

**INSTRUCTION AND
OPERATING MANUAL
FOR
FITTING AND ACCESSORIES**

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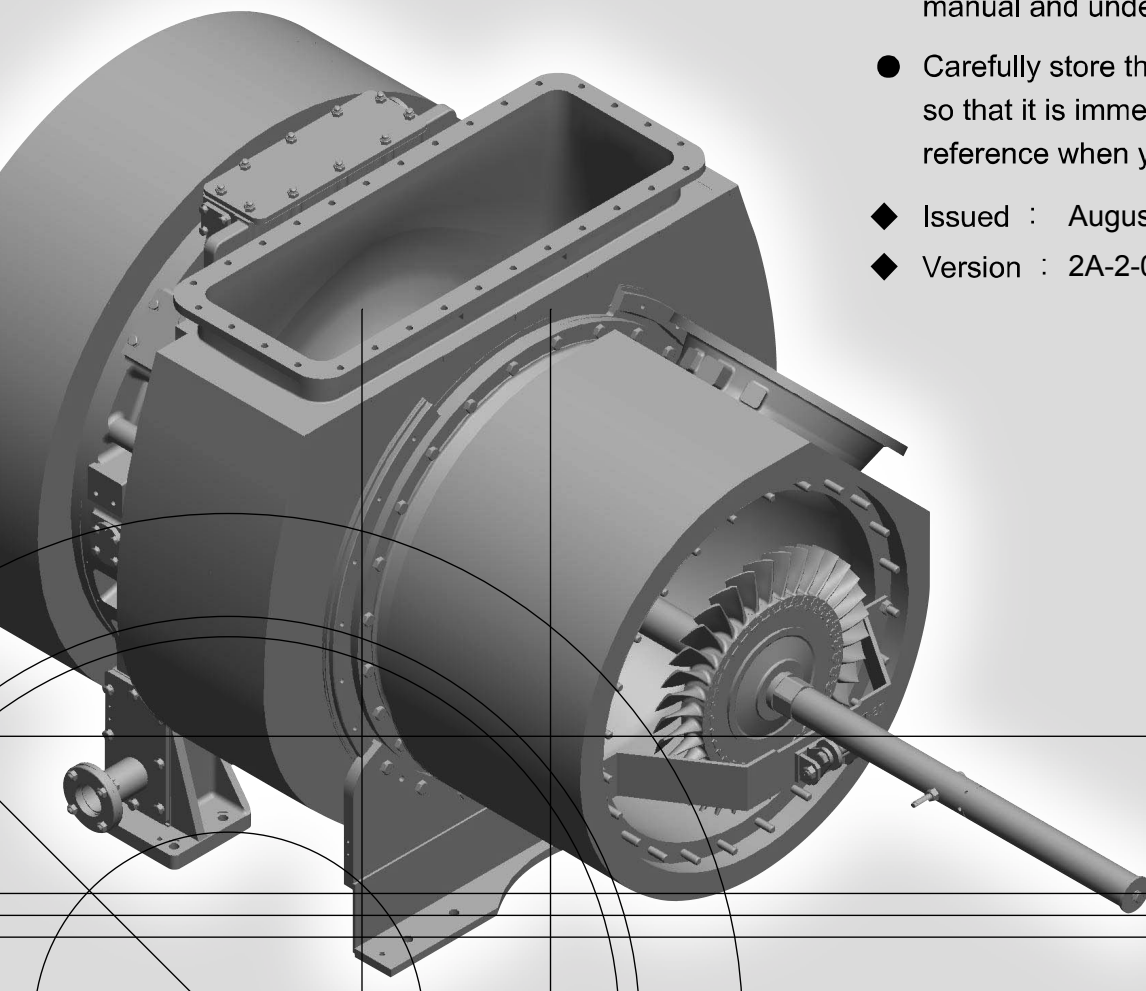
Mitsubishi Exhaust Gas Turbocharger

Model MB

Instruction Manual

NOTICE

- Operate or service the exhaust gas turbocharger only after you have read this manual and understood its contents.
- Carefully store this manual in a fixed place so that it is immediately available for your reference when you need it.
- ◆ Issued : August 2011
- ◆ Version : 2A-2-0000



Introduction

This manual is intended to provide users with an understanding of the structure of the Mitsubishi MET turbocharger, appropriate maintenance procedures, and proper response in the rare event of malfunctioning. Accordingly, this manual should always be placed in a location where it can be easily accessed from the vicinity of the turbocharger. Also, all personnel concerned with the engine to which the turbocharger is attached should carefully read this manual and understand its content. If the content requires further clarification, please make direct inquiries by facsimile, e-mail, etc.

LIMITED WARRANTY

In the event that the turbocharger becomes faulty in normal status of use, we will warrant as follows:

- (1) The term of warranty is either 12 months after ship delivery or 18 months after the turbocharger delivery, whichever comes first.
- (2) Should the turbocharger be faulty or damaged due to causes including faulty design, defective materials and poor workmanship, deemed to be the responsibility of the manufacturer (Mitsubishi Heavy Industries, Ltd. Herein after referred to as MHI), and such fault or damage be claimed by the customer during the term of the above (1), MHI will provide a substitute free of charge or repair at the site as necessary.
- (3) Should the warranty work be performed outside of Japan, the cost equivalent to the cost that would be charged if such a warranty work is performed in Japan by the manufacturer will be paid to the customer.
- (4) The following is excluded from the scope of the warranty:
 - A) Any failure deemed to be caused by mis-handling or misuse of the customer after due consultation between the customer and MHI
 - B) Any failure or disadvantage caused due to use of the parts which are not MHI's genuine parts.
Any service and maintenance for the turbocharger equipped with pirated parts or using them can not be accepted by the engineers from MHI and its authorized agent.
 - C) Consumables subject to natural wear and/or tear
 - D) Any failure caused due to natural disasters and/or force majeure
- (5) MHI will not be responsible for any consequential damages caused by any failure.

The warranties set forth above are exclusive and in lieu of all other warranties.

MHI makes no warranty, either expressed or implied, except as provided herein, including, without limitation thereof, warranties as to marketability, merchantability or fitness for particular purpose.

MHI shall not be responsible for any damages or consequential damages including without limitation thereof or other costs resulting from any abuse, misuse, misapplication of the equipment supplied by MHI.

IMPORTANT INFORMATION

- MHI will not be held responsible for any loss or damage resulting from failure to observe the instructions described in this manual, any modification of Mitsubishi exhaust gas turbocharger (herein after referred to as turbocharger) or operation / maintenance without care which must normally be taken.
- The turbocharger is a turbo-machine with a high speed rotor. The rotational energy of the rotor during operation is, therefore, immense. For this reason, improper handling can result in substantial damage to the equipment, as well as the possibility of human injury.
- Only when the turbocharger is installed to the exclusive diesel engines, it compresses and supplies combustion air suitable for such diesel engines.
Do not modify the turbocharger, remove from specified diesel engine or install to any other internal combustion engines.
If the turbocharger is modified, removed from the specified engines or installed to any other engines, the warranty will not cover.
- MHI is not able to foresee all dangers in handling the turbocharger. We cannot tell all risks, warnings or cautions by this manual or labels adhered to the turbocharger. Consequently, when performing operation and daily inspection of the turbocharger, it is necessary to take measures in addition to the items described in this manual.
- It is obvious that the performance, failure, durability of the turbocharger depends on its design, materials and/or manufacturing technique. It also depends on the daily handling or maintenance.
- In order to avoid generating of injury and/or damage, do not exceed the original purpose of use of the turbocharger and the specification range, and also do not perform the operation and maintenance work unless it is instructed to do so in this instruction manual.
- When transferring or lending the turbocharger, attach the instruction manual together with the turbocharger so that they should be able to fully understand the contents.
When transferring (or reselling), be sure to inform MHI of the resale place.
In this case, submit all things which come with the turbocharger to the resale group. The reseller shall not hold anything duplicated or reproduced.
- This instruction manual is prepared for English native speaker. In case that person whose native language is not English handles this turbocharger, he or she must be instructed on safety by the customer.
- The contents of this instruction manual are subject to change without prior notice for improving the turbocharger.
- Your turbocharger may different from the illustrations in this manual. A part of the illustrations may be omitted in order to facilitate explanation about the inside of the turbocharger.
- This manual is copyrighted and all rights are reserved. This manual may not, in whole or part, be copied, photocopied, translated or reduced to any electronic medium or machine-readable form without prior written consent from MHI.
- If you lost or damaged the instruction manual, order from MHI immediately.
- For further questions or information, contact MHI (10. Where to Contact).

Revision History

Name of Instruction Manual	Mitsubishi Exhaust Gas Turbocharger Model MB		
Document No.			
Rev.	Date of issue	Contents	Revised by
1A-2-0000	March 2011	New issue	Yoshihisa Ono
2A-2-0000	August 2011	“2 MET Turbocharger Basics”, “4 Maintenance/Inspection”, “5 Disassembly”, “9 Attached Diagrams and Tables” and “10 Where to Contact” changed.	

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1 Safety

1.1 About this Section

Safety precautions given in this section provide guidelines to prevent accidents resulting in injuries or death from occurring to operators for the turbocharger.

To ensure safety of the operators for the turbocharger, refer to the “Guidelines on occupational safety and health management systems ILO-OSH 2001”, and local rules and regulations including the following contents:

- (1) Safety measures
- (2) Customer’s responsibility to have their operators to understand about assurance of safety
- (3) Customer’s responsibility to manage their operators and machines

To operate the turbocharger based on the occupational safety and health management systems established by the customer, provide safety educations and trainings periodically in addition to understanding and observing of the safety instructions described herein.

In this section, to ensure the safety as above, the following safety information is also provided for all the operators of the turbocharger.

- (1) 1.4 and 1.5 --- Information for operators to ensure safety by themselves
- (2) 1.6 --- How to rescue from accidents resulting in injuries or death
Trainings in case of accidents, in addition to daily safety assurance activities, is required.
- (3) 1.7---Information from MHI about “Occupational Safety and Health Management” executed by the customer
This instruction manual (dangers, warnings and cautions), warning labels on the turbocharger and signals are important information to prevent anyone from accidents resulting in injuries or death.

To assure safety and/or to prevent damage of the turbocharger itself, warnings (dangers, warnings, cautions and notices) are described in the section “1.2.1 Warning description.”

For individual operation, understand and observe the contents of the manual.

In addition to “1.3 General Precautions”, the warnings are also important for individual works and operations.

1.2 Warnings

The following two methods are provided for the turbocharger to call attention of operators to danger.

- Warning descriptions in this manual
- Warning labels on the turbocharger

Read carefully all the safety warnings described in this manual.

Check the locations and the contents of all the warning labels adhered to the turbocharger before operating.

1.2.1 Warning description

The following four categories warn the dangerous situation that may occur during operation. If they are ignored, serious injuries or accidents corresponding to the respective warning sign may result. In extreme case, there is also a possibility of death, damage to the turbocharger or environmental fracture.

Kinds	Meaning of Warnings
 DANGER	Indicates an urgent (imminently) dangerous situation, which if mis-handled, will result in death, serious injury, serious property damage or environmental damage.
 WARNING	Indicates dangerous situation, which if mis-handled, could result in death, serious injury, serious property damage or environmental damage.
 CAUTION	Indicates a potentially dangerous situation, which if mis-handled, will result in minor or moderate injury, property damages or environmental damage.
<u>NOTICE</u>	Indicates to emphasize important or helpful information.

- Meanings of the symbols (extracted from ISO3864-1 (2002))

The following three symbols indicate signals for danger.

