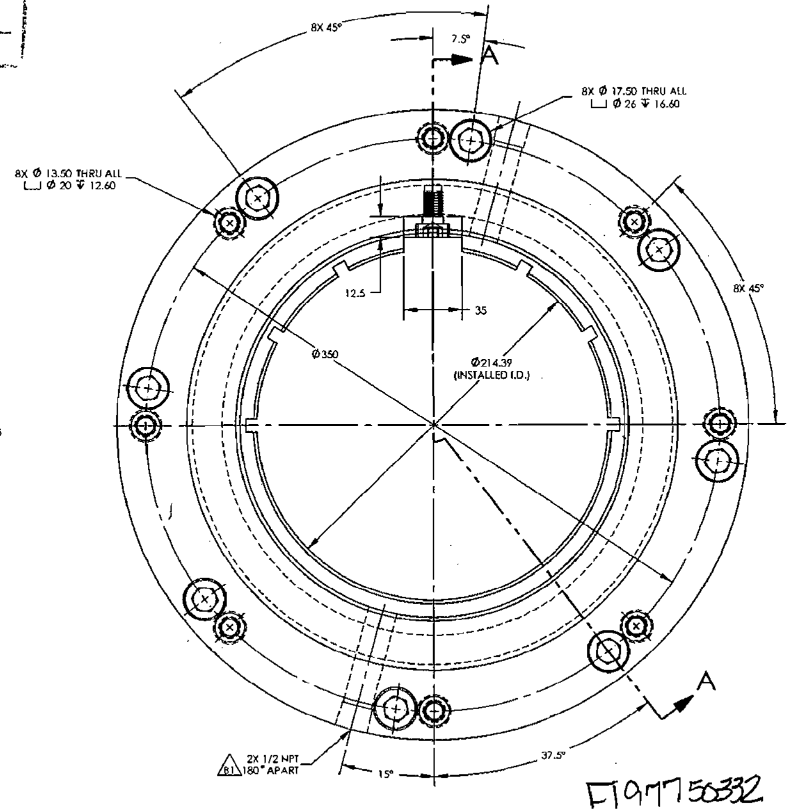
ALL DIMENSIONAL INFORMATION IS BASED ON A MACHINING TEMPERATURE OF 21 °C, UNLESS STATED OTHERWISE. MACHINE GROOVES ONLY WHERE SHOWN

THORDON BEARINGS INC
APPROVED
FOR
PRODUCTION

18 Oct 2010
APPROVED BY

ITEM NO.	QTY.	PARTNO	Description	Material	REMARKS	DRAWING NUMBER
1	1	F______	BEARING	THORDON COMPAC		TG-21140
2	1	F______	CARRIER	BRONZE		TG-21141
3	1	F______	KEY	BRONZE		TG-21142
4	1	F______	RING	BRONZE		TG-21144
5	2	F______	GASKET	GARLOK		TG-21145
6	3	F______	CAPSCREW, LOW PROFILE HEX SOCKET HEAD	BRONZE C95400	DIN 6912-M12X20	TG-21130
7	8	F______	CAPSCREW, HEX SOCKET HEAD	316 ST. STEEL	DIN 912-M12X90	PURCHASE
A1 8	8		CAPSCREW, HEX SOCKET HEAD	AISI 316 ST. STEEL	DIN 912- M16X50 LG	BY CUSTOMER
9	1		MECHANICAL SEAL			BY CUSTOMER





F197750332

CARRIER WEIGHT = 33.05KG.
BEARING WEIGHT = 3.7KG
MINIMUM INSTALLED CLEARANCE: 1.39
RUNNING CLEARANCE: 0.87
THERMAL EXPANSION ALLOWANCE: 0.20
WATER SWELL ALLOWANCE: 0.32
TEMPERATURE RANGE: -2 °C TO 45 °C
SHAFT DIA.: = 213
HOUSING DIA.: = 257
HOUSING LENGTH = 220

GENERAL NOTES:

01. MATERIAL: SEE PARTS LIST
02. DIMENSIONS ARE EXPRESSED IN MM UNLESS NOTED OTHERWISE.
03. DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
04. TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
05. BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
06. ALL FILLET AND RADII DIMENSIONS ARE NOMINAL UNLESS NOTED OTHERWISE.
C1 07. SHIPSETS #1 THRU 4 SUPPLIED AT Ø290

Rolls-Royce | Date: 2010-11-10 | Approved: JH
Sheet: 1 of: 1 | Drawing no: RRM 200 006 476 | Revision: C

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED

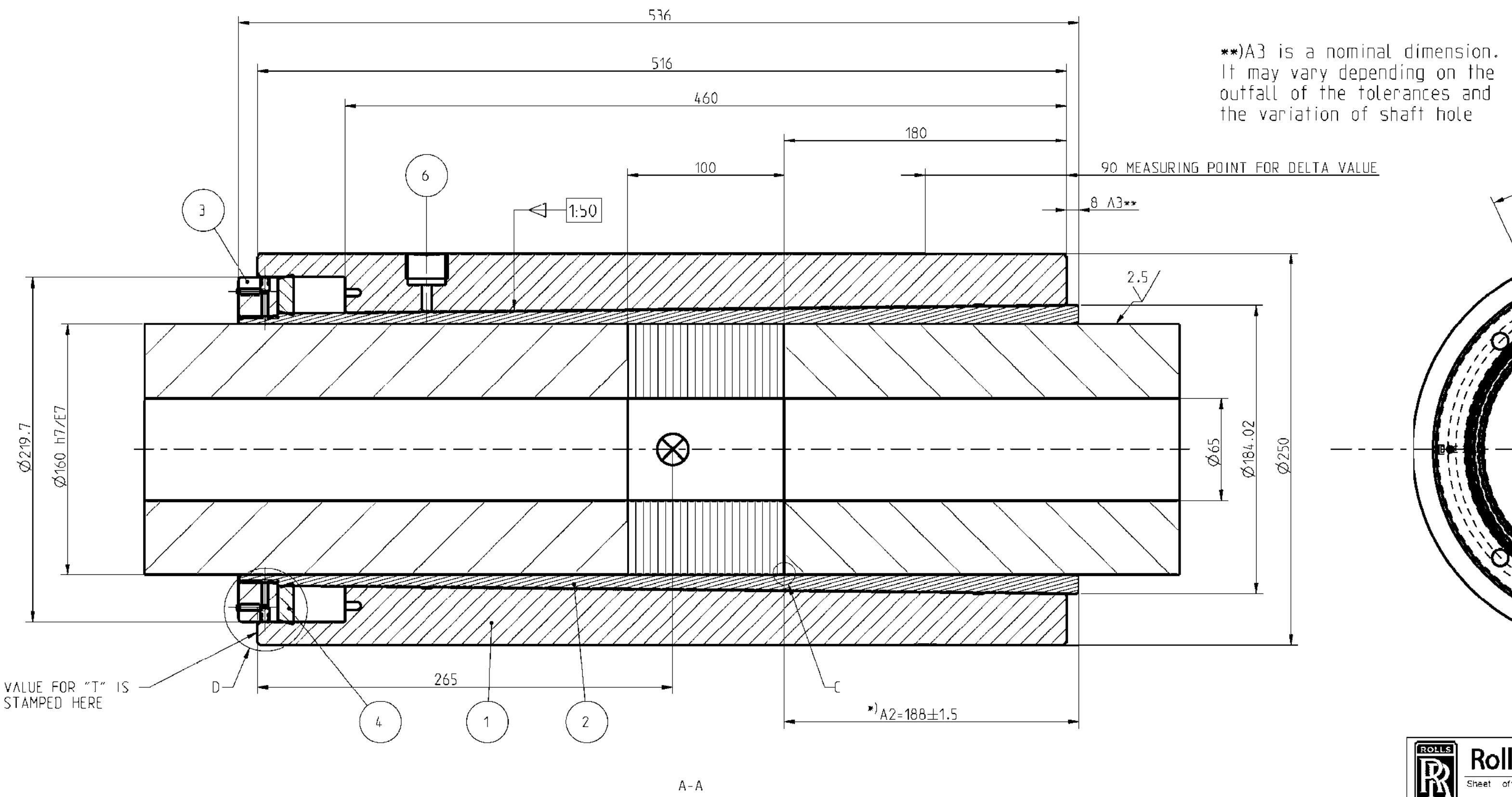
UNLESS SHOWN OTHERWISE, MACHINING TOLERANCES ARE:

LINEAR UP TO 1m(40") +/-0.5 mm(±0.020")
OVER 1m(40") +/-1.0 mm(±0.040")
ANGULAR +/-0.25°
SURFACE FINISH 3.2μmRa (125μinch)
THORDON MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPARATOR

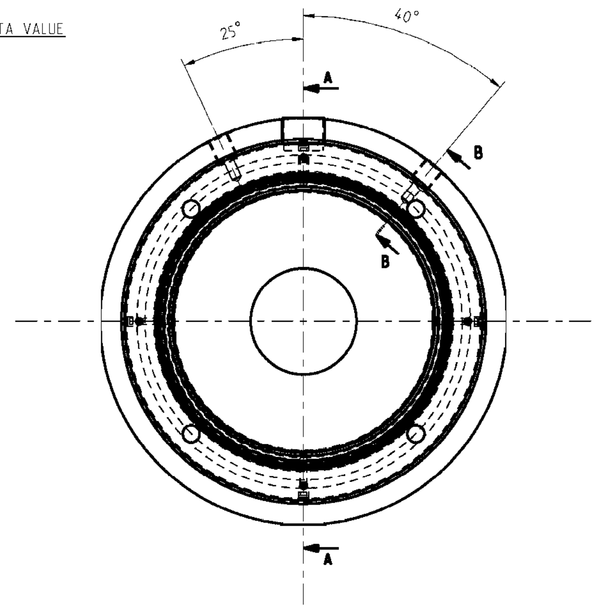
REV	DESCRIPTION	DATE	DWN	CKD	APPV
C1	WAS Ø290 & ADDED NOTE. 07	10/18/2010	GL	GA	GA
B1	ADDED NPT	9/22/2010	GL	GA	GA
A1	BOLT MATERIAL WAS BRONZE	8/18/2010	CP	GA	GA

THORDON BEARINGS INC.
BURLINGTON, ONTARIO, CANADA

DWN/DESS: C.PREDOI | CKD/VER: G.AUGER | APPVL/APP: G.AUGER
CUSTOMER/CLIENT: ROLLS ROYCE DUWEL TECHNO | DRAWING DATE / DATE DU DESSIN: 06-AUG-2010 | MRP NO.: F197750332 | SIZE: C
TITLE/TITRE: THORDON COMPAC FWD. BEARING ASSEMBLY | DRAWING NO / NO DU DESSIN: TG-20845 | REV: C
SHEET / FEUILLE 1 OF / DE 1



A-A

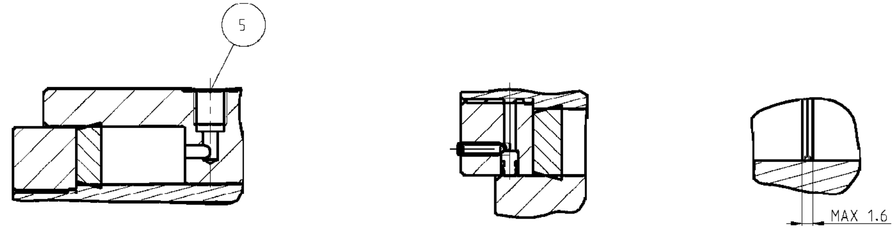


Rolls-Royce	Date: 2011-01-25		Approved: JH	
Sheet 1	of 1	Drawing no: RRM 200 005 975		Revision: B

MAX TORQUE CAPACITY= 121 kNm

TOTAL WEIGHT= 115 KG

INERTIA WITH RESPECT TO CENTER AXIS= 1.3 kgm^2



B-B

D

C

INCREASE OF COUPLING OUTER DIAMETER

△ = 0.24mm

*) FINAL POSITIONING OF THE SHAFT (A2):
A2= 180.0+T-27.3
NOTE: VALUE FOR "T" IS STAMPED ON THE COUPLING

Qty.	Item	Name	Material	Weight	PartNo.
1	6	PLUG BSP 3/4"			415182
2	5	PLUG BSP 1/4"			405024
1	4	SEALING	MSC001-60	0.3	38876-160
1	3	NUT	MSC001-30	3.0	38875-160
1	2	INNERSLEEVE	MSC001-44	20.7	3001670
1	1	OUTERSLEEVE	MSC001-11	91.0	28533

SKF PRODUCTS	Date 100430	Scale
OK COUPLING	Issued SS	Checked AR
ASSEMBLY DRAWING	Project no. 90406	
OKCAX 160/28436	Drawing no. 28436	Revision 2
Rolls-Royce		

SKF COUPLING SYSTEMS AB

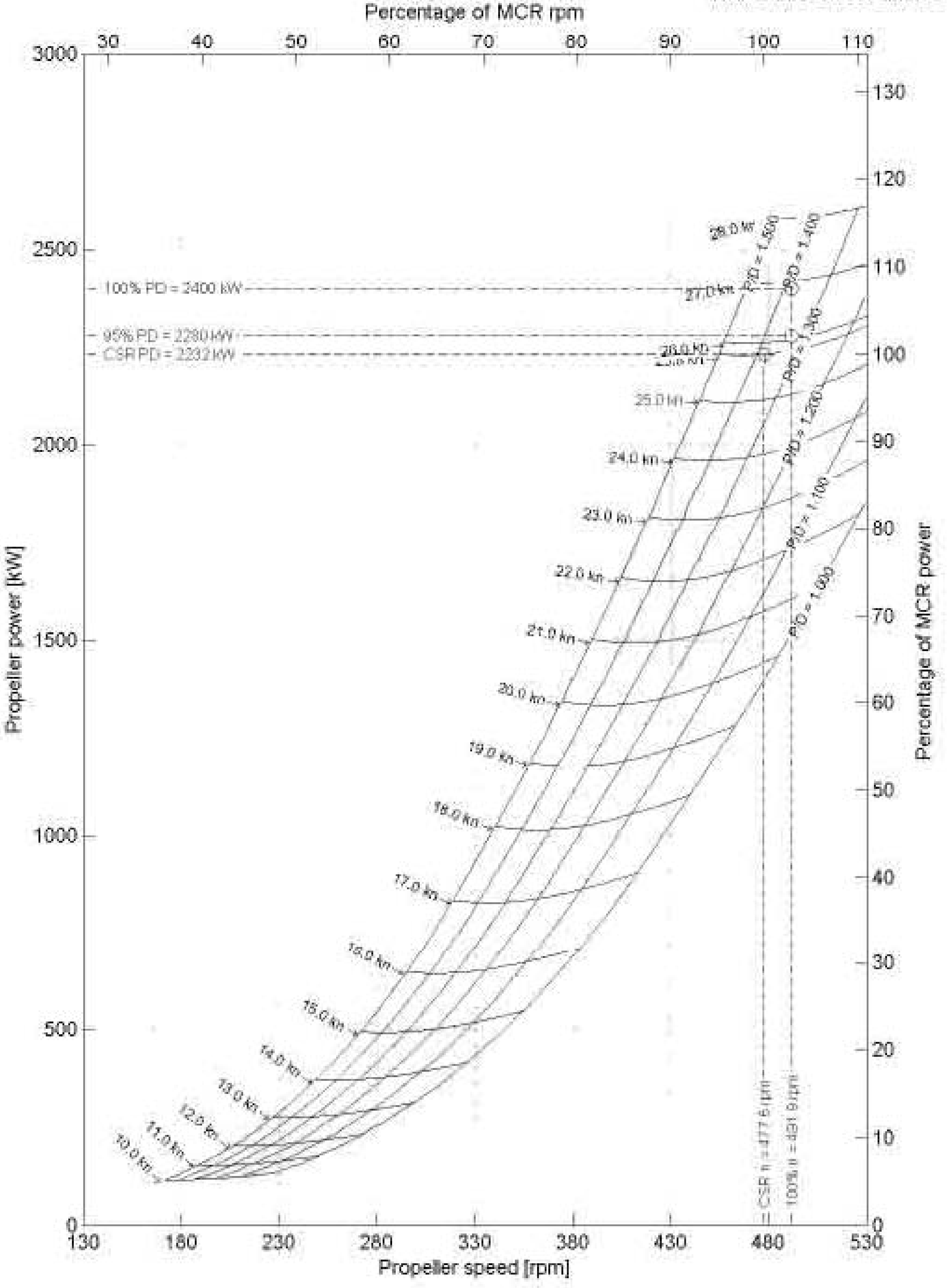
Rev. No.	Revision Note	Date	Issued	Approved
2	Torque and delta value changed	100920	MM	ME

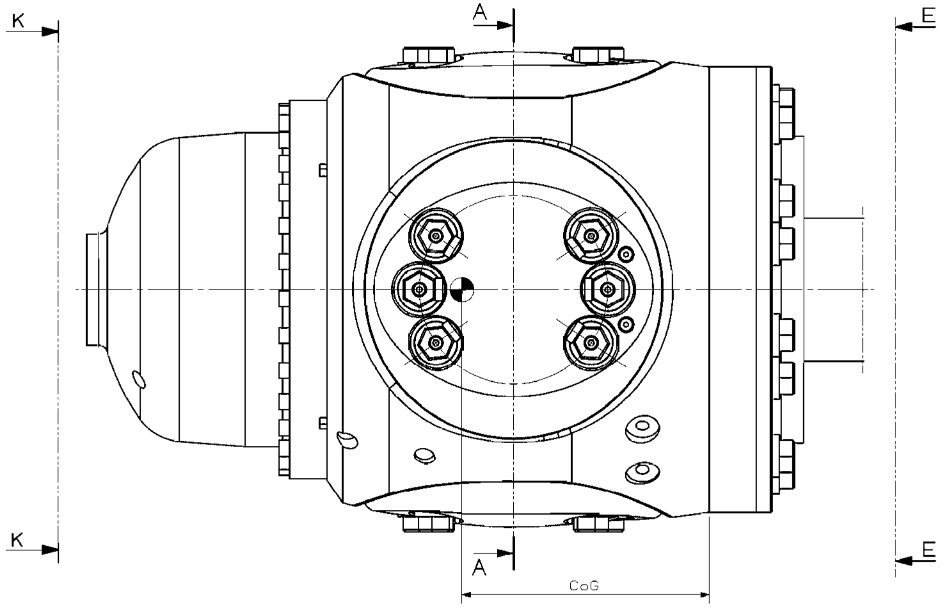
Permissible machining variations in dimensions without tolerance indications: SS-ISO 2768-m.

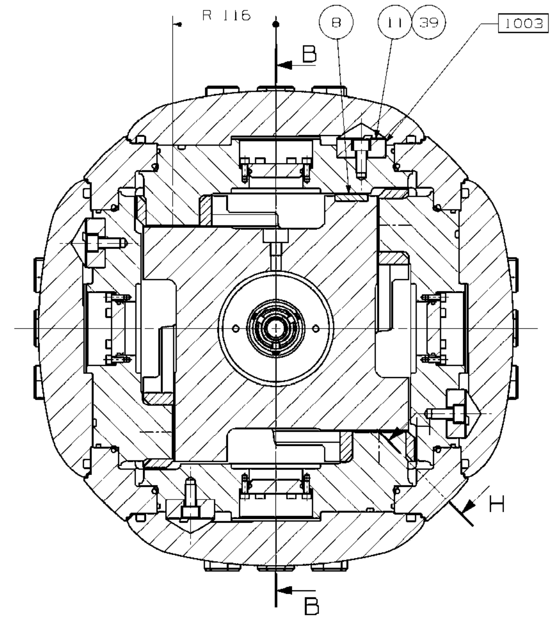
ORIGINAL SIZE: A2

Rolls-Royce HYDRODYNAMIC RESEARCH CENTRE		
	Pd-n Diagram	42061
	Halifax Shipyard	-
		2010-06-04
	Pe at 25.8 given,prop.factor.given,Curve est	Fgr

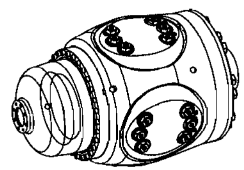
RRAB Info Class: Limited

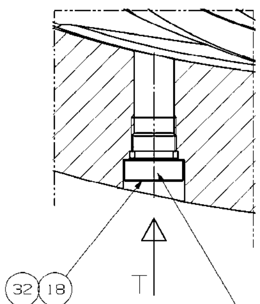






A-A





H-H
1:1

PLUGGEN LASES MED PUNKTSVETS
EFTER ATT AXELN ÄR INSTALLERAD
SYSTEMET OLJEFYLLT OCH LUFTAT

THE PLUG TO BE LOCKED BY SPOT WELD
AFTER SHAFT IS INSTALLED
THE SYSTEM IS OILFILLED AND VENTED

TÄTHETSPROV	PRESSURE TEST	
FÖRE BEARBETNING BEFORE MACHINING	-	
EFTER BEARBETNING AFTER MACHINING	X	
KONTROLLMEDIUM TEST MEDIUM	OLJA OIL	
KONTROLLTRYCK TEST PRESSURE	3 bar	
KONTROLLTRYCK I PILENS-T RIKTNING TEST PRESSURE APPLIED IN DIRECTION OF		
TID TIME	5 h	

Centre of gravity
256-300mm

1000 KAMEWA SEALING COMPOUND
1001 TEFLON GREASE
1002 LOCTITE 243
1003 LOCTITE 648
1004 MOLYCOTE G-RAPID

2000 INSTRUCTION FOR LOCKING 998174A
2001 INSTRUCTION FOR TIGHTENING 586431A

PREVIOUS DRAWING RRM200006186

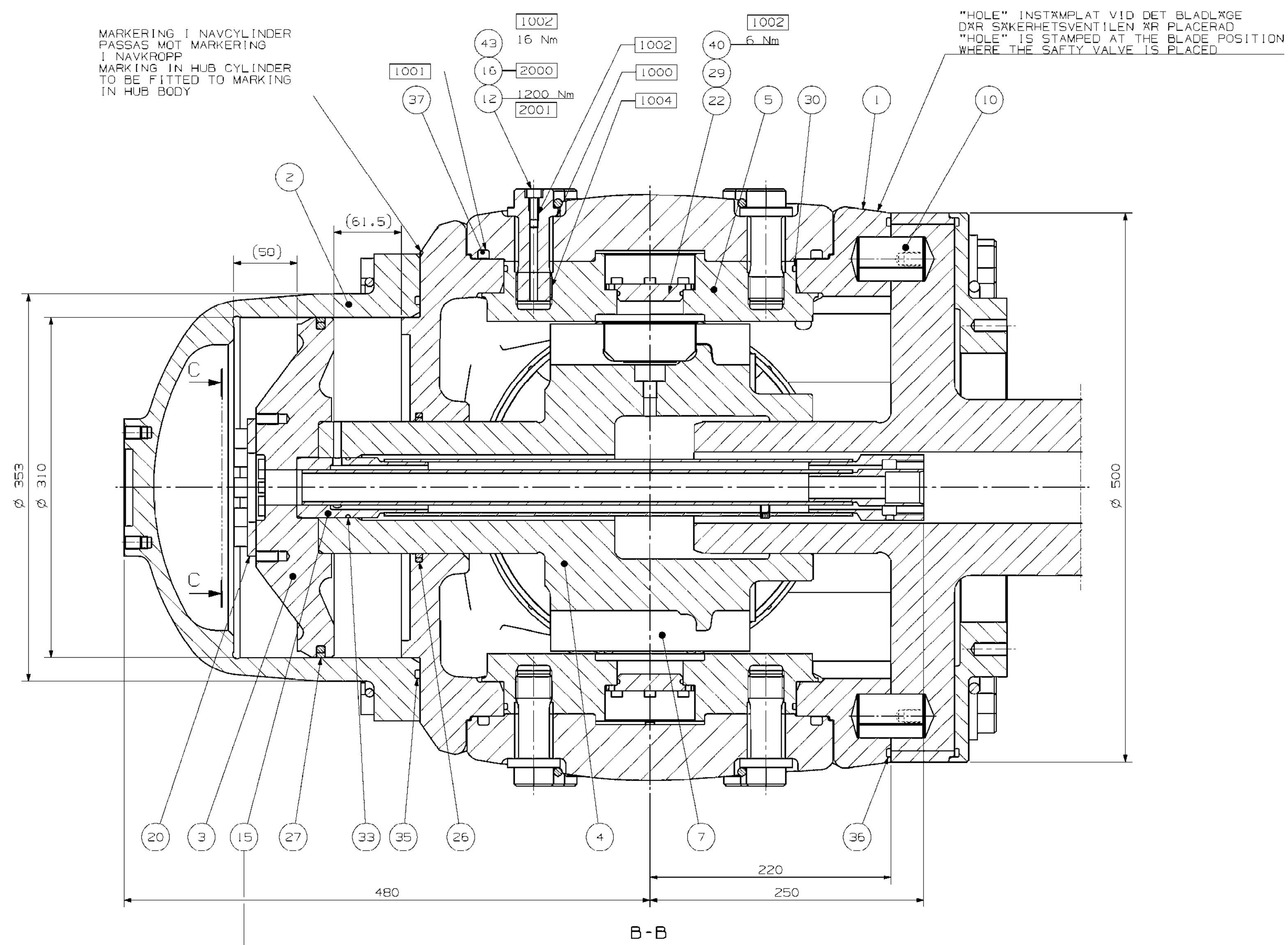
General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,1 - 0,5	ISO 1302 Ra µm	R 0,8 - 1,6	498

Propeller Hub
55A/4D-B Left
AHEAD 32° (61,5mm) ASTERN -30° (58mm)

Rolls-Royce
Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin/Date	Scale	Format	Sheet
Wkg 2010.07.09	1:3	A1	1 of 3

Drawing no:	Revision:
RRM200009345	A



B-B

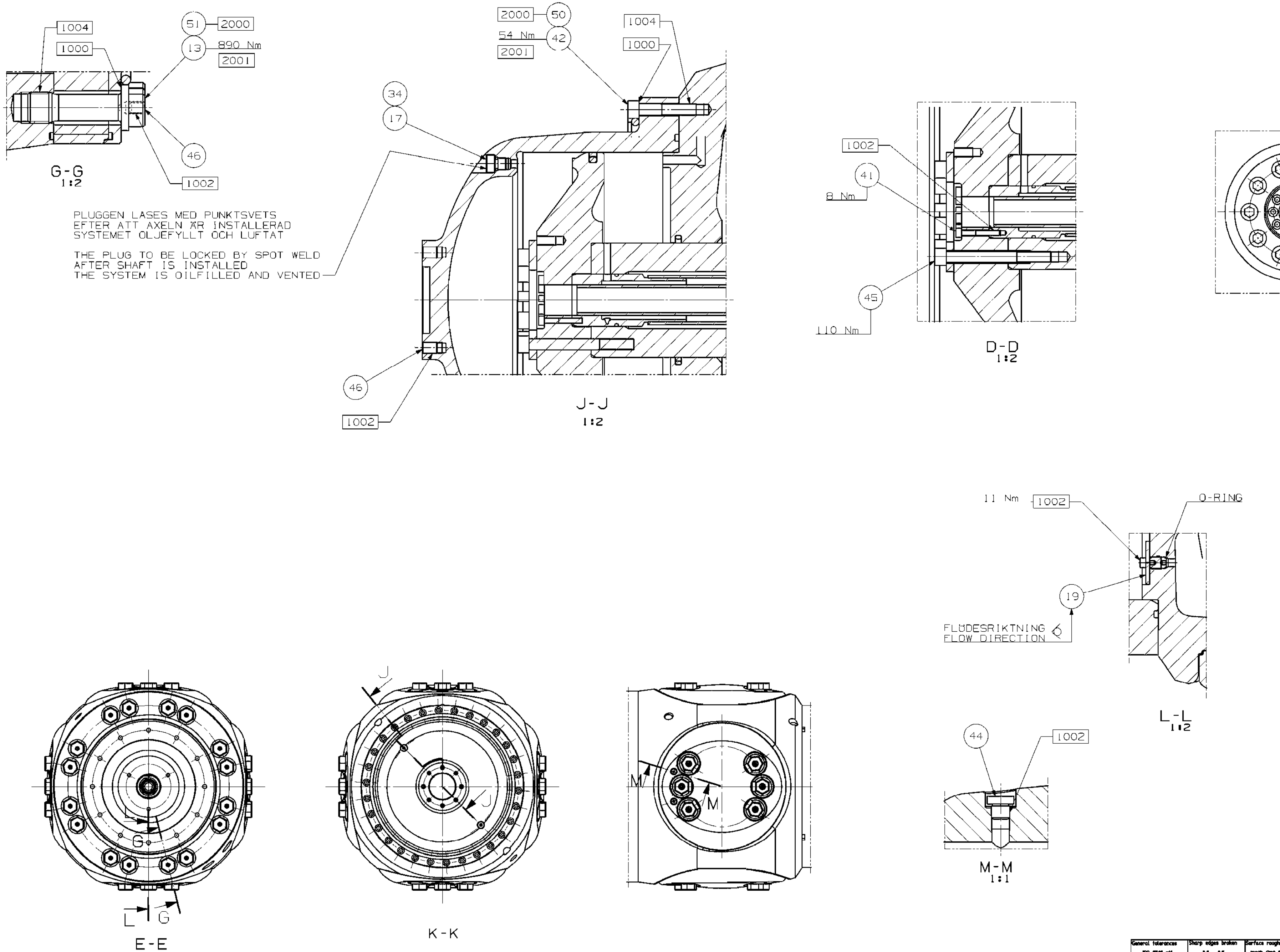
NOT: SKARVSTYCKET MONTERAS SÅ ATT RADIELLA HÅL
I NAVMUFFEN HAMNAR MITT FÖR RADIELLA HÅL I KOLVSTANGEN

NOTE: THE CONNECTION PIECE IS TO BE MOUNTED IN SUCH WAY
THAT THE RADIAL HOLES IN HUB MUFF CORRESPOND TO RADIAL
HOLES IN PISTON ROD

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,1 - 0,5	ISO1302 Ra µm	R 0,8 - 1,6	-

Propeller Hub
55A/4D-B Left
AHEAD 32° (61.5mm) ASTERN -30° (58mm)

Rolls-Royce	Origin/Date	Scale	Format	Sheet
Rolls-Royce AB S-681 29 KRISTINEHAMN	Wkg 2010.07.09	1:2	A1	2 of 3
	Drawing no: RRM200009345			Revision: A



General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,1 - 0,5		R 0,8 - 1,6	–

Propeller Hub
55A/4D-B Left
AHEAD 32° (61,5mm) ASTERN -30° (58mm)

Rolls-Royce
Rolls-Royce AB
S-681 29 KRISTINEHAMN

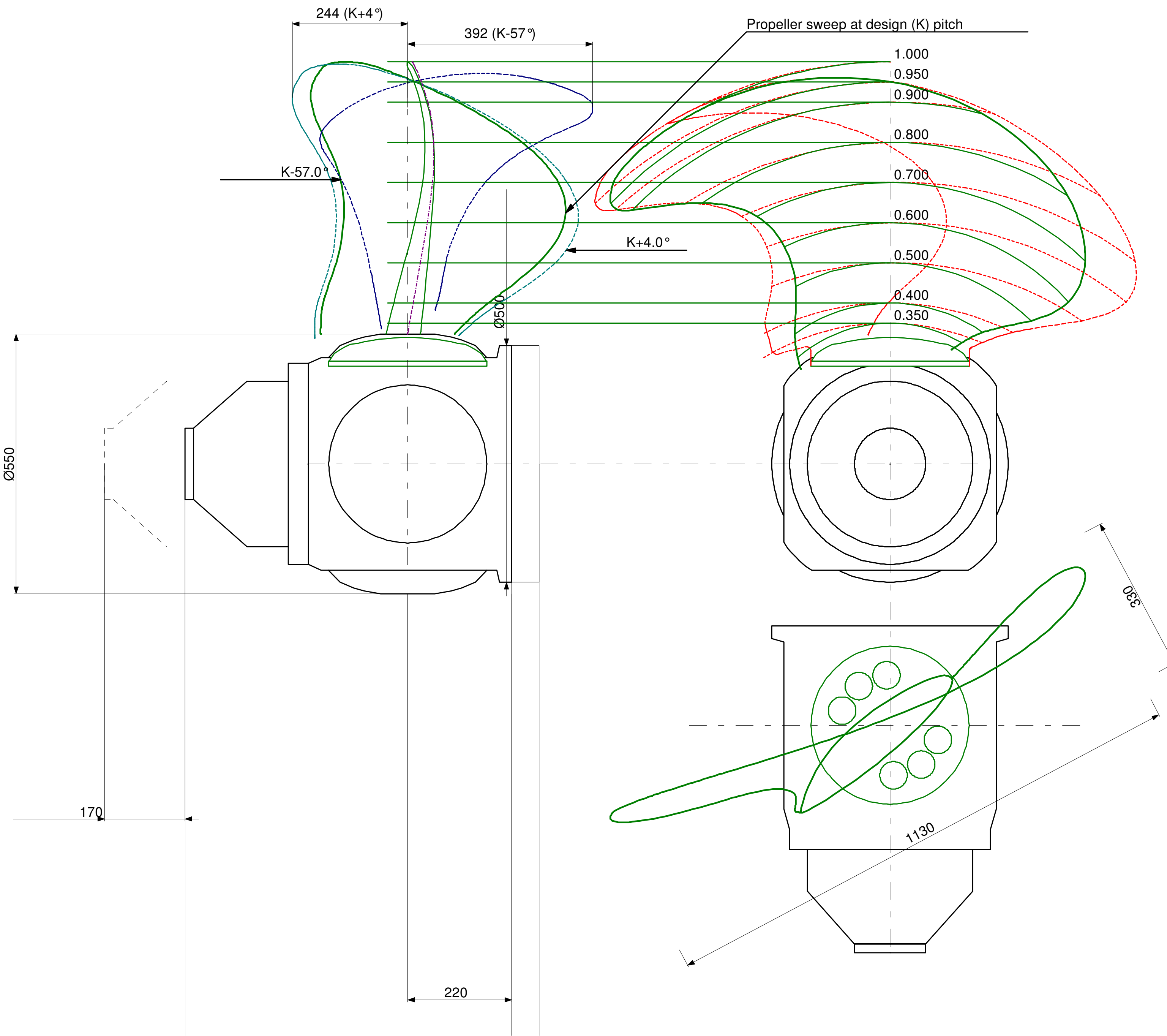
Origin/Date		Scale:	Format:	Sheet:
Wkg	2010.07.09	1:5	A1	3 of 3

Drawing no:	Revision:
RRM200009345	A

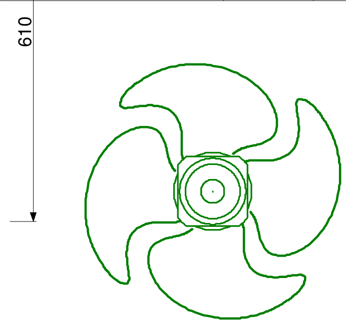
Rolls-Royce

Blade Outline
Ref:30-09-0920 10S000239-4/DESIGN

Date 2010-06-01
Time 10:26:03
Issued by Rolf Fagerberg



r/R		0.35	0.6	0.95
Radius	mm	297.5	510	807.5
L	mm	481	805	698
LF	mm	206	522	2
LA	mm	275	283	696
Pitch	mm	1537	2281	1650
Max thickn.	mm	70	35	11.8



Propeller Data

Propeller diameter	(D)	*1700*	mm
Hub diameter	(d)	*550*	mm
Number of blades	(Z)	*4*	
Expanded blade area ratio	(AE/A0)	*0.757*	
Pitch ratio at 0.7R	(P0.7/D)	*1.347*	

Data for One Blade

Expanded area	*0.430*	m²
Weight	*102*	kg

K-200	
55A/4D-B-G	R-185033--O

Bild-kort	Utf. Design
_	A
	B
	C
	D
	E
	F
	G
	H
	K

Bild-kort	Ändr. Revis	Zon Zone	Ändringen omfattar Revision comprises	Datum Date	Uppgj. Drawn	Godk. Approved
_	a	_	Texten kompletterad	801010	Deb	_
_	b	_	KaMeWa-propeller utgick	860428	BLöw	_
B	c	_	Text ändrad + omritad i CAD	920613	Alg	JnH
B	d	_	Mått 1000 var felaktigt måttsatt	940829	Alg	JnH
B	e	_	Text ändrad	950228	Alg	JnH
_	f	_	Removed swedish text	000719	BEK	DB
_	g	_	Svensk text tillkom	030916	Alg	KO

Tillåtna måttavvikelser när tolerans ej direkt utsatts på bearbetade detaljer SMS 715 Medel enligt tabell nedan. För rundningsradier, faser och vinkelmått följs SMS 715 Medel enligt separat standardblad.

Machining tolerances for linear dimensions unless otherwise specified For radii and curvatures, bevels and angle measurements, SMS 715 Average according to separate standard sheets must be followed.

Basmått Basic size	Måttavvikelser Tolerances	Basmått Basic size	Måttavvikelser Tolerances
- 3	±0,1	(1000) - 2000	±1,2
(3) - 6	±0,1	(2000) - 4000	±2
(6) - 30	±0,2	(4000) - 8000	±3
(30) - 120	±0,3	(8000) - 12000	±4
(120) - 315	±0,5	(12000) - 16000	±5
(315) - 1000	±0,8	(16000) - 20000	±6

Modif. Modif.	Modifikationen omfattar Modification comprises			
	_			
Bild-kort	Zon Zone	Datum Date	Uppgj. Drawn	Godk. Approved
	_			

Användning av momentdragningsverktyg

Momentdragningsverktyg användes för förspänning av blad-, axelfläns- och navcylinderskruv.

Vid förspänning skall smörjmedel påföras på skruvens gänga och tätningsmassa påföras under skruvskallen (se Nav smst).
Skruvarna skall förspännas två gånger.

1. Kontrollera att skruven löper lätt i gängan.
   Ansätt samtliga skruvar med handverktyget.
   OBS! Mutterdragare (pneumatisk, hydraulisk eller elektrisk) får ej användas!
   Montera verktygen för momentdragning enligt förebild.

2. Förspänn skruvarna korsvis och avläs på dynamometern det på ritning Nav smst angivna momentet.

3. Vänta i 15 minuter
   Börja sedan med att lossa den först förspända och förspänn denna ånyo till på Nav smst angivet moment varefter samtliga skruvar lossas och förspännes en efter en enligt ovan

Use of tools for torque tightening

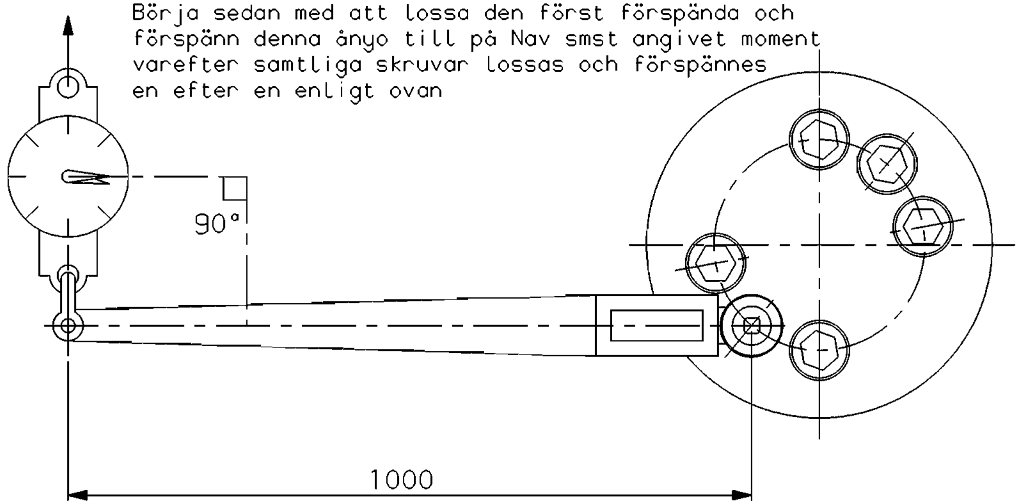
Tools for torque tightening are to be used pre-stressing of blade-, shaft flange- and hub cylinder screws.

Lubricant is to be used on the threads of the screw and sealing compound under the screw head when pre-stressing (see hub assembly drawing).
The screws are to be pre-stressed twice.

1. Check that the screw runs easily in the thread.
   Thighten all the screws with a hand tool.
   Note! Wrench (pneumatic, hydraulic or electric) may not be used!
   torque tightening according to instructions.

2. Pre-stress the screws crosswise and read on the dynamometer the torque stated on the hub assembly drawing.

3. Wait in 15 minutes
   Then begin untightening the screw first pre-stressed and pre-stress this again to the torque stated on the hub assembly drawing and then untighten all screws and pre-stress again one after each other according to above.



Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark
Anläggning Plant: –			Best. nr/Prod.gr. nr. Order No./Prod.gr. No.: –		Tot. vikt Tot.weight kg: –

Uppgj. Drawn	Kontr. Checked	Godk. Approved	Ytjämnhet enligt SMS 672 Ra µm / Surface texture ISO/R 1302 Ra µm
Deb	IP	Lös	

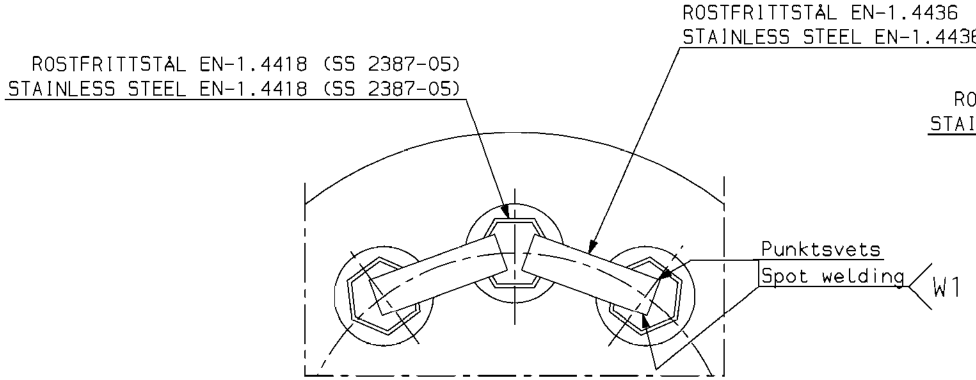
KaMeWa
A Vickers P.L.C. company
KRISTINEHAMN
SWEDEN

PROPELLERNAV
PROPELLER HUB
INSTR. FÖR DRAGNING AV SKRUV
INSTR. FOR TIGHTENING OF SCREW

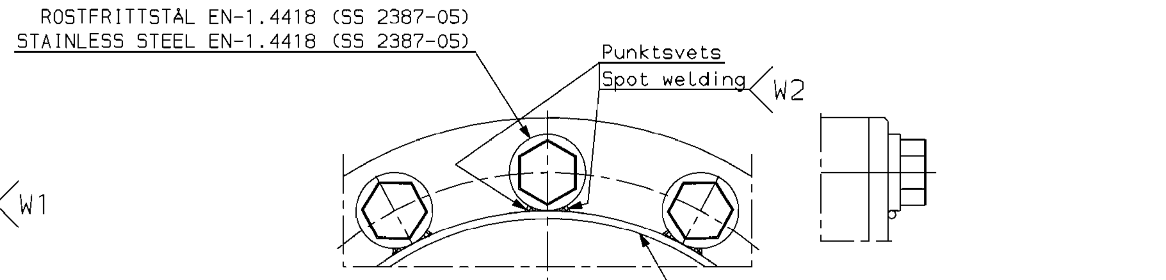
Skala Scale		Datum Date	
–	A3	800312	
Blad Sheet 1	av of 1	Föreg. ritn. Previous drg.	577077
586431		Utf. Design	Ändr. Revis. g

REV.	ZONE	REVISION COMPRISES	DATE	MADE BY	CHECKED	APPROVED
a	_	WELDING INFORMATION ADJUSTED	051026	Har	KO	Gök

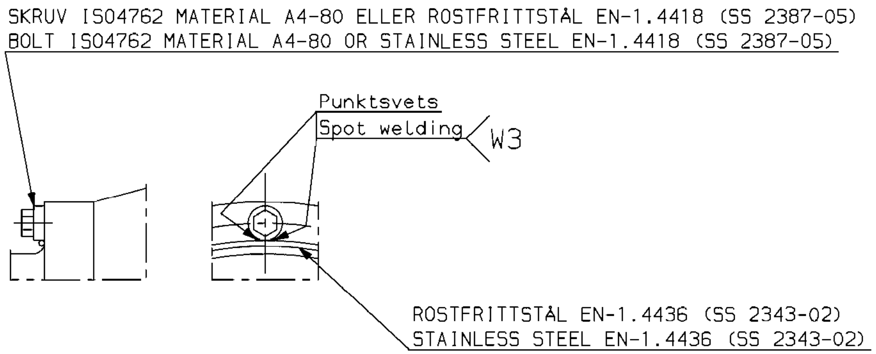
DESIGN
A
B
C
D
E



SKRUV, BLADFLÄNS
SCREW, BLADE FLANGE



SKRUV, AXELFLÄNS
SCREW, SHAFT FLANGE



SKRUV, NAVCYLINDER
SCREW, HUB CYLINDER

Svetsbestämmelser / Welding rules	Svetsstandard för Rolls-Royce AB / Welding standard for Rolls-Royce AB
Grundmaterial / Parent metal	_
Avspänningsglödgningstemperatur / Stress-relieving heat treatment at	_
Svetsplan / Sequence of welding	Se SVETSDATABLAD / See WELDING PROCEDURE SPECIFICATION (WPS)
Täthetskrav / Sealing requirements	_
Svetstolerans / Welding tolerance	EN ISO 13920-BE

Svets nr / Weld No	Svetsklass / Welding class	Svetsmetod / Welding process	Provningsomfattning / Extent of Examination: Röntgenundersökning / Radiographic Examination	Ultraljudundersökning / Ultrasonic Examination	Magnetpulverundersökning / Magnetic Particle Examination	Penetrantundersökning / Liquid Penetrant Examination	Anmärkning / Remark
W1	D	_	_%	_%	_%	_%	_
W2	D	_	_%	_%	_%	_%	_
W3	D	_	_%	_%	_%	_%	_

GENERAL TOLERANCE SS-ISO 2768-mH	SHARP EDGES BROKEN 0.2-0.5	PLANT _	
SURFACE ROUGHNESS SS-ISO 1302 Ra µm	FILLET RADII R 0.8-1.6	PREVIOUS ORG. 998334	CODE _

NAV 50-121XF5
HUB
INSTRUKTION FÖR LÅSNING AV SKRUV
INSTRUCTION FOR LOCKING OF SDREW

WEIGHT kg _	DATE 960430
SCALE DO NOT SCALE	MADE BY KO
CHECKED Alg	APPROVED JnH
SHEET 1 OF 1	A2
998174	DESIGN REV. a

Rolls-Royce

ROLLS-ROYCE AB
KRISTINEHAMN
SWEDEN

6 5 4 3 2

Bild-kort	Utf. Design	Det. nr	Gr nr	Anm.
_	A	Det01-05	126	1 sats/blad
	B			
	C			
	D			
	E			
	F			
	G			
	_			
	_			

Bild-kort	Ändr. Revis	Zon Zone	Ändringen omfattar Revision comprises	Datum Date	Uppgj. Drawn	Godk. Approved
_	_	_	_	_	_	_

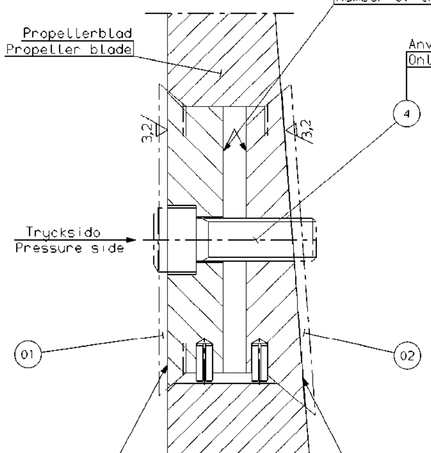
Tillåtna måttavvikelser när tolerans ej direkt utsatts på bearbetade detaljer SMS 715 Medel enligt tabell nedan. För rundningsradier, faser och vinkelmått följs SMS 715 Medel enligt separat standardblad.

Machining tolerances for linear dimensions unless otherwise specified. For radii and curvatures, bevels and angle measurements, SMS 715 Average according to separate standard sheets must be followed.

Basmått Basic size	Måttavvikelser Tolerances	Basmått Basic size	Måttavvikelser Tolerances
- 3	±0,1	(1000) - 2000	±1,2
(3) - 6	±0,1	(2000) - 4000	±2
(6) - 30	±0,2	(4000) - 8000	±3
(30) - 120	±0,3	(8000) - 12000	±4
(120) - 315	±0,5	(12000) - 16000	±5
(315) - 1000	±0,8	(16000) - 20000	±6

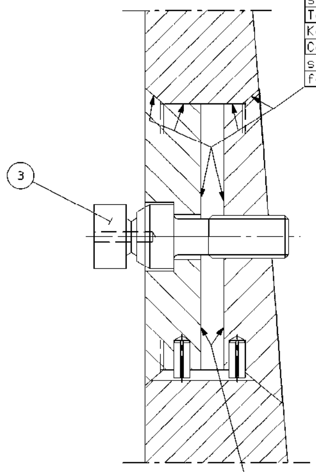
Bild-kort	Modif. Modif.	Zon Zone	Modifikationen omfattar Modification comprises	Datum Date	Uppgj. Drawn	Godk. Approved
		_	_			

1. Avslipning av plugg utföres vid verkstad (KaMeWa, Kristinehamn).
Grinding of plug to be carried out at the workshop.

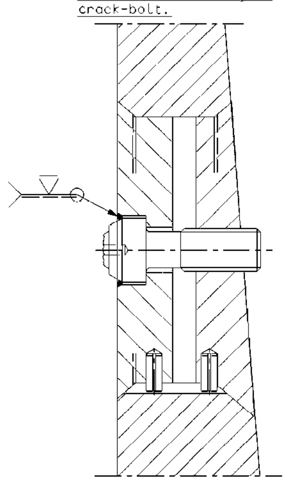


2a,b,c. Fastsättning av plugg utföres vid varv.
Fastening of plug to be carried out at the shipyard.

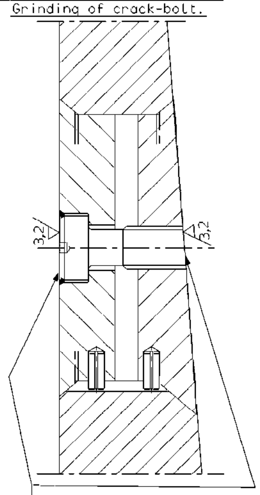
2a. Montering av pluggdetaljer.
Mounting of plug details.



2b. Avdragning av brottskruv och svetslåsning av skruvskalle.
Cracking and locking of crack-bolt.

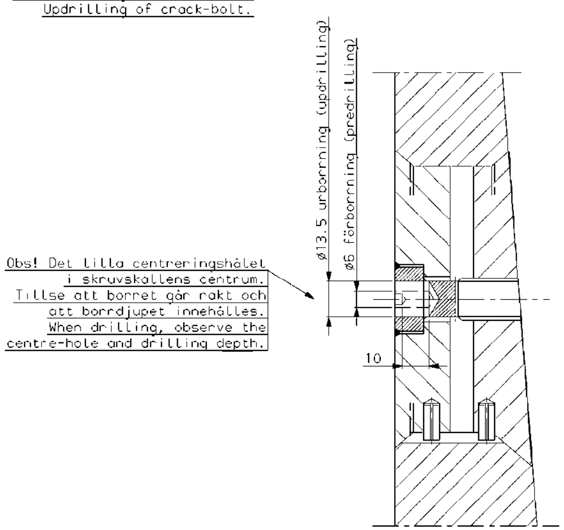


2c. Avslipning av brottskruv.
Grinding of crack-bolt.

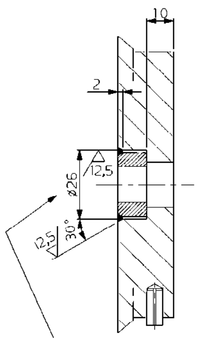


3a,b,c. Borttagning av plug.
Removal of plug.

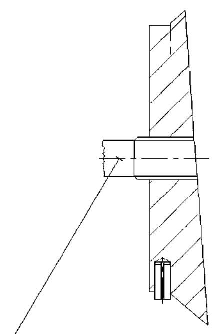
3a. Urborrning av brottskruv.
Updrilling of crack-bolt.



3b. Bortsvarvning av skruvskalle.
Upturning of crack-bolt head.



3c. Borttagning av gängad skruvdel.
Removal of threaded screw part.



4. Återinsättning av plugg.
Refitting plugs.

Vid återinsättning av demonterade pluggar tillses att de ligger jäms med bladytan. Nya brottskruvar, det nr 3, som skall finnas som reserv ombord på fartyget, användes.

Det. nr 4 är inte reservdel.

F.ö. förfares enl. anvisning 2a,b,c. "Fastsättning av plugg utföres vid varv."

When refitting dismounted plugs check that the plugs are flush to blade surface. Use new crack-bolts, item no 3, to be kept onboard the vessel as spare part.

Item no 4 is not spare part.

Otherwise to be made according to 2a,b,c. "Fastening of plug to be carried out at the shipyard."

Max. bladtjocklek:130
Max. blade thickness:130

	Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark
Drilling of liftinghole			Borrn. av lyfthål och	_	_	_
Protecting sleeve	05	1	Skyddshylsa	144113A	_	_
Screw	4	1	6K.HÅLSKR. M16x130-8.8	1504762	_	_
Crack-bolt	3	1	Brottskruv	518926B	Avesta	248 SV
Plug	02	1	Lyfthålsplugg	144116A	Avesta	248 SV
Plug	01	1	Lyfthålsplugg	144115A	Avesta	248 SV

Anläggning Plant: —
Best. nr/Prod.gr. nr. Order No./Prod.gr. No.: —
Tot. vikt Tot. weight kg: —

Uppgj. Drawn: TWD | Kontr. Checked: Gök | Godk. Approved: JÅN
Ytjämnhet enligt SMS 672 Ra µm
Surface texture ISO/R 1302 Ra µm

KAMEWA
A Vickers P.L.C. company
KRISTINEHAMN SWEDEN

KAMEWA propeller
Propellerblad
Plugg för lyfthål Smst
Plug for lifting hole Assy

Skala Scale: 1:1 | A1 | Datum Date: 010515
Blad Sheet: 1 av of
Föreg. ritn. Previous drg.: 518923
144112
Utf. Design | Ändr. Revis.: _

Bild-kort	Utf. Design		REF.DET.17/ITEM 17	MÅLNINGSINSTR.
_	A	TO-BOX HÖGER/OD-BOX RIGHT HAND	214012A	214016
_	B	TO-BOX VÄNSTER/OD-BOX LEFT HAND	214012B	214016
	C	TO-BOX HÖGER/OD-BOX RIGHT HAND	214012A	ORDER SPEC.
	D	TO-BOX VÄNSTER/OD-BOX LEFT HAND	214012B	ORDER SPEC.
	E			
	F			
	G			
	H			
	K			

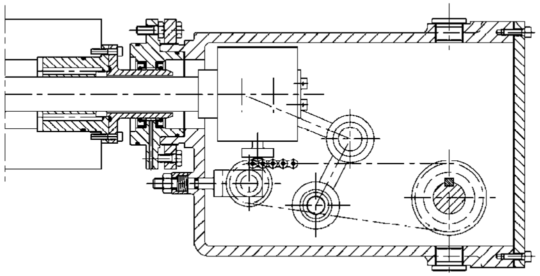
Tillåtna måttavvikelser när tolerans ej direkt utsatts på bearbetade detalj er SMS 715 Medel enligt tabell nedan. För rundningsradier, faser och vinkelmått följs SMS 715 Medel enligt separat standardblad.

Machining tolerances for linear dimensions unless otherwise specified. For radii and curvatures, bevels and angle measurements, SMS 715 Average according to separate standard sheets must be followed.

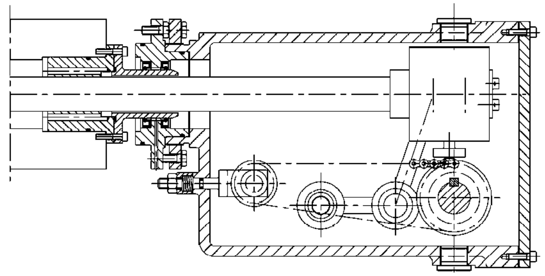
Basmått Basic size	Måttavvikelser Tolerances	Basmått Basic size	Måttavvikelser Tolerances
- 3	±0,1	(1000) - 2000	±1,2
(3) - 6	±0,1	(2000) - 4000	±2
(6) - 30	±0,2	(4000) - 8000	±3
(30) - 120	±0,3	(8000) -12000	±4
(120) - 315	±0,5	(12000) -16000	±5
(315) -1000	±0,8	(16000) -20000	±6

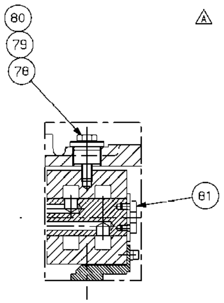
Bild-kort	Modif. Modif.	Zon Zone	Modifikationen omfattar Modification comprises	Datum Date	Uppgj. Drawn	Godk. Approved
		_	_			

BACK
ASTERN



FRAM
AHEAD





ENDAST FÖR TRANSPORT
ONLY FOR TRANSPORTATION

Description	Det.nr Item no.	Ant. No.off	Benämning	Referens Reference	Material Material	Anmärkning Remark
SOCKET SCREW	81	2	6K.HÅLSKR. M6x8-8.8	IS04762	_	_
SEALING WASHER	80	1	TÄTN.BRICKA 10.7x16	KS1147	_	_
HEXAGON HEAD SCREW	79	1	6k.SKRUV M10x35	IS04014	_	_
REDUCTION NIPPEL	78	1	REDUCERINGSNIPPEL	R13/4-1/4		
SPARES	77	_	RESERVDELAR	214017A	_	_
TOOLS	76	_	VERKTYG	940832A	_	_
DIMENSION DRAWING	75	_	DIMENSIONSRITNING	154903A	_	_
LOCTITE	74	_	LOCTITE 243	_	_	_
SOCKET SCREW	73	4	6K.HÅLSKR.M5x12-8.8	IS04762	_	_
_	72	_	_	_	_	_
CHAIN LOCK	71	1	KEDJELÅS 455 / 11	KEDJETEKNIK	_	_
CONNECTION LINK	70	2	BEFÄSTNINGSLÄNK 455/B7	KEDJETEKNIK	_	_
CHAIN	69	1	KEDJA NR.455 56 LÄNKAR	KEDJETEKNIK	_	_
CHAIN WHEEL	68	1	KEDJEHJUL 12/455,HÅLØ10H7	KEDJETEKNIK	_	_
CHAIN WHEEL	67	1	KEDJEHJUL 21/455,HÅLØ30H7	KEDJETEKNIK	KILSPÅR B=8, HÅL M6	
SPRING	66	1	TRYCKFJÄDER NR.12450	STEGE-BARNES	_	135N VID L=10
KEY	65	1	PLATTKIL 8x7x28	SMS2306	_	RUNDA ÄNDAR
SOCKET SCREW	64	4	6K.HÅLSKR. M3x8-12.9	IS04762	_	_
SEALING RING	63	1	SIMMERRING BABSL	SIMRIT	75FPM595	45-62-7
SEALING RING	62	1	SIMMERRRING BAUMX7	SIMRIT	75FPM585	45-62-8
CONICAL TOOTH WHEEL	61	2	KONISKA KUGGHJUL	214558A	_	_
DISTANCE	60	1	DISTANS Ø20/Ø11x6	_	St52	_
LOCKING WASHER	59	2	LÅSBRICKA 5.2X9	_	_	NORDLOCK
PACKING	58	1	PACKNING 1x230x230	_	KLINGERSIL	_
PLUG	57	4	PROPP VSTI R3/4-ED	TEMETO	_	_
PLUG	56	2	PROPP VSTI R3/8-ED	TEMETO	_	_
HEXAGON HEAD SCREW	55	8	6K.SKRUV M8x25-8.8	IS04014	_	_
HEXAGON HEAD SCREW	54	8	6K.SKRUV M8x20-8.8	IS04014	_	_
SOCKET SCREW	53	8	6K.HÅLSKR. M5x25-8.8	IS04762	_	_
SOCKET SCREW	52	3	6K.HÅLSKR. M6x30-8.8	IS04762	_	_
LOCKING NUT	51	1	6K.LÅSMUTTER M10-8	IS04032	_	_
SET SCREW	50	2	STOPPSKRUV MSK6SS 8x12	IS04029	_	_
SOCKET SCREW	49	10	6K.HÅLSKR. M5x16-8.8	IS04762	_	_
SOCKET SCREW	48	12	6K.HÅLSKR. M6x20-8.8	IS04762	_	_
SOCKET SCREW	47	3	6K.HÅLSKR. M8x22-8.8	IS04762	_	_
SOCKET SCREW	46	2	6K.HÅLSKR. M8x16-8.8	IS04762	_	_
_	45	_	_			
O-RING	44	1	O-RING 5.3x2.4	SMS1586	_	_
O-RING	43	1	O-RING 74.5x3	SMS1586	_	_
PARALLEL PIN	42	1	CP 2m6x8	IS02338	_	_
RETAINING RING	41	2	SPÅRRING SgA 30	SMS1581	_	_
RETAINING RING	40	1	SPÅRRING SgA 10	SMS1581	_	_
RETAINING RING	39	6	SPÅRRING SgA 17	SMS1581	_	_
_	38					

TO-BOX DATA
TOT.SLAG=175mm
VIKT=50kg
MAX OLJEFLÖDE=50L/min

OD-BOX DATA
STROKE=175mm
WEIGHT=50kg
MAX OIL FLOW=50L/min

PROVNING ENLIGT QI-02-133-20
TESTING ACCORDING TO QI 02 133 20

Description	Det.nr Item no.	Ant. No.off	Benämning	Referens Reference	Material Material	Anmärkning Remark
_	37	_	_	_	_	_
O-RING	36	2	O-RING 26.2x3-704	SMS1586	_	_
O-RING	35	2	O-RING 10.1x1.6-704	SMS1586	_	_
O-RING	34	2	O-RING 24.2x3-704	SMS1586	_	_
O-RING	33	1	O-RING 44.2x3-704	SMS1586	_	_
O-RING	32	1	O-RING 59.5x3-704	SMS1586	_	_
O-RING	31	1	O-RING 89.5x3-704	SMS1586	_	_
FOOT GUARDE	30	1	TRAMPSKYDD	214798A	_	_
CHAIN ATTACHEMENT	29	1	KEDJEFÄSTE	214799A	_	_
PISTON GUIDE	28	2	KOLVSTYRRING PWR/S 30/24x10		_	SEALPOOL
SEALING	27	16	KOLVSTANGSTÄTN.GHH/SS-22/33x4.2-292/N70			SEALPOOL
PROTECTION SHIELD	26	1	KLÄMSKYDD	214367A	_	_
CLAMP	25	2	KLÄMMA	214277A	_	_
CAGE	24	1	HYLSA	154986A	_	_
PIN	23	1	TAPP	214015A	_	_
WASHER	22	2	BRICKA	934218A	_	_
YOKE	21	1	GAFFEL	214014A	_	_
SLEEVE	20	1	HYLSA	214013A	_	_
BUSHING	19	1	BUSSNING	986661A	_	_
POINTER	18	1	VISARE	154924A	_	_
SCALE	17	1	SKALA	SE UTF./SEE DESIGN		
SOCKET SCREW	16	2	SKRUV	948635A	_	_
WASHER	15	6	BRICKA	934219A	_	_
WASHER	14	1	BRICKA	948639A	_	_
STUB SHAFT	13	1	STUBBAXEL	214011A	_	_
	12	_	_	_	_	_
SWIVEL, ASSY.	11	2	SVIVEL, SMST.	214009A	_	_
SWIVEL, ASSY.	10	2	SVIVEL, SMST.	937863A	_	_
BOLT	9	2	BULT	937867A	_	_
BOLT	8	2	BULT	987099A	_	_
CONNECTION PIPE	7	2	ANSLUTNINGSRÖR	214008A	_	_
COVER	6	1	LOCK	214007A	_	_
FLANGE NUT	5	1	FLÄNSMUTTER	214006A	_	_
CONNECTION FLANGE	4	1	ANSLUTNINGSFLÄNS	214005A	_	_
SHAFT	3	1	AXEL	214004A	_	_
OD-BOX RING	2	1	TO-BOXRING	214749A	_	_
BOX HOUSING	1	1	BOXHUS	214001A	_	_

Anläggning Plant: _	Best. nr/Prod.gr. nr. Order No./Prod.gr. No.: _	Tot. vikt Tot. weight kg: 48	
Uppgj. Drawn: Gök	Kontr. Checked: KO	Godk. Approved: Lly	Ytjämnhet enligt SMS 672 Ra µm Surface texture ISO/R 1302 Ra µm
KAMEWA A Vickers P.L.C. company KRISTINEHAMN SWEDEN	TO BOX 35 FA - OD-BOX 35 FA	Skala Scale: 1:2.5 A1	Datum Date: 100331
	SAMMANSTÄLLNING ASSEMBLY	Blad Sheet 1 av of 3	Föreg. ritn. Previous drg.: _
		214000	Ändr. Revis.: A

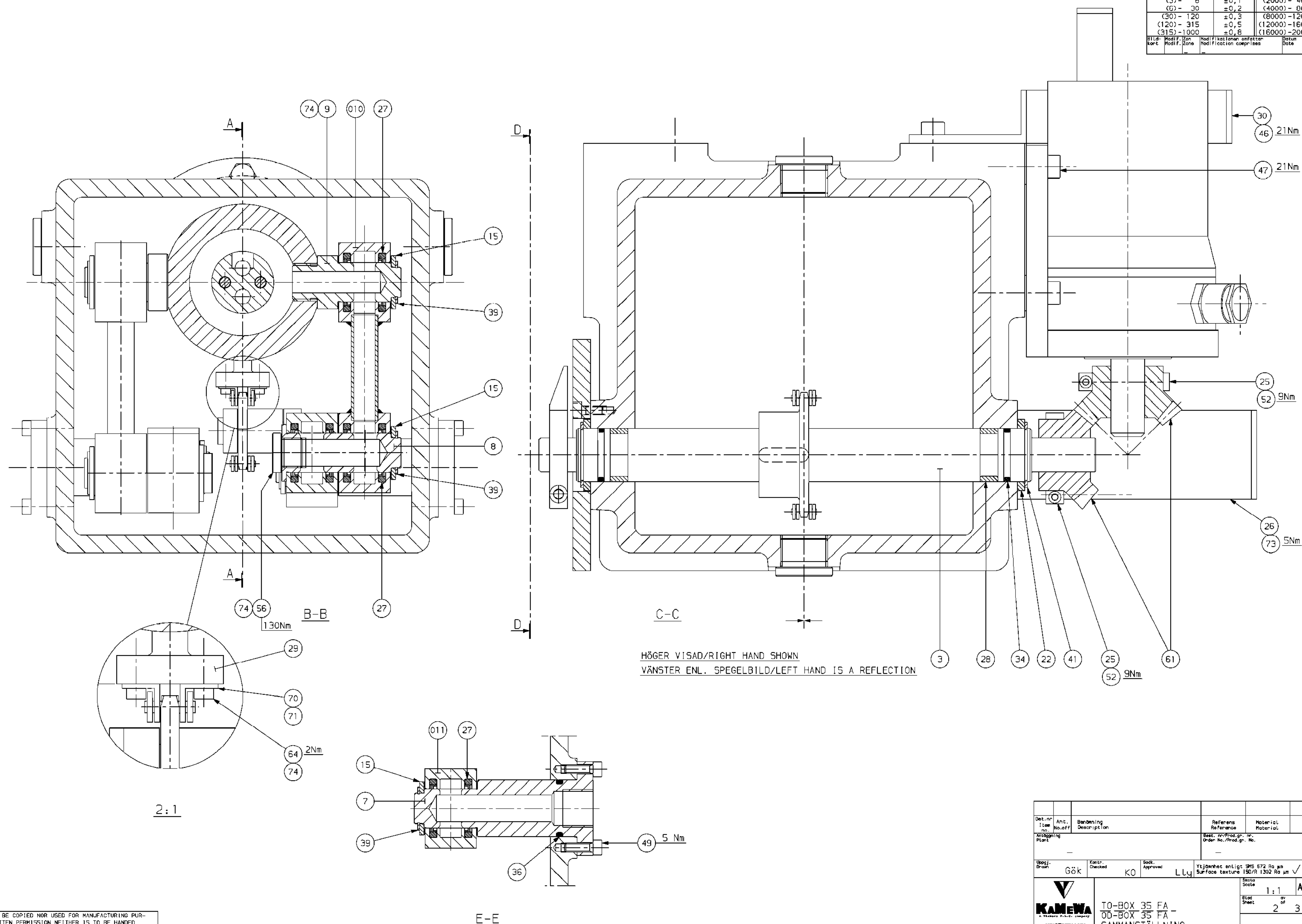
8 7 6 5 4 3 2 1

Tillåtna måttavvikelser när tolerans ej direkt utsatts på bearbetade detalj er SMS 715 Medel enligt tabell nedan. För rundningsradier, faser och vinkelmått följs SMS 715 Medel enligt separat standardblad.

Machining tolerances for linear dimensions unless otherwise specified. For radii and curvatures, bevels and angle measurements, SMS 715 Average according to separate standard sheets must be followed.

Basmått Basic size	Måttavvikelser Tolerances	Basmått Basic size	Måttavvikelser Tolerances
- 3	±0,1	(1000) - 2000	±1,2
(3) - 6	±0,1	(2000) - 4000	±2
(6) - 30	±0,2	(4000) - 8000	±3
(30) - 120	±0,3	(8000) - 12000	±4
(120) - 315	±0,5	(12000) - 16000	±5
(315) - 1000	±0,8	(16000) - 20000	±6

Bildkort	Modif. Modif.	Zon Zone	Modifikationen omfattar Modification comprises	Datum Date	Uppgj. Drawn	Godk. Approved
		–	–			



HÖGER VISAD/RIGHT HAND SHOWN
VÄNSTER ENL. SPEGELBILD/LEFT HAND IS A REFLECTION

Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark

Anläggning Plant	Best. nr/Prod.gr. nr. Order No./Prod.gr. No.	Tot. vikt Tot.weight kg
–	–	–

Uppgj. Drawn	Kontr. Checked	Godk. Approved	Ytjämnhet enligt SMS 672 Ra µm Surface texture ISO/R 1302 Ra µm
Gök	KO	Lly	

KaMeWa
A Vickers P.L.C. company
KRISTINEHAMN SWEDEN

TO-BOX 35 FA
OD-BOX 35 FA
SAMMANSTÄLLNING
ASSEMBLY

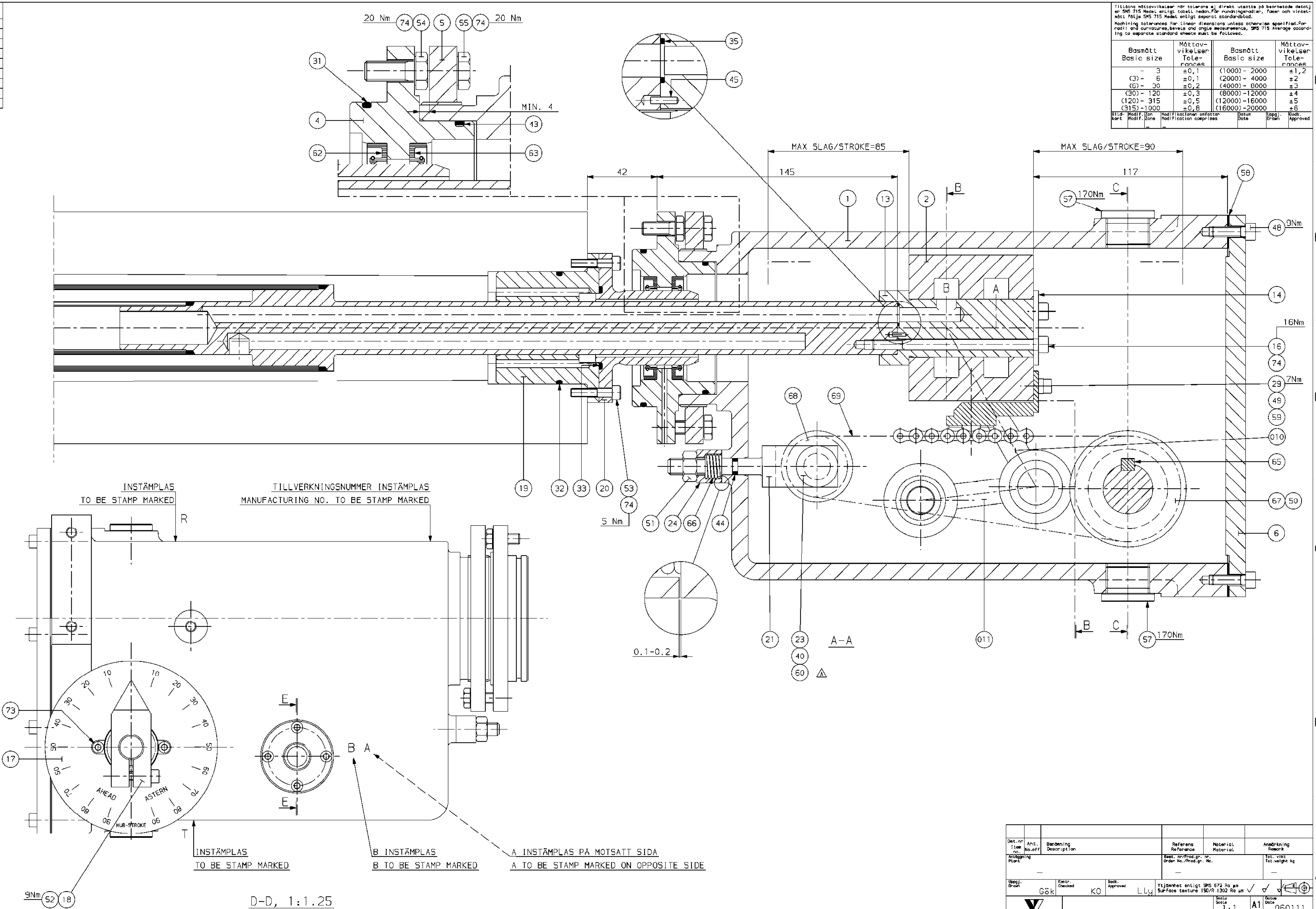
Skala Scale		Datum Date	Blad Sheet	av of	Föreg. ritn. Previous drg.	Ritn. nr	Ändr. Revis.
1:1	A1	100331	2	3	–	214000	A

Tillåtna måttavvikelser när tolerans ej direkt utsatts på bearbetade detalj er SMS 715 Medel enligt tabell nedan. För rundningsradier, faser och vinkelmått följs SMS 715 Medel enligt separat standardblad.

Machining tolerances for linear dimensions unless otherwise specified. For radii and curvatures, bevels and angle measurements, SMS 715 Average according to separate standard sheets must be followed.

Basmått Basic size	Måttavvikelser Tolerances	Basmått Basic size	Måttavvikelser Tolerances
- 3	±0,1	(1000)- 2000	±1,2
(3)- 6	±0,1	(2000)- 4000	±2
(6)- 30	±0,2	(4000)- 8000	±3
(30)- 120	±0,3	(8000)-12000	±4
(120)- 315	±0,5	(12000)-16000	±5
(315)-1000	±0,8	(16000)-20000	±6

Bild-kort	Modif. Modif.	Zon Zone	Modifikationen omfattar Modification comprises	Datum Date	Uppgj. Drawn	Godk. Approved
		–	–			



Det.nr Item no.	Ant. No.off	Benämning Description	Referens Reference	Material Material	Anmärkning Remark

Anläggning Plant	Best. nr/Prod.gr. nr. Order No./Prod.gr. No.	Tot. vikt Tot.weight kg
–	–	–

Uppgj. Drawn	Kontr. Checked	Godk. Approved	Ytjämnhet enligt SMS 672 Ra µm Surface texture ISO/R 1302 Ra µm
Gök	KO	Lly	

KaMeWa
A Vickers P.L.C. company
KRISTINEHAMN SWEDEN

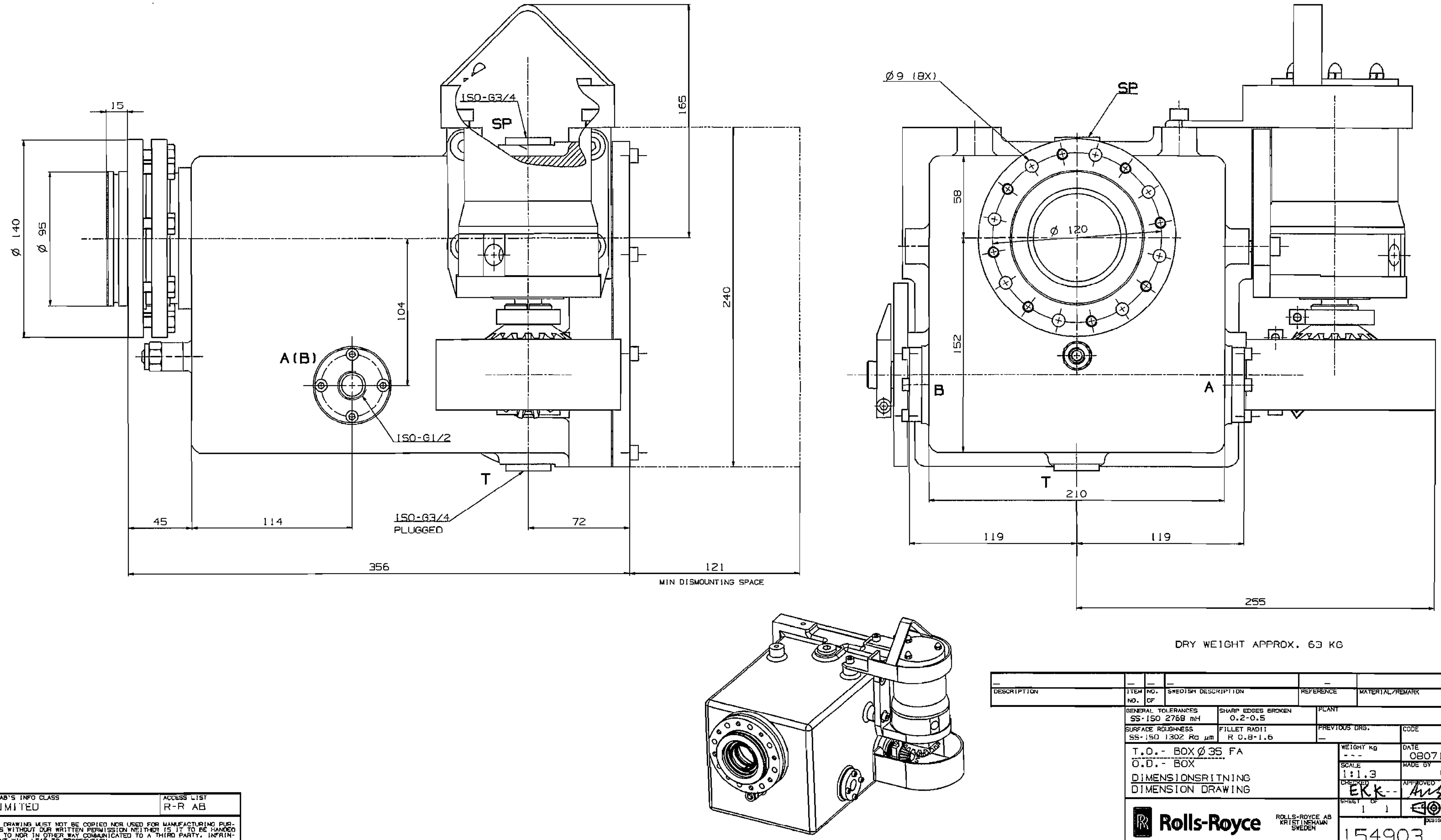
TO-BOX ø35 FO
OD-BOX ø35 FO
SAMMANSTÄLLNING
ASSEMBLY

Skala Scale		Datum Date
1:1	A1	060111

Blad Sheet	av of	Föreg. ritn. Previous drg.
3	3	–

214000 — Ändr. Revis. A

REV.	ZONE	REVISION COMPRISES	DATE	MADE BY	CHECKED	APPROVED
–	–	–	–	–	–	–



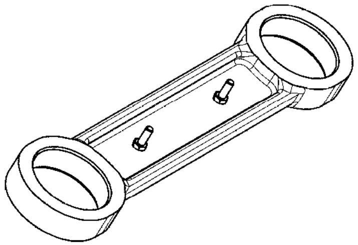
DRY WEIGHT APPROX. 63 KG

DESCRIPTION	ITEM NO.	NO. OF	SWEDISH DESCRIPTION	REFERENCE	MATERIAL/REMARK
–	–	–	–	–	–

GENERAL TOLERANCES SS-ISO 2768 mH	SHARP EDGES BROKEN 0.2-0.5	PLANT	
SURFACE ROUGHNESS SS-ISO 1302 Ra µm	FILLET RADII R 0.8-1.6	PREVIOUS DRG. –	CODE
T.O.- BOX Ø 35 FA O.D.- BOX DIMENSIONSRITNING DIMENSION DRAWING		WEIGHT kg ---	DATE 080714
		SCALE 1:1.3	MADE BY QRT
		CHECKED EKK--	APPROVED Ang---
Rolls-Royce	ROLLS-ROYCE AB KRISTINEHAMN SWEDEN	SHEET 1 OF 1	A1
		154903	DESIGN REV. -

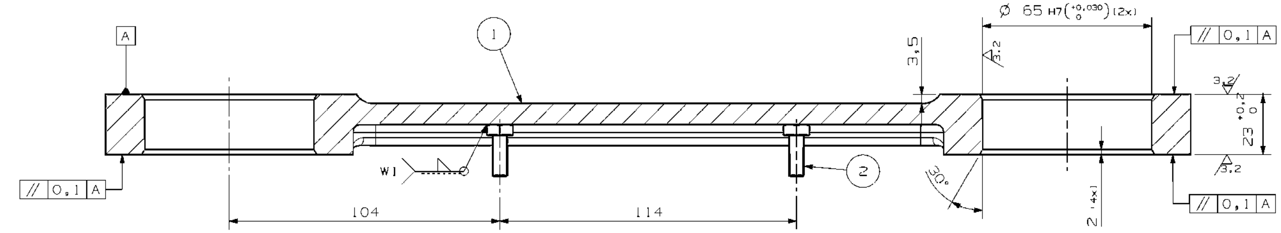
R-R AB'S INFO CLASS	ACCESS LIST
LIMITED	R-R AB

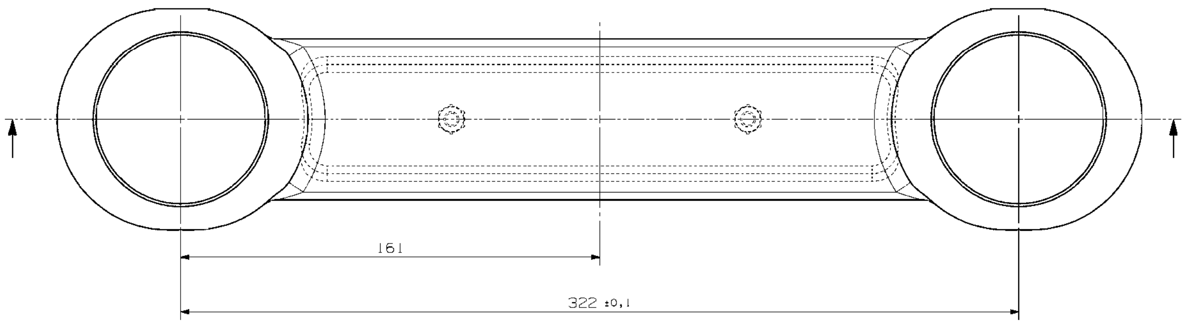
REV.	ZONE	REVISION COMPRISES	DATE	MADE BY	CHECKED	APPROVED
-		-	-	-	-	-



Svetsbestämmelser Welding rules	Svetsstandard för Rolls-Royce AB Welding standard for Rolls-Royce AB
Grundmaterial Parent metal	SEE PARTS LIST
Avspänningsglödgningstemperatur Stress-relieving heat treatment at	—
Svetsplan Sequence of welding	SE SVETSDATABLAD SEE WELDING PROCEDURE SPECIFICATION (WPS)
Täthetskrav Sealing Requirements	—
Svetstolerans Welding Tolerance	EN ISO 13920-BE

			Provningsomfattning Extent of Examination				
Svets nr Weld no	Svetsklass Welding class	Svetsmetod Welding Process	Röntgen undersökning Radiographic examination	Ultraljud undersökning Ultrasonic examination	Magnetpulver undersökning Magnetic particle examination	Penetrant undersökning Liquid Penetrant examination	Anmärkning Remark
W1	C	_	_%	_%	_%	_%	_





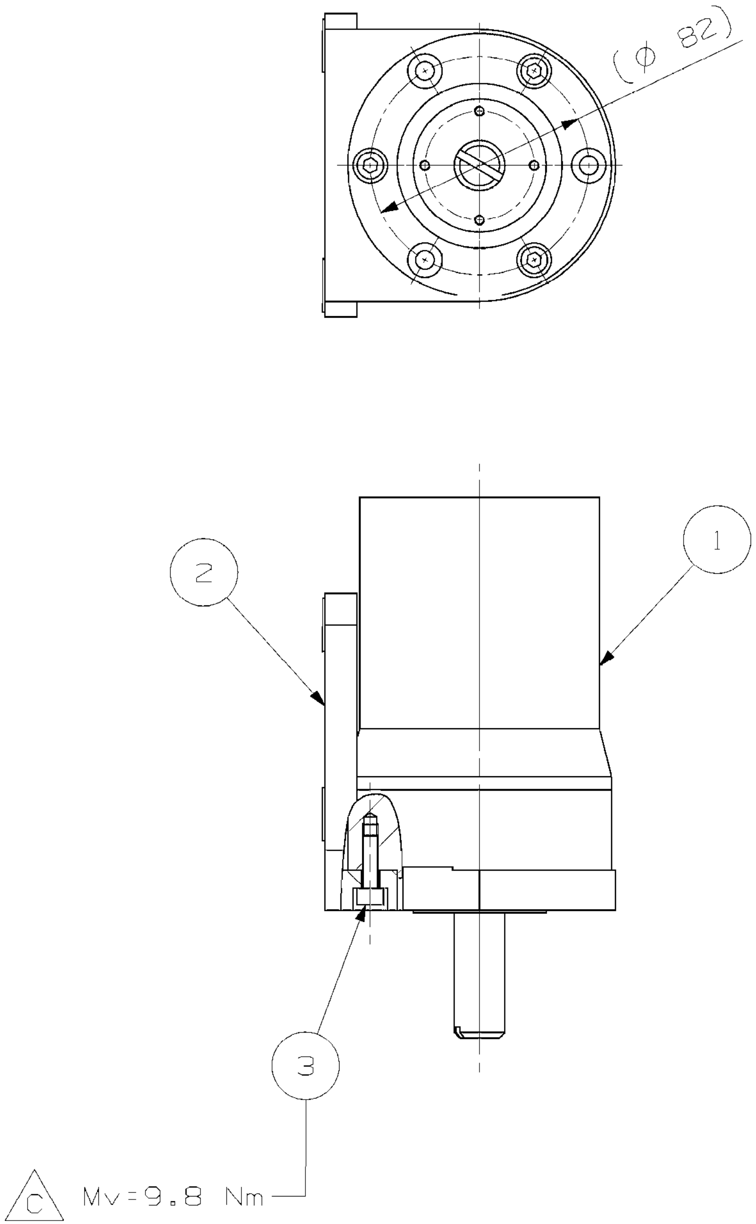
SKARPA KANTER BRYTES / SHARP EDGES BROKEN

KVALITETSINSTRUKTION / QUALITY INSTRUCTION: QI-5-220-08SE

DESCRIPTION	ITEM NO.	NO. OF	SWEDISH DESCRIPTION	REFERENCE	MATERIAL/REMARK
HEX HEAD SCREW	2	2	6K.SKRUV M6x16	ISO401/	A4-80 2343
LINK ARM, BLANK	1	1	LÄNKARM,ÄMNE	21//41A	(1.4470)

GENERAL TOLERANCES SS-ISO 2768-mH	SHARP EDGES BROKEN 0,2-0.5	PLANT _	
SURFACE ROUGHNESS SS-ISO 1302 Ra µm	FILLET RADII R 0.8-1.6	PREVIOUS DRG. _	CODE _
45 S3		WEIGHT kg 2.5	DATE 071207
		SCALE 1:1	MADE BY T.N
LÄNKARM, BEARBETNING LINK ARM, MACHINING		CHECKED Enl	APPROVED Jnp
Rolls-Royce	ROLLS-ROYCE AB KRISTINEHAMN SWEDEN	SHEET 1 OF 1	A1
		217740	DESIGN REV. _

RR AB'S INFO CLASS	ACCESS LIST
Restricted	RR AB



General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra µm	R 0,8 - 1,6	5.5

Transmitter

ENCODER SMST

Rolls-Royce

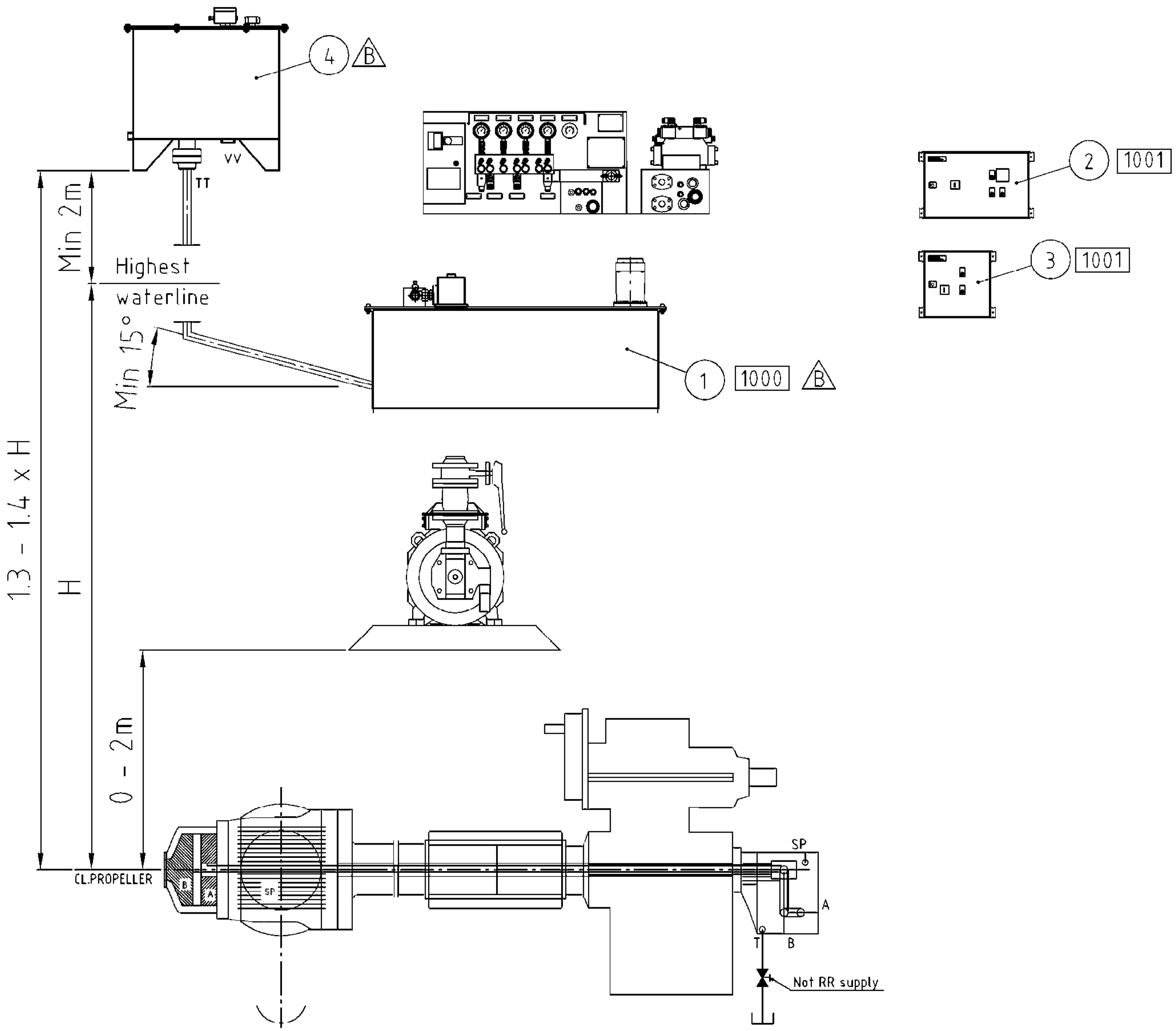
Rolls-Royce AB
S-681 29 KRISTINEHAMN

Origin./Date:	Scale:	Format:	Sheet:
mnmn 2010.07.05	1:2	A3	1 of 1
Drawing no: RRM200000128			Revision: C

Acess List:

RR AB's Info class: Limited

Colour	
Hydraulic power pack	RAL 5024
Gravity oil tank	RAL 5024
Pump motor starter	RAL 7035



1001 Spare parts starter, see drawing RRM200007041

1000 Spare parts hydraulic, see drawing RRM200007040

Plant	Order No./Prod.gr. No.	Tot. Weight kg	Surface texture ISO/R 1302 Ra um

Hydraulic system assembly
Main propeller
Hub 55 A/4D - 35FA

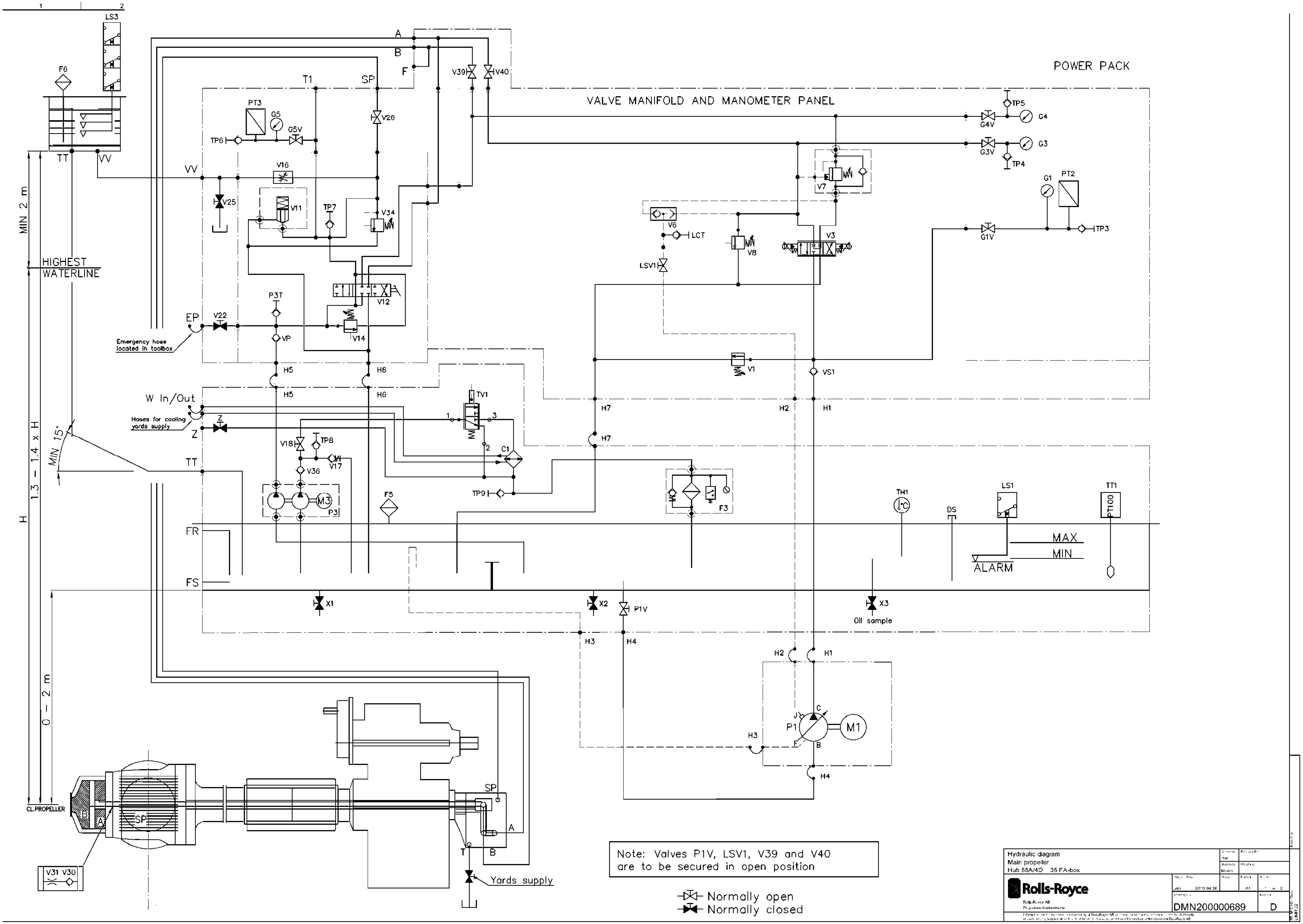
Checked	Previous Drg
Har	
Approved	Weight kg
Mnmn	

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Origin / Date	Scale	Format	Sheet
Jnla 2010-04-27		A2	1 of 1

Drawing no: RRM200007036 Revision: B



POWER PACK
VALVE MANIFOLD AND MANOMETER PANEL
LS3
F6
TT
VV
MIN 2 m
HIGHEST WATERLINE
H
1.3 – 1.4 x H
MIN 15°
0 – 2 m
CL.PROPELLER
V31 V30
A
B
F
T1
SP
V39
V40
PT3
G5
G5V
TP6
V26
V16
V25
V11
TP7
V34
V12
EP
V22
P3T
VP
V14
Emergency hose located in toolbox
H5
H6
W In/Out
Hoses for cooling yards supply
Z
TT
TV1
V18
TP8
V36
V17
C1
TP9
M3
P3
F5
FR
FS
X1
X2
P1V
X3
Oil sample
H3
H4
H7
H2
H1
V1
VS1
V6
LCT
LSV1
V8
V3
V7
TP5
G4
G4V
G3V
G3
TP4
G1
PT2
G1V
TP3
F3
TH1
DS
LS1
TT1
PT100
MAX
MIN
ALARM
P1
M1
C
J
Yards supply
Note: Valves P1V, LSV1, V39 and V40 are to be secured in open position
Normally open
Normally closed
Hydraulic diagram
Main propeller
Hub 55A/4D 35 FA-box
Rolls-Royce
2010 04 26
DMN200000689
D

List of components

C1	Cooler
DS	Dip stick
F3	Oil circulation filter
F5	Air breather filter main tank
F6	Air breather filter gravity tank
G1	Pressure gauge system pressure
G1V	Shut off valve
G3	Pressure gauge conn A astern pitch
G3V	Shut off valve
G4	Pressure gauge conn B ahead pitch
G4V	Shut off valve
G5	Pressure gauge static pressure
G5V	Shut off valve
LCT	Test point
LS1	Level switch main tank
LS3	Level switch gravity tank
LSV1	Shut off valve, load sensing line pump P1
P1	Pump unit 1
P1V	Shut off valve, suction line pump P1
P3	Static pressure / cooling filtration pump
P3T	Test point
PT2	Pressure transmitter system pressure
PT3	Pressure transmitter static pressure
TH1	Thermometer main tank
TP3–TP9	Test point
TT1	Temperature sensor main tank
TV1	Temperature control valve
V1	Safety valve
V3	Proportional control valve
V6	Shuttle valve
V7	Counter balance valve
V8	Pressure relief valve (astern manoeuvre)
V11	Pressure valve for static pressure
V12	Selector valve for emergency control
V14	Pressure relief valve for emergency control
V16	Throttle valve
V17	Pressure valve for by-pass filter
V18	Shut off valve
V22	Shut off valve
V25	Shut off valve
V26	Shut off valve
V30	Check valve
V31	Nozzle
V34	Pressure relief valve
V36	Check valve
V39	Shut off valve
V40	Shut off valve
VS1	Check valve
VP	Check valve
X1	Shut off valve
X2	Shut off valve
X3	Shut off valve (oil sample)
Z	Shut off valve

Pressure valves setting values (MPa)

V1	13	(Safety valve)
PR	12	(Pressure regulator, pump)
LSR	2	(Load sensing regulator, pump)
V7	15,5	(Counter balance valve)
V8	6	
V11	0,15	
V14	6	
V17	0,5	
V34	0,4	

OD–Box connections

A	ISO G1/2"
B	ISO G1/2"
SP	ISO G3/4"
T	ISO G3/4"

External hoses (Yard supply)

Location	Inner dia. min	Design press. (MPa)
H1 to H1	3/4"	13
H2 to H2	1/4"	13
H3 to H3	1/2"	0,6
H4 to H4	1 1/4"	0,6
H5 to H5	1/2"	6
H6 to H6	1"	0,6
H7 to H7	1"	0,6

External tube (yard supply)

Location	Material	Inner dia. min (mm)	Thickness min (mm)	Design press. (MPa)
A to A	Steel	25	2	13
B to B	Steel	25	2	13
SP to SP	Steel	20	2	0,6
T	Steel	20	2	0,6
VV to VV	Steel	16	1,8	0,6
TT to TT	Steel	40	2	0,6
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–

Max tube length=10m, if longer please contact RR
Recomended tube material quality acc. to St 37.4
acc. to DIN 2391 C and DIN 1630
Min. tubewall thickness
acc. to LRS regulations part 5 chapt. 12 table 12.2.4

Hydraulic system

Main data:
Max working pressure 13 MPa (pitch setting system) (Design pressure)
Max oil flow 35 lit/min. Total oil volume 160 lit
Calculated pitch setting time 14 sec. with one pumpunit in service

Hydraulic power pack

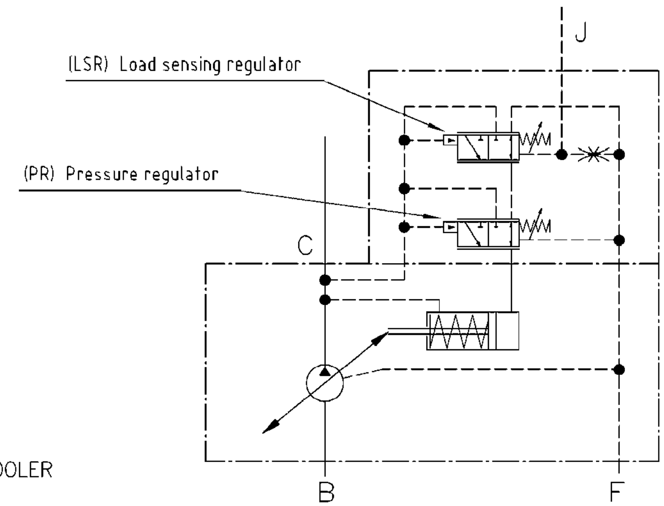
Pump unit P1
Load sensing variable piston pump, Vickers type PVM020
Capacity 35 lit/min at 1750 RPM

El-motor P1
Mez type 7BA132M04, 8,6kW at 1750 RPM, 600V, 60Hz, 3 Phases
Full load current 10,1 A, Starting current 68 A,

Pump unit P3
Gera double pump, Settima DG33 010 + 006
Capacity 17 + 10 lit/min at 1720 RPM

El-motor P3
Mez type 7AA90L04, 1,8 kW at 1720 RPM, 600V, 60Hz, 3 Phases
Full load current 2,3 A, Starting current 12 A,

Cooler C1
Type H8A-IG16-9, Cooling capacity 3 kW, Cooling water req. 0.6 m3/h
Sea water at max 32 °C, dp water 5 kPa



LOAD SENSING VARIABLE DISPLACEMENT PISTON PUMP

NOTE: THERE SHOULD ALWAYS BE FLEXIBLE HOSES ATTACHED TO THE COOLER

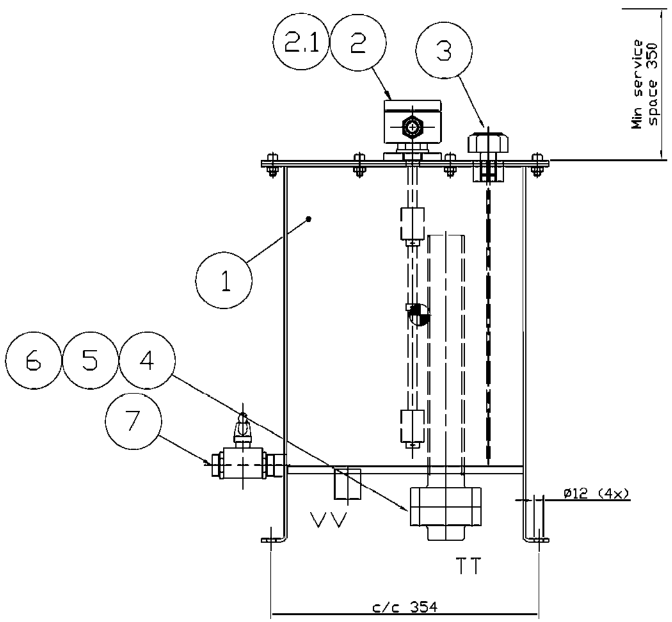
NOTE: OIL ALWAYS TO BE FILLED BY USING CONNECTION Z

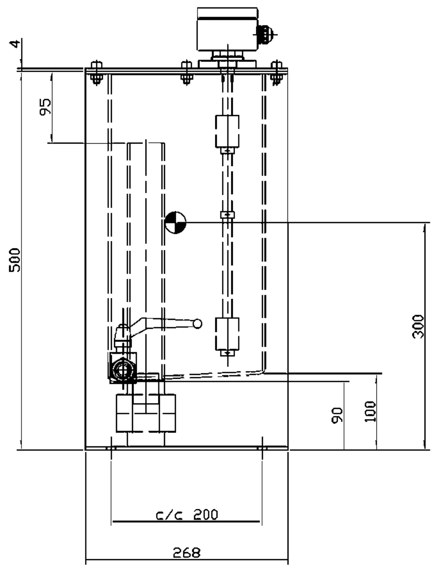
Hydraulic diagram
Main propeller
Hub 55A/4D 35 FA-box

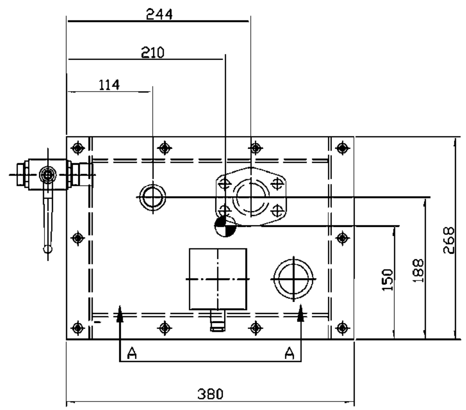
Rolls-Royce
Rolls-Royce AB

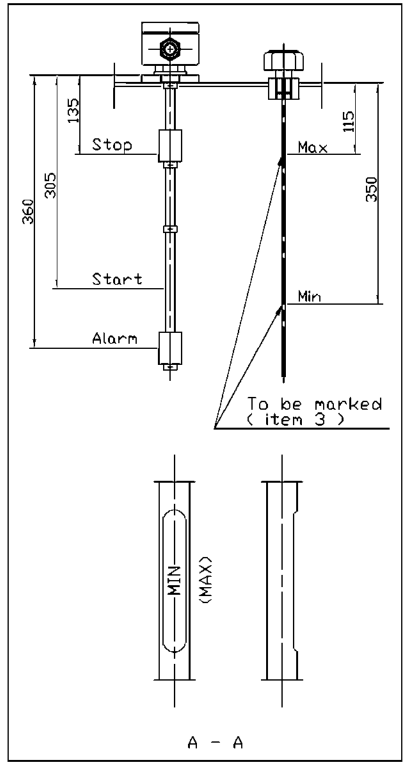
2010 04 26 | A1 | 2 of 2

DMN200000689 | D









Note:
Total weight incl. oil about 42 kg.
Total weight excl. oil about 25 kg.
"VV" gravity tank pressure ISO G 3/4.
"TT" overflow tube SAE 1 1/2".

8	-	Colour			See hydraulic diagram
7	1	Shut-off valve 1/2"	8090-08-08 DN15		Specma
6	1	O-ring	47,22x3,53		Specma
5	4	Hex. socket cap screw	M12x45	12,9	ISO 4762
4	1	Flange for welding	AFS-106ST	48,5x38	Specma
3	1	Air breather whit dip stick	SES2-M-500		Parker
2.1	1	Adapter	G8113		Specma
2	1	Level switch	UNS2000-S-VA/T1-KLS2-BN30-L3/3		Barksdale
1	1	Oil tank 20 lit.	G09179		Specma
Item	Qty	Description	Reference	Material	Remark

General tolerances	Sharp edges broken	Surface roughness	Fillet radii	Weight (kg)
ISO 2768-mH	0,2 - 0,5	ISO/R 1302 Ra μm	R 0,8 - 1,6	-

Hydraulic System
Main propeller
Gravity tank 20 lit.

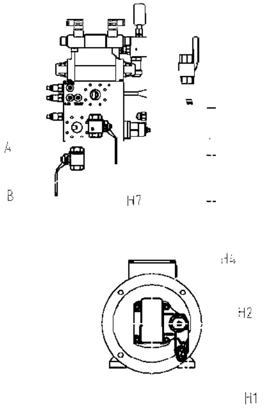
Rolls-Royce
Rolls-Royce AB
S-681 29 KRISTINEHAMN

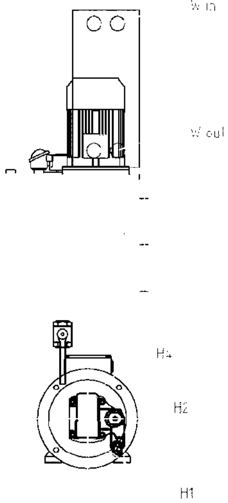
Origin / Date:		Scale:	Format	Sheet
TAN	2010-10-12	1:5	A2	1 of 1
Drawing no				Revision
RRM200011521				A

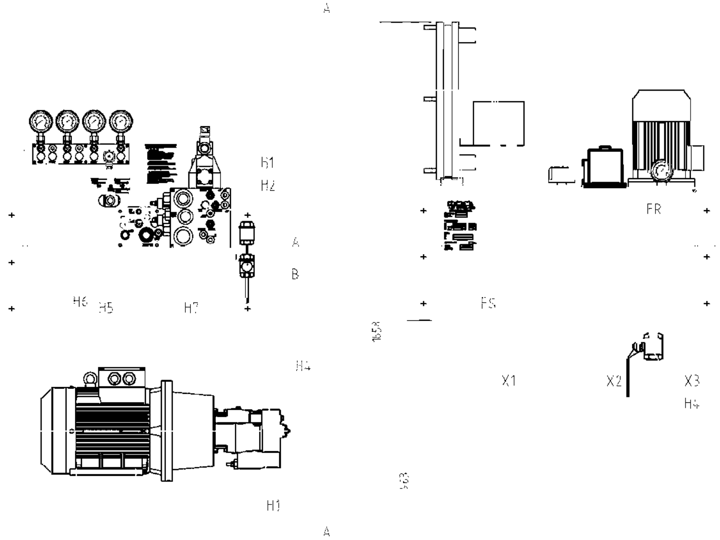
Acess List
RR A3 S Info Class: LIMITED

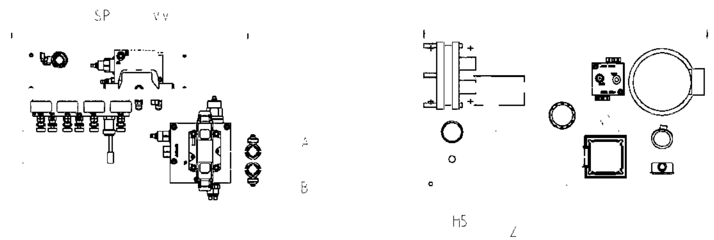
View A

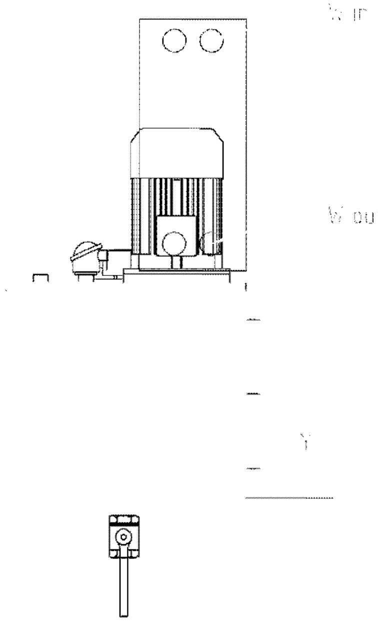
View B

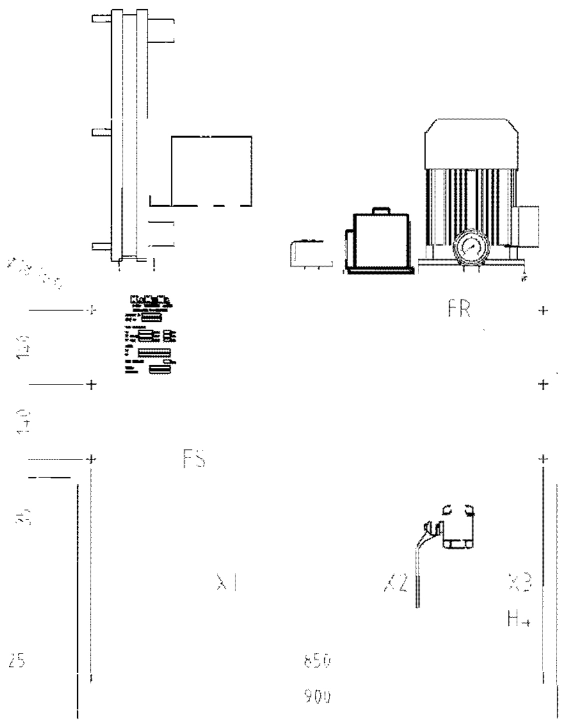

A
B
H7
H4
H2
H1

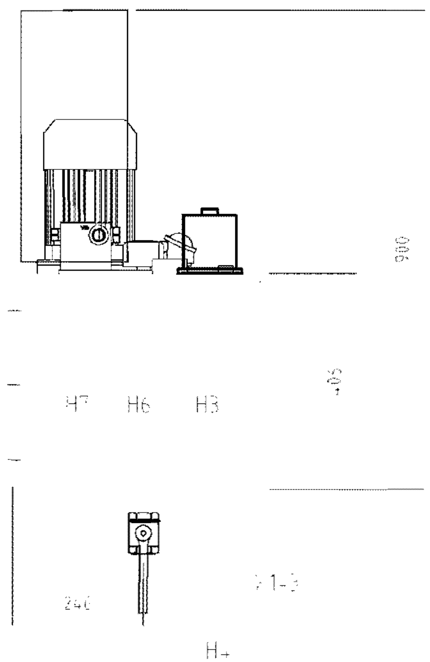

W in
W out
H4
H2
H1


A
B
H1
H2
A
B
H6
H5
H7
H4
H1
FR
FS
X1
X2
X3
H4

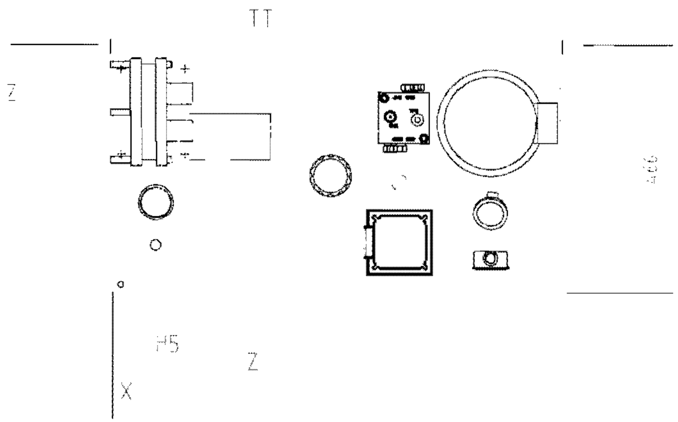

SP
VV
A
B
H5
Z

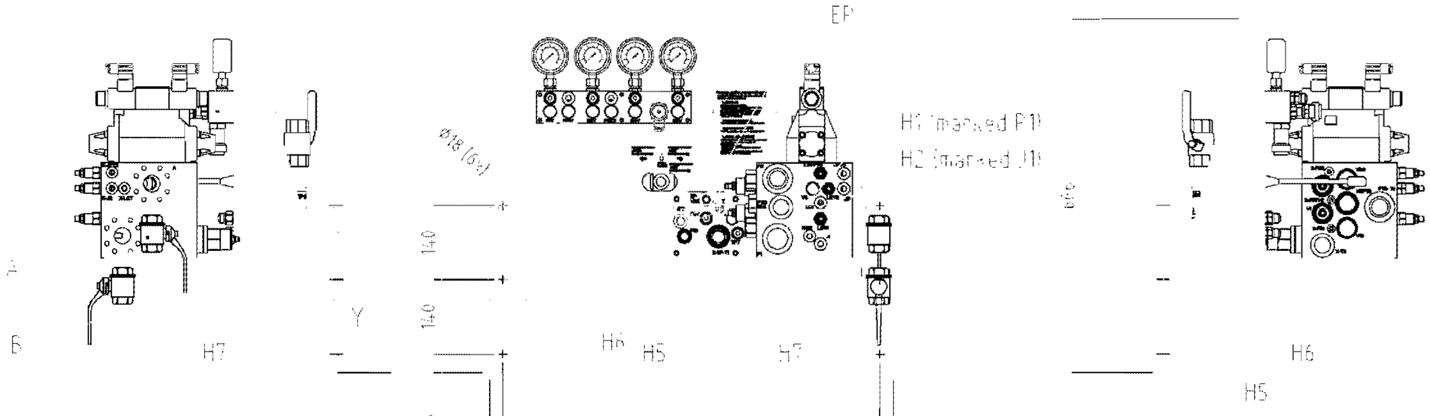


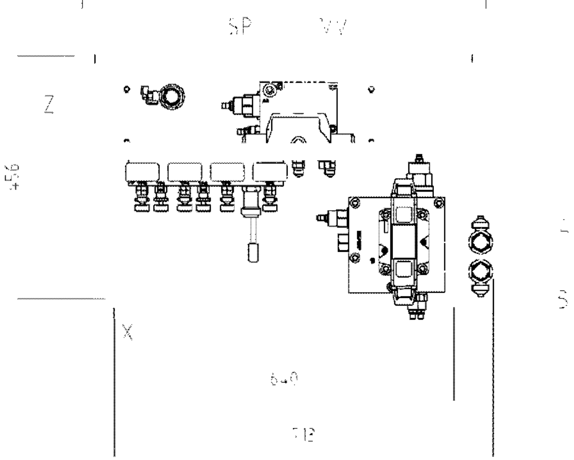




Connection	Size	X	Y	Z
TT	G 2"	80	435	295
Water In	[illegible]	150	860	90
Water Out	[illegible]	150	480	90
Z	G 3/4"	190	435	490
X1	G 1 1/2"	135	-100	760
X2	G 1 1/2"	485	-100	360
X3	G 1 1/2"	685	-100	350
FS	G 1"	135	55	100
FR	G 1"	745	305	335
H3	G 1/2"	15	345	30
H4	G 1 1/4"	665	-120	245
H5	G 1/2"	60	435	375
H6	G 1"	15	345	165
H7	G 1	15	345	90

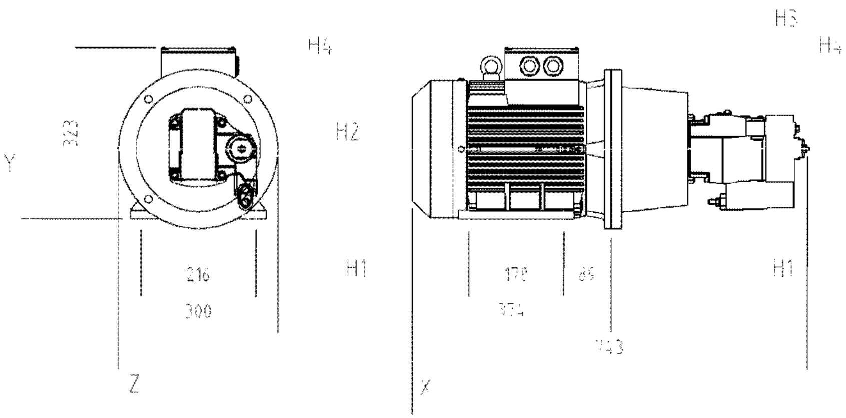


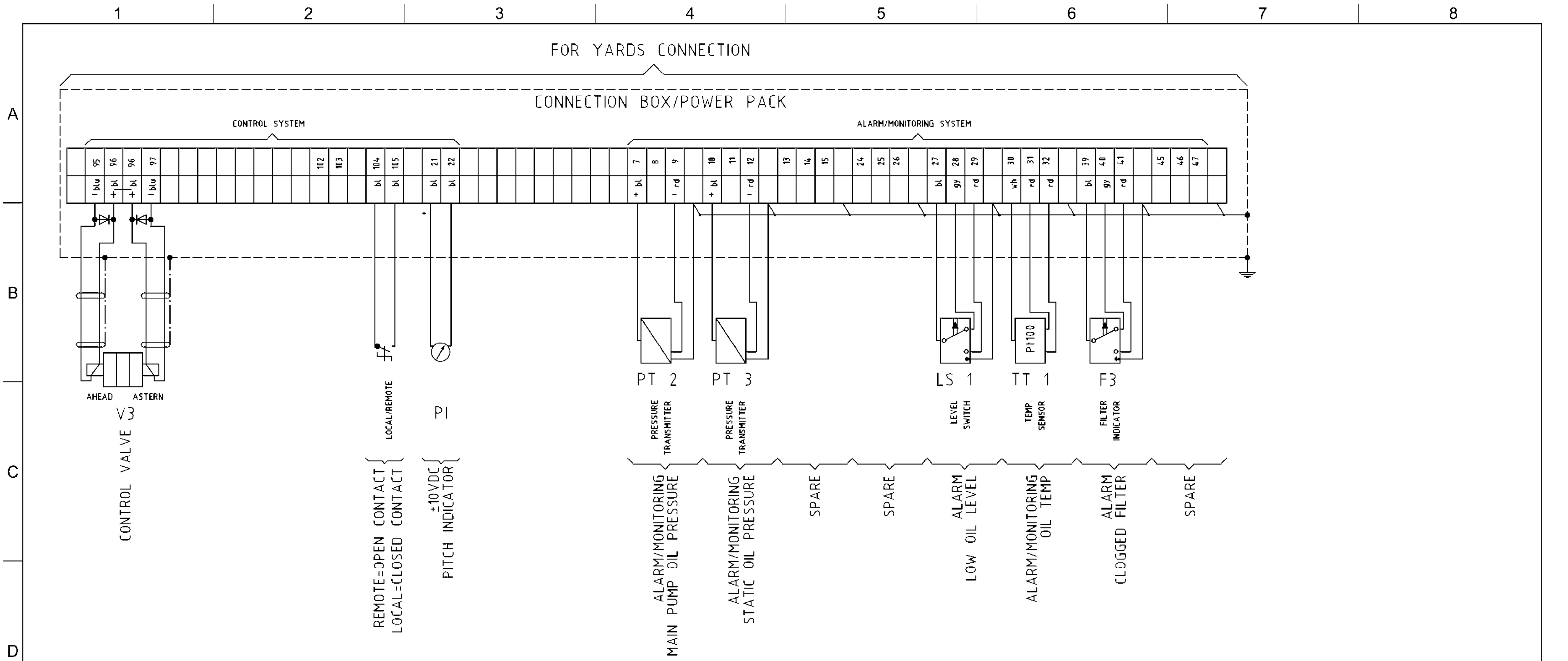


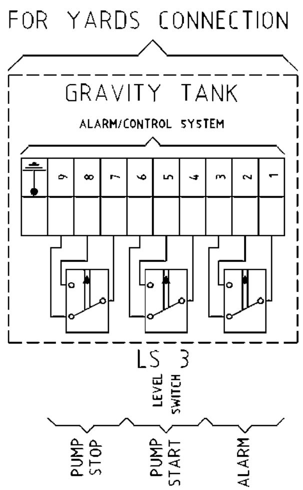


Connection	Size	X	Y	Z
A	G 1"	390	225	350
B	G 1"	440	180	405
SP	G 1"	110	475	75
[illegible]	G 3/8	295	[illegible]	65
EP	G 1/8	350	325	265
H1	G [illegible]	450	255	445
H2	G 1/4"	565	245	445
H5	G 1/2	375	165	120
H6	G 1"	325	165	120
H7	G 1"	480	165	305

Connection	Size	X	Y	Z
H1	G 3/4"	640	70	150
H2	G 1/4"	690	90	260
H3	G 1/2"	570	200	150
H4	SAE 1 1/4"	490	195	150







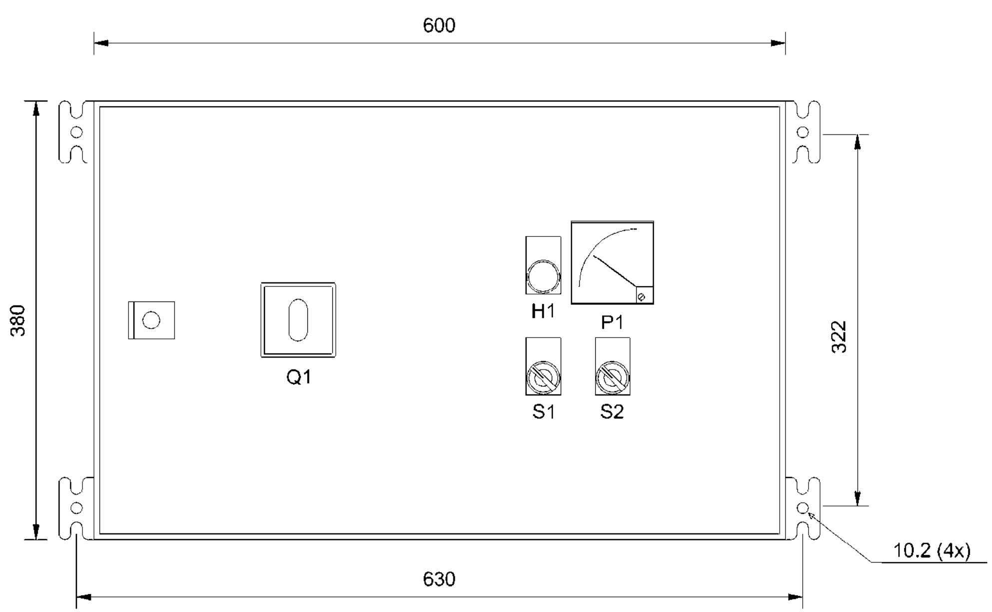
SWITCHES ARE SHOWN IN PRESSURE LOSS,LOW LEVEL,LOW TEMP. POSITIONS.

CABLES CONNECTING VALVES MIN 1,5mm², ALARM CABLES MIN 1,0mm²

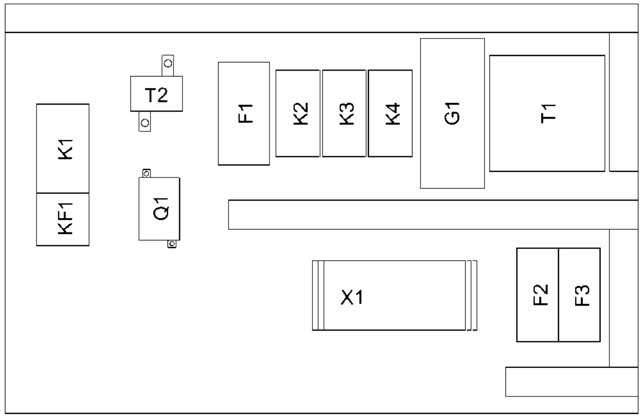
COLOUR CODES: bl-BLACK gy-GRAY rd-RED blu-BLUE wh-WHITE

CABLE TO BE CONNECTED TO THE SWITCHES WHEN APPLICABLE.

Connection diagram Main propeller Kopplingsschema	Checked: Har	Previous Drg:	
	Approved: Mnmn	Weight kg:	
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: Jnla 2010-04-27	Scale:	Format: A3	Sheet: 1 of 1
	Drawing no: DMN200000981		Revision: B



DEPTH: 210mm



ELEKTROMONTAGE

Revis.	Revision comprises	Date	Made by	Checked	Approved

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P1/P2

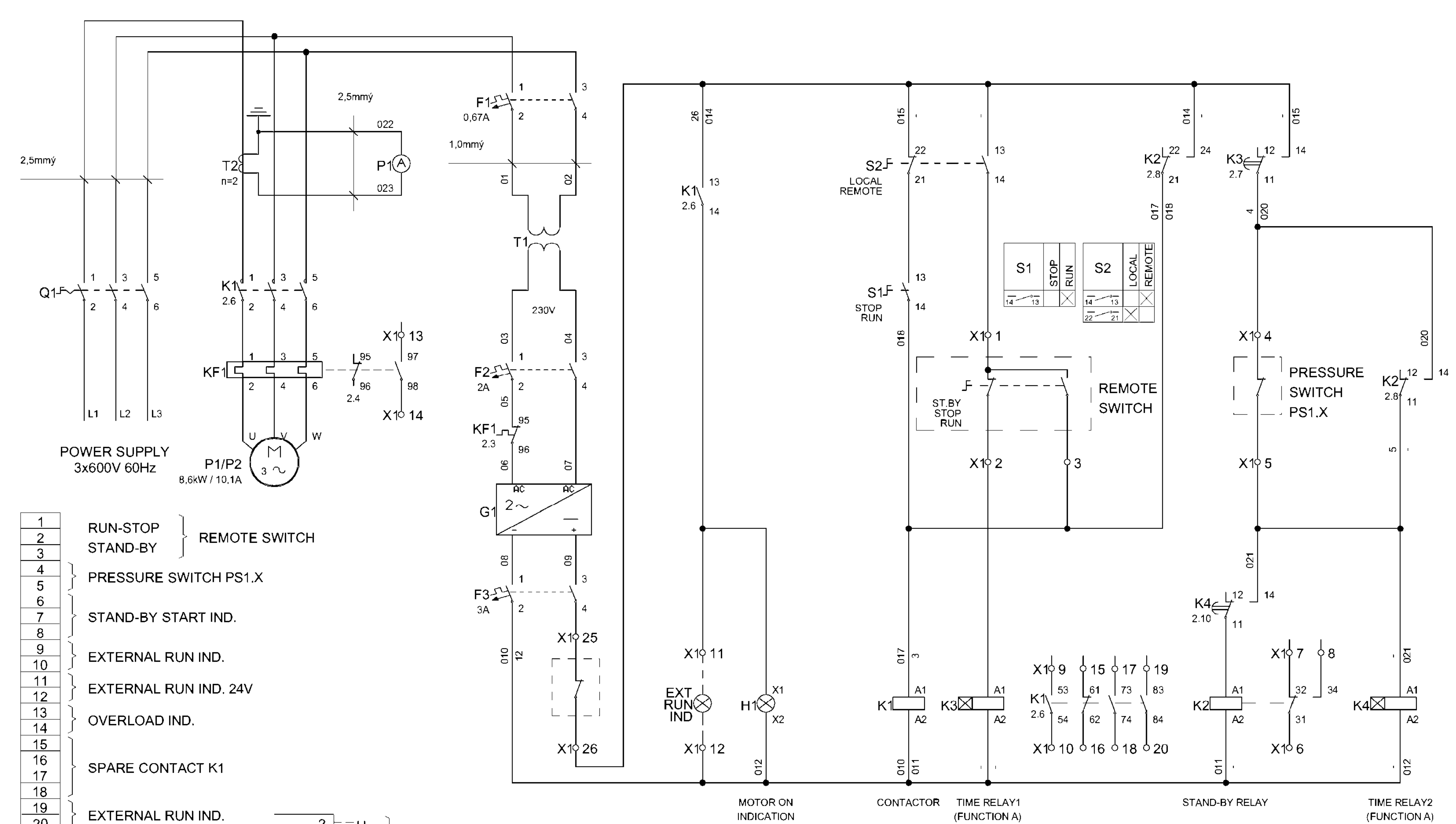
Checked.	SGR
Previous Drg.	
Approved.	LBE
Weight kg.	~25 Kg
Origin. / Date:	MLI / 10.05.05
Scale.	
Format.	A3
Sheet:	1 of 4
Drawing no:	RRM200007038
Revision:	A

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Acess List

RR AB'S Info. Class.
LIMITED



1	RUN-STOP	REMOTE SWITCH	
2	STAND-BY		
3			
4	PRESSURE SWITCH PS1.X		
5			
6	STAND-BY START IND.		
7			
8			
9	EXTERNAL RUN IND.		
10			
11	EXTERNAL RUN IND. 24V		
12			
13	OVERLOAD IND.		
14			
15	SPARE CONTACT K1		
16			
17			
18			
19	EXTERNAL RUN IND.		
20			
21	SPARE TERMINALS		
22			
23			
24			
25	EMERGENCY STOP		
26			

KF1	2	U	ELEC. MOTOR
	4	V	
	6	W	
Q1	2	L1	POWER SUPPLY
	4	L2	
	6	L3	

H.ONo:

ELEKTROMONTAGE

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P1/P2

Checked: SGR	Previous Drg.			
Approved: LBE	Weight kg. ~25 Kg			
Origin. / Date: MLI / 10.05.05	Scale:	Format: A3	Sheet: 2 of 4	
Drawing no: RRM200007038			Revision: A	

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Revis.	Revision comprises	Date	Made by	Checked	Approved

Acess List

RR AB'S Info. Class. LIMITED

Item.	Quant.	Description	Type	Manufacturer	Note
	1	CABINET 600X380X210	AE1039.500	RITTAL	
	4	WALL BRACKETS	SZ2508/4	RITTAL	
F1	1	MOTOR CIRCUIT BR. 0,63-1A	GV2RT05	TELEMECANIQUE	
F2	1	MINIATURE CIRCUIT BREAKER	C60N 2P C2A	MERLIN GERIN	
F3	1	MINIATURE CIRCUIT BREKAER	C32H DC 2P C3A	MERLIN GERIN	
G1	1	POWER SUPPLY 230/24V 3A	CP SNT 70W 24V 3A	WEIDMšLLER	
H1	1	LENSE YELLOW LED	ZB4BV053	TELEMECANIQUE	
H1	1	YELLOW LED PILOT LIGHT BODY	ZB4BVB5	TELEMECANIQUE	
K1	1	CONTACTOR 18A 24VDC	LC1D18BD	TELEMECANIQUE	
K1	1	AUX. CONTACT BLOCK 3NO+1NC	LADN31	TELEMECANIQUE	
K2	1	RELAY 3-POLE 24VDC	C3A30D24D	RELECO	
K2	1	SOCKET FOR 11-PIN RELAY	S3MP	RELECO	
K3	1	MULTIFUNCTIONAL TIME RELAY	PU2R3	CROUZET	
K3	1	SOCKET FOR 11-PIN RELAY	S3MP	RELECO	
K4	1	MULTIFUNCTIONAL TIME RELAY	PU2R3	CROUZET	
K4	1	SOCKET FOR 11-PIN RELAY	S3MP	RELECO	
KF1	1	OVERCURRENT RELAY 12-18A	LRD21	TELEMECANIQUE	
P1	1	AMMETER	IQ72 25/5A	CEWE INSTRUMENT	
Q1	1	LOAD BREAK SWITCH 40A 3P	OT 40 F3	ABB CONTROL	
Q1	1	HANDLE	OHBS2AJ	ABB CONTROL	
Q1	1	EXTENDED SHAFT 330mm	OXS6X330	ABB CONTROL	
S1	1	HANDLE 2-POS, BLACK	ZB4BD2	TELEMECANIQUE	
S1	1	CONTACT BODY 1NO	ZB4BZ101	TELEMECANIQUE	
S2	1	HANDLE 2-POS, BLACK	ZB4BD2	TELEMECANIQUE	
S2	1	CONTACT BODY 1NO	ZB4BZ101	TELEMECANIQUE	
S2	2	COMPLEMENTARY BLOCK 1NC	ZBE102	TELEMECANIQUE	

Acess List

ELEKTROMONTAGE

Revis.	Revision comprises	Date	Made by	Checked	Approved

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P1/P2

Checked. SGR | Previous Drg.
Approved. LBE | Weight kg. ~25 Kg

Rolls-Royce
Rolls-Royce AB
Propulsion Kristinehamn

Origin. / Date: MLI / 10.05.05 | Scale. | Format. A3 | Sheet: 3 of 4

Drawing no: RRM200007038 | Revision: A

RR AB'S Info. Class. LIMITED

Item.	Quant.	Description	Type	Manufacturer	Note
T1	1	TRANSFORMER 690/230,24V	SUS120B 375+25VA	NORATEL	
T2	1	CURRENT TRANSFORMER	MAK 50/5A 45/14	CEWE INSTRUMENT	
X1	26	TERMINAL 2,5mm	WDU 2,5	WEIDMšLLER	

Revis.	Revision comprises	Date	Made by	Checked	Approved

ELEKTROMONTAGE

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P1/P2

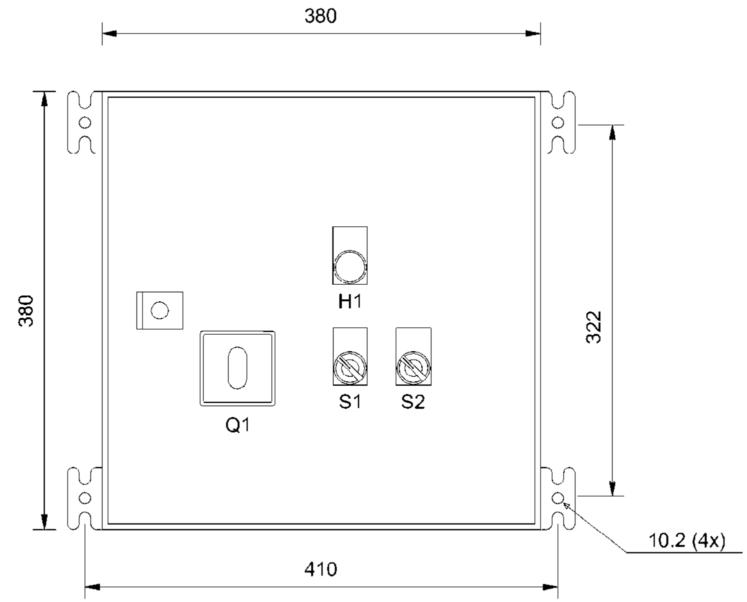
Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

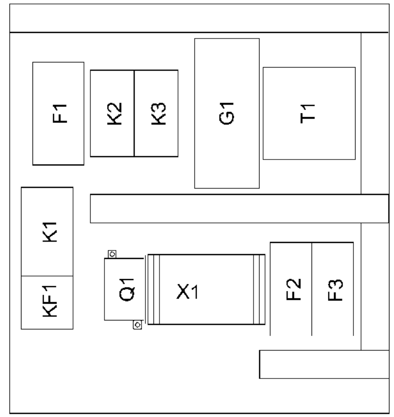
Checked. SGR
Previous Drg.
Approved. LBE
Weight kg. ~25 Kg
Origin. / Date: MLI / 10.05.05
Scale.
Format. A3
Sheet: 4 of 4
Drawing no: RRM200007038
Revision: A

Acess List

RR AB'S Info. Class. LIMITED



DEPTH: 210mm



HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P3

ELEKTROMONTAGE

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Checked.	Previous Drg.
SGR	

Approved.	Weight kg.
LBE	~17 Kg

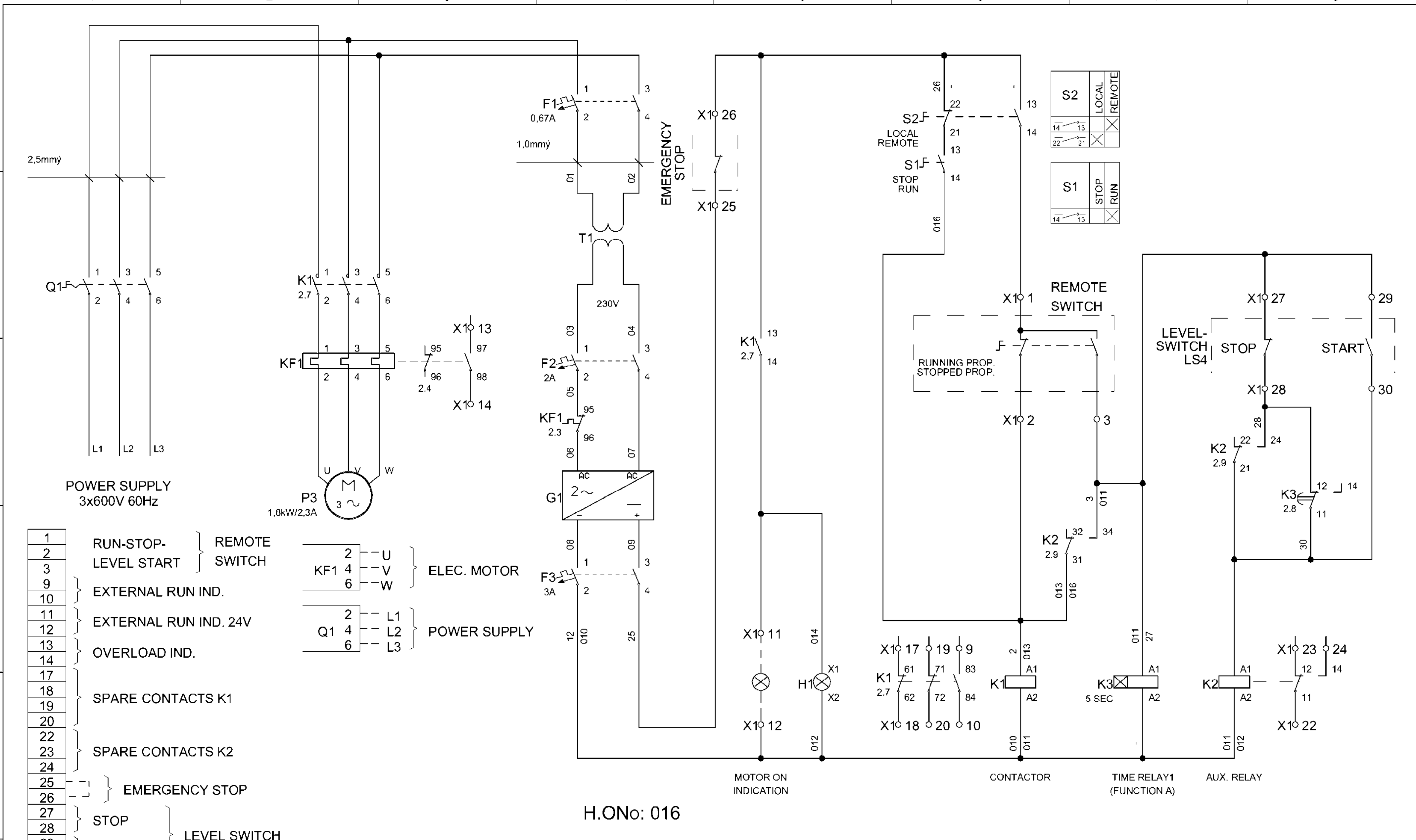
Origin. / Date:	Scale.	Format.	Sheet:
MLI / 10.05.05		A3	1 of 3

Drawing no:	Revision:
RRM200007039	B

Revis.	Revision comprises	Date	Made by	Checked	Approved
B	Gravity tank added	10.10.19	Mikael Lindvall	Leif Bengtsson	Stefan Gr"nlund

Acess List

RR AB'S Info. Class.
LIMITED



H.ONo: 016

NOTE: IF EMERGENCY STOP NOT IS USED, CONNECT 25 TO 26

ELEKTROMONTAGE

Revis.	Revision comprises	Date	Made by	Checked	Approved

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P3

Checked: SGR
Approved: LBE
Previous Drg.:
Weight kg: ~17 Kg

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Origin. / Date: MLI / 10.05.05
Scale:
Format: A3
Sheet: 2 of 3
Drawing no: RRM200007039
Revision: B

Access List

RR AB'S Info. Class. LIMITED

Item.	Quant.	Description	Type	Manufacturer	Note
	1	CABINET 380x380x210	AE1380.500	RITTAL	
	4	WALL BRACKETS	SZ2508/4	RITTAL	
F1	1	MOTOR CIRCUIT BR. 0,63-1A	GV2RT05	TELEMECANIQUE	
F2	1	MINIATURE CIRCUIT BREAKER	C60N 2P C2A	MERLIN GERIN	
F3	1	MINIATURE CIRCUIT BREKAER	C60H DC 2P C3A	MERLIN GERIN	
G1	1	POWER SUPPLY 230/24V 3A	CP SNT 70W 24V 3A	WEIDMšLLER	
H1	1	LENSE YELLOW LED	ZB4BV053	TELEMECANIQUE	
H1	1	YELLOW LED PILOT LIGHT BODY	ZB4BVB5	TELEMECANIQUE	
K1	1	CONTACTOR 9A 24VDC	LC1D09BD	TELEMECANIQUE	
K1	1	AUX. CONTACT BLOCK 2NO+2NC	LADN22	TELEMECANIQUE	
K2	1	RELAY 3-POLE 24VDC	C3A30D24D	RELECO	
K2	1	SOCKET FOR 11-PIN RELAY	S3MP	RELECO	
K3	1	MULTIFUNCTIONAL TIME RELAY	PU2R3	CROUZET	
K3	1	SOCKET FOR 11-PIN RELAY	S3MP	RELECO	
KF1	1	OVERCURRENT RELAY 1,6-2,5A	LRD07	TELEMECANIQUE	
Q1	1	LOAD BREAK SWITCH 16A 3P	OT16F3	ABB CONTROL	
Q1	1	HANDLE	OHBS2AJ	ABB CONTROL	
Q1	1	EXTENDED SHAFT 330mm	OXS6X330	ABB CONTROL	
S1	1	HANDLE 2-POS, BLACK	ZB4BD2	TELEMECANIQUE	
S1	1	CONTACT BODY 1NO	ZB4BZ101	TELEMECANIQUE	
S2	1	HANDLE 2-POS, BLACK	ZB4BD2	TELEMECANIQUE	
S2	1	CONTACT BODY 1NO	ZB4BZ101	TELEMECANIQUE	
S2	1	COMPLEMENTARY BLOCK 1NC	ZBE102	TELEMECANIQUE	
T1	1	TRANSFORMER 690/230,24V	SUS120B 375+25VA	NORATEL	
X1	22	TERMINAL 2,5mm	WDU 2,5	WEIDMšLLER	

Acess List

ELEKTROMONTAGE

Revis.	Revision comprises	Date	Made by	Checked	Approved

HYDRAULIC SYSTEM
MAIN PROPELLER
PUMP MOTOR STARTER P3

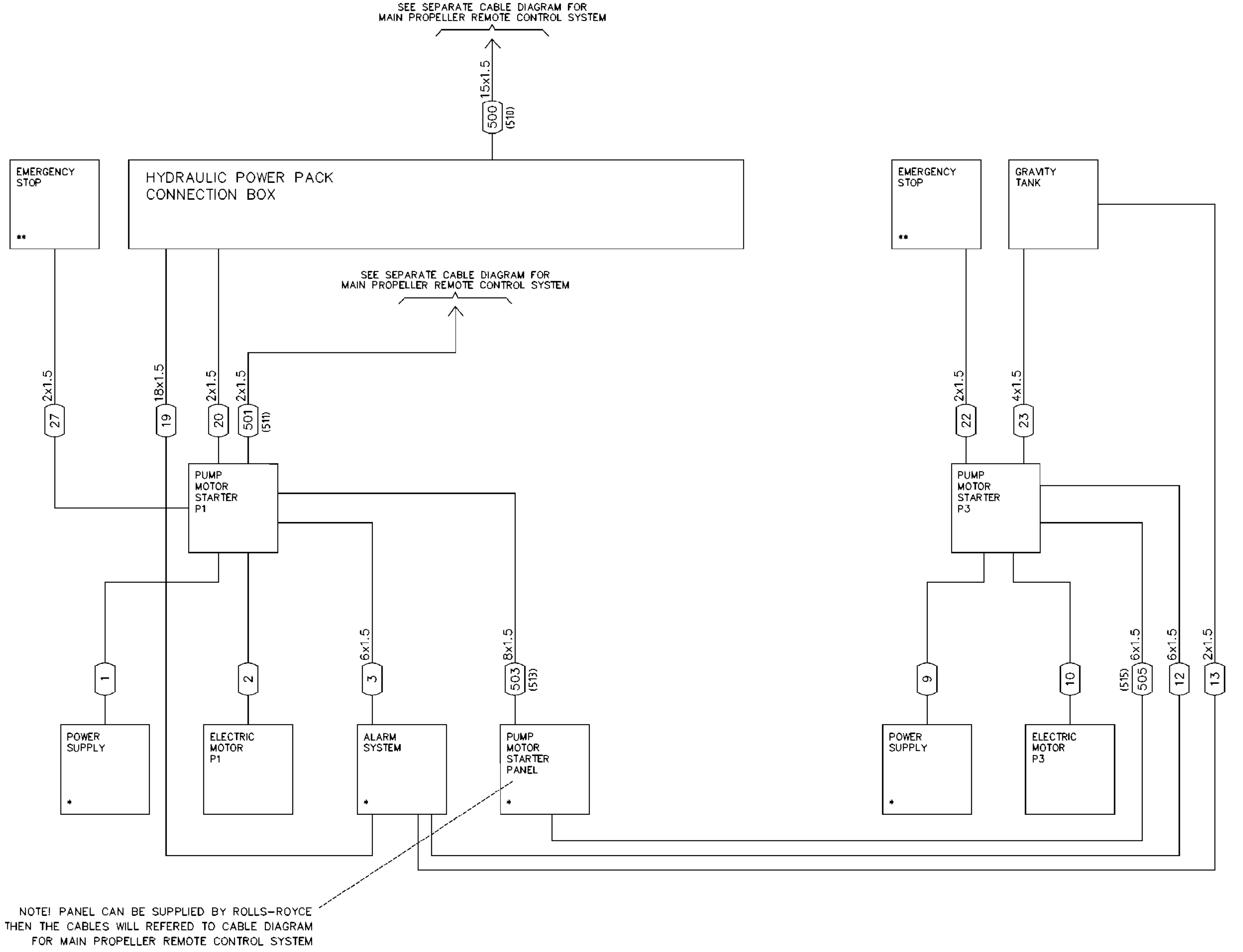
Checked. SGR | Previous Drg.
Approved. LBE | Weight kg. ~17 Kg

Rolls-Royce
Rolls-Royce AB
Propulsion Kristinehamn

Origin. / Date: MLI / 10.05.05 | Scale. | Format. A3 | Sheet: 3 of 3

Drawing no: RRM200007039 | Revision: B

RR AB'S Info. Class. LIMITED

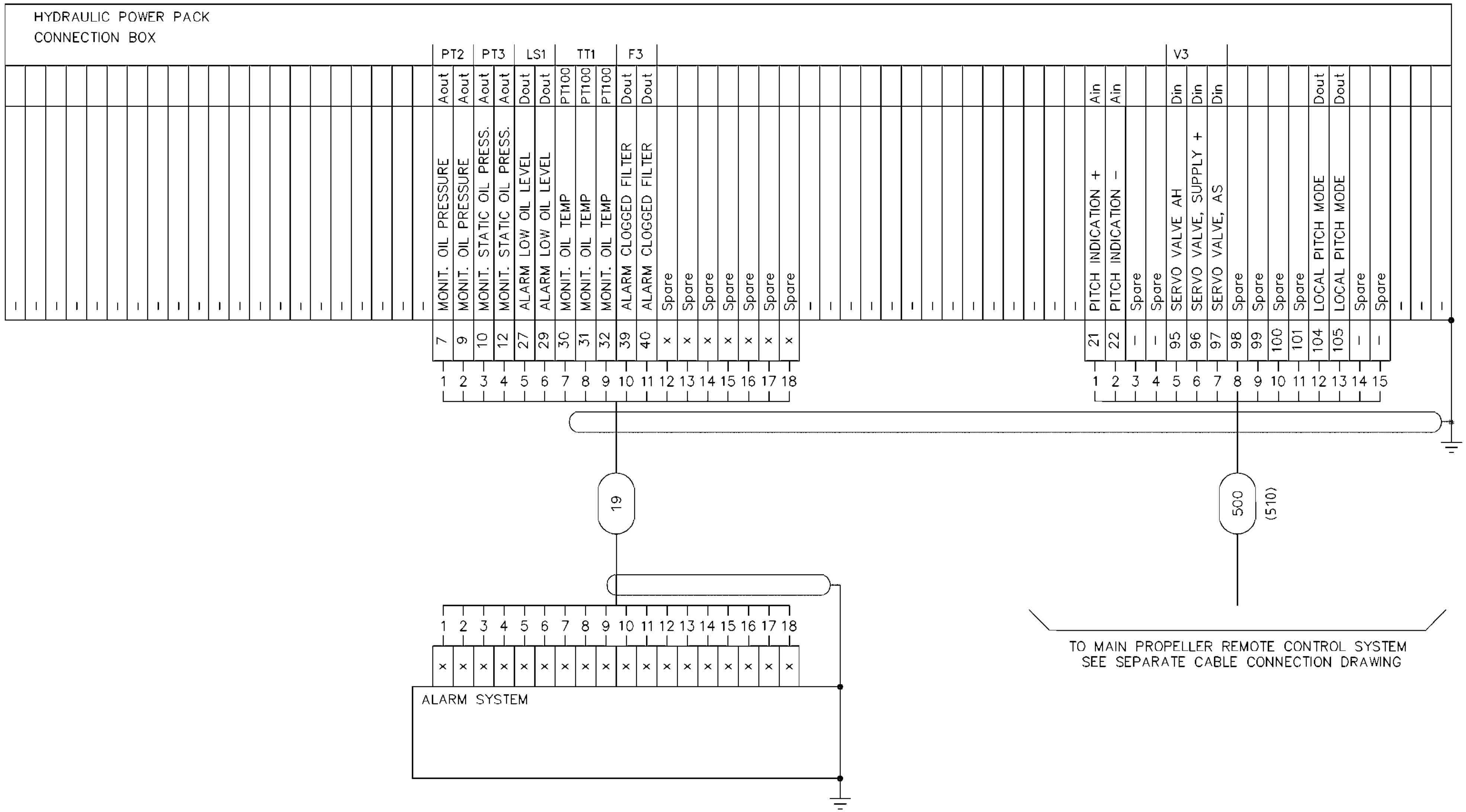


** = DEPENDING ON CLASSIFICATION SOCIETY THE EMERGENCY STOP IS NOT NEEDED

* = NOT ROLLS-ROYCE DELIVERY

THIS CABLE DRAWING SHOWS THE CABLES FOR ONE PROPELLER.
IF TWO PROPELLER THE OTHER PROPELLER TO BE CONNECTED EQUALLY.
IF TWIN PROPELLER CABLE NUMBERS 500, 501, 503, 505 ARE FOR PORT SIDE AND 510, 511, 513, 515 ARE FOR STARBOARD SIDE.

Cable drawing Main propeller		Checked Har	Previous Drg		
		Approved Mnmn	Weight kg		
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin / Date Jnla 2010-04-28	Scale	Format A2	Sheet 1 of 1	
	Drawing no: DMN200000983			Revision: B	



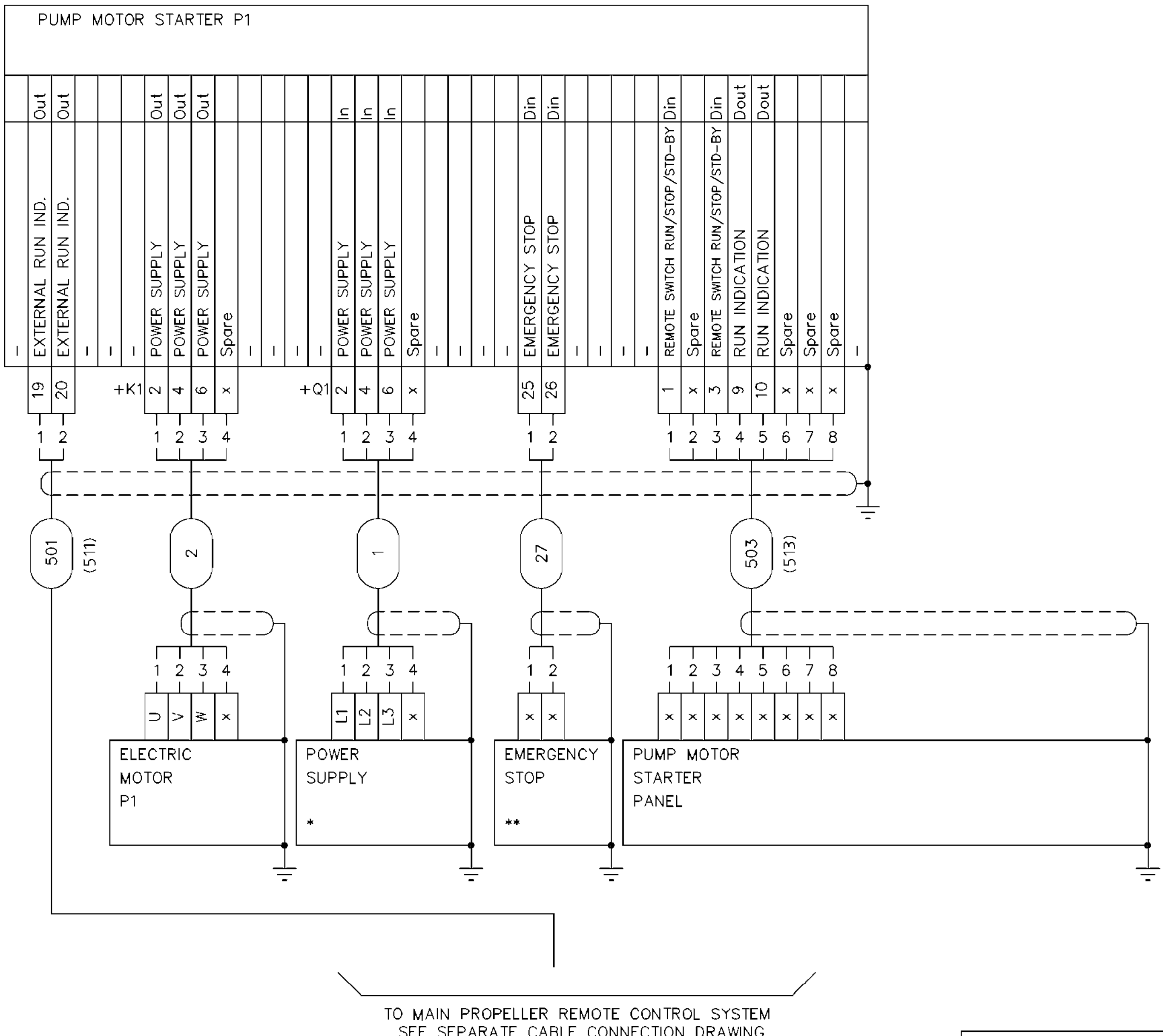
THIS CABLE CONNECTION DRAWINGS SHOWS CONNECTION FOR A ONE PROPELLER SYSTEM.
IF TWIN PROPELLER INSTALLED, THE PORT AND STBD PROPELLER SYSTEMS ARE CONNECTED EQUALLY.
IF TWIN PROPELLER CABLE NUMBERS 500, ARE FOR PORT SIDE
AND 510 ARE FOR STARBOARD SIDE.