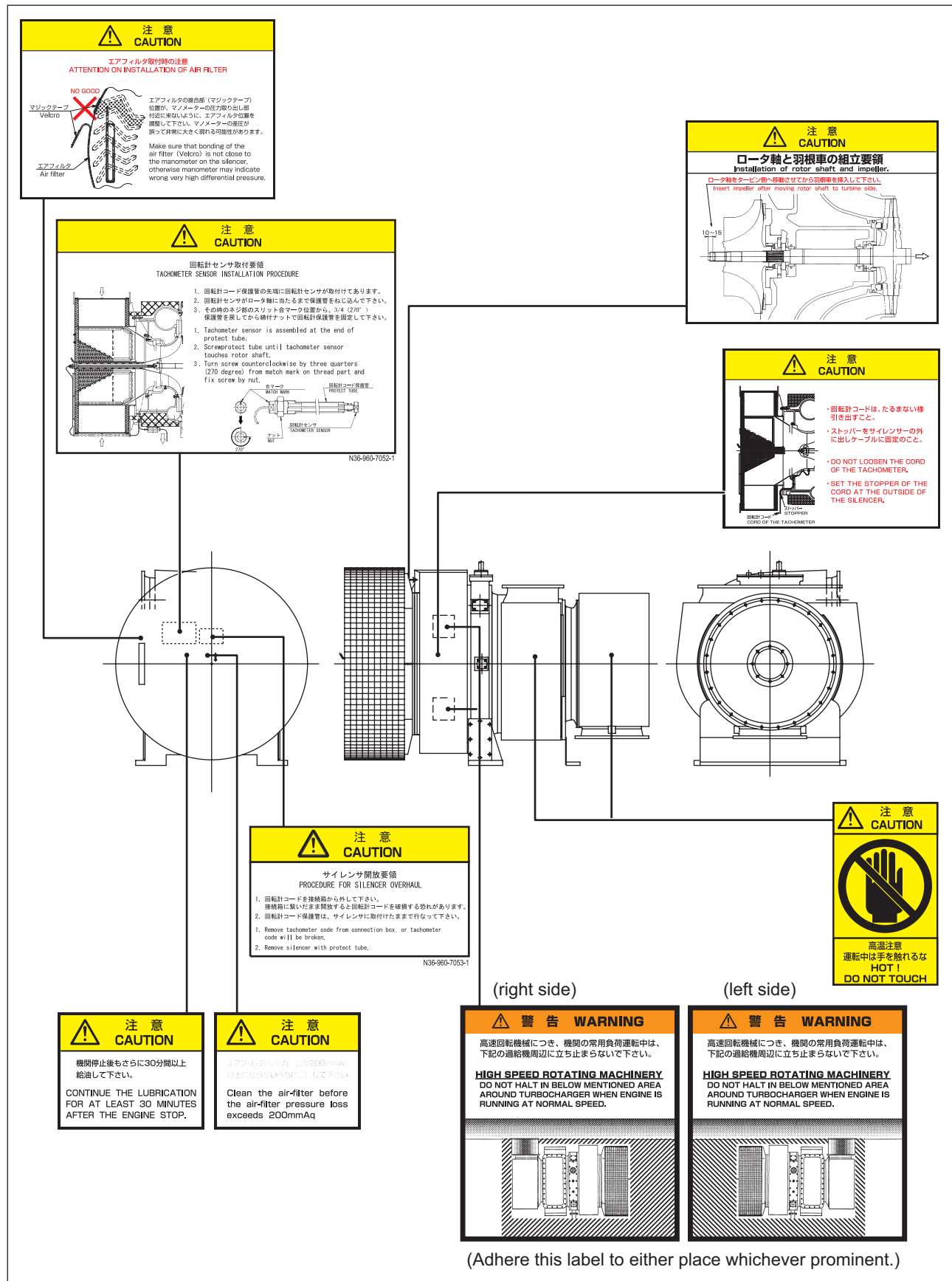
Symbols	Meanings		Examples
	Prohibition sign	Indicates prohibition of dangerous actions. The illustration inside or near the symbol is stylized prohibited action.	 (Prohibition)
	Direction sign	Indicates direction about the works and/or operations. The illustration inside or near the symbol is stylized required action. This action is necessary to avoid danger.	 (General direction)
	Caution sign	Indicates warnings about the dangerous places or actions, or that the dangerous situation may result due to neglect of safety obligation or carelessness. The illustration inside the symbol is stylized danger.	 (General caution)

1.2.2 Warning labels

■ Precautions in handling

- The turbocharger is provided with warning labels stating important precaution. Fully understand the meanings of the warning labels for safety operations which will not cause damages to the turbocharger.
- Never operate the turbocharger unless fully understanding the meanings of the labels. If you do not fully understand meaning of any label, contact MHI.
- Always observe the instructions of the warning labels on the turbocharger and warnings described in the manual.
- Do not tear off or damage the warning labels, or do not wipe them using solvent.
- When re-painting the turbocharger, do not paint the warning labels.
- If the warning labels adhered on the turbocharger became illegible, damaged or peeled, purchase them from MHI and replace as per the arrangement shown in the next page.
- If any part with a warning label is replaced, adhere a new warning label to the new part in the same manner as before.

Locations of warning labels



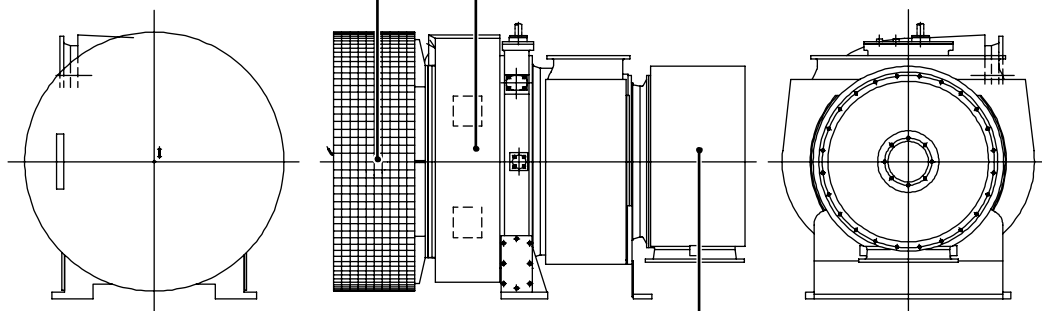
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■ Locations of main nameplates and caution plates

このフィルタ用カバーは陸上運転時には取り外してください。
過給機を造船所に出荷する時は再び取り付けてください。

During the shop test, this filter protector should be took off.
Please re-install this protector in turbocharger when delivered.

SERIAL NO.		MFG. DATE	
 MITSUBISHI EXHAUST -GAS TURBOCHARGER TYPE MET			
SPEC.			
MAX. CONT. SPEED		rpm	
MAX. CONT. GAS TEMP		°C	
MITSUBISHI HEAVY INDUSTRIES, LTD. TOKYO, JAPAN			



 注意 CAUTION	
洗浄実施のインターバル INTERVALS	100 HOURS
空気圧力 AIR PRESS	0.4~0.9MPa 4~9kg/cm ² (bar)
MET	
固体洗浄剤投入量(ℓ/1回) QUANTITY OF APPLICABLE CLEANING MEDIUM(ℓ/ONCE)	
洗浄実施の過給機許容最高回転数 MAXIMUM PERMISSIBLE REVOLUTIONS FOR CLEANING (min ⁻¹ (RPM))	

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1.3 General Precautions

The safety precautions describe herein provides guidelines to prevent accidents resulting in injury or death, property damage or environmental pollution. It is necessary to always observe the precautions when handling the turbocharger.

If not observed, it may cause serious injury of operators, damage of the turbocharger and environmental pollution. Be sure to, therefore, understand the precautions before handling the turbocharger.

1.3.1 Modification and specification change of the turbocharger



WARNING



Do not modify the turbocharger or change the specification without prior consent of MHI.

When screws from the turbocharger main unit are used to fasten other components, or when other components are welded to the turbocharger main unit, be sure to consult with MHI first.

- * It may deteriorate the performance or reliability of engines as well as the turbocharger.

Never use any parts or components other than genuine parts supplied by MHI for the turbocharger.

- * It may deteriorate the performance or reliability of engines as well as the turbocharger.

1.3.2 During operation



WARNING



Do not enter the danger zone during operation.

The silencer air inlet port sucks in large amounts of air and, in the event of sudden surging, there is a possibility of the reverse flow of high-pressure air from the silencer.

- * If not observed, you may trip over and get injured.

Do not put anything in a pocket of working wear during operation.

Take anything out of the pocket of the working wear.

- * The air inlet of the silencer inhales large amounts of air. There is a possibility that small objects you have on such as pens are sucked in.
If not observed, small objects may be sucked into the silencer, resulting in damage of the impeller.

Do not directly touch the surface of the turbocharger during operation of the engine.

If the insulation on the surface is damaged or peeled, cover it with flame-retardant mats, etc. temporarily, and then consult with MHI.

- * There is high temperature areas, which may cause heat injury.

**WARNING**

If you smell order of exhaust gas emitted from the exhaust gas piping or turbocharger, immediately stop the engine and then check to find gas-leaking places.

A part of the exhaust gas or a component of the gas from diesel engines is known for toxic gas causing cancers, birth defects and other toxicity of reproduction.

- * Inhaling of the gas may result in tracheal disorders or heat injury.
There is also a possibility that the turbocharger would suck in exhaust gas through the silencer, resulting in that sufficient air would not be supplied to the engine and that the temperature of the compressor impeller would rise, thus leading to unexpected accidents.

If you have to approach any danger zone during operation, the actions must be completed within a possible minimum time.

- * There is a possibility that the rotating parts inside the turbocharger become damaged and then jump out, leading to accidents resulting in injury or death.

If such leakage occurs, immediately stop the engine, and take appropriate measures to eliminate the leakage.

- * If oil leaks from the lubricant piping connected to the turbocharger, particularly in the high-pressure inlet piping, there is a possibility of ignition and fire due to the discharge of lubricant.

**CAUTION**

Wear an ear protection equipment (ear plugs, etc.) when approaching the danger zone during operation.

- * If not observed, hearing disorder may be caused due to noise around the turbocharger.

NOTICE

- While the engine is operating, the air filter must be kept mounted. If the air filter is torn off or damaged, replace with a new one. If the air filter is peeled or mis-mounted, immediately stop the engine or decelerate the engine to exhaust air pressure of 0.03MPa or less before re-mounting the filter appropriately.

1.3.3 Maintenance, disassembly and assembly

The turbocharger is designed for those who have skills of disassembling and assembling general large-size equipment. It is possible to disassemble and assemble the turbocharger by reading this manual thoroughly without any special training.

Disassembling or assembling of the turbocharger, however, is accompanied by dangerous work such as lifting heavy loads. Anyone handling the turbocharger must have skill and knowledge to perform disassembly and assembly safely, and such work must be performed under an appropriate safety management system.



WARNING



Do not disassemble or assemble the turbocharger when you are under influence of drinking, short of sleep or in poor physical condition.

- * It may cause unexpected accidents.

Do not use fire while the turbocharger is cleaned using any flammable liquids such as kerosene.

- * It may cause fire due to flash ignition.

Do not go under any equipment or part which is suspended.

- * The equipment or part may fall off due to failure of the lifting tool, causing accidents resulting in injury or death.



Check the clogged status of the filter everyday with the manometer installed to the silencer.

Be sure to clean or replace the filter before the pressure measured with the manometer exceeds 2.0 kPaG (200 mmAq).

- * If not observed, the air volume of the engine may become insufficient, resulting in reduction of output and generation of surging.
Then, the element of the air filter may be clogged and then ventilation resistance may become large, causing incomplete combustion due to the insufficient air, discharging gases harmful to the environment.

If the oil labyrinth or housings are damaged or worn out exceeding the standard value of the gap, replace with a new one.

- * The damaged or worn out oil labyrinth or housing may cause not only oil leakage but also a problem that the oil drops are discharged to outside through the air extractor of the turbocharger.

Operation of cranes and slinging must be performed by an authorized person.

The owner is obliged to give their employee who handles suspending equipment (chain block) training on safety. (Observe the national rules and regulations.) Only the persons who are trained on safety and designated by the owner may handle the suspending equipment.

- * If the suspended loads are unbalanced during transportation or fall off due to mis-slinging, it may cause accidents resulting in injury or death or damage of the turbocharger.

Before using materials to suspend the machine or parts (wires, slings, tools, etc.), check the weight of the object to be suspended. Use a material of sufficient strength.

- * If load exceeding the allowable value of the suspending material is applied, such a material may be broken and then the suspended object may fall off, causing accidents resulting in injury or death. There also is a possibility that broken wires or slings may jump out and hit a person, causing accidents resulting in injury or death.

 WARNING


Load to be applied to a suspending material will change depending on the angle of suspending. Consider it when selecting the size.

Do not select the size of the suspending material unless you understand the meaning of the instruction above.

- * If not observed, it may cause unexpected accidents.

Dispose of any suspending materials a part of which is broken. Use a new one.

Before using the suspending material, check if it is normal.

- * If any abnormal material tool is used, it may break during suspending work, causing accidents resulting in injury or death.