Cable connection drawing
Main propeller

Checked: Har
Approved: Mnmn
Previous Drg:
Weight kg:

Rolls-Royce
Rolls-Royce AB
Propulsion Kristinehamn

Origin. / Date: Jnla 2010-04-27
Scale:
Format: A3
Sheet: 1 of 4
Drawing no: DMN200000984
Revision: B



* NOT ROLLS ROYCE DELIVERY

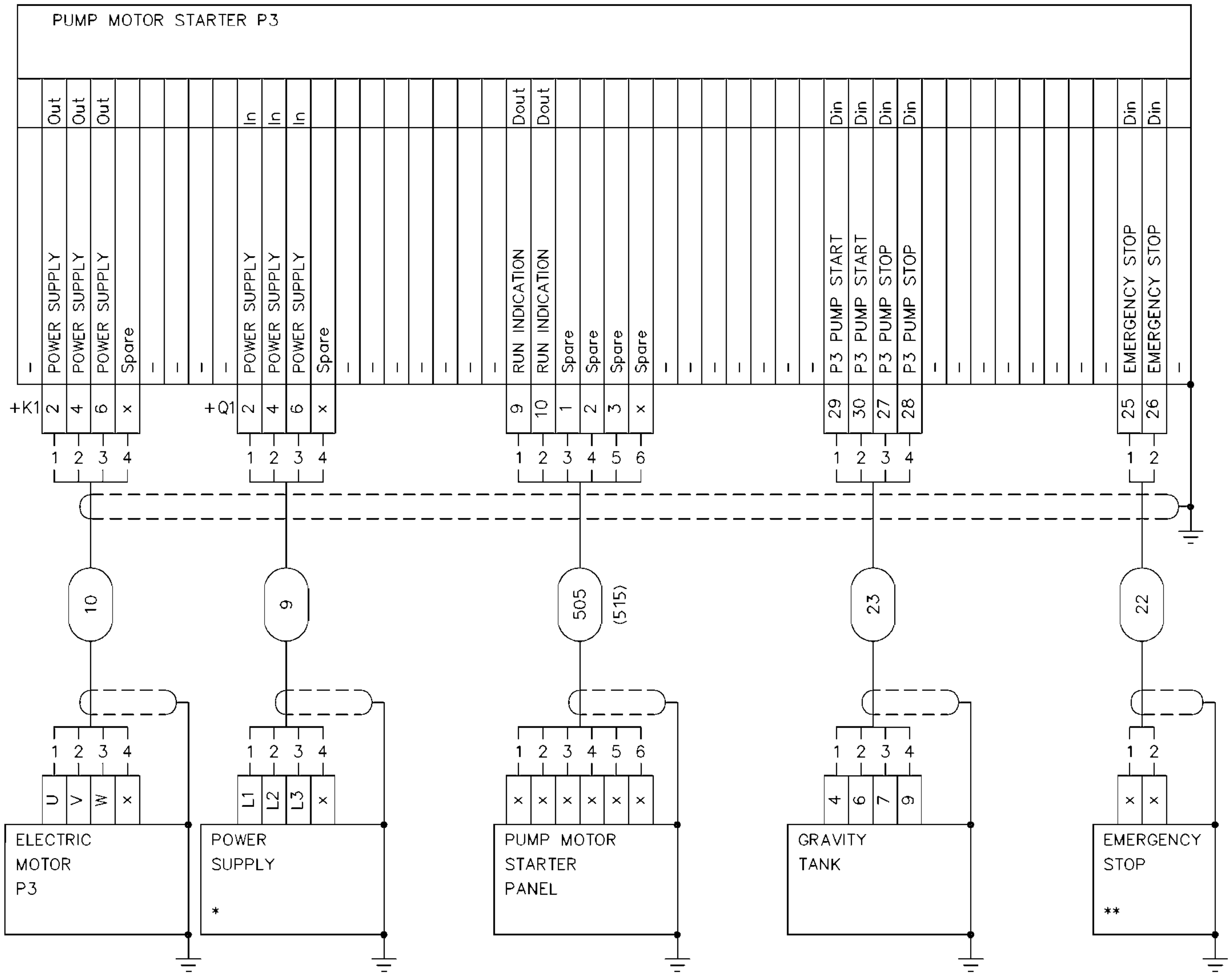
** DEPENDING ON CLASSIFICATION SOCIETY THE EMERGENCY SWITCH IS NOT NEEDED.
IF SO CONNECT 25 TO 26

THIS CABLE CONNECTION DRAWINGS SHOWS CONNECTION FOR A ONE PROPELLER SYSTEM.
IF TWIN PROPELLER INSTALLED, THE PORT AND STBD PROPELLER SYSTEMS ARE CONNECTED EQUALLY.
IF TWIN PROPELLER CABLE NUMBERS 501, 503 ARE FOR PORT SIDE
AND 511, 513 ARE FOR STARBOARD SIDE.

Cable connection drawing Main propeller	Checked: Har	Previous Drg:		
	Approved: Mnmn	Weight kg:		
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: Jnla 2010-04-27	Scale:	Format: A3	Sheet: 2 of 4
	Drawing no: DMN200000984			Revision: B

Acess List

RR AB'S Info. Class: LIMITED



* NOT ROLLS ROYCE DELIVERY

** DEPENDING ON CLASSIFICATION SOCIETY THE EMRGENCY SWITCH IS NOT NEEDED.
IF SO CONNECT 25 TO 26.

THIS CABLE CONNECTION DRAWINGS SHOWS CONNECTION FOR A ONE PROPELLER SYSTEM.
IF TWIN PROPELLER INSTALLED, THE PORT AND STBD PROPELLER SYSTEMS ARE CONNECTED EQUALLY.
IF TWIN PROPELLER CABLE NUMBERS 505 ARE FOR PORT SIDE
AND 515 ARE FOR STARBOARD SIDE.

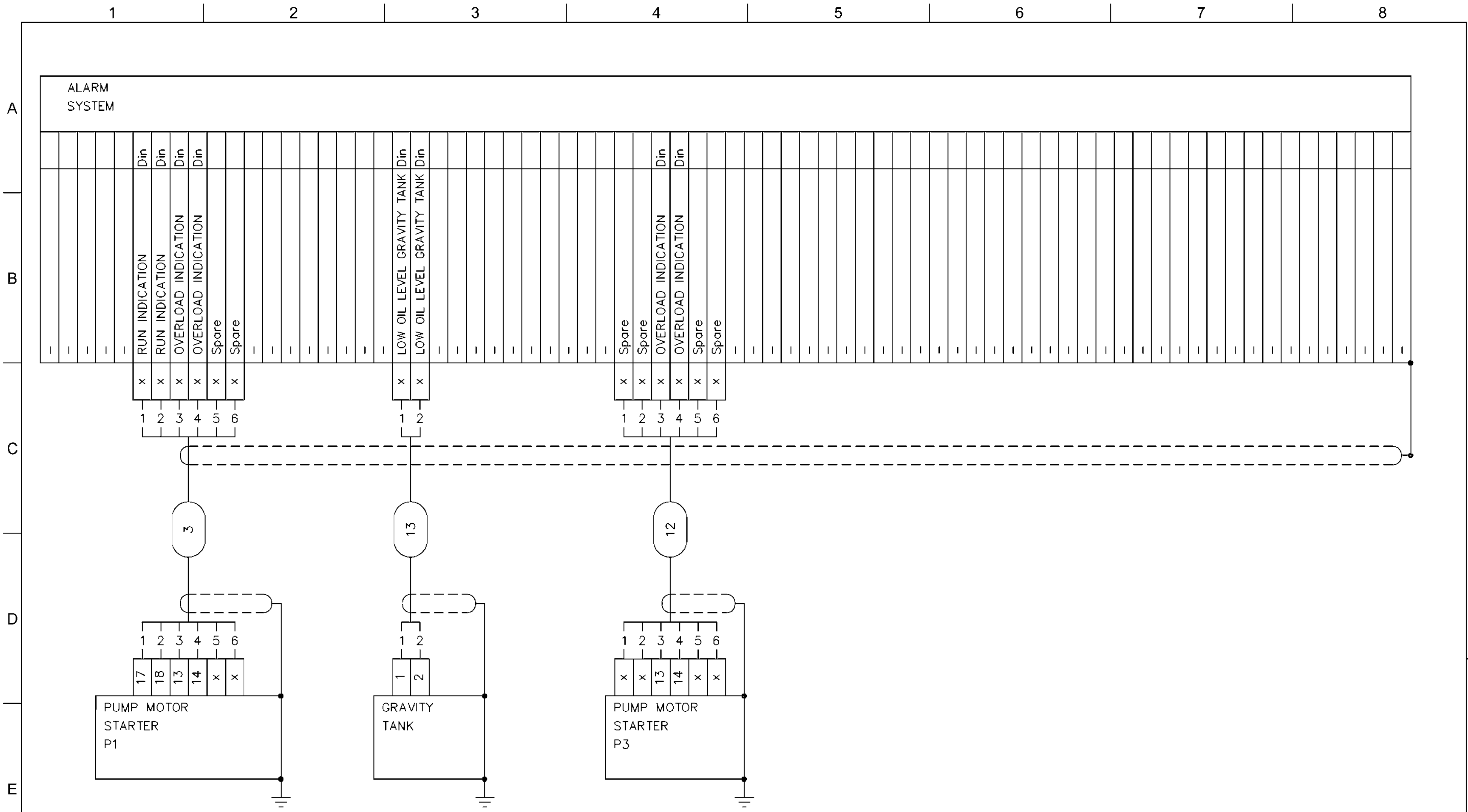
Cable connection drawing
Main propeller

Checked: Har	Previous Drg:				
Approved: Mnmn	Weight kg:				
Origin. / Date: Jnla 2010-04-27	Scale:	Format: A3	Sheet: 3 of 4		
Drawing no: DMN200000984			Revision: B		

Rolls-Royce
Rolls-Royce AB
Propulsion Kristinehamn

Acess List

RR AB'S Info. Class: LIMITED



THIS CABLE CONNECTION DRAWINGS SHOWS CONNECTION FOR A ONE PROPELLER SYSTEM.
IF TWO PROPELLER INSTALLED, THE PORT AND STBD PROPELLER SYSTEMS ARE CONNECTED EQUALLY.

Cable connection drawing
Main propeller

Checked: Har	Previous Drg:			
Approved: Mnmn	Weight kg:			
Origin. / Date: Jnla 2010-04-27	Scale:	Format: A3	Sheet: 4 of 4	
Drawing no: DMN200000984			Revision: B	

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Acess List

RR AB´S Info Class: LIMITED

No.	SUPERVISION OF	LOCATION	TO LOW	TO HIGH	TYPE	FUNCTION	MAKER	SETTING POINT	DELAY SEC.	NOTE
1										
2										
3										
4										
5										
6										
7										
8										
9										
10	Overload P1	PMS			R	Overload on pump motor starter for P1	R-R AB			NC
11										
12	Overload P3	PMS			R	Overload on pump motor starter for P3	R-R AB			NC
13										
14										
15										
16										
17	Pressure transmitter PT2	PP			A	Alarm/monitoring oil pressure in mainpump system	Hydac	low 0,8 MPa	10	4-20 mA (0-25MPa)
18	Pressure transmitter PT3	PP			A	Alarm/monitoring static oil pressure in hub	Hydac	low 0,08 MPa	10	4-20 mA (0-1,6MPa)
19										
20	Temperature sensor TT1	PP			S	Alarm/monitoring oil temperature	Thermotech	high 65°C	10	Pt100
21	Level switch LS1	PP	X		L	Alarm low oil level	Barksdale		10	NC
22	Level switch LS3	GT			L	Alarm low oil level, start, stop static pressure pump	Barksdale		10	NC, NO & NC
23										
24	Pressure switch F3	PP		X	P	Alarm clogged filter F3	Hydac	Fixed	10	NC
25										
26										

TYPE:
P=PRESSURE SWITCH
R=RELAY, VOLTAGE FREE CONTACT
L=LEVEL SWITCH
A=ANALOGIC TRANSMITTER
T=TEMPERATURE SWITCH
E=ELECTRIC SWITCH
D=DIFFERENTIAL PRESSURE SWITCH
S=TEMPERATURE SENSOR
M=ELECTRIC MOTOR
V=HYDRAULIC VALVE

LOCATION:
CU=CENTRAL UNIT CLOSED LOOP
PMS=PUMP MOTOR STARTER
PP=HYDRAULIC POWER PACK
DOT=DRAIN OIL TANK
GT=GRAVITY TANK
JCU=JOYSTICK CENTRAL UNIT
OD=OD-BOX

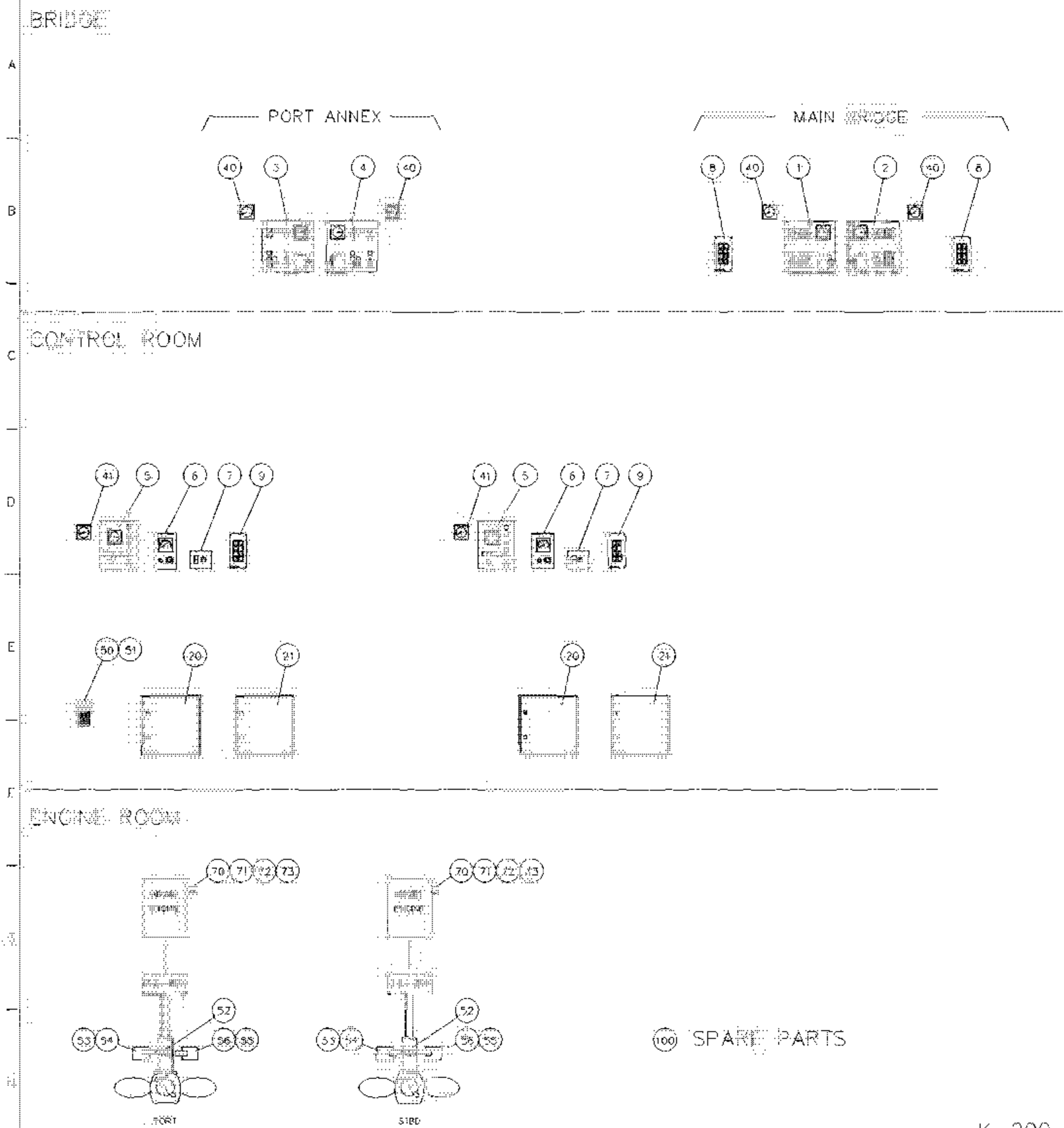
NOTE:
NO=NORMALY OPEN
NC=NORMALY CLOSED

Remote supervision
Main propeller
Alarmlista

Rolls-Royce
Rolls-Royce AB
Propulsion Kristinehamn

Checked: Har | Previous Drg:
Approved: Mnmn | Weight kg:
Origin. / Date: Jnla 2010-04-27 | Scale: | Format: A3 | Sheet: 1 of 1
Drawing no: DMN200000982 | Revision: B

Acess List
RR AB'S Info. Class: LIMITED



NOTES

Item 1: Option 1,2,3,4,5

Item 2: Option 1,2,3,4,5

Item 3: Option 1,2,3, 56

Item 4: Option 1,2,3, 56

K-200

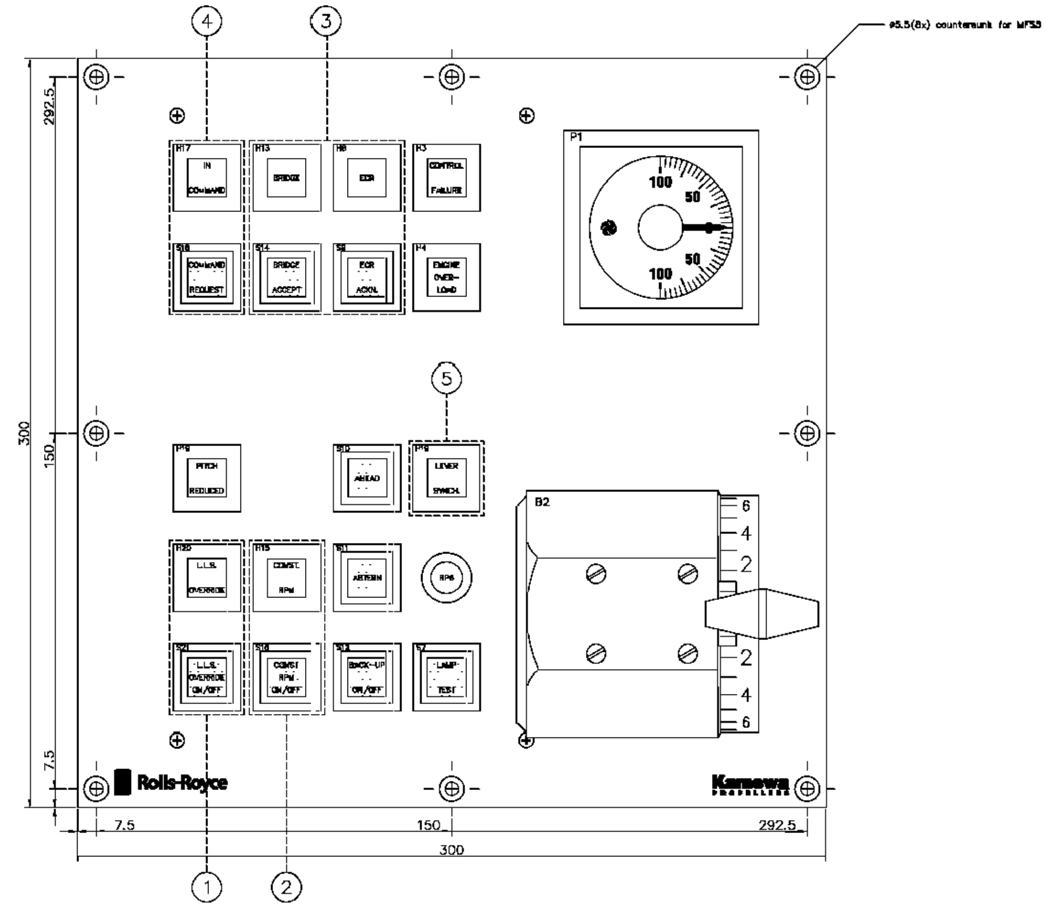
Cable connection diagram

Kamewa Basic

Rolls-Royce

RRM200005995

A

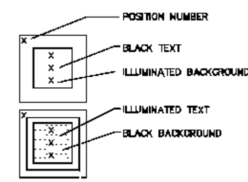


YELLOW LAMP: H–5,8,15,19,20
RED LAMP: H–3,4
BLUE LAMP:
GREEN LAMP: H–13,17
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON:
BLUE PUSH–BUTTON: S–12
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON: S–7,9,10,11,14,16,18,21

BLACK LENS (DUMMY):
PUSH–BUTTON COVER:
PROTECTION COVER (SILICON):

SWITCH:



HEIGHT OVER PANEL: 180mm
MAX DEPTH: 100mm
WEIGHT: 3,3Kg
PROTECTION DEGREE: IP65
PANEL SURFACE: BLACK ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: BLACK/YELLOW
CUT OUT IN DESK: 270 x 270 mm(H x W)

FUNCTIONAL OPTIONS

1. LOAD CONTROL
2. CONSTANT RPM. (COMBINATOR)
3. MANOEUVRE RESPONSBILITY, BRIDGE CONTROL ROOM
4. MANOEUVRE RESPONSBILITY, BRIDGE ANNEX
5. LEVER SYNCHRO LAMP

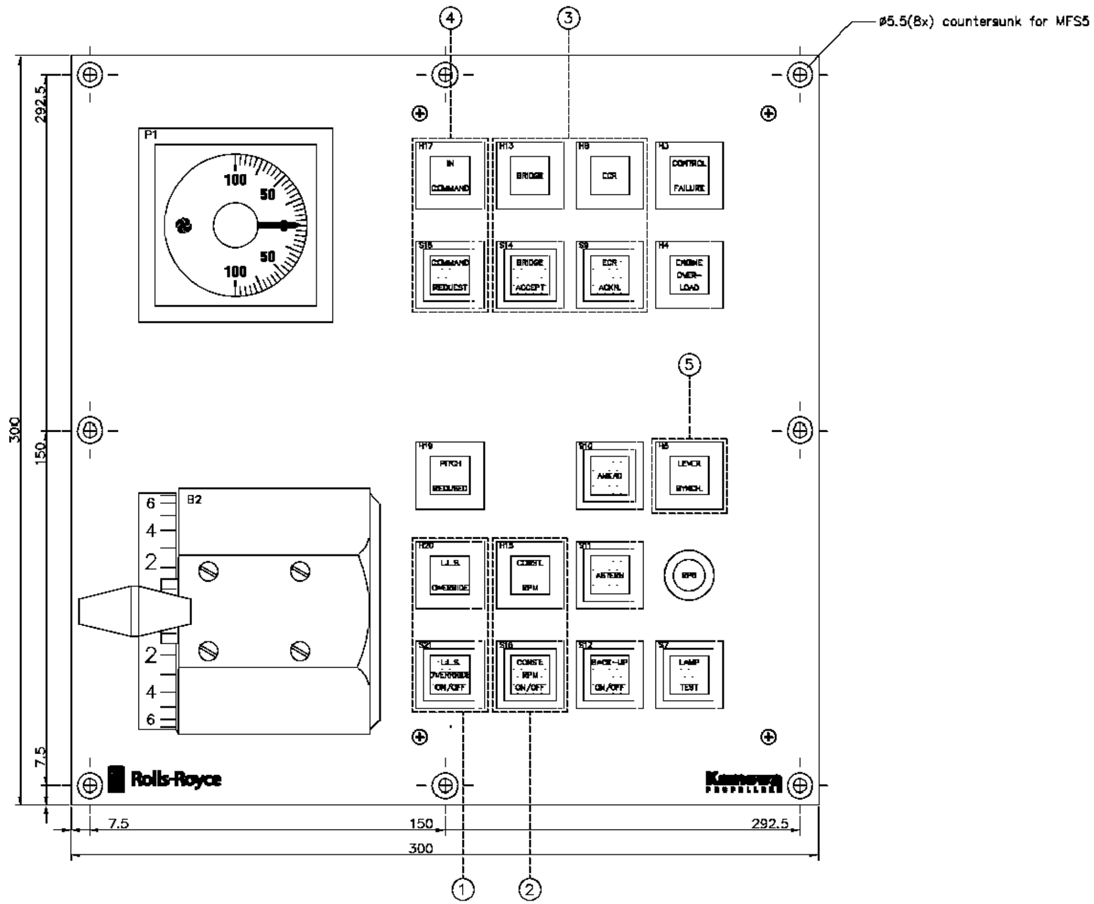
Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken 0.2-0.5

Control panel, layout

Kamewa Main Propeller, Basic bridge

Checked	KK201
Approved	KK35
Origin./Date	WKM 22.09.2010
Scale	1:1
Format	A1
Sheet	1 of 5
Drawing no.	RRM200005922
Revision	A

Rolls-Royce AB
Propulsion Kristinehamn

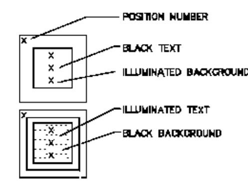


YELLOW LAMP: H-5,8,15,19,20
RED LAMP: H-3,4
BLUE LAMP:
GREEN LAMP: H-13,17
TRANSPARENT LAMP:

YELLOW PUSH-BUTTON:
RED PUSH-BUTTON:
BLUE PUSH-BUTTON: S-12
GREEN PUSH-BUTTON:
TRANSPARENT PUSH-BUTTON: S-7,9,10,11,14,16,18,21

BLACK LENS (DUMMY):
PUSH-BUTTON COVER:
PROTECTION COVER (SILICON):

SWITCH:



HEIGHT OVER PANEL: 180mm
MAX DEPTH: 100mm
WEIGHT: 3.3Kg
PROTECTION DEGREE: IP65
PANEL SURFACE: BLACK ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: BLACK/YELLOW
CUT OUT IN DESK: 270 x 270 mm(H x W)

FUNCTIONAL OPTIONS

1. LOAD CONTROL
2. CONSTANT RPM. (COMBINATOR)
3. MANOEUVRE RESPONSBILITY, BRIDGE CONTROL ROOM
4. MANOEUVRE RESPONSBILITY, BRIDGE ANNEX
5. LEVER SYNCHRO LAMP

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken 0.2-0.8	
Control panel, layout Kamewa Main Propeller, Basic bridge		Checked: KK201 Approved: KK35	Previous Dwg: Weight, kg:
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: WKM 22.09.2010	Scale: 1:1	Format: A1 — Sheet: 1 of 6
	Drawing no: RRM200005925		Revision: A

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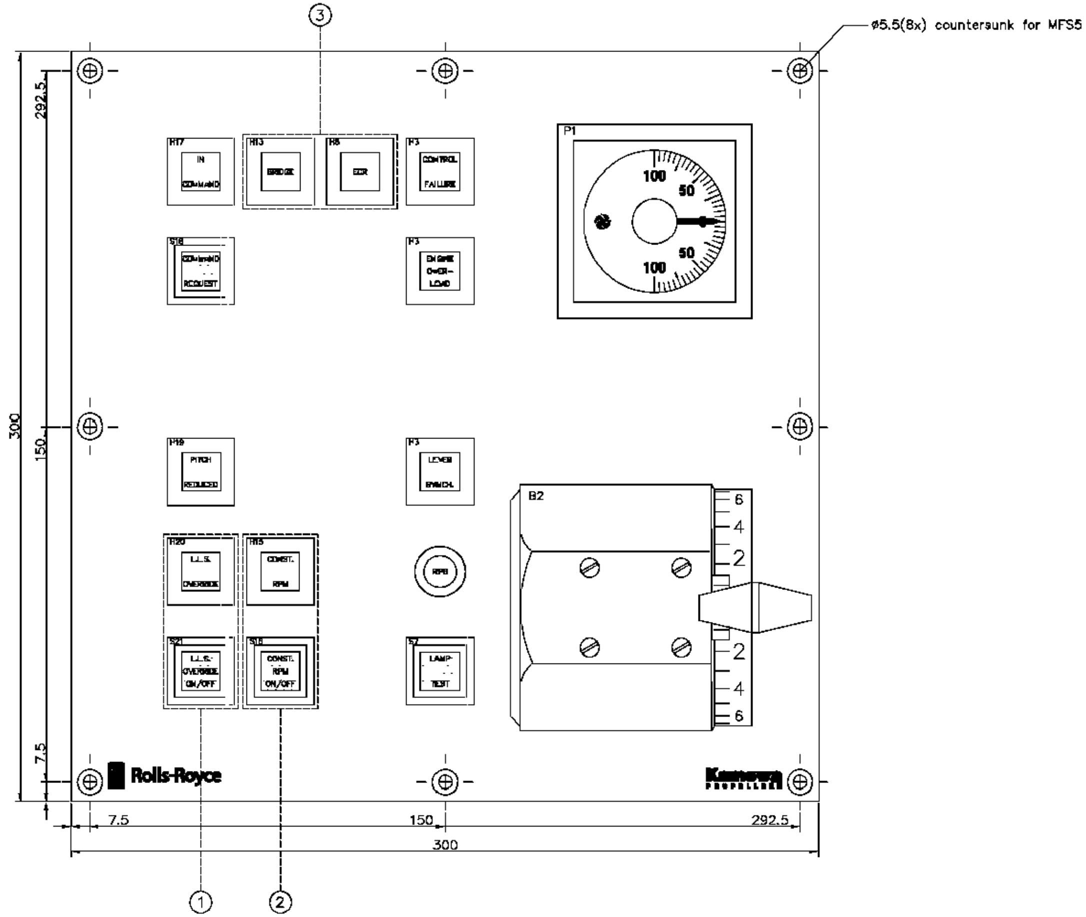
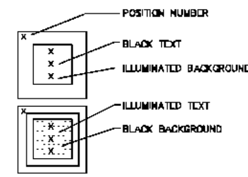


YELLOW LAMP:	H–5,8,15,19,20
RED LAMP:	H–3,4
BLUE LAMP:	
GREEN LAMP:	H–13,17
TRANSPARENT LAMP:	
YELLOW PUSH–BUTTON:	
RED PUSH–BUTTON:	
BLUE PUSH–BUTTON:	
GREEN PUSH–BUTTON:	
TRANSPARENT PUSH–BUTTON:	S–7,16,18,21
BLACK LENS (DUMMY):	
PUSH–BUTTON COVER:	
PROTECTION COVER (SILICON):	S–7,16,18,21
SWITCH:	

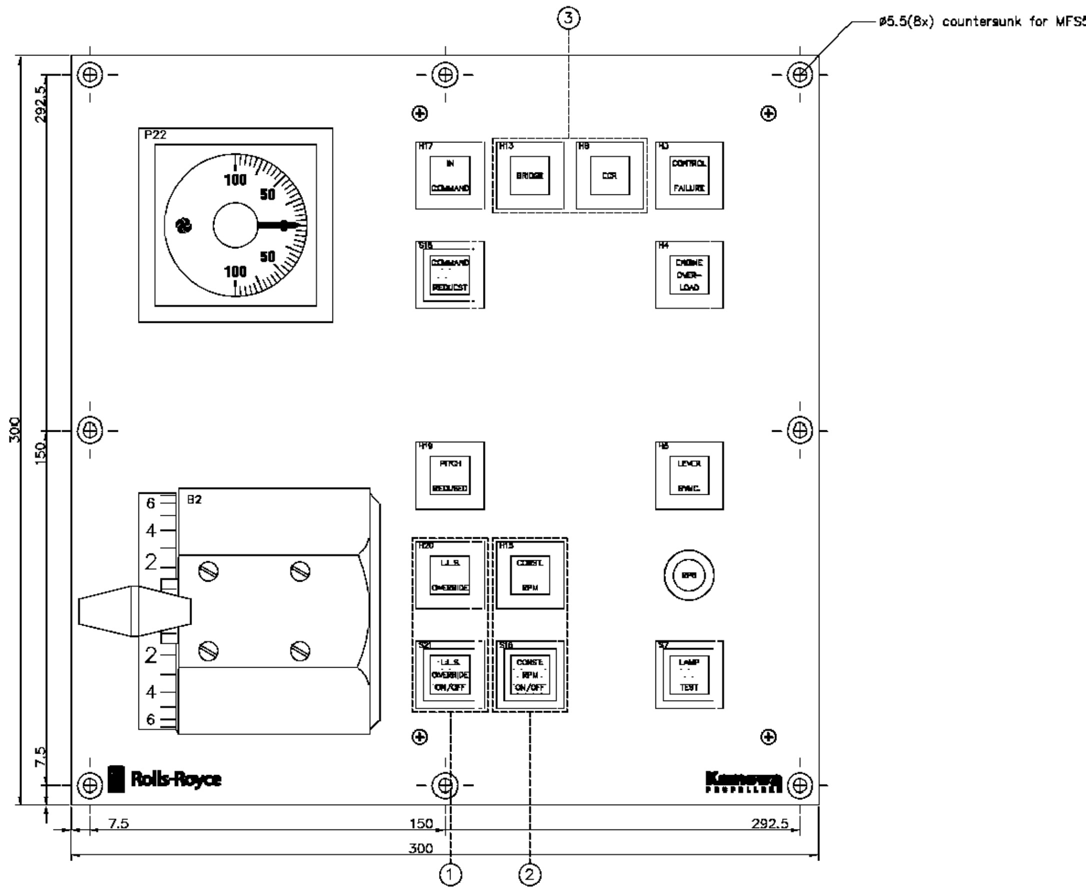


HEIGHT OVER PANEL:	180mm
MAX DEPTH:	100mm
WEIGHT:	3.2Kg
PROTECTION DEGREE:	IP66
PANEL SURFACE:	BLACK ANODIZED
SCREEN PRINT COLOUR:	YELLOW
LOGO COLOUR:	WHITE
INSTRUMENT COLOUR:	BLACK/YELLOW
CUT OUT IN DESK:	270 x 270 mm(H x W)

OPTIONAL FUNCTIONS:

1. LOAD CONTROL
2. CONSTANT RPM, (COMBINATOR)
3. MANOEUVRE RESPONSBILITY, BRIDGE–CONTROL ROOM

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken 0.2-0.5		
Control panel, layout / Kamewa Main Propeller, Basic bridge wing	Checked: KK201	Approved: KK35	Previous Dgr:	Weight kg:
Rolls-Royce / Rolls-Royce AB / Propulsion Kristinehamn	Orig./Date: WKM 22.03.2010	Scale: 1:1	Format: A1	Sheet: 1 of 6
	Drawing no: RRM200005949			Revision: A

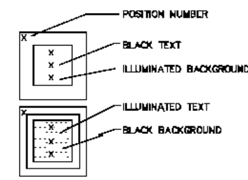


YELLOW LAMP: H–5,8,15,19,20
RED LAMP: H–3,4
BLUE LAMP:
GREEN LAMP: H–13,17
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON:
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON: S–7,16,18,21

BLACK LENS (DUMMY):
PUSH–BUTTON COVER:
PROTECTION COVER (SILICON): S–7,16,18,21

SWITCH:



HEIGHT OVER PANEL: 160mm
MAX DEPTH: 100mm
WEIGHT: 3.2Kg
PROTECTION DEGREE: IP66
PANEL SURFACE: BLACK ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: BLACK/YELLOW
CUT OUT IN DESK: 270 x 270 mm(H x W)

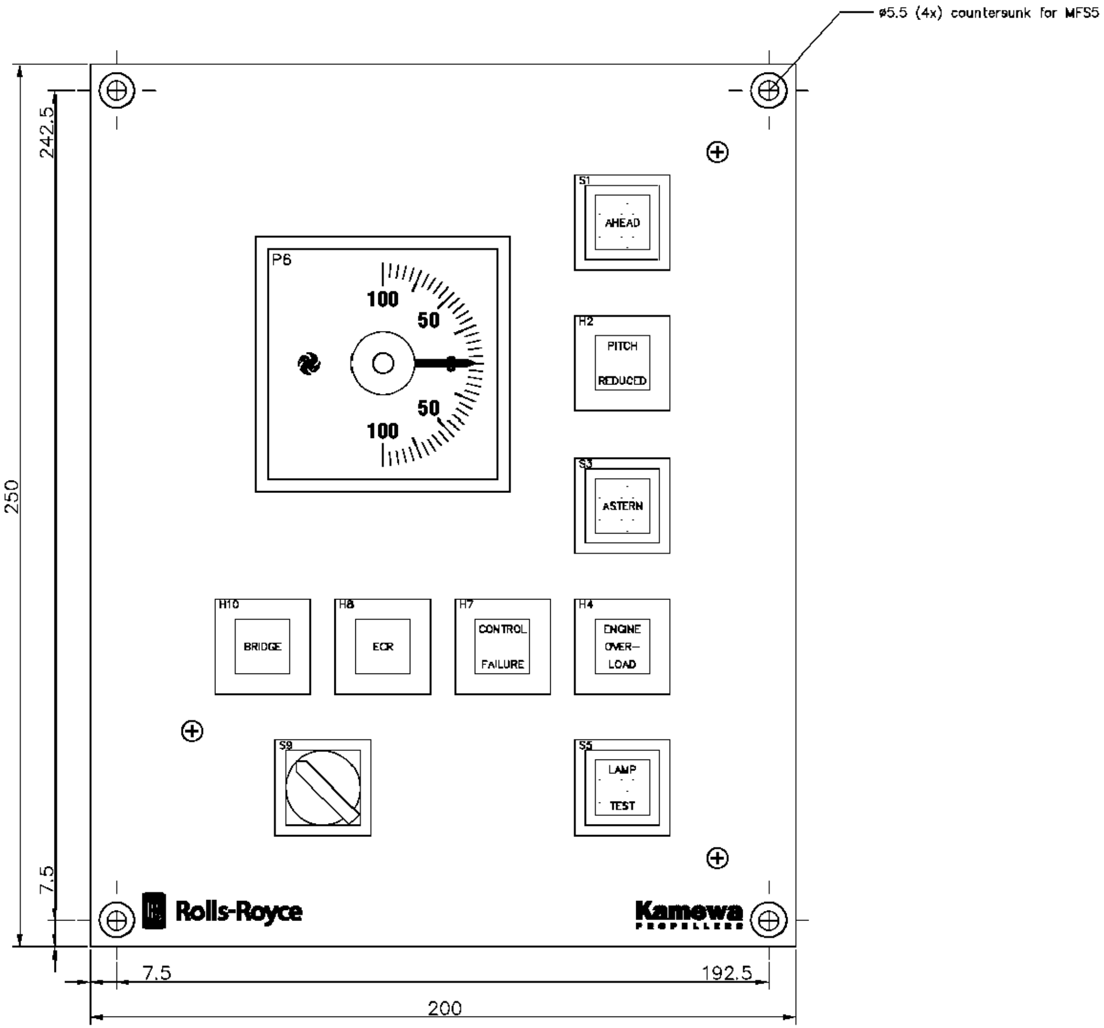
FUNCTIONAL OPTIONS

(1) LOAD CONTROL

(2) CONSTANT RPM, (COMBINATOR)

(3) MANOEUVRE RESPONSBILITY, BRIDGE CONTROL ROOM

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken 0.2-0.5	
Control panel, layout Kamewa Main Propeller, Basic bridge wing		Checked: KK201 Approved: KK35	Previous Dwg: Weight, kg:
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: WKM 22.09.2010	Scale: 1:1	Format: A1 · Sheet: 1 of 5
	Drawing no: RRM200005950		Revision: A

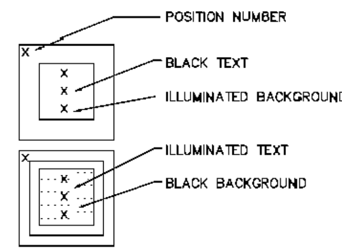


YELLOW LAMP: H–2,10
RED LAMP: H–4,7
BLUE LAMP:
GREEN LAMP: H–8
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON:
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON: S–1,3,5

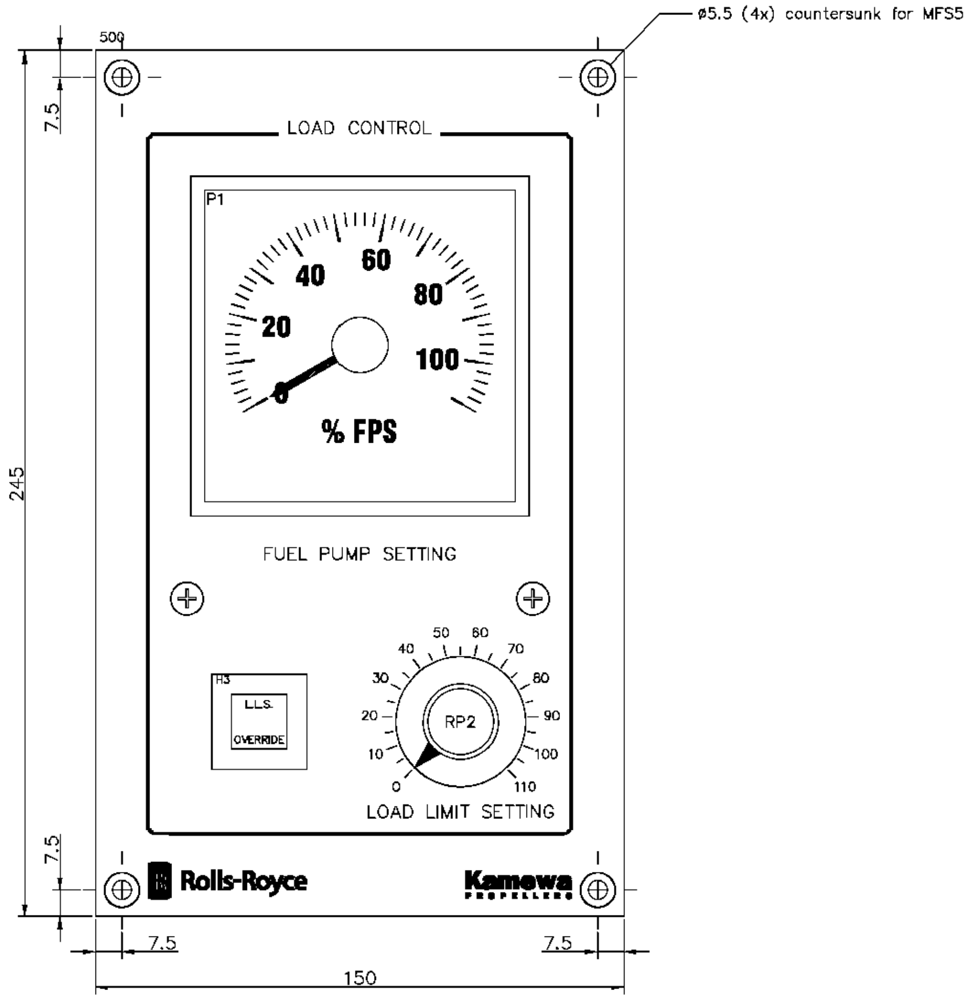
BLACK LENS (DUMMY):
PUSH–BUTTON COVER:
PROTECTION COVER (SILICON):

SWITCH: S–9



HEIGHT OVER PANEL: 15mm
MAX DEPTH: 100mm
WEIGHT: 3Kg
PROTECTION DEGREE: IP52
PANEL SURFACE: BLACK ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: WHITE/BLACK
CUT OUT IN DESK: 220x170mm (H x W)

Only panel plates, Surface Roughness. SS-ISO 1302 Ra 1.6 um	General Tolerances. SS-ISO 2768-f	Sharp edges broken. 0.2-0.5		
Control panel, layout Kamewa Main Propeller, ECR Basic		Checked: KK201 Approved: KK35	Previous Drg: Weight kg:	
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: WKM 22.03.2010	Scale: 1:1	Format: A2	Sheet: 1 of 4
	Drawing no: RRM200005951			Revision: A

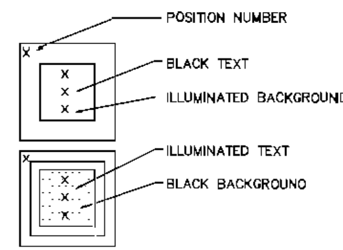


YELLOW LAMP: H–3
RED LAMP:
BLUE LAMP:
GREEN LAMP:
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON:
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON:

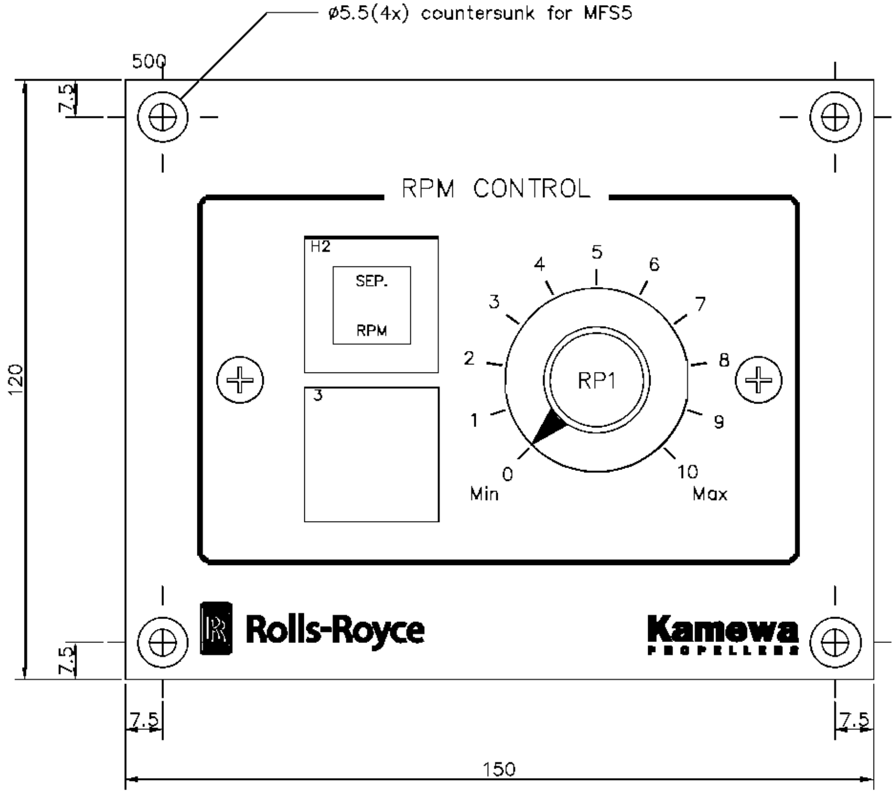
BLACK LENS (DUMMY):
PUSH–BUTTON COVER:
PROTECTION COVER (SILICON):

SWITCH:



HEIGHT OVER PANEL: 23mm
MAX DEPTH: 180mm
WEIGHT: 1kg
PROTECTION DEGREE: IP52
PANEL SURFACE: BLACK ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: WHITE/BLACK
CUT OUT IN DESK: 215 x 120 mm(H x W)

Only panel plates, Surface Roughness. SS-ISO 1302 Ra 1.6 um	General Tolerances. SS-ISO 2768-f	Sharp edges broken. 0.2-0.6	
Control panel, layout		Checked: KK201	Previous Drg: 129011
Kamewa Main Propeller, load control panel		Approved: KK35	Weight kg:
Rolls-Royce	Origin. / Date: KK172 23.09.2009	Scale: 1:1	Format: A2 / Sheet: 1 of 3
Rolls-Royce AB, Propulsion Kristinehamn	Drawing no: RRM200001864		Revision: A

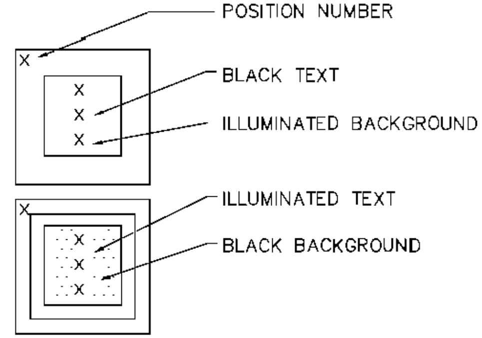


YELLOW LAMP: H–2
RED LAMP:
BLUE LAMP:
GREEN LAMP:
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON:
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON:

BLACK LENS (DUMMY): 3
PUSH–BUTTON COVER:
PROTECTION COVER (SILICON):

SWITCH:



HEIGHT OVER PANEL: 23
MAX DEPTH: 180
WEIGHT: 0.7kg
PROTECTION DEGREE: IP54
PANEL SURFACE: BLACK, ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: –
CUT OUT IN DESK: 90x120 mm (HxW)

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken: 0.2-0.5	

Control panel, layout

Kamewa Main Propeller, Separate RPM control panel

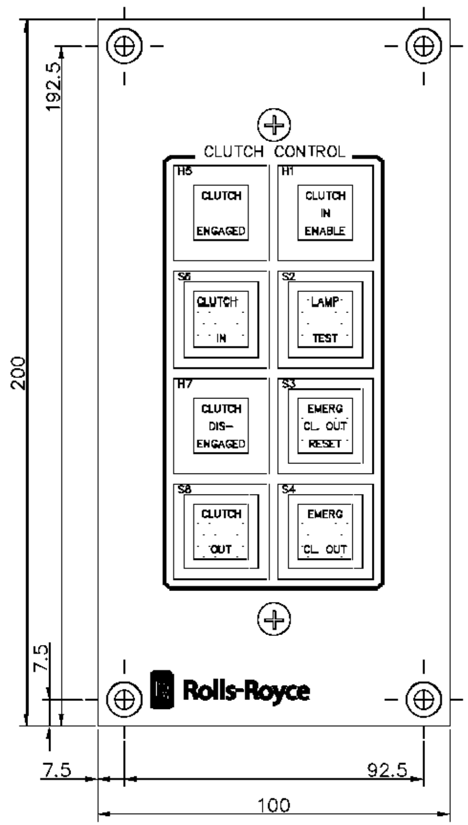
Checked: KK201	Previous Drg: Standard		
Approved: KK35	Weight kg: 0.7kg		
Origin. / Date: KK172 20.10.2009	Scale: 1:1	Format: A3	Sheet: 1 of 3
Drawing no: RRM200002414			Revision: A

Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Access List

RR AB'S Info Class: LIMITED

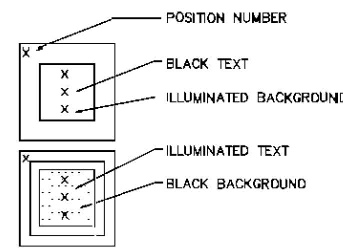


YELLOW LAMP: H–7
RED LAMP:
BLUE LAMP:
GREEN LAMP: H–1,5
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON: S–3,4
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON: S–2,4,6

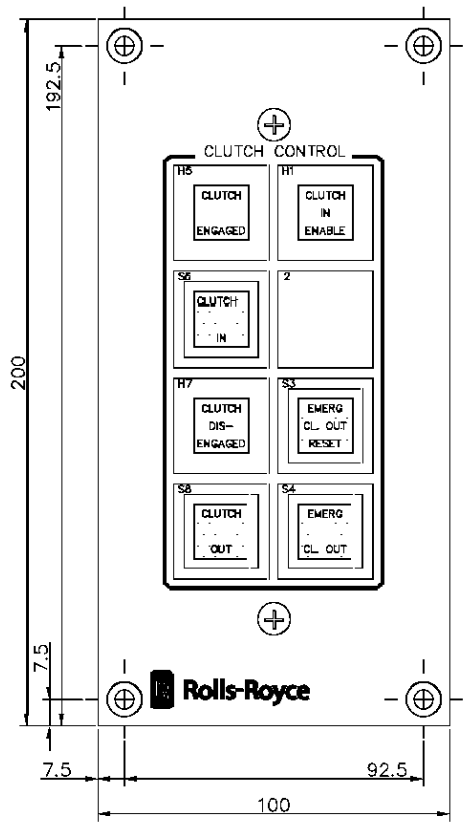
BLACK LENS (DUMMY):
PUSH–BUTTON COVER: S–4
PROTECTION COVER (SILICON):

SWITCH:



HEIGHT OVER PANEL: 5 mm
MAX DEPTH: 180 mm
WEIGHT: 1 kg
PROTECTION DEGREE: IP 65
PANEL SURFACE: BLACK, ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: BLACK/YELLOW
CUT OUT IN DESK: 170 x 70 mm(H x W)

Only panel plates, Surface Roughness. SS-ISO 1302 Ra 1.6 um	General Tolerances. SS-ISO 2768-f	Sharp edges broken. 0.2-0.5			
Control panel, wiring Kamewa Main Propeller, Basic Bridge Clutch Control panel			Checked KK35 Approved: KK201	Previous Drg: Weight kg:	
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn		Origin. / Date: WKM 31.03.2010	Scale: 1:1	Format: A2	Sheet: 1 of 3
		Drawing no: RRM200005928			Revision: A

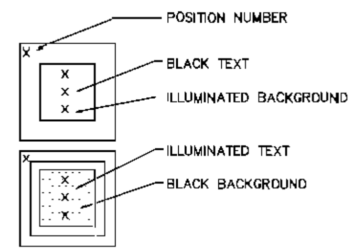


YELLOW LAMP: H–7
RED LAMP:
BLUE LAMP:
GREEN LAMP: H–1,5
TRANSPARENT LAMP:

YELLOW PUSH–BUTTON:
RED PUSH–BUTTON: S–3,4
BLUE PUSH–BUTTON:
GREEN PUSH–BUTTON:
TRANSPARENT PUSH–BUTTON: S–4,6

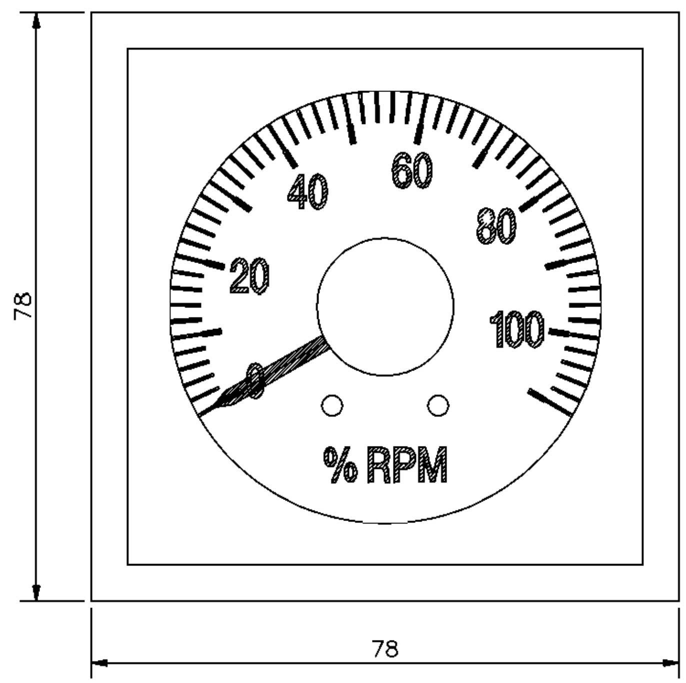
BLACK LENS (DUMMY): 2
PUSH–BUTTON COVER: S–4
PROTECTION COVER (SILICON):

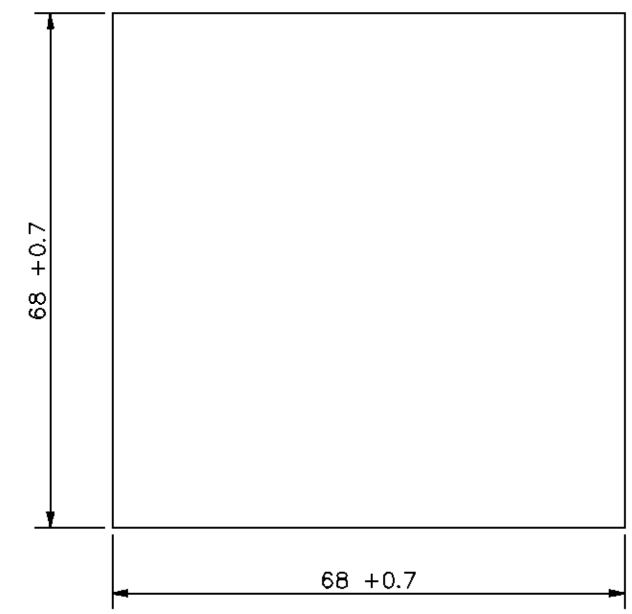
SWITCH:



HEIGHT OVER PANEL: 5 mm
MAX DEPTH: 180 mm
WEIGHT: 1 kg
PROTECTION DEGREE: IP 65
PANEL SURFACE: BLACK, ANODIZED
SCREEN PRINT COLOUR: YELLOW
LOGO COLOUR: WHITE
INSTRUMENT COLOUR: BLACK/YELLOW
CUT OUT IN DESK: 170 x 70 mm(H x W)

Only panel plates, Surface Roughness. SS-ISO 1302 Ra 1.6 um	General Tolerances. SS-ISO 2768-f	Sharp edges broken. 0.2-0.5		
Control panel, wiring Kamewa Main Propeller, Basic ECR Clutch Control panel			Checked: KK35 Approved: KK201	Previous Drg: Weight kg:
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: WKM 30.03.2010	Scale: 1:1	Format: A2	Sheet: 1 of 3
	Drawing no: RRM200005952			Revision: A



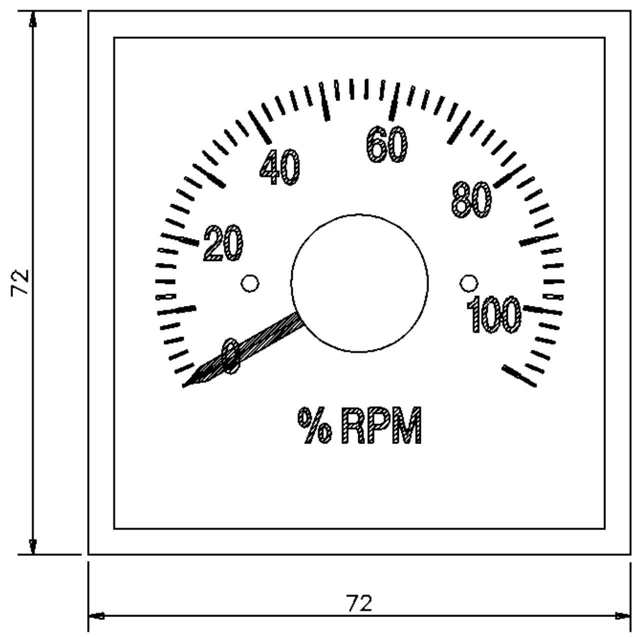


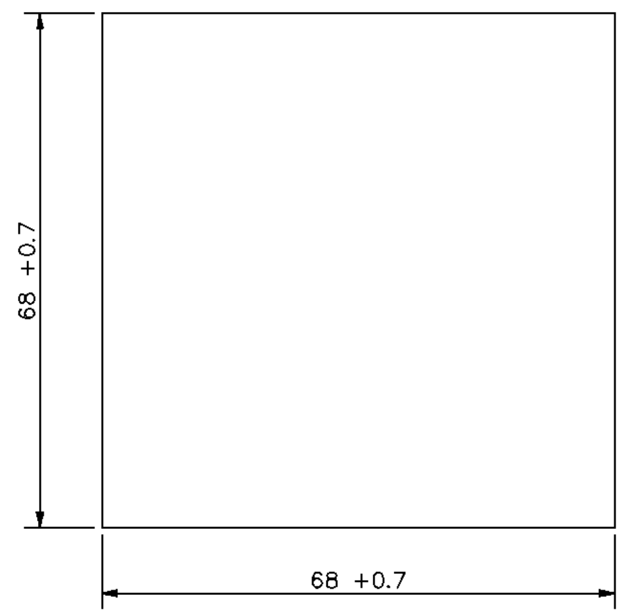
PANEL CUT OUT

HEIGHT OVER PANEL: 6 mm
MAX DEPTH: 100 mm
WEIGHT: 0.23 Kg
PROTECTION DEGREE: IP66
SURFACE: BLACK
SCALE/TEXT: YELLOW

INSTRUMENT: DEIF DLQW72-pc-PY
ILLUMINATION: 24VDC
MEASURING RANGE: 0-10V, 0-110 %RPM
SCALE DRAWING: 1113500131

KAMEWA KRISTINEHAMN SWEDEN	Electronic control	Drawn: Jnm	Checked: Ena	Approved: Ena	Scale: 1:1	Form: A3
	Standard	Date: 020121	Previous drg.: 109146		Sheet: 1	of: 1
	MAIN PROPELLLER RPM Indicator DLQW72	128952			Design: –	Revis.: –





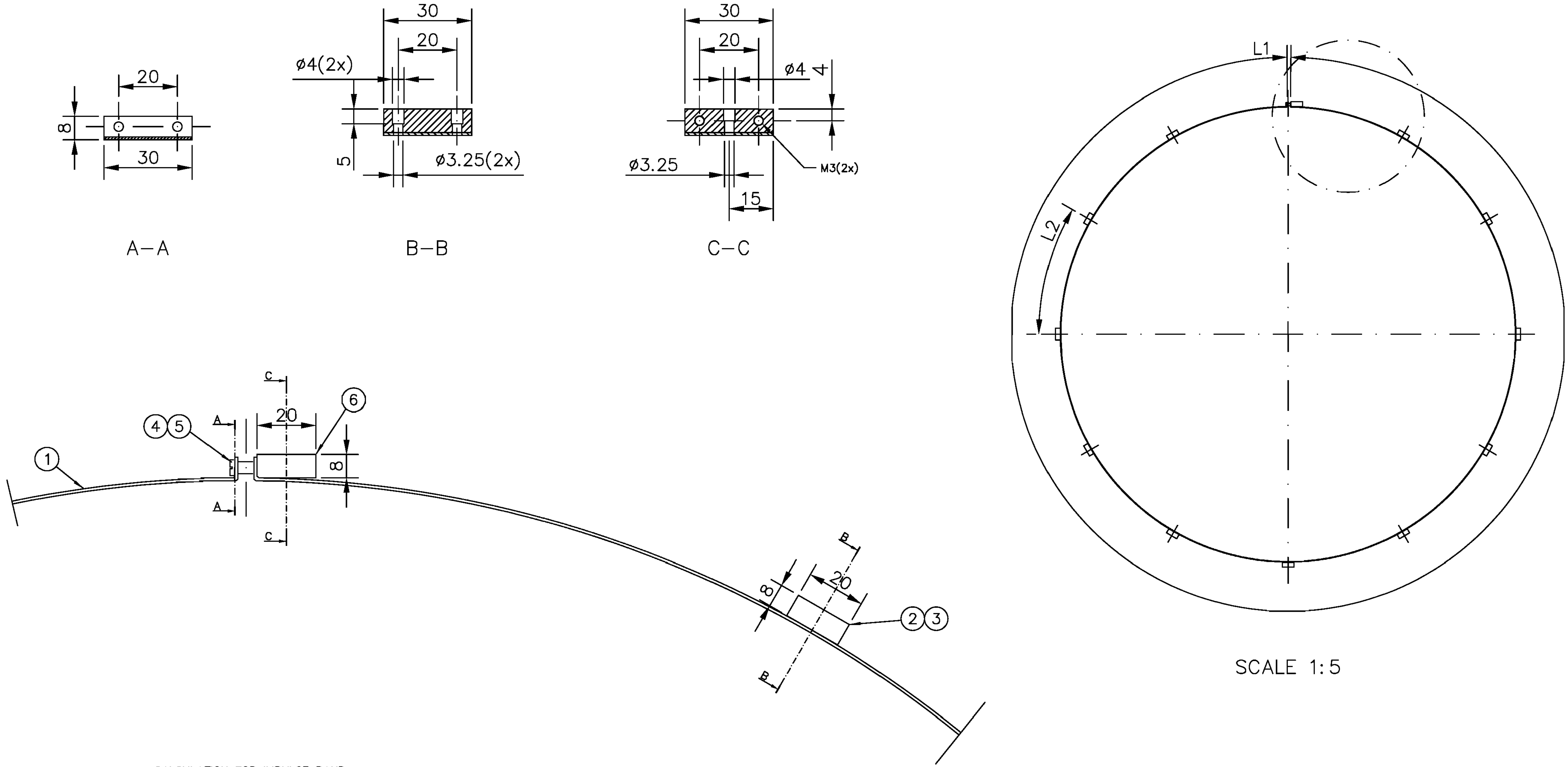
PANEL CUT OUT

HEIGHT OVER PANEL: 6 mm
MAX DEPTH: 100 mm
WEIGHT: 0.23 Kg
PROTECTION DEGREE: IP52
SURFACE: WHITE
SCALE/TEXT: BLACK

INSTRUMENT: DEIF DQ72-c-NB
ILLUMINATION: None
MEASURING RANGE: 0-10V, 0-110 %RPM
SCALE DRAWING: 1114010129

KAMEWA KRISTINEHAMN SWEDEN	Electronic control Standard MAIN PROPELLLER RPM Indicator DQ72	Drawn: Jnm	Checked: Ena	Approved: Ena	Scale: 1:1	Form: A3
		Date: 020121	Previous drg.		Sheet: 1	of: 1
		128967			Design: –	Revis.: –

Phot.	Revis.	Revision comprises	Date	Drawn	Checked	Approved	Mod.note
	a	Revised	19.03.1997	AMA	-	-	
	b	New frame, general update. Cam dimension updated.	10.03.2009	KK172	ENA	ENA	



CALCULATION FOR IMPULSE BAND

LENGTH OF STRIP L1 = SHAFT CIRCUMFERENCE – 5mm

NUMBER OF CAMS Z = (f*60)/n
f = MAX RPM
n = 35–120Hz

DISTANCE BETWEEN CAMS L2 = (L1+5)/Z (MUST BE ≥ 56mm)

THE FIRST CAM IS POSITIONED BY THE JOINT, SEE ABOVE.
ALL DIMENSIONS TO BE ROUNDED OFF TO EVEN MILLIMETER.
ALL DATA TO BE NOTIFIED ON THE MAIN ASSEMBLY OF THE REMOTE CONTROL SYSTEM.
STATE THE FOLLOWING DATA WHEN ORDERING THE IMPULSE BAND:
L2/Z/L1

Pos	No.of	Description	Referens	Customer	Article No.	Remark
6	1	Cam, bright zincified, material SIS 1312	–	–	–	Size 8x20x30
5	2	Washer,bright nickel–plated,BRB 3.2x6,SIS 5170	SMS 70	–	–	
4	2	Screw,bright nickel–plated,MCS 3x16 fnb,SIS 5170	SMS 18	–	–	
3	2xZ	Pop–rivet, TAP/D 46 BS	–	–	–	
2	Z–1	Cam, bright zincified, SIS 1312	–	–	–	Size 8x20x30
1	1	Strip, SIS 4106	–	–	–	t=1

Acess List

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken: 0.2-0.5

Impulse band, assembly

Kamewa Main Propeller, impulse band assembly

Checked: EKO | Previous Drg:

Approved: EKO | Weight kg:

Rolls-Royce

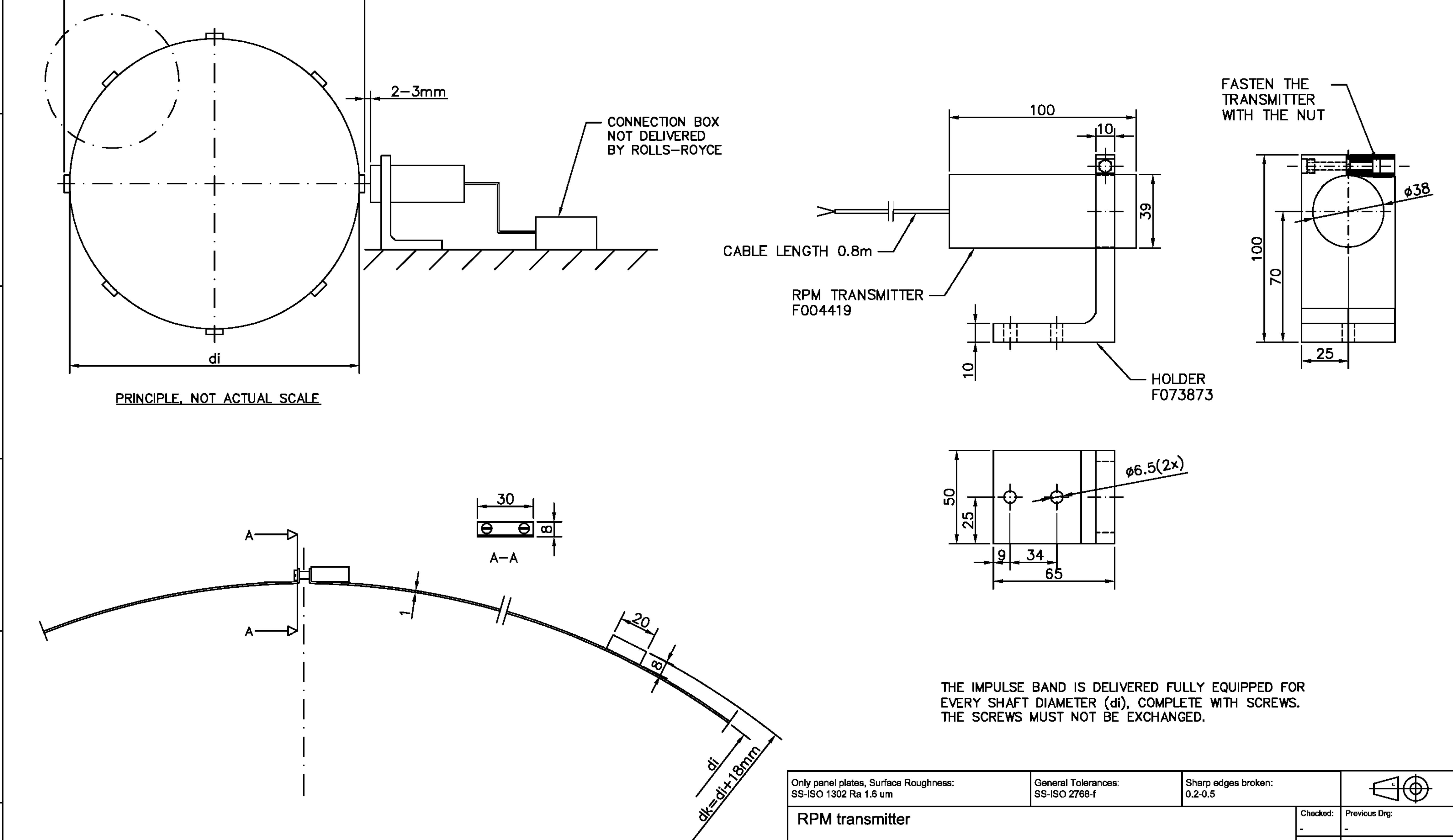
Rolls-Royce AB
Propulsion Kristinehamn

Origin. / Date:	Scale:	Format:	Sheet:
AMA 11.03.1997	1:2	A2	1 of 1

Drawing no: 107127

Revision: b

Phot.	Revis.	Revision comprises	Date	Drawn	Checked	Approved	Mod.note
	a	Text corrected	03.10.1988	NNP	-	-	
	b	RPM-pickup art. no. changed	20.12.1990	APK	-	-	
	c	New frame, general update	03.02.2009	KK172	KK35	KK35	



THE IMPULSE BAND IS DELIVERED FULLY EQUIPPED FOR EVERY SHAFT DIAMETER (di), COMPLETE WITH SCREWS. THE SCREWS MUST NOT BE EXCHANGED.

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken: 0.2-0.5

RPM transmitter

Kamewa Main Propeller, transmitter ind. system installation description

Checked: -	Previous Drg: -
Approved: -	Weight kg:
Origin. / Date: WOM 01.03.1974	Scale: 1:2
Format: A3	Sheet: 1 of 1
Drawing no: 510800	Revision: c

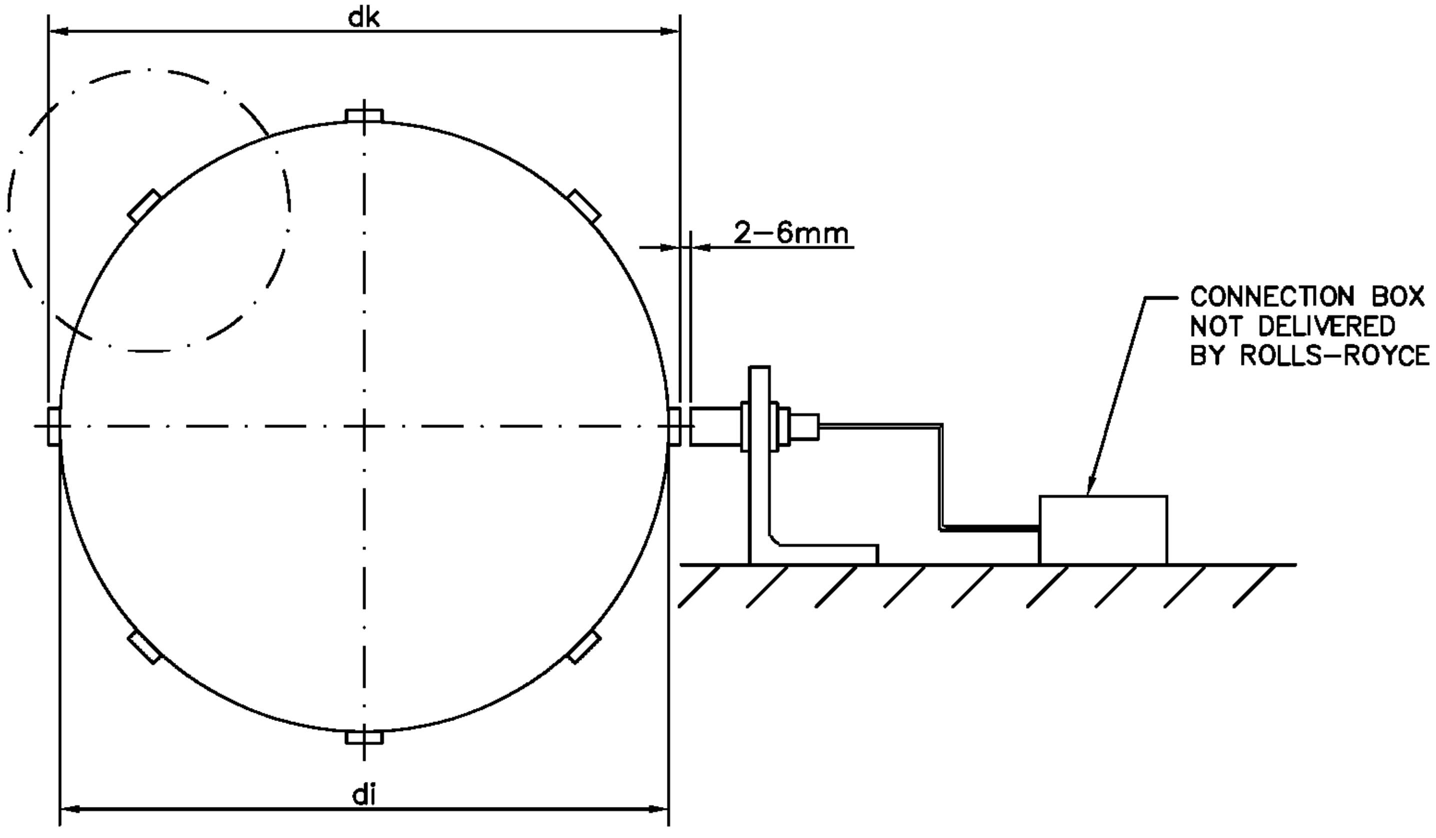
Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

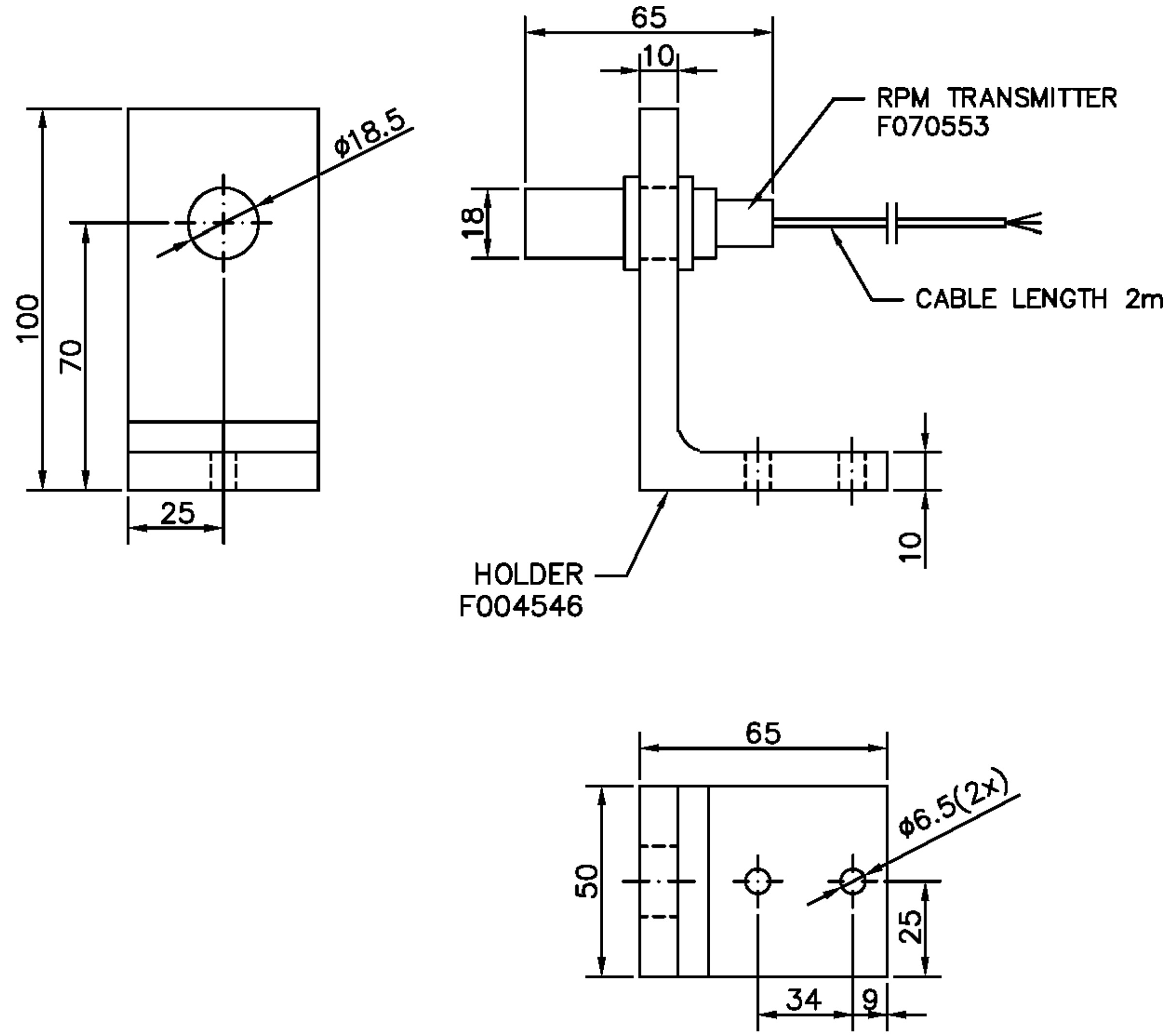
Acess List

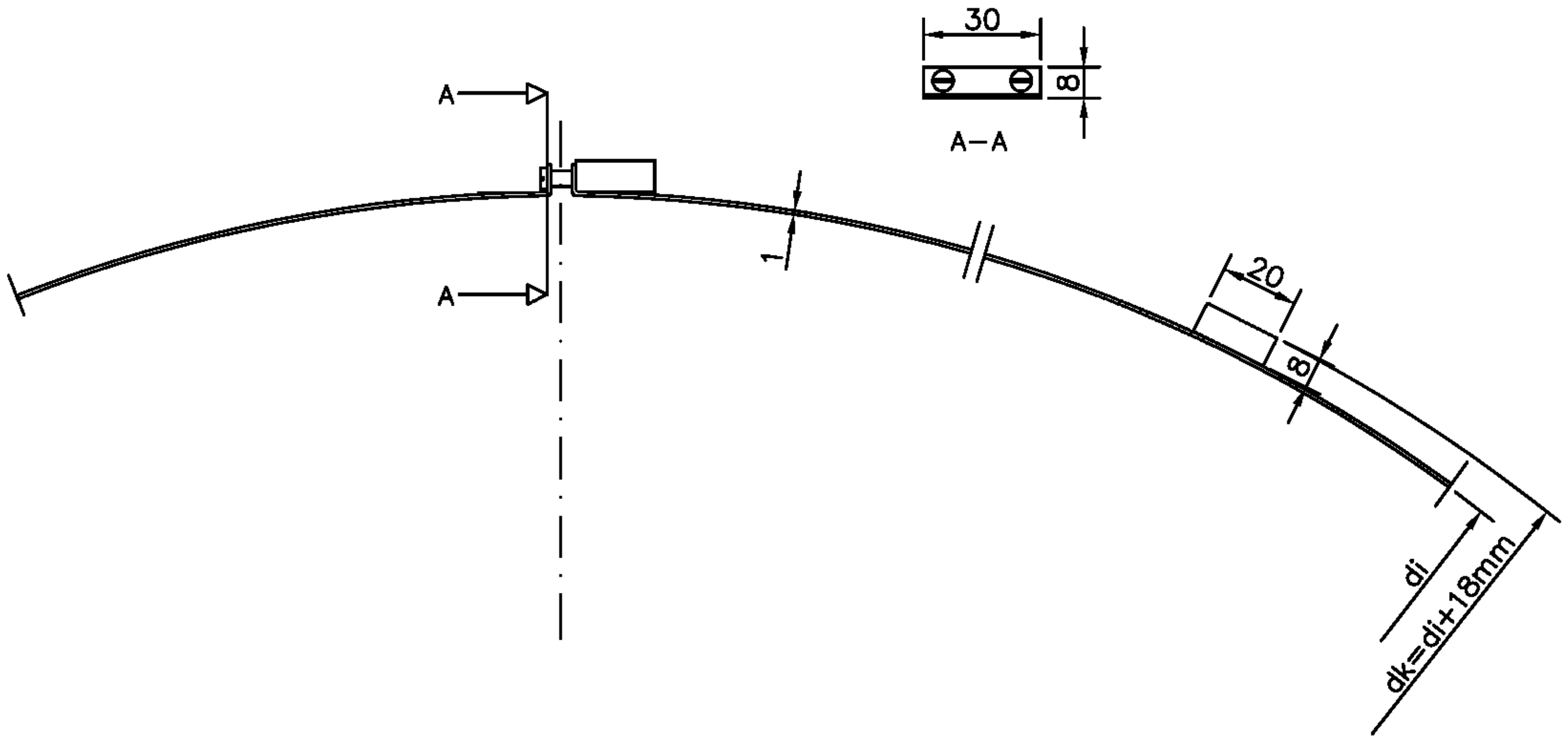
RR AB'S Info. Class: LIMITED

Phot.	Revis.	Revision comprises	Date	Drawn	Checked	Approved	Mod.note
	a	Measure 18 was 8	11.03.1997	AMA	EKO	EKO	
	b	Revised	18.03.1997	AMA	EKO	EKO	
	c	New frame, general update	03.02.2009	KK172	KK35	KK35	



PRINCIPLE, NOT ACTUAL SCALE





THE IMPULSE BAND IS DELIVERED FULLY EQUIPPED FOR EVERY SHAFT DIAMETER (di), COMPLETE WITH SCREWS. THE SCREWS MUST NOT BE EXCHANGED.