When suspending any equipment or part, place the hook in the center of the gravity of the suspended object.

Adjust the position so that each wire is applied with the same load.

- * If not observed, the object may be unbalanced when suspended or a certain wire is applied with large load and then broken, causing accidents resulting in injury or death.

After disassembling the silencer of the turbocharger and casing at inlet of the gas, if the rotor of the turbocharger is rotating, take measures of 5.2.

- **Never touch the impeller or turbine blade while it is rotating.**
- **Do not try to stop the rotation of the rotor by applying a piece of wood or waste cloth.**

Even when the engine is stopped, upward flow may be generated inside the duct due to afterheat of the exhaust duct or exhaust gas economizer, which makes the rotor of the turbocharger rotating. Such low rotational speed may not be detected by the rotational speed counter. Thus, even if the rotational speed counter reads "0", the rotor may not be stopped.

- * If not observed, you may get entangled in, or some foreign substances may hit the rotor.

To prevent accidents in disassembling and assembling, inspect required tools and exclusive tools beforehand.

- * If neglected, unexpected accidents may occur.



Take care not to step off or not to drop any object during the work.

If the scroll of the compressor in the turbocharger is removed, the intake of the duct for discharge air of the compressor will be turned downward.

- * There is a possibility of injury.

 CAUTION


Wait until the turbocharger is cooled enough after it is stopped before disassembling.

- * There is a possibility of heat injury.

1.3.4 Allowable turbocharger temperature and speed

The allowable turbocharger temperature and speed (rpm) are stated on the main nameplate (refer to the figure below). These values are not exceeded during normal operation. However, particular care is required under the following circumstances, as the allowable values may be exceeded, possibly resulting in serious damage or accidents.

1. Occurrence of turbocharger surging (phenomenon in which reverse flow of air from the compressor is accompanied by intermittent loud noise)
2. Failure of fuel system of engine.
3. Leakage of air and/or exhaust gas
4. Excessive exhaust gas energy due to irregular combustion in the engine

Main nameplate

SERIAL NO. MFG. DATE
MITSUBISHI EXHAUST -GAS TURBOCHARGER
T Y P E MET
 SPEC.
 MAX. CONT. SPEED rpm
 MAX. CONT. GAS TEMP °C
MITSUBISHI
 HEAVY INDUSTRIES, LTD.
 TOKYO, JAPAN

01-003

1.3.5 Clothing and personal protective equipment

 CAUTION	
	When performing works around the turbocharger while it is operating, wear protective equipment. It may make noise of 85 db or more while it is operating. * Work or operation without wearing the ear protective equipment (ear plugs, etc.) may cause hearing disorder.
	Get tidily dressed and your hair arranged tidy when performing works around the turbocharger. * Dressed untidily or untidy hair may cause accidents resulting in injury or death.

1.3.6 Others

- To prevent surging, not only periodical cleaning inside the turbocharger but also the maintenance of the engine is necessary. For further information about the engine, refer to the instruction manual of the engine.
- When abnormal combustion occurs due to failure of the engine or aging, the rotational speed of the turbocharger will increase extraordinarily, resulting in death or serious injury due to jumping out of pieces of broken parts as well as serious damage to the turbocharger. Keep the engine in a good condition by maintenance following the manual of the engine.

1.5 Protection of Human Body

To protect those handling the turbocharger, observe the following requirements.

- Put on protective footwear.
- Put on a hard hat.
- Working wear must be neatly fit to the body. The cuffs must be firmly fastened.
- Do not wear a tie, sort of accessories, etc. There is a possibility of being entangled. Long hair may be entangled in the turbocharger. Put on a hat as necessary.
- For handling cleaning liquids and solvents, observe the instructions shown on MSDS (1.7.3 Dangerous and harmful materials).
- Put on protective gloves when handling tools and suspending wires, etc.
- When operating or working, wear appropriate cloths.
 - Wearing loose clothing or high-heeled shoes, long hair, pendants or ties may cause accidents such as tumbling over or entanglement.
 - Wearing clothing with half sleeves or short pants may cause injury in case of contact with some objects.
- Adopt instructions above in your work rules.

1.6 Measures for Emergencies

1.6.1 Dealing with accident resulting in injury or death

It is very important to determine a course of action during an emergency to come to the aid and rescue operators who are involved in the accidents of the turbocharger.

Examples of steps included in a course of action during an emergency are shown below:

- (1) Assigning of persons to contact as personnel to assist in rescue operation
- (2) Procedure sheet outlining how to release hand, fingers and other body parts entangled in the turbocharger
- (3) Posting at least one person trained on rescue operation in one shift
- (4) Appropriate tools and equipment to achieve a successful rescue

1.6.2 Dealing with environmental damage

In case of accidental spill of waste oil, etc., follow the instruction below:

- (1) Contact the places concerned.
(Understand where to contact in case of emergency)
For example:
 - (a) Public institution to perform regional environmental management
 - (b) Fire department
 - (c) Police department
 - (d) Fishermen's union
 - (e) MHI or authorized service agency
- (2) Take action according to the instructions given by the public institution.

1.7 Occupational Safety and Health Management

This section describes the occupational safety and health management the customer must follow. In order to prevent accidents resulting in injury or death, property damage and environmental damage, make sure of this information along with legislations enforced by the national, state or local government, and independent safety management items of your own.

1.7.1 Training program

The technical skill related to safety can be improved by training in the same manner for technical skills for other operations. Be sure to include items related to safety in the education training programs provided by the customer.

All employees of the customer must be aware of potential dangers and keep the warning in mind. It is also necessary for the employees to improve their awareness of safety in order to quickly respond to danger and follow predetermined procedures.

If employees' safety awareness is increased, they can grasp the situation, avoid dangerous actions and dangerous zones, and eliminate potential danger to protect themselves.

The following are considered to be the minimum necessities for safety education and training.

(1) The following safety information is included in this manual.

- 1.3 General Precautions
- 1.4 Operating Procedure inside the Danger Zone
- 1.5 Protection of Human Body
- 1.6 Measures for Emergencies
- 1.7.3 Dangerous and harmful materials
- 1.7.5 Housekeeping
- 1.7.6 Fire prevention

(2) Items which must be stated in the warning descriptions (danger, warning and caution) in this manual and manuals for peripheral devices and warning labels attached on the turbocharger

(3) Measures that should be taken for non-English speakers to operate the turbocharger.

- Drastic safety education for operators
- Adhere warning labels translated into the native language of the operators to the turbocharger.

(4) Noise

(5) Other customer's rule

1.7.2 Understanding and observing the instructions described in the manual

Operators must fully understand the following included in this manual and also trained to avoid any danger in handling the actual turbocharger.

- (1) As described in the “IMPORTANT INFORMATION”, it is prohibited to disclose or photocopy the plans and technical reference, including this manual without prior written consent from MHI.
- (2) As described in “LIMITED WARRANTY”, MHI is not responsible for any loss or damage resulting from operators’ failure to observe the instructions and warnings in this manual.
- (3) About description of “1.3 General Precautions”
- (4) About “1.6 Measures for Emergencies”
- (5) Items which must be stated in the warning descriptions in this manual.

NOTICE

- **If non-English speakers operate the turbocharger, be sure to train about safety.**

1.7.3 Dangerous and harmful materials

Exposure to chemical substances might cause serious health problems such as heart diseases, damages to kidneys or lungs, sterility, cancer, heat injury or rash.

Some of the chemical substances could cause fire, explosion or other serious disasters.

When purchasing such dangerous and harmful materials, obtain MSDS (material safety data sheet) from the manufacturer and keep it close to the area of first use.

Handling the dangerous and harmful materials requires transmission of necessary information, providing education and training to those who handle the dangerous and harmful materials in accordance with ISO 11014 (1994).

Inform, educate and apply training to those who handle chemical substances based on the warnings shown below as well as MSDS (material safety data sheet).

- (1) Secure enough ventilation to the zones where dangerous or harmful materials are used.
- (2) Follow the methods recommended by the manufacture to handle and store dangerous or harmful materials.
- (3) Label the container of dangerous and harmful materials. Follow the directions given by the manufacturer to handle them. Keep chemical materials away from heat, sparks or flames. Store them in cool and dry places.
- (4) Check the MSDS (material safety data sheet) before handling dangerous or harmful materials. Follow the directions shown in the sheet.
- (5) Operators must wear personal protective equipment (gloves, aprons, etc.) to handle dangerous and harmful materials as directed in the MSDS (material safety data sheet) given by the manufacturer.
- (6) If there is a possibility that dangerous or harmful materials could harm operators' eyes, inform the operators about the location and usage of the EYE WASHER beforehand.
- (7) Operators who handle dangerous or harmful materials must wash their hands before eating or smoking.

■ Disposal of waste liquid, solutions and materials

Discarding chemical materials such as solutions used for the turbocharger and waste cloths stained with such materials are subject to various regulations for environmental protection.

It is requested to control these materials by observing registrations enforced by national and local government and regulations of your own.

Companies certified by ISO 14001 must observe their own regulations.

■ MSDS (MSDS: Material Safety Data Sheet)

MSDS states detailed information about dangerous points on health and safety, influence on the environment, safety handling and countermeasures for emergency.

1.7.4 Noise

There is a danger that operators might suffer permanent hearing loss if they work in an environment at a dangerous noise level. Noise is a critical issue in safety and health management in a plant. Hearing disorder is caused by the following unsafe behaviors.

- Entering danger zone without wearing ear protection equipment (ear plugs, etc.)
- Spending long hours in danger zone without ear protective equipment (ear plugs, etc.), or with inappropriate protective equipment.

1.7.5 Housekeeping

Poor housekeeping might cause operators' tripping or falling down at the things on the floor. Housekeeping also has effects on the efficiency of operations. It is proven that good housekeeping improves efficiency and causes less injury.

The following are about the house keeping.

- (1) Thoroughly wipe off oils (lubricating oil) on the floor. If adhered to the backside of the shoes, there is a high possibility of slippage.
- (2) Store all the tools outside the aisles.
- (3) Apply marking to show the permanent isles and regular isles.
- (4) Before operating the turbocharger, clear all the used waste cloths, tools and equipment from the turbocharger and its vicinity.
- (5) Clean all the isles and equipment and do not leave anything which is not related to the work on them.

Examples of troubles caused by poor housekeeping.

- Things left on the floor: Operators might trip on them.
- Slippery surface on the floor: Operators might slip and fall down.
- Things placed at high locations above head: They might fall on operators.
- Things that are not placed at the designated locations: Operators might bump against them.
- Untidily stacked things: They might fall down and hit operators.
- Tools that are not stored in an appropriate manner: They might cut or hit operators.
- Trash scattered work places: They might deteriorate operators' working manners and habits.

The following are examples for methods to improve housekeeping ability.

- Decide places to put things back (for all things).
- Return everything to its original place after use.
- Put cans, bottles, wrapping paper, etc. into appropriate refuse container or recycling container.

1.7.6 Fire prevention

Though it is important to prevent the fire, it is also necessary to provide training for case of fire. It is also necessary to provide training in case of fire.

The general fire preventive actions are as follows:

- Do not put anything flammable near the place at which fire is used.
- When using fire temporarily, obtain permission to do so.
- Prepare a fire extinguisher and water while using fire.
- Clean up after using fire.
- Replace or install fire extinguisher or fire hydrant periodically.
- If the cover of the electric wiring is damaged, repair or replace immediately.
- To prevent fire due to aging of the wiring equipment, check or replace.

Always perform measures as well as those described above to prevent fire.

1.7.7 Communication with manufacturer

Communicate with the manufacturer if you notice anything about safety at the time of contact, delivery and during operation of the turbocharger thereafter.

If you need further information or question about the contents of the manual, contact MHI or our service agency.

NOTICE

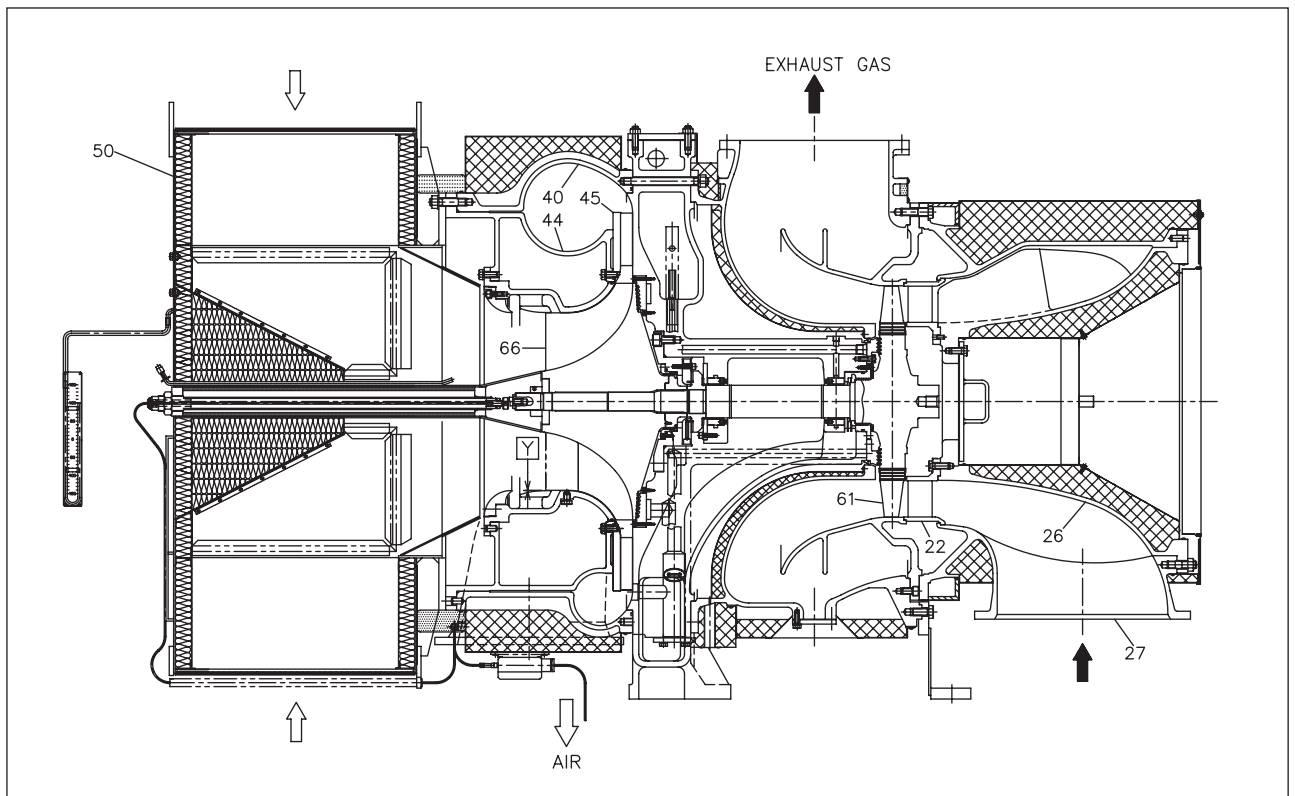
- **When taking protective measures, refer to the instruction manual submitted by the manufacturer above and “information on use” such as descriptions on the warning labels on the turbocharger.**

2 MET Turbocharger Basics

Because the turbocharger runs automatically as a result of the energy contained in exhaust gas from the engine, it does not usually require any special manipulation when the engine is operating normally. However, the turbocharger plays an essential role in supplying combustion air to the engine, and it is therefore important to maintain its performance in order to ensure the performance and reliability of the engine itself.

2.1 Turbocharger Structure

2.1.1 Exhaust gas energy and air compression



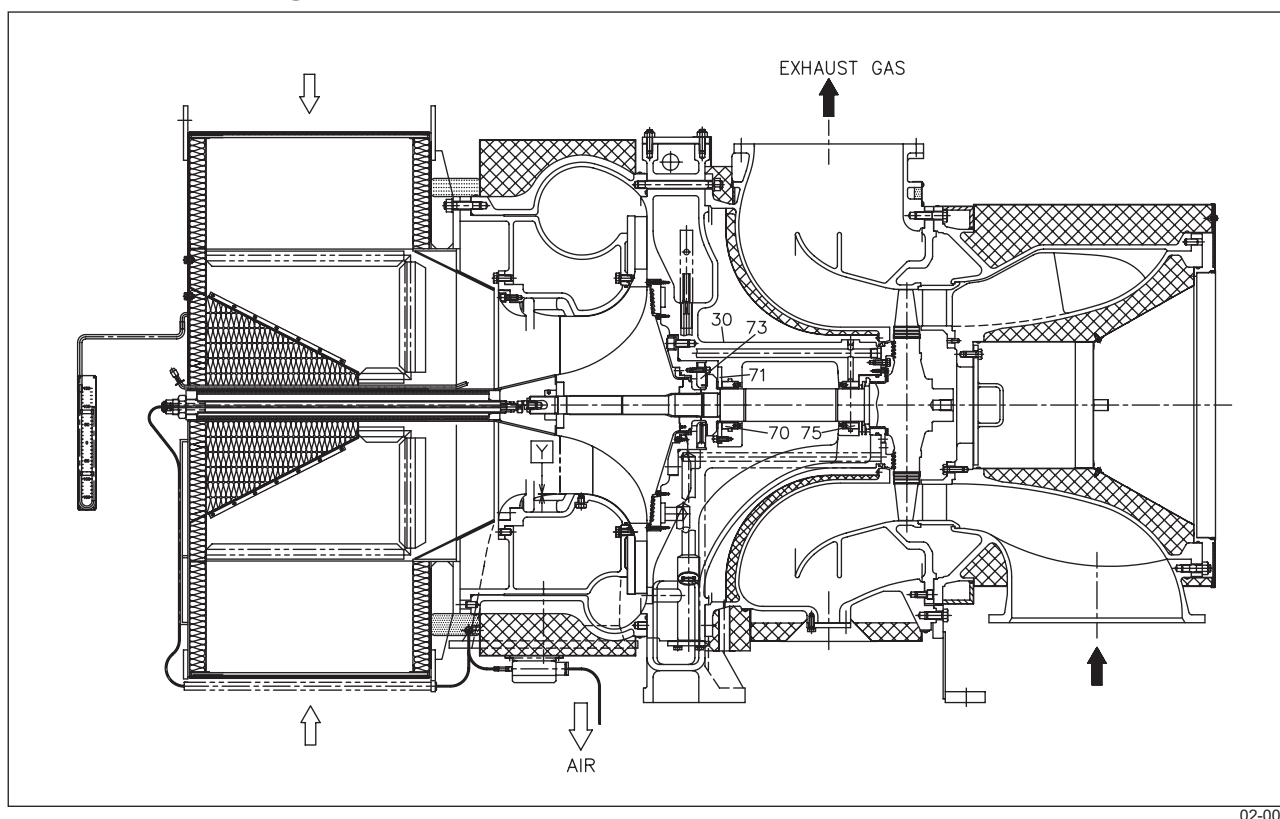
A turbocharger is a device that utilizes the energy contained in exhaust gas from the engine in order to compress fuel combusting air and send to the engine. Thus, a turbocharger consists of a turbine for the conversion of exhaust gas energy into motive force and air compressor driven by this force.

Exhaust gas released from the engine is channeled to the turbocharger inlet casing (26, 27), and after being expanded and accelerated by means of a nozzle (22), it comes into contact with the turbine blades (61). This serves to efficiently convert the energy into rotational motive force.

A turbine blade (61) and compressor impeller are positioned at either end of the rotor, and the motive force of the turbine directly drives the compressor impeller. As the compressor impeller rotates, external air is channeled through the silencer (50) to the impeller (66), and is accelerated to obtain high velocity and pressure. The high level of energy contained in the air exiting the impeller (66) is recovered in the form of pressure as it passes through the diffuser (45). Then, after passing through the scroll (40, 44), air having the required pressure and flow volume is sent to the engine.

The ratio, the energy obtained by pressurization of the surrounding air, divided by the energy lost as the exhaust gas passes through the turbocharger turbine, is known as the turbocharger efficiency, and this is a basic measure of turbocharger performance. Fouling and wear affecting the turbine and compressor are causes of reduced efficiency, and these factors can result in failure to deliver air having the requisite pressure and flow volume to the engine. It is therefore important to perform periodic maintenance of the turbocharger in order to maintain its performance.

2.1.2 Bearing and lubrication



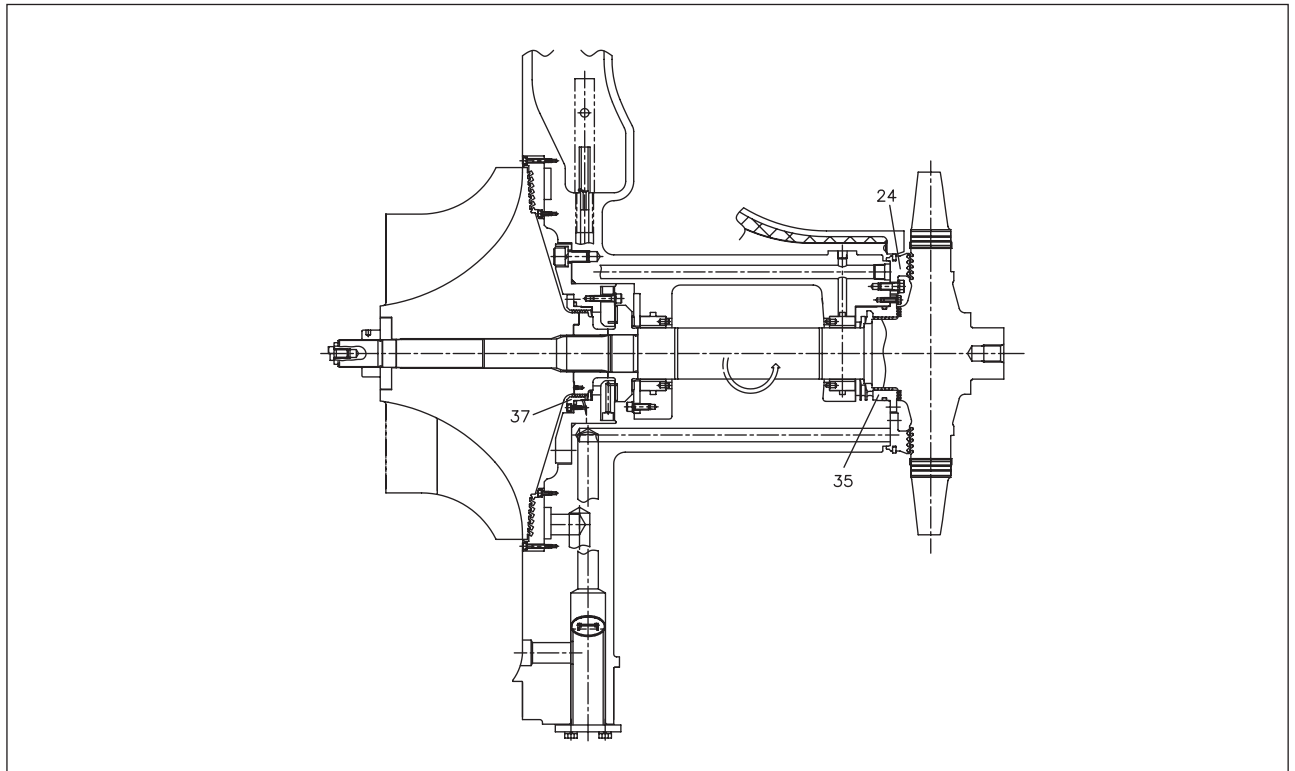
In operation, the rotor rotates at very high speeds, and the bearing that support it are specially designed to prevent the occurrence of harmful vibration. In particular, vibration is inhibited by the distinct internal shape journal bearing (70, 75) that support the weight of the rotor, as well as by the lubricant layer formed between the journal bearing periphery and the housing.

The pressure of the exhaust gas and air that act on the turbine blades and compressor impeller produce force on the rotor in the axial direction (thrust), which is applied to the thrust bearing (71, 73). Because this thrust acts on the compressor side during normal operation, the thrust bearing (73) on the compressor side is larger than that on the turbine side.

The lubricant is externally supplied to the turbocharger at a specified pressure and temperature. Engines are normally equipped with instrumentation for the monitoring of turbocharger lubricant pressure and temperature, as well as equipment for the protection of the turbocharger in the event of abnormalities. For detail, refer to the engine manual.

The lubricant head tank is integrated with the upper part of the turbocharger bearing pedestal (30). This allows lubrication to continue for about 20 minutes in the event that the lubricant supply is cut off for some reason and/or the engine stops.