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken: 0.2-0.5

RPM transmitter

Kamewa Main Propeller, transmitter control system installation descript.

Checked: EKO	Previous Drg: 510800			
Approved: EKO	Weight kg:			
Origin. / Date: AMA 25.02.1997	Scale: 1:2	Format: A3	Sheet: 1 of 1	
Drawing no: 107009			Revision: c	

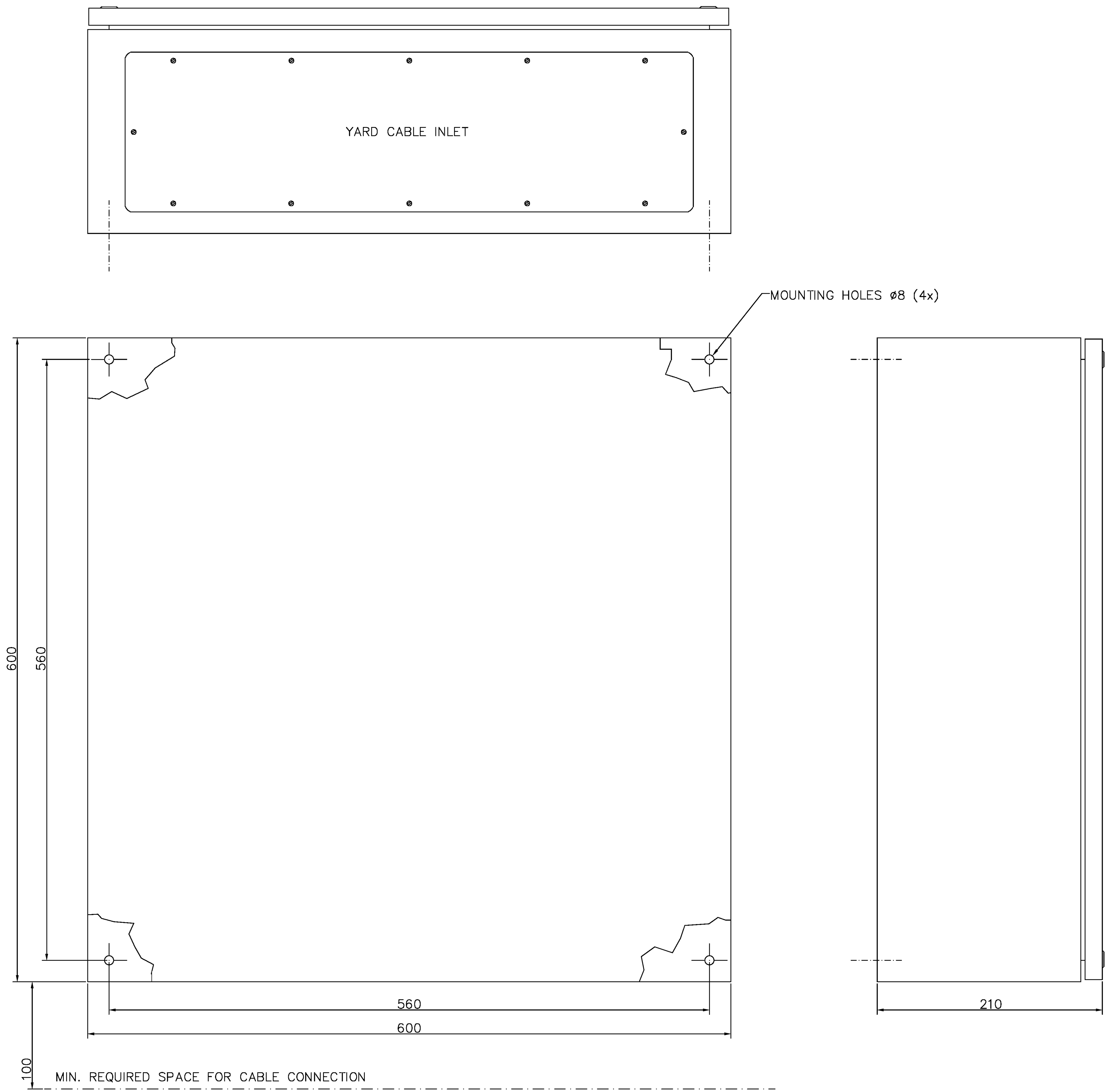
Rolls-Royce

Rolls-Royce AB
Propulsion Kristinehamn

Acess List

RR AB'S Info. Class: LIMITED

Phot.	Revis.	Revision comprises	Date	Drawn	Checked	Approved	Mod.note
	a	New standard colour, RAL 7035.	21.06.2005	BNAE	PNG	PNG	
	b	Converted due to new CAD tool	28.05.2008	CS5	CS1	KK35	



HOUSING: RITTAL AE1060.500
DETACHABLE COVER, WITHOUT HINGES, 4 LOCKS
WITH 1 FLANGE

PROTECTION DEGREE: IP 66

ROLLS–ROYCE STANDARD COLOUR: RAL 7035 (Light grey)
SPECIAL COLOUR, SEE ORDER DOCUMENTATION

Only panel plates, Surface Roughness: SS-ISO 1302 Ra 1.6 um	General Tolerances: SS-ISO 2768-f	Sharp edges broken: 0.2-0.5	
Casing, layout Kamewa Main Propeller/Waterjet, customer		Checked: JNM Approved: JNM	Previous Drg: Standard Weight kg:
Rolls-Royce Rolls-Royce AB Propulsion Kristinehamn	Origin. / Date: KK35 25.03.2002	Scale: 1:2	Format: A1 / Sheet: 1 of 1
	Drawing no: 129066		Revision: b

Acess List
RR AB'S Info. Class: LIMITED

Produced by: SS Approved by:Nna Revision: Sign:
Creation date: 2005-05-31 Revision date:

Revision

Document No.	Rev.	Date	Section	Description	Approved

Produced by:KK295 Approved by: Nna Revision: o Sign: Nna
Creation date: 2005-07-21 Revision date: 2009-01-19

Subsupplier Manuals

Title	Document Number	Rev
SKF		
The SKF OKCX Coupling for Shafts Mounting and Dismounting Instruction	49990-E	
High Pressure Pump Assembly	49035-E	
Service Guide High Pressure Stripped Pump	49036-E	
Service Guide Pneumatic Logic Air Motor	49037-E	
B+V Industrietechnik GmbH		
Installation of the seal Simplan Seal Typ:SIC-P	Enclosed	
Instruction Manual Simplan Seal Typ:SIC-P	Enclosed	
Removal of split ring Simplan Seal Typ:SIC-P	Enclosed	
Thordon		
Compac Propeller Shaft Bearing Specification	49892-E	
Marine Bearing Installation Manual	48081-E	
Corrpro		
Instruction Manual (Analog) Propeller Shaft Grounding and Monitoring Assembly	49884-E	
Oil Tech		
Water Oil Cooler PWO Installation and Service Instructions	49995-E	

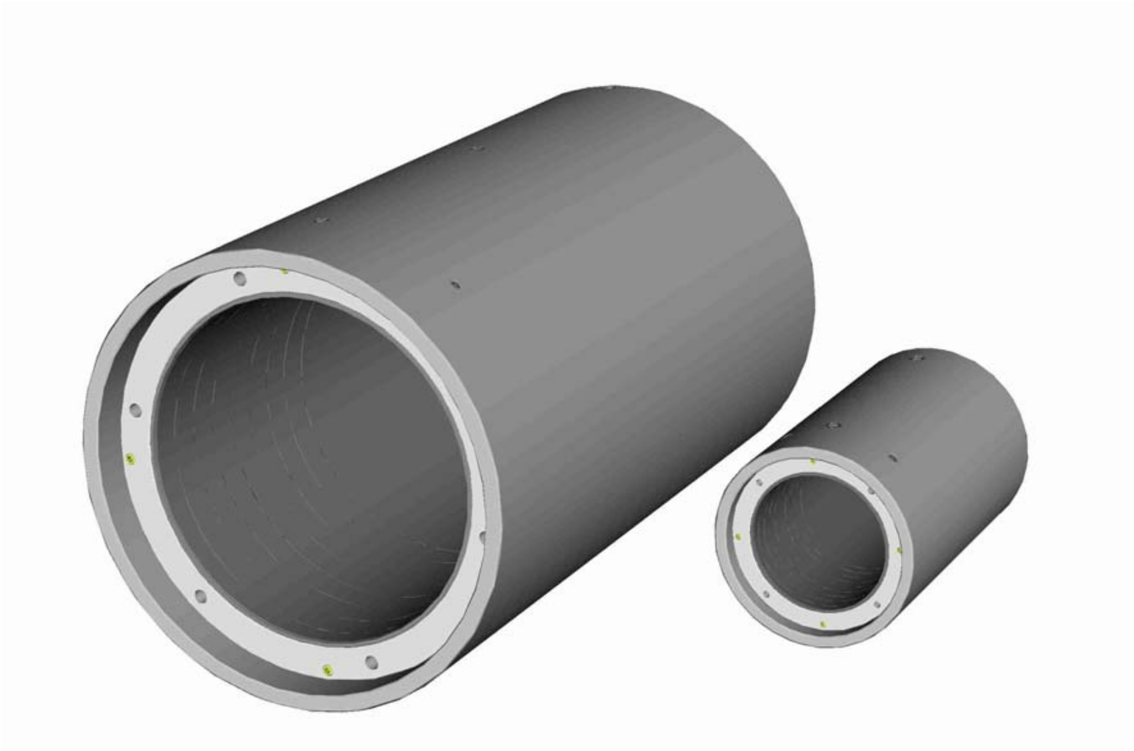
The SKF OKCX coupling

for shafts 100-900

mounting and dismounting instruction

Instruction No.: 81569 **Edition: A**

Edition Date: 2006-02-17



SKF Coupling Systems AB

S-813 82 Hofors, Sweden. Tel +46 (290) 250 00. Fax +46 (290) 282 70

CONTENTS

1 CAUTIONS AND PERSONAL SAFETY

- When using the hydraulic equipment and injectors, always wear eye protection and gloves.
- When handling the coupling with crane, make sure that the lifting device is adapted to the weight of the coupling.
- Use the correct oil as shown in the instructions.
- Use all equipment strictly in accordance with the instructions, or the instructions supplied by the equipment manufacturer.
- Inspect all equipment for damage before use.
- As a precaution, when mounting/dismounting the coupling, the area in front of and behind the coupling must be kept clear of all personnel.

2 THE PRINCIPLE OF THE COUPLING

The OKCX type coupling consists basically of two sleeves of high quality steel, a thin inner sleeve and a thick outer sleeve.

The outer surface of the inner sleeve is slightly tapered and the bore of the outer sleeve has a corresponding taper.

The inner sleeve bore is somewhat larger than the diameter of the shafts, so that the sleeve can be passed over them with ease.

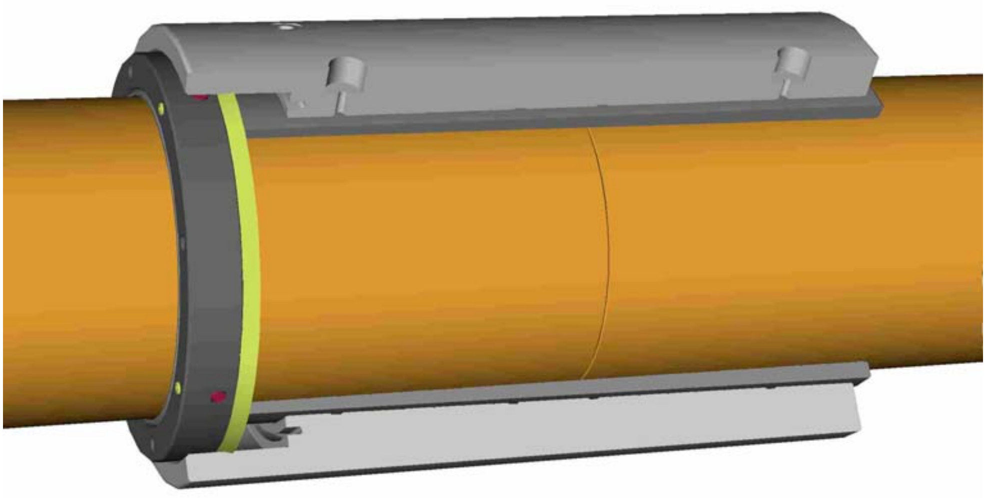
The coupling is mounted by driving the outer sleeve up on the taper of the inner sleeve using the hydraulic unit incorporated in the coupling.

This action compresses the inner sleeve onto shaft creating a powerful interference fit.

To allow this drive-up, the friction of the matching tapered surfaces is overcome by injecting oil at high pressure between them, where it forms a load-carrying film separating the two components.

When the outer sleeve has reached the correct drive up position, the injection pressure is released and the oil is drained off between the mating tapered surfaces, restoring normal friction between the sleeves.

Dismounting the coupling is equally simple. Oil is injected between the coupling sleeves to overcome the friction. As a result of the taper, the compressive force has an axial component which causes the outer sleeve to slide down the taper, forcing the oil out of the hydraulic unit.



3 OIL RECOMMENDATION

The oil to be used for the injector should have a viscosity of 300 mm^2/s (300cS) at the temperature of the coupling. If the oil used for mounting is too thick, there is a risk that it will remain between the sleeves, resulting in a considerably deteriorated grip. The adequate viscosity will generally be obtained with sufficient accuracy if the oil is chosen as follows:

Temperature range		*Viscosity in SAE*
0 - 8°C	Motor Oil	SAE 10 W
8 - 18°C	Motor Oil	SAE 20 W
18 - 27°C	Motor Oil	SAE 30
24 - 32°C	Motor Oil	SAE 40
32 - 38°C	Motor Oil	SAE 50

4 DESIGNATION OF THE COUPLING

The coupling is designated as ”Type "OKCX", ”OKCEX”, ”OKCAX” or ”OKCKX”. OKCEX and OKCAX are elongated and OKCKX is shortened compared with standard OKCX.

Coupling sizes are specified using the following system:

OKCX (EX, AX, KX), shaft diameter / drawing number.

For example: OKCX 280/xxxxx

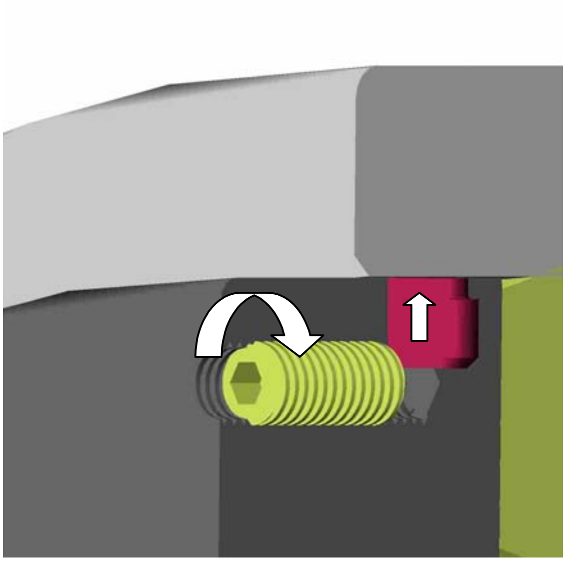
COUPLING DETAILS

For details see enclosed assembly drawing.

5 COUPLING DETAILS

5.1 Locking device

The couplings are provided with a locking device which prevents the outer sleeve from being driven up unintentionally on the inner sleeve during transport and when the coupling is positioned on the shaft. After the coupling has been installed it prevents the nut from turning due to centrifugal force. The locking device is located in the nut and consists of four S6SS screws and four plugs. When tightening the screws in an axial direction the plugs are vertically pressed against the internal diameter of the hydraulic chamber creating a lock function.



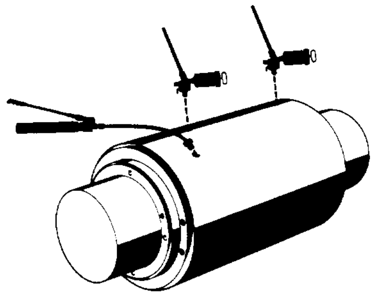
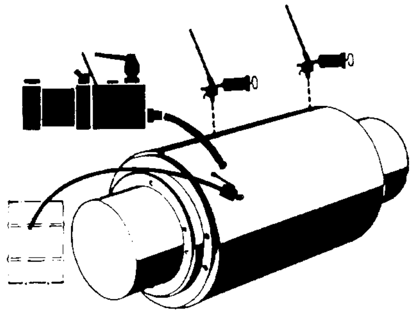
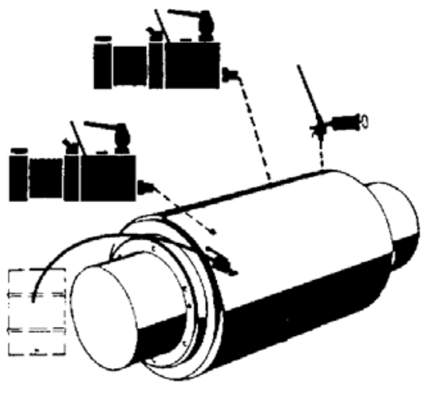
5.2 Handling the locking device

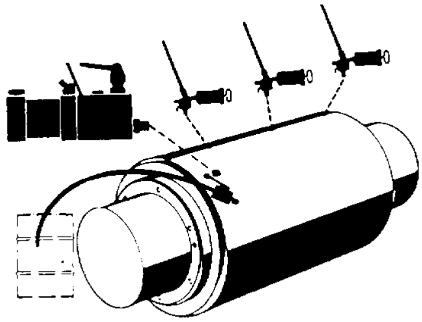
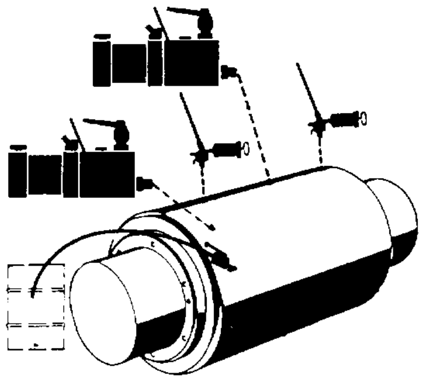
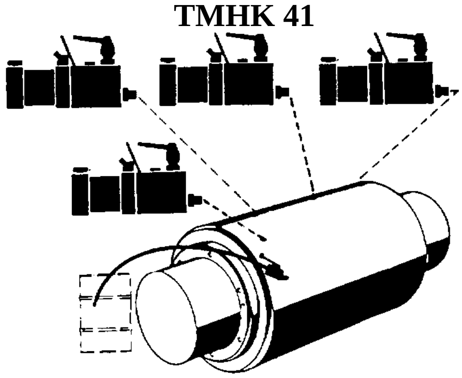
The locking devices should be released by unscrewing the screws 1/2 turn before starting the mounting procedure. When the coupling is finally mounted, the locking devices should be tightened once again. When tightening, tighten the screws crosswise (see table below for tightening torque). The gap between the nut and the hydraulic chamber can be inspected with a feeler gauge to make sure that the locking devices are activated.

Coupling size	**Tightening torque**
200-290	7 Nm
300-490	12 Nm
500-700	20 Nm

6 EQUIPMENT FOR MOUNTING AND DISMOUNTING

For mounting and dismounting of the coupling, a number of tool kits has been assembled. The kit to be used is selected with reference to the coupling size.

Coupling size	Description	SKF set no.
OKX / OKXA / OKXE 200- 500	1 Tool case 728245-3 2 Oil injector 226400 1 Hand operated pump TMJL 50 1 Pipe 227958A 1 Adapter block 226402 1 Set of hex keys 1 Spare parts for injector 226400 Mass: 28.1 kg. Set TMHK 38 can also be used for these coupling sizes. The set contains a hydraulic pump driven by compressed air which enables the coupling to be mounted more quickly.	**TMHK 37** 
OKX / OKXA / OKXE 200- 500	1 Air driven pump set: THAP 030/SET 1 Return hose 729147A 2 Oil injectors 226400 1 Set of hex keys 1 Spare parts for injector 226400 Mass: 32.1 kg	**TMHK 38** 
OKX / OKXA / OKXE 200- 500	1 Air driven pump set: THAP 030/SET 1 Return hose 729147A 1 Air-driven pump THAP 150 1 Oil injector 226400 1 Set of hex keys 1 Spare parts for injector 226400 Mass: 76.2 kg including weight of pallet	**TMHK 38S** 

OKX / OKXA / OKXE 500 >	1 Air driven pump set: THAP 030/SET 1 Return hose 729147A 3 Oil injectors 226400 1 Set of hex keys 1 Spare parts for injector 226400 Mass: 35.1 kg. This set is intended for use on board ship where dismounting and mounting is only carried out infrequently. For shipyards and workshops TMHK 40 or TMHK 41 is recommended.	**TMHK 39** 
OKX / OKXA / OKXE 500 > OKX / OKXA / OKXE 500 >	1 Air driven pump set: THAP 030/SET 1 Return hose 729147A 1 Air-driven pump THAP 150 2 Oil injectors 226400 1 Set of hex keys 1 Spare parts for injector 226400 Mass: 78.2 kg including weight of pallet This set or also set TMHK 41 are recommended for shipyards and workshops. The air-driven high pressure pump simplifies works considerably. 1 Air driven pump set: THAP 030/SET 1 Return hose 729147A 3 Air-driven pump THAP 150 1 Set of hex keys Mass 126.7 kg including weight of pallet. This set is recommended for shipyards and workshops.	**TMHK 40**  **TMHK 41** 

7 MOUNTING INSTRUCTIONS

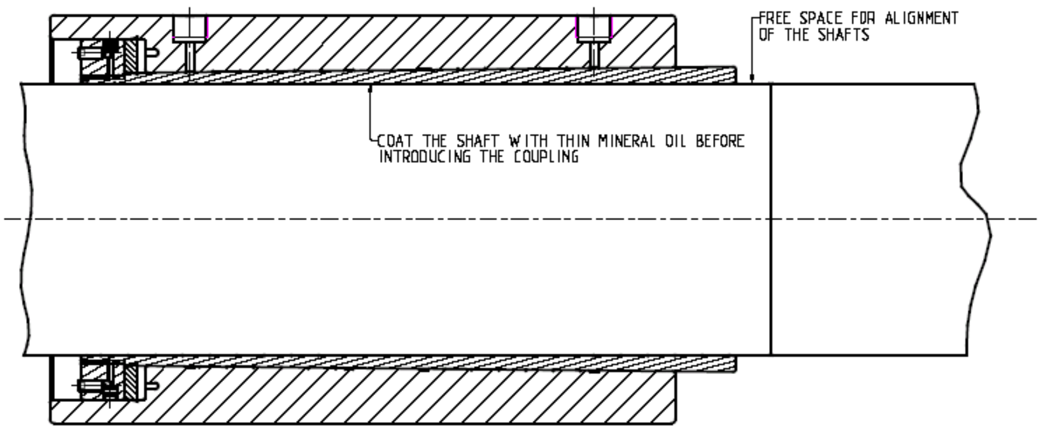
See enclosed assembly drawing for references.

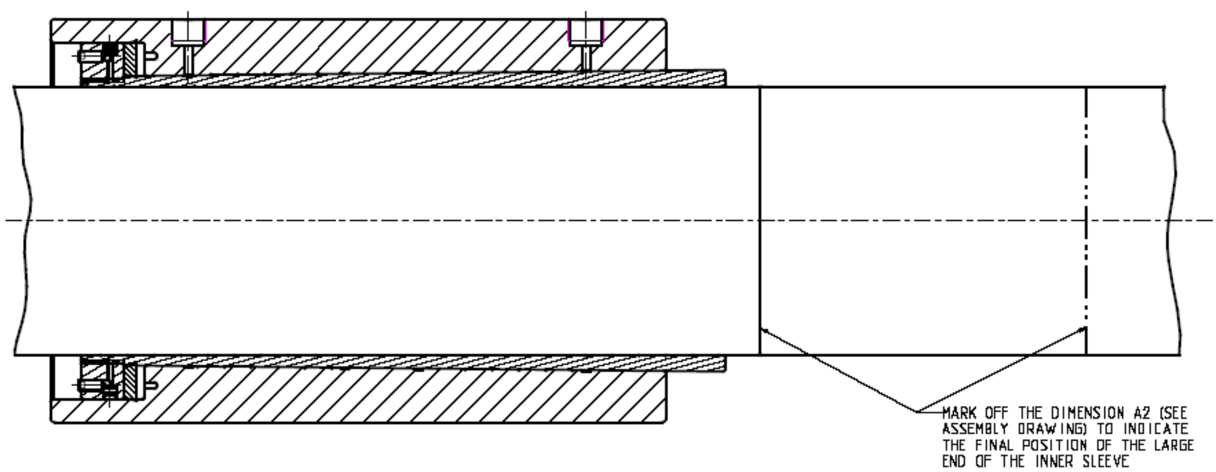
Remove any burrs on the coupling seating on the shaft. **Clean and wash the inner sleeve bore and the coupling seating with white spirit, so that the anticorrosive agent is removed.**

7.1 Positioning of the Coupling on shaft.

Suspend the coupling opposite the shaft on which dimension A_2 has been marked off, ensuring that the large end of the inner sleeve faces this shaft and that the connection holes are at the top of the coupling. Coat the shaft with thin oil before introducing the coupling. Slide the coupling on, guiding it carefully to prevent it from damaging the shaft. Push the coupling on until so much of the seating emerges that the shafts can be aligned accurately.

NOTE The locking devices should be kept tightened while positioning the coupling on the shaft.



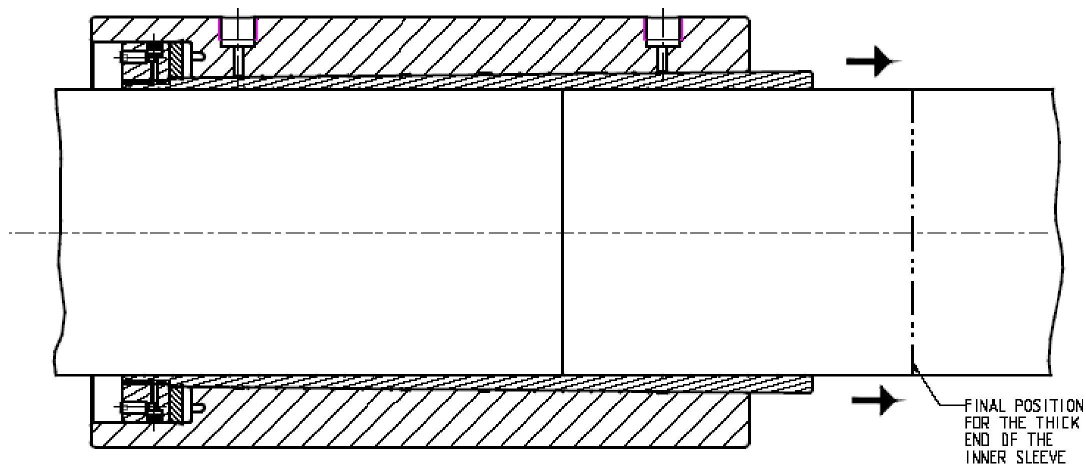


7.2

Align the shafts with precision, vertically and horizontally and ensure that the gap between the shaft ends is not more than 1% of the shaft diameter. Support the shafts and the coupling during the mounting process so that no misalignment appears. Coat the seating on the shaft with thin oil to prevent scraps on the shafts when sliding the coupling in position.

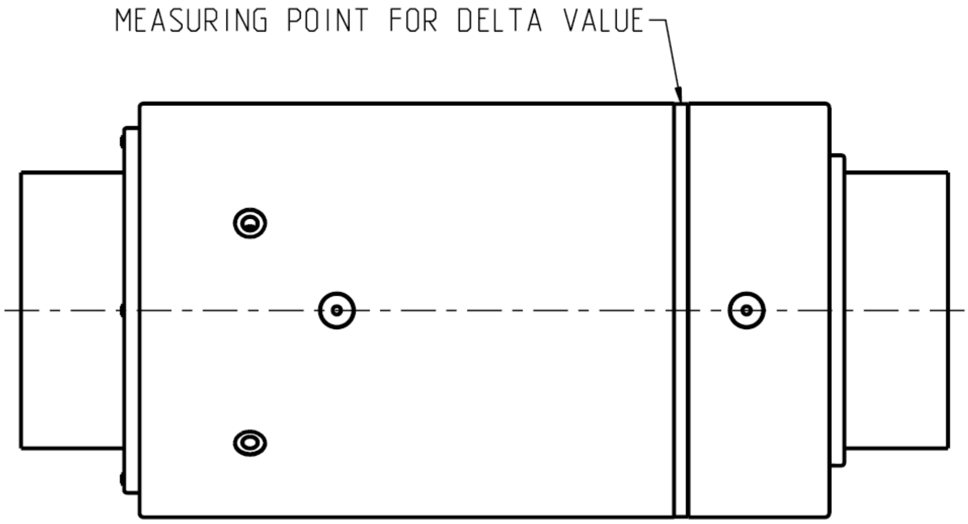
Slide the coupling back along the shafts until the large end face of the inner sleeve coincides with the A2 mark on the shaft.

NOTE The coupling must not weigh upon the shafts



7.3

When the coupling is in correct position and before mounting, measure the outside diameter of coupling and record it. The place for measuring is marked on the outside of the coupling with a shallow groove. (see assembly drawing for Δ value and position of the groove).



7.4 Drive up procedure

Position the coupling so that one of the two ¼" plugs connected to the oil chamber is in top position (12^{00} a clock).Couplings≥ 700 has one ½” and one ¼” hole and the ½” hole should be in top position. Unscrew the plugs and connect the low pressure pump to the lower ¼" hole. Connect the high pressure injectors to the ¾" holes on the coupling hub.

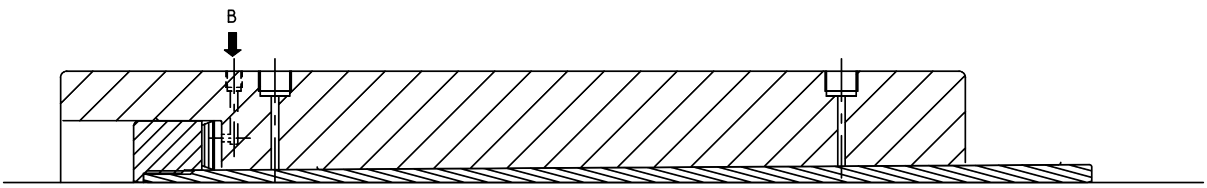
Calculate the final diameter of the coupling after drive up. Use the measured outside diameter +Δ value stamped on the coupling or see the assembly drawing for the Δ value.

Stainless steel coupling.

The stainless steel coupling is delivered with plastic plugs mounted and one steel plug is supplied for the venting hole (¼” or ½”). When the coupling is finally mounted the plastic plugs should be remounted.

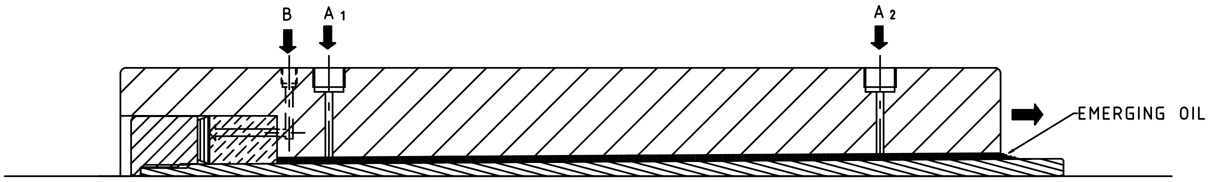
7.4.1 Couplings using 1 or 2 high pressure injectors (size 100 - 490)

Start pumping oil into the hydraulic chamber (B) until oil free from air bubbles escapes through the open ¼" hole (or the ½” hole for larger couplings). Then close that hole with the plug.

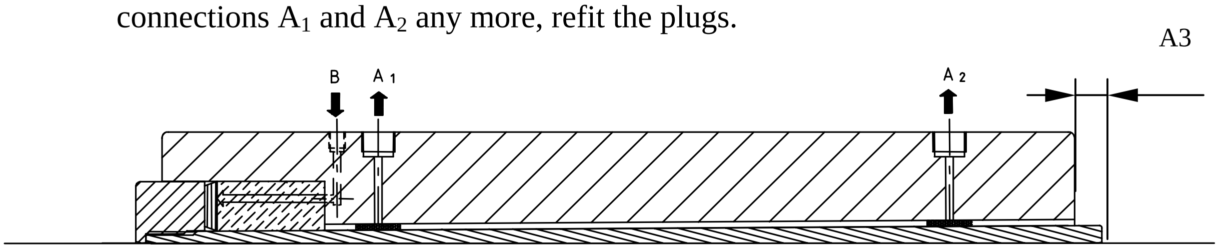


Begin working the high pressure injector connected to the ¾” hole A_1 and then (if there is more than one injector) start working the high pressure injector connected to A_2. Work the high pressure pumps with even strokes until oil emerges around the periphery at the large end of the inner sleeve. Continue pumping for a couple of minutes.

Start the pump connected to the oil chamber (B) to begin the drive up of the outer sleeve. **It is important to continue working the high pressure injectors with even strokes during the entire drive up operation.** If it is necessary to refill the container of injector 226400 during the drive up procedure, always stop the pump connected to the oil chamber first. After refilling, work the injectors first until oil emerges again around the periphery at the large end of the inner sleeve. Continue the drive up procedure until the diameter of the outer sleeve has increased by the dimension Δ see 7.4. As the Δ value should be confirmed after the oil is drained out, the value measured before draining should be 5% higher.

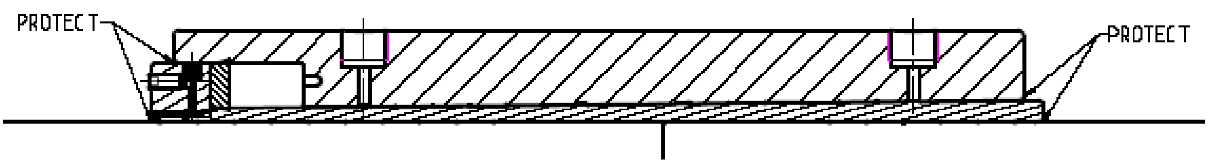


Stop the pump connected to the hydraulic chamber B, but keep the pressure. Open the return valves on the injectors A_1 and A_2. Keep the pressure (B) in the hydraulic chamber. After 10 minutes, measure the Δ value again, to confirm the correct diameter increase according to 7.4. Open the return valve on the pump connected to the oil chamber (B) slowly to release the pressure, make sure the outer sleeve not is moving. Remove the injectors connected to the ¾" holes A_1 and A_2. Disconnect the pump connected to the oil chamber (B) and refit the plug. When oil is not draining out from connections A_1 and A_2 any more, refit the plugs.



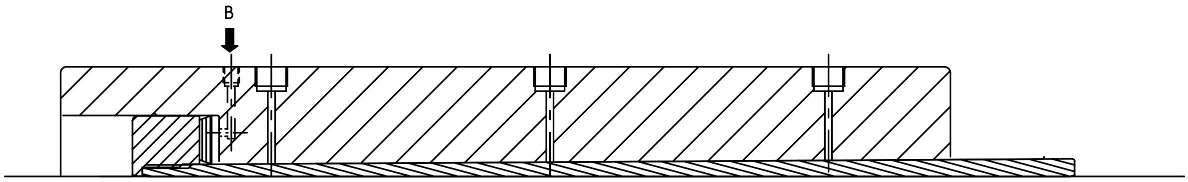
After this first mounting of the coupling the distance A3 (distance from the end of the inner sleeve to the end of the outer sleeve) should be measured and recorded, this can be used as a confirmation at the next mounting of the coupling instead of measuring the Δ value increase.

Protect the ends of the coupling at the shaft and the clearance between the nut and the outer sleeve using silicon or similar protective. This will prevent moisture from penetrating the coupling parts. Tighten the locking device as described in chapter 5.2.



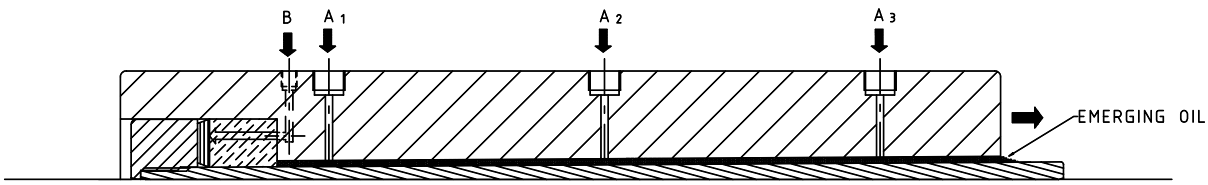
7.4.2 Couplings using 3 high pressure injectors (size >500).

Start pumping oil into the hydraulic chamber (B) until oil free from air bubbles escapes through the open ¼" hole, or from the open ½" hole on coupling≥ 700. Then close that hole with the plug.

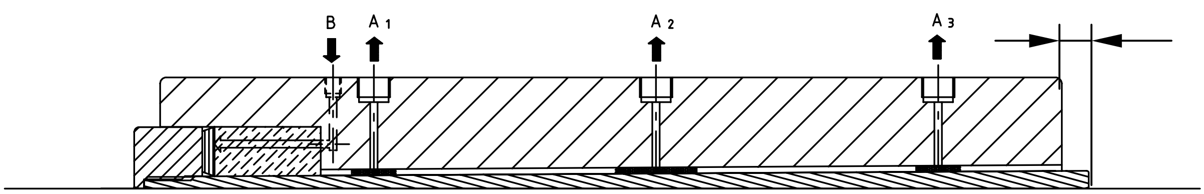


Begin working the high pressure injector connected to the ¾" hole A_2 located in the middle of the coupling. When oil emerges around the periphery at the large end of the inner sleeve, start injection also with the other two injectors A_1 and A_3. Work all injectors for a couple of minutes.

Start the pump connected to the oil chamber to begin the drive up of the outer sleeve. **It is important to continue working the high pressure injectors with even strokes during the entire drive up operation.** If it is necessary to refill the container of injector 226400 during the drive up procedure, always stop the pump connected to the oil chamber first. After refilling, work the injectors first until oil emerges again around the periphery at the large end of the inner sleeve. Continue the drive up procedure until the outer sleeve has increased by the dimension Δ see 7.4. As the Δ value should be confirmed after the oil is drained out, the value measured before draining should be 5% higher.

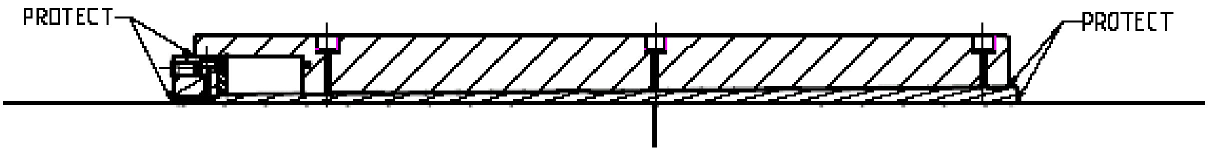


Stop the pump connected to the hydraulic chamber B, but keep the pressure. Open the return valves on the injectors A_1, A_2 and A_3. Keep the pressure (B) in the hydraulic chamber. After 10 minutes, measure the Δ value again, to confirm the correct diameter increase according to 7.4. Open the return valve on the pump connected to the oil chamber (B) slowly to release the pressure, make sure that the outersleeve not is moving. Remove the injectors connected to the ¾" holes A_1, A_2 and A_3. Disconnect the pump connected to the oil chamber (B) and refit the plug. When oil is not draining out from connections A_1, A_2 and A_3 any more, refit the plugs.



After this first mounting of the coupling the distance A3 (distance from the end of the inner sleeve to the end of the outer sleeve) should be measured and recorded, this can be used as a confirmation at the next mounting of the coupling instead of measuring the Δ value increase.

Protect the ends of the coupling at the shaft and the clearance between the nut and the outer sleeve using silicon or similar protective. This will prevent moisture from penetrating the coupling parts. Tighten the locking device as described in chapter 5.2.



8 DISMOUNTING INSTRUCTIONS

1 Support the shafts on both sides of the coupling. Release the locking devices on the coupling, see chapter 5.2.

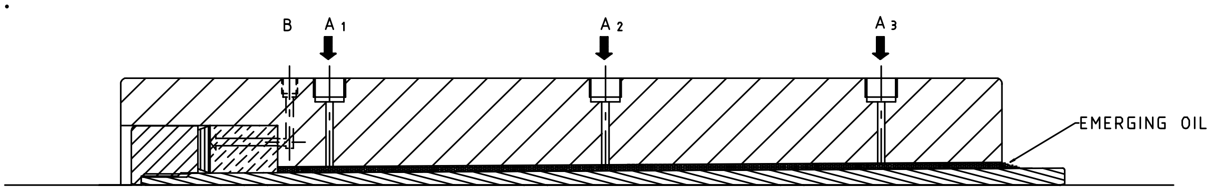
2 Connect the pump and injectors as for mounting and fill up the oil chamber with oil as the procedure for mounting, see chapter 7.4.Connect also the extra return pipe to the ½”or the other ¼” vent hole at the hydraulic chamber.

3 Pressurise the oil chamber to ˜ 10 MPa and start the high pressure injectors following the procedure for mounting. See 7.4.

4 Continue to work the high pressure injectors until oil emerges around the periphery at the large end of the inner sleeve. If the outer sleeve moves relatively the inner sleeve taper while the pressure in the oil chamber increases also indicates that there is a satisfying oil film. Open the return valve on the pump connected to the hydraulic chamber and at the same time the valve on the extra return pipe, this while the injectors are working, and the outer sleeve will slide down on the inner sleeve. **Work the high pressure injectors until a fully dismounted position is obtained in order to maintain a good oil film between the sleeves**

NOTE Make sure that the A3 dimension is not decreasing while dismounting the coupling

.



9 REPLACING THE OIL CHAMBER SEALING

The OKXC coupling is a unit, which normally should not be disassembled. If it however is necessary because of a damaged sealing, the nut must be removed first.

9.1 Coupling removed from the shaft

Release the locking device in the nut as described in chapter 5.2.

Unscrew the nut and remove the sealing using a tool with rounded edges to avoid damaging the surfaces. Replace it with the new sealing and guide it carefully over the inner sleeve threads not to destroy the sealing edge. Push it against the bottom of the chamber. Correct mounted the sealing outer edge and inner edge will have good contact against the bottom and the face will have a convex form.

Remount the nut and tighten it properly. With a blast of compressed air in one ¼ " hole, the sealing will be forced in position. Tighten the locking device (see 5.2).

9.2 Coupling mounted on the shaft.

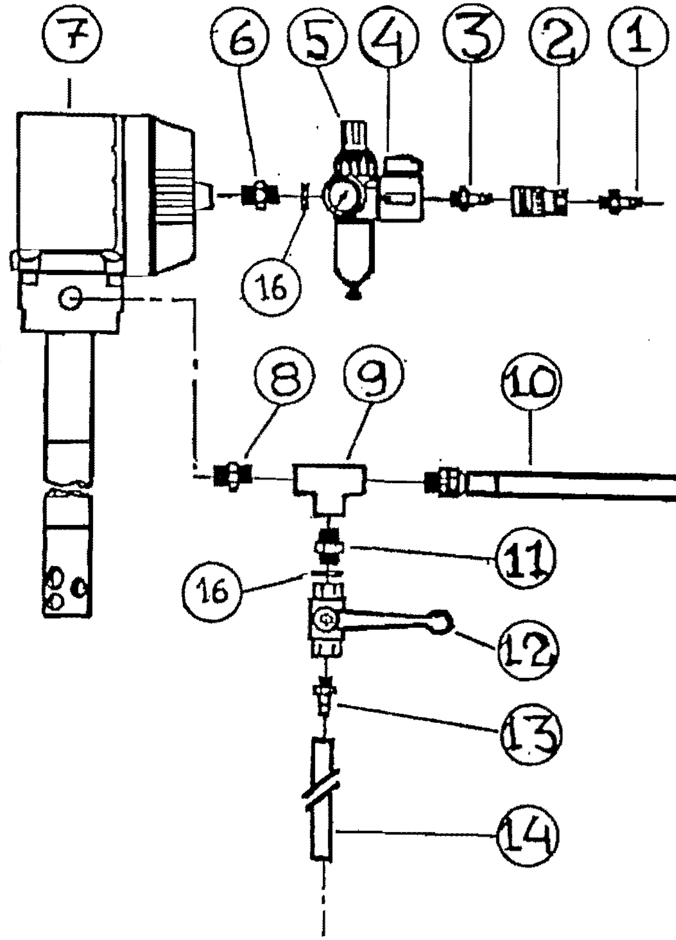
If there is a leakage from the oil chamber when preparing for dismounting procedure, it is necessary to replace the sealing.

Follow the above mentioned procedure for removing the coupling nut and removal of the sealing. Place the nut on the shaft to get good access to the chamber. The new sealing must be cut to get it around the shaft. Do this with a long knife so that it will be a straight and smooth cut. Place the sealing around the shaft with the smallest outer diameter facing the nut. The flat surface of the nut can be used as a template. Use a cyanoacrylat glue for rubber to glue the divided surfaces together. Place the sealing in the chamber guiding it carefully over the threads and 10mm up on the taper of the inner sleeve. Try to get the sealing as straight and flat as possible. Remount the nut and position the sealing with a blast of compressed air in one of the ¼ " hole.

WARNING! NEVER USE HIGH PRESSURE INJECTORS (A_1-A_3) IF THE NUT HAS BEEN REMOVED

10 ASSEMBLY DRAWING

Pos.	Benämning	Artikelnr.
1	Slangfäste	1817413
2	Snabbkoppling	1817464
3	Snabbkopplingsnippel	1817465
4	Ventil	1817077
5	Filterregulator	EAW2000-F02-X64
	inkl. manometer	K8-10-40
6	Nippel	02024-R4
7	PML Fettpump	9650
8	Nippel	02024-R4+0203-6-4
9	T-stycke	0143-4
10	Fettslang L 3 m.	GR2T1/4+03500404x2 +0002-4x2
11	Nippel	1700/04/04
12	Ventil	BKH R1/4
13	Slangfäste	3822-4-6
14	Slang L 1m.	OL10040 10 1m
15	Fett svivel 1/4"	1100-A
16	Gummistålbricka	GBR 1/4"



Leveransutförande:
Pos 1-6+16 monteras.
Pos 8-9+11-14+16 monteras i pump
Pos 10+15 monteras.
Delmonteringar packas i pumpkartong.

Kartong märkes med 071056 P17D-14

KaMeWa Högtryckspump

Eurolube AB
Box 55 132 22 Saltsjö-Boo

49036-E

Service Guide

9611
9650
338043-J1

ALEMITE

High-Pressure Stripped Pump

Description

The major components of these stripped pump models consist of an air-operated motor and a pump tube. The air motor connects directly to the single-acting reciprocating pump tube.

These high-pressure stripped pumps (50:1 ratio) are designed to deliver a range of greases [up to NLGI # 3] and operate directly from their original drums or bulk containers.

Each pump model is designed with a pump tube length to accommodate different size containers. See **Figure 1.**

Specifications

Air Motor

Piston Diameter x Stroke		Air Inlet	Maximum Air Pressure	
Inches	Centimeters		psi	Bars
2-15/16 x 3	7.5 x 7.6	1/4 " NPTF (f)	150	10.3
For details on the air motor, refer to Service Guide SER 338066-A1				

Pump Tube

Material Outlet	Max. Material Pressure		Delivery/Minute (Approximate)*		Displacement per Cycle	
	psi	Bars	Pounds	Kilograms	In^3	Cm^3
3/8 " NPTF	7500	517	3	1.4	0.39	6.39
* For detailed information, refer to Figure 3						

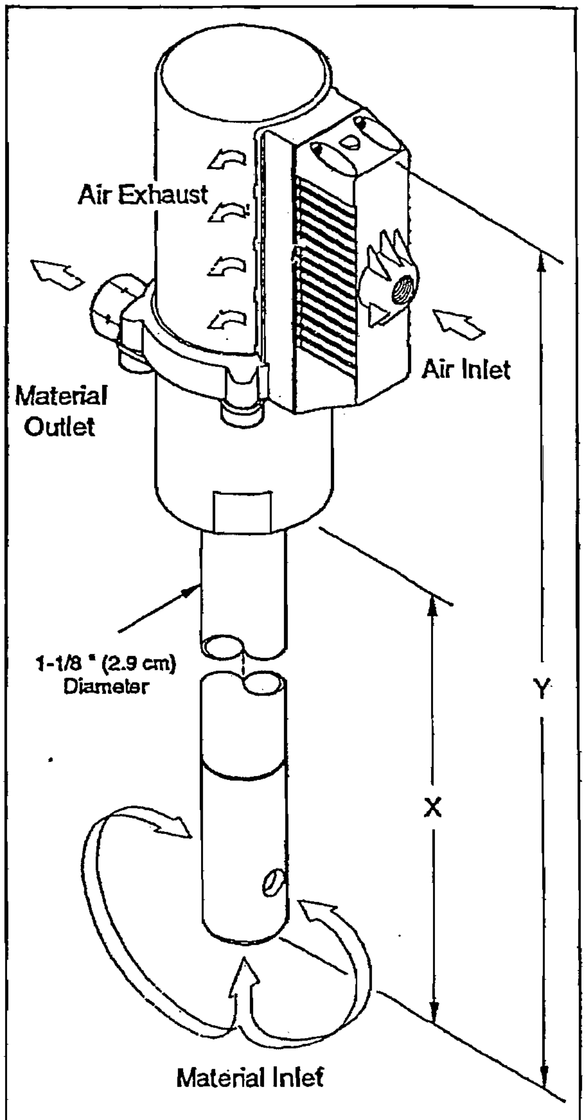
Table 1 *High-Pressure Stripped Pump Specifications*

Package Models

The usage for each model of stripped pump is indicated below.

Stripped Pump Model	Package Model
9611	9611-H, 9611-Z
9650	9650-A, 9651, 9651-S, 9651-T
338043-J1	9611-A, 9611-B

Table 2 *High-Pressure Stripped Pump Usage*



Stripped Pump Model	Container	X		Y	
		Inches	Cm	Inches	Cm
9611	35 pounds	13.75	34.9	22	55.9
9650	120 pounds	27.75	70.5	36	91.4
338043-J1	70 pounds	17.68	45	25.9	65.8

Figure 1 *High-Pressure Stripped Pump Models 9611, 9650, and 338043-J1*

Alemite Corporation
PO Box 473515, Charlotte, North Carolina 28247-3515

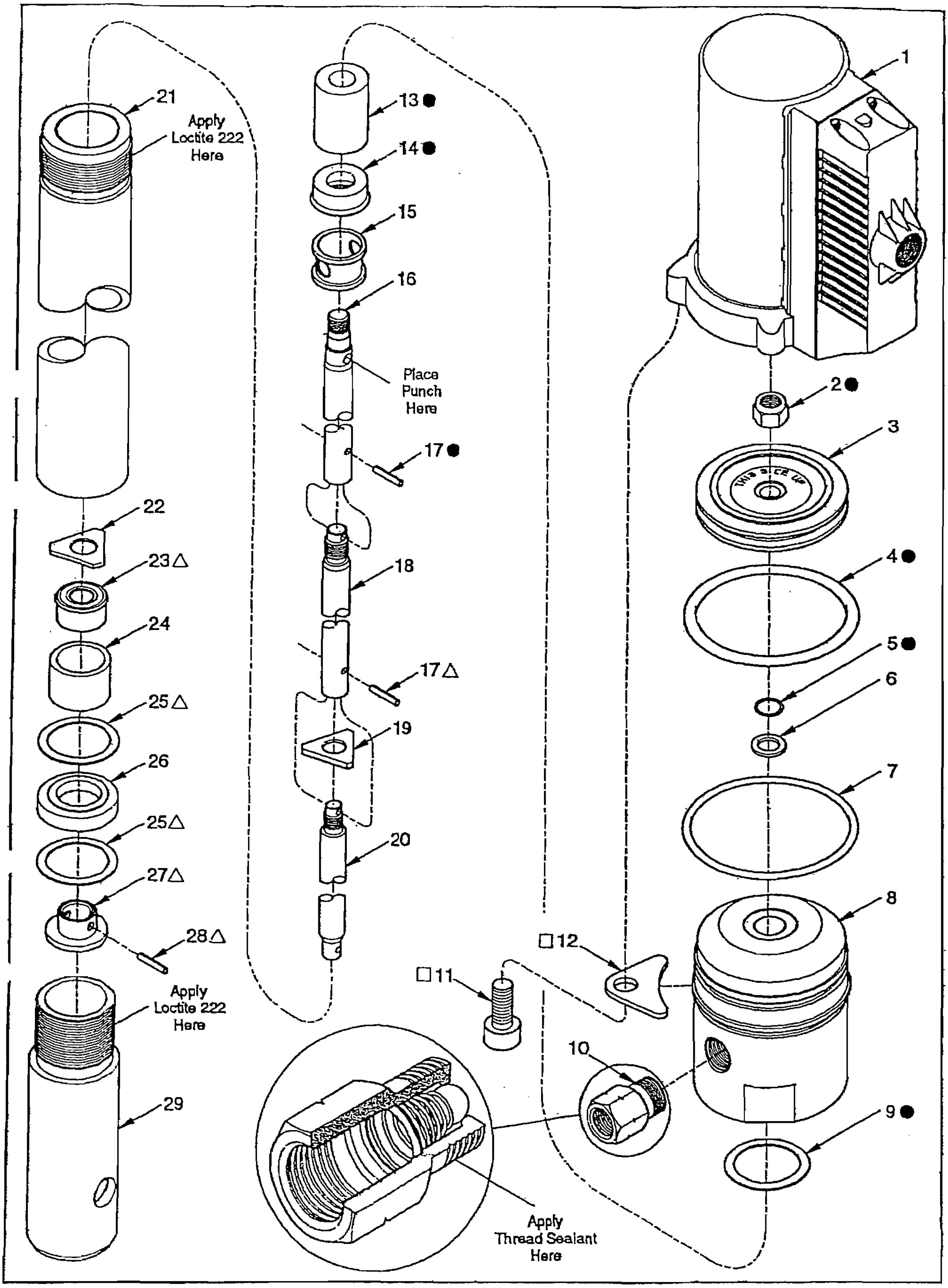


Figure 2 *High-Pressure Stripped Pump Models 9611, 9650, and 338043-J1 - Exploded View*

Item No.	Part No.	Description	Qty	Notes		Numeric Order Part #	(Item #)
1		Motor Assembly, Air	1		See SER 338066-A1	51929	(2)
2	51929	Nut, Elastic Stop, 3/8 " -24	1	●		171000-7	(5)
3	338111	Piston, Air	1			*171000-103*	(4)
4		O-Ring, 2-5/8 " ID x 3 " OD	1	●		171003-10	(7)
5	171000-7	O-Ring, 3/8 " ID x 1/2 " OD	1	●		*171031-5*	(17)
6	338109	Washer, 3/8 "	1			*171032-3*	(28)
7	171003-10	O-Ring, 2-3/4 " ID x 3 " OD	1			*171892*	(11)
8	338515	Body	1			*172190-10*	(23)
9		Gasket, 0.90 " ID (Aluminum)	1	●		*172190-26*	(14)
10	338512-A	Valve Assembly, Check	1			*338041*	(12)
11		Bolt, 5/16 " -18 x 1/2 "	4	□		338056	(22)
12		Keeper	4	□		*338066-A1*	(1)
13		Bearing (Brass)	1	●		338071	(24)
14		Seal, 1/2" ID x 7/8 " OD	1	●		338092-1	(21)
15	338094	Ring, Lantern	1			338092-2	(21)
16	338108	Rod, Upper	1			338092-7	(21)
17		Pin, Roll, 5/64 " Dia. x 1/2 " Long	2	●△	Qty of 1 in each kit	338093	(29)
18	338099-1	Extension, 6.66 " Long	1		Model 9611	338094	(15)
	338099-2	Extension, 20.66 " Long	1		Model 9650	*338095*	(13)
	338099-7	Extension, 10.59 " Long	1		Model 338043-J1	*338096*	(9)
19	338104	Guide	1			338098	(20)
20	338098	Rod, Primer	1			338099-1	(18)
21	338092-1	Tube, 11.54 " Long	1		Model 9611	338099-2	(18)
	338092-2	Tube, 25.54 " Long	1		Model 9650	338099-7	(18)
	338092-7	Tube, 15.47 " Long	1		Model 338043-J1	*338100*	(25)
22	338056	Stop	1			338101	(26)
23		Seal, 0.182 " ID x 0.532 " OD	1	△		338102	(27)
24	338071	Valve, Foot	1			338104	(19)
25		Gasket, 0.75 " ID (Aluminum)	2	△		338108	(16)
26	338101	Seat	1			338109	(6)
27	338102	Disc, Primer	1	△		338111	(3)
28		Pin, Roll, 3/32 " Dia. x 3/8 " Long	1	△		338512-A	(10)
29	338093	Body, Primer	1			338515	(8)

Legend:
Part numbers left blank (or in *italics*) are not available separately
●△□ designates a repair kit item

Repair Kits

Part No.	Kit Symbol	Description
393573-1	●	Kit, Repair (for Upper Pump Tube Assembly) [Includes tube of 393590 Teflon Grea
393574	△	Kit, Repair (for Lower Pump Tube Assembly)
393641	□	Kit, Repair, Air Motor Keeper and Screw
393530-10		Kit, Seal [includes five (5) of item number 23]
393530-26		Kit, Seal [includes five (5) of item number 14]

Accessories

Part Number	Description
326750-F1	Bung Adapter, 2 " NPTF (m)

Table 3 *High-Pressure Stripped Pump Accessory Component*

Preventive Maintenance

Refer to section entitled **Overhaul** for the procedures necessary to perform maintenance.

Daily	Weekly	Monthly	Yearly
Wipe Exterior with Clean Cloth	Inspect for Air and/or Material Leakage		

Table 4 *High-Pressure Stripped Pump Preventive Maintenance Schedule*

Performance Curves

A pump's ability to deliver material is based on the pressure (psi/Bars) and quantity (cfm/lpm) of air supplied to the motor and the amount of material discharge [back] pressure to be overcome within the system.

This chart contains curves based on three different air pressures. The curves relate delivery in pounds (kilograms) per minute (X axis) to air consumption in cubic feet (liters) per minute (right Y axis) and to material discharge pressure in psi/Bars (left Y axis).

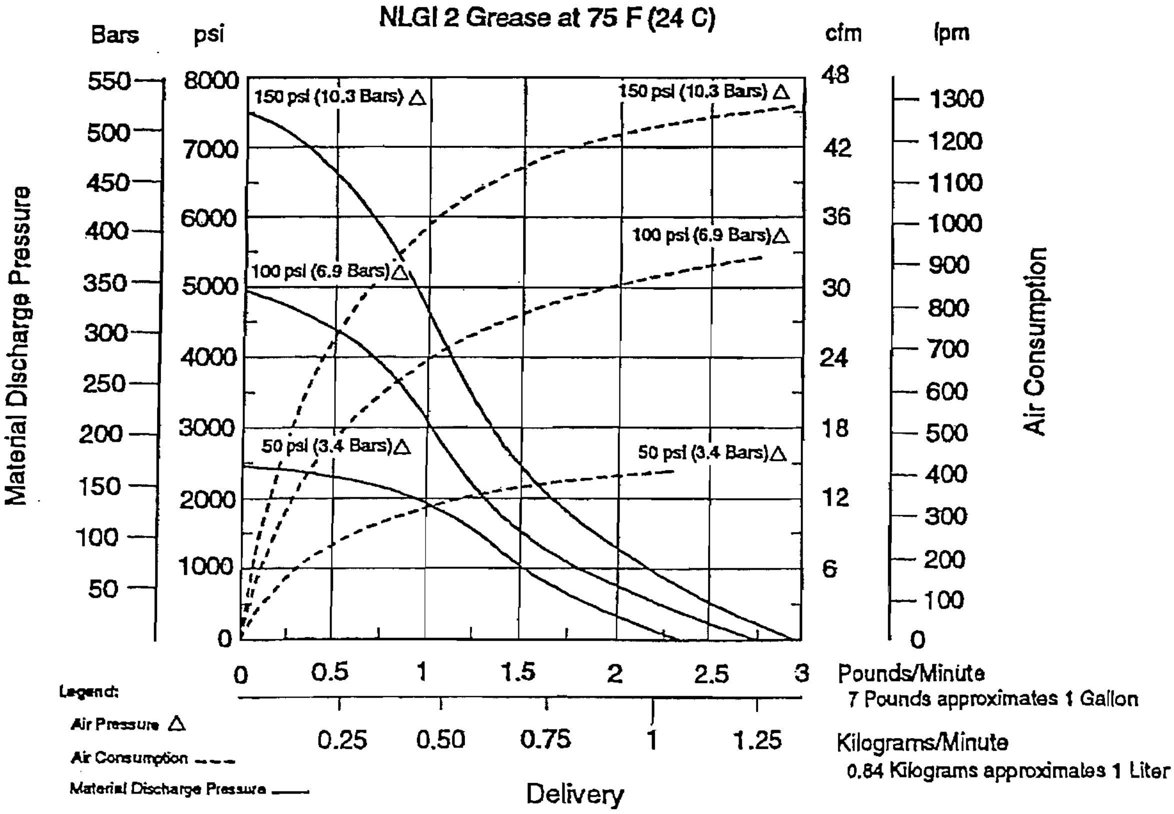
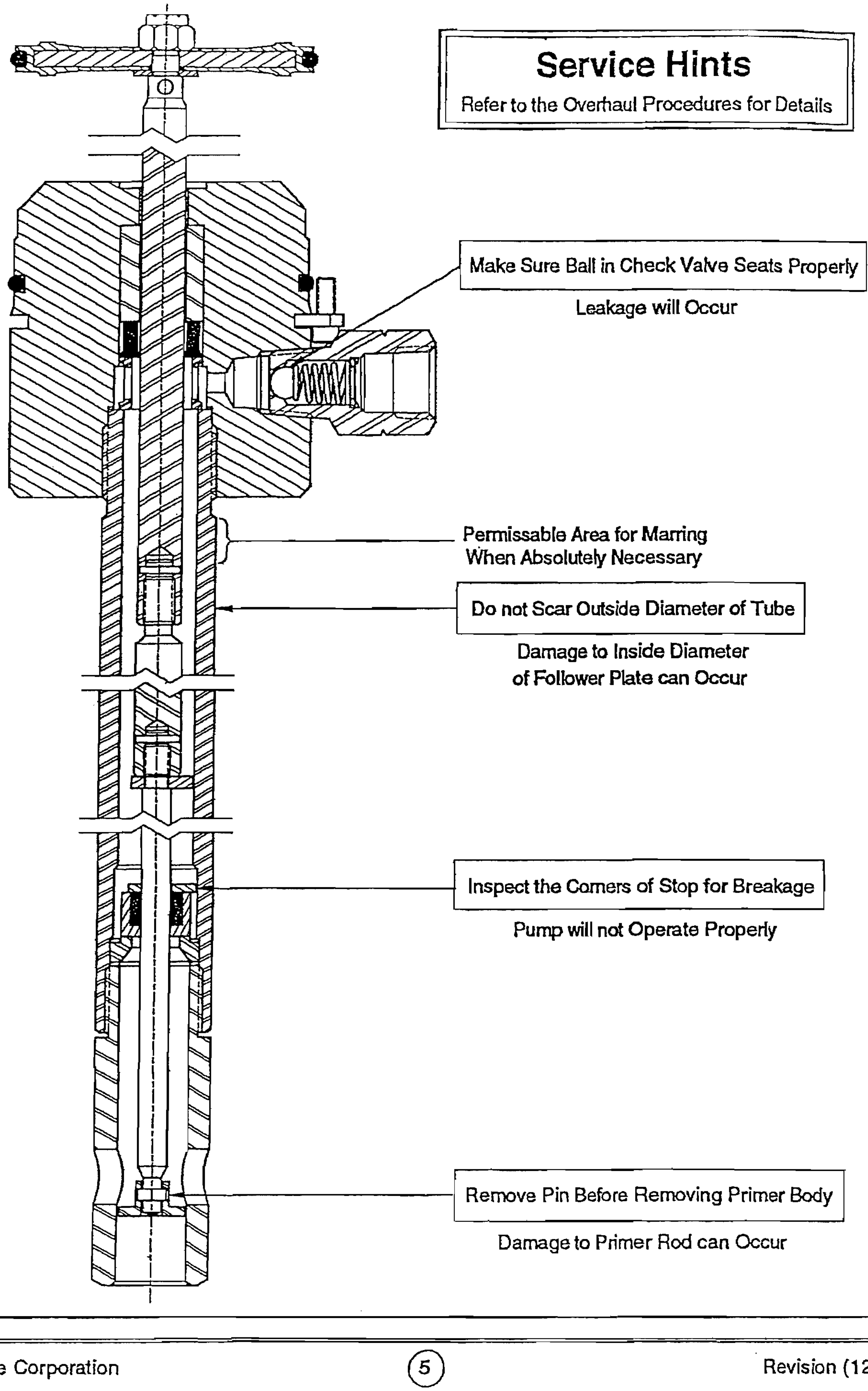


Figure 3 *Delivery versus Discharge Pressure and Air Consumption*

Service Hints

Refer to the Overhaul Procedures for Details



Overhaul

NOTE: Refer to **Figure 2** for component identification on all overhaul procedures.

Prior to performing any maintenance procedure, the following safety precautions must be observed. Personal injury may occur.

WARNING

Do not use halogenated hydrocarbon solvents such as methylene chloride or 1,1,1-trichlorethane in this pump. An explosion can result within an enclosed device capable of containing pressure when aluminum and/or zinc-plated parts come in contact with halogenated hydrocarbon solvents.

Release all pressure within the system prior to performing any overhaul procedure.

- **Disconnect the air supply line from the pump motor.**
- **Into an appropriate container, operate the control valve to discharge remaining pressure within the system.**

Never point a control valve at any portion of your body or another person. Accidental discharge of pressure and/or material can result in injury.
Read each step of the instructions carefully. Make sure a proper understanding is achieved before proceeding.

Removal

Remove the pump assembly from the package model.
- Refer to the applicable package model Service Guide for detailed information. See **Table 2**.

Disassembly

Separate Air Motor from Pump Tube

1. Clamp the pump assembly in a soft-jaw vise at Body (8).
2. Remove Bolts (11) that secure the Body to Air Motor Assembly (1).
   - Remove Keepers (12) from the Body.
3. With a side-to-side motion, pull the Air Motor assembly from the Body.
   - Lubricate O-Ring (7) with oil to ease separation.

Pump Tube

4. Remove Nut (2) that secures Air Piston (3) to Upper Rod (16).
   - Remove the Air Piston from the Rod.

   NOTE: Place an appropriate size punch or other suitable tool into the hole of the Upper Rod. See **Figure 2.**

5. Remove O-Ring (5) and Washer (6) from the Upper Rod.
6. Remove O-Ring (4) from the Air Piston.
7. Remove Roll Pin (28) that secures Primer Disc (27) to Primer Rod (20).
   - Use an appropriate size punch.

   NOTE: Position the rod assembly as required to align the Roll Pin with the hole in Primer Body (29).

8. Remove the Primer Disc from the Primer Rod.
9. Break the connection of Tube (21) from the Body.
   - Place an appropriate size tool into the hole of the Primer Body. At the same time turn the Tube with a strap wrench.
10. Unscrew Primer Body (29) from the Tube.
    - Prevent the rotation of the Tube with the use of the strap wrench.
11. Pull the entire rod assembly from the bottom of the Tube.
12. Unscrew the Tube from the Body.

Rod Assembly

13. Remove Gasket (25), Seat (26), additional Gasket (25), Foot Valve (24) [with Seal (23)], and Stop (22) from the Primer Rod.
    - Remove the Seal from the Foot Valve.
14. Remove Roll Pin (17) that secures Extension (18) to the Primer Rod.
    - Use a punch and a small hammer.
15. Unscrew the Primer Rod from the Extension.
16. Remove Guide (19) from the Primer Rod.
17. Remove Roll Pin (17) that secures Upper Rod (16) to the Extension as required.
    - Use a punch and a small hammer.
18. Unscrew the Extension from the Upper Rod.

Body

19. Remove Gasket (9) from the Body.

20. Remove Lantern Ring (15), Seal (14), and Bearing (13) from the Body.

21. Remove O-Ring (7) from the Body.

22. Unscrew Check Valve Assembly (10) from the Body.

Clean and Inspect

NOTE: Use the appropriate repair kit for replacement parts. Make sure all the components are included in the kit before discarding used parts.

1. Clean all metal parts in cleaning solvent. The solvent should be environmentally safe.
2. Inspect all parts for wear and/or damage.
   • Replace as necessary.
3. Inspect Air Piston (3) for fatigue cracks.
   • Replace as necessary.
4. Inspect Upper Rod (16) and Primer Rod (20) closely. Use a magnifying glass to detect any score marks on the Rods.
   • Replace as necessary.
5. Closely inspect the mating surfaces of Foot Valve (24) and Seat (26) for any imperfections. Ensure a smooth and clean contact is obtained.
6. Fill Check Valve Assembly (10) with solvent. Make sure no leakage occurs.
7. Inspect the corners of Stop (22) for breakage. Place the Stop into the bottom of Tube (21). Make sure the Stop is secure within the Tube when pressure is applied.

Assembly

NOTE: Prior to assembly, certain components require lubrication. Refer to **Table 5** for details.

Pump Tube

NOTE: Refer to **Figure 4** for a section view of the pump tube assembly.

1. Install O-Ring (7) onto Body (8).
2. Install and seat Bearing (13) and Seal (14) [heel end first] into the Body.
3. Install Lantern Ring (15) into the Body.
4. Screw Extension (18) into Upper Rod (16).
   • Make sure the hole in the Extension aligns with the hole in the Upper Rod.
5. Install Roll Pin (17).
   • Use a small hammer.
6. Install Guide (19) onto the threaded end of Primer Rod (20).
7. Screw the Primer Rod assembly hand-tight into the Extension.

   IMPORTANT: Do not back-off the Primer Rod more than 1/2 turn.
8. Unscrew the Primer Rod until the hole in the Primer Rod aligns with the hole in the Extension.
9. Install Roll Pin (17).
   • Use a small hammer.
10. Install the Rod assembly [chamfer end first] into the bottom of the Body.
    • Use care passing the Seal.

Item No. on Figure 2	Description	Item No. on Figure 2	Description
Clean Oil			
4	O-Ring, 2-5/8 " ID x 3 " OD	14	Seal, 1/2 " ID x 7/8 " OD
5	O-Ring, 3/8 " ID x 1/2 " OD	23	Seal, 0.182 " ID x 0.532 " OD
7	O-Ring, 2-3/4 " ID x 3 " OD		
Magnalube-G Teflon Grease *			
Coat the Inside Diameter of the Air Motor Assembly			
*.Part number 393590 is a 0.75 ounce (21.8 gm) tube of Magnalube-G Teflon grease			

Table 5 *Lubricated Components*

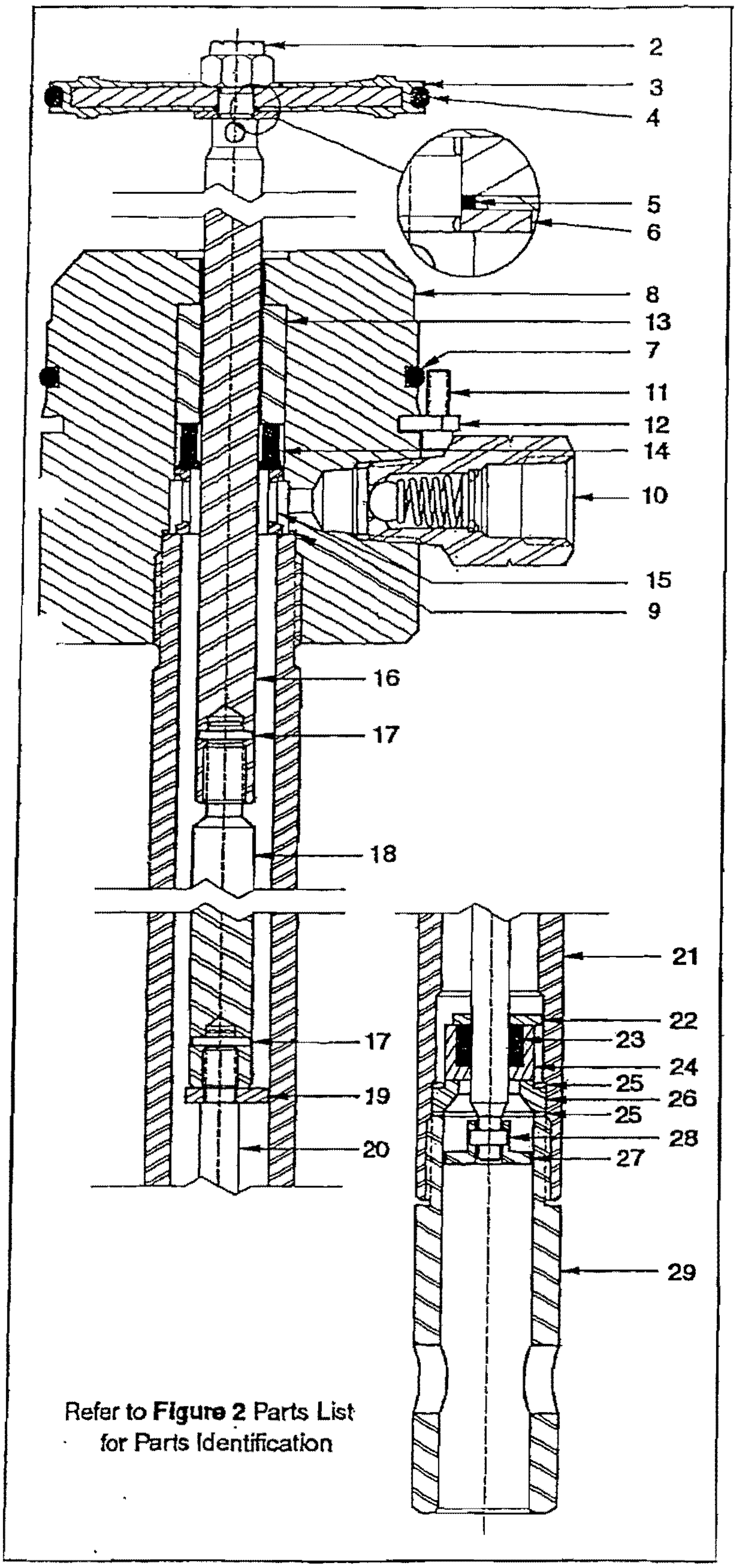


Figure 4 *Pump Tube Assembly 338087-A1, B1, and H1 Section View*

11. Install and seat Gasket (9) into the Body.

    IMPORTANT: If a primer is used with Loctite 222, the curing time is greatly reduced.

12. Screw Tube (21) [with Loctite 222] into the Body. See **Figure 2.**
    - Follow the thread sealant manufacturer's recommendations
    - Do not tighten at this time.
13. Install Stop (22) onto the Primer Rod.
14. Install Seal (23) [heel end first] into Foot Valve (24).
15. Install the Foot Valve assembly (Seal first) onto the Primer Rod.
16. Install and seat Gasket (25) into the Tube.
17. Install Seat (26) [stepped end first] into the Tube:
18. Install additional Gasket (25) onto the Seat.
19. Screw Primer Body (29) [with Loctite 222] into the Tube. See **Figure 2.**
    - Follow the thread sealant manufacturer's recommendations
20. Place an appropriate size tool into the hole of the Primer Body.
    - Tighten the Primer Body into the Tube and at the same time the Tube into the Body.
    - Make sure to properly crush all Gaskets.
21. Position the rod assembly as required so the hole in the Primer Rod is visible through the hole in the Primer Body.
22. Install Primer Disc (27) onto the Primer Rod.
    - Make sure the hole in the Primer Disc aligns with the hole in the Primer Rod.
23. Install Roll Pin (28).
    - Use a small hammer and a punch.

Air Piston

24. Install Washer (6) and O-Ring (5) onto the Upper Rod.
25. Install O-Ring (4) onto Air Piston (3).

26. Place the Air Piston (observe THIS SIDE UP) on top of the Upper Rod.

27. Install Nut (2) that secures the Air Piston to the Upper Rod.
    - Tighten the Nut securely.

    NOTE: Place an appropriate size punch or other suitable tool into the hole of the Upper Rod. See **Figure 2.**

28. Screw Check Valve Assembly (10) [with thread sealant] into the Body.
    - Tighten the Check Valve securely.

Attach Air Motor to Pump Tube

29. Clamp the Body securely in a soft-jaw vise.

30. Install Air Motor Assembly (1) squarely onto the Body.
    - Use care passing the O-Ring.
    - Make sure the Check Valve Assembly orients properly with the inlet of the Air Motor.

31. Install Keepers (12) into the groove of the Body.
    - Make sure the holes align with the Air Motor Assembly.

32. Install Bolts (11) that secure the Body to the Air Motor Assembly.
    - Tighten the Bolts evenly and securely in a crisscross pattern.

Bench Test and Operation

1. Slowly supply air pressure [not to exceed 15 psi (1 Bar)] to the pump's motor.
    - The pump assembly should cycle.

If the pump assembly does not cycle, refer to the **Troubleshooting Chart** for details.

With air pressure at zero:

2. Connect a product hose to the pump's Check Valve Assembly.
    - Direct the hose into an appropriate collection container.

3. Place the pump in the product to be dispensed.

4. Slowly supply air pressure to the pump's motor.

5. Allow the pump to cycle slowly until the product is free of air.

If the pump assembly does not prime, refer to the **Troubleshooting Chart** for details.

WARNING

Should leakage occur anywhere within the system, disconnect air to the motor. Personal injury can occur.

With air pressure at zero:

6. Attach a control valve to the outlet hose of the pump.
    - Make sure the nozzle on the control valve is open.

7. Slowly supply air pressure to the pump's motor.

8. Allow the pump to cycle slowly until the product is once again free of air.

9. Set the air pressure to 100 psi (6.9 Bar).

10. Operate the control valve into a container.

11. Shut off the control valve.
    - Visually inspect the pump for external leaks.
    - The pump should not cycle more than once or twice in one hour.

If the pump does not stall, refer to the **Troubleshooting Chart** for details.

12. Check the motor for air leakage.

If the motor leaks, refer to the **Air Motor Service Guide** for details.

IMPORTANT: Make sure to reset the air pressure to the required operating pressure.

Installation

Additional items that should be incorporated into the air piping system are listed in **Table 6.**

Part Number	Description
560412	Moisture Separator
7604-B	Regulator and Gauge

Table 6 *Air Line Components*

Troubleshooting Chart

Pump Indications	Possible Problems	Solution
Pump does not cycle	1. Air motor not operating properly 2. Pump tube jammed and/or contains loose components 3. Insufficient air pressure	1. Inspect air motor and rebuild or replace as necessary. Refer to SER 338066-A1 2. Rebuild pump tube 3. Increase air pressure
Pump will not prime	1. Excessive cycling speed 2. Pump leaking internally	1. Reduce air pressure 2. See **Internal Leaks**
Pump cycles rapidly	Product source empty	Replenish product
Pump will not stall (cycles more than once or twice per hour)	1. Pump requires break-in period 2. Pump leaking internally 3. Pump leaking externally 4. Distribution system leaking	1. Operate the pump against moderate fluid pressure for up to one hour 2. See **Internal Leaks** 3. See **External Leaks** 4. Correct leak
External Leaks		
Product leakage visible at bottom of Body (8)	1. Tube (21) not sufficiently tight 2. Damaged Gasket (9)	1. Tighten Tube (21) into Body (8) 2. Separate Tube (21) from Body (8) and replace Gasket (9)
Product leakage visible between Tube (21) and Primer Body (29)	1. Primer Body (29) not sufficiently tight 2. Damaged Gasket (25)	1. Tighten Primer Body (29) into Tube (21) 2. Separate Primer Body (29) from Tube (21) and replace Gasket (25)
Internal Leaks		
Pump does not prime or cycles continuously, or slowly (once or twice/hour)	1. Foreign material between Foot Valve (24) and Seat (26) 2. Foreign material in Check Valve Assembly (10) 3. Worn or damaged Foot Valve (24) 4. Worn or damaged Seat (26) 5. Worn or damaged Check Valve Assembly (10) 6. Worn or damaged Seal (23) 7. Worn or damaged Primer Rod (20) 8. Primer Disc (27) missing	Locate and eliminate source of foreign material. Disassemble pump tube, clean, inspect, and replace worn or damaged components.
Product leakage visible at Air Motor Assembly (1) exhaust	1. Worn or damaged Seal (14) 2. Worn or damaged Upper Rod (16)	Separate Tube (21) from Body (8) and replace worn or damaged component(s).

Changes Since Last Printing
Initial Release

49037-E

Service Guide

338066-A1
338066-C1

ALEMITE

Pneumatic Logic Air Motor

Description

The air motors in the model 338066 series power a variety of fluid and material reciprocating pumps.

The pump tube assembly is secured to the motor with bolts. The bolts retain keepers that hold the body of the pump tube to the mounting ring of the air motor. See **Figure 3**.

Models 338066-A1 and 338066-C1

The difference between these models is the standard of thread for the air inlet. Refer to **Table 1**.

CAUTION

To comply with the warranty, an air line lubricator must not be used with this air motor.* The motor is packed with Teflon lubricant (part number 393590) and requires no additional lubrication except during service.

A moisture separator/filter should be used to prevent contamination and the washout of lubricant.

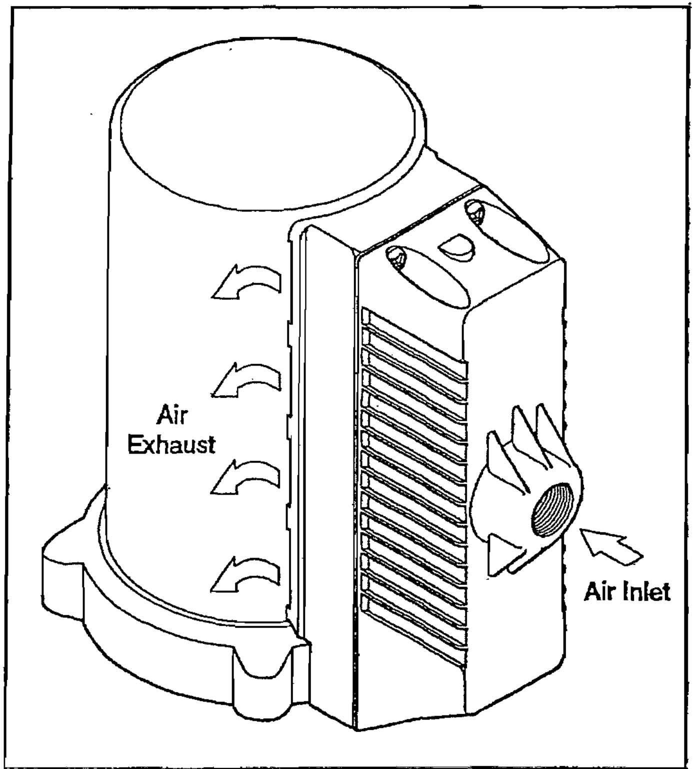


Figure 1 *Air Motor Model 338066 Series*

Operation

The designation pneumatic motor logic (PML) is derived from the method of controlling movement of the components within the motor's valve assembly.

Pneumatically actuated pilot valves (one at each end of a spool valve) cause the spool valve to shift. The spool valve directs air pressure to one side of the motor's piston and exhausts air from the opposite side.

Pilot ports in the cylinder control the pilot valves as the ports are uncovered by the piston. The section view of the motor on **Pages 6** and **10** illustrate the upstroke and downstroke respectively.

NOTE: These air motors are not available to be purchased separately.

Specifications

Air Motor Model	Piston Diameter x Stroke		Air Inlet	Maximum Air Pressure	
	Inches	Centimeters		psi	Bars
338066-A1	2-15/16 x 3	7.5 x 7.6	1/4 " NPTF (f)	150	10.3
338066-C1			1/4 " BSP (f)		

Table 1 *Air Motor Model 338066 Series Specifications*

* For icing conditions, an air line lubricator is permissible. The lubricator must deliver an ethylene glycol based (non alcohol) anti-icing agent. Alemite Corporation recommends Kilfrost (tested and approved).

Alemite Corporation
PO Box 473515, Charlotte, North Carolina 28247-3515

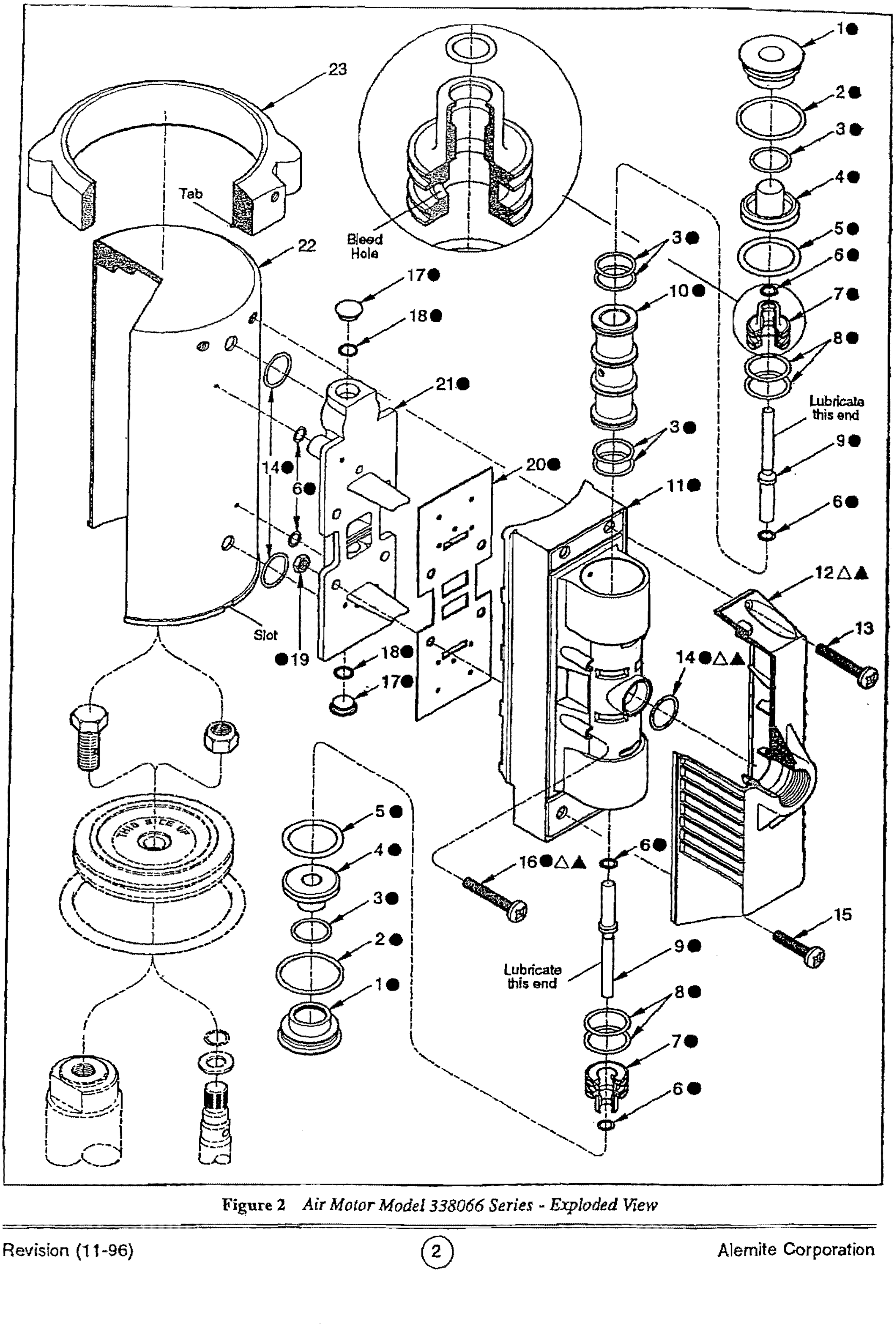


Figure 2 *Air Motor Model 338066 Series - Exploded View*

Item No.	Part No.	Description	Qty	Notes		Numeric Order Part #	(Item #)
1		Plug (Brass)	2	●		*77903*	(19)
2	171009-7	O-Ring, 13/16 " ID x 15/16 " OD	2	●		171000-3	(18)
3		O-Ring, 0.437 " ID x 0.562 " OD (Red Dot)	6	●		171000-7	(14)
4	338051	Piston, Pilot	2	●		171009-1	(8)
5		O-Ring, 0.750 " ID x 0.937 " OD (Red Dot)	2	●		171009-7	(2)
6		O-Ring, 1/8 " ID x 1/4 " OD	6	●		*172353*	(13)
7	338052	Bushing (Brass)	2	●		*172398*	(15)
8	171009-1	O-Ring, 7/16 " ID x 9/16 " OD	4	●		338040	(23)
9	338053	Valve, Pilot (Brass)	2	●		338042	(22)
10	338049	Valve, Directional Spool	1	●		338044	(21)
11	338046	Body	1	●		338046	(11)
12		Cover, w/ 1/4 " NPTF air inlet (Aluminum)	1	△	Model 338066-A1	*338047*	(17)
		Cover, w/ 1/4 " BSPT air inlet (Aluminum)	1	▲	Model 338066-C1	*338048*	(20)
13		Screw, 10-24 x 1-1/4 "	2			338049	(10)
14	171000-7	O-Ring, 3/8 " ID x 1/2 " OD	3	●△▲	Qty of 1 in △▲ Kits	*338050*	(1)
15		Screw, 10-24 x 5/8 "	2			338051	(4)
16		Screw, 8-32 x 1-1/4 "	4	●△▲		338052	(7)
17		Plug (Steel)	2	●		338053	(9)
18	171000-3	O-Ring, 3/16 " ID x 5/16 " OD	2	●		*338384-1*	(6)
19		Nut, 8-32	4	●		*338384-2*	(3)
20		Gasket	1	●		*338384-3*	(5)
21	338044	Manifold	1	●		*338483-1*	(12)
22	338042	Cylinder	1			*338483-2*	(12)
23	338040	Ring, Mounting	1			*338484*	(16)

Legend:
Part numbers left blank (or in italics) are not serviced separately
● △ ▲ designates a repair kit item

Repair Kits

Part No.	Kit Symbol	Description
393567-1	●	Kit, Air Valve (Assembled)
393596	△	Kit, Aluminum Cover (w/ 1/4 " NPTF air inlet) [Retrofit for plastic cover]
393596-A	▲	Kit, Aluminum Cover (w/ 1/4 " BSPT air inlet) [Retrofit for plastic cover]

Replacement Module (Air Valve and Aluminum Cover with 1/4 " NPTF Air Inlet)

Part No.	Description	Notes
393631	Module Assembly, Replacement (Assembled)	Consists of Repair Kits **393567-1** and **393596**

NOTE: Additional repair kits are illustrated on the following page.

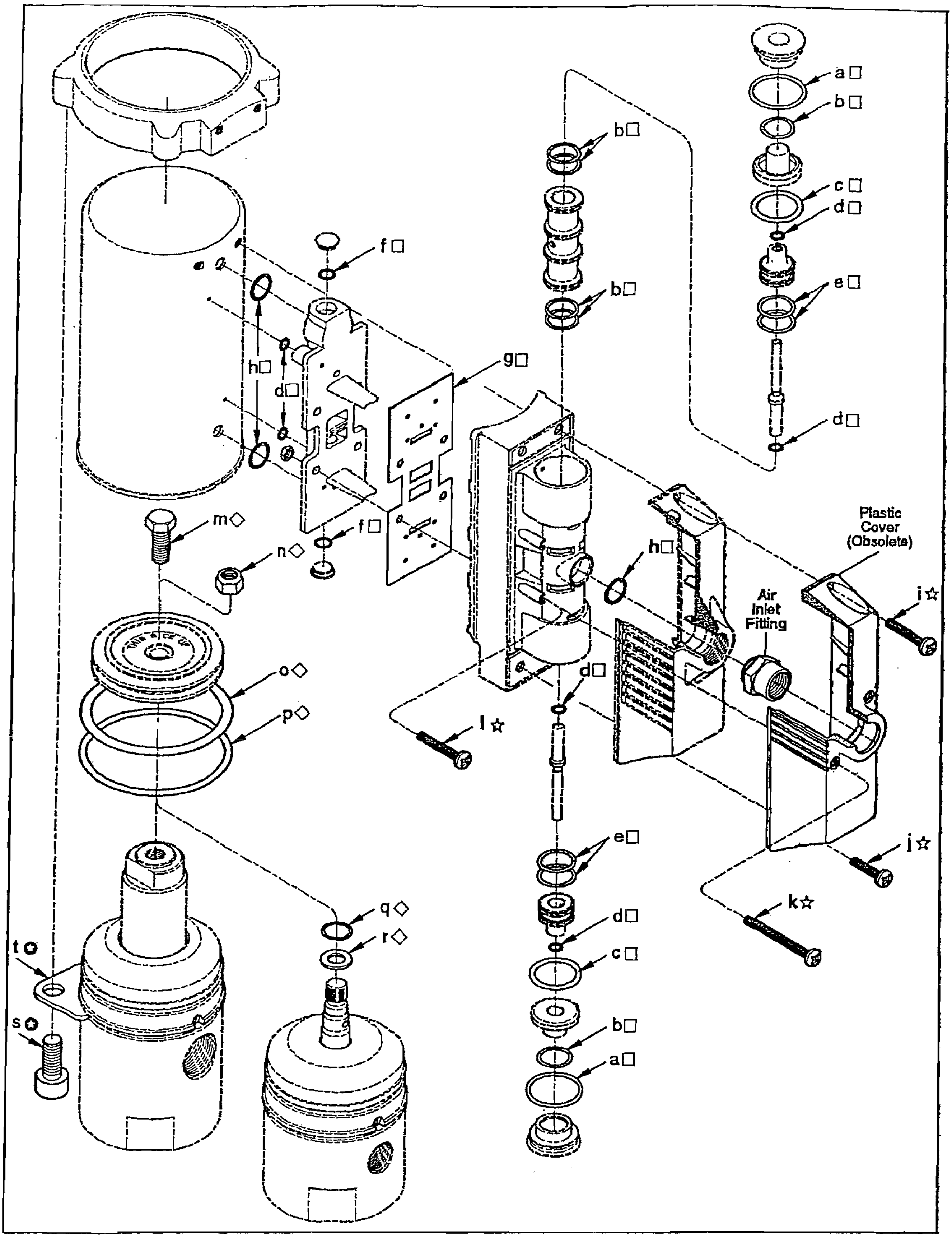


Figure 3 *Additional Kits for Air Motor and Pump Tube Assembly*

Item	Part No.	Description	Qty	Notes		Numeric Order Part # (Item #)	
a	171009-7	O-Ring, 13/16 " ID x 15/16 " OD	2	□		51929	(n)
b		O-Ring, 0.437 " ID x 0.562 " OD (Red Dot)	6	□		*171000-103*	(o)
c		O-Ring, 0.750 " ID x 0.937 " OD (Red Dot)	2	□		*171003-10*	(p)
d		O-Ring, 1/8 " ID x 1/4 " OD	6	□		171000-3	(f)
e	171009-1	O-Ring, 7/16 " ID x 9/16 " OD	4	□		171000-7	(h, q)
f	171000-3	O-Ring, 3/16 " ID x 5/16 " OD	2	□		171009-1	(e)
g		Gasket	1	□		171009-7	(a)
h	171000-7	O-Ring, 3/8 " ID x 1/2 " OD	3	□		*171892*	(s)
i		Screw, 10-24 x 1-1/4 "	2	☆		*172353*	(i)
j		Screw, 10-24 x 5/8 "	2	☆		*172398*	(j)
k		Screw, 8-32 x 1-3/4 "	4	☆	For plastic cover	*172399*	(k)
l		Screw, 8-32 x 1-1/4 "	4	☆	For aluminum cover	*172409*	(m)
Additional Kit Items Applicable to the Pump Tube Assembly						*338041*	(t)
m		Screw, (w/ Nyloc Insert) 3/8 " -24 x 3/4 "	1	◇		*338048*	(g)
n	51929	Nut, Elastic Stop, 3/8 " -24	1	◇		338109	(r)
o		O-Ring, 2-5/8 " ID x 3 " OD	1	◇		*338384-1*	(d)
p		O-Ring, 2-3/4 " ID x 3 " OD	1	◇		*338384-2*	(b)
q	171000-7	O-Ring, 3/8 " ID x 1/2 " OD	1	◇		*338384-3*	(c)
r	338109	Washer, 3/8 "	1	◇		*338484*	(l)
s		Bolt, 5/16 " -18 x 1/2 "	4	✪			
t		Keeper	4	✪			

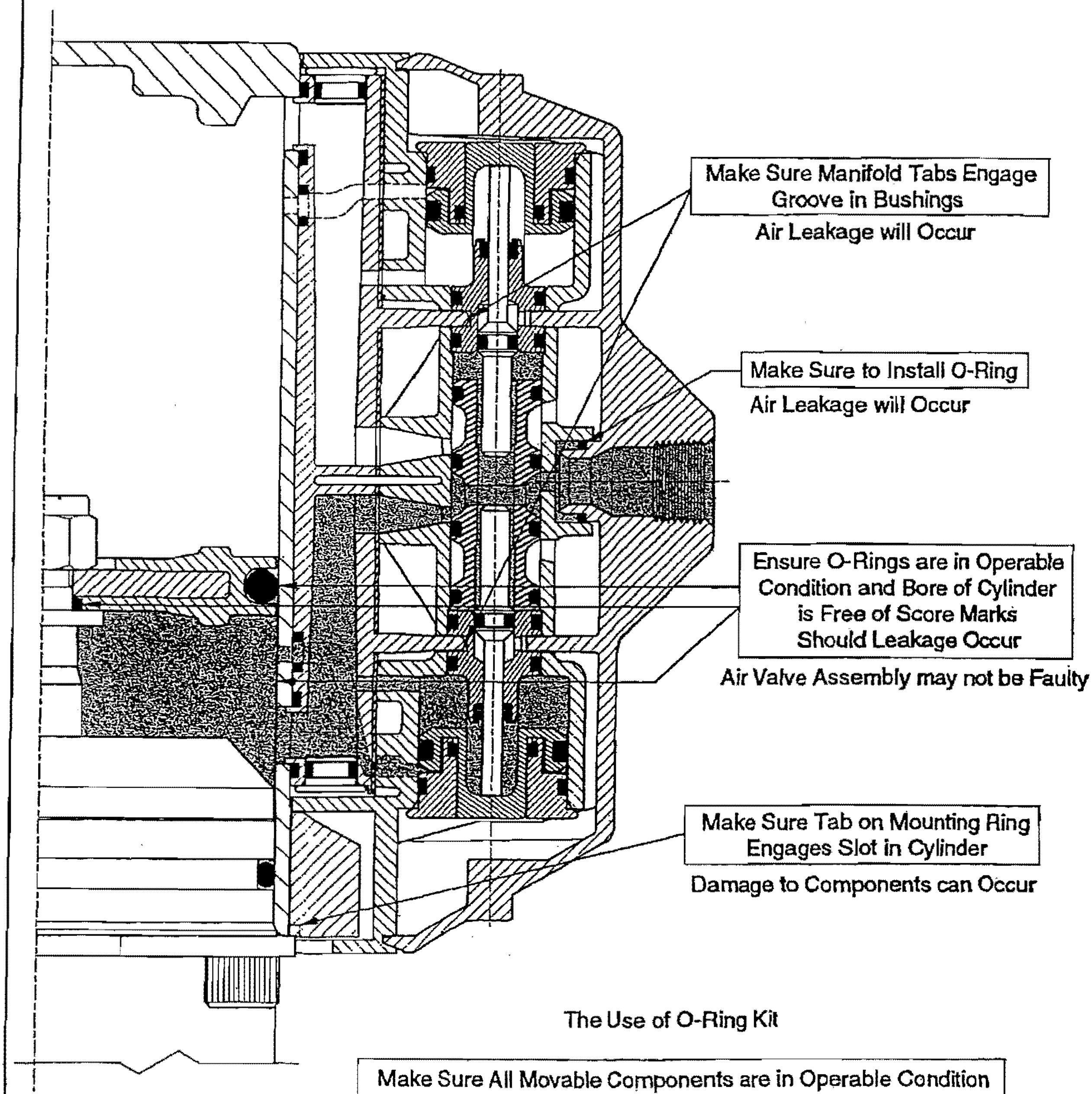
Legend:
Part numbers left blank (or in italics) are not serviced separately
□ ◇ ☆ ✪ designates a repair kit item

Repair Kits

Part No.	Kit Symbol	Description
393568	□	Kit, Air Valve (Rubber Components) [Includes tube of 393590 Teflon lubricant]
393569	◇	Kit, Air Motor Cylinder and Piston Seal (Includes tube of 393590 Teflon lubricant)
393570-1	☆	Kit, Screw Assortment (For both plastic and aluminum covers)
393641	✪	Kit, Keeper

Service Hints

Refer to the Overhaul Procedures for Details



The Use of O-Ring Kit

Make Sure All Movable Components are in Operable Condition and Bore of Body is Free of Score Marks Prior to Kit Installation

O-Rings will Deteriorate Prematurely

Test Air Valve on Pump Known to be in Operable Condition After Kit Installation

Rebuilt Air Valve Assembly may not be Faulty

IMPORTANT: Prior to performing any maintenance procedure, the following safety precautions must be observed. Personal injury may occur.

WARNING

Do not use halogenated hydrocarbon solvents such as methylene chloride or 1,1,1 - trichloroethane in this motor. An explosion can result within an enclosed device capable of containing pressure when aluminum and/or zinc-plated parts come in contact with halogenated hydrocarbon solvents.

Release all pressure within the system prior to performing any overhaul procedure.
- **Disconnect the air supply line from the motor.**
- **Into an appropriate container, operate the pump's control valve to discharge remaining pressure within the system.**

Never point a control valve at any portion of your body or another person. Accidental discharge of pressure and/or material can result in injury.

Read each step of the instructions carefully. Make sure a proper understanding is achieved before proceeding.

Overhaul

NOTE: Refer to **Figure 2** for component identification on all overhaul procedures.

Disassembly

Separate Air Motor from Pump Tube

1. Clamp the pump assembly in a soft-jaw vise at the body.
2. Remove the bolts that secure the body to Mounting Ring (23).
   - Remove the keepers from the body.
3. With a side-to-side motion, pull the air motor assembly from the body.
   - Lubricate the O-Ring with oil to ease separation.

Air Motor

4. Remove Screws (13) and (15) that secure Cover (12) to Cylinder (22).
   - Remove the air valve assembly from the Cylinder.
5. Remove O-Rings (14) and O-Rings (6) from the rear of Manifold (21).
6. Remove Mounting Ring (23) from the Cylinder.

   NOTE: On earlier models, remove Screws (k) that secure the plastic cover to the Body and Manifold. See **Figure 3**.

7. Remove the Cover from Body (11).
8. Remove O-Ring (14) from the Cover.

   NOTE: On earlier models, remove O-Ring (h) from the air inlet fitting. See **Figure 3**.

9. Remove Screws (16) that secure the Body to the Manifold.
   - Remove Nuts (19) from the rear of the Manifold.
10. Separate the Body from the Manifold.
11. Remove Gasket (20) from the Manifold.
12. Remove Plugs (17) from each end of the Manifold.
    - Remove O-Ring (18) from each Plug.

CAUTION

Should Pilot Piston (4) remain within the Body, use care during removal. Damage can occur.

13. Remove Plugs (1) [w/ Pilot Piston (4)] from each end of the Body.
    - Separate the Pilot Piston from each Plug.
14. Remove O-Rings (2) and (3) from both Plugs.
15. Remove O-Ring (5) from each Pilot Piston.
16. Remove Pilot Valve (9) [w/ Bushing (7)] from each end of the Body.
    - Separate the Bushing from each Pilot Valve.
17. Remove O-Ring (6) from both Pilot Valves.
18. Remove O-Rings (6) and (8) from each Bushing.

CAUTION

Remove Spool Valve (10) from the Body with care. Damage to either component can occur.

19. Remove Spool Valve (10) from the Body.
20. Remove O-Rings (3) from the Spool Valve.

Clean and Inspect

NOTE: Use the appropriate repair kit for replacement parts. Make sure all the components are included in the kit before discarding used parts.

1. Clean all metal parts in a cleaning solvent. The solvent should be environmentally safe.
2. Inspect all parts for wear and/or damage.
   - Replace as necessary.
3. Inspect the bores of Body **(11)** and Cylinder **(22)** closely for score marks.
   - Replace as necessary.

Assembly

NOTE: Prior to assembly, certain components require lubrication with Magnalube-G Teflon grease. Refer to **Table 2** for details.

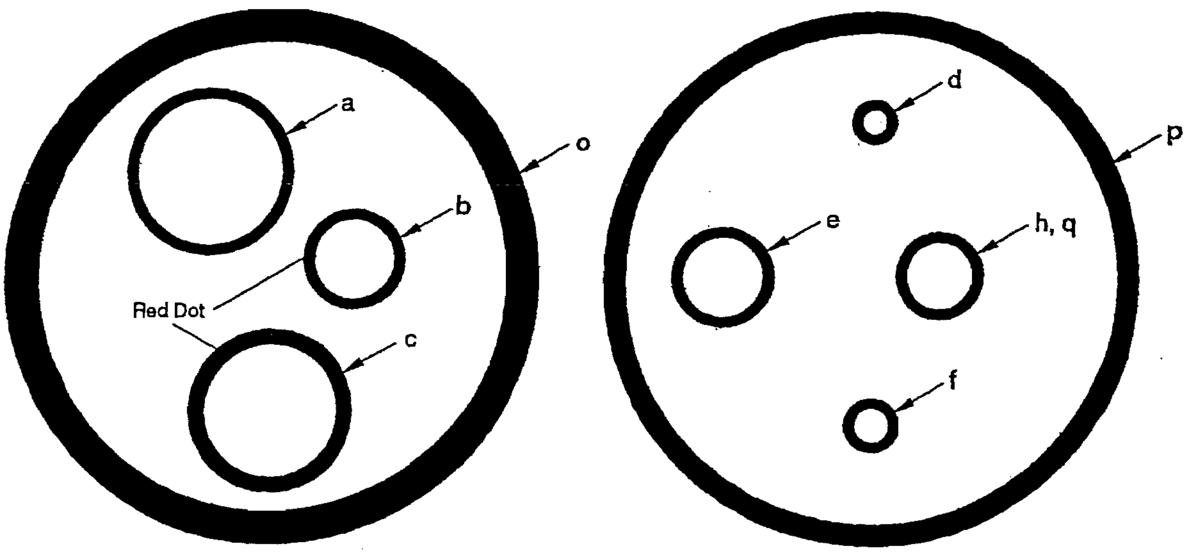
IMPORTANT: Always use Magnalube-G Teflon grease in this air motor.

Air Motor

NOTE: Refer to **Figure 2** and **Figure 5** for component identification on all assembly procedures.

Item No. on Figure 2	Description	Notes	Item No. on Figure 2	Description
9	Pilot Valve - O-Ring Groove and Long Stem.	See Figure 2	11	Body - All Bores
10	Spool Valve - O-Ring Grooves and Bore		22	Cylinder - Bore
All O-Rings illustrated in Figure 4				
NOTE: Part number 393590 is a 0.75 ounce (21.8 gm) tube of Magnalube-G Teflon grease				

Table 2 *Components Lubricated with Magnalube-G Teflon Grease*



O-Rings b, c, and d are manufactured of an internally-lubricated compound.

Item on Figure 3	Description	Item on Figure 3	Description
a	O-Ring, 13/16 " ID x 15/16 " OD	e	O-Ring, 7/16 " ID x 9/16 " OD
b	O-Ring, 0.437 " ID x 0.562 " OD (Red Dot)	h, q	O-Ring, 3/8 " ID x 1/2 " OD
c	O-Ring, 0.750 " ID x 0.937 " OD (Red Dot)	f	O-Ring, 3/16 " ID x 5/16 " OD
d	O-Ring, 1/8 " ID x 1/4 " OD	o	O-Ring, 2-3/4 " ID x 3 " OD
		p	O-Ring, 3/8 " ID x 1/2 " OD

Figure 4 *O-Ring Chart (Actual Size)*

To ease the assembly process, identify all the O-Rings. Position each O-Ring on the chart. See **Figure 4.**

1. Install O-Rings (3) onto Spool Valve (10).
2. Install O-Ring (6) into each Bushing (7).
3. Install O-Rings (8) onto the outside diameter of each of the Bushings.
4. Install O-Ring (6) onto both Pilot Valves (9).
5. Install and seat the Pilot Valve (small diameter first) into the larger diameter of the Bushing.
   - Repeat the process for the additional Pilot Valve and Bushing.
6. Install one of the Pilot Valve and Bushing assemblies (large diameter first) into the Body.
   - Make sure the Bushing seats properly in the bore.
7. Position the Spool Valve partially into the bore of Body (11).
   - Use care not to unseat the Bushing.
8. Install and seat the additional Pilot Valve and Bushing assembly (large diameter first) into the opposite end of the Body.

   IMPORTANT: Push the Bushing assembly fully into the Body. This positions the Spool Valve properly. The valve assembly will fail to operate unless the Spool Valve is properly installed.

9. Install O-Ring (5) onto each Pilot Piston (4).
10. Install O-Ring (3) into each Plug (1).
11. Install O-Ring (2) onto the outside diameter of each of the Plugs.
12. Install and seat the Pilot Piston (stem first) into the bottom of the Plug.
    - Repeat the process for the additional Plug.
13. Install and seat each Plug assembly into the Body.
14. Install O-Ring (18) onto each Plug (17).
15. Install and seat the Plugs into each end of the Manifold.
16. Install Gasket (20) onto the flat side of Manifold (21).
17. Install and seat the Manifold (tabs first) into the back of the Body.

    IMPORTANT: The tabs on the Manifold must engage the groove in each Bushing (7). When each Bushing is seated properly in the Body, the Manifold will seat properly.

18. Install Nuts (19) into the rear of the Manifold.
19. Install Screws (16) through the Body.
    - Tighten the Screws evenly and securely in a crisscross pattern. Do not overtighten.

    NOTE: On earlier models (See **Figure 3**):
    - Install O-Ring (h) onto the Air Inlet Fitting.
    - Position the Inlet Fitting (threads first) into the Plastic Cover.
    - Position the Cover onto the Body.
    - Install the nuts into the rear of the Manifold.
    - Install Screws (k) through the Cover and Body.
    - Tighten the Screws in a crisscross pattern. Do not overtighten.
20. Install O-Ring (14) onto the bushing on the inside of Cover (12).
21. Install the Cover onto the Body.

    IMPORTANT: Make sure the tab on Mounting Ring (23) engages with the slot in Cylinder (22). Damage to components can occur.

22. Install Mounting Ring (23) onto Cylinder (22).
23. Install O-Rings (6) into the smaller ports on the Manifold.
24. Install O-Rings (14) into the larger ports on the Manifold.

    IMPORTANT: Make sure the O-Rings remain in position. Spot the O-Rings with Teflon grease as necessary.

25. Align the valve assembly with the holes in the Cylinder and Mounting Ring.
26. Install Screws (13) into the top of the Cover and into the Cylinder.
27. Install Screws (15) into the bottom of the Cover and into the Mounting Ring.
28. Tighten all the screws evenly and securely in a crisscross pattern. Do not overtighten.

For details on pump tube components, refer to the Pump **SER Service Guide** for details.

Attach Air Motor to Pump Tube

29. Clamp the body securely in a soft-jaw vise.
30. Install the air motor assembly squarely onto the body.
    - Use care passing the O-Ring.
    - Make sure the material outlet on the body orients properly with the inlet of the air motor.

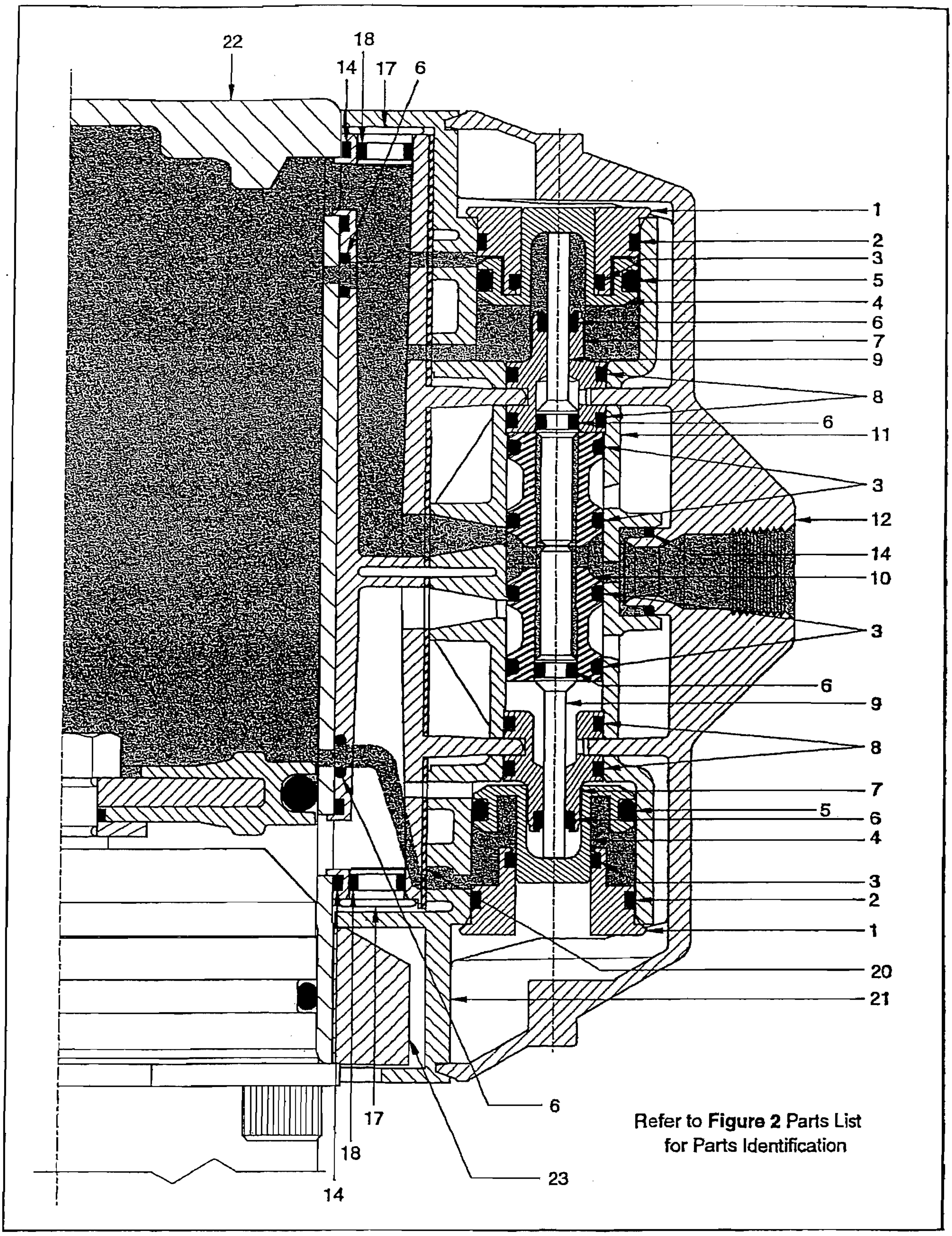


Figure 5 *Air Motor Model 338066 Series- Section View*

31. Install the keepers into the groove of the body.

32. Install the bolts that secure the body to the air motor assembly.
    - Tighten the bolts evenly and securely in a crisscross pattern.

Bench Test and Operation

1. Slowly supply air pressure [not to exceed 50 psi (3.4 Bar)] to the pump's motor.
    - The pump assembly should cycle.

If the pump assembly does not cycle, refer to the Pump **SER Service Guide** for details.

With air pressure at zero:

2. Connect a product hose to the pump's material outlet.
    - Direct the hose into an appropriate collection container.

3. Place the pump in the product to be dispensed.

4. Slowly supply air pressure to the pump's motor.

5. Allow the pump to cycle slowly until the product is free of air.

If the pump assembly does not prime, refer to the Pump **SER Service Guide** for details.

WARNING

Should leakage occur anywhere within the system, disconnect air to the motor. Personal injury can occur.

With air pressure at zero:

6. Attach a control valve to the outlet hose of the pump.
    - Make sure the nozzle on the control valve is open.

7. Slowly supply air pressure to the pump's motor.

8. Allow the pump to cycle slowly until the product is once again free of air.

9. Set the air pressure to 60 psi (4.1 Bar).

10. Operate the control valve into a container.

11. Shut off the control valve.
    - Visually inspect the pump for external leaks.
    - The pump should not cycle more than once or twice in one hour.

If the pump cycles more than once or twice an hour, refer to the Pump **SER Service Guide** for details.

12. Check the motor for air leakage.

If the motor leaks, refer to the **Troubleshooting Chart** for details.

Installation

Additional items that should be incorporated into the air piping system are listed **in Table 3.**

Part Number	Description
338860	Regulator, Gauge, Separator Combination (w/ Auto Dump)
7604-B	Regulator and Gauge (Included with 338860)
5604-2	Moisture Separator (Included with 338860)

Table 3· *Air Line Components*

Troubleshooting Chart

Indications	Possible Problems	Solution
Air Motor does not cycle	1. Insufficient air pressure 2. Jammed air valve assembly 3. Pump tube jammed and/or contains loose components	1. Increase air pressure 2. Rebuild or replace air valve assembly 3. Rebuild pump tube
Air motor does not cycle and air blowing at exhaust	Spool Valve **(10)** hung-up on center position *	Reposition Spool Valve **(10)** Disassemble air motor, clean, inspect, and replace worn or damaged components and lubricate with Magnalube-G Teflon grease.
Air motor cycles and air blowing at exhaust	Missing O-Ring(s)	Disassemble air motor, clean, inspect, and install O-Ring(s). Lubricate with Magnalube-G Teflon grease.
Air motor cycles and slight air leakage at exhaust	1. Worn or damaged O-Ring(s) 2. Initial tightening of Screws **(13)** and/or Screws **(15)** not sufficient	1. Disassemble air motor, clean, inspect, and replace worn or damaged O-Ring(s) Lubricate with Magnalube-G Teflon grease. 2. Tighten Screws **(13)** and/or **(15)**

* Spool Valve **(10)** can hang on the center positiion due to icing, lack of lubrication, and/or contaminants. Use an anti-icing agent as required.

Changes Since Last Printing

New Format

S I M P L A N

INSTALLATION OF THE SEAL

A) **When the seals are unpacked from the packaging, disassemble the rotating boot assembly from the seal stationary flange #7.**

B) **Remove stationary ring #24 from stationary flange #7. This is achieved by first finding the anti-rotation pins #22. Place a feeler gauge or thin knife blade under the ring and locate the position of the pins. To remove the ring, place your hands over the pin locations and pull the ring out. Care must be taken to pull the ring evenly. *Lifting one side more than the other could cause the ring to break.* Silicon Carbide is a very hard material but it should be handled with care, as the material is very brittle. Check the two o-rings #21/#23 for damage.**

> **WARNING!: It is extremely important that the very sensitive sealing faces on rings #9 and #24 are not damaged in any way, however slight, and that they do not come into contact with oil or grease at any time.**

C) **The stationary flanges #7/#4 should be mounted on the sterntube flange and secured.**

D) **The propeller shaft should now be installed in the vessel.**

E) **When the propeller shaft has been pulled up to position to re-install the muff coupling, coat the shaft with "green soap", in order to grease it. Fit the boot assembly on the shaft. At this time you have to adjust the 4 nylon pins #13 in the boot #14. This is achieved by hand filing the pins by equal amounts. The arrangement of the pins is to stop any movement of the boot when the shaft is operated. Set a small clearance between the pins and shaft (approx. 1/16"). Take care to remove all filings from the insides of the boot #14.**

F) **After completing the adjustment of the pins #13, remove the boot from the shaft.**
- **a) Fit the o-rings #21/#23 in the stationary housing ring #7.**
- **b) Place the stationary ring #24 on the shaft. Wrap the ring with rags etc. to avoid any damage to the ring.**
- **c) Place the boot #14 back on the shaft. Leave the sealing ring #9 in the boot assembly. Wrap again with rags to avoid damage.**

G) **Jump the muff coupling back on the prop shaft and pull the shaft up to the gearbox coupling. Place a couple of bolts in the coupling.**

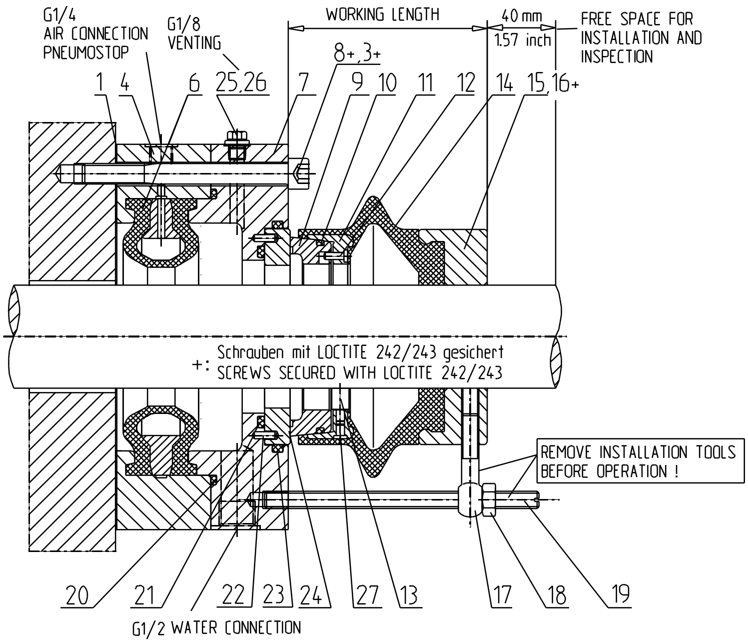
H) **Assemble stationary ring #24 in the flange assembly.**
1. **Mark the location of pins #22 on flange #7.**
2. **Mark the location of the holes in the ring (with chalk).**
3. **Coat the o-rings #21/#23 with the white paste (Klüber 46 MR 401) supplied with the seal unit.**

4. **Line up the marks.**
5. **Press stationary ring #24 into the locating pins #22, place your hands over the pin locations when pressing in.**

I) Push the boot assembly along the shaft to meet the stationary flange #7. Install the tension gear (4 rods #19 & 4 eyebolts #17). Locate loosely the split brass clamp (locking) ring #15 over boot #14. Tighten nuts #18 on the tension bars #19 taking care to move the nuts approximately the same distance by crosswise tightening.

<u>Note</u>: On the drawings the distance given between the flange face and back of the split ring is the compressed seal length. I.e. model 120 shows 116 mm or 4.56". As a word of caution, a little "less" tension is better than a little more. When the compression of the seal is achieved, tighten cap screws #16 on split clamp (locking) ring #15. Remove the tension gear from the seal.

Seal Size	Working Length	
	mm	inch
60	96	3,78
70	96	3,78
80	96	3,78
90	116	4,57
105	116	4,57
120	116	4.57
135	116	4.57
150	116	4.57
165	116	4.57
180	116	4.57
195	128	5,04
210	128	5,04
225	128	5,04



J) Remove the plastic cap from the water connection at the bottom of the flange (½" pipe thread).
a) Connect the water supply pipe if necessary.
b) If cooling is coming from a scoop on the sterntube, place a plug in the flange.

K) a) Connect a quick-release air connection on the pneumostop outlet (1/8" pipe thread). This is the most aft connection.
b) Connect an open vent pipe without a vent valve to a suitable height above the water level, or, if not possible, a vent valve on the flange (1/4" pipe thread).

L) When the vessel goes back into the water open the vent valve, if installed, on top of the seal to completely fill the seal with water, removing all air.

M) At full revolutions the seal temperature will be approx. 15 to 20 degrees F (8 to 12 °C) above sea temperature.

0 CONTENTS

ThyssenKrupp

B+V Industrietechnik GmbH
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1 General about SIMPLAN – Seal

Type: **SIMPLAN – (SiC-P)**, with standstill seal (Pneumostop).

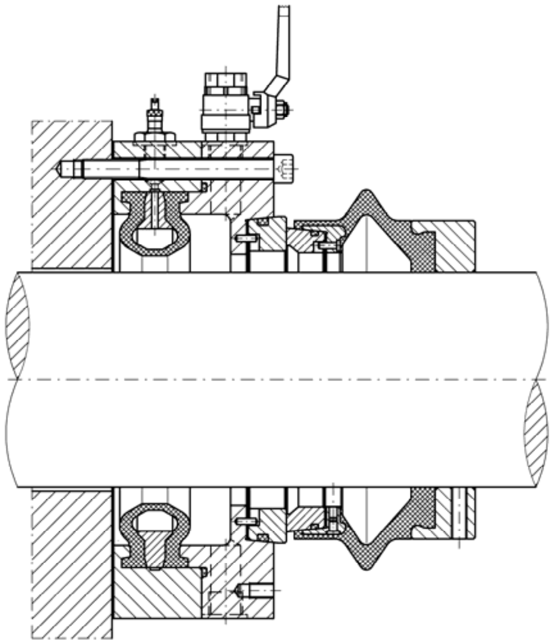

Fig. 1: Cross sectional view SIMPLAN Standard

1.1 General description about sterntube seals

The SIMPLAN seal is a mechanical face seal for water lubricated sterntubes. It is equipped with a standstill seal. Type SiC-P is fitted with silicon carbide sealing rings.
These sealing rings are wear-resistant.

The standstill seal included in the seal unit consists of housing rings (4 and 7) and an inflatable tube ring (6) which is clamped between rings (4, 7) and insert ring (5).

Counter ring (24) is fixed in the housing ring (7) by o-ring (23). Relative motion of sealing ring (24) to housing ring (7) is stopped by two dowel pins (22). The stationary sealing ring (24) forms, together with the rotating ring (9), the axial seal. Both sealing rings (9 and 24) are made of silicon carbide.

The rotating sealing ring (9) is pressed into a metal insert ring (11) vulcanised to a rubber seal body called boot or bellows (14). Tightness between sealing ring (9) and insert ring (11) is guaranteed by an o-ring (10).

The boot/bellows (14) is held fixed on the shaft by means of clamp ring (15). This ring (15) ensures that the necessary contact pressure is provided between counter ring (24) and sealing ring (9). Pins (12, 13) fitted radially and axially in insert ring (11) ensure reliable torque transmission to sealing ring (9) and optimal centricity of the rubber seal body (14) to the shaft.

The seal is supplied ready to install.

The water connection necessary for flushing the seal is located at the bottom side of the housing ring (7). The venting line is connected to the top.

Prior to operating the seal unit its housing must be vented.

Further data on the individual components and materials from which the SIMPLAN seal is made is given in the enclosed parts list. *

* See Part 3, drawing „ Aft SIMPLAN seal with parts list “.

1.2 Application and specified usage

Our seals are intended only for the stipulated application (e.g. for sealing rotating ship's shafting against water).
Any other or additional usage shall be considered not as specified.

The specified use includes also following the operating instructions and adhering to the inspection and maintenance conditions.

Usage not in accordance with specifications shall lead to the loss of all warranty rights.

1.3 Explanation of symbols and notes

This symbol will be found next to **danger notes** which indicate direct or indirect hazards to life and limb.

Grave or critical injuries may result if these notes are not followed. The seal and/or surrounding items may also be damaged or destroyed.

This symbol will be found next to **safety notes** containing instructions or rules.

Faults and malfunctions of the seal may result if these notes are not followed. Damage to the seal and/or surrounding items may also occur.

This symbol will be found next to a **note** that contains special information on key functions, or special tips for use that help you to make optimum use of the seal.

Rights under the warranty will be lost if the danger and safety notes are not followed.

- The numbers in parentheses () are the reference numbers on the corresponding drawings.
- Data in square brackets $\boxed{}$ are nominal dimensions for a specific project; the actual values may vary from these.

1.4 Copyright

These operating instructions are intended for the fitters, the operator, and the operating personnel.

The manufacturer, **B+V Industrietechnik**, retains the copyright in these operating instructions.

These operating instructions may only be reproduced in the context of their incorporation into wider documentation, just as the seal is incorporated into a wider installation to be documented.

Any use beyond this, whether it be partial or complete duplication, or reproduction, requires the written consent of the manufacturer.

2 SHIP DESIGN CRITERIA IN REGARD TO THE SIMPLAN SEAL

During the vessel design stage, the following data must be taken into account:

- Maximum allowed water pressure. *
- The rpm limits of the seal.
- Axial and radial movement of the shaft. *
- Maximum air pressure for the emergency standstill seal. *
- Type of air supply, venting of air supply line.

and:

- The front face of the sterntube must be rectangular to the shaft.
- The flange connection (PCD) at the sterntube must be checked *
- Seal must be ordered for the final shaft diameter.

Also important:

- Minimum quantity of flushing water required.
- Venting line from seal to be well above water level.
- The flushing water arrangement (forced lubricatied system) *:
    - Main flow into the sterntube.
    - Auxiliary flow into the seal.
    - Pipe always below water line.
    - Bottom connection on seal to be used.
    - We recommend to install a flushing water pump.
    - We recommend to install a water cooler with thermostatic valve.
    - We recommend to install a flow indicator.

* See Part 3, drawing SGC:3-201-0015-000. „Cooling Water Diagram“.

✱	The engine room must be heated in order to avoid freezing of the flushing water within the SIMPLAN seal during the winter time.

✱	Any additives to the sterntube flushing water must be approved by B+V Industrietechnik for compatibility with materials of the seal.

3 FITTING THE SIMPLAN SEAL

3.1 Before installation of the seals

The SIMPLAN seal will be supplied machined to the final shaft diameter and ready to fit.

The seal may only be removed from the box in which it was supplied immediately prior to fitting.

- The entire sterntube system must be checked to ensure absolute cleanness.
- Prior to fitting the seal, the true running and rectangularity of the sterntube front face in respect to the shaft must be checked when shaft is coupled. *
- The various surfaces and the shaft surface within the seal area must be cleaned and inspected for damage.
- Check recess and PCD at sterntube and SIMPLAN housing for correct dimensions.
- Remove the seal from the box, remove fitting device (17, 18, 19).
- Check the seal for transport damage and cleanliness.

The finely machined sealing surfaces of the sealing ring (9) and counter ring (24) are extremely sensitive and must under no circumstances be damaged.

3.2 Fitting the seal from inboard, with the propeller shaft being fitted from aft/outboard

The shaft is already inserted into the sterntube from the aft/outboard into a position such that the aft and forward SIMPLAN seal can be fitted.

- Remove the rotating boot / bellow assembly (14) (with clamp ring 15) from the stationary flange ring (7).
- Fit gasket (1) on the shaft.
- Fit pre-assembled, stationary part of the seal (4, 5, 6, 7) (with counter ring (24) installed) on the shaft and slide it to the sterntube together with the gasket (1).

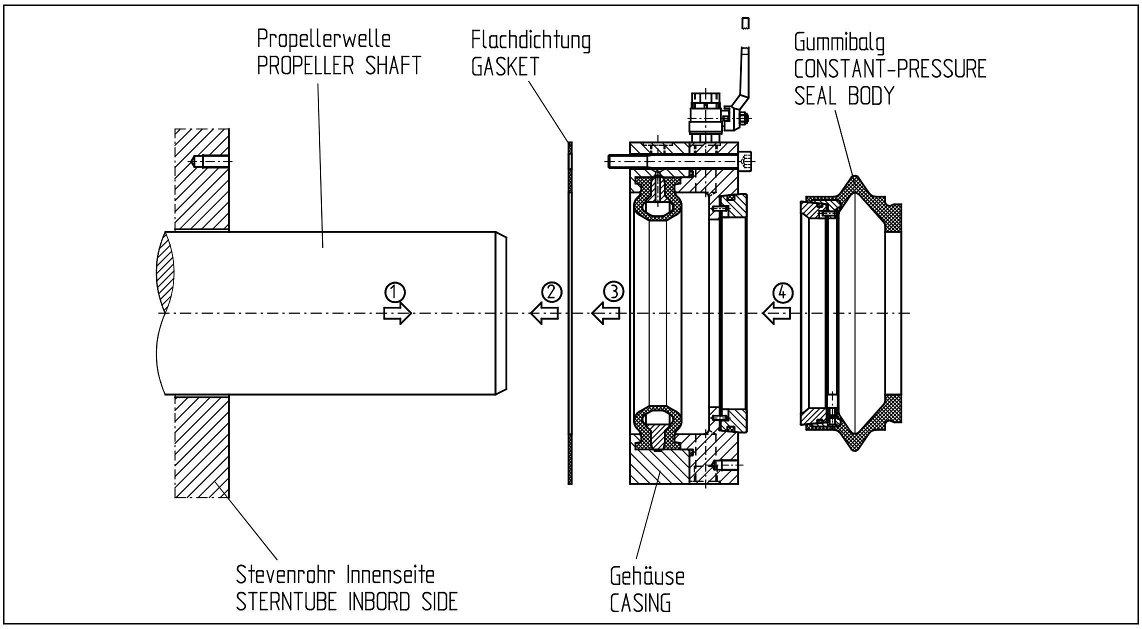

Fig. 2: Fitting the Simplan Shaft fitted from aft/outboard

It must be ensured that the sealing faces of the counter rings (24) and sealing rings (9) are not damaged.

- Fasten the pre-assembled part of the seal (4, 5, 6, 7 and 24) together with the gasket (1) to the sterntube with bolts (8), secured with Loctite.
- If not installed, fit the, for the special shaft diameter ready machined, centering pins (13) into the inner area of the boot (14).
- Check the distance between two opposite centering pins (13).
  It must be bigger than the shaft outer diameter: 0,5 to 0,8 mm (0.002 and 0.032 inch) for Size 180 and below; or 0,8 to 1,2 mm (0.032 and 0.047 inch) for Size 195 and above.
- Coat the rubber seal body (boot/bellows) (14) neck collar on its shaft contact surface with "Klüberpaste 46 MR 401".

Ensure, that the white “Klüber” paste contacts neither the silicon carbide sealing ring faces nor the area between clamp ring and shaft. These contact surfaces must be clean and dry.

- Fit the boot (14) with inserted sealing ring (9) and centering pins (13), but without clamp ring (15) on the shaft and slide it against the counter ring (24).

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	Do not fix boot / bellow assembly (14) to the shaft by clamp ring (15) until the shaft is coupled.

- Bring the shaft into its final position.

☞	Slide the boot/bellows (14) with the inserted sealing ring (9) and centering pins (13) in direction of the counter ring (24) while moving the shaft.

- Couple up the shaft.

	Do not allow temperatures above $\boxed{95°C}$ (200 °F) for more than one hour to heat the boot/bellows (14) via the shaft and clamp ring (15), while fitting or removing the coupling muff. If required, cool the shaft in the area of the boot/bellows (14). Too much heat will destroy or harden the boot/bellows (14).

- Check shaft displacement ‘W’ relative to the seal housing. *
- Slide the boot (14) with inserted sealing ring (9) carefully against the counter ring (24).

* See Part 3, drawing SGC:3-201-0012-000. „Installation dimensions with tolerances “.

For further instructions go ahead with chapter **“Fitting the aft seal”.**”

3.3 Fitting the seal with the propeller shaft being fitted from inboard the vessel

The shaft is in a temporary position in front of the sterntube, so that the inner seal can be moved over the shaft.

- Remove the boot/bellows (with clamp ring 15) from the stationary flange (7).
- If not installed, fit the, for the special shaft diameter ready machined, centering pins (13) into the inner area of the boot (14).
- Check the distance between two opposite centering pins (13). It must be bigger than the shaft outer diameter: $\boxed{0,5 \text{ to } 0,8 \text{ mm}}$ (0.002 and 0.032 inch) for Size 180 and below; or $\boxed{0,8 \text{ to } 1,2 \text{ mm}}$ (0.032 and 0.047 inch) for Size 195 and above.
- Coat the boot/bellows (14) neck collar on its shaft contact surface with "Klüberpaste 46 MR 401".

Ensure that the white "Klüber" paste contacts neither the silicon carbide sealing ring faces nor the area between clamp ring and shaft. These contact surfaces must be clean and dry.

- Fit the boot/bellows (14) with inserted sealing ring (9) and centering pins (13) on the shaft and slide it towards the coupling flange.

Do not fix boot / bellow assembly (14) to the shaft by clamp ring (15) until the shaft is coupled.

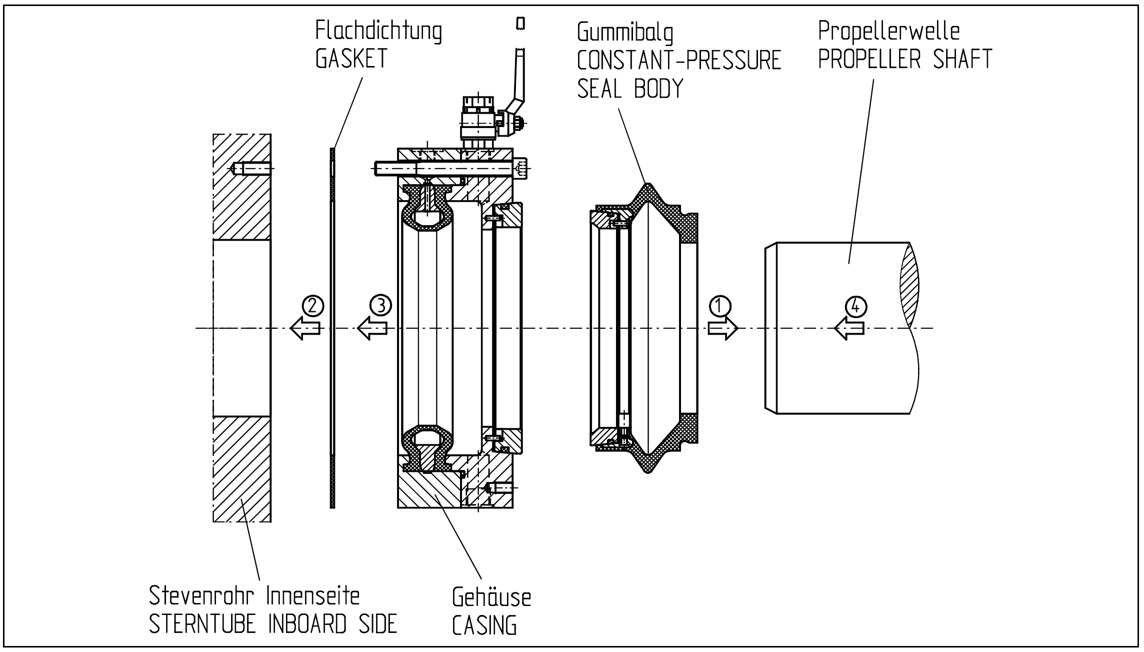

Fig. 3: Fitting the Simplan Shaft fitted from inboard

It must be ensured that the sealing faces of the and sealing rings (9) are not damaged.

- Fit pre-assembled, stationary part of the seal (4, 5, 6, 7), with counter rings (24) installed and with the gasket (1), at the sterntube by bolts (8), secured with Loctite
- Draw in the shaft into the sterntube.
- Bring the shaft into its final position.

☞ Slide the boot/bellows (14) with the inserted sealing ring (9) and centering pins (13) in direction of the coupling flange while moving the shaft.

- Couple up the shaft.

Do not allow temperatures above 95°C (200 °F) for more than one hour to heat the boot/bellows (14) via the shaft and clamp ring (15), while fitting or removing the coupling muff.

If required, cool the shaft in the area of the boot/bellows (14).
Too much heat will destroy or harden the boot/bellows (14).

- Check shaft displacement 'W' relative to the seal housing. *
- Slide the boot (14) with inserted sealing ring (9) carefully against the counter ring (24).

* See Part 3, drawing SGC:3-201-0012-000. „Installation dimensions with tolerances ".

For further instructions go ahead with chapter **"Fitting the aft seal"**.

3.4 Final Assembly and aligning the seal

Keep in mind that the shaft must be in its final position and coupled when fastening and aligning the seal.

3.4.1 Final Assembly

- Coat the contact face of boot/bellows (14) in way of the clamp ring halves (15) with "Klüberpaste 46 MR 401".
- Place the clamp ring halves (15) around the boot/bellows (14) and the shaft, insert screws (16) and only tighten to the extent that clamp ring (15) can still be moved by means of the tensioning device (18,19) for pre-tensioning the boot/bellows (14) on the shaft.
- Attach the device (17, 18, 19). Therefor proceed as follows:
    - Screw the eye bolts (17) into the clamp ring (15) and turn it back until the eyes are in direction of the shaft.
    - Screw the threaded bolts (19) through the eye bolts (17) into the housing ring (7).
    - Screw the nuts (18) onto the threaded bolts (19) against the eye bolts (17) by hand.
- For the initial position, turn nuts (18) manually against the eyebolts (17) **until the faces of the counter ring (24) and sealing ring (9) make contact.**

In the initial position, the distance deviation between the rear edge of clamp ring (15) and front edge of housing (7) ring should not be more than ± 0,3 mm in the area of eyebolts (17).

- Tighten each nut (18) clockwise halve turn **until the preload specified in the drawing is reached**.

* See Part 3, drawing SGC:3-201-0012-000. „Installation dimensions with tolerances “.

1.1.1 Alignment check

- Check the alignment of the clamp ring. The distance deviation between the rear edge of the clamp ring (15) and front edge of the housing ring (7) should not be more than ± 0,2 mm in the area of the eye bolts, otherwise realign it (as described in section below).
- Check the gap between sealing ring with 0,05 mm feeler gauge, minimum at top and bottom. Then turn the shaft 180° and check again. If the feeler gauge can be inserted into the gap, realign the clamp ring (15) (as described in chapter “Realigning the seal (ship is in the water), and cleaning the surfaces”).

3.4.2 Fastening the Clamp ring

- Tighten the clamp ring (15) with the screws (16), using Loctite.

The final distance deviation between the rear edge of clamp ring (15) and front edge of housing ring (7) should not be more than ± 0,2 mm in the area of eyebolts (17). *

- Remove tensioning screws and eyebolts (17, 18, 19) and store on board.

* See Part 3, drawing SGC:3-201-0012-000. „Installation dimensions with tolerances “.

1.2 Pipework for the seal

A flushing-water system for the seal must be provided (i.e. circulating water pump, scoop or a connection to the engine cooling water system)

The pipe lines should always be below the water level to ensure that no air can enter the system.

We recommend a flushing system with a main flow to the sterntube for cooling the sterntube and an auxiliary flow using smaller diameter pipe for cooling the seal.

After installation of the SIMPLAN seal, the pipe work is carried out (use cleaned pipes only)

- Install piping for flushing the sterntube.
- Install piping for flushing the seal.
- Install piping for the standstill seal (Pneumostop) and connect this to the air supply. Remove the valve insert of valve (32), install vent valve in supply line.
- Install piping for venting the seal.

* See Part 3, drawing SGC:3-201-0012-000. „Installation dimensions with tolerances “.

1.3 Final check of the seal (ship is out of the water)

Ensure that the white “Klüber” paste will contact neither the silicon carbide sealing ring surfaces nor the area between clamp ring and shaft. These contact surfaces must be clean and dry.

- Check the Pneumostop (at standstill) for tightness (ship is out of the water) by inflating to 2,5 bar air pressure. Then vent the Pneumostop completely.
- Be prepared to inflate the Pneumostop if leakage occurs during floating of the vessel.
- Be prepared to shut off the water connection to the seal.
- Float the vessel.

While floating the vessel, check the seals visually for tightness.
If there is leakage, inflate the Pneumostop to 2,5 bar above water pressure, and shut off the water connection to the seal.

4 MEASURES PRIOR TO THE OPERATION OF THE SEAL

1.4 Final installation check of the seal (ship is in the water)

- Check the underside of the seal for moisture (dampness is acceptable). Water drops are unacceptable. If there is water the seal surfaces must be cleaned or the clamp ring realigned (see chapter "Realigning the seal (ship is in the water) and cleaning the surfaces).
- Open the vent line.
- Open the valves in flushing-water line.

1.4.1 Checking the Pneumostop for correct functioning

- Inflate the Pneumostop (6) to 2,5 bar above water pressure.

⚠ **<u>Do not turn the shaft</u> when the Pneumostop is inflated.**
If the Pneumostop is not vented, it will be destroyed when the shaft starts turning.
If the Pneumostop is damaged, the drain must be closed and the ship dry-docked for repair!

- Close the valves in the flushing water line.
- Keep vent line open.
- Disconnect or drain the flushing water line to drain the seal.
- Check the seal for leakage at the flushing water line connection or drain.

☞ If water runs out of the drain continuously, the Pneumostop is not inflated, or is damaged, or unable to seal as dirt is between the Pneumostop and the shaft surface.

- Connect flushing water line / close drain valve.
- Vent the Pneumostop (6) by opening or removing valve (32) insert and release the air pressure completely.
- Open the valves in the flushing water line.

1.4.2 Alignment check

- Check the alignment of the clamp ring. The distance deviation between the rear edge of the clamp ring (15) and front edge of the housing ring (7) should not be more than ± 0,2 mm in the area of the eye bolts, otherwise realign it (as described in section below).

- Check the gap between sealing ring with 0,05 mm feeler gauge, minimum at top and bottom. Then turn the shaft 180° and check again. If the feeler gauge can be inserted into the gap, realign the clamp ring (15) (as described in section below).

1.4.3 Realigning the seal (ship is in the water), and cleaning the surfaces

Always secure the clamp ring (15) by fitting the tensioning device (threaded bolt, eye bolt and hexagon nuts 17, 18, 19).

- Inflate the Pneumostop (6) as described in chapter “Checking the Pneumostop for correct functioning”.
- Loosen the clamp ring (15) and relieve the tension on the boot/bellows. If the seal surfaces stick together, pull the boot/bellows back, away from the seal housing.

To avoid damage, never use metal tools such as screwdrivers to separate the silicon carbide rings.

- Clean the carbide ring surfaces carefully (only if necessary)
- Realign clamp ring (15) and fix it as described in chapter “Aligning the seal”.

1.5 Start up

- The seal must be vented by means of the vent valve (ball cock 25) when the ship is in the water.

Operating the sealing rings dry will result in the destruction and failure of their sealing faces. It is absolutely necessary, therefore, to vent the seal housing after every docking, refilling of sterntube lubricant and periodically during the vessel’s operation. This can be done by fitting a short pipe to the vent valve (ball cock 25) whereby the vent valve has to be opened regularly, or, to have a permanent venting by means of an open pipe line with the end as far as possible above the water line, while ball cock (25) must be open all the time.

- Check whether the standstill seal (Pneumostop) is pressureless.
- Open the flushing water connection to the seal.
- Check whether the flushing water pump is operating and there is a flow in the line.

1.6 Checking the seal during HAT or engine trials

During the following manoeuvres, check the seals as described in chapter “Final installation check of the seal (ship is in the water)“.

- With the Pneumostop (6) not inflated, run the shaft ahead (ship is tied up at the quay).
- With the Pneumostop (6) not inflated, run the shaft astern (ship is tied up at the quay).
- After HAT (Harbour Acceptance Test) check visually for leakage at the seal. If there is leakage, check the seal, clean the sealing ring surfaces or realign if necessary (see chapter “Realigning the seal (ship is in the water), and cleaning the surfaces”).

> Remember that the ball cock (25) in the vent line at the seal must be open when the vent line ends above water line, otherwise vent manually at regular intervals.

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5 MAINTENANCE

1.7 Maintenance of the seal during OPERATION

The SIMPLAN seal is classified by Germanic Lloyd in accordance with the rules laid down by the so-called ZKR (Central Commission for International Rhine River Shipping). Accordingly, the seal is maintenance-free for a minimum period of five years.

- It is recommended to check the seal water system with the pump in operation prior to each sailing. If scoops are used, the check should be carried out when the vessel starts moving.

1.8 Maintenance of the seal during LAYUPS

In order to prevent standstill corrosion in the seal:

- The flushing water pump must be switched on minimum once a week for about 5 minutes and the seal flushed through.
- If scoops are used (no pump system), the shaft must be turned by whatever means for at least 5 minutes per week.

5.1 Long Term Maintenance

Every 5 years when the ship is due for docking, renew the following parts:

- The Pneumostop (6).
- Constant-Pressure seal Body (14) with Sealing Ring (9) and O-Ring.(10)
- The O-rings (20) and (23).

To be checked and to be renewed or replaced if necessary:

- The Counter Ring (24).
- The Packing (1) at the Casing Ring surfaces.

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6 TROUBLE SHOOTING

When working on the seal while the ship is floating, always:

- Prevent the shaft from turning.
- Inflate the "Pneumostop" emergency seal.
- Block the flushing line and drain the seal
- Secure the clamp ring (15) by fitting the installation tools (17, 18, 19) before slackening the screws (8).

If there is leakage, the seal unit in general, and the sealing ring faces in particular must be checked as soon as possible.

No.	Problem	Cause	Remedy
1	Seal is leaking during operation	**Dirt between sealing rings**	Clean surfaces of sealing rings (9 and 24) after inflating the Pneumostop when shaft is at standstill.
		Misalignment	Realign clamp ring (15) after inflating the Pneumostop when shaft is at standstill. See „Alignment check".

No.	Problem	Cause	Remedy
2	Seal is leaking during operation	**Compression set**	Pre-tension the boot/bellows (14) as follows: • Inflate the "Pneumostop" emergency standstill seal. • Fit the tensioning screws and tighten the nuts (18) until the boot/bellows is held in place. • Loosen the clamp ring (15) and release the tension on the boot/bellows until the two silicon carbide rings are making contact with each other without pressure. • Then increase the tension on the boot/bellows until the tension value on the respective drawing is reached, plus a maximum of 3 mm more beyond the previous position of the clamp ring on the shaft. If the boot/bellows has a compression set such that the drawing dimensions cannot be achieved, the boot/bellows must be replaced.
3	Pneumostop does not deflate	Valve (32) insert keeps air in the Pneumostop.	Remove the air valve (32) insert to remove all air from the Pneumostop.
		Air supply line pressurised.	Vent the air supply line.
4	Water flows out of the drain continuously (during repair)	Flushing water line is not closed.	Close flushing water line.
		Pneumostop is not inflated, is damaged, or unable to seal as dirt is between the Pneumostop and the shaft surface.	Activate Pneumostop, replace if damaged or clean area between Pneumostop and shaft surface.
5	Seal runs hot	Valve(s) in vent line is closed	Vent line valve(s) must be open.
		No flushing water flow	Water must flow through flushing line into the seal.

Tab. 1: Trouble shooting SIMPLAN Standard

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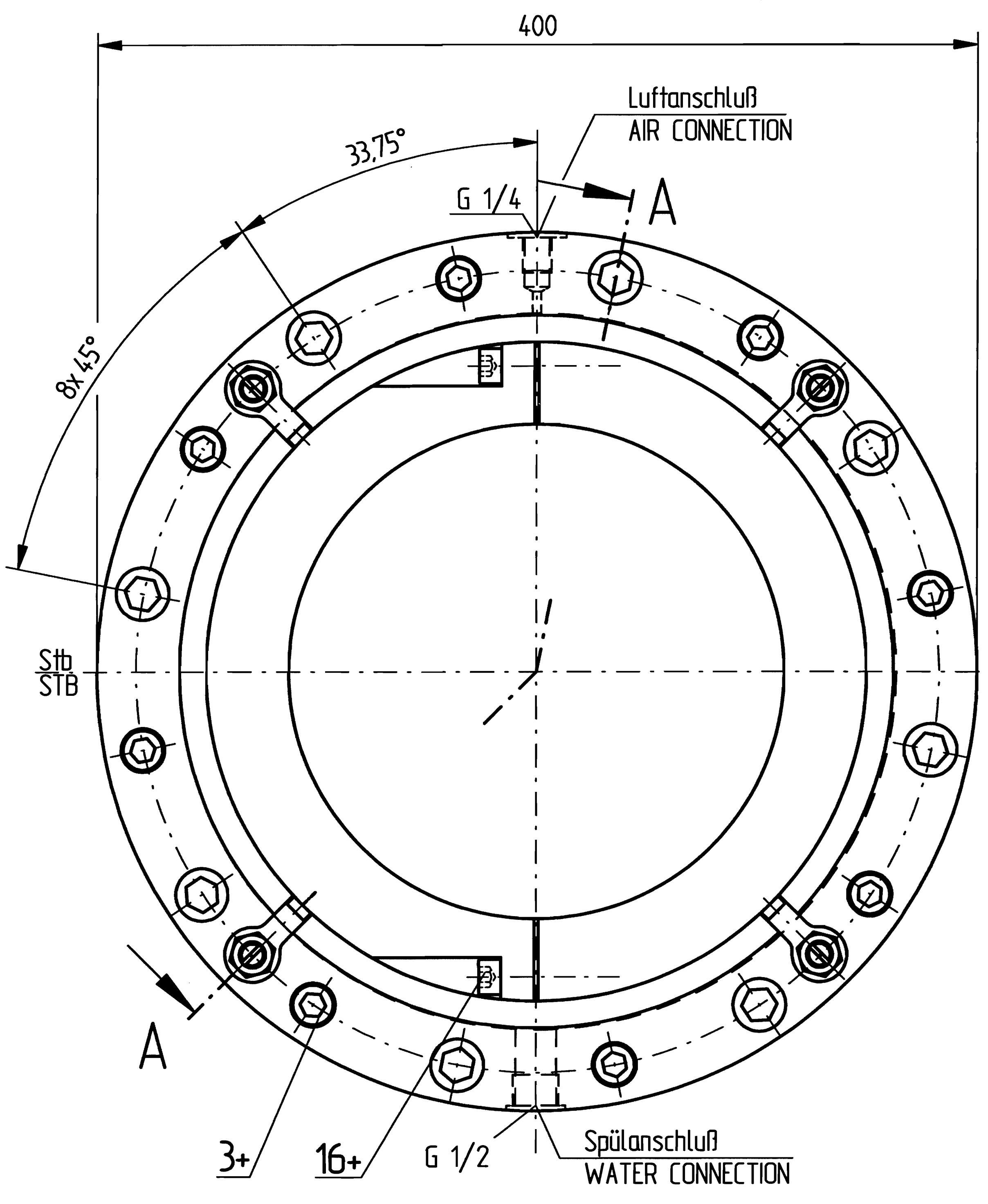
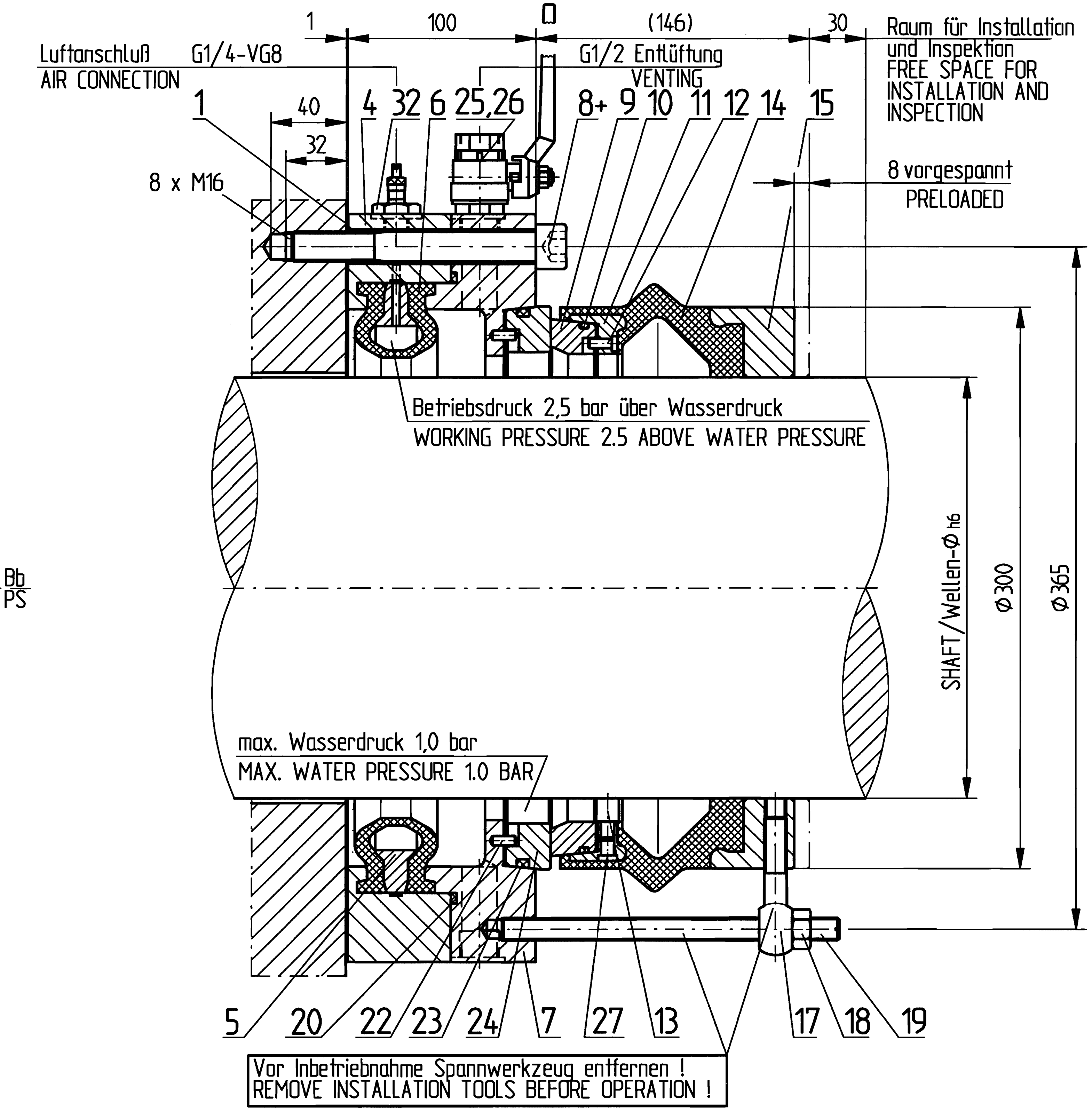




erforderliche Wassermenge für die Abdichtung
im Normalbetrieb 1l/h pro 1mm Wellendurchmesser
WATER QUANTITY REQUIRED FOR SEAL AT STANDARD
OPERATION 1L/h PER 1mm SHAFT DIAMETER

Anzugsmoment fuer / TIGHTENING TORQUE FOR

Pos. / POS	Gr. / SIZE	Nm
	M 8	14
16	M 10	30
3	M 12	50
8	M 16	120

Zulässige Wellenbewegung im Betrieb
ALLOWABLE SHAFT DEFLECTION DURING OPERATION
radial ± 3mm
axial ± 3mm

+: Schrauben mit LOCTITE 243/245 gesichert
SCREWS SECURED WITH LOCTITE 243/245

SHAFT-/Wellen-Ø 225 - 240

Projektion:

Maßstab %
WEIGHT: 66,5 kg

SIMPLAN SEAL TYP: SIC-P

	Datum	Name
Bearb.	03.02.2003	Vetterma
Gepr.	26.02.08	
Norm		
CAD: G:8EE94400.SZA		MS22

Vordere Abdichtung, Gr.225
FWD SEAL, SIZE 225

Blohm + Voss Industries GmbH

SGC : 3-218-0008-000.1

Blatt
Bl.