2.1.3 Lubricant and exhaust gas seals



02-006

Oil labyrinth (35, 37) are used to seal the lubricant so as to prevent leakage from the turbocharger, while a gas labyrinth (24) is used to seal the exhaust gas within the turbine discs. Sealing air is also channeled from the scroll to prevent oil and gas leakage from inside the turbine discs.

In case of low load on the engine, the scroll can be subject to negative pressure due to the suction of air from the engine side. This creates negative pressure in the air channels for the sealing air mentioned above, and a vacuum breaker is therefore installed along the sealing air channel in order to prevent oil from being sucked out.

2.2 Specification

Continuous max. allowable temperature		580°C	
Short-time max. allowable temperature		610°C	
Lubricant lubrication method		External forced lubrication method	
Lubricant type		Equivalent to SAE20 to 30	Equivalent to SAE40
Turbocharger inlet lubricant pressure (standard) (MPa)		0.06 to 0.15	
Turbocharger inlet lubricant temperature (standard) (°C)		35 to 50	35 to 60
Turbocharger outlet lubricant temperature (allowable value) (°C)	Size for 33	95	95
	Other sizes	85	90
Paint		Heat-resistant silver	

■ MB Series

Frame size	53		60		66		71		83		90	
Impeller Type (*1)	V	U	V	U	V	U	V	U	V	U	V	U
Impeller size	3											
Max. allowable rotating speed (min-1)	17,810	18,900	16,010	16,990	14,300	15,170	13,210	14,020	11,300	11,990	10,240	10,860
Total weight (kg)	4,100		4,500		6,500		8,000		12,500		15,600	

(*1) Impeller type : for example, Spec : **GU3L23DCD8K3** [GU3L] is compressor spec

U : U series

V : V series

3 Inspection Before and After Startup

Be sure to complete the following inspection and other listed steps before/after startup.

3.1 Before Startup

	Inspection item	Inspection content	Notes
1	Lubricant inlet oil pressure	Is oil pressure showing on the engine side gauge within the specified value?	Refer to Table 1
2	Lubricant inlet oil temperature	Is oil temperature showing on the engine side gauge within the specified value?	Refer to Table 1
3	Air filter	Is there any damage to air filter or obvious blockage?	
4	Turbocharger underside	Is there any lubricant leakage?	
5	Lubricant inlet and outlet piping	Is there any lubricant leakage?	
6	Heat-resistant lagging	Is there any loss or other damage?	
7	Lubricant filter	Is there any abnormal rise in differential pressure?	

3.2 After Startup



WARNING



Do not enter the danger zone during operation.

The silencer air inlet port sucks in large amounts of air and, in the event of sudden surging, there is a possibility of the reverse flow of high-pressure air from the silencer.

* If not observed, you may trip over and get injured.

	Inspection item	Inspection content	Notes
1	Lubricant inlet oil pressure	Is oil pressure showing on the engine side gauge within the specified value?	Refer to Table 1
2	Lubricant inlet oil temperature	Is oil temperature showing on the engine side gauge within the specified value?	Refer to Table 1
3	Exhaust gas, air piping	Is there any exhaust gas or air leakage?	
4	Turbocharger underside	Is there any lubricant leakage?	
5	Turbocharger main unit	Is there any abnormal vibration or sound?	
6	Exhaust gas temperature	Is there any difference as compared with the past measurement values?	
7	Scavenging air pressure	Is there any difference as compared with the past measurement values?	
8	Turbocharger speed	Is there any difference as compared with the past measurement values?	
9	Bearing pedestal side surfaces	Is air blowing normally? Does blown air contain oil mist?	

Table 1 Utilization standards for lubricating oil

	Min.	Standard	Max. (Dead slow/stop) *
Lubricant inlet oil pressure MPa	0.06	0.06 - 0.15	0.2
(At turbocharger center height) kg/cm ²	0.6	0.6 - 1.5	2.0
bar	0.6	0.6 - 1.5	2.0
Lubricant inlet oil temperature, °C	25	35 - 50	55
Lubricant outlet oil temperature, °C	-	-	85
Oil supply time following engine stop, min.	30	-	-

* : If lubricating oil temperature is 25 deg. C or lower at engine stand-by or low loaded manoeuvring condition, maximum oil pressure can be 2.5 bar considering increased oil inlet pressure.

NOTICE

- Please be sure to use lubricant having properties that satisfy the conditions shown in the following table (Table 2).

Table 2 Lubricant properties

			Spec. for new lubricants		Spec. for lubricants in-service	
Type			Engine oil	Turbine oil *	Engine oil	Turbine oil *
Viscosity grade			SAE#20, 30, 40	VG68, 100	SAE#20, 30, 40	VG68, 100
Kinematic viscosity ν	40°C	mm ² /s	-	61.2 - 110	0.85IV**< ν <1.3IV	0.95IV< ν <1.05IV
	100°C	mm ² /s	5.6 - 16.3	-	0.85IV< ν <1.3IV	0.95IV< ν <1.05IV
Flash point	COC method	°C	> 190	> 190	> IV -15	> IV -15
Pour point	°C		< -10	< -10	< -10	< -10
Water content	Wt%		< 0.01	< 0.01	< 0.2	< 0.1
Total base number (TBN)	mgKOH/g		-	-	> 0.25IV	-
Total acid number (TAN)	mgKOH/g		-	< 0.3	-	< IV +0.3
Pentane insoluble (B method)	wt%		< 0.01	-	< 1.0	-
RBOT life	min.		-	> 250	-	> 0.25IV
Sludge resistance	-		-	<100mg/kg@ 25%RBOT	-	-

* : Used in case of the independent lubrication system.

** : Initial Value

4 Maintenance / Inspection

4.1 Cautions for Maintenance and Inspection

WARNING



Do not use fire while the turbocharger is cleaned using any flammable liquids such as kerosene.

- * It may cause fire due to flash ignition.

Do not go under any equipment or part which is suspended.

- * The equipment or part may fall off due to failure of the lifting tool, causing accidents resulting in injury or death.



If the oil labyrinth or housings are damaged or worn out exceeding the standard value of the gap, replace with a new one.

- * The damaged or worn out oil labyrinth or housing may cause not only oil leakage but also a problem that the oil drops are discharged to outside through the air extractor of the turbocharger.

Operation of cranes and slinging must be performed by an authorized person.

The owner is obliged to give their employee who handles suspending equipment (chain block) training on safety. (Observe the national rules and regulations.) Only the persons who are trained on safety and designated by the owner may handle the suspending equipment.

- * If the suspended loads are unbalanced during transportation or fall off due to mis-slinging, it may cause accidents resulting in injury or death or damage of the turbocharger.

Before using materials to suspend the machine or parts (wires, slings, tools, etc.), check the weight of the object to be suspended. Use a material of sufficient strength.

- * If load exceeding the allowable value of the suspending material is applied, such a material may be broken and then the suspended object may fall off, causing accidents resulting in injury or death. There also is a possibility that broken wires or slings may jump out and hit a person, causing accidents resulting in injury or death.

Load to be applied to a suspending material will change depending on the angle of suspending. Consider it when selecting the size.

Do not select the size of the suspending material unless you understand the meaning of the instruction above.

- * If not observed, it may cause unexpected accidents.

Dispose of any suspending materials a part of which is broken. Use a new one.

Before using the suspending material, check if it is normal.

- * If any abnormal material tool is used, it may break during suspending work, causing accidents resulting in injury or death.

When suspending any equipment or part, place the hook in the center of the gravity of the suspended object.

Adjust the position so that each wire is applied with the same load.

- * If not observed, the object may be unbalanced when suspended or a certain wire is applied with large load and then broken, causing accidents resulting in injury or death.

4.2 Periodic Maintenance and Inspection Check List

In order to keep the turbocharger in a good condition and prevent troubles from occurring, perform periodic inspections and maintenance including cleaning with the following table as the target.

Inspection item	Work	Maintenance Frequency	Refer to
Turbocharger operating state	Inspection	Twice a day or more	4.3
Turbine under operation	Washing	Every 100 hours after an initial operation (until 2000 hours elapses after the start of operation or cleaning of the turbine) The frequency should increase / decrease thereafter depending on the performance value.	4.12
Compressor under operation	Washing	Arrival in / leaving a port	4.13
Thrust bearing	Inspection / Replacement	When initial check of bearing is performed and every time when overhaul inspection in 4.4 is performed	4.5.1 4.5.2
Thrust collar	Inspection / replacement	Every time when overhaul inspection in 4.4 is performed	4.5.1 4.5.2
Journal bearing	Inspection / replacement	Every time when overhaul inspection in 4.4 is performed	4.5.3
Rotor Shaft	Inspection / replacement	Every time when overhaul inspection in 4.4 is performed	4.6
Impeller dye-check	Inspection	Every time when overhaul inspection in 4.4 is performed	4.7
Compressor Impeller	Inspection / Washing	Every time when overhaul inspection in 4.4 is performed	4.7
Turbocharger internal cleaning	Cleaning	Every time when overhaul inspection in 4.4 is performed	4.4
Sealing air passage	Inspection	Every time when overhaul inspection in 4.4 is performed	4.8.1
Vacuum breaker	Inspection	Every time when overhaul inspection in 4.4 is performed	4.8.2
Head tank	Cleaning	Every time when overhaul inspection in 4.4 is performed	4.8.3
Turbine blade wear	Inspection / Replacement	Every time when turbine inspection in 4.4 is performed	4.9
Nozzle wear	Cleaning / Inspection / Replacement	Every time when turbine inspection in 4.4 is performed	4.10
Gas outlet guide wear	Inspection	Every time when turbine inspection in 4.4 is performed	4.4
Air Filter	Washing	Every time when filter inspection in 4.11 is performed	4.11

4.3 Monitoring of the Turbocharger Operating State

WARNING



Check the manometer installed to the silencer everyday for clogged status of the air filter.

Before the manometer indicating pressure exceeds 2.0 kPaG (200 mmAq), be sure to wash or replace the filter.

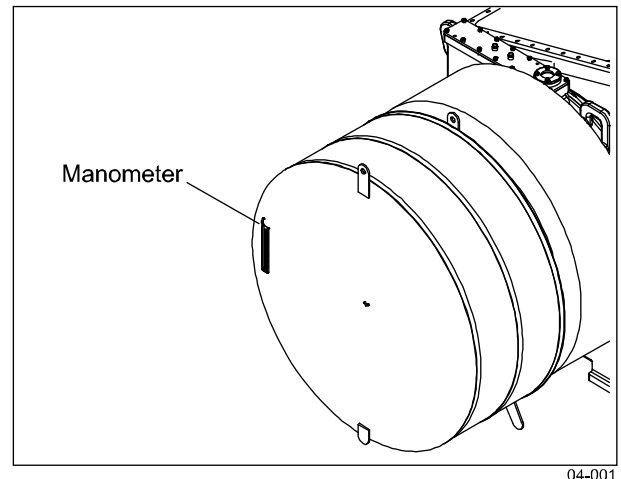
- * If not observed, it will cause insufficient air to the engine, resulting in decrease of the engine output. The decreased output of the engine may cause surging.
Also, air resistance may be increased due to clogging of the element of the air filter, resulting in incomplete combustion due to the insufficient air, which may discharge some gas polluting environment.

Record temperature, pressure, and turbocharger speed, etc. related to the turbocharger at regular intervals in accordance with guidelines for such record-keeping established by the engine manufacturer or independently by the user. These records are important in ascertaining the normal operating state of the turbocharger.

In particular, changes in scavenge air pressure, turbocharger speed, and exhaust gas temperature are reflective of changes in turbocharger performance, and must be periodically measured and recorded.

The temperature of the air sucked into the turbocharger silencer will have a significant impact on the above-noted measurement values. For accurate evaluation of turbocharger performance, it is necessary to measure inlet temperature near the silencer, preferably at several points around the circumference.

The silencer is equipped with a manometer for measuring the pressure downstream from the air filter (refer to the right figure).



04-001

4.4 Turbocharger Overhaul Intervals

Turbochargers are subject to the following changes over time:

- Wear of the bearing
- Fouling of the rotor, nozzle, etc.
- Wear of the turbine blades, nozzle, gas labyrinth, oil labyrinth, and gas outlet guide.

For recommended turbocharger overhaul intervals, refer to the table below.