Zust.	Änderung	Datum	Name
1	Anzugsmomente neu	22.02.2008	Old

Urspr.
Ers. f.:
Ers. d.:

22. 02. 2008

Einzelteilliste / PARTS LIST

Thyssen B+V Industrietechnik

SIMPLAN Abdichtung / SIMPLAN SEAL **vorn / FORWARD** Größe / SIZE: **225 SiC-P**	Zeichnungs-Nr./ DRAWING-No. SGC:3-218-0008-000.1	Seite/ PAGE 1 von / of 2

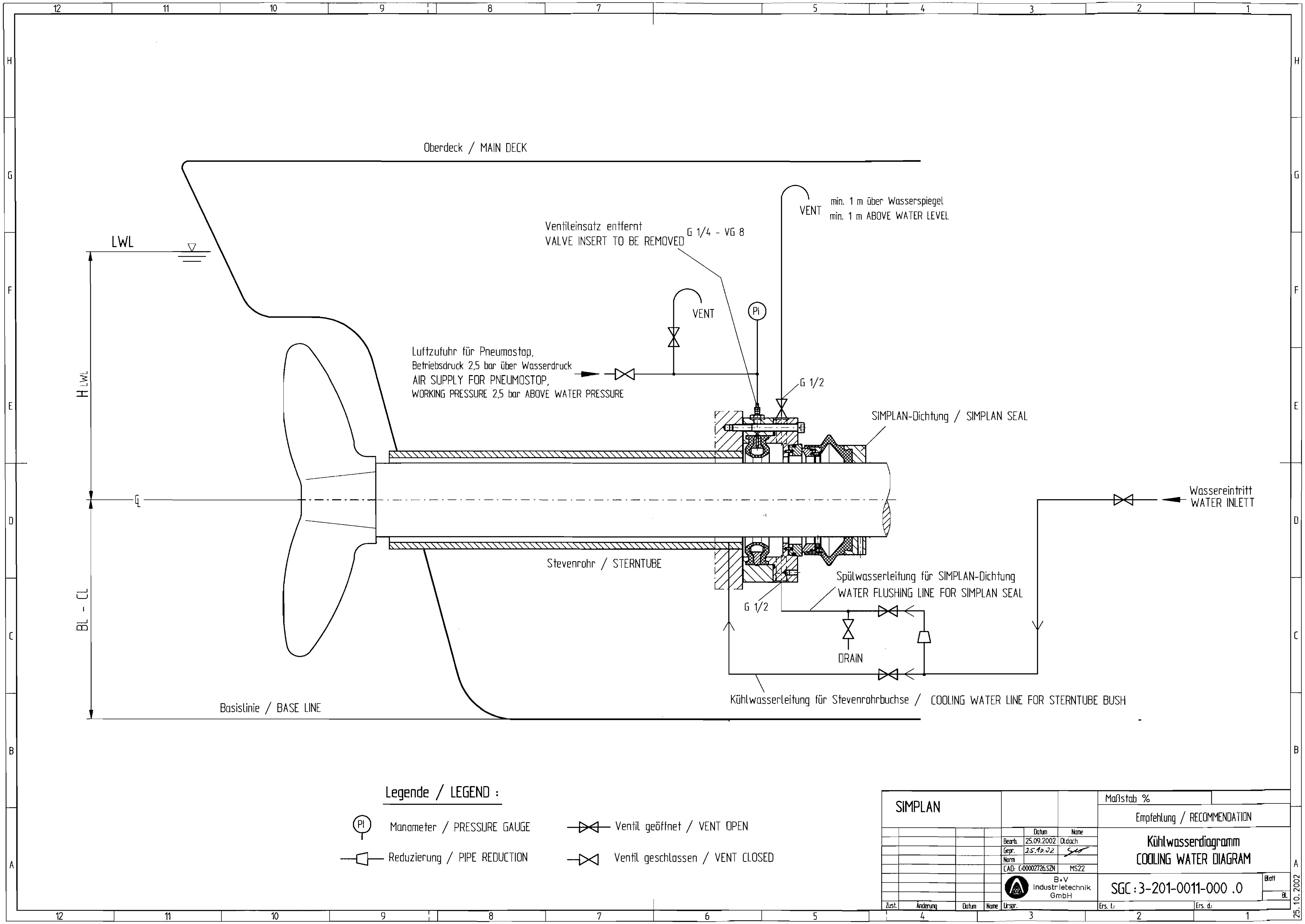
Pos. POS.	Anzahl No.	Bennenung NAME		Zeichnungs-Nr. DRAWING-No.	Werkstoff MATERIAL
1	1	Flachdichtung GASKET		SGC:4-218-0001-001.	AFM 34
3	8	Zylinderschraube HEXAGON SOCKET HEAD CAP SCREW	M12 x 50	DIN 912	A4 - 70 STAINLESS STEEL
4	1	Gehäusering CASING RING		SGC:3-218-0005-004.	Bronze BRONZE
5	1	Einlegering NECK RING		SGC:4-218-0003-005.	Bronze BRONZE
6	1	Pneumostop PNEUMOSTOP		SGC:4-218-0003-006.	Neopren NEOPRENE
7	1	Gehäusering CASING RING		SGC:3-218-0006-007.	Bronze BRONZE
8	8	Zylinderschraube HEXAGON SOCKET HEAD CAP SCREW	M16 x 130	DIN 912	A4 - 70 STAINLESS STEEL
9	1	Gleitring SEALING RING		SGC:4-218-0006-009.	SiC-3
10	1	O-Ring O-RING	ø 270 x 3,5	DIN 3771	Viton VITON
11	1	Einlegering NECK RING		SGC:3-218-0001-011.	Bronze BRONZE
12	2	Stopfen PLUG		SGC:4-216-0001-012.	Bronze BRONZE
13	8	Zentrierstift CENTERING PIN		SGC:4-216-0002-013.	Bronze BRONZE
14	1	Gummibalg CONSTANT-PRESSURE SEAL BODY		SGC:2-218-0001-014.	Neopren NEOPRENE
15	1	Klemmring, geteilt CLAMP RING, SPLIT		SGC:3-218-0001-015.	Bronze BRONZE
16	2	Zylinderschraube HEXAGON SOCKET HEAD CAP SCREW	M10 x 35	DIN 912	A4 - 70 STAINLESS STEEL
17	4	Augenschraube EYE BOLT	M12 x 60		St STEEL
18	4	Sechskantmutter HEXAGON NUT	M12	DIN 555	St STEEL
19	4	Gewindebolzen THREADED BOLT	M12 x 180	SGC:4-216-0001-019.	St STEEL
20	1	O-Ring O-RING	ø 330 x 4	DIN 3771	Perbunan PERBUNAN

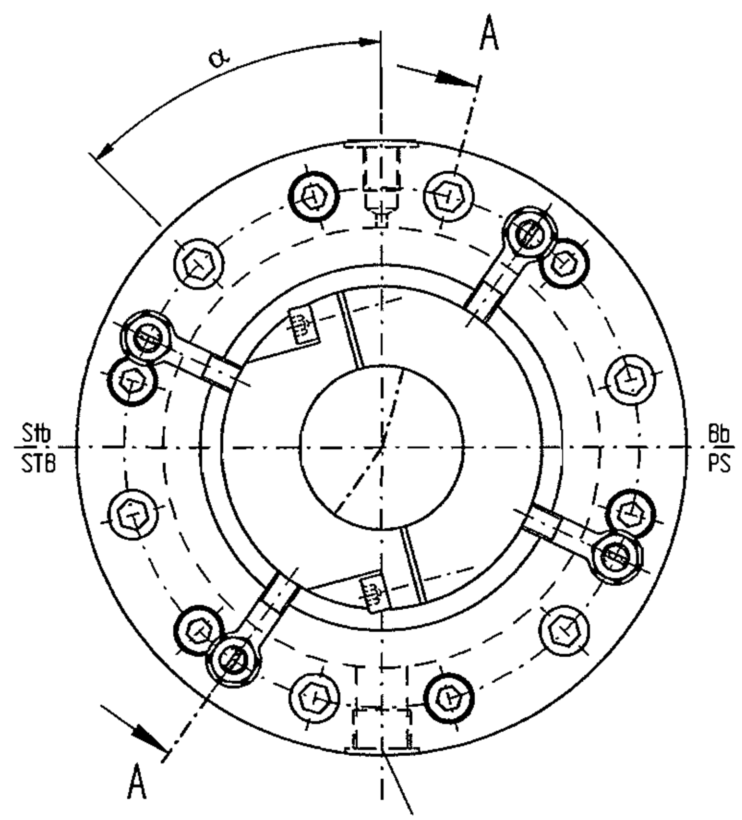
*218_0008

Einzelteilliste / PARTS LIST

SIMPLAN Abdichtung / SIMPLAN SEAL **vorn / FORWARD** Größe / SIZE: **225 SiC-P**	Zeichnungs-Nr./ DRAWING-No. SGC:3-218-0008-000.1	**Thyssen B+V Industrietechnik** Seite/ PAGE 2 von / of 2

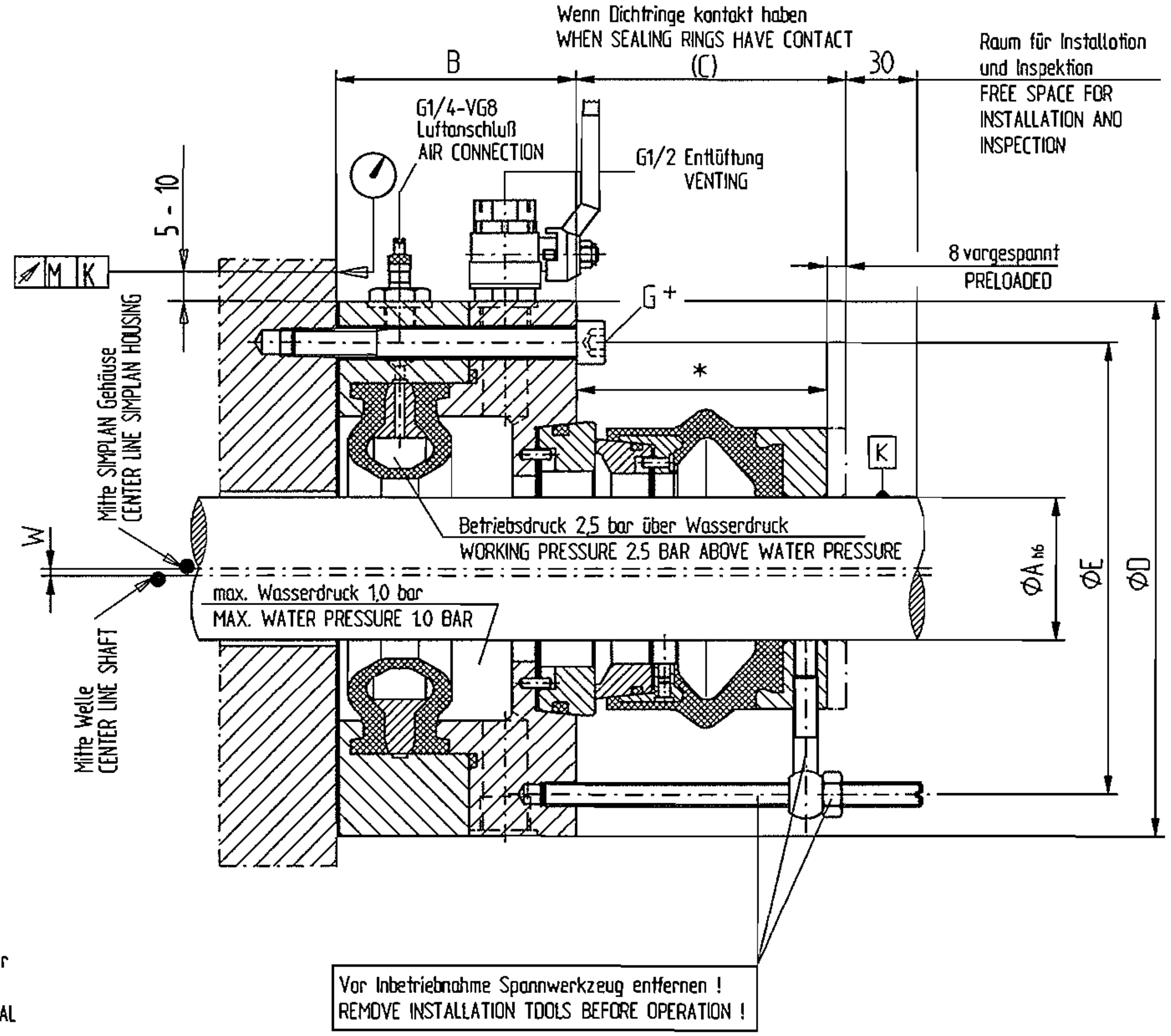
Pos. POS.	Anzahl No.	Bennenung NAME	Zeichnungs-Nr. DRAWING-No.	Werkstoff MATERIAL
22	2	Paßkerbstift 5 x 12 GROOVED PINS	DIN 1472	Chromstahl STAINLESS STEEL
23	1	O-Ring ø 285 x 5 O-RING	DIN 3771	Viton VITON
24	1	Gegenring COUNTER RING	SGC:4-218-0003-024.	SiC-2
25	1	Kugelhahn G 1/2 i/a BALL COCK	03-117 201/12	MS/Ni
26	1	Dichtband SEALING TAPE		PTFE
27	8	Stopfen PLUG	SGC:4-216-0001-027.	Bronze BRONZE
32	1	Pneumostop Ventil G 1/4 – VG8 PNEUMOSTOP VALVE	18-080-041.1	Ms BRASS


Oberdeck / MAIN DECK
LWL
H LWL
BL - CL
Basislinie / BASE LINE
VENT
min. 1 m über Wasserspiegel
min. 1 m ABOVE WATER LEVEL
Ventileinsatz entfernt
VALVE INSERT TO BE REMOVED
G 1/4 - VG 8
VENT
PI
Luftzufuhr für Pneumostop,
Betriebsdruck 2,5 bar über Wasserdruck
AIR SUPPLY FOR PNEUMOSTOP,
WORKING PRESSURE 2,5 bar ABOVE WATER PRESSURE
G 1/2
SIMPLAN-Dichtung / SIMPLAN SEAL
Wassereintritt
WATER INLETT
Stevenrohr / STERNTUBE
Spülwasserleitung für SIMPLAN-Dichtung
WATER FLUSHING LINE FOR SIMPLAN SEAL
G 1/2
DRAIN
Kühlwasserleitung für Stevenrohrbuchse / COOLING WATER LINE FOR STERNTUBE BUSH
Legende / LEGEND :
Manometer / PRESSURE GAUGE
Reduzierung / PIPE REDUCTION
Ventil geöffnet / VENT OPEN
Ventil geschlossen / VENT CLOSED
SIMPLAN
Maßstab %
Empfehlung / RECOMMENDATION
Datum
Name
Bearb. 25.09.2002 Oldach
Gepr. 25.10.02
Norm
CAD: C-00002726.SZN MS22
B+V Industrietechnik GmbH
Kühlwasserdiagramm
COOLING WATER DIAGRAM
SGC : 3-201-0011-000 .0
Blatt
Bl.
Zust.
Änderung
Datum
Name
Urspr.
Ers. f.:
Ers. d.:
25.10.2002



G1/2 Spülanschluss
Erforderliche Wassermenge für die Abdichtung
im Normalbetrieb 1 l/h pro 1 mm Wellendurchmesser
G1/2 WATER CONNECTION
WATER QUANTITY REQUIRED FOR SEAL DURING NORMAL
OPERATION: 1 l/h PER 1 mm SHAFT DIAMETER

Zulässige Wellenbewegung im Betrieb
ALLOWABLE SHAFT DEFLECTION DURING OPERATION
radial ± 3 mm
axial ± 3 mm



Größe SIZE	Wellendurchmesser SHAFT DIAMETER ØA h6	B	(C)	ØD	ØE	α	G	M max.	W ** max.
60	60 - 69	101	114	225	190	45°	6 x M12	1,6	± 2
70	70 - 79	101	114	235	200	45°	6 x M12		
80	80 - 89	101	114	245	210	45°	6 x M12		
90	90 - 104	101	134	255	220	33,75°	8 x M12	1,8	
105	105 - 119	101	134	270	235	33,75°	8 x M12		
120	120 - 134	101	134	285	250	33,75°	8 x M12		
135	135 - 149	101	134	300	265	33,75°	8 x M12	1,6	
150	150 - 164	101	134	315	280	33,75°	8 x M12		
165	165 - 179	101	134	330	295	33,75°	8 x M12		
180	180 - 194	101	134	345	310	33,75°	8 x M12		
195	195 - 209	101	146	370	335	33,75°	8 x M16	2,2	
210	210 - 224	101	146	385	350	33,75°	8 x M16		
225	225 - 240	101	146	400	365	33,75°	8 x M16		

** Bei Verdopplung des max. zulässigen Wertes ist eine Neuausrichtung des Gehäuses notwendig
IF THIS MAX. ALLOWABLE VALUE HAS DOUBLED, SIMPLAN HOUSING HAS TO BE READJUSTED

* max. zulässige Abstands-Abweichung im Bereich der vier Augenschrauben:
MAX. ALLOWED DISTANCE DEVIATION AT THE FOUR EYE BOLTS: ± 0,3 mm

+ Schrauben mit LOCTITE 242/243 gesichert
SCREWS SECURED WITH LOCTITE 242/243

Maßstab 1:1

SIMPLAN SEAL TYP: SIC-P

FWD SEAL
DIMENSIONS WITH TOLERANCES

	Datum	Name
Bearb.	26.09.2002	Wiegers
Gepr.	25.10.02	
Norm		
CAD: E-00002734.SZN		MS22

B+V Industrietechnik GmbH

SGC: 3-201-0012-000.0

Blatt / Bl.

Zust. | Änderung | Datum | Name | Urspr. | Ers. f.: | Ers. d.:

25.10.2002

SPARE PARTS ORDERING

All parts / replacements shall be ordered from Blohm + Voss Industries GmbH by furnishing the following information:

- The information marked by * on the cover page
- Designation of the parts required **
- Pos.-No. of the parts required **
- Quantity of the parts required **

** See enclosed drawings in accordance with cover page

Please use the following contacts:

Blohm + Voss Industries GmbH
Ship components spares / service
Department MS 30
Hermann-Blohm-Straße 5
20457 Hamburg, Germany

Or one of our worldwide service stations:

(see enclosed leaflet)

Phone: +49 40 3011 - extension

Fax: +49 40 3011 -1987 (seals and separators)
Fax: +49 40 3196189 (stabilizers, also dept. head)

Company web address: www.bv-industrie.de

Extention	Activities
-1195 -2120	Quotations for seal spare parts
-2395	Commercial handling of orders for seal spare parts, and Huhn-seals
-2964	Delegating technicans for seals and TURBULO separators
-1684	Commercial and technical handling of orders for seal spare parts
-1283	Commercial handling of orders for seal spare parts
-2967	Commercial and technical handling of spare parts orders and quotations for TURBULO separators
-2308	Guarantee handling and service for stabilizers and steering gears
-1689	Spare parts order processing, delegating technicians for stabilizers and steering gears
-1676	Guarantee handling and service for stabilizers and steering gears
-1276 -1673	Guarantee handling and service, technical consulting and support for seals, TURBULO separators and bearings
-2963	Commercial and technical handling of orders for SIMPLAN seal spare parts

Sales Agents
for SIMPLEX and TURBULO PRODUCTS
and **Service Stations** for SIMPLEX Seals
Worldwide

A company
of ThyssenKrupp
Marine Systems

Blohm + Voss Industries

Blohm+Voss

Sales Agents – Worldwide

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Maritime Propulsion Technologies Ltd.
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Weaverham, Northwich
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Mobile: +44-7879-84 38 98
technical@maritimepro.com
www.maritimepro.com
Contact: Andy Thomson

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Ulf Lienhard
Hans Dyrzka

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Bahama Islands
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Bahrain
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Bangladesh
see Singapore

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see Netherlands

Bermuda Islands
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vendas@metalock.com.br
Contact: Capt. Fabio Ruiz

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Contact: Emil Petrov

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Chile
Colombia
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Sidi Gaber - Alexandria
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Tel.: +20-3-545 45 02
+20-3-542 32 76
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memco@myself.com
ahmedyacoub47@yahoo.com
Contact: Mrs. Essmat Yacoub
Mr. Ahmed Yacoub

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+30-210-459 88 00
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Iraq
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Israel
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Kuwait
Lebanon
Libya
see Middle East

Malaysia (excl. Navy)
see Singapore

Malaysia Navy
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stern_bvimalaysia@yahoo.de

Commercial Vessels see Singapore

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Tel.: +356-23 99 30 45
info@maltashipyards.com
www.maltashipyards.com

Mexico
see USA

Middle East (excl. Egypt)
M.I.E. (Overseas) Ltd.
via M.I.E. Services Ltd.
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Myanmar
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Contact: H.F. Uittenbogaart

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Oman
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Pakistan
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Peru
see USA

Philippines
see Singapore

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Saudi Arabia
see Middle East

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Venezuela
see USA

Vietnam
see Singapore

Yemen
see Middle East

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Service Stations

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+54-11-43 02 74 07
Tel.: +54-11-43 01-41 24
+54-11-43 01-41 25
+54-11-43 01-50 69
+54-11-43 01-06 02
Mobile: +54-911-44 15 47 94
+54-911-49 17 71 91
info@cromwell.com.ar
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Contact: David Dutton

Bahama Islands
see USA

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SIMPLAN Seal

Split Ring Assembly

Model SIC-P

Instructions:

Removing the unsplit and installing the split sealing rings (9) and (24)

1. Removal

Prerequisites:
- Ship in dock **or**
- Pneumostop inflated to $\boxed{\text{2,5 bars above water pressure}}$ and checked for leaks
- Flushing-water supply de-activated
- Water drained from the Simplan seal
- Split rings (9, 24), new O rings (10, 23), A+B adhesive and heater for O-rings on hand

- Clean the surface of the shaft around 150 mm behind the clamp ring (15) thoroughly

Clamp ring:

- Release the tension of the constant-pressure seal body (14) by loosening the screws (16). Do not unscrew the screws (16) entirely, or remove the halves of the clamp ring (15) from the constant-pressure seal body

Due to the initial tension, the clamp ring (15) may jump backwards a bit when the screws (16) are loosened.

- Retract the clamp ring (15) with the constant-pressure seal body (14) and rings (11) and (9) from the casing far enough that both ring (9) and ring (24) can be extracted freely (see also attached sketch).

Sealing ring:

- Remove ring (9) from ring (11), for example by levering it out with two tools applied at opposite sides.

- Destroy ring (9), for example by hitting its outer diameter with a hammer.

SAFETY NOTE: Because of the fragments that may fly around, the technician should wear appropriate safety clothing and safety goggles!

To prevent splinters getting into the seal, the ring (9) should be wrapped with rags.

Counter ring:

- Remove ring (24) from ring (7), for example by levering it out with two tools applied at opposite sides.
- Destroy ring (24) (see notes for ring (9)).
- Cut up the O rings, and dispose of them together with the fragments of the ring.
- Remove all fouling, splinters, etc. carefully from along the shaft between the casing (4, 5, 6, 7) and the clamp ring (15) with constant-pressure seal body (14) and ring (11), and clean the surface of the shaft thoroughly.

2. Installation

General safety hints:

- Do not remove the new rings (9, 24) from their packaging until immediately before installing them.

The super-finished sealing surfaces of the sealing ring (9) and the counter-ring (24) are very delicate, and must not be damaged under any circumstances!

Make absolutely sure that no oil or grease gets onto the bearing surfaces of the silicon-carbide rings (9, 24). These surfaces must be clean and dry!

Make sure that no foreign bodies get between the fracture surfaces of the ring halves!

Counter ring

- Cut through the O-ring (23) supplied, place it around the shaft in the section between the casing ring (7) and constant-pressure seal body (14), and glue it together again with A+B adhesive, with the aid of a heater.

- First unpack ring (24), taking special care not to damage either the sealing surface or the fracture surface of the ring.

- Place the halves of the ring around the shaft, paying attention to the direction of taper (the smaller diameter must face towards the casing ring (7)), and carefully join them so that the fracture surfaces match precisely.

- Grease the O-ring (23) lightly, and insert it into the O-ring groove in ring (24).

- Slide the complete ring (24) into the taper of the casing ring (7), paying particular attention to the position of the keyways with respect to the grooved pins (22); see also attached sketch, steps 1 to 3.

Sealing ring

- Cut through the O-ring (23) supplied, place it around the shaft in the section between the casing ring (7) and constant-pressure seal body (14), and glue it together again with A+B adhesive, with the aid of a heater.

- Unpack ring (9), taking special care not to damage either the sealing surface or the fracture surface of the ring.

- Place the halves of the ring around the shaft, paying attention to the direction of taper (the smaller diameter must face towards the neck ring (11)), and carefully join them so that the fracture surfaces match precisely.

- Grease the O-ring (10) lightly, and insert it into the O-ring groove in ring (9).

- Slide the complete ring (9) into the taper of the neck ring (11), paying particular attention to the position of the keyways with respect to the plugs (12); see also attached sketch, steps 4 to 6.

Clamp ring

- Slide the clamp ring (15) together with the constant-pressure seal body (14) and rings (11) and (9) up against the counter-ring (24).
- Position the installation device (17, 18, 19).
- For the initial position, turn the nuts (18) with your fingers against the eyebolts (17) until the bearing surfaces of the counter-ring (24) and sealing ring (9) are in contact.

☞ In the initial position, the deviation in the distance between the rear edge of the clamp ring (15) and the front edge of the casing ring (7) in the vicinity of the eyebolts (17) should not exceed $\boxed{\pm 0{,}3 \text{ mm}}$.

- Tighten the nuts (18) clockwise half a turn with a wrench, until the pre-loading given in the drawing has been reached.
- Fasten the clamp ring (15) with the screws (16) finally.

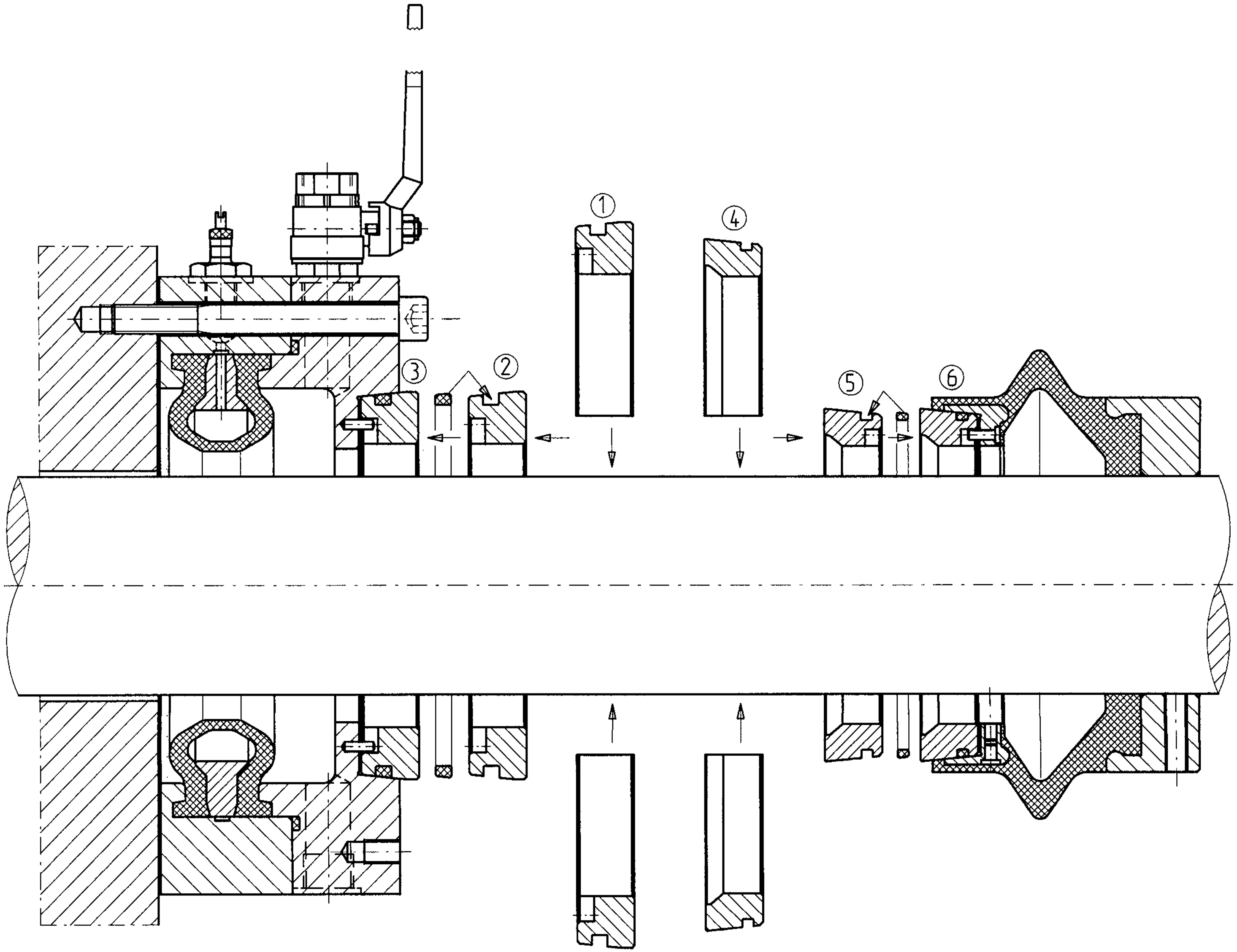
☞ The final deviation in the distance between the rear edge of the clamp ring (15) and the front edge of the casing ring (7) in the vicinity of the eyebolts (17) should not exceed $\boxed{\pm 0{,}2 \text{ mm}}$.

Final steps:

- Dismantle the installation device (17, 18, 19), and store it on board.
- Vent the Pneumostop completely.
- Put the flushing-water supply into operation.
- Vent the Simplan seal

SIMPLAN Seal

Split Ring Assembly



THORDON BEARINGS INC. A member of the Thomson-Gordon Group

DUWEL TECNO AB

Ref. RD/JS 2007-03

COMPAC PROPELLER SHAFT BEARINGS SPECIFICATION

The information in this specification has been prepared based upon Thordon Bearings / Duwel Tecno experience and best practices developed over many years in designing and installing propeller shaft bearings.

More detailed information can be found in:
The Thordon Engineering Manual, the Thordon Water Lubricated Propeller Shaft Bearing Design Manual and Thordon's Bearing Sizing Calculation Program which supplement the information provided here.

If there are any questions regarding this specification, please contact Duwel Tecno.

Design

1. General

The bearing wear surface is Thordon COMPAC, a non-metallic, elastomeric polymer alloy. To reduce start-up friction and eliminate stick-slip, COMPAC's formulation includes special lubricants to provide a low coefficient of friction. To promote early formation of hydrodynamic film between the shaft and bearing, the lower (loaded) portion of the bearing is smooth, while the upper half of the bearing incorporates grooves for flow of the water lubricant/coolant.

The stern tube bearings shall be of water lubricated construction using forced water flow for cooling and lubrication. For strut type bearings, forward or astern movement of the vessel provides the cooling water flow.

The L/D ratio of the bearing shall be determined by taking into account the design pressure and the minimum shaft operating speed. As a general rule, the aft bearing L/D ratio can be 2:1 and the forward bearing 1:1, in accordance with the applicable classification society rules. In cases where the design involves only a stern tube bearing, this arrangement is acceptable as long as the bearing pressures are within classification society limits.

2. Arrangement

Interference fitting is the recommended method for fitting the propeller shaft bearings. To achieve this, the bearing shall have a minimum wall thickness to permit interference fitting as specified by Thordon Bearing Sizing Calculation Program.

The bearing may be a solid tube or non-split and may comprise of single or multiple bearing segments. If the bearing is in multiple segments, an annular groove must exist between the segments to allow water flow in case of accidental angular misalignment.

3. Axial retention

All bearings must be fitted with mechanical means for limiting axial movement. Most commonly, this will be a step in the bore at one end and a circular, bolted retaining ring at the other.

4. Shaft liner

The shaft in way of the bearing should be fit with a circular, smooth continuous surface that may either be welded or a shrunk on liner. If a shaft liner is to be used, the liner shall be made from a good quality centrifugally cast bronze alloy or equivalent material with minimum thickness in accordance with classification society requirements.

Nickel aluminum bronze is not recommended as a shaft liner material. Please contact Duwel Tecno for other options.

5. Corrosion protection

If the shafting is made from a ferrous material, then the sections of the shaft exposed to seawater shall be suitably protected from corrosion. The shaft coating shall be applied in accordance with the manufacturers recommendations with care to be taken to ensure the integrity of the coating where it meets the shaft liners.

6. Cooling water

Cooling/lubrication water shall be supplied at the forward end of the stern tube so that it flows over the full length of the forward bearing through the stern tube, then over the full length of the aft bearing before exiting outboard.

The recommended method of supplying water to the stern tube is with a dedicated pump, however other methods are acceptable provided that the minimum water flow requirements are met at all shaft speeds. The water should be as cool as possible and water above 40°C (104°F) should be avoided.

The minimum water flow rate for COMPAC bearings is 0.15 liters per minute per millimeter (1 U.S. gal. per minute per inch) of shaft diameter.
For strut bearings, water flow is normally provided by the forward motion of the vessel. To ensure that the water supply is sufficient, there needs to be sufficient opening area at the forward and aft ends of the strut.

The water supply piping arrangement shall include an electrical flow switch indicating low flow that is connected to an alarm in the control room or bridge. The low flow alarm should be set to alarm at a flow rate of 80% of the recommended flow rate.

If required by the customer, an additional flow meter providing a quantitative reading of water flow can be installed and situated in such location to be easily monitored by the ship's engineer.

7. Filters

Typically, the removal of abrasives between two operating surfaces will prolong the wear life in most mechanical systems. In blue water operation, the removal of abrasives is not normally required. However, if the vessel is to operate in waters containing sand or other abrasives, it is recommended to remove such abrasives to minimize bearing wear.

The removal of abrasives can be accomplished by many methods. The method chosen should remove abrasive particles down to a size of between 100 to 200 microns.

9. Seals

A face or lip seal is recommended, however other water lubricated seal options can be used.

Installation

The recommended method for fitting COMPAC bearings is to install using an interference fit. To ensure that the force generated to hold the bearings is sufficient, the dimensions of the machined bearing should be verified against the design dimensions for the installation.

The bearings can be installed with either dry ice or liquid nitrogen. During installation, it is recommended to leave gaps between the bearing segments and the retaining rings. The lower (loaded) part of the bearing I.D. is smooth and the upper half of the bearing has grooves. With multiple bearing segments, the grooves in the bearings should be aligned. Further information can be found in the Thordon Water Lubricated Propeller Shaft Bearing Design Manual.

Important: Please refer to our Marine Bearing Installation Manual regarding precautions when using a chocking compound.

Bearing Care – Installation to Delivery

Once the COMPAC bearing has been installed in the ship, it should be protected while in dry dock from:

1. Debris – the bearing should be protected against debris entering the bearing such as sandblasting material, paint, weld slag, etc.

2. Heat – the bearing should be protected from temperatures in excess of 50°C (122°F), especially from the heat of welding.

3. Chemical Attack – the bearing should be protected from any chemicals entering it.

4. Corrosion – adjacent metal parts should be protected from corrosion as the corrosion particles could enter the bearing and cause premature wear.

While the ship is afloat, the bearing should be protected from:

1. Debris – the bearing should be protected against waterborne debris such as sandblasting material or heavy sediment entering the bearing. The ship's propulsion system should not be tested at dockside or in dry dock basin where large amounts of debris can be stirred, allowing entry into the bearing.

2. Heat – the bearing should be protected from temperatures in excess of 50°C (122°F).

3. Chemical Attack – the bearing should be protected from any chemicals entering it.

4. Corrosion – adjacent metal parts should be protected from corrosion as the corrosion particles could enter the bearing and cause premature wear.

5. Marine Growth – The shaft should be turned two compete revolutions, every second day, to prevent marine growth.

Storage and Maintenance

Prior to Installation

Testing and experience indicate that Thordon COMPAC bearings can be stored for 5 years in the packaging provided and possibly in excess of 10 years.

The following steps will extend the life of the bearing in storage:

1. **Store out of direct sunlight protected from weather, preferably in warehouse or similar.**

2. **If possible, wrap the bearing in plastic wrapping or similar**

3. **Store at ambient temperature – avoid excessive humidity and temperatures above 40°C (104°F).**

4. **Avoid contact with solvents**

5. **Store tubular material on end to minimize product deformation**

Long-term exposure to sun (ultraviolet radiation) may cause the surface of the material to undergo a colour change. However, once the surface layer is removed, the underlying material will be original colour and still maintain its physical properties.

Maintenance in Service

The wear of stern tube bearings is generally caused by either abrasive wear or overheating caused by excessive loading, high vibrations or reduction in cooling water to the bearings.

In Harbour

When the ship is in harbour for extended periods of time, marine growth may adhere to the shaft liner and lead to an increase in abrasive wear of the bearing. To try and prevent marine growth on the shaft, we recommend that the shaft be rotated 2.5 revolutions every three days.

At Sea

The filters should be monitored to ensure that they do not become clogged reducing water flow to the bearings.

Water Supply

The water supply to the stern tube should be fit with a flow-measuring device to alarm if the flow should go below .12liters/minute/mm shaft diameter. The flow meter should be checked on a quarterly basis to ensure that the setting is correct.

Bearing Wear

The bearing will provide many years of service provided that it is operated and maintained properly. To provide information for future renewal due to wear the bearing clearance should be measured on an annual basis.

Divers should check the clearance every six months by fitting a feeler gauge into the space between the bearing and shaft at the aft end at top dead center. See figure 1 below.

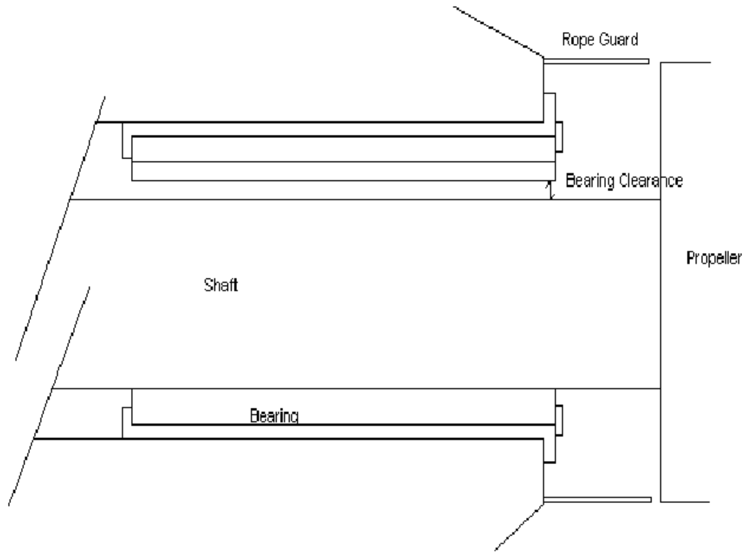


Figure 1

The readings should be recorded and maintained in the ships log.

In Drydock

When the ship is in Drydock, the clearance between the shaft and bearing at the aft end of the aft bearing at top dead center should be recorded. If the shaft is to be withdrawn, the shaft diameter and bearing bores should be measured at a minimum of three locations along the length and at top dead center and 60 and 120 degrees off of the vertical measurement.

Maximum Clearance

Water lubricated bearings, when properly designed, installed and maintained, will provide many years of satisfactory service. In service, however, the bearings will wear either as a result of abrasive or adhesive conditions.

As the bearing wears, the clearance in the bearing will increase and as clearance is normally easier to measure than wear, it is usual to state a maximum clearance limit for a bearing. The maximum clearance that can be accommodated is dependent upon both the bearing design and the shafting arrangement.

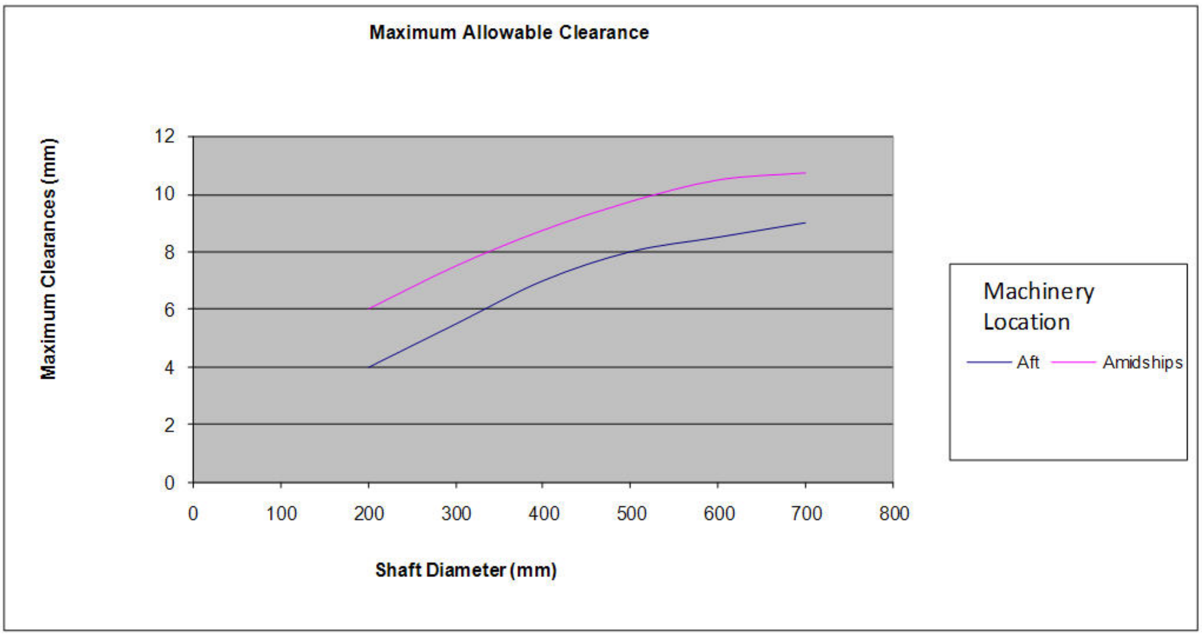
The maximum clearance recommended for water-lubricated bearings is then dependent upon the bearing design and the shafting arrangement. Bearing design includes bearing wall thickness, bearing configuration (grooved or ungrooved), loading, and shaft size while shafting arrangement dictates the positional relationship between the bearing and the propulsion machinery.

The maximum bearing clearance is normally governed by the bending stresses in the shafting and the load transference to bearings located internally within the ship. The graph below provides a maximum recommended clearance for arrangements where the propelling machinery is either located amidships or is located aft.

The shafting arrangement needs to be reviewed to determine whether the machinery is considered aft or amidships. The machinery is considered amidships if there are 2 or more line shaft bearings forward of the stern tube. This ensures that if there is wear in the strut or stern tube bearings that load transference associated with the wear down does not affect the gearbox or propelling equipment. The machinery is considered aft if there is a single or no line shaft bearing forward of the stern tube.

Secondary considerations that need to be accounted are that there is sufficient bearing wall thickness above the edge of the retaining ring. In most normal applications, the wall thickness of the bearing is greater than the wear allowable to reach the maximum clearance. This ensures that when the bearing has worn to its maximum clearance, that the shaft has not contacted the bearing retaining ring and caused mechanical damage.

Maximum Allowable Clearance for Stern Tube and Strut Bearings



We trust that the above provides general guidelines in the determination of maximum clearances and wear.
If there are issues related to a specific installation, we recommend that you contact us at Duwel Tecno direct for more detailed information.

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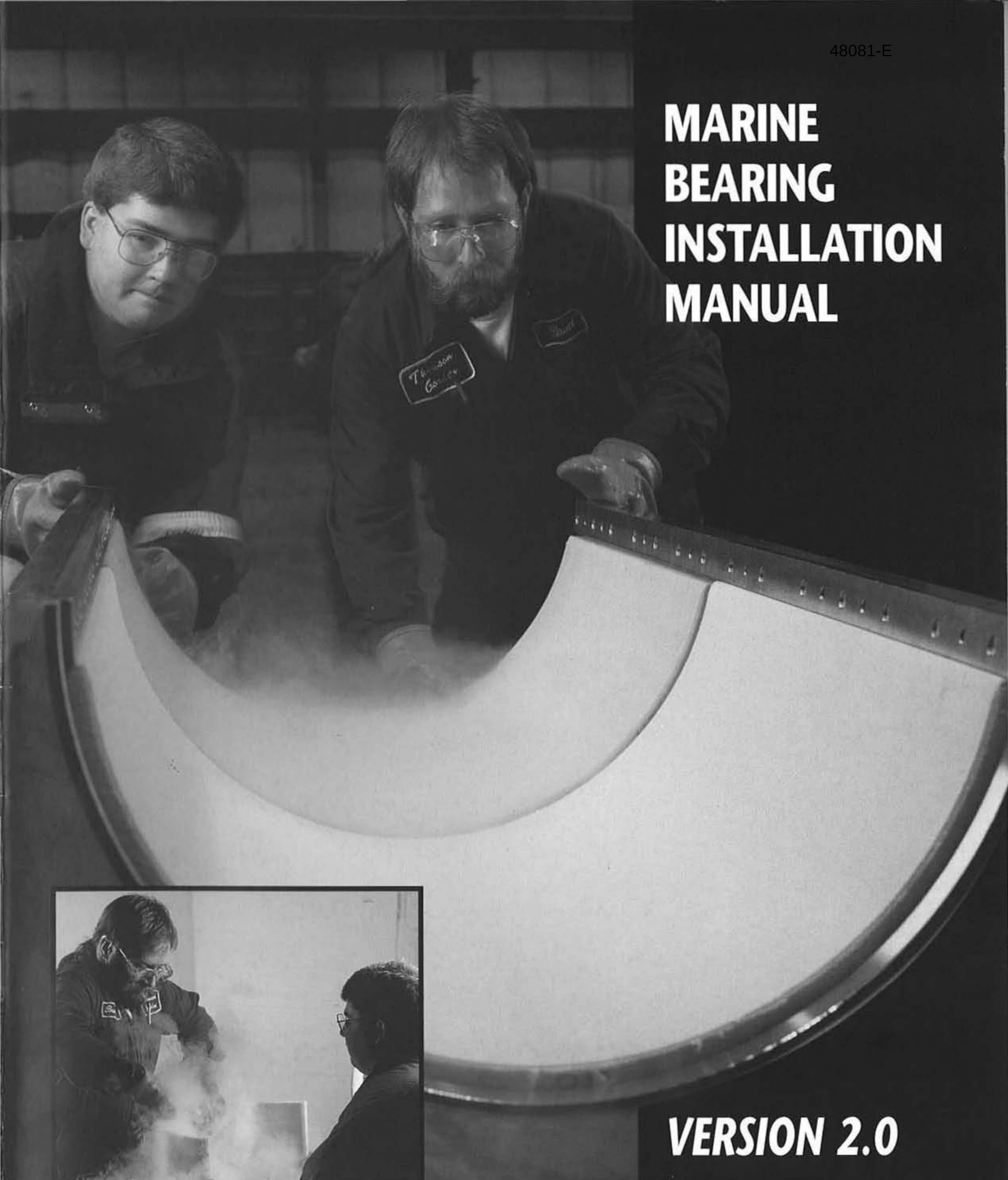
MARINE BEARING INSTALLATION MANUAL



VERSION 2.0

THORDON

BEARINGS INC. *A member of the Thomson-Gordon Group*

THORDON

BEARINGS INC. A member of the Thomson-Gordon Group

48081-E

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THORDON
ENVIRONMENTALLY FRIENDLY
BEARING SOLUTIONS

INTRODUCTION

Thordon is a unique polymer alloy developed by Thordon Bearings Inc. for use as a high performance bearing material, particularly in marine applications. Thordon bearings provide long life and offer a unique combination of low friction, high elasticity and good mechanical properties (abrasion and shock resistance). Thordon is homogeneous and has a relatively high coefficient of thermal expansion that facilitates freeze fitting. It is also resilient and shock resistant. Thordon marine bearings are much easier to handle and install than other traditional marine bearings. The important thing to remember is that Thordon is different from metallic bearing materials and therefore requires slightly different handling. Anyone accustomed to working with bronze or other metallic bearing materials will find that the recommended amounts of interference and running clearance for Thordon are greater than for metals. The securing methods common for bronze or bronze-shelled bearings must also be re-considered when fitting Thordon. For example, flanged fitting, set screwing along the O.D. and welding near the bearing are not acceptable with Thordon. Alternate methods of axially securing the bearing such as bolted end rings must be used. Thordon is a very easy material to machine. It is non toxic and machines dust free and therefore there are no health hazards involved.

Thordon is available in four grades for marine bearing system installations. These are XL, SXL, Compac and Composite. XL is the standard grade used in general marine applications. SXL is accepted as the preferred rudder material, especially for highly loaded rudder applications, because of its lower coefficient of friction and ability to run dry. SXL in TRAXL or Thor-Tape form is also used in deck gear applications. A separate instruction booklet is available. Compac is similar to SXL in composition and is specified for propeller shaft applications where low friction and long life are required. Composite is specially designed to provide long life in extremely abrasive conditions such as river boats, or suction cutter head dredges. All the Thordon grades are similar in their basic chemical composition, and the same approach can be taken to installing any of them. Where differences do exist, they will be pointed out in the text of this manual.

This manual is designed to provide all the information necessary to install Thordon marine bearings of any size. If you have any questions or concerns please contact your local Thordon Distributor, or Thordon Bearings Inc., for further information or design assistance. For easy reference we have divided the manual into chapters as follows:

1) Propeller Shaft Bearings
2) Rudder Bearings
3) Dimensioning
4) Machining and Measuring Thordon
5) Mating Surfaces and Housings
6) Installation Methods

CHAPTER 1

PROPELLER SHAFT BEARINGS

1.1.1 General

Thordon propeller shaft bearings are available to fit any size of shaft from 3/4" (20mm.) to 40" (1000mm.), and larger if required. They are available in a variety of forms that are described in the following sections of this chapter. Thordon propeller shaft bearings are normally fitted using an interference fit to hold them in place. In some applications anti-rotation or split tapered keys may be used. Thordon bearings are also bonded in place in certain circumstances. Axial retention rings are recommended for all Thordon bearing installations. Water lubrication is most commonly used with Thordon propeller shaft bearings but comments on oil lubrication are provided in section 1.4.2.

1.1.2 Bearing Length

Conventional propeller shaft bearings are normally supplied with a length/diameter ratio of 4:1 for the bearing next to the propeller. (Shorter lengths are used for inboard bearings.) This specification was based on the limited load bearing capability of other water lubricated propeller shaft bearings. Because of its significantly higher load bearing capability, Thordon is approved by most marine classification societies for use with a length/diameter ratio of 2:1. This means that Thordon bearings can be half the length of conventional marine bearings. Comments that relate specifically to the shorter length option will be provided where appropriate in this manual.

1.2 CYLINDRICAL BEARINGS

1.2.1 Fully Finished

Any Thordon bearing can be provided in fully finished form, ready to install. Such bearings may be machined by Thordon Bearings Inc, by the yard, or by your local distributor. Fully finished bearings can be supplied to meet any inch or metric housing and shaft combination. For standard sizes each bearing is given a reference code. Please refer to the Thordon Marine Bearing Standard Size List, for code names and nominal dimensions.

Fits and Clearances

Thordon fully finished bearings are normally designed for a press or shrink (interference) fit into the strut or stern tube. Sufficient oversize is allowed on the outside diameter of the bearing to prevent bearing movement, if the housing has not been pitted, corroded or rebored beyond its nominal diameter. Set screws are not recommended for securing the bearing in place. Fully finished bearings are not suitable for bonding into place unless they have been machined specifically for a bond fit. Final dimensions for machining Thordon bearings can be easily determined by using Thordon Bearing's computor sizing calculation program.

SXL, XL, Compac, or Composite

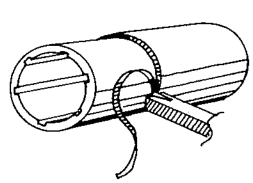
XL is the standard material for propeller shaft bearings. Compac is the special Thordon design incorporating the 2:1 length/diameter ratio, elimination of water grooves on the bottom of the bearing (to promote hydrodynamic lubrication), and the SXL grade of Thordon. Composite bearings are designed for extremely dirty water conditions where traditional bearing materials, and even the other grades of Thordon exhibit accelerated wear. For standard fully finished sizes of all styles, refer to the Thordon Marine Bearing Size List.

1:2:2 Semi Finished

Semi finished marine bearings are also available for shaft sizes from 2" (50mm.) up. A standard size range is produced for shafts up to 12" (300mm.). These bearings have similar dimensions to the fully finished bearings mentioned in section 1:2:1, but they have an oversize allowance on the outside, and undersize allowance on the inside. This extra material (approximately 1/16" (1.5mm.) up to 6" (150mm.) shaft size and 1/8" (3mm.) over 6" shaft)is added to give flexibility in machining to fit non-standard housings, shafts and liners. All standard semi finished bearings have the water grooves moulded in them. The O.D. and I.D. must be machined before installation. Refer to chapters 3 and 4 of this manual for dimensioning and machining instructions.Thordon Marine Bearing Size List provides nominal dimensions for Thordon semi finished marine bearings. They are available in XL, Compac or Composite as indicated.

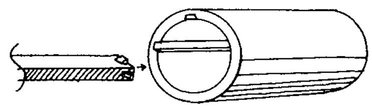
The "oversize" dimensions of semi finished bearings are based on calculated recommended dimensions for cold water installations, not on nominal shaft and housing sizes. Thus the I.D. of a semi finished bearing will be approximately 1.5mm (0.06") smaller than the calculated recommended I.D., not than the nominal I.D. (shaft size).

When semi finished bearings are supplied in two of more segments ("Grey" or larger) they come with an annular groove machined or moulded in one end of each segment. This is to facilitate water flow if there is misalignment of the water grooves. The annular grooves should be at the ends where the Thordon bearing segments meet.



1:2:3 Machined from Stock Tube

Thordon bearing material is available from most stocking distributors in standard tube form. These tubes are 13" (330mm.) long, and come in a variety of inside and outside diameters to suit almost any application. The only problem that arises in using stock tube for propeller shaft bearings is that this material does not have water grooves. Therefore it is necessary to machine these grooves before installation. TG drawing TG10520 on page 48 provides all the detailed information required for designing the appropriate groove configuration. Groove machining is normally done by using the boring bar on the lathe as a "shaper". Thordon Bearings Inc. has developed some special pneumatic router type cutters because of the number of water grooves that our machine shop cuts. Details are available on request.



Since Thordon stock tube comes in standard lengths of 13" (330mm.), it will often be necessary to use several pieces to make one marine bearing. The multiple piece concept is common with Thordon bearings. The only precaution that must be observed on installation is that the water grooves must be aligned. In view of the risk of misalignment on installation, we recommend an annular groove (approximately the width and depth of the longitudinal grooves) be machined on one end of each piece where it will meet another piece. The annular groove allows water to flow from one spool to the next even if the grooves are not perfectly aligned.

Inside and outside diameters of the Thordon bearings machined from stock tube can be determined by following the detailed calculation instructions in chapters 3 and 4.

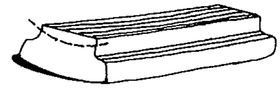
Stave Construction

1:3:1 STAXL Semi Finished Staves

Thordon STAXL staves are preformed profile sections, each designed to cover a range of housing and shaft diameters with a minimum of machining. All STAXL staves are 1000mm. (39.4") long. The profile of STAXL staves is designed so that, in most cases, the only machining required is the boring of the inside diameter after the staves have been installed in the housing, carrier, or machine shop rig; or fly cutting of the ID surface of each stave to the appropriate radius before fitting. In the fitting process it is often necessary to cut the edge of one or two staves to achieve the required circumference.

STAXL staves are available in seven different sizes in cross sections coded A to G. Dimensions of each stave cross section are shown on drawing TG11069 on page 46. For each cross section, a range of shaft and housing sizes is shown. This information should be used as a guide to the suitability of a specific STAXL stave segment for a particular combination of shaft and housing. In addition, the thickness of the stave should be checked to ensure that there is sufficient material to machine to the required dimensions. It should be noted that, in all cases, the inside diameter of the STAXL staves must be machined to the appropriate radius. Some rubber staves are designed for tangential contact between stave and liner. This is not possible with Thordon.

If a standard STAXL stave segment is not suitable for a given installation "as is", it is normally possible to adapt one by machining the side angles and outside diameter radius. Stave thickness should be checked to ensure that there is sufficient material for the I.D. machining. If a very thin stave is required, it may be necessary to machine the O.D. of the stave, or deepen the water groove as machining of the I.D. only might eliminate the water grooves.



The number of staves required for an installation will vary with the actual size of the housing and the l/d ratio of the bearing. It also will vary with the number and size of keepers used (if any). The number of staves required to make a complete circle for a specific installation can be determined by using the following formula:

$$\frac{C-K}{W}$$

where ***C=Circumference*** of housing
K=Total width of all keepers
W=Chordal width of stave to be used

Note 1) The number of staves is rounded up to the next whole number when one keeper strip is used, or to the next even number when two keeper strips are used.
Note 2) The above number, to make a complete circle, must be increased appropriately for bearing lengths greater than one metre (39.37"). Avoid multiple small pieces to make up the stave lengths. The following table gives the chordal width of each STAXL stave cross section:

STAVE SEGMENT	***CHORDAL WIDTH***
A	84 mm. (3.307")
B	78 mm. (3.071")
C	78 mm. (3.071")
D	75 mm. (2.953")
E	66 mm. (2.598")
F	58 mm. (2.283")
G	50 mm. (1.969")

The calculated number of staves required should be taken to the next highest number, or, in situations where two keeper strips are used, to the next highest even number.

1:3:2 Custom Moulded Staves

Thordon staves are also available in a fully moulded form. In this case full details of the housing and shaft including drawings where possible must be provided to Thordon Bearings Inc. in advance. Fully moulded bearings are designed to be fitted directly into the housing. No O.D. or I.D. machining is required. It may, however, be necessary to machine the side of the last stave during fitting. The staves would normally be fitted using the freezing method. If we are advised in advance that freezing will not be used, then we can provide staves suitable for a drive fit. In this case keeper strips will be required to prevent rotation of the staves in the housing. When installing fully moulded staves we recommend that the inside diameter of the bearing be checked after assembly of the staves to ensure that it is consistent with the calculated inside diameter as indicated in chapter 3.

The "housing" referred to in this section can be either the stern tube or strut itself, or a bronze carrier. In either case the housing must be in good condition, and the dimensions must be as indicated in the drawings provided to Thomson-Gordon, or the fully moulded staves will not fit correctly. In view of this requirement, and the fact that production time for fully moulded staves may be 6-8 weeks, this type of stave is more suited to new construction than to repair.

Fully moulded staves are available in XL, SXL or Composite grades.

1:3:3 No-Groove Staves

Most conventional propeller shaft bearings have a length/diameter (L/D) ratio of 4:1, but Thordon can be used with half of the normal length (L/D ratio 2:1). This concept is accepted by the majority of the Marine Classification Societies. Some Societies require that the bottom half of a 2:1 l/d ratio bearing have no water grooves. This concept (developed by Thordon Bearings Inc.) facilitates the formation of hydrodynamic film and therefore lower friction. To meet this requirement, XL and SXL staves designed with no water grooves are available.

1:3:4 Dovetail Staves

Thordon staves are also available in dovetail form for installation in slotted housings. Ten standard sizes are available for different dovetail groove and housing dimensions. All staves are supplied with a flat top to be machined or bored after assembly and a standard 10° side angle. (15° side angle staves are available on special order). See the following table for stave dimension details.

NAME	SIZE NO.	(A) CHORD WIDTH		(B) THICKNESS	
		mm	inches	mm	inches
Boyne	1	43.00	1.693	0.875	7/8
Dnestr	2	46.18	1.818	0.875	7/8
Larch	3	49.61	1.953	0.938	15/16
Nethe	4	52.53	2.068	0.938	15/16
Rufiji	5	55.70	2.193	0.938	15/16
Eagle	6	58.88	2.318	0.936	15/16
Halil	7	70.00	2.756	1.063	1-1/16
Pelly	8	74.75	2.943	1.063	1-1/16
Nemunas	9	77.93	3.068	1.189	1-3/16
Tejo	10	81.10	3.193	1.189	1-3/16

Thordon dovetail staves are designed to be freeze fitted into the dovetail housing or carrier. After installing all the staves they must be line bored to the correct inside diameter. Many rubber type staves are designed with flat interior surfaces. This approach cannot be used with Thordon. A contoured inside surface is essential in all cases where Thordon is used. One acceptable alternative to line boring is fly cutting of each stave prior to installation.

1:4 LUBRICATION

1:4:1 Water

Water is the most common lubricant used with Thordon propeller shaft bearings. A positive flow of cooling water from a pump source is recommended. The flow rate should be 1 U.S. gallon per minute per inch of shaft diameter (0.15 litres/minute/mm.).

An increased water supply during the initial break in period is recommended if possible. Two water supply pipes are preferable to one large one. The cooling water should be as close as possible to the temperature of the water in which the vessel is operating. Water which has already been used to cool the main engine or other machinery before it reaches the bearings may not be suitable. Water over 60 deg C (140° F) can not be used as it will have a detrimental effect on the Thordon bearing.

Water should be injected ahead of the inboard bearing in a stern tube. Thordon bearings can run without water for a very limited time, but any sign of heating should be investigated immediately. For larger installations, temperature sensors and water flow alarms are recommended to ensure that an adequate flow of cool water is being maintained. If a vessel equipped with Thordon XL or SXL bearings spends a significant amount of time manoevering in very shallow or dirty water, consideration should be given to providing a source of clean water for bearing lubrication. A strainer or cyclone separator system can be used or even a temporary source of clean water (either sea ballast or fresh). The life of the bearings will be extended if clean lubricating water is supplied to the bearings under these conditions.

1:4:2 Oil

Thordon XL can be used in an oil filled stern tube if precautions are taken to ensure that the bearings are properly cooled. Due to the high viscosity and lower specific heat of oil (compared to water), and the low thermal conductivity of Thordon, there will be more heat buildup at the bearing surface than with traditional white metal bearings. This heat build up can be overcome by using an oil circulation pump and by ensuring that the stern tube is cooled by exposure to sea water in a flooded afterpeak, or by using a heat exchanger. Standard Thordon running clearances should be used in an oil lubricated system (not those for white metal). Provision should be made for thermal expansion. For oil lubricated stern tube installations we recommend that you consult your local Thordon distributor/technical representative, or Thordon Bearings Inc.

1:4:3 Grease

Grease lubrication of Thordon propeller shaft bearings is not recommended because grease cannot facilitate heat dissipation readily.

1:4:4 Thor-Lube

In the mid 1980's Thordon Bearings Inc. developed a unique pollution free stern tube system as an alternative to the conventional oil/white metal system. The system uses Thordon XL bearings and our special Thor-Lube lubricant. Thor-Lube is a completely water soluble lubricant which therefore eliminates pollution problems related to seal failure. The combination of Thor-Lube and Thordon XL bearings provides lower start up friction than a conventional oil/white metal system. Thor-Lube systems are available for new construction projects as well as for conversion of existing ships from other oil lubricated tailshaft systems. Detailed information on the Thor-Lube system is available from your Thordon distributor or from Thordon Bearings Inc.

CHAPTER 2

RUDDER BEARINGS
2:1 GENERAL

Thordon rudder bearings have become very popular for large and small vessels because of their long life and their ability to withstand impact and abrasion. Supplied in either tube or stave form, Thordon rudder bearings can operate with any type of lubrication - water, grease, oil, or, in the case of SXL, they can operate with no external lubrication at all. Water lubrication, or no lubrication are preferred because this eliminates the need for lubrication lines and pollution associated with grease lubrication. Where Thordon rudder bearings are expected to run dry, Thordon SXL grade should be used rather than XL because SXL has a lower dry coefficent of friction. SXL is also recommended for highly loaded submerged rudder bearings because its lower coefficient of friction provides better performance when high pressure reduces the lubricating properties of water.

Thordon bearings can be specified in all rudder bearing locations including stock, pintle and carrier bearings as well as bearings for tiller arm steering machines. On some spade rudder designs for military vessels Thordon SXL TRAXL bearings are recommended due to the high pressures generated by extreme manoevres at high speeds. In some older rudder configurations Thordon is not recommended for use in the bottom pintle position.

Thordon rudder bearings are now approved by some classification societies for pressures to 12 N/mm^2. This allows the designer to more closely match bearing pressure limits to the bending and torsion requirements for the rudder stock. Significant weight and cost savings can be achieved as well as a more slender rudder profile.

CYLINDRICAL BEARINGS

2:2:1 Complete tube

The most common type of Thordon rudder bearing is XL or SXL in tubular form. Because rudders move very slowly over a limited range, there is no need for a forced cooling water system, and therefore no need for the water grooves normally found in propeller shaft bearings. A full range of Thordon SXL rudder bearings in nominal diameters from 300 mm. (12"0) to 950 mm. (37") and an L/D ratio of 1.5:1 is available. Larger sizes can be supplied. Rudder bearings can also be made from standard stock Thordon tubes, although several tubes (normally 330 mm. (13") long) may be required to make a complete bearing.

Thordon rudder bearings are normally supplied in semi finished form for machining to the final dimensions required. (See chapters 3 and 4 for dimensioning and machining instructions.) Your local Thordon distributor also can supply fully finished bearings machined to the required dimensions and ready to install, if he is given the correct housing, shaft and operating environment information.

2:2:2 Split bearings

It is sometimes preferable to use split tubular bearings rather than complete tubes. Split bearings facilitate installation without removing the complete rudder, or completely dismantling the steering gear. Any Thordon tubular bearing can be split to facilitate installation. A standard milling machine is normally used for this purpose, although Thordon Bearings Inc. has developed technology for splitting rudder bearings without a saw cut, thus leaving no gap. If the splitting is accomplished by milling, then shims are normally used to fill the gap left by the cut. Assuming that the shims are the same width as the cut, then the bearings can be fully machined before cutting. Alternatively, they can be cut (split) in their semi finished form, and then bonded back together with **TG-75** for machining. This approach avoids the requirement for shims. Split bearings can be fitted with the same interference fit as tubular bearings. The inside diameter of the split bearings should be relieved along the edges of the split.

2:3 Stave Construction

Stave type bearings are sometimes used for large rudder installations, particularly for retrofit when it is desirable to avoid unshipping the rudder assembly or steering gear. Thordon XL or SXL can be supplied in stave form. Working with staves usually requires more time and labour than working with tubes, so the use of tubes is recommended when feasible. If Thordon is replacing laminated phenolic for example, just because the phenolic bearings was made in stave form is no reason to make the replacement Thordon bearing from staves.

2:3:1 Semi Finished Staves

A complete range of semi finished Thordon rudder bearing staves has not been produced because of the general preference for tube type bearings. Some sizes are available, however, for particularily large diameters and details are available from Thordon Bearings. Other sizes can be produced on request. Semi finished rudder staves are moulded to suit the required O.D., but must be machined on the I.D. to suit the specific stock dimensions and clearance requirements. The difference between rudder staves and STAXL propeller shaft staves is that the former do not have water grooves.

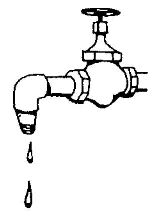
2:3:2 Fully Moulded Staves

When time permits, fully moulded rudder staves, ready to install, can be produced. To do this, Thordon Bearings Inc. must have full details of the housing, shaft and operating environment at least 6 weeks lead time before the staves are required.

2:4 LUBRICATION

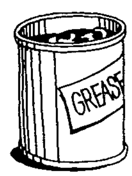
2:4:1 Water

Pintle bearings are immersed under most loading conditions. Stock bearings may operate wet or dry. Since SXL is designed to run dry it is generally the best choice, allowing standardization. SXL is also recommended for highly loaded rudder bearings. The maximum recommended operating pressure for a water lubricated XL bearing is 5.5 N/mm2 (750psi). For SXL, water lubricated or dry, this limit can be raised to 12 N/mm2 (1680 psi). Thordon Bearings has no evidence that a water lubricated rudder stock or pintle bearing will last any longer than one operating dry.



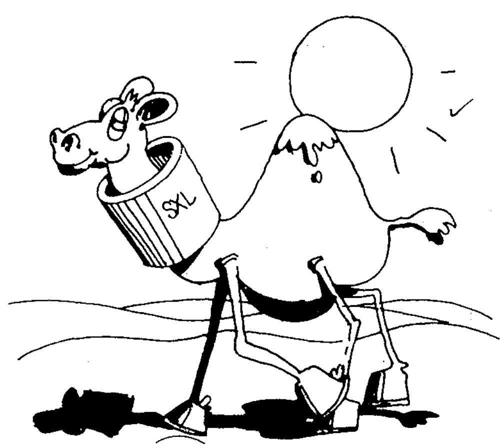
2:4:2 Grease

Grease lubrication can be used with any type of Thordon rudder bearing if the assembly is designed for grease lubrication. However, since one of the advantages of Thordon SXL is its ability to run dry, removal of an existing greasing system tends to make the Thordon installation more cost effective and eliminates a potential source of pollution.



2:4:3 Dry Running

If a rudder bearing is expected to run dry, Thordon SXL should be used. An initial application of grease will facilitate assembly and initial bedding in of the bearing.

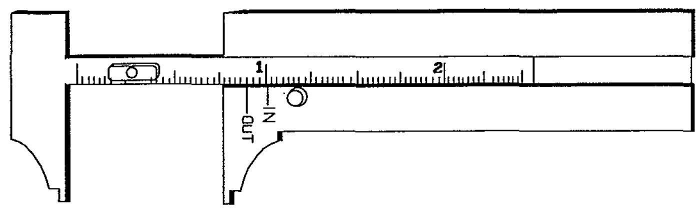


CHAPTER 3

DIMENSIONING

3:1 GENERAL

Dimensioning procedures for Thordon bearings are different from traditional bearing materials. Thordon bearings cannot be made to the same dimensions as the bronze, rubber, wood or other bearing materials they may be replacing. This chapter will provide the information necessary to dimension Thordon bearings. The process should be followed in the sequence indicated.



3:2 INFORMATION REQUIRED

The following information is required for dimensioning a Thordon bearing:

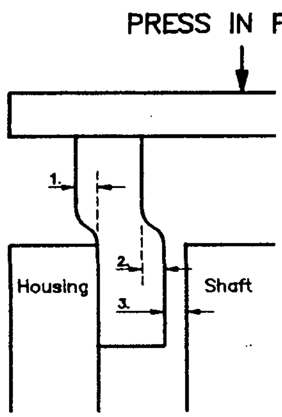
Housing:	***Maximum diameter*** ***Minimum diameter*** ***Roundness***
Shaft:	***Maximum diameter***
Temperature:	***Minimum expected operating temperature*** ***Maximum expected operating temperature*** ***Ambient temperature in the machine shop***
Lubrication:	***Water, Thor-lube, oil, grease, or none***
Application:	***Propeller shaft, rudder, or other***

It is important to check that the housing is round and has not been worn or pounded into an oval shape. Thordon, being a flexible elastomer, will adapt to the shape of the housing. See Chapter 6 for installation instructions if dealing with an out-of-round housing.

Prior to calculating bearing dimensions, the housing should be checked for alignment. If reboring is necessary, the bearing O.D. can then be sized to the new housing dimensions. If reboring is not appropriate see Chapter 6 for alternative installation procedures.

3:3 BEARING OUTSIDE DIAMETER
TUBE TYPE BEARINGS

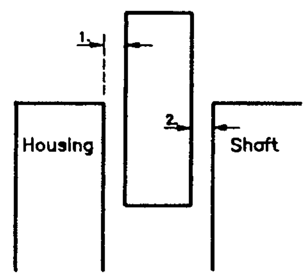
INTERFERENCE FIT PARAMETERS



Where: 1. Is Interference.
2. Is Bore Closure.
3. Is Installed Running Clearance.

Note: Minimum Installed Clearance =
Running Clearance
+ Thermal Expansion Allowance (if aplicable)
+ Water Swell Allowance (if applicable)

BOND FIT PARAMETERS



Where: 1. Is Bond Thickness
2. Is Installed Running Clearance.

Note: Minimum Installed Clearance =
Running Clearance
+ Thermal Expansion Allowance (if aplicable)
+ Water Swell Allowance (if applicable)

3:3:1 Interference

Thordon bearings are normally installed with an interference fit. The amount of interference will vary with the size of the bearing and with the minimum temperature at which it will operate. Additional interference is required for cold operation. Pages 39-42 provide graphs showing recommended interference at different variances from machine shop ambient. In all cases you should use the lowest temperature to which the bearing could possibly be exposed. Additional interference causes no harm, but insufficient interference for cold operations could cause the bearing to come loose in the housing. The amount of interference required should be added to the maximum housing diameter to give the minimum bearing outside diameter.

3:3:2 Machining Tolerance

The appropriate machining tolerance should be added to the minimum bearing O.D. figure calculated in 3:3:1 to give the maximum bearing O.D. Refer to page 24.

3:3:3 Summary

Maximum Housing O.D. + Interference = Minimum Bearing O.D.

Maximum Housing O.D. + Interference + Machining Tolerance = Maximum Bearing O.D.

3:4 BEARING INSIDE DIAMETER
TUBE TYPE

3:4:1 Bore closure

Bore closure is the diametral reduction of the bearing I.D. that occurs when it is installed in a housing using an interference fit to hold it in place. The interference oversize is transferred to the bearing I.D. Page 43-44 gives the percentage of bore closure. This percentage should be applied to the average interference (calculated interference plus 50% of housing tolerance and 50% of machining tolerance on the bearing O.D.). The resultant figure will be the amount of expected bore closure. Actual bore closure may vary +/-15% from the calculated amount. Since the volume of a Thordon bearing at any given temperature remains constant, constraining the O.D. results in a reduced I.D. and a slight increase in length.

3:4:2 Running clearance

The recommended running clearance for Thordon bearings is given on Pages 37-38.

3:4:3: Dimensional changes due to water absorption

When immersed in water, Thordon only increases in volume 1.3% under normal conditions. Some of this expansion simply increases the amount of interference, but there is also an effect on the inside diameter of the bearing and length of the bearing. The normal water swell "Cs" calculation is:

Cs (diametrical) = .011 x wall thickness

Although axial water swell is not normally significant for propeller shaft bearings, it can become a significant factor for large rudder bearings. The calculation for axial water swell where required is:

Cs (axial) = .005 x Length

Thordon swells slightly more in warm water. An additional allowance should be calculated if the water temperature is higher than 25 deg C (80 deg F). Axial swell is important when calculating the gap to leave between the last bearing spool and the ring keeper. Refer to paragraph 3:6:6.

3:4:4 Thermal Expansion

In cases where the maximum operating temperature of a bearing exceeds by more than 10 deg C (18 deg F) the ambient temperature in the machine shop where it is machined, an allowance for Thermal expansion should be included in the bearing I.D. calculation. Thermal expansion is calculated as follows:

Ct = 2W x # x (To - Ta)

where:

Ct = thermal expansion allowance
W = bearing wall thickness
# = coefficient of Thermal expansion for Thordon as follows:

XL (Centigrade)= 0.000178 ***XL*** (Farenheit)= 0.000099

SXL (Centigrade)= 0.00023 ***SXL*** (Farenheit)= .000128

To = Maximum operating temperature
Ta = Machine shop ambient temperature

3:4:5 Machining Tolerance

The appropriate machining tolerance must be included in the bearing I.D. calculation.

3:4:6 SUMMARY

Maximum shaft diameter
+ Bore closure allowance
+ Running clearance
+ Water swell (if any)
+ Thermal expansion (if any)

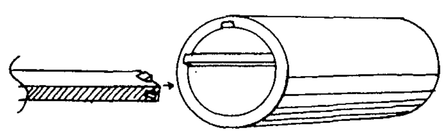
= Minimum Bearing I.D.

+ Machining tolerance

= Maximum Bearing I.D.

For standard shaft (or liner) sizes in propeller shaft bearing applications refer to Thordon Marine Bearing Standard Size List.

3:5 WATER GROOVES



3:5:1 Propeller Shaft Bearings

Thordon propeller shaft bearings should always have water grooves to facilitate an adequate flow of cooling water. Most small propeller shaft bearings are supplied with water grooves already moulded in place. When water grooves must be machined into an ungrooved tube, drawing TG-10520 (page 48) provides the necessary water groove design information. Some Thordon bearings, especially the Compac style 2:1 length/diameter ratio bearings, are supplied with water grooves in the top half only. This design improves hydrodynamic performance.

3:5:2 Rudder Bearings

There is no need for water grooves in Thordon rudder bearings.

3:6 STAXL STAVES

3:6:1 Introduction

In the past we have used several different methods for dimensioning Thordon STAXL staves. As a result of our extensive field experience in recent years, a more precise dimensioning method has evolved that we now recommend for all installations.

3.6.2 Pre Assembly

We believe that pre assembly is the most accurate method of dimensioning Thordon STAXL staves. In this method the staves, at room temperature, are placed in the housing until a gap of less than one stave width is left. For most installations with two keeper strips, each half of the bearing would be dimensioned separately. Once the staves have been placed in the housing use threaded jacking bars, a small Enerpac or other similar means to press them together to eliminate any gaps. (Refer to illustration on page 17.) With the staves pressed together measure the gap between the last stave and the keeper. Note this measurement.

3.6.3 Interference Calculation

Using the appropriate graph on pages 39-42 determine the recommended diametrical interference (as recommended for a tubular bearing in section 3:3:1). Multiply the diametrical interference by pi (3.1416) to convert it to a circumferential interference. In the typical case of two axial keeper strips, where each half of the bearing is dimensioned separately, divide the circumferential interference in two.

3:6:4 Final Stave Width

Add the calculated interference 3:6:3 (for the full or half bearing as appropriate) to the measured gap 3:6:2 to determine the required width of the final stave. Mill the last stave to this width.

3:6:5 Stave Assembly ID

IN ALL CASES THE ID OF THORDON STAXL STAVES MUST BE MACHINED TO THE APPROPRIATE DIAMETER. STAVES ARE SUPPLIED FLAT ON THE ID, BUT, UNLIKE SOME RUBBER STAVES, THEY CANNOT BE USED WITH THE FLAT ID. IT MUST BE CONTOURED.

Normally staves are line bored after installation in the housing, carrier, or machine shop dummy housing. In this case the inside diameter of the bearing will be maximum shaft diameter plus running clearance (3:4:2) plus water swell (3:4:3, plus thermal expansion allowance (3:4:4)(if required). Machining tolerance should be as indicated in 3:4:5.