Frame size	Bearing initial check (Compressor side)	Turbine inspection and manual cleaning	Overhaul
53	After ship's delivery Approx. 7,000 hours	Every 10,000 to 13,000 hours	Every 22,000 to 27,000 hours
60 66 71	After ship's delivery Approx. 8,000 hours	Every 12,000 to 15,000 hours	Every 25,000 to 30,000 hours
83 90	After ship's delivery Approx. 8,000 hours	Every 15,000 to 20,000 hours	Every 30,000 to 35,000 hours
Recommended service kit	Kit "A"	Kit "B"	Kits "C1" and "C2"

NOTICE

- The service kits "A", "B", and "C1" are required for each overhaul. Whether or not the kit "C2" is necessary depends on the parts condition. Therefore, if there is no kit "C1" or "C2" in stock, order so that they should arrive before overhaul.

For detail of each kit, refer to the next page.

If any other parts than kits above are necessary, inform us of the parts Nos. (refer to "9.5 Part Numbers and Names) and serial No. of the turbocharger and order from us.

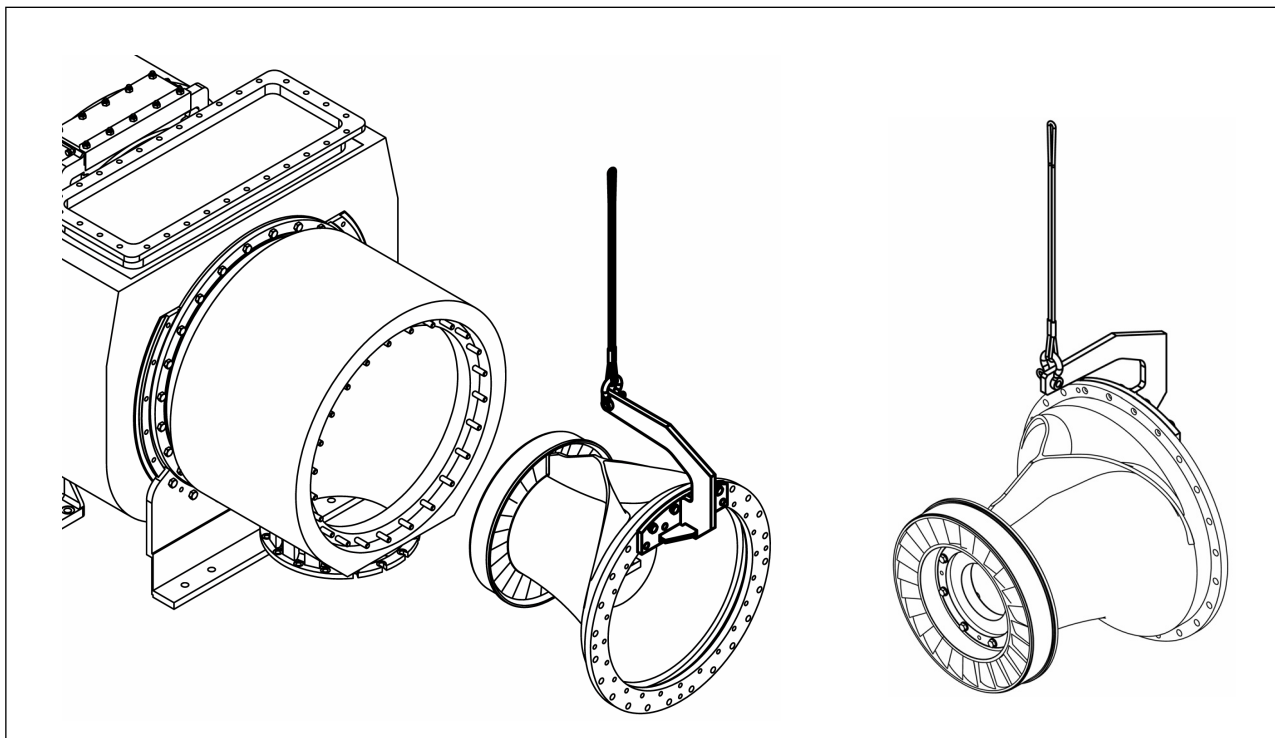
- Overhaul includes cleaning and inspection for turbine side and bearing inspection.
- Turbine inspection and cleaning can be performed by removal of gas inlet inner casing only.
- Initial thrust bearing inspection is recommended to ensure no damage by remained particles in the oil pipe during assembling work.
- Required time for bearing inspection and overhaul is valid for turbocharger with standard silencer. If the turbocharger has air intake housing, it may take longer.

MET-MB OVERHAUL KIT

No.	PART No.	PART NAME	QUANTITY (PER 1 TURBO)	Initial check of bearings (Compressor side)	Turbine inspection, and manual cleaning	Full overhaul	
				A	B	Consumption parts	Depending on the parts condition
1	225	BOLT	8		✓	✓	
2	226	DOUBLE TONGUED WASHER	8		✓	✓	
3	234	BOLT	3				✓
4	241	BOLT	5				✓
5	242	SPRING WASHER	5				✓
6	251	GAS SEAL RING	1				✓
7	351	SPRING WASHER	4			✓	
8	354	O-RING	1			✓	
9	362	O-RING	1	✓		✓	
10	373	O-RING	1	✓		✓	
11	449	O-RING	1	✓		✓	
12	472	O-RING	1	✓		✓	
13	831	PACKING	1			✓	
14	871	PACKING	1			✓	
15	24	GAS LABYRINTH(B)	1				✓
16	35	OIL LABYRINTH(T)	1				✓
17	37	OIL LABYRINTH(B)	1				✓
18	63	THRUST COLLAR	1				✓
19	70	JOURNAL BEARING(B)	1				✓
20	75	JOURNAL BEARING(T)	1				✓
21	71	THRUST BEARING(T)	1				✓
22	73	THRUST BEARING(B)	1				✓

Among these items, the progress of bearing wear is not apparent from factors such as engine performance, and there is no way to accurately check this other than inspection of the bearing. If bearing wear reaches the point of seizure, major damage will be caused to the turbocharger rotor and other components.

- Because bearing wear occurs mainly due to the inclusion of foreign object in the lubricant, the influence of the lubricant supply system on bearing lifetime is substantial. The least amount of wear can be expected with an independent lubrication system dedicated solely to the turbocharger, or with a system that is shared only by equipment external to the engine such as reduction gear etc. In addition, the use of a 30 micron continuous back-flushing type lubricant filter dedicated to the turbocharger is effective in prolonging the lifetime of the bearing.
- It is also envisioned that foreign object introduced during installation work on the turbocharger may not be fully removed by flushing. Accordingly, regardless of the lubricant supply system being used, the initial thrust bearing inspection should be performed according to the tables in pages 4-2 and 4-4. In the event that this inspection reveals wear or sliding damage with foreign matters to the thrust bearing, it will be necessary to inspect the journal bearing as well.
- If the lubricant properties are kept in good condition and bearing wear is not allowed to progress, the risk that the turbocharger cannot be operated suddenly is greatly reduced. Normally, bearing wear will progress very slowly if an independent lubrication system is used. Therefore, bearing inspections conducted during turbocharger overhauls will be sufficient.
- However, when the overhaul interval is substantially extended, turbocharger performance will tend to gradually decline due to fouling of the internals and wear-down of the turbine blades and nozzle. This will necessarily have a negative impact on engine performance. It is therefore important from the standpoint of maintaining turbocharger performance to perform regular inspection and cleaning of at least the turbine side. Mitsubishi MET model turbochargers are designed for easy inspection of the turbine side, simply by removing the gas inlet inner casing (refer to the figure below).



04-002

4.5 Inspection of Bearing

NOTICE

- For disassembly / assembly of the bearing, refer to “5 Disassembly” and “6 Re-assembly”.

Bearing wear proceeds as the bearing metal is abraded by foreign object in the lubricant. Hardly any bearing wear occurs when the lubricant layer is extremely thick compared to the size of the foreign particles, however wear proceeds quickly when the particle size is about the same as the lubricant film.

In cases where system oil from the engine is used as the lubricant for the turbocharger, a suitable lubricant filter is installed on the engine side to remove damaging particles. However, smaller particles cannot be completely removed, and these induce bearing wear.

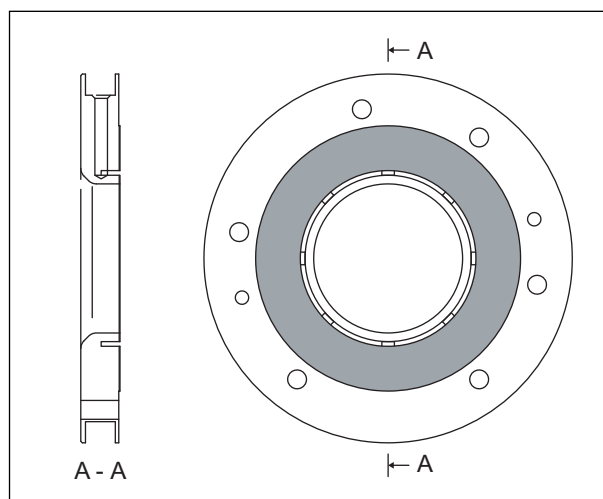
Accordingly, maintaining the engine lubricating oil in good condition is important from the standpoint of the turbocharger bearing. For more detailed information, refer to the engine manual.

4.5.1 Compressor side thrust bearing

The compressor side thrust bearing has flat surface. Pads are attached to the thrust collar, which is taper land type, consisting of taper part and flat part. Oil is fed into the wedge-like gap forming between the bearing and thrust collar taper part, generating the hydraulic pressure to withstand the thrust load.

For the replacement cycle of the thrust bearing, refer to the following.

- Measure the thickness in the shaft direction (colored part in the right figure) including the bearing metal. Then, if the value decreases, replace the thrust bearing.
- In case that the inner surface of the thrust bearing is contacting and the color has changed blistered, replace the thrust bearing.



04-034

Frame size	Thrust bearing thickness(mm)	
	Planned value	To be replaced
53	23.0	22.8
60	25.0	24.8
66	28.0	27.8
71	32.5	32.3
83	35.5	35.3
90	39.0	38.8

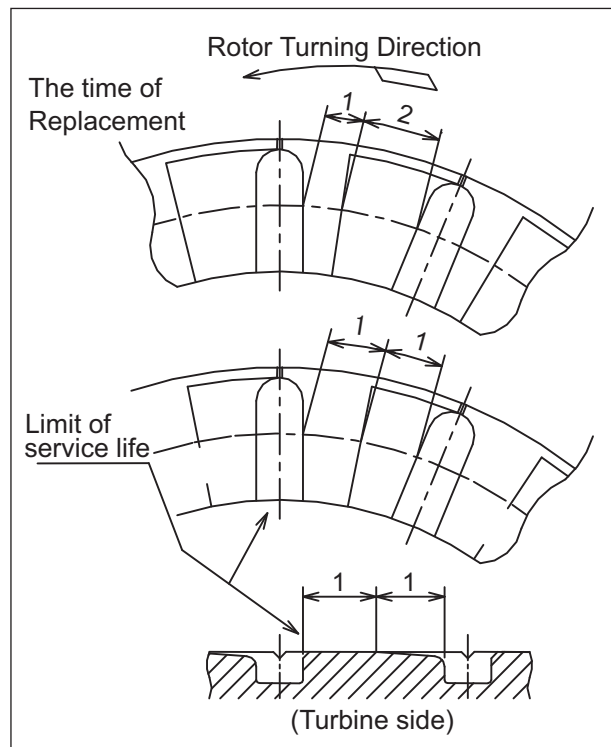
4.5.2 Turbine side thrust bearing

Thrust bearing are of the tapered land type, consisting of a tapered part and a flat part. Oil is pulled into the wedge-shaped opening formed between the thrust collar and the tapered part of the bearing by means of the rotating action of the thrust collar, thus creating oil pressure that supports the thrust load. When the thrust bearing become worn, the ratio occupied by the flat part increases. The limit of service life for thrust bearing is as follows:

Length of tapered part: Length of flat part
= 1:1 (for turbine side, refer to figure below.)

However, even if the ratio has not yet reached 1:1 (turbine side), replace the bearing when it is anticipated that the ratio will reach 1:1 (turbine side) before the next inspection.

Regarding the inspection procedure for the ratio of the tapered part to the flat part, please refer to the next page.



04-026

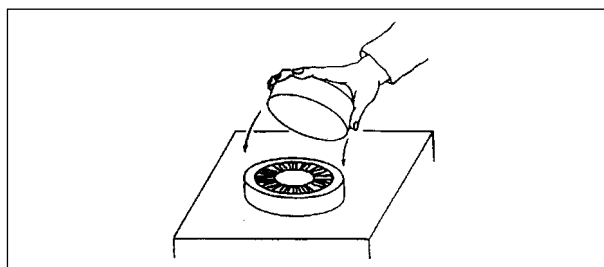
■ Inspection procedure for the tapered: flat part ratio

- 1** Color the thrust collar or base plate lightly and evenly using a red-lead paint.



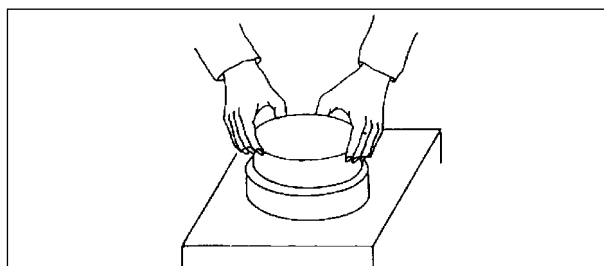
04-008

- 2** Lightly place the colored side against the metal surface of the thrust bearing.



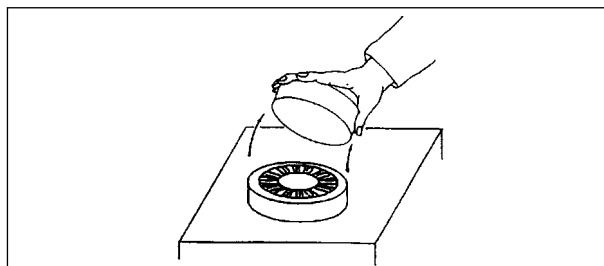
04-009

- 3** Rotate the thrust collar or base plate in one direction so that the red-lead paint contacts the thrust bearing.



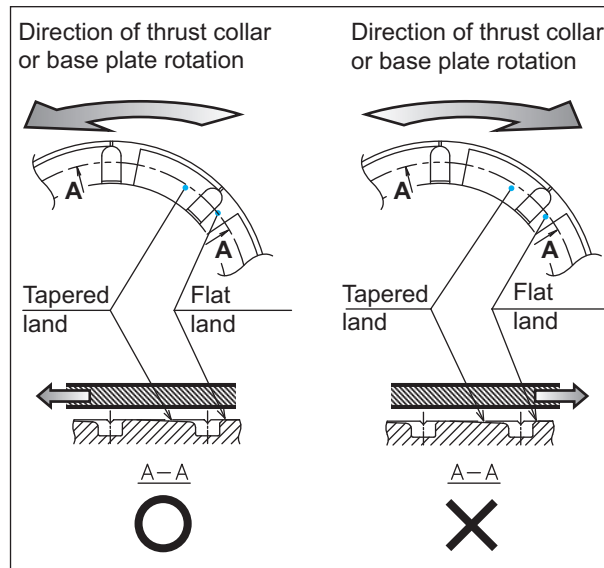
04-010

- 4** Remove the thrust collar or base plate, and check the transfer of the red ink in order to determine the need for replacement.



04-011

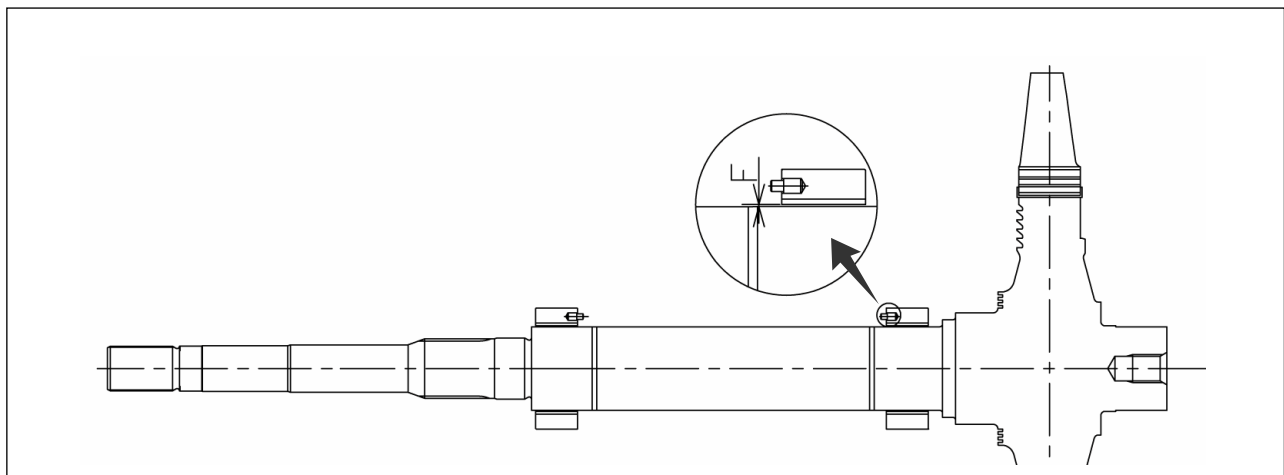
- If a long, deep scratch of 20 mm in length or greater are found on the thrust bearing metal surface, or if multiple deep scratches add up to a total length of 50 mm or more, replace the thrust bearing with new ones.
- Any visible exfoliation or cracking of the thrust bearing metal surface also indicates the need for replacement.



04-035

4.5.3 Journal bearing

- 1** After removing the rotor, insert it through the journal bearing.
- 2** Using a dial gauge, measure the clearance between the inner surface of the journal bearing and the rotor shaft with the upper side of the inner surface of the journal bearing put against the shaft on the sliding part of the journal bearing.



04-013

- 3** Compare the measured results with the clearance standard table shown in Section 9.1.

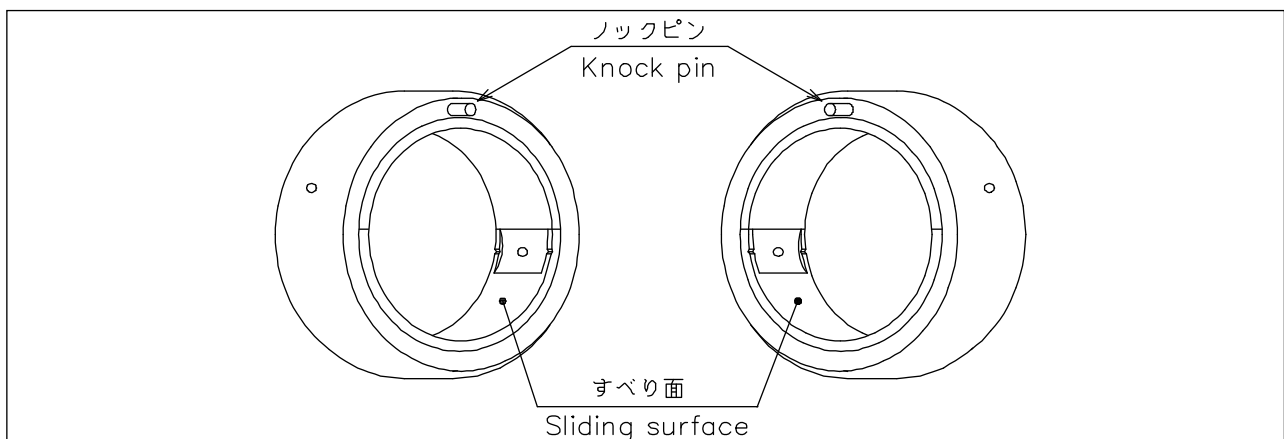
- Do not fix the dial gauge to the rotor when measuring (as magnetic force will remain on the rotor shaft).
- If the clearance is greater than the allowable value, it will be necessary to check whether the rotor shaft and/or the journal bearing have become worn. Refer to Section 4.6 in determining whether the rotor shaft has become worn.

- 4** If the rotor shaft is not worn and the clearance between the shaft and the journal bearing is greater than the standard value, replace the journal bearing with new ones.

■ Knock pin

A knock pin for locking is located on the journal bearing.

If the pin diameter has been worn by 20% or more, or if it is damaged, replace the journal bearing with new ones.



04-014

4.6 Inspection of Rotor Shaft

NOTICE

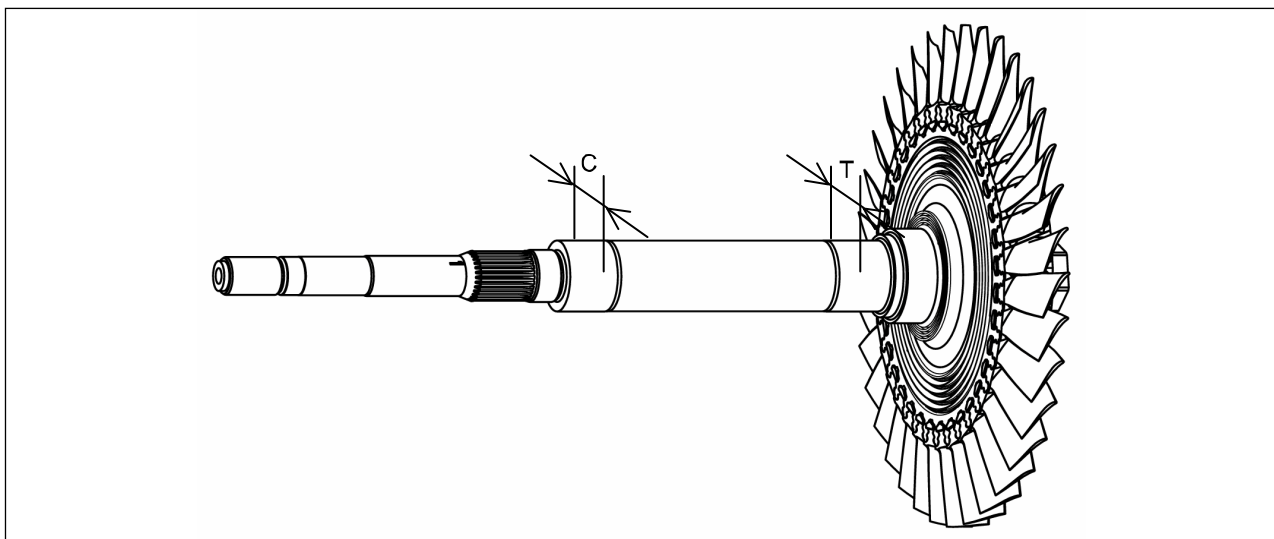
- For disassembling / assembling the rotor shaft, refer to “5. Disassembly” and “6 Re-assembly.”

The part of the rotor shaft that slides against the journal bearing is known as the journal part, and the shaft side is also subject to wear.

Close observation of the rotor shaft will reveal the sliding width relative to the journal bearing. Wear on the journal part of the shaft is determined by measuring the diameters of the journal bearing sliding parts and the areas outside (C and T).

If the outer diameter of the sliding part is at least 0.02 mm less than the diameter of the adjacent area outside, consult with MHI.

Note that the diameter of the center part of the shaft is slightly less than the journal part at the time of manufacture.



04-015

4.7 Inspection and Washing of Compressor Impeller

NOTICE

- For disassembling / assembling the impeller, refer to “5. Disassembly” and “6 Re-assembly.”

4.7.1 Inspection

- Check that there are no abnormalities such as peeling and cracking on the claw clutch on the back side. Perform dye-check on the back side of the compressor impeller, as well as all surfaces of the blades. If any defects are detected by the test, replace the impeller with a new one.
- Light contact with the labyrinth fins on the back side of the impeller is not a problem, and the impeller may continue to be used.
- Similarly, light contact between the impeller blade tips and the air guide casing (such that a metallic luster is exhibited) is not a problem, and the impeller may continue to be used. However, if contact results in burrs on the blade tips, consult with MHI.
- If the leading edges of the impeller blades are dented from collision with a foreign object, note the location and size, and consult with MHI.

4.7.2 Washing

The impeller is made of heat-resistant aluminum alloy. Use a soft object such as a sponge for washing, with surface dirt removed using kerosene or warm water. Do NOT use a wire brush or any similar hard object.