3:6:6 Longitudinal Water Swell

End keepers or stops are always recommended with Thordon bearings as added security to prevent axial movement in the event of unbalanced loads, excessive vibration, or other unanticipated factors. A gap should be left between the end keeper and the staves to allow for axial water swell. This gap should be:

0.005 x bearing length

3:6:7 Encapsulated Keeper Strips

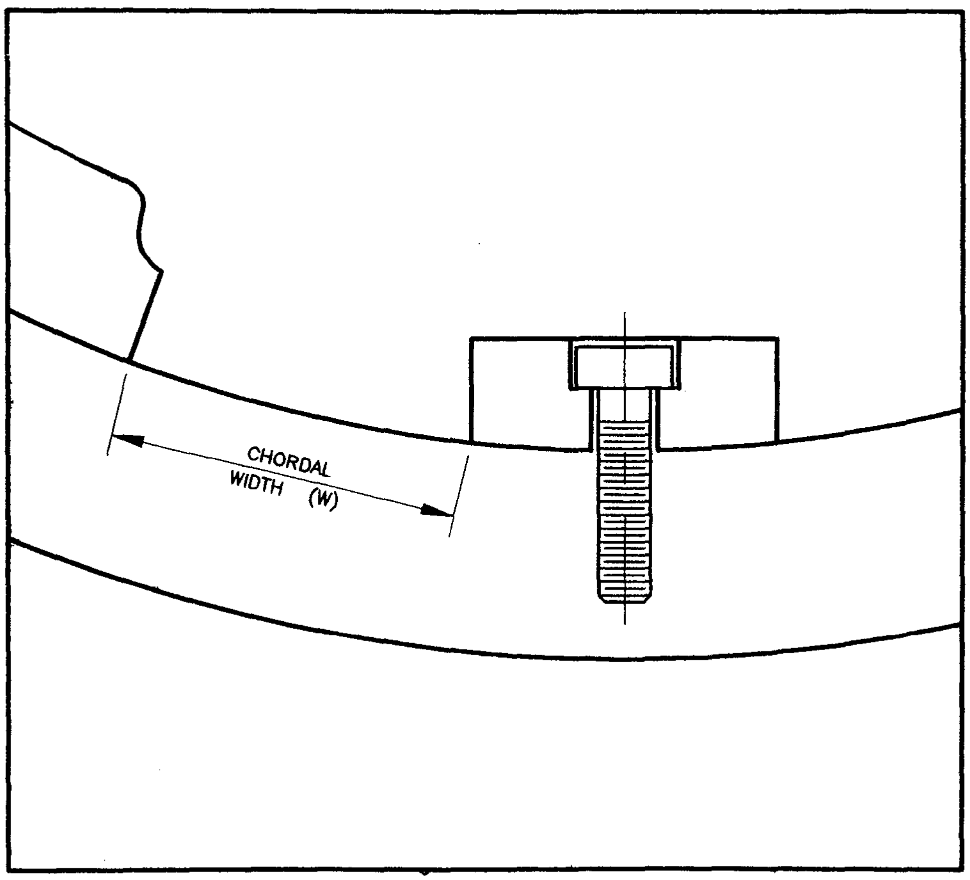
Occasionally stave installations are designed so that keeper strips fit into machined grooves in the back of staves rather than between staves. In this case dimensioning should be the same as for an installation using no keeper strips. Grooves should be machined in the backs of the appropriate staves. These grooves should provide ample clearance over the keepers so that a proper fit can be achieved even when the staves are frozen.

3:7 Dovetail Stave Assemblies

Thordon staves are also available in dovetail form for dovetail (slotted) housings.

Thordon Dovetail staves are designed for interference fitting into the slotted carriers. This ensures a snug fit throughout the length of the stave. Interference can be calculated using the same interference graphs as are used for tubular bearings (pages 39-42). For "Housing diameter" use the average slot width. The amount of interference will be the amount of oversize required on the stave width. The standard side angle of Thordon dovetail staves is 10 degrees. If the carrier has a 15 degree side angle, then the staves should be milled to suit.

The ID of the Thordon dovetail stave assembly must be machined. Although a flat interior surface is acceptable for some rubber staves, it is not acceptable for Thordon. The ID of the Thordon dovetail stave assembly should be calculated using the same approach as for tubular bearings except that bore closure need not be considered. the bearing ID will be shaft diameter plus running clearance (3:4:2) plus water swell (3:4:3) plus thermal expansion allowance (3:4:4) if required.



Use threaded jacking bars, a small Enerpac or other similar means to press the staves together so the chordal width (w) can be measured.

CHAPTER 4

MACHINING AND MEASURING THORDON

4:1 GENERAL MACHINING

Thordon is a hard tough elastomeric polymer product that can be easily machined. It is necessary, however, to remember that Thordon is a non-metallic, and must be machined differently than metal. Due to the elastomeric nature of Thordon it has a tendency to "move away" from anything that exerts pressure on it, including machine tools of all types. Thordon cannot be burnished or chipped, it must be **cut** with a **sharp** tool. The importance of sharp cutting tools can not be over emphasized if Thordon is to be successfully machined.

When thin wall bearings are being machined it is important to recognize that the exertion of excess pressure may actually deform the bearing. In some situations it may be necessary to use modified chuck jaws, to support the tube using a spider, plug or a mandrel or to mount the tube using a face plate.

Cutting speeds are also important. Low feed rates combined with too low a turning speed tend to produce a rough cut due to the toughness and elastomeric nature of Thordon. High speeds combined with a low feed rate may produce excessive frictional heat which results in a gummy galled finish. The most suitable speed/feed combinations are similar to those used when machining aluminium.

Clearances, as specified using the design information in this manual, may seem excessive in comparison to metals. Thordon, however, expands from temperature change and submersion in water as well as exhibiting bore closure shrinkage at a rate greater than 100% of interference. This is due to the incompressible nature of Thordon. The minimum installed clearance takes all of these factors into account. As well, clearance for a liquid lubrication film if the bearing is water or oil lubricated **and** safety clearance for frictional heat build up is also accounted for. The recommended running clearance should **not be decreased** with out first consulting your Thordon distributor or Thordon Bearings Inc.

NOTE: Failure of the bearing is almost certain if adequate running clearance is not provided.

Virtually all operations that can be performed on metal, including machining, drilling, tapping, shaping, routing, sawing, milling and bonding, can be performed on Thordon. Thordon can also be worked or shaped with conventional hand tools. Keep in mind that carbide tipped cutting tools should be used to prevent heat build up and improve tool life.

4:2 MACHINING XL AND SXL

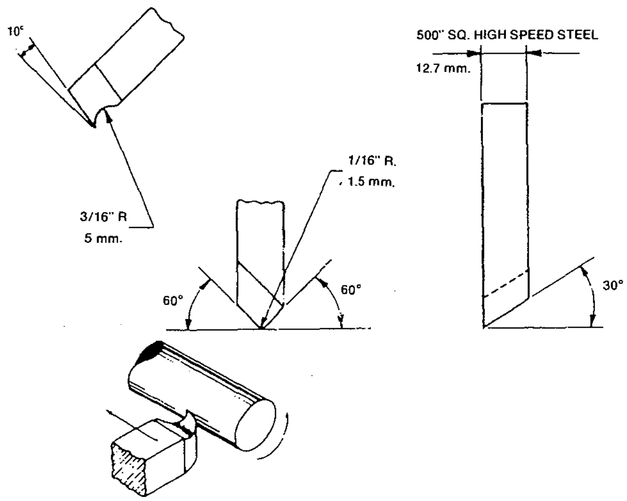
4:2:1 Cutting Tool

To machine Thordon it is critical that the correct cutting tool be used. The tool must be designed to slice and project the material away from the machined surface. When machining Thordon a continuous streamer is projected from the cutting tool. The cutting tool **must be sharp.** After grinding, the cutting tool should be honed with an oil stone to ensure a sharp cutting edge.

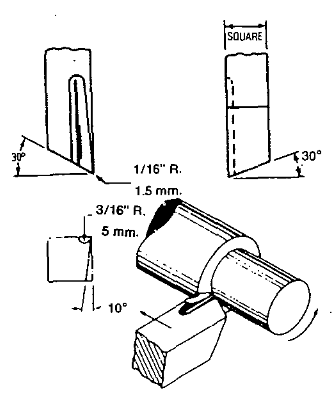
It is important when machining Thordon and particularily when boring, to ensure that the machining streamer is removed from the work. If this is not done, it will interfere with the cutting tool and a rough finish will result.

The drawings below illustrate the proper cutting tool configuration. High speed steel may be used for SXL and Composite. Tungsten carbide tool bits must be used with XL.

General Machining Tool Bit



Step Machining Tool Bit



4:2:2 Machining Speeds and Feeds

Normal turning speeds for bearings of various diameters are given in the chart below.

BEARING DIAMETER METRIC	IMPERIAL	RPM
75mm	3.0"	600
150mm	6.0"	450
300mm	12.0"	300
450mm	18.0"	150
600mm	24.0"	120
750mm	30.0"	95
900mm	36.0"	80

Normal cutting feed rates are as follows:

METRIC — Coarse Feed: 0.50 to 0.60 mm/Rev
Fine Feed: 0.40 mm/Rev.

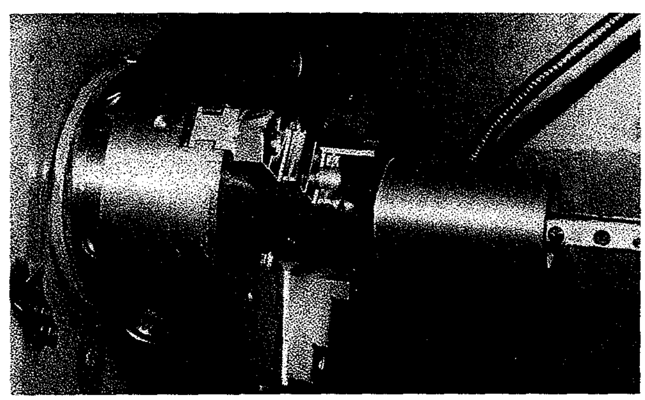
IMPERIAL — Coarse Feed: 0.020" to 0.025" /Rev
Fine Feed: 0.015"/Rev.

NOTE 1: The turning and feed speeds are provided as a guide only. The optimum speed may vary higher or lower depending on such variables as the length of tube, the wall thickness, and how the bearing is being supported, ie. simply chucked, spider at chuck or on a full length mandrel. As is common with all machining operations, some experimentation is required to obtain optimum results.

NOTE 2: Cutting lubricants are not required and are not recommended.

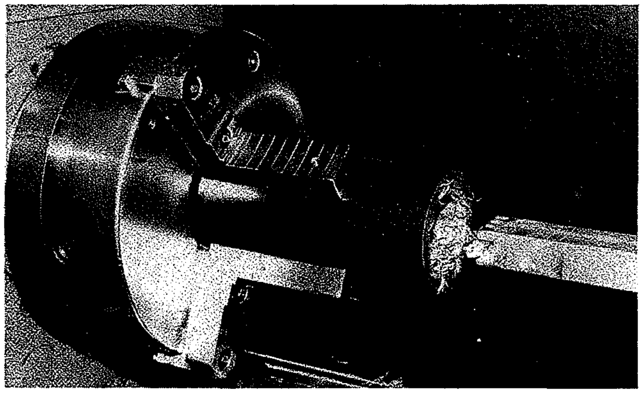
4:2:3 Bearing Set Up

Machining - Partial length from a tube:



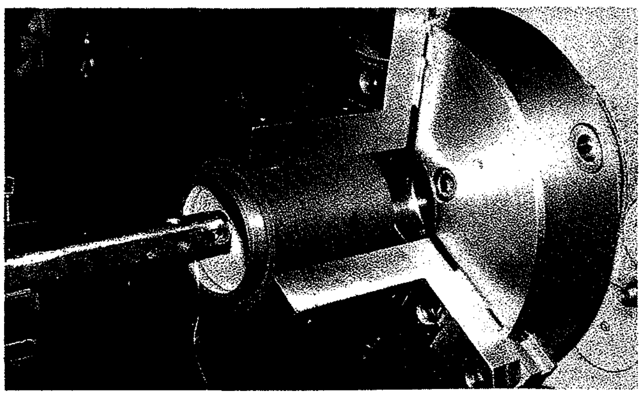
A bearing that is being made from the partial length of a tube can be chucked at one end in a normal 3 jaw chuck, the O.D. rough machined, the I.D. finish machined, the O.D. finish machined and then parted to length. Care must be taken not to over tighten the chuck and distort the tube.

Machining - I.D. - thin wall tube with soft jaw chuck:



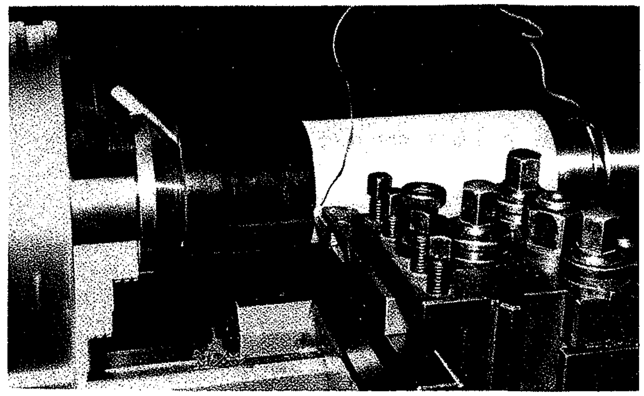
To machine the I.D. of a thin wall tube, the O.D. should be rough machined, the tube gripped in an extended soft jaw chuck and the I.D. finish machined. The extended chuck will grip and support the tube without deforming.

Machining - I.D. - thin wall tube with external sleeve:



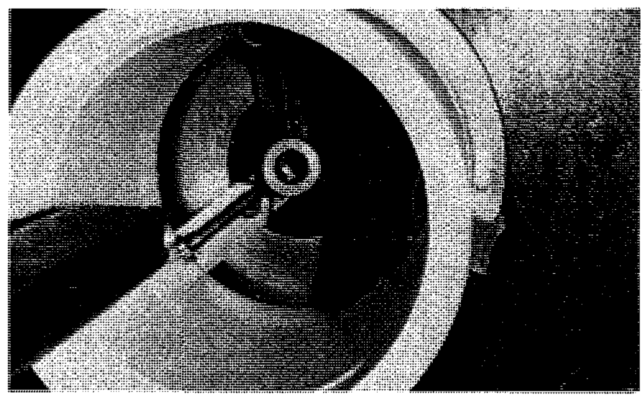
A thin wall tube I.D. can also be machined by first machining the O.D. to size, lightly pressing the tube into a machined metal housing, chucking the housing and then machining the I.D. of the tube. It is possible to obtain tighter tolerances than those obtained with external soft jaws with this method but it is more involved and usually not necessary.

Machining - O.D. - full length of a lubrication grooved bearing - supported on centres:



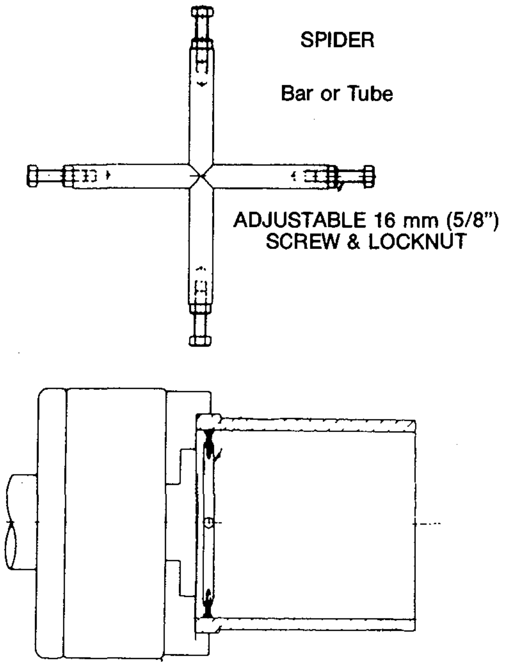
After the I.D. of a bearing with lubrication grooves has been finish machined the bearing can be chucked on centres, driven by a key in one of the grooves and the O.D. finish machined.

Machining - O.D. - machined steel plug or adjustable spider:

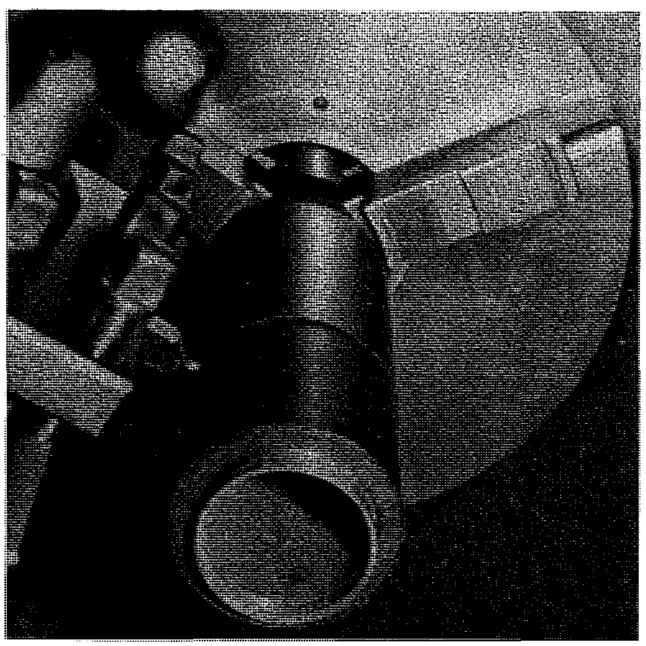


After the I.D. of a tube has been finish machined, a machined steel plug can be slip fit into the I.D. of the bearing. On larger tubes a 3 or 4 arm spider can be set to the inside diameter of the tube and located opposite the chuck jaws. Both of these devices eliminate distortion from chuck jaw pressure. A simply constructed 4 arm spider is illustrated on the following page. With either of these methods it is necessary to add a 50 mm (2.0") chucking allowance to the required length of the bearing.

Adjustable Spider

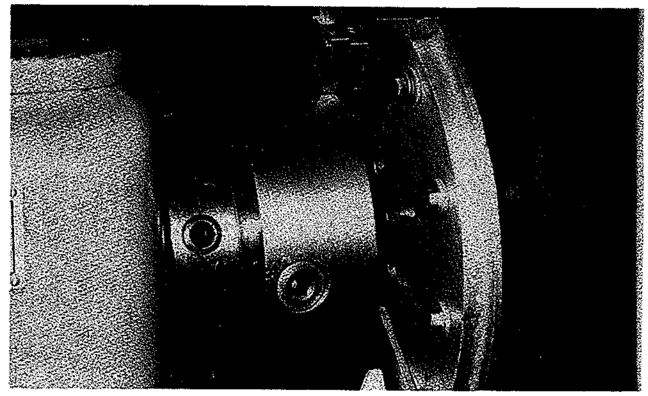


Machining - O.D. - stepped steel mandrel:



After the I.D. of the bearing has been finish machined, a stepped steel or Thordon mandrel machined to slip fit into the bearing and chucked in the jaws can be used to support the bearing for machining of the O.D. It is possible to obtain tighter tolerances with this method but it is more involved and usually not necessary.

Machining-O.D. and I.D.-tube mounted to a face plate



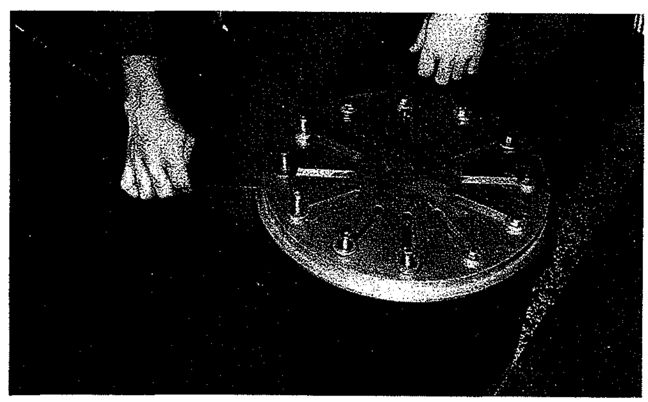
Bearings larger than 380mm (15.00") O.D. are most easily mounted for machining by lag screwing them to a face plate. The face plate can then be chucked in the lathe. An additional 50mm (2.0") must be added to the required length of the bearing as a chucking allowance.

The O.D. of the tube is rough machined first, then the I.D. finish machined, the O.D. finish machined and the bearing is then parted to length from the tube.

If the bearing is too large to safely catch as it is parted off from the tube, the following procedure should be used. Part the tube approximately 80-90% of the way through, remove face plate and tube from the lathe and knife cut the bearing from the tube.

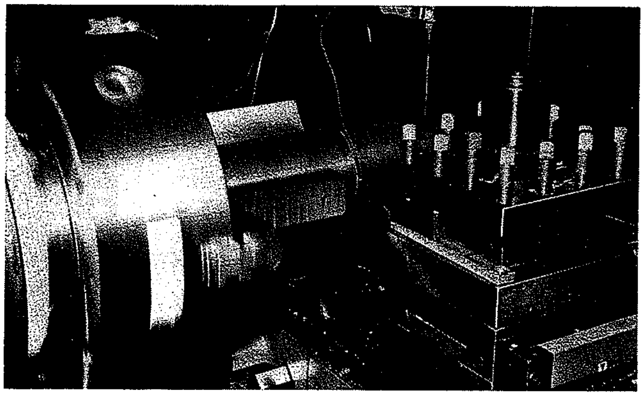
The bearing should be completely machined without stopping for extended periods of time. This prevents the bearing drooping or going out of round under its own weight.

NOTE: Ensure that the tube is securely mounted to the face plate before turning. Failure to mount the tube securely could result in the tube coming loose and causing personal injury.



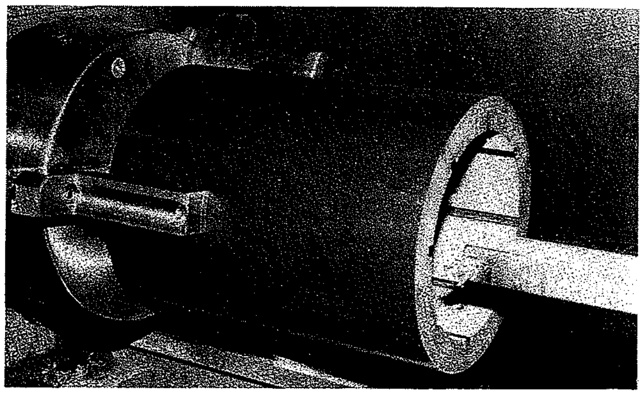
The face plate is centered as accurately as possible and then screwed to the tube. After mounting, the tube can be trued for machining, if required, by loosening the screws and adjusting the position of the tube using the slots in the face plate.

4:2:4 Parting to Length:



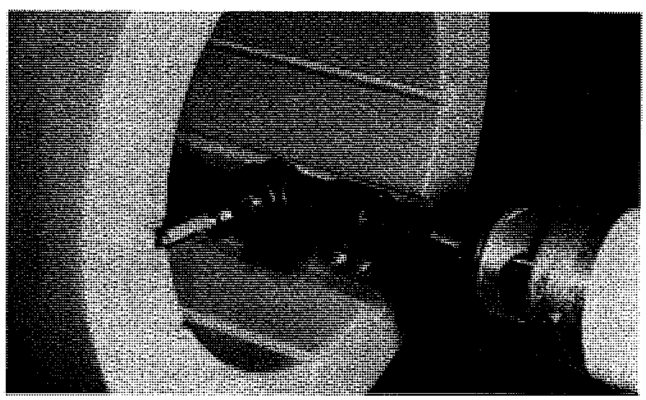
Thordon can be parted to length with a standard parting tool, however, additional rake and side clearance are helpful to prevent heat generation resulting from the Thordon contacting the side of the parting tool.

4:2:5 Machine lubrication Grooves:

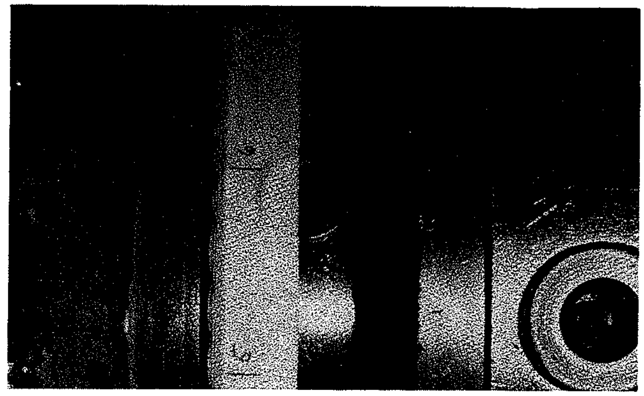


Lubrication grooves can be machined by hand or with a router.

To machine lubrication grooves by hand, a formed tool bit is mounted to the lathe boring bar and manually pushed through the bearing. Several passes may be required to achieve the final groove depth.



The grooves can be machined much more easily by mounting a router to the boring bar and then machining to the correct depth in one pass through the bearing.



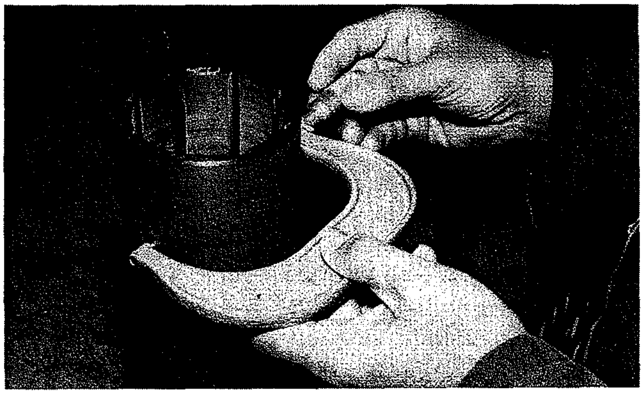
The outside diameter of the chuck can be divided and marked to act as a guide for locating the grooves in the bearing.

4:2:6 General Machining Tips:

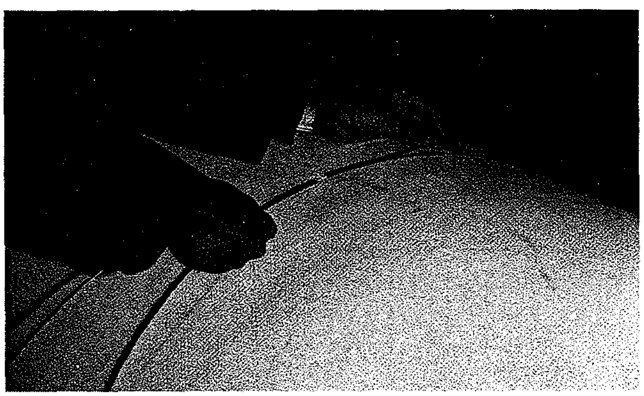
1. To obtain optimum dimensional and surface finish results the final machining cut should be 1.5 mm (0.060") to 2.5 mm (0.100") and the cutting tool razor sharp.
2. Machining must be performed in a controlled environment and with minimal heat build up. Changes in temperature can result in significant dimensional changes.
3. Due to the elastomeric nature of Thordon, if a machining error is made on the I.D. and if the wall thickness is still adequate, it may be possible to re-calculate the O.D. of the bearing and still use it. In other words, one can compensate for an I.D. machined too large by increasing the bearing interference.

4:3 DIMENSIONAL AND SURFACE FINISH MEASUREMENTS

4:3:1 Dimensional Measurements



In most cases Thordon can be measured using the same instruments and methods as any other material. It must be remembered that Thordon is an elastomer and a light touch must be used when measuring because it is possible to deform the bearing out of round. In addition, Thordon has a high coefficient of expansion compared to metals and measurements must be taken at machine shop temperature. If this is not possible then the dimensions must be corrected for the thermal expansion or contraction that has occurred because of the difference between the machine shop and ambient measuring temperatures.

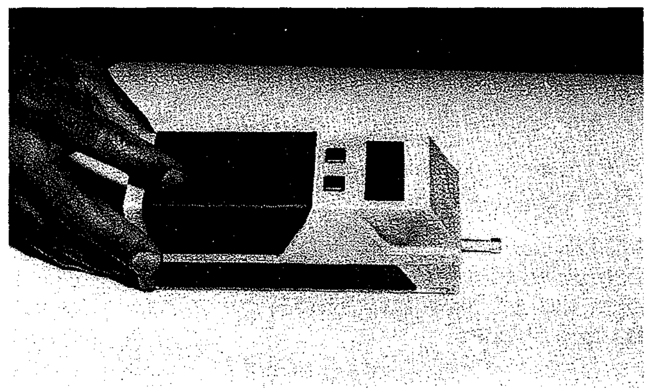


In the case of larger diameter, relatively thin wall bearings that have been machined and removed from the lathe, it is quite common to find that they go oval. This deformation can be the result of the bearing "sagging" under its own weight or from being secured to a pallet for shipping. The bearing may appear to be out of tolerance due to the fact that it has gone out of round. This is not a problem because when the bearing is pressed into a housing it will conform to the shape of the housing and will be round. To accurately measure the bearing outside the housing, use a pi tape to measure the O.D. and then measure the wall thickness to obtain the correct I.D. dimension.

A pi tape is a precision steel tape calibrated to measure diameters by measuring circumference.

4:3:2 Surface Finish:

Thordon, due to its non-metallic elastomeric nature, cannot be machined to as smooth a surface finish as metals. This is not a problem because the bearing goes through a normal break in period during which the inital surface roughness is worn smooth. This process can be enhanced by using T-G 8, Thordon's bearing break in lubricant. It is important, however, to strive for as good a surface finish as possible to reduce friction and initial break in wear. The mechanics of obtaining a good surface finish have been covered in the machining section but it is important to know how to measure the surface finish of a Thordon bearing.



Due to the non-metallic nature of Thordon it will tend to "feel" smoother to the touch in comparison to metal than what it really is. To accurately measure Thordon surface finish a stylus type of surface finish gauge should be used. Practical experience has shown that the use of a comparator will usually result in a value that is less than the actual value. This is because Thordon is softer than metal and "feels" smoother than what it actually is when measured with a stylus.

4:3:3 Machining and Surface Finish Tolerances

Thordon is a non-metallic and consequently cannot be machined to the same tight tolerances as bronze or other rigid materials. Conversely tight "metallic" tolerances are not necessary to obtain optimum performance. The standard Thordon machining tolerances are as follows:

Bearings up to 380mm (15.00")

O.D.	−0.00mm,	+0.13mm	(−0.000", +0.005")
I.D.	−0.00mm,	+0.13mm	(−0.000", +0.005")

Bearings between 380 and 600mm (15.00" and 24.00")

O.D.	−0.00mm,	+0.18mm	(−0.000", +0.007")
W.T.	+0.00mm,	−0.13mm	(+0.000", −0.005")

Bearings over 600mm (24.00")

O.D.	−0.00mm,	+0.25mm	(−0.000", +0.010")
W.T.	+0.00mm,	−0.13mm	(+0.000", −0.005")

The tolerances on surface finish are as follows:

XL: 3.2 micro-metres (125 micro-inches)
SXL: 3.2 micro-metres (125 micro-inches)
Composite: 4.2 micro-metres (175 micro-inches)

NOTE: Due to the unique characteristics of Thordon, compared to metals, optimal performance can still be obtained at relatively high (compared to metal) surface finishes.

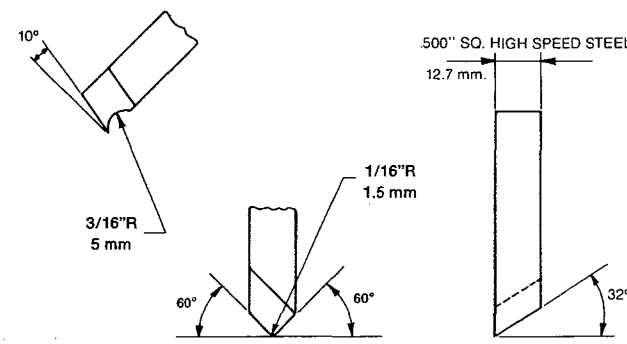
4:4 MACHINING COMPOSITE

Machining Thordon Composite is different than machining Thordon XL or SXL because of the softer Composite material that is used. The O.D., because it is regular Thordon, can be machined using the same techniques as outlined in section (b) Machining XL and SXL. The I.D., however, machines differently and that is what will be covered in this section.

4:4:1 Cutting Tool

The cutting tool for machining Composite should be made to the configuration illustrated below. As with other types of Thordon it is essential that the cutting tool is kept sharp. Even with the correct cutting tool, it is necessary to grind the inside diameter on the final cut to obtain an acceptable surface finish. This operation will be explained in detail in the grinding information section following.

High Speed Steel Cutting Tool



4:4:2 Machining Feeds and Speeds

Normal turning speeds for Composite bearings of various diameters are given in the chart below.

BEARING DIAMETER		
METRIC	IMPERIAL	RPM
150mm	6.0"	250
300mm	12.0"	100
450mm	18.0"	75
600mm	24.0"	60
750mm	30.0"	50
900mm.	36.0"	40

Normal cutting feed rates are as follows:

METRIC — 0.40 mm to 0.50mm/Rev.

IMPERIAL — 0.015" to 0.020"/Rev.

NOTE 1: The turning, feed and grinding speeds are provided as a guide only. The optimum speed may vary higher or lower depending on such variables as the length of tube, the wall thickness and how the bearing is being supported. As is common with all machining operations, some experimentation is required to obtain optimum results.

NOTE 2: Cutting lubricants are not required and are not recommended.

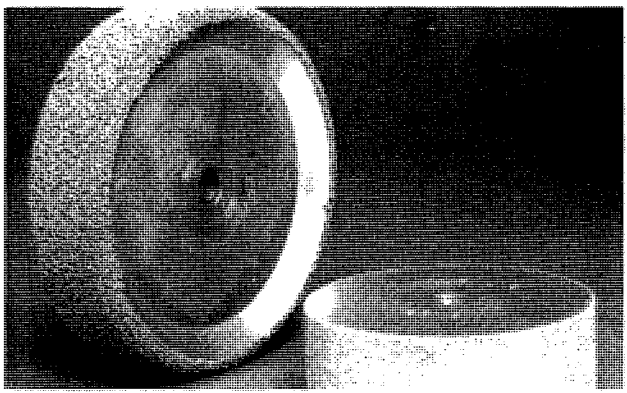
4:4:3 Machining Procedure (O.D. up to 250mm (10.0"))

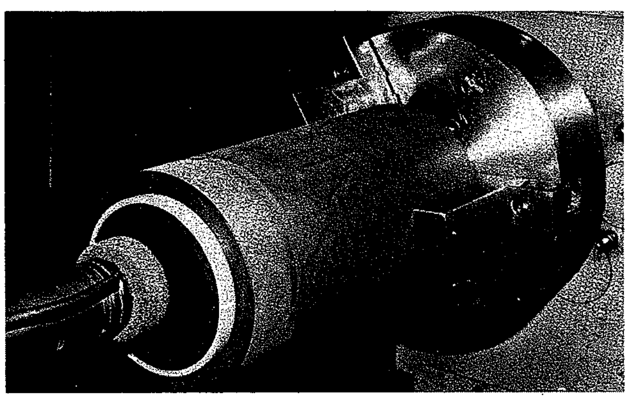
The procedure for machining Thordon Composite bearings up to 250mm (10.0") O.D. can be summarized in the following steps.

a) Part the bearing oversize and face to the required finished length.

b) Mount the bearing on centres and rough machine the O.D.

c) Press the bearing (light press fit) into a housing to support it and machine the I.D. to within 0.25 to 0.40mm (0.010" to 0.015") of the finished dimension. To achieve a satisfactory surface finish it is necessary to grind the Composite lining to its finished dimension using a fine coated tungsten carbide grinding hog (shown below).





d) Grind the I.D. to the required dimension. The grinding pass should only be 0.25 to 0.40mm (0.010" to 0.015") deep and at a feed rate of 0.50 to 0.60mm/Rev. (0.020" to 0.025"/Rev.)

The turning speeds when **grinding** composite based on the above are:

BEARING DIAMETER		
METRIC	IMPERIAL	RPM
150mm	6.0"	55
300mm	12.0"	50
450mm	18.0"	40
600mm	24.0"	30
750mm	30.0"	25
900mm	36.0"	20

The grinding hog should be operated with a peripheral speed between 12.5 - 15.5m/sec. (2500 - 3000 fpm) and the bearing rotated in the opposite direction to the grinding hog.

e) Lightly press the bearing onto a mandrel and finish machine the O.D.

4:4:4 Machining Procedure (O.D. larger than 250mm (10.0"))

Composite bearings larger than 250mm (10.0") are best machined by mounting them to a face plate and then machining and grinding the I.D., machining the O.D., parting oversize and facing to length.

NOTE: Ensure that the bearing is securely mounted to the face plate before turning. Failure to mount the bearing securely could result in the bearing coming loose and causing personal injury.

4:4:5 Finish Machining a Composite Bearing without Grinding

Finish machining the I.D. of a Composite bearing by grinding is the recommended method, however it is possible to finish machine using a conventional tool bit and achieve acceptable results. The procedure that must be used is the following:

a) Rough machine the I.D. of the bearing so that the finish machining operation can be done in two EQUAL passes approximately 2.0 to 3.0mm. (0.080" to 0.120") deep.

b) Two equal machining passes are required because the Thordon Composite bearing lining material wears tool bits very quickly. In the course of one machining pass through the I.D. of a typical bearing tool bit wear can result in a taper of 0.15 mm. (0.006") from one end of the bearing to the other. The first pass is used to predict what the amount of taper is going to be. The second pass is then used to correct for the expected taper based on the first pass.

c) To make the required correction a dial indicator is set up on the lathe tool post and the tool post marked in 25 mm. (1") increments. If the amount of taper is equal to 0.15mm. (0.006") over the length of a 300mm. (12.0") bearing then a correction of 0.013mm (0.0005") per 25mm. (1.0") of bore length is required. The correction on the dial indicator will be half of this amount which is 0.0065 (0.00025") per 25mm. (1.0") of bore length.

d) The correction is made while machining by tapping the tool post over an amount equal to 0.013mm. (0.0005") at 25mm. (1.0") increments along the bore as the final machining pass is being made. It is important to note that the final pass must be at the same depth, speed and feed rate as the preceding pass. Otherwise the amount of taper may increase or decrease and the correction that is being made will not be correct.

e) The burr that is left on the lubrication grooves must be removed using emery cloth. Although the surface finish of the bearing will be somewhat rough it will bed in quickly and perform well.

CHAPTER 5

MATING SURFACES -HOUSINGS

5:1 Mating Surfaces - Hardness

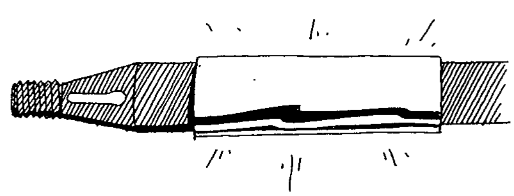
5:1:1 Bronze

Bronze is probably the most commonly used shaft liner material in marine service. It resists sea water corrosion, is easily machined, commonly available, and can be shrunk onto shafts without major problems. The only bronze we have encountered that has given adverse service has been nickel aluminum bronze. We suspect that the aluminum content is etched out by electrolytic action of sea water corrosion, producing sharp grain boundaries that have in turn been abrasive to bearings. Poor quality porous bronze castings should be avoided for similar reasons.

There is a vast range of materials commonly called bronze. Two specific types which have given good service with Thordon, and that are fully approved by Lloyds, are Gunmetal (88% Cu, 10% Sn, 2% Zn) and "70-30 Copper Nickel". Both are relatively hard.

In general bronze is not a highly wear resistant material. If abrasive content exists, regardless of the bearing material, bronze will be worn away more quickly than harder materials. It is generally true that the harder the shaft liner material, the longer its life will be against almost any bearing. Considering bearing materials in general, it is also true that harder bearing materials will tend to create more liner wear than softer materials, simply because the hard material presses the abrasive particles against the liner surface with more force than a softer material. This is one reason why we choose Composite bearings that have a special softer interior, when dealing with abrasive field conditions.

In conjunction with Thordon, bronze liners are acceptable for propeller shaft service as long as the vessel is not operating continually in abrasive conditions. In abrasive water, a harder liner material should be used.



For rudder applications bronze seems to be an acceptable liner material. Lower pintle bearing positions for vessels operating under dirty conditions should be equipped with a harder liner if wear has been experienced in this position.

5:1:2 Carbon Steel

Carbon steel shafts are relatively inexpensive in smaller sizes and as long as the corrosion problem is not too bad, (ie. fresh water service) these shafts can be fitted without liners. If, however, the vessel experiences a lay-over during which corrosion occurs on the shaft in way of the bearing a high bearing wear rate may occur upon start-up. This high wear is a result of the rough, corroded shaft surface effectively "machining" the Thordon bearing.

5:1:3 Hard Metal Sleeves

Sleeves manufactured from hard, corrosion and abrasion resistant steels are particularly common on tug or push boats operating in river systems. These operating conditions are usually very abrasive and a hard liner material is necessary for long life operation. There are many alloys available. Cost and availability play a role in selection. Some hard sleeves use a carbide coating such as boron carbide or tungsten carbide. They typically have hardnesses in the range of 50-60 Rockwell C. A flame sprayed coating of nickel, chrome or boron alloy over a stainless steel substrate provides consistently good wear performance in abrasive water conditions with Thordon Composite bearings.

5:1:4 Inconel 625

The U.S. Navy, and several other navies have experienced excellent results with submerged arc welded Inconel 625 alloy coatings. This alloy is a high nickel (60%) content, corrosion resistant, alloy that can be applied by cladding or in the form of a tubular liner or sleeve.

***Note*: Some classification societies will not permit welded liners, but many Naval authorities do.**

5:1:5 Stainless Steel

Stainless steel is not a particularly wear resistant material, this is particularly true of its easily machinable alloys. A liner should offer both good corrosion and abrasion resistance. This combination is often difficult to achieve; the most corrosion resistant alloys often offer poor abrasion resistance. We have had occasional reports of stainless steel shafts exhibiting substantial wear when running against a Thordon bearing. It is probable that the vessels were operating in abrasive water conditions. Some types of stainless steel shafting are good under abrasive conditions. Alloys with hardness higher than 30 Rockwell C would be the most appropriate. In very abrasive conditions, however, a separate hard liner should be fitted. (see 5:1:3)
A peculiar form of corrosion can take place on stainless steel if the surface is totally deprived of oxygen. This can happen with a soft rubber bearing on a vessel that is left idle for sometime. The shaft will exhibit signs of substantial corrosion in areas masked by adhesion to the rubber. We have not experienced this problem with Thordon. The greater stiffness of Thordon does not allow the same degree of contact and will permit a film of water to cover practically the entire shaft or liner surface.

5:2 Mating Surfaces - Finish

Thordon functions better with a highly polished mating surface. Badly corroded or scored shafts or liners should be avoided. The recommended surface finish is 16-32 micro-inch RMS, maximum.

5:3 Housing - Roundness

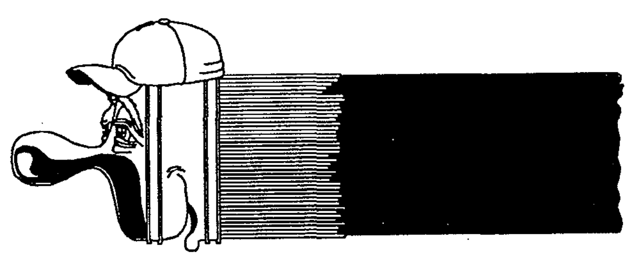
Thordon is a flexible material and will adapt to the shape of the housing into which it is pressed. For this reason, out-of-round housings must be avoided unless special fitting methods are used. For out-of-round housings, there are three alternatives. First, the bearing can be pressed into the housing and then bored to ensure it is round. (Boring of the housing instead should be considered as a more permanent solution.) Second, the bearing can be bonded into place using TG-75 adhesive, or an epoxy resin such as Chockfast. Thirdly, the housing can be repaired locally, by applying epoxy and grinding.

5:4 Corrosion Protection

Thordon, a non-metallic, avoids the type of electrolytic corrosion normally found between a metallic bearing and the housing. For this reason, Thordon is especially well suited to use in aluminum boats. Further housing corrosion protection can be achieved by painting the interior of the housing with a corrosion resistant epoxy paint prior to the installation of the Thordon bearing. Thordon, with its interference fit, usually presses against a new housing tightly enough to avoid penetration of corrosive water between the bearing O.D. and the housing.

Propeller shafts which are subject to corrosion in sea water must be protected between the liners by a corrosion resistant coating. The most common coatings used are vulcanized rubber and epoxy fiberglas. Both have disadvantages, and consequently the shaft survey interval for open systems is a maximum of only 4 years.

Thordon Bearings is developing a shaft coating system with the goal of extending this survey interval to 5-10 years. This shaft coating system is based on a sprayed elastomer and is expected to be available for evaluation in late 1995 or 1996.



CHAPTER 6

INSTALLATION METHODS

6:1 General

Thordon bearings are generally fitted with an interference fit. Actual installation is very quick and easy, especially when freeze fitting is used. The housing should always be clean and dry. No grease or oil should be used to help press or drive fitting as this will have a negative effect on the interference. The housing should be round and not tapered or bell mouthed. It should provide support to the Thordon bearing along its full length. Thordon will not function well when not fully supported. Gaps in the housing should be filled in or a sleeve fitted before installing the Thordon bearing. The relative light weight of Thordon is a significant advantage in the installation of large bearings. Large tubular bearings can be handled and freeze fitted manually or with light lifting equipment. The interference fit is sufficient to prevent bearing rotation under normal conditions, so anti rotation keying is usually not necessary. A forward stop and an end keeper ring are required to avoid any possibility of axial movement. These keeper rings must be of adequate proportion and have an inside diameter equal to the maximum bearing/liner weardown plus 10%. The removable keeper ring should be retained with bolts rather than welded.

As an alternative to interference fitting, it is possible to bond Thordon bearings into housings.

6:2 FREEZE FITTING

6:2:1 General

Because of Thordon's relatively high coefficient of thermal expansion, it contracts significantly when cooled. This makes shrink fitting the easiest way to install Thordon bearings. Dry ice is the usual cooling agent used but liquid nitrogen is the optimum cooling agent if available. When using dry ice it should be in pelleted form, or if supplied in block form, it must be broken into smaller pieces. The dry ice must make good contact with both the inside and outside surface of the bearing. The bearing should remain in the dry ice for a minimum of 3 hours and can then be checked to see if it has shrunk sufficiently for installation. If not, it should be re-packed and checked in another hour. Liquid nitrogen should only be used in a tight container where the liquid cannot leak out and cause harm. The bearing should be completely immersed or evenly coated with liquid nitrogen. When the liquid nitrogen stops boiling, the bearing has reached a temperature of -196° C (-320° F) and can be easily installed. The amount of shrinkage that can be expected can be estimated as follows:

Each 10° C decrease in temperature will result in an approximate decrease in diameter of 0.0014 mm/mm of diameter.

Each 10° F decrease in temperature will result in an approximate decrease in diamter of 0.0008 inches/inch of diameter.

CAUTION

Use of liquid nitrogen in closed or poorly ventilated areas should be avoided as the boiled off gasses tend to displace air. Similar precautions should be observed with significant quantities of dry ice.

6:2:2 Tubular Bearings

Thordon tubular bearings, when frozen, can normally be slid into the housing without difficulty. If some resistance is encountered, however, a hammer or jack can be used to finish the job.

For all tubular bearings, we recommend a machined stop or ring at an appropriate point to prevent the bearing from moving too far when being installed. We also recommend a keeper ring at the other end to eliminate any possibility of axial movement. The designed interference fit is usually sufficient to hold bearings in place, but the end stop or keeper is added insurance, especially for large bearings. A tapered housing, or cyclical unbalanced loading may occasionally cause a large bearing to move axially if it is not secured.

Most tubular Thordon bearings are supplied in more than one length. This is done to make handling and machining easier. The first section is fitted, and pushed home against the forward stop. Then subsequent sections are fitted. For large bearings with more than two sections, each section should be allowed to warm up and lock itself in place before the next section is fitted. Alternately, a small space can be left between sections to permit axial expansion during warming up.

Grooves of propeller bearings should be aligned to avoid restriction of the water flow. This can be done visually, or a piece of flat bar stock can be fitted so that it engages the grooves on adjoining sections. To avoid possible constriction problems from minor misalignment of water grooves, each section of a Thordon tubular bearing should be machined with a circular recess at one end (the same width and depth as the water grooves -see page 48). This facilitates flow of water from one set of grooves to another even if there is misalignment. Care must be taken to ensure that these recessed ends are properly installed -in the middle, not on the outside.

6:2:3 Stave Bearings

Care should be taken to ensure that all staves are cooled by alternating layers of staves and dry ice. The staves should be placed in dry ice with at least a 25mm.(1") covering over the staves. They should be left in dry ice for approximately 2-3 hours. A cylinder of liquid nitrogen large enough to immerse the staves can also be used. The staves should be immersed until bubbling of the nitrogen stops.

Frozen staves are placed side by side in the housing until all staves are assembled. The machined staves should be placed next to the keeper strips. It is sometimes necessary to drive the last stave into the housing if the assembly has begun to warm up during installation. While frozen, Thordon staves, especially composite staves, may twist or warp a little, but this should not unduly affect the assembly. Any staves that come loose should be hammered back into place. While it is warming up, the assembly should be checked to ensure that all staves are tightly seated against the housing.

When staves of different length are used, an interlocking pattern is recommended -long-short and then short-long. Care should be taken to ensure that the long and short staves are matched together against the keeper strips.

When fitting staves on the upper half of the assembly they may be kept in place by using hoops, wooden discs, or other devices. Once the staves begin to warm up, no special support will be required. Once the staves are fully warmed up, they will be tightly held in place by their interference fit.

With stave bearings a forward stop and an end keeper ring should be used to eliminate any possibility of axial movement of the staves under unusual operating conditions.

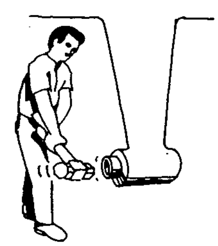
6:3 PRESS OR DRIVE FITTING

6:3:1 Cylindrical Bearings

Although freeze fitting is the preferred way to install Thordon bearings, it is also possible to use a drive or press fit when freezing facilities are not available. Driving is possible for small bearings. Hammer impact will not harm the bearings. Because of the significant amount of interference on Thordon bearings, considerable pressing force is required to install larger bearings. All press or drive fit bearings should be machined with an entry chamfer to facilitate starting them into the housing. For multiple piece bearings, a piece of flat steel bar should be fitted into adjoining grooves to ensure proper groove alignment. To avoid possible constriction problems from minor misalignment of water grooves, each section of a Thordon tubular bearing should be machined with a circular recess at one end (the same width and depth as the water grooves -see page 45). This facilitates flow of water from one set of grooves to another even if there is minor misalignment. Care must be taken to ensure that these recessed ends are properly installed -in the middle, not on the outside (see page 43-44). Pressing force required to fit a Thordon bearing can be calculated as follows:

$$F(\text{lbs.}) = \frac{\text{Interference(in)} \times \text{wall thickness(in)} \times 3 \times 100000}{\text{Housing bore(in)}}$$

$$F(\text{kg.}) = \frac{\text{Interference(mm.)} \times \text{wall thickness(mm.)} \times 211}{\text{Housing bore(mm)}}$$



6:4 ALTERNATIVE METHODS —BONDING

Bonding of Thordon bearings into a housing is an alternative method to interference fitting. Reasons for using bonding include:

a) to compensate for an irregular or out-of round housing
b) to fill recesses in a housing that would not otherwise provide adequate bearing support.
c) when the bearing wall is too thin for an interference fit (less than recommended wall/diameter)
d) in new construction to avoid finish machining of struts or housings.

We recommend bonding be done using Thordon's TG-75 two part epoxy type adhesive. If there are gaps between the bearing and the housing greater than 3.0mm. (0.125") a chocking compound such as Chockfast may be used.

6:4:1 Dimensioning For Bonding

A bonded fit normally involves no interference, so the bearing OD will be the Housing ID less an allowance for bond thickness, normally 0.13 - 0.38mm. (.005 - .015"). The bearing ID can be calculated as indicated in Chapter 3 except that the allowance for bore closure should be eliminated.

Thordon bearings, especially large, thin walled rudder bearings are sometimes fitted with a combination of interference and bonding. In this case the standard dimension calculations from Chapter 3 should be used.

6:4:2 TG-75

TG-75 is a flexible, high strength, two-part epoxy based adhesive that has replaced TG-4. It is used primarily to form strong bonds between cured elastomers and metals. It can fill gaps up to 3mm. (0.125"). Use of alternative adhesives should be avoided.

To bond a Thordon bearing you must:

A) Measure the housing ID (multiple readings) and machine the bearing OD to 0.25mm. (0.010") less than the smallest housing diameter reading. Maximum gap should not exceed 3mm. (.125").
B) Machine ID to appropriate dimension as indicated in 6:4:1.
C) Clean housing with Acetone, M.E.K. or any other solvent that does not leave an oily residue. Avoid solvents such as Varsol Mineral Spirits or Paint Thinners that leave an oily film that impedes bonding. Alternately use a clean new wire wheel and wipe with a clean cloth.

D) Remove any oil or grease from the machined bearing O.D.

E) Apply TG-75 as outlined in the TG-75 instruction booklet supplied with the product.

F) Apply TG-75 in the following sequence, assuming the bearings comprise more than one section in a single bore. The purpose of such sequence is to ensure the adhesive has the best chance to remain where it is needed, and to keep it from squeezing into the space between the sections where it could block either an annular groove or flushing grooves.
(1) The first section to be installed should be lightly coated with TG-75 while a heavier coat is applied to that portion of the bore where it will be positioned. (The use of plastic spreaders sold for applying auto body filler makes the job less messy.) The total amount of adhesive applied should depend on the voids to be filled. If these are small, then less adhesive should be applied, as the excess will be displaced and may tend to block the water ports, etc.
(2) Slide the first section into position, ensuring it has travelled fully to its forward limit. Don't panic, you have lots of working time to make sure everything's properly positioned.

(3) Apply a light coat of TG-75 to the rest of the housing bore and a heavier coat to the OD of the next bearing section.
(4) Insert the second section into position making sure that the water grooves (if any) are aligned.
(5) Repeat for the third section, if applicable.

G) Remove any TG-75 from the bearing bore or grooves immediately. Acetone works well for clean-up. Do not contaminate the bond line with solvent.

H) Allow 8 hours after mixing at room temperature before fitting shafts and propellers or mounting the rudder.

I) We recommend waiting 16 hours before turning the shafts, and 48 hours before any full speed trials are planned.

6:4:3 Filling Recesses

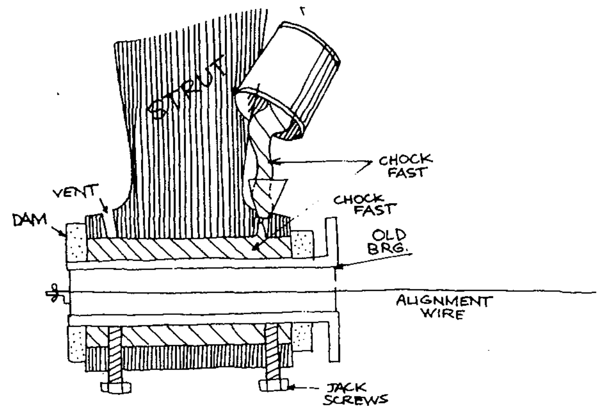
Thordon bearings must be supported along their full length if they are to perform effectively. Unsupported areas deflect with shaft pressure and can carry only a fraction of their normal pressure. This reduces the "effective length" of the bearing. To overcome this problem Thordon can, sometimes, be fitted into the bored out bronze jacket of an old rubber/metal rubber bearing. Alternately, the annular spaces can be filled with Chockfast, or another suitable epoxy compound.

6:5 Chockfast Fitting

This proprietary product made by Philadelphia Resins Inc. is a two component epoxy base material. The PR-610 (Chockfast Orange) is recommended by the manufacturer for bearing fitting. Many shipyards are familiar with Chockfast and like to use it. It can fill substantial gaps with minimal shrinkage. Potlife and viscosity are such that it can be poured into the annular space between a bearing and its housing without difficulty as long as proper venting provisions are allowed.

In the curing process Chockfast produces an exothermic heat. When the wall of the Chockfast is thick, this heat may be sufficient to damage the Thordon bearing. The manufacturer advises that wall thicknesses of 12mm.(0.5") will not generate sufficient heat to damage a Thordon bearing. For thicker cross sections of Chockfast see the special procedures outlined in section 6:5:2 or contact Thordon Bearings for further information.

Essentially there are two installation methods using Chockfast, one using chockfast as an adhesive to bond the bearings in place, and the other using Chockfast to form a housing into which a bearing can be interference fitted. The use of Chockfast is popular in new construction as an alternative to boring and aligning struts, and in repair when badly worn housings are encountered.



6:5:1) Bonding directly into the housing using Chockfast

1(a) Ensure that the OD of the bearing is roughened, either by machining or grinding.
1(b) When fitting multiple piece bearings, butt together the sections, with the circular groove at the join. Wrap the seam on the OD with duct tape to prevent Chockfast from entering the bearing.

1(c) Install shaft
1(d) Fit bearing(s) over shaft in correct position.

1(e) Jack shaft up until it is positioned above the point of theoretical alignment by an amount equal to the total bearing clearance.

1(f) A light wooden wedge at the bottom of the bearing in the clearance space will prevent motion during pouring.

1(g) Prepare assembly for Chockfasting with appropriate dams, vent holes, etc. according to standard Chockfast instructions. Maximum recommended thickness for Chockfast orange is 1", but due to possible damaging exotherm, we recommend a 12mm. (0.5") max gap.

1(h) Pour Chockfast observing set up times.

6:5:2 Chockfast with Dummy Bearing to create a housing into which a Thordon bearing can be interference fitted.

2(a) A Dummy bearing (metal tube, used rubber/metal bearing with good OD, etc.) is used as a core pattern. The OD of the core should be smaller than the OD of the finished Thordon bearing to be fitted by the amount of interference on the Thordon bearing.

2(b) Coat the OD of the core with a release agent so that the Chockfast will not adhere to it.

2(c) Place core in housing in the appropriate position where the bearing is to be fitted.

2(d) Align core with or without shaft in place.

2(e) Prepare assembly for Chockfasting with appropriate dams, vent holes, etc.

2(f) Pour Chockfast using standard Chockfast procedures.

2(g) When Chockfast has cured, jack out the dummy core leaving a round, aligned Chockfast housing.

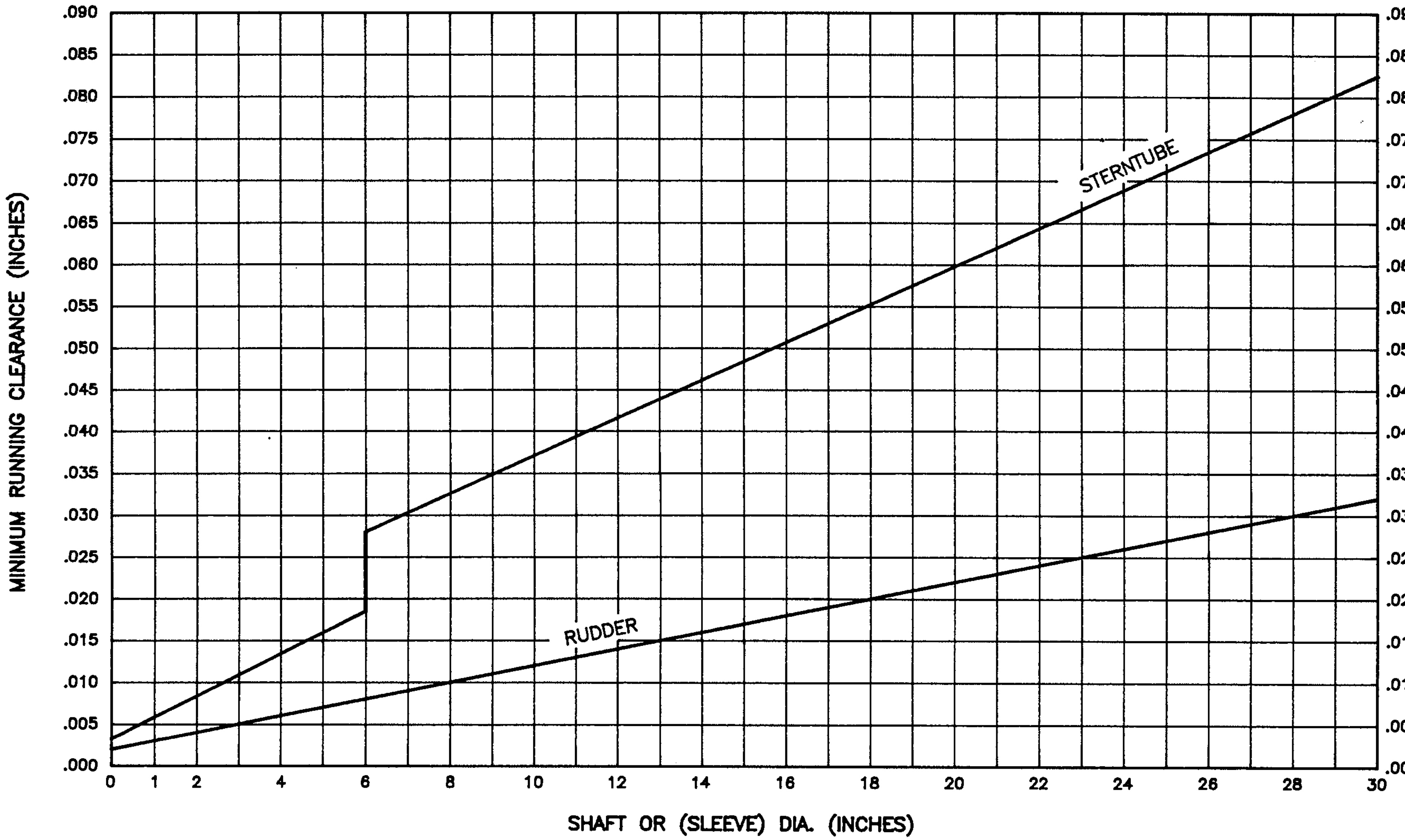
2(h) Press or shrink fit the Thordon bearing following guidelines for interference fitting.

This procedure can be used for thicker cross sections of Chockfast because the Thordon is not exposed to the Chockfast while it is curing.

6:5:3 Chockfasting stern tubes or bearing carriers

Some shipyards like to fit Thordon bearings into carriers or stern tubes, and then Chockfast the carrier or stern tube into position. This procedure is acceptable as long as a relatively thin cross section of Chockfast is used. We would not recommend more than 12mm.(0.5"). The exothermic reaction from thicker cross sections can heat transfer sufficient heat through the carrier or stern tube to stress relieve the Thordon bearing causing it to lose its interference fit. This procedure should not be used with SXL or Compac because of its lower stress relieving point.

MINIMUM RUNNING CLEARANCE FOR THORDON MARINE BEARING RELATED TO SHAFT DIAMETER IMPERIAL



NOTE: When applicable, additional allowances must be made for water absorption and thermal expansion. Refer to steps 3 and 4 in Inside Diameter Calculations.

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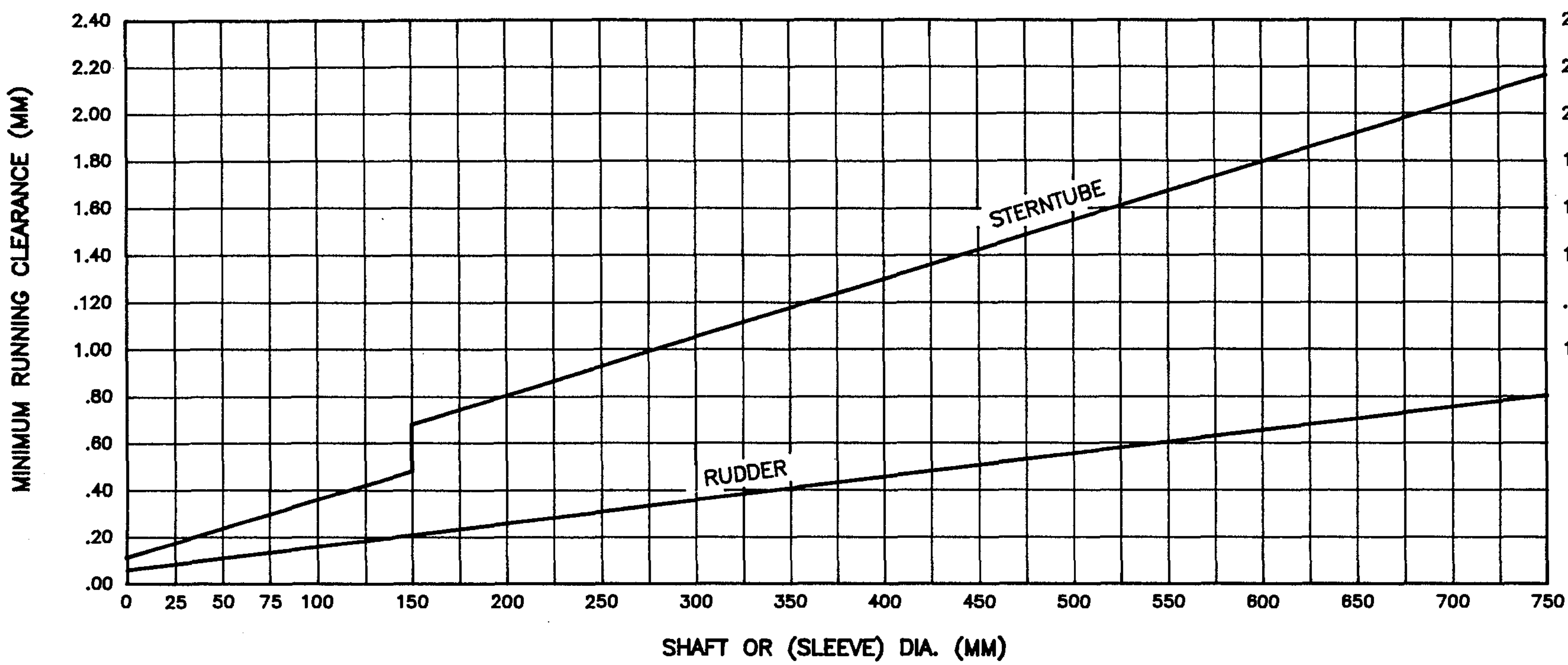
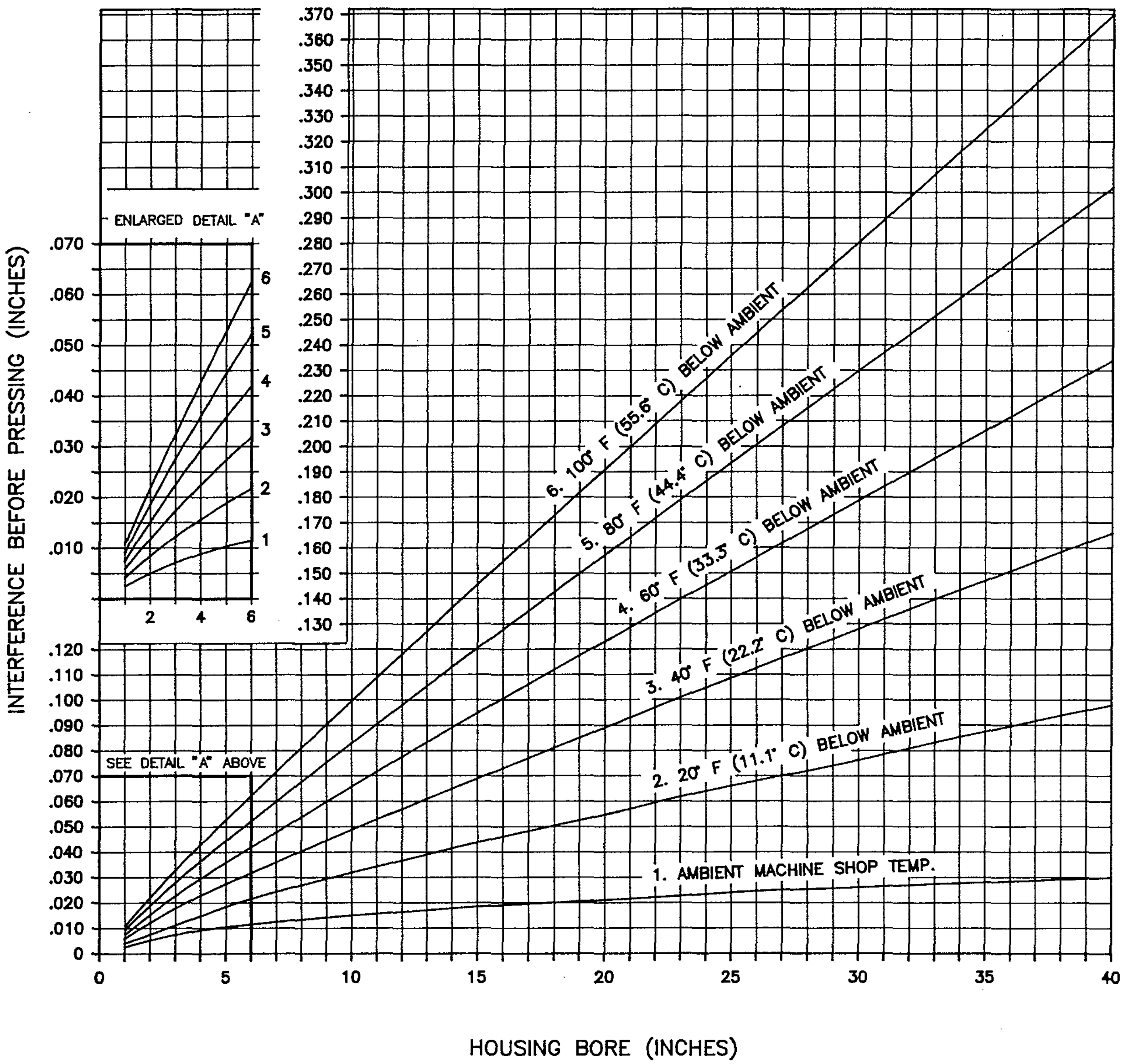
MINIMUM RUNNING CLEARANCE FOR THORDON MARINE BEARING RELATED TO SHAFT DIAMETER METRIC



NOTE:When applicable, additional allowances must be made for water absorption and thermal expansion. Refer to steps 3 and 4 in Inside Diameter Calculations.

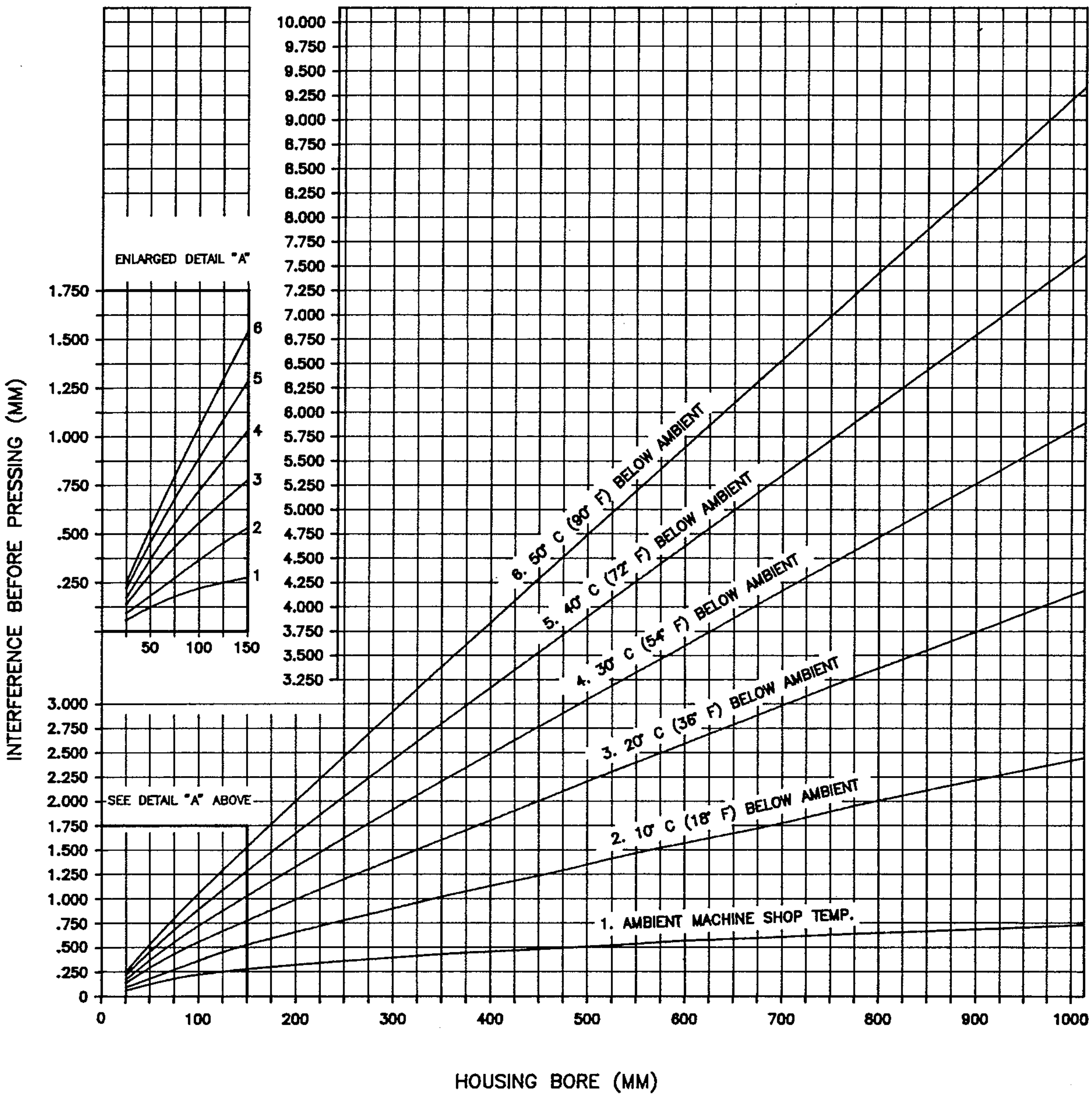
THORDON ELASTOMERIC PRODUCTS

HOUSING INTERFERENCE
GRADE XL IMPERIAL UNITS



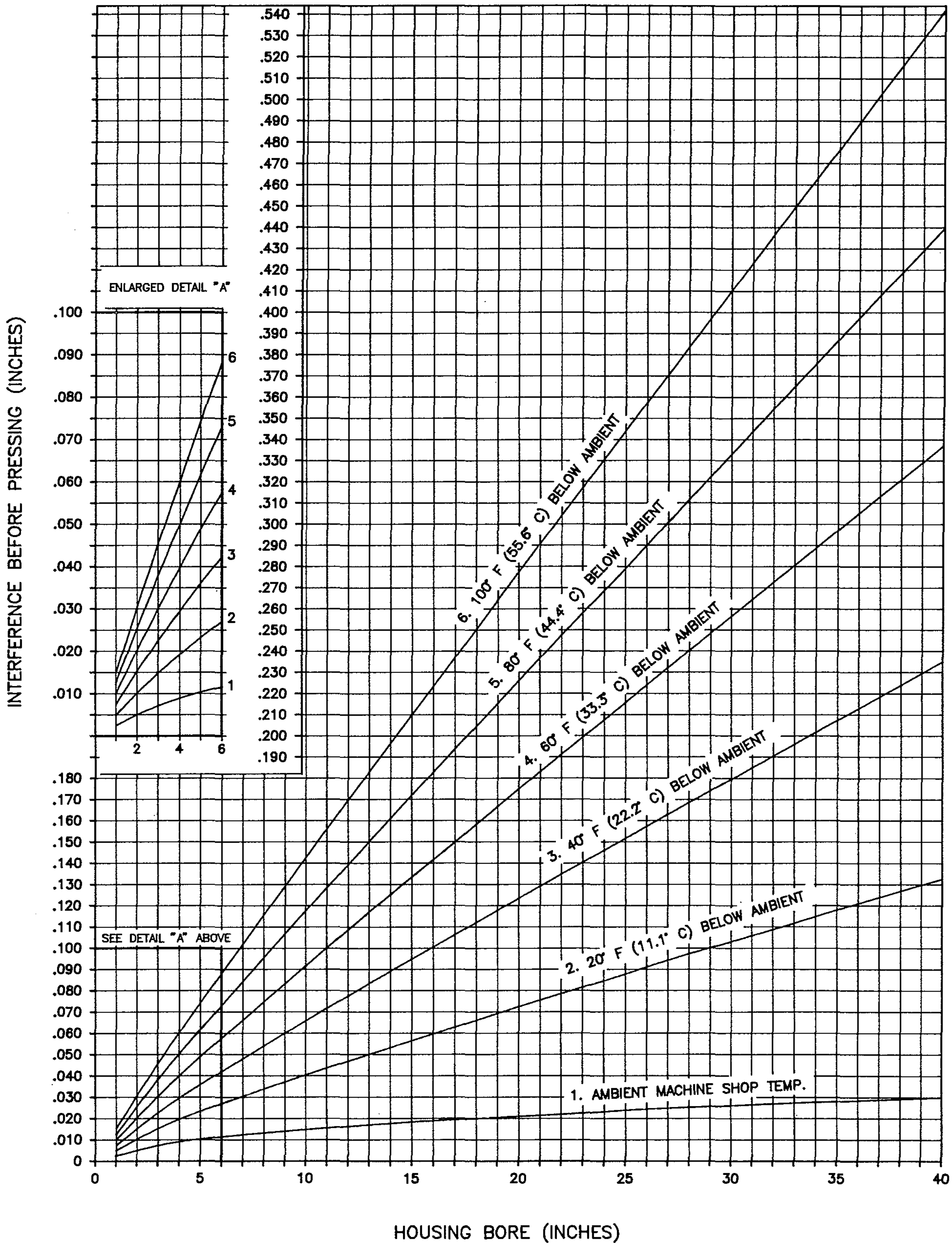
THORDON ELASTOMERIC PRODUCTS

HOUSING INTERFERENCE
GRADE XL METRIC UNITS



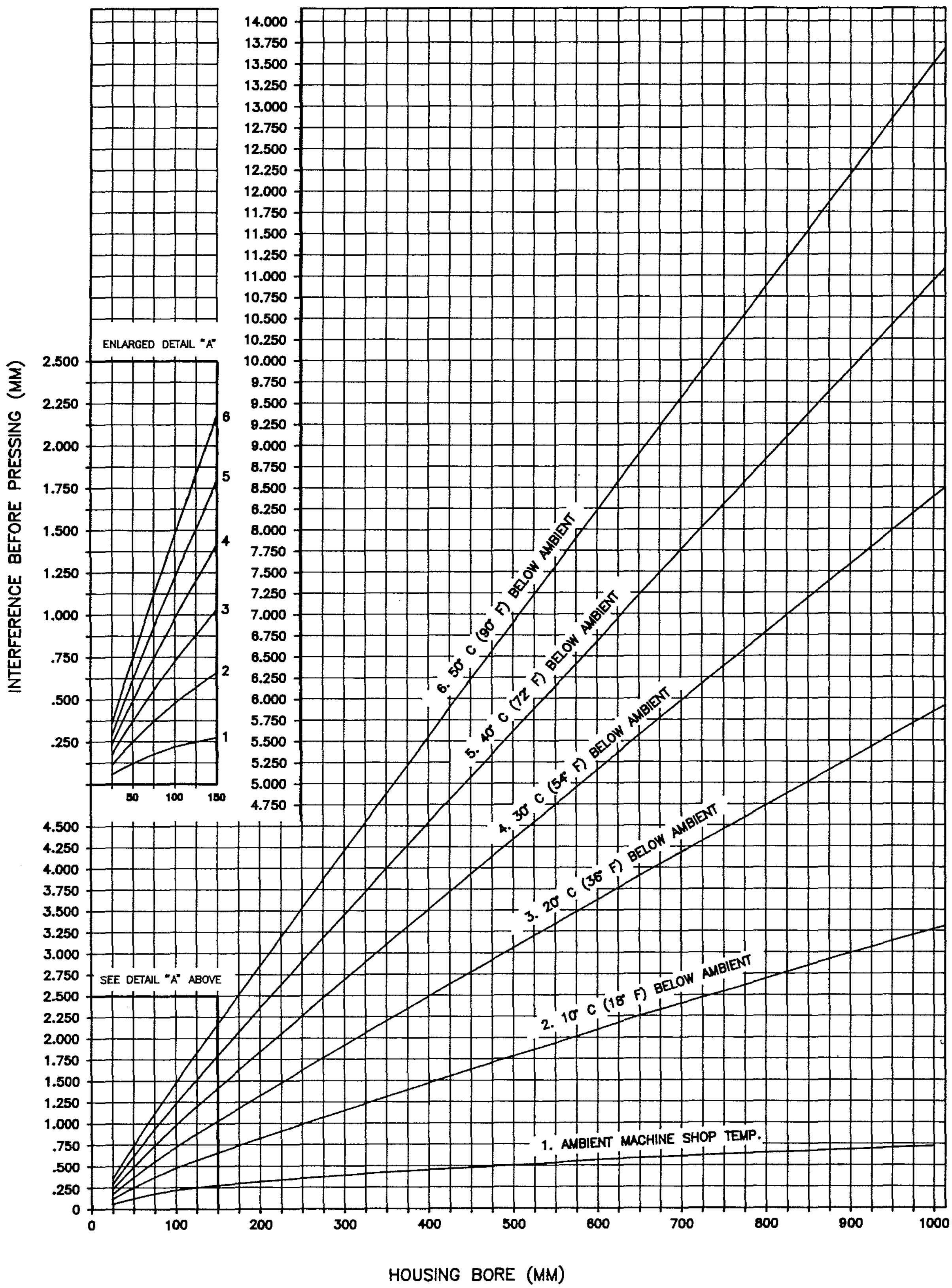
THORDON ELASTOMERIC PRODUCTS

HOUSING INTERFERENCE
GRADE SXL IMPERIAL UNITS

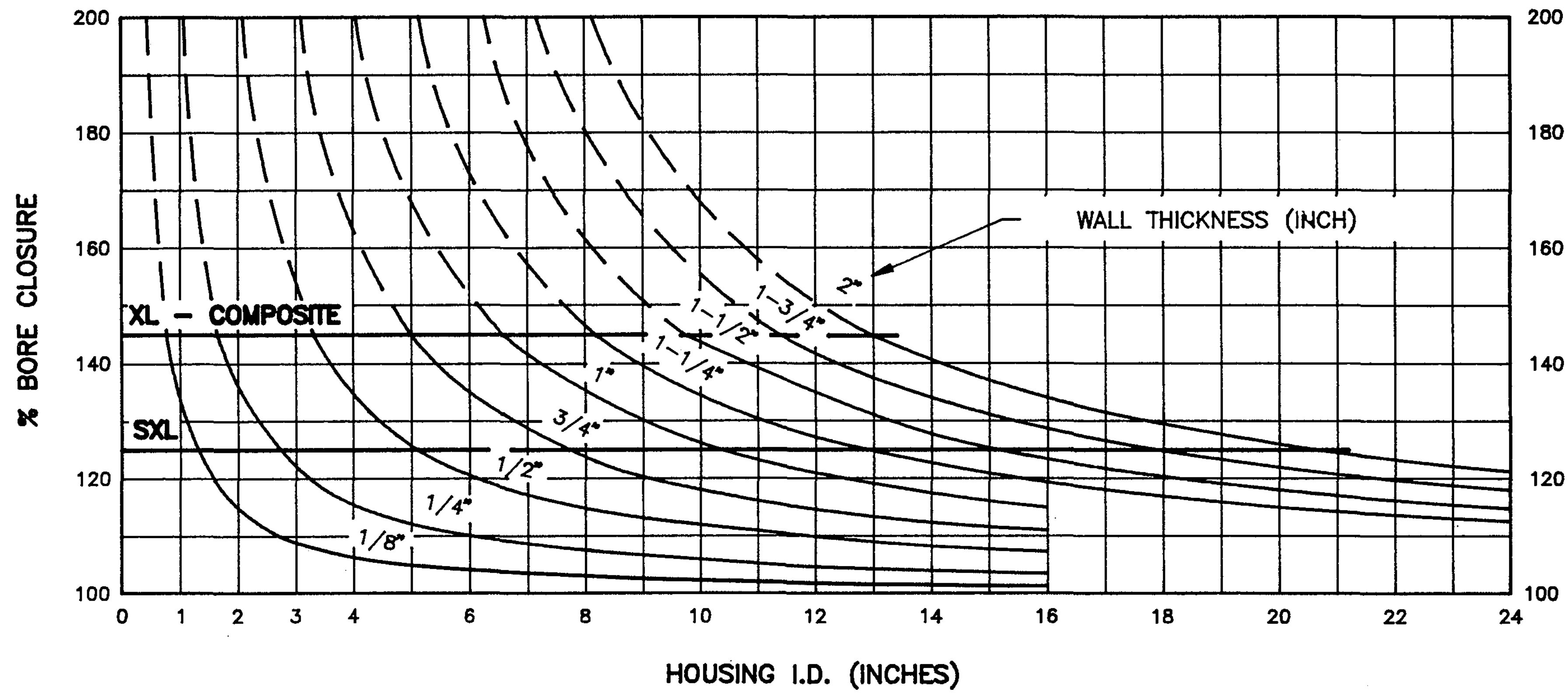


THORDON ELASTOMERIC PRODUCTS

HOUSING INTERFERENCE
GRADE SXL METRIC UNITS



PERCENTAGE BORE CLOSURE AGAINST HOUSING DIAMETER FOR VARIOUS WALL THICKNESSES IMPERIAL



NOTE: THIS GRAPH HAS BEEN LIMITED FOR USE UP TO A MAXIMUM OF 125% BORE CLOSURE FOR SXL, AND A MAXIMUM 145% BORE CLOSURE FOR XL.

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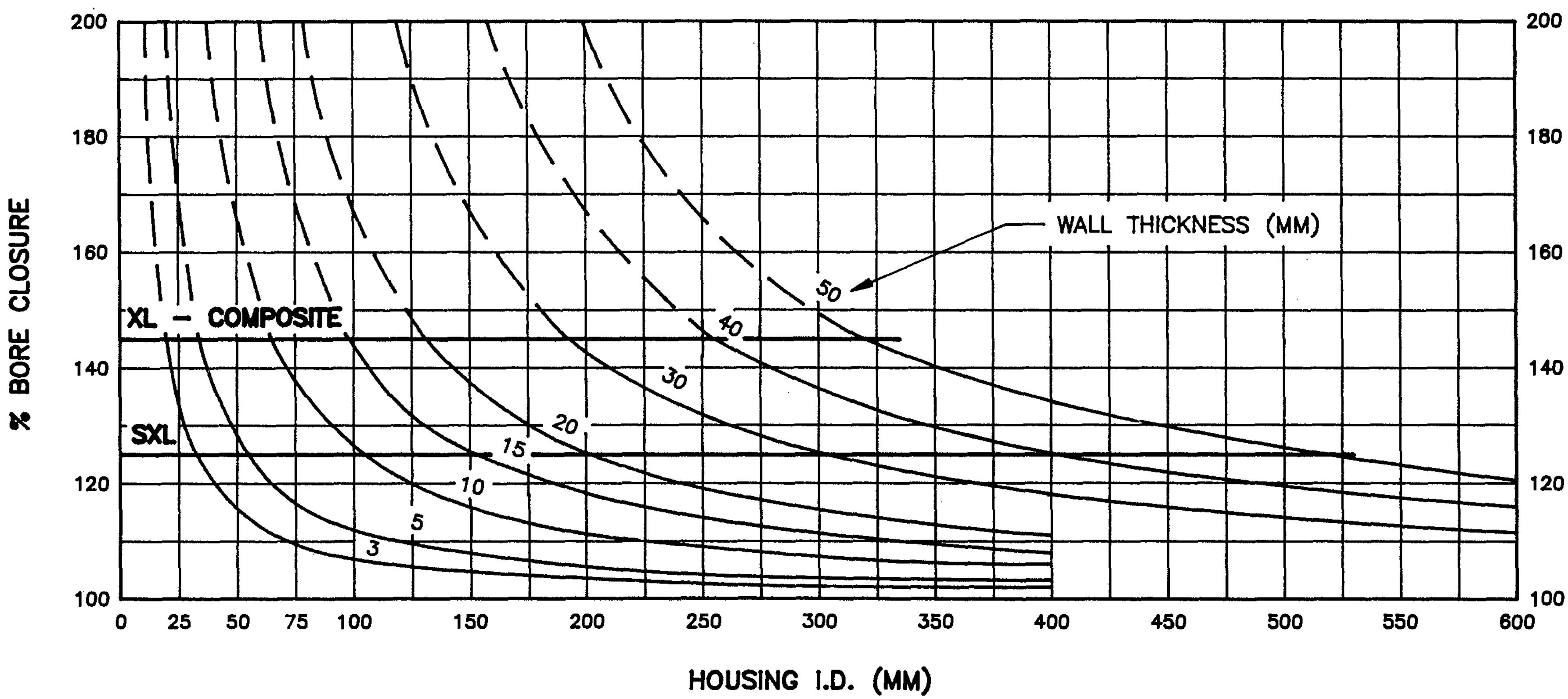
PERCENTAGE BORE CLOSURE AGAINST HOUSING DIAMETER FOR VARIOUS WALL THICKNESSES METRIC



NOTE: THIS GRAPH HAS BEEN LIMITED FOR USE UP TO A MAXIMUM OF 125% BORE CLOSURE FOR SXL, AND A MAXIMUM 145% BORE CLOSURE FOR XL.

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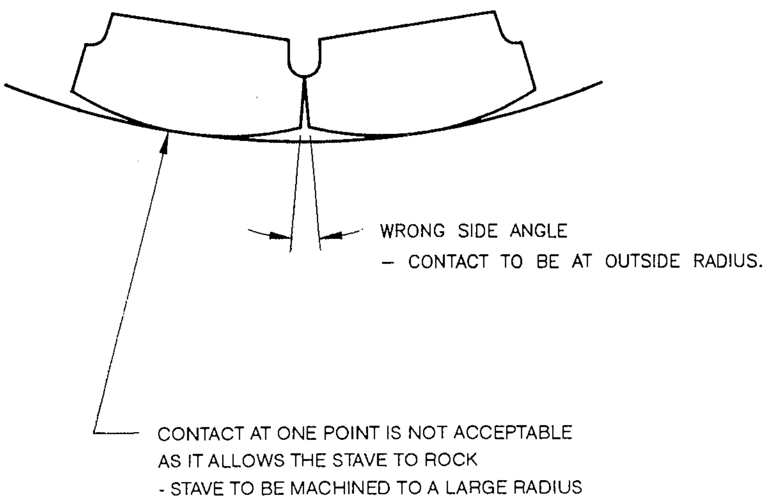
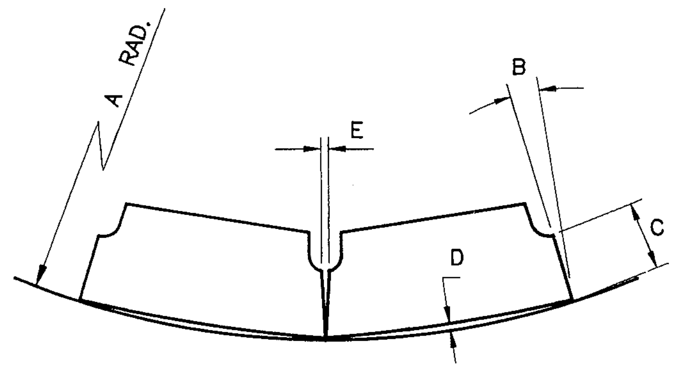
INCORRECT FITTING



CORRECT FITTING



NOTE: ALL DIMENSIONS SHOWN IN M.M.					
SEGMENT	A	B	C	D	E
"A"	390	6–3/4"	20	.457	.483
"B"	325	7–1/2"	20	.432	.457
"C"	270	8–3/4"	20	.406	.432
"D"	235	9–3/4"	20	.381	.406
"E"	205	9–3/4"	15	.356	.381
"F"	180	9–3/4"	15	.330	.356
"G"	156	9–3/4"	15	.305	.330

NOTE: ALL DIMENSIONS SHOWN IN IN.					
SEGMENT	A	B	C	D	E
"A"	15.354	6–3/4"	.787	.018	.019
"B"	12.795	7–1/2"	.787	.017	.018
"C"	10.630	8–3/4"	.787	.016	.017
"D"	9.252	9–3/4"	.787	.015	.016
"E"	8.071	9–3/4"	.591	.014	.015
"F"	7.087	9–3/4"	.591	.013	.014
"G"	6.142	9–3/4"	.512	.012	.013

REV | DESCRIPTION | APP'D | DATE

THOMSON–GORDON LTD.
BURLINGTON, ONTARIO, CANADA

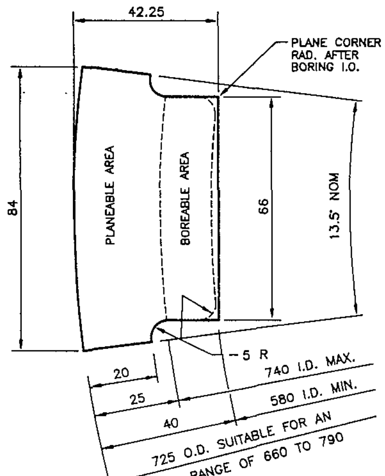
TOLERANCES UNLESS OTHERWISE SPECIFIED:
DEC. .XX: ± 0.01" DEC. .XXX: ± 0.005" FRACTIONAL: ± 1/64" ANGULAR: ± 0.5°

TITLE: THORDON STAVES SHOWING INCORRECT & CORRECT FITTINGS

DATE: 90/03/12 | APP'D BY:
SCALE: N.T.S. | APP'D DATE:
DWN BY: RG | PLOT:
CAD DIR: \CAD\BEARING\PROPOSAL
PRODUCT:
CUSTOMER:

DWG NO/PART NO: TG–11070
REV: A
SUPERSEDES: TG–10389

48081-E



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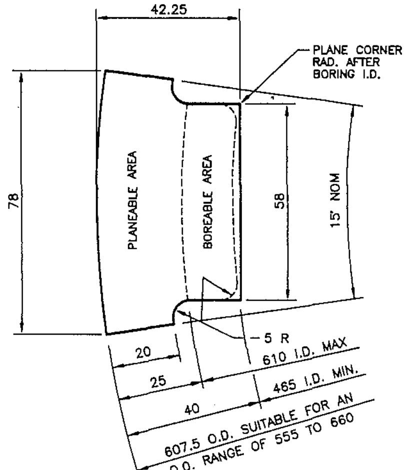

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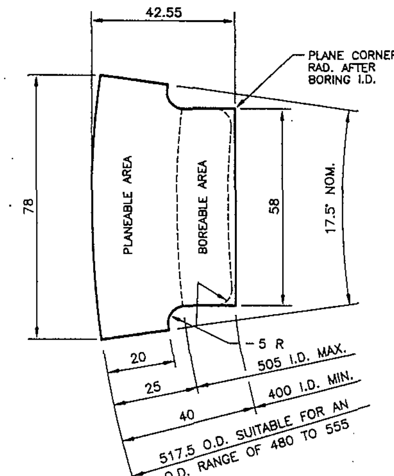

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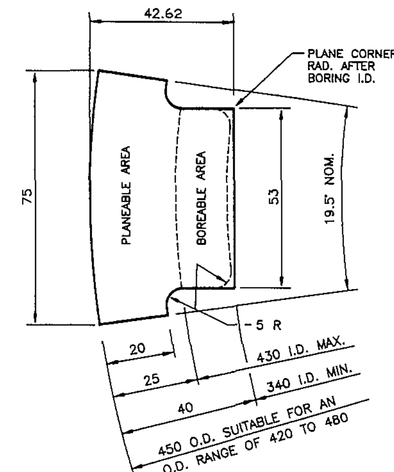

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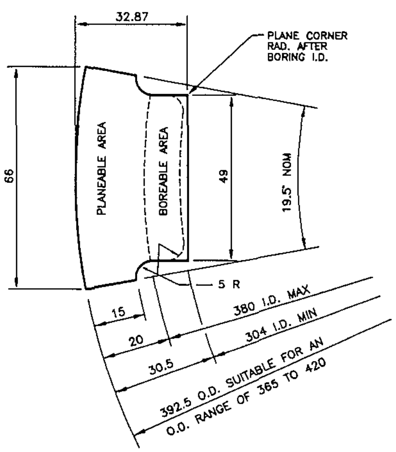

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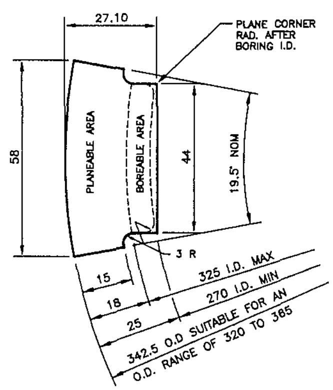

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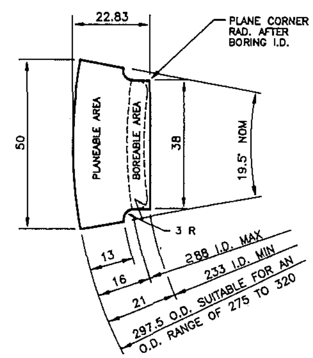

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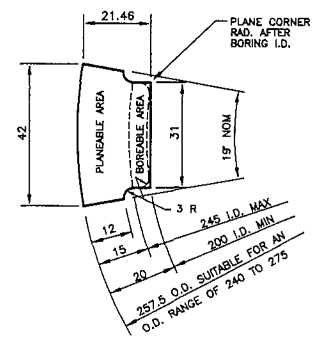
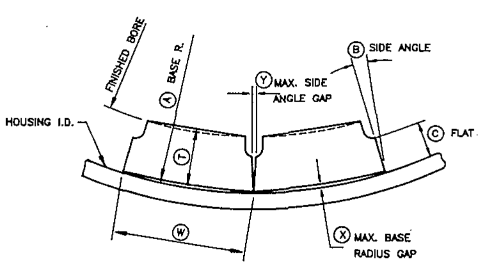


SEGMENT "H"



SEGMENT	SHAFT MIN I.D.	SHAFT MAX I.D.	HOUSING MIN O.D.	HOUSING MAX O.D.	SEGMENT DIMENSIONS W	SEGMENT DIMENSIONS T	SEGMENT DIMENSIONS LENGTH	A	B	C	X	Y
"A"	580	740	660	790	84	42.25	1000	390	6-3/4°	20	.457	.483
"B"	465	610	555	660	78	42.25	1000	325	7-1/2°	20	.432	.457
"C"	400	505	480	555	78	42.55	1000	270	8-3/4°	20	.406	.432
"D"	340	430	420	480	75	42.62	1000	235	9-3/4°	20	.381	.406
"E"	304	380	365	420	66	32.87	1000	205	9-3/4°	15	.356	.381
"F"	270	325	320	365	58	27.10	1000	180	9-3/4°	15	.330	.356
"G"	233	288	275	320	50	22.83	1000	156	9-3/4°	13	.305	.330
"H"	200	245	240	275	42	21.46	1000	135	9-1/2°	12	.279	.305

REV | DESCRIPTION | APP'D | DATE

THOMSON-GORDON LTD.
BURLINGTON, ONTARIO, CANADA

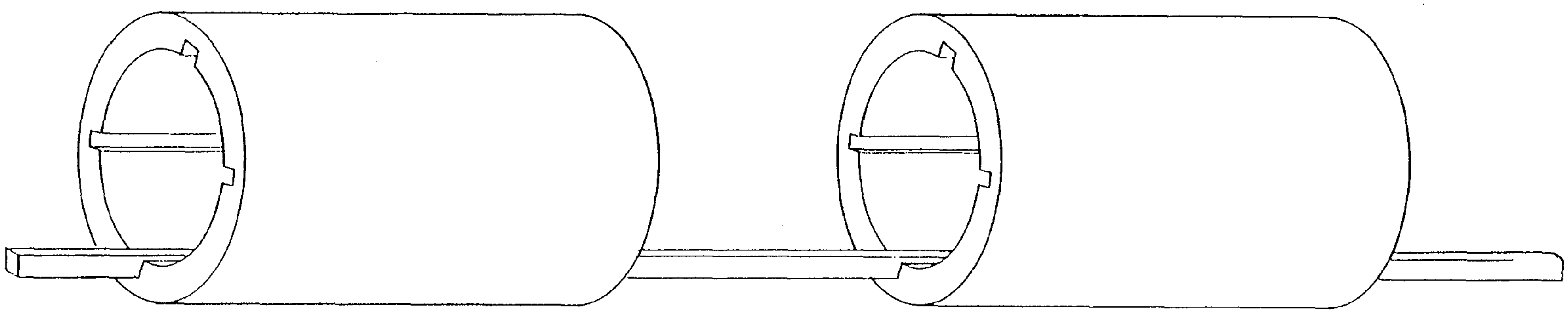
TOLERANCES UNLESS OTHERWISE SPECIFIED:
DEC. .XX: ± 0.01" DEC. .XXX: ± 0.005" FRACTIONAL: ± 1/64" ANGULAR: ± 0.5°

TITLE:
THORDON XL MOLDED STAVES

DATE: 90/03/15	APP'D BY:	DWG NO/PART NO: TG-11069
SCALE: N.T.S.	APP'D DATE:	REV:
DWN BY: RG	PLOT:	
CAD DIR: \CAD\BEARING\PROPOSAL		
PRODUCT:		SUPERSEDES: TG-10221

CUSTOMER: T.G.

48081-E



BY	ITEM	PART NUMBER	QT'Y.	DESCRIPTION

THOMSON - GORDON LTD.
BURLINGTON, ONTARIO, CANADA

DATE	DESCRIPTION	REV

PRODUCT

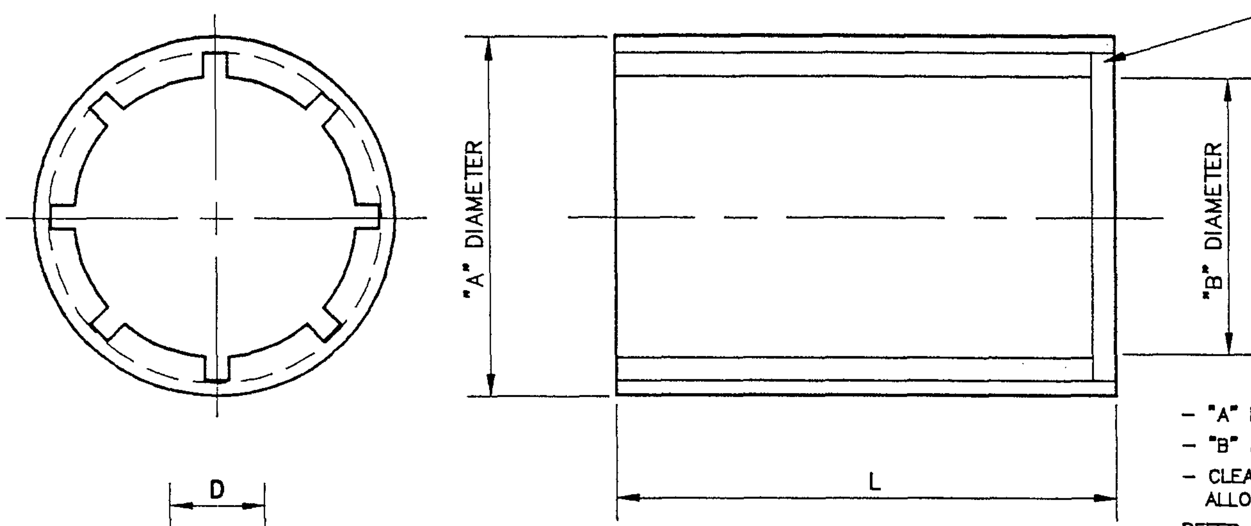
SCALE	DATE	DRAWN BY	APP

TITLE
GROOVE ALIGNAMENT

CUSTOMER

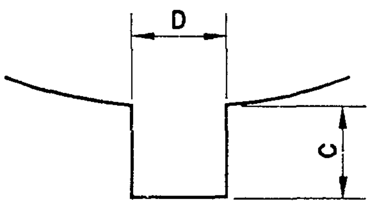
DWG NO
TG-10245

48081-E



- "A" DIAMETER= HOUSING DIAMETER + INTERFERENCE FIT
- "B" DIAMETER= SHAFT DIA. + BORE CLOSURE + RUNNING
- CLEARANCE + WATER SWELL + THERMAL EXPANSION ALLOWANCE

REFER TO TECHNICAL LITERATURE OR CONTACT TG REPRESENTATIVE FOR DETAILS ON CALCULATIONS



NOTE 1.– GROOVE DEPTH "C" IS NOT TO EXCEED ONE HALF OF THE WALL THICKNESS

2.– AN ANNULAR RING OR RADIAL GROOVE IS RECOMMENDED WHEN INSTALLING MORE THAN 1 LENGTH OF BEARING. THIS ENSURES PROPER WATER FLOW EVEN IN THE EVENT OF MISALIGNMEMT OF ONE OR MORE BEARINGS.

MAXIMUM RECOMMENDED SLEEVE BEARING WEAR			
SHAFT OR SLEEVE DIAMETER		CLEARANCE	
INCH	MM.	INCH	MM.
UP TO 3"	76	.120	3.0
3" TO 12"	76 TO 305	.240	6.1
OVER 12"	OVER 305	.370	9.4

GROOVE DETAILS

GROOVES TO BE EQUALLY SPACED

SHAFT DIA.		NO.	C (SEE NOTE)		D	
INCH	MM.	GROOVES	INCH	MM.	INCH ±.015	MM.
TO 1"	25	3	1/8"	3	1/8"	3
1–1/8" TO 2"	29 TO 51	6	3/16"	5	3/16"	5
2–1/8" TO 5"	54 TO 127	8	3/16"	5	1/4"	6
5–1/4" TO 7"	133 TO 178	10	1/4"	6	5/16"	8
7–1/4" TO 12'	184 TO 305	12	5/16"	8	5/16"	8
12–1/4" TO 15"	311 TO 381	14	5/16"	8	5/16"	9.5
15–1/4" TO 20"	387 TO 508	16	3/8"	9.5	3/8"	9.5
20–1/4" TO 28"	514 TO 711	20	3/8"	9.5	3/8"	9.5
28–1/4" TO 36"	717 TO 914	24	3/8"	9.5	7/16"	11

REV.	DESCRIPTION	DATE
C	RADIAL GROOVE ADDED	APR. 22/88
B	ADDED 15–1/4" TO 36" SHAFT DIA.	JUN. 9/87
A	GROOVE RADIUS ELIMINATED AND TITLE WAS WATER LUBE BRG. DESIGN	APR. 1/87

THIRD ANGLE PROJECTION

THOMSON–GORDON LTD.
BURLINGTON, ONTARIO, CANADA

PRODUCT: THORDON XL

TITLE: GROOVE DETAIL FOR WATER LUBE BEARING

DRAWN BY: R.G.

DATE: APR. 1/87

APP'D BY:

CUSTOMER:

SCALE: N.T.S.

DRAWING NO.: TG–10520

REV. C

48061-E

PROPELLER SHAFT GROUNDING AND MONITORING ASSEMBLY

INSTRUCTION MANUAL

INDEX

1.0 SLIPRING ASSEMBLY

A turning propeller shaft on a ship becomes electrically insulated from the hull by the lubricating oil firm in the bearings and by the use of non-metallic bearing materials in the tail shaft. When the shaft is insulated in this way an electrical potential can be measured between the shaft and the hull and this can accelerate corrosion in the ship. If the ship has a system of cathodic protection, whether it is sacrificial anodes or an impressed current system, the shaft insulation will prevent the propeller and the boss from receiving protection.

The electrical potential between the shaft and the hull can also cause a heavy current to flow in bearings when the oil film breaks down or is contaminated with seawater. This current can cause deep pitting of the bearing surface. Excessive ware on the shaft bearings can often be traced to this cause.

Trouble can be avoided and cathodic protection extended to the propeller if the shaft is properly earthed with a propeller slipring. The effectiveness of the shaft earthing system should encourage a maximum contact resistance of no greater than 0.001 ohms for a water filled bearing and 0.01 ohms for an oil filled bearing.

Our own tests indicate that high silver content brushes running on a silver track have repeatable low conductivity that can maintain these limits and ensure a low resistance contact is maintained even under dirty conditions.

The shaft earthing assembly comprises a pair of high silver content/graphite compound brushes mounted in a balanced brush holder, running on a copper slipring with a solid silver inlay track.

Each brush holder has an adjustable spring tensioner with 5 settings, which is supplied preset to the minimum, and result in a pressure of 450 grams on each brush.

At this pressure the expected life of the brushes is in excess of one year.

2.0 SHAFT EARTHING INSTALLATION

The shaft slipring is supplied as a complete unit with copper/silver band and clamping arrangement which can be easily installed by competent ship's engineering personnel, in the following order:

(a) Select a suitable position on the shaft to install the slipring which should be close to a pedestal or convenient piece of ships structure where the brush holder can be installed.

Then thoroughly clean the shaft in the area where the slipring is to be fitted ensuring that all grease, dirt and impurifications on the shaft are removed.

(b) The sliprings are manufactured slightly oversized to allows for a small variation in shaft diameter so when installing, the excess material should be removed by filing or cutting joint faces before securing the clamping arrangements.

(c) After removing the excess material the two band clamps are tightened so that the copper/silver strip is a close tight fit around the shaft.

(d) Remove any excess banding strip from the assembly and ensure that this strip is cut back to the housing.

(e) Fill the join between the two sliprings and soft solder to ensure a smooth surface.

(f) Install a 20mm diameter rod (brush holder spigot) on a convenient piece of ships structure or pedestal bearing so that it is centre parallel to the shaft centre in both planes. (The mounting bracket and rod are ship or shipyard supply items.)

(g) It is essential that the complete brush holder assembly should provide a good electrical contact between the shaft and the hull, therefore the brush holder spigot support, should either be welded to the ships structure or if bolted, a short length of $70mm^2$ bonding cable should be connected between the brush holder and ships structure.

(h) The brush holder should be clamped in this rod and aligned centrally over the silver track.

(i) Install the silver graphite brushes and the brush holder and check that the clearance between the silver track and the brush holder is approximately 3mm.

(j) After checking this dimension tighten the brush holder into position.

(k) Connect the silver graphite brushes to their connections and check all bolts and nuts for tightness and that the brush pressure is set at 50g/kw.

NOTE

TO PREVENT BUSH 'BOUNCE' AND ENSURE MAXIMUM UTILISATION OF THE SILVER GRAPHITE BRUSHES, IT IS ESSENTIAL THAT THE JOINTS FORM A SMOOTH, FLUSH PROFILE OVER THE FULL EXTENT OF THE SLIPRINGS.

DRAWING No. AM1041 - DETAIL OF BAND CLAMP ASSEMBLY REFERS.

3.0 SLIPRING INSTALLATION CHECKS

1.	Confirm slipring and brush gear are installed as per drawing No 1041.	
2.	Is assembly clean and free from oil and grease?	YES/NO
3.	Is slipring a tight fit to the shaft over its whole length? Ensure no bumps or indentations can be felt over the whole of the working surface.	YES/NO
4.	Are joints a good fit with no gap?	YES/NO
5.	Is brush holder secure on its shaft?	YES/NO
6.	Confirm that brush holder and its mounting are solid and that it will not be affected by vibration?	YES/NO
7.	Confirm that brush faces are tangential to slipring.	YES/NO
8.	Confirm that brushes are free to move in their holders.	YES/NO
9.	Is there electrical continuity between tail shaft and hull?	YES/NO

4.0 SLIPRING MAINTENANCE

This grounding assembly should be checked every seven days for cleanliness. If there has been a build-up of oil on the slipring face this should be removed with a degreaser. Inspect and clean the brushes and brush holder to prevent blocking from dirt. Inspect the brush copper leads (pig tails) to ensure they have not become loose or corroded. The brush wear-down should be noted and the compression of the hold-down springs on the brushes should be adjusted to ensure good electrical contact.

5.0 PROPELLER SHAFT MONITORING M/V METER (When fitted).

A. Fabricate a support for an additional spindle to mount the second brush holder and brush (drawing AM1042 & AM1038).
The second brush holder must be insulated from the main hull structure mounted on either an insulated spindle or an insulated sleeve on a steel spindle (Drawing AM1043).

B. Adjust the brush holder so that at the nearest point they are approximately 3-4mm from the surface of the silver insert in the slip-ring assembly. The brush holders are geared together to ensure symmetrical adjustment. Tighten the two brush gear adjustment screws.

C. Tighten the brush assembly clamp screw to ensure the assembly in position on the spindle with the brush holders central over the silver insert.

D. Adjacent to the propeller shaft slip-ring assembly and easily visible mount the potential monitoring panel (Drawing AM709 / AM709-1) on a vertical surface.

E. Place the brush in its holder and connect the cable tail to the clamp back to the brush holder assembly. Adjust the slip-ring so that the brush pressure is 450 grams.

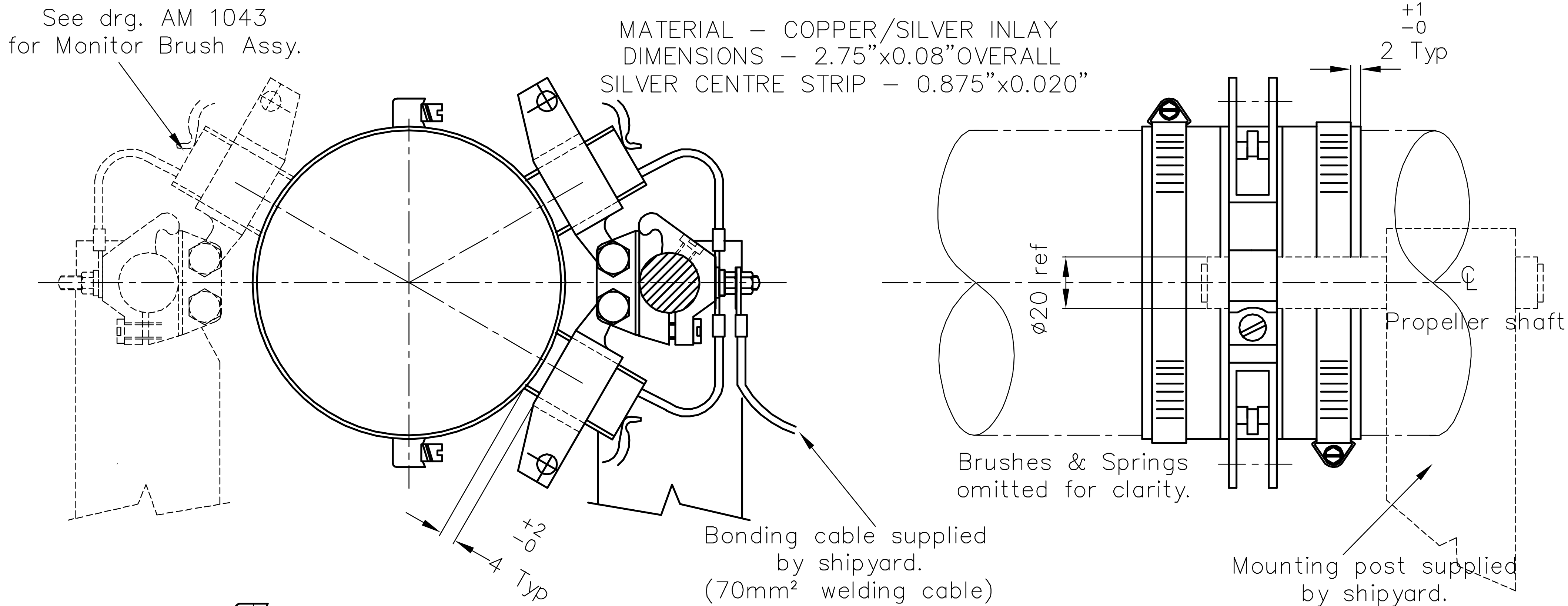
F. Provide and install the inter-connecting cables between the brush holder on the insulated spindle and the hull [hull to terminal 2] use a 1.5mm^2 flexible cable.

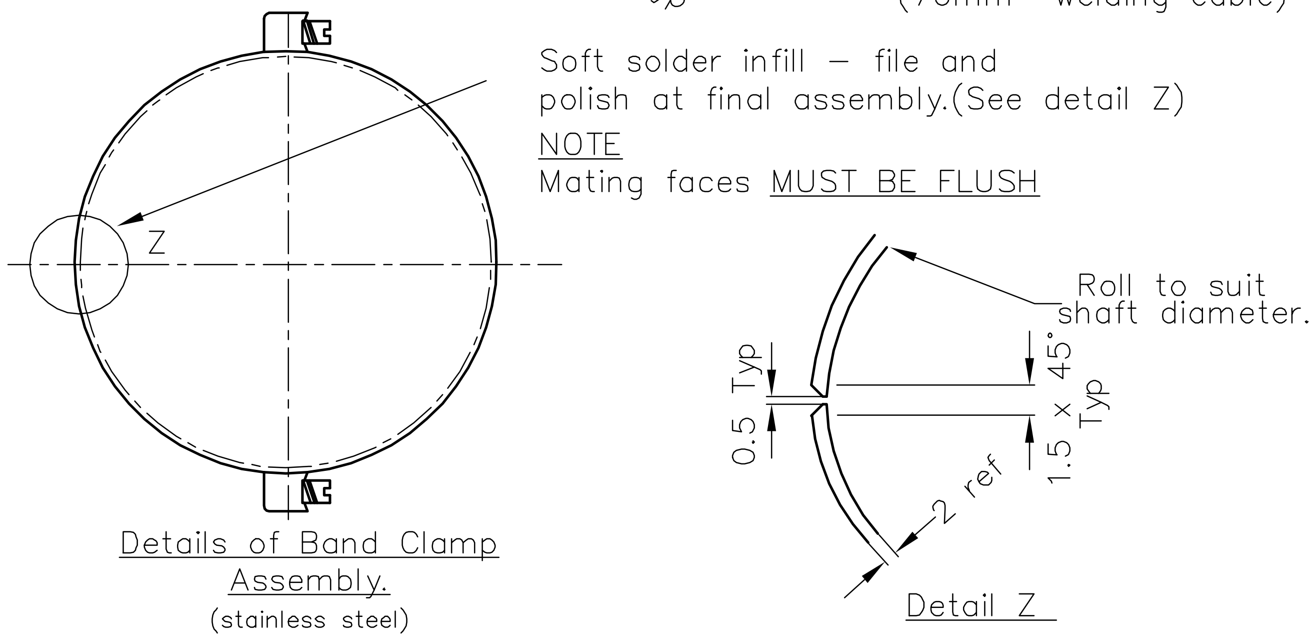
G. Provide and install a cable between the ship structure and the other terminal of the millivolt meter [shaft to terminal one] use a 1.5mm^2 flexible cable.

H. A reading of 25.0 to 50.0 mV is acceptable. However a potential greater than 50 mV is an indication of a dirty slip-ring which should be cleaned.

6.0

DRAWINGS.





No.	DESCRIPTION	DCR No.	BY	CHECK	DATE
O	REDRAWN ONTO CAD		C.G.		21/3/96

Wilson Walton International (UK) Ltd.
a corrpro company
Adam Street,Bowesfield Lane,
Stockton-on-Tees,Cleveland TS18 3HQ.
Tel: (01642) 614106. Fax: 614100 Telex: 587388

WILSON WALTON

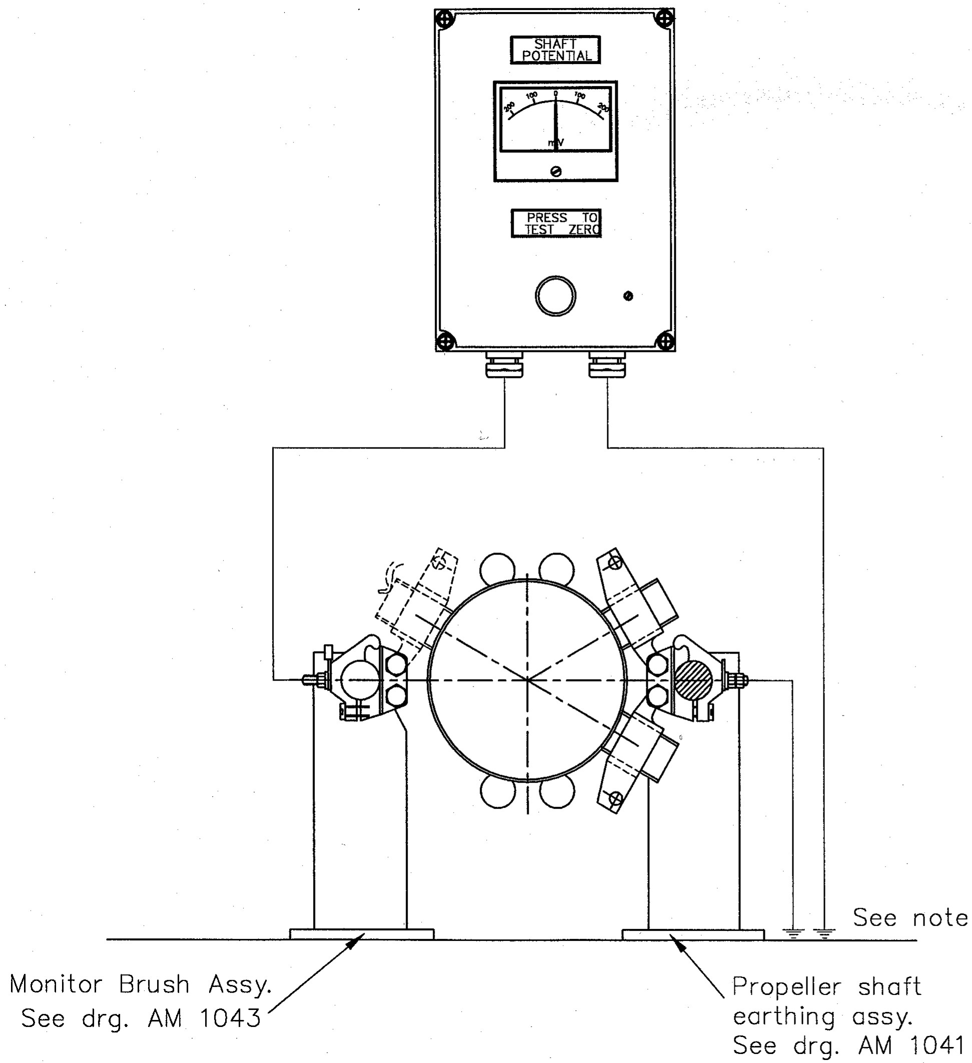
Information shown on this drawing is confidential and must not be copied or conveyed to third parties without the express permission of Wilson Walton International (UK)Ltd.

Certain items shown on this drawing are subject to worldwide patent applications.

P & O

PROPELLER SHAFT EARTHING ASSEMBLY
FOR COPPER / SILVER INLAY SLIPRING

Drawn	Date	Checked	Date
C.G.	21/3/96	PR	18/4/96
Scale	**DRG. No.**		**Issue No.**
N.T.S.	AM 1041		00



NOTE
Earth connections to be separate from each other.

No.	DESCRIPTION	DCR No.	BY	CHECK	DATE
0	REDRAWN ONTO CAD		C.G.		25/3/96

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a corrpro company
Adam Street,Bowesfield Lane,
Stockton-on-Tees,Cleveland TS18 3HQ.
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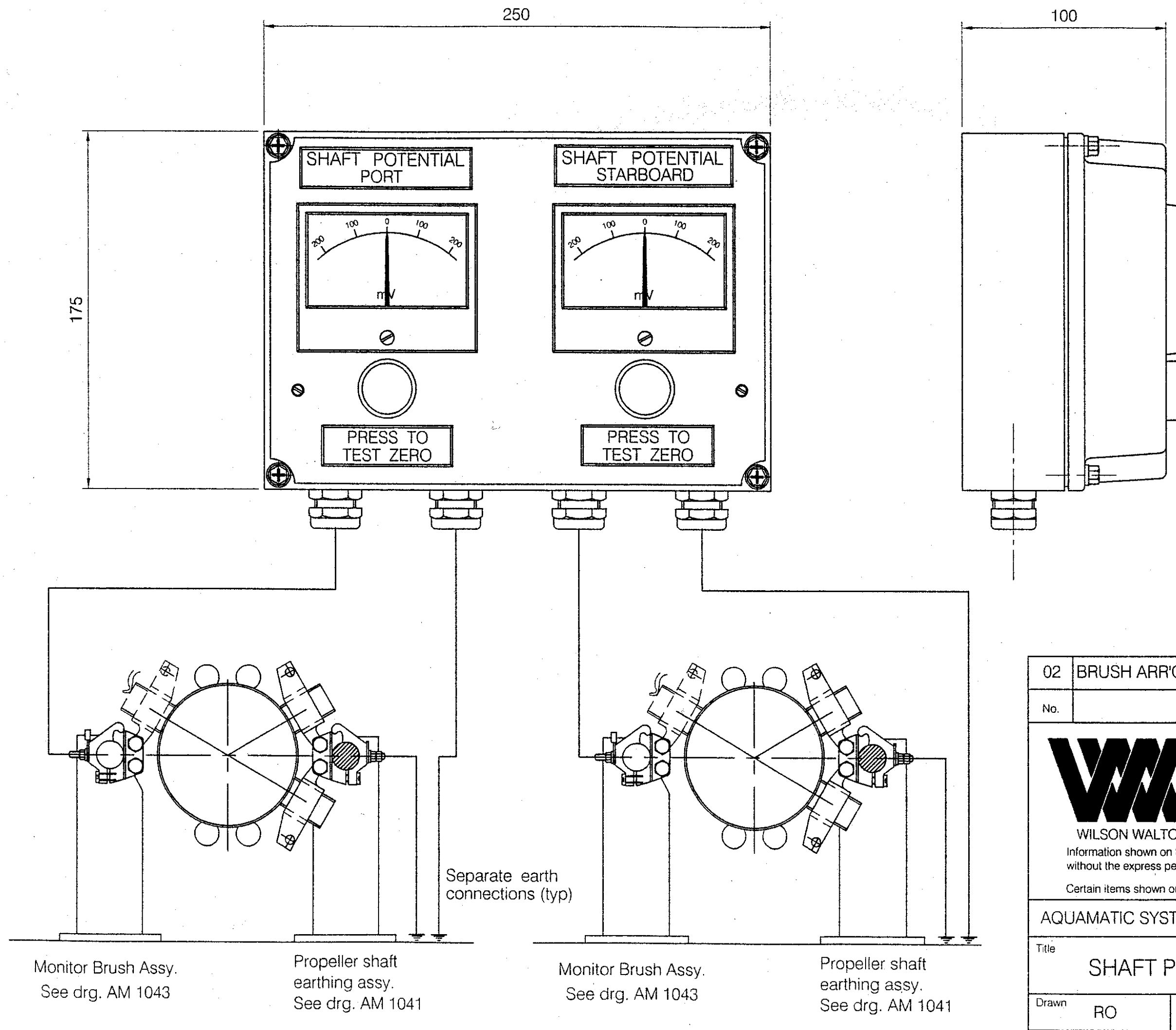
WILSON WALTON

MONITOR UNIT & SLIPRING
INTERCONNECTION DIAGRAM

Drawn	Date	Checked	Date
C.G.	25/3/96	PR	22/4/96
Scale: N.T.S.	DRG. No.: AM 1045		Issue No.: 0



No.	DESCRIPTION	DCR No.	BY	CHECK	DATE
02	BRUSH ARR'GT ADDED; 0-200 WAS 0-600	1271	RO	BM	24/5/01

WILSON WALTON

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a corrpro company
Adam Street,Bowesfield Lane,
Stockton-on-Tees,Cleveland TS18 3HQ.
Tel: (01642) 614106. Fax: 614100 .Telex: 587388

AQUAMATIC SYSTEM | TWIN SCREW

Title: SHAFT POTENTIAL MONITOR PANEL/ARR'GT

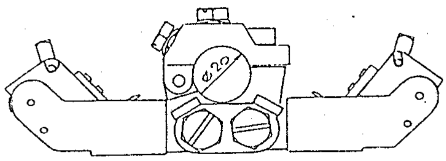
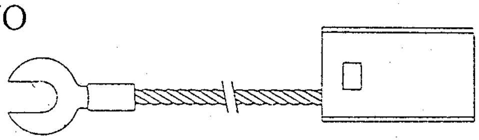
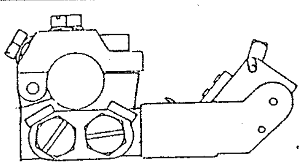
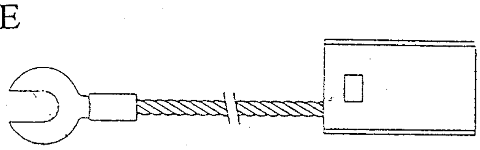
Drawn	Date	Checked	Date
RO	1/4/96	BM	1/4/96

Scale	DRG. No.	Issue No.
1:2	AM 1278	02

7.0

SPARES.

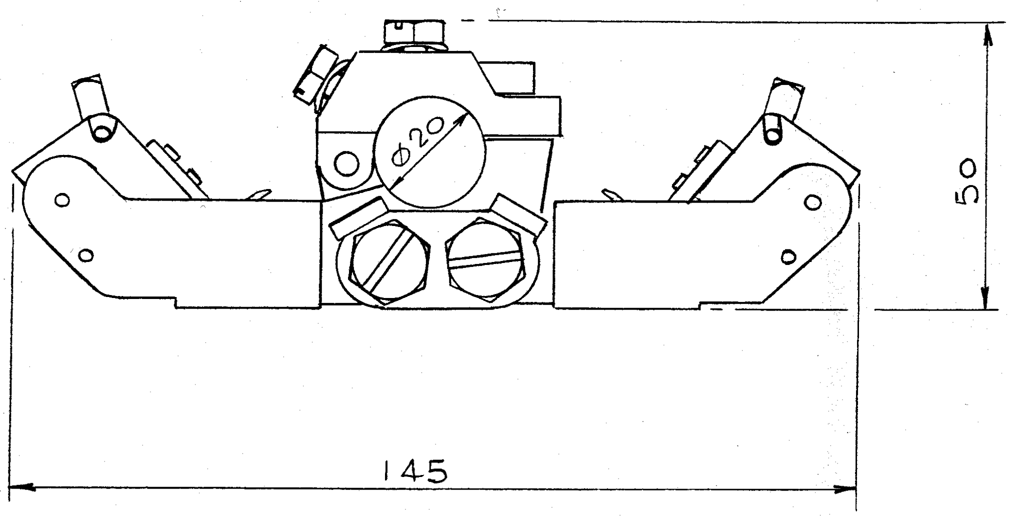
AQUAMATIC SPARE PARTS LIST. PROPELLER SHAFT GROUNDING & MONITORING ASSEMBLY.

EQUIPMENT	QUANTITY	DRAWING.
GROUNDING ASSEMBLY.		
DOUBLE BRUSH HOLDER	ONE	
SILVER GRAPHITE BRUSH	TWO	
MONITORING ASSEMBLY.		
SINGLE BRUSH HOLDER	ONE	
SILVER GRPHITE BRUSH	ONE	

NOTE

UNIT AS DRAWN TO BE USED AS EARTHING ASSY SEE DRG. N° AM.1041.

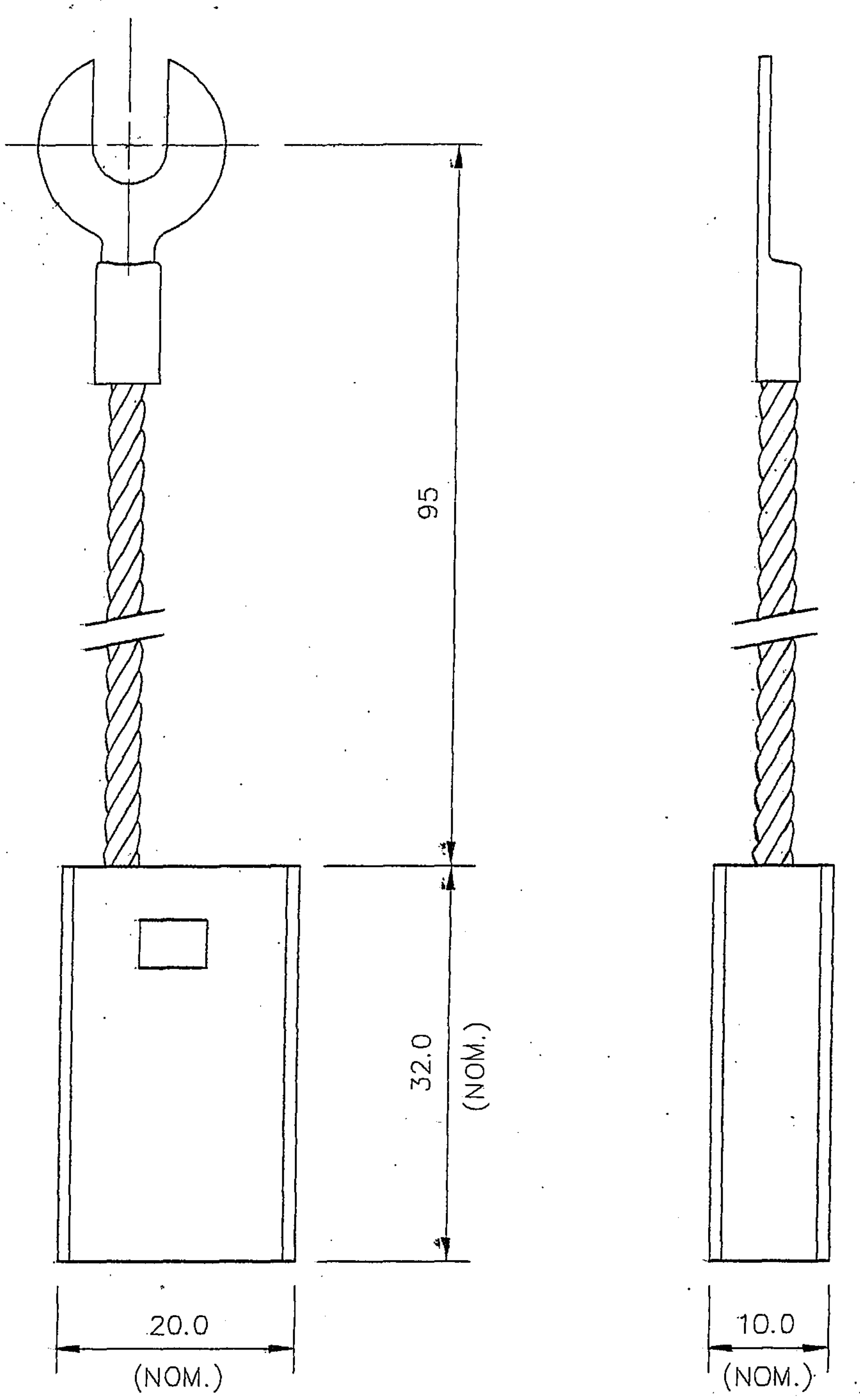
ONE ARM TO BE REMOVED FOR USE AS MONITORING ASSY. SEE DRG. N° AM 1043.



FOR USE WITH SILVER GRAPHITE BRUSH DRG N° AM 1042

Wilson,Walton International (UK) Ltd.
Adam Street, Bowesfield Lane,
Stockton-on-Tees, Cleveland TS18 3HQ.
Tel: (0642) 614106 Telex: 587388

BRUSH HOLDER (SILVER GRAPHITE BRUSH)			
DRAWN RO	DATE 7/3/88	SCALE 1:1	
DRAWING No. AM 1038			ISSUE



MATERIAL : GRADE SM9173

Wilson Walton International (UK) Ltd.
a corrpro company
Adam Street, Bowesfield Lane,
Stockton-on-Tees, Cleveland TS18 3HQ.
Tel: (01642) 614106. Fax: 614100 Telex: 587366

WILSON WALTON

SILVER GRAPHITE EARTHING AND MONITORING BRUSH

Drawn	Date	Checked	Date	Chill No.	Scale
DPS	3/10/95	[signature]	26/10/95	N/A	NTS

DRG.No. AM 1042/1

ISSUE 01

49995-E

Oiltech
PWO

INSTALLATIONS- OCH SERVICEANVISNINGAR ◆ INSTALLATION AND SERVICING INSTRUCTIONS
INSTALLATIONS- UND WARTUNGSANLEITUNG ◆ NOTICE D'INSTALLATION ET DE MAINTENANCE ◆ INSTALLATIE EN ONDERHOUD INSTRUCTIES ◆ INSTRUCCIONES DE FUNCIONAMIENTO Y MANTENIMIENTO ◆ ISTRUZIONI DI MONTAGGIO E MANUTENZIONE

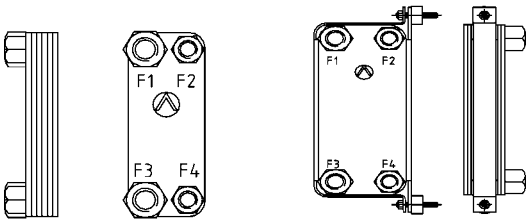
OILTECH
MEMBER OF THE OLAER GROUP

PW00012M

Följ denna anvisning noga vid installation av Oiltechs vattenoljekylare typ PWO.

Anslutning av in- och utgående olja och vatten

För standard PWO vattenoljekylare:
Oljeanslutningarnas diametrar är alltid större än vattenanslutningarnas.
Anslut olja in till undre vänstra anslutningen. (F3)
Anslut olja ut till övre vänstra anslutningen (F1).
Anslut vatten in till övre högra anslutningen (F2).
Anslut vatten ut till undre högra anslutningen. (F4)
Observera att PWO B56 har en annorlunda inkoppling!
Använd filter om det finns risk för att partiklar i vätskan kan sätta igen kylaren.
Partiklar mindre än 1 mm utgör normalt inga problem.



Placering

Kylaren kan monteras i vilket läge som helst. Finns behov av att kunna tömma något av omloppen, bör hänsyn dock tas till detta. För att minimera risken för igensättning på vattensidan, montera PWO vertikalt enligt bild.

Hur man undviker materialspänning

Alla enheter, som inte är försedda med stödben, bör monteras med hjälp av Oiltechs fästklämma runt kylaren. Vissa större enheter bör dessutom utrustas med fixeringsskruvar på anslutningssidan. Kylaren bör dock inte hänga enbart i dessa skruvar. Kylaren bör ej monteras i stel ram. Använd flexibla hydraulslangar för mjuk och elastisk installation. All rördragning skall utföras på så sätt att spänningar och vibrationer på anslutningar och kylare minimeras. I hydraulsystem där kylaren är ansluten till retursidan, använd slangar och eventuellt en by-passventil på oljeinloppet för att undvika övertryck.

Tecken på igensättning

För att fastställa igensättning, kontrollmät kylarens ingående och utgående vattentemperatur. Igensättning minskar värmeöverföringsförmågan, vilket resulterar i ökad vattenförbrukning, minskad skillnad mellan in- och utgående vattentemperatur och förhöjd oljetemperatur.
En annan metod är att mäta tryckfallet över kylaren. Igensatta och trånga passager ger ökad flödeshastighet och ökat tryckfall. Det är viktigt att vattenflödet är rätt när mätningar görs. Avvikelser från angivet flöde påverkar naturligtvis temperaturen och tryckfallet.

Rengöring

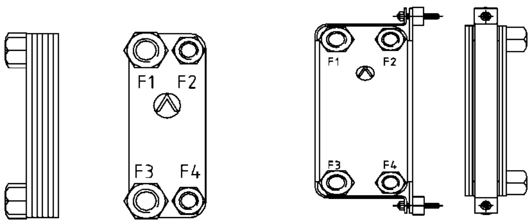
Som regel får man bort alla mjuka avlagringar genom att spola kylaren med vatten i riktning motsatt den normala flödesvägen. Vid hårda avlagringar, skölj kylaren med svag syra. Använd 5% fosforsyra eller om kylaren görs rent ofta med 5% oxalsyra eller annan liknande svag organisk syra. Skölj därefter med stora mängder vatten. All syra måste avlägsnas innan systemet startas igen. Vänta aldrig med rengöring tills kylaren är helt igensatt.

Material AISI 316. Max arbetstryck 31 bar, max arbetstemperatur 185°C. Alla PWO vattenoljekylare är trycktestade vid 47 bar innan leverans.

Lean cuidadosamente esta información antes de instalar el intercambiador agua/aceite PWO.

Conexión de entrada y salida para aceite y agua

PWO modelo estándar:
El diámetro de conexión del aceite, siempre tiene que ser mayor que la del agua.
La entrada del aceite tiene que ser por abajo izquierda (F3).
La salida del aceite tiene que ser por arriba izquierda (F1).
La entrada del agua tiene que ser por arriba derecha (F2).
La salida del agua tiene que ser por abajo derecha (F4).
El modelo PWO B56 lleva otro tipo de conexión.
Para evitar obstrucciones, utilizar un filtro. Partículas menores de 1 mm, no suelen causar problemas.



Montaje

El intercambiador puede colocarse en cualquier posición. Se ha de tener en cuenta la necesidad de purgar el circuito. Para minimizar obstrucciones en el circuito de agua, colocar el PWO en posición vertical como se indica en las figuras arriba.

Cómo evitar fatigas de material

Todos los intercambiadores - sin soporte - se deben montar mediante abrazaderas. Algunos modelos grandes equipan también pasadores roscados, situados en el lado conexión, que sin embargo no debe emplearse como sujeción única del intercambiador. Evitar montajes rígidos. Utilizar conexiones flexibles. Todos los conexiones deben realizarse para minimizar los vibraciones. En aquellos circuitos hidráulicos donde el intercambiador se instala en retorno, emplear tuberías flexibles para reducir pulsaciones y ev. una válvula by-pass en la entrada del aceite para evitar sobrepressiones.

Síntomas de obstrucción

El estado de obstrucción puede valorarse, verificando las temperaturas de entrada y salida del agua, ya que hace disminuir la transferencia térmica y por lo tanto aumenta el consumo de agua con valores de temperatura del agua inferiores a los especificados, y temperatura de aceite elevada.
Otra manera de analizar la obstrucción es controlando la pérdida de carga. Las obstrucciones reducen la sección, aumenta la velocidad y por lo tanto mayor pérdida de carga. Antes de aplicar estos criterios verificar que el caudal de agua es el especificado. Un caudal de agua diferente afecta a la temperatura y a la pérdida de carga, como es de prever.

Limpieza

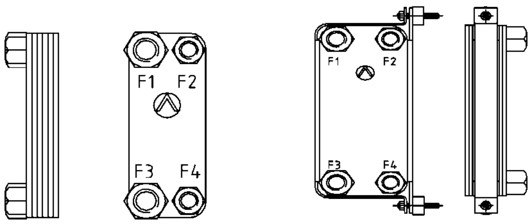
En general, los depósitos no incrustantes pueden eliminarse, enjuagando el intercambiador a contracorriente y los depósitos incrustantes utilizando un ácido débil, como por ejemplo ácido fosfórico al 5%. Si el intercambiador debe limpiarse frecuentemente, utilizar ácido oxálico al 5%, u otro ácido orgánico similar. Una vez limpio, y antes de su conexión al circuito, debe enjuagarse con abundante agua para eliminar toda traza de ácido. Limpiar el intercambiador sin esperar a que se obstruya totalmente.

Material AISI 316. Presión máxima de servicio: 31 bar. Temperatura máxima de servicio: 185ºC. Todos los intercambiadores PWO han sido probados hidraulicamente a 47 bar.

Attenersi scrupolosamente alle istruzioni per l'installazione dello scambiatore acqua - olio Oiltech PWO.

Collegamento degli attacchi dell'olio e dell'acqua

Scambiatore standard acqua-olio PWO:
I diametri degli attacchi olio sono sempre maggiori di quelli per l'acqua.
L'ingresso dell'olio deve essere collegato all'attacco inferiore sinistro. (F3)
L'uscita dell'olio deve essere collegata all'attacco superiore sinistro. (F1)
L'ingresso dell'acqua deve essere collegato all'attacco superiore destro . (F2)
L'uscita dell'acqua deve essere collegata all'attacco inferiore destro.(F4)
N.B. Il collegamento olio/acqua è differente per lo scambiatore modello PWO B56.
Inserire un filtro se nel fluido fossero presenti particelle che potrebbero intasare lo scambiatore. Particelle fino ad 1 mm di diametro non causano alcun inconveniente.



Posizionamento dello scambiatore

Lo scambiatore può essere montato in qualsiasi posizione, considerando la messa a scarico del circuito.
Per ridurre le incrostazioni lato acqua, installare il PWO in verticale come presentato nella figura.

Come evitare la fatica del materiale

Tutte gli scambiatori - senza supporto - sono montate con una staffa che avvolge lo scambiatore. Alconi modelli grandi sono dotate di prigionieri, da non considerarsi come bulloni di sostegno, posizionati sul lato attacchi olio/acqua.
Non montare lo scambiatore rigidamente, ma interporre supporti elastici Armaflex o equivalenti (antivibranti). I collegamenti con le tubazioni devono essere eseguiti in modo da ridurre al minimo le vibrazioni. Nei sistemi idraulici, dove lo scambiatore viene montato sulla linea di ritorno, occorre prevedere tubi flessibili e eventuali by-pass sulla linea d'ingresso dell'olio per evitare sovrapressioni.

Verifica del grado d'incrostazione

La misurazione delle temperature dell'acqua, in ingresso ed in uscita dallo scambiatore, indica se si è verificato un fenomeno di incrostazione in quanto si riduce lo scambio termico ed aumenta il consumo dell'acqua; riduce infatti la differenza delle temperature dell'acqua e aumenta la temperatura dell'olio.
Un altro metodo è il controllo della caduta di pressione attraverso lo scambiatore. L'aumento della velocità e aumento della caduta di pressione, possono verificarsi a causa di incrostazioni e passaggi ridotti.
E' importante controllare che la portata dell'acqua sia come da specifica, poiché ogni variazione della stessa può influenzare la temperatura e la caduta di pressione.

Pulizia

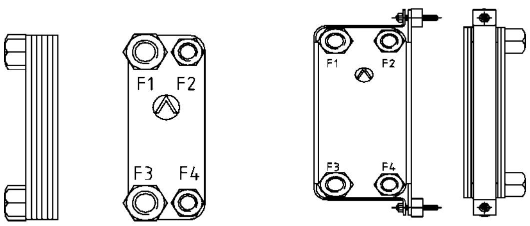
Quando è necessario, un lavaggio controcorrente (controflussaggio) con acqua rimuove il grosso del deposito "tenero". Per depositi duri, far circolare acido fosforico al 5% (acido debole) attraverso lo scambiatore, sempre in direzione opposta al normale flusso d'acqua; per pulizie frequenti utilizzre invece 5% di acido ossalico (o analogo acido organico). Risciacquare poi con acqua, per eliminare tutto l'acido dallo scambiatore prima di far ripartire il sistema. La pulizia si deve effettuare prima che lo scambiatore sia completamente intasato.

Materia AISI 316. Massima pressione di lavoro: 31 bar. Massima temperature di lavoro: 185°C.
Gli scambiatori saldobrasati sono tutti testati a 47 bar per controllare le saldature e quindi la tenuta in pressione dei fluidi.

Neem deze instructies voor de installatie van Oiltech PWO water/olie koelers nauwkeurig in acht.

Aansluiting van olie en water in- en uitlaat

Standaard PWO water/olie koeler:
De diameters van de olie aansluitingen zijn altijd groter dan die van de water aansluitingen.
De olie inlaat moet worden aangesloten aan de linksonder aansluiting (F3).
De olie uitlaat moet worden aangesloten aan de linksboven aansluiting (F1).
De water inlaat moet worden aangesloten aan de rechtsboven aansluiting (F2).
De water uitlaat moet worden aangesloten aan de rechtsonder aansluiting (F4).
Let op! Het type PWO B56 heeft afwijkende aansluitingen.
Gebruik een waterfilter, indien het koelwater opgeloste deeltjes bevat met een diameter groter dan 1 mm. Kleinere opgeloste deeltjes veroorzaken in het algemeen geen probleem.



Montage van de koeler

De PWO water/olie koeler kan in alle posities gemonteerd worden, rekening houdend met de behoefte aan aftappen. De positie van de koeler dient vertikaal te zijn zoals afgebeeld, om vervuiling van de waterzijde te voorkomen. Zie boven!

Vermijden van spanningen in het materiaal

Alle modellen zonder frame dienen te worden gemonteerd met een beugel rondom de koeler. Sommige grotere modellen zijn uitgerust met standaard aangelaste draadeinden aan de aansluitzijde. De koeler mag echter niet alleen aan deze draadeinden opgehangen worden.
Monteer de koeler niet op een onbuigzaam onderstel. Gebruik het Armaflex-systeem of vergelijkbare flexibele vorm van installatie. Alle aansluitingen moeten zodanig gebeuren dat de trillingen op de koeler tot een minimum worden beperkt. In hydraulische systemen waar de koeler in de retourleiding geplaatst wordt dienen er flexibele slangen te worden toegepast om pulsaties te verminderen en ev. een by-pass klep in de olie inlaat om overdruk te vermijden.

Signalering van vervuiling

Door de watertemperatuur aan de in- en uitlaat van de koeler te meten kan worden bepaald of deze al dan niet vervuild is. Als de inwendige oppervlakte van de koeler vervuild is, vermindert de warmeoverdracht, het geen waterverbruik verhoogt en het watertemperatuurverschil tussen inlaat en uitlaat vermindert alsmede de olietemperatuur in het systeem verhoogt.
De vervuilingsgraad kan ook worden bepaald door de drukval over de waterzijde van de koeler te meten. Vervuiling in het watercircuit van de koeler veroorzaakt een hoge vloeistofsnelheid en een hoge drukval. Alvorens deze methode te gebruiken, moet u ervoor zorgen dat het waterdebiet gelijk is aan de gespecificeerde waarde, want een afwijkend waterdebiet heeft invloed op het temperatuurverschil en de drukval over de koeler.

Onderhoud

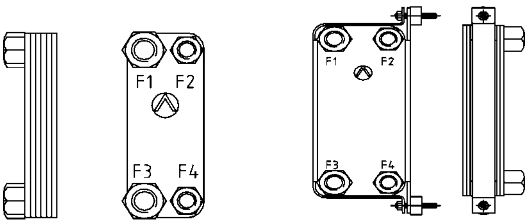
De meest losse aanslag verwijderen middels een waterspoeling in omgekeerde richting dan de standaard stroomrichting van het koelwater. Als een harde aanslag is gevormd, laat dan een zwak zuur door koeler circuleren. Gebruik 5% fosfor zuur of, indien dikwijls gereinigd 5% oxaalzuur of een ander zwak organisch zuur. Spoel daarna met veel water om alle zuuraanslag te verwijderen alvorens het systeem weer in gebruik te stellen. Gebruik altijd persoonlijke beschermingsmiddelen tijdens spoelwerkzaam-heden.

Materiaal: AISI 316. Maximale bedrijfsdruk: 31 bar: Maximale bedrijfstemperatuur: 185°C. Alle PWO water/olie koelers zijn getest op een druk van 47 bar.

Please read this information prior to installing Oiltech PWO water oil cooler.

Connection of oil/water inlets and outlets

Standard PWO water oil cooler:
Oil connection diameters should always be larger than water connection diameters.
Connect inlet oil to lower left connection (F3).
Connect oil outlet to upper left connection. (F1)
Connect water inlet to upper right connection. (F2)
Connect water outlet to lower right connection (F4).
Please note that on PWO B56 the oil/water inlets and outlets are different to above!
Use filter to prevent clogging due to contamination. However, deposits less than 1 mm will not cause any problem.



Positioning

The cooler can be installed in any position, bearing in mind the need for draining. To minimise clogging on the water side, we recommend a vertical installation as shown in figure above.

How to avoid material stress

All units – without support – should be fitted with a clamp around the cooler. Some larger units are should be fitted with additional fixing screws on the connection side. However, never mount the cooler using only these screws!
Never install the cooler in a rigid frame. Use hydraulic hoses for soft and flexible installation. All tubing should be made to minimise stress and vibration. In a hydraulic system, where the cooler is connected on the return line, use flexible hoses to minimize pulsations and if necessary fit a by-pass valve on the oil inlet to avoid overpressure from static loads.

Signs of clogging

To establish clogging, check water inlet and outlet temperatures. Clogging will reduce heat transfer capacity, causing increased water consumption, reduced difference in water inlet and outlet temperature and a rise in oil temperature.
Another method is to check pressure drop across the cooler. Clogged and narrow passages will cause acceleration in flow rate and increased pressure drop. Always observe that water flow is as advised. Any deviation from stated flow will, of course, affect temperature and pressure drop.

Cleaning

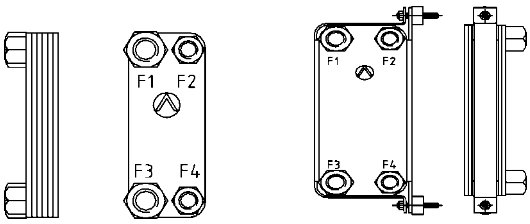
In general, all minor deposits can be removed by back flushing the cooler with water. Fouling can be dealt with using light acid. Use 5% phosphoric acid or, when cleaned frequently, 5% oxalic acid or similar light organic acid. Rinse the cooler with a large quantity of water. Remove all acids before restarting the system. Always clean the cooler before it becomes completely clogged.

Material AISI 316. Max. working pressure 31 bar. Max. working temperature 185°C. All PWO water oil coolers are pressure tested for leakage at 47 bar prior to delivery.

Bitte beachten Sie für die Installation der Oiltech PWO Öl/Wasser Wärmetauscher folgende Hinweise.

Anschlüsse für den Öl- und Wasserkreislauf

Standard PWO Öl/Wasser Wärmetauscher:
Die Anschlüsse für den Ölkreis sind immer grösser als die Anschlüsse des Wasserkreislaufes.
Ölaustritt erfolgt am oberen linken Gewindeanschluss (F1).
Wassereintritt erfolgt am oberen rechten Gewindeanschluss (F2).
Öleintritt erfolgt am unteren linken Gewindeanschluss (F3).
Wasseraustritt erfolgt am unteren rechten Gewindeanschluss (F4).
Bitte beachten Sie, dass bei den PWO B56 F4, F2 die Ölanschlüsse, F1, F3 die Wasseranschlüsse sind.
Verwenden Sie einen Filter, um Ablagerungen zu vermeiden. Partikel bis zu 1 mm Durchmesser bereiten normalerweise keine Probleme.



Montage

Der PWO Wärmetauscher kann in jeder Lage eingebaut werden. Es ist jedoch darauf zu achten, dass beide Kammern gegebenenfalls einwandfrei entleert werden können. Um die Verstopfungsgefahr der Wasserkanäle zu verringern, ist es von Vorteil den PWO Wärmetauscher vertikal zu montieren. Siehe Abbildung.

Vermeiden von Ermüdungsbrüchen

Alle Wärmetauscher ohne Füsse müssen mit einer Halterung seitlich befestigt werden. Einige grössere Einheiten sind auch mit Stehbolzen auf der Anschlussseite ausgerüstet. Niemals den Wärmetauscher nur mit diesen Stehbolzen befestigen.
Um Ermüdungsbrüche an den Anschlussstellen wirksam zu verhindern, empfehlen wir Schläuche einzusetzen. Bei der Installation eines Wärmetauschers in der Rücklaufleitung, sollte ein Umgehungsventil eingesetzt werden, um eventuell auftretende Druckspitzen auffangen zu können. Der Anschluss des Wärmetauschers sollte grundsätzlich mit Schläuchen vorgenommen werden, um Spannungen in der Anschlussplatte zu vermeiden.

Primäre Gründe für Ablagerungen

Ein Zeichen dafür, dass Ablagerungen vorhanden sind, ist, wenn eine unüblich grosse Wassertemperaturdifferenz zwischen Eingang und Ausgang des Wärmetauschers gemessen wird. Ablagerungen schränken die Wärmeübertragungskapazität ein, verursachen einen erhöhten Wasserverbrauch und eine Reduzierung der Kühlleistung.
Eine weitere Möglichkeit zur Feststellung von Ablagerungen ist die Messung des Druckabfalles über den Wärmetauscher. Ablagerungen erhöhen die Geschwindigkeit und den Druckabfall. In beiden Fällen müssen die spezifizierten Durchflussmengen von Wasser und Öl gemessen werden. Jede Abweichung des Durchflusses beeinflussen die Temperaturen und den Druckabfall.

Reinigung

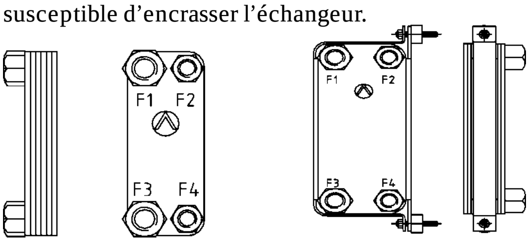
Nahezu alle weichen Ablagerungen können durch Rückspülen mit Wasser entgegen der normalen Wasserdurchflussrichtung entfernt werden. Bei starker Ablagerung verwenden Sie 5%-ige Phosphorsäure oder für häufige Reinigungen 5%-ige Oxalsäure oder ähnlich weiche organische Säuren. Spülen Sie in jedem Fall nach einer Säurebehandlung den Wärmetauscher ausreichend mit Wasser. Warten Sie mit der Reinigung nicht bis der Kühler verstopft ist.

Werkstoff AISI 316. Maximale Betriebsdruk: 31 bar.
Maximale Betriebstemperatur: 185°C.
Um die Dichtheit zu prüfen, wird vor Auslieferung jeder PWO Öl/Wasser Wärmetauscher einer Druckprobe von 47 bar unterzogen.

Lire attentivement ces instructions avant installer l'échangeur eau/huile PWO.

Branchement des entrées et sorties d'huile et d'eau

Pour l'échangeur PWO standard:
Les diamètres des raccords d'huile sont toujours supérieurs à ceux des raccords d'eau.
L'entrée d'huile doit être branchée sur le raccord gauche inférieur (F3).
La sortie d'huile doit être branchée sur le raccord gauche supérieur (F1).
L'entrée eau doit être branchée sur le raccord droit supérieur (F2).
La sortie d'eau doit être branchée sur le raccord droit inférieur (F4).
NB: Les raccordements eau/huile sont inversés sur le modèle PWO B56.
Utiliser des filtres lorsque le fluide transporte des particules supérieures à 1 mm de diamètre susceptible d'encrasser l'échangeur.



Positionnement

L'échangeur PWO peut être monté dans toutes les positions, tout en tenant compte de la vidange éventuelle des circuits. Pour éviter tout encrassement côté eau, monter l'échangeur verticalement selon les instructions ci-dessus.

Comment éviter toute fatigue mécanique

Tous les échangeurs – sans support – se montent à l'aide d'une bride placée autour du corps. Pour les échangeurs de grande capacité en complément des brides, des goujons sont prévus. Ces goujons sont situés sur la face de raccordement. L'échangeur ne doit pas être uniquement supporté par ces goujons! Ne pas monter l'échangeur sur un châssis rigide. Utiliser le système Armaflex ou tout autre support élastique similaire. Tous les raccordements doivent être réalisés de sorte que le niveau de vibration soit minimum. Pour des circuits hydrauliques où l'échangeur est relié au retour au réservoir, utiliser des tuyauteries souples pour reduir les pulsations et éventuellement un clapet by-pass sur l'entrée d'huile pour éviter toute surpression.

Facteurs d'encrassement

L'encrassement se détermine en contrôlant la température d'eau en entrée et sortie de l'échangeur. L'encrassement réduit le transfert thermique, ce qui se traduit par une consommation d'eau élevée, des différences de température d'eau inférieures aux valeurs spécifiées et une température d'huile élevée. Une autre manière de déterminer l'encrassement consiste à mesurer la perte de pression à travers l'échangeur. Etant donné que l'encrassement diminue la section de passage et, par conséquent, augmente la vitesse d'écoulement, ceci se traduira par une perte de pression plus importante. Avant d'utiliser ces méthodes, s'assurer que le débit d'eau est égal au débit spécifié. Un débit d'eau différent aura naturellement un effet sur la température et la perte de pression.

Nettoyage

Un rinçage à contrecourant à l'aide d'eau permettra l'élimination de la plupart des dépôts. Si l'encrassement consiste en des dépôts consistants, faire circuler un acide peu agressif à travers l'échangeur. Utiliser 5% acid phosphorique - 5% acide oxalique nettoyage fréquent - ou de tout autre acide organique faible. Ensuite, rinçer à grande eau afin d'éliminer toute trace d'acide avant d'utiliser à nouveau le système. Ne jamais attendre l'encrassement complet de l'échangeur pour procéder au nettoyage.

Materiaux AISI 316. Pression de travail maximale: 31 bar. Température maximale de travail: 185°C. Tous les échangeurs PWO sont soumis à des tests d'épreuves à 47 bar avant livraison.