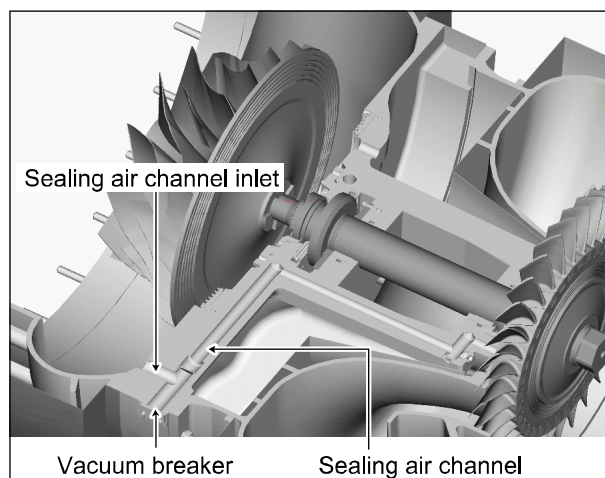
When using any cleaning agent commercially available, be sure to check that it will not have any negative effect on aluminum material.

4.8 Inspection and Washing of Pedestal

4.8.1 Sealing air channel

There is an inlet for sealing air located in the vicinity of the diffuser blades on the pedestal compressor side.

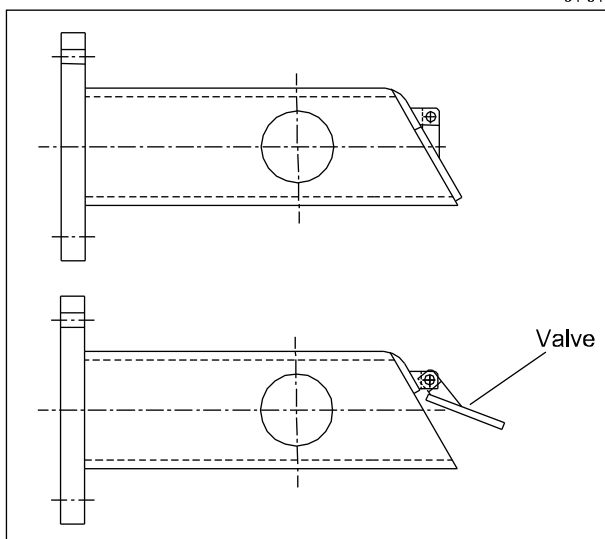
- Check that there is no evidence of lubricant leakage into the sealing air channel.
- Check that air flows through the air channel out to the turbine side when general service air is fed in.



04-016

4.8.2 Vacuum breaker

The vacuum breaker is attached to the side of the pedestal. Remove the bolt to pull out the vacuum breaker, and check that there is no abnormality with the valve disc and that the valve operates smoothly.



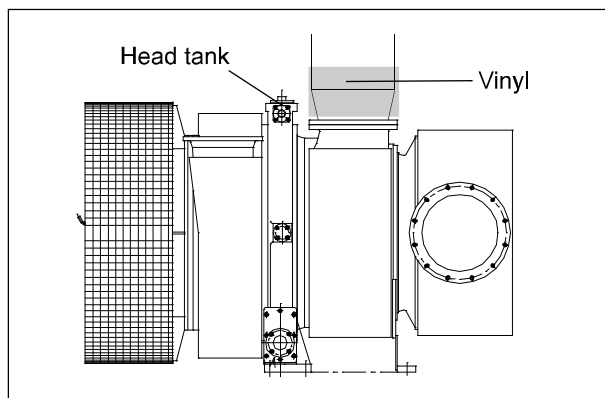
04-017

4.8.3 Head tank

MET turbochargers contain a head tank built into the pedestal. Refer to the following subsections for the procedure and cautionary points for cleaning the inside of the head tank.

1. Preparation for cleaning

- 1** Stop the oil pump.
- 2** After 20 minutes or more of the stop of the pump, check that the oil pump is stopped and the turbocharger inlet lubricant pressure is 0.
- 3** In order to ensure that foreign object does not enter inside the tank from the gas outlet duct, etc., wrap the duct using vinyl or other suitable material.



04-018

2. Cleaning procedure

1 Remove the head tank cover.

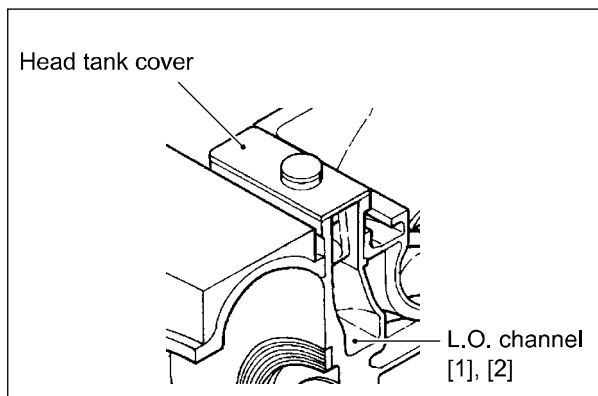
- If the packing material becomes damaged when removing the cover, replace it with new material.
Use sealant bond to affix the lid and the new packing.

2 Wipe off any remaining oil from the tank using a sponge or clean waste rags, etc.

3 If there is heavy fouling, use a spatula or similar object to remove it from the inner walls of the tank.

- Do NOT use a wire or nylon brush to wipe off fouling. (This is because bristle ends can break off and introduce new fouling.)
- When cleaning, take care that fouling does not enter L.O. channels [1] and [2] (refer to the next section).

4 Wipe off any remaining fouling using clean rags, etc.



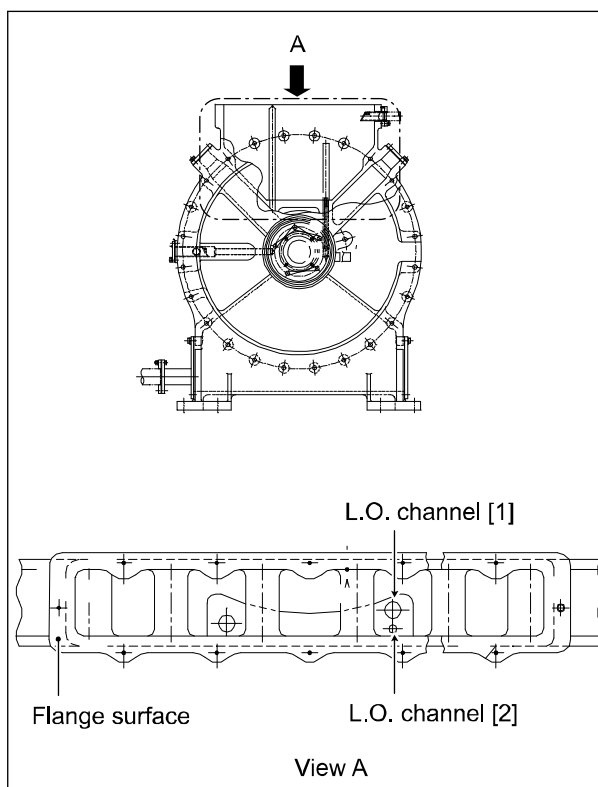
04-019

3. Recovery

1 Blow compressed air to the L.O. channels to remove any dirt between the channels.

2 Clean the flange surface of the pedestal, making sure that foreign object does not enter between the packing and the pedestal flange surface.

3 Make sure again that there are no fouling left inside the tank, and replace the cover. (Do not use sealant bond between the pedestal side and the packing.)



04-020

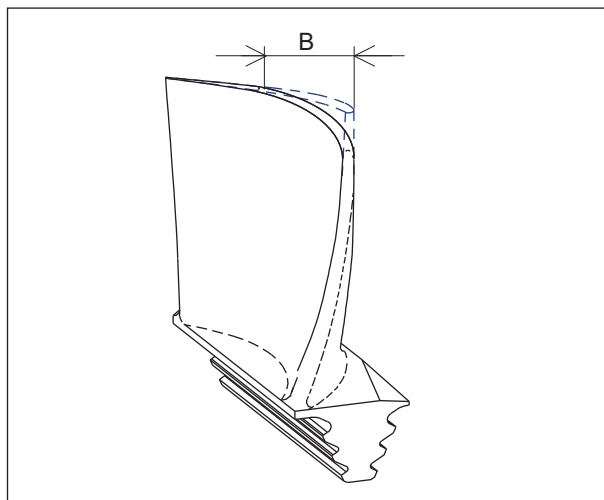
4.9 Inspection and Cleaning of Turbine blades

NOTICE

- For disassembling / assembling the turbine blades, refer to “5. Disassembly” and “6 Re-assembly.”

4.9.1 Wear of turbine blade tips

Although turbine blade tip wear does not immediately lead to turbocharger damage, it does cause a gradual deterioration of turbocharger performance, thus raising the temperature of engine exhaust gas, and increasing the rate of fuel consumption. Consequently, if the turbine blades appear as illustrated in the figure below, replace the turbine blades at a suitable opportunity such as dry dock. Turbine blade replacement requires specialized technology and equipment; consult with a service company authorized by MHI.



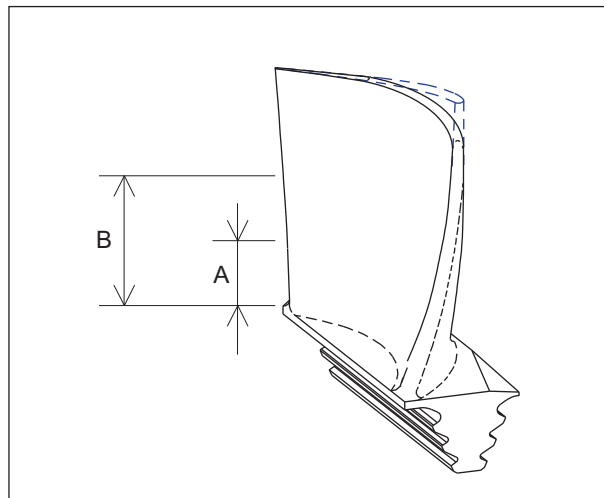
04-032

Standards for replacement due to turbine tip wear

Frame size	B(mm)
53	16
60	18
66	20
71	21
83	24
90	27

4.9.2 Wear of turbine blade trailing edges

When the turbine blades are subjected to long-term use, there are cases in which the trailing edges become worn as well as the tip. If the trailing edges become thin, and unevenness is caused by corrosion of the surface, cracks may appear that can lead to turbine blade breakage. If the thickness of the turbine blade trailing edge reaches the values indicated in the figure below, replace the turbine blade.



04-033

Standards for replacement due to turbine wheel trailing edge wear

Frame size	MET-SD			MET-SE/SE II /MA/MB		
	Measuring position (mm)		Allowable wall thickness (mm)	Measuring position (mm)		Allowable wall thickness (mm)
53	A	19.6	0.6	A	22.6	0.8
	B	39.3	0.4	B	45.2	0.4
60	A	—	—	A	25.1	0.9
	B	—	—	B	50.3	0.5
66	A	24.5	0.7	A	28.1	0.9
	B	49.0	0.5	B	56.2	0.5
71	A	—	—	A	30.4	1.0
	B	—	—	B	60.9	0.5
83	A	31.0	1.0	A	35.6	1.1
	B	62.0	0.6	B	71.2	0.6
90	A	—	—	A	39.3	1.2
	B	—	—	B	78.6	0.7

4.9.3 Non-destructive testing of turbine blades

Because the turbine blades used in MET turbochargers are made of magnetic material, magnetic particle test can be conducted. Periodic magnetic particle test is recommended during turbine blade inspections. Particularly in cases where the trailing edges have become thin in 4.9.2 but the blades cannot be immediately replaced, magnetic particle examination must be carried out.

Perform non-destructive testing by persons who are fully experienced in test procedures.

4.9.4 Turbine blade washing

Hard carbon deposits on turbine blades not only reduce performance, but are also a cause of surging as well as shaft vibration and bearing damage due to imbalance.

1 Soak the blade into a suitable container filled with warm water in order to remove the deposited scale.

- The addition of a commercially available cleaning agent is effective, but it must be checked that the cleaning agent used will not corrode the rotor shaft or turbine blade materials. It is important to remove the scale in a uniform manner.
- Even in cases where the carbon is hard and difficult to remove, do NOT use a chisel or similar tool.

2 Dry sufficiently after cleaning.

3 Coat with rust-preventing oil for anti-rust treatment during the recovery period.

4.9.5 Contact between the turbine blade tips and the gas outlet guide

The clearance between the turbine blade tips and the gas outlet guide is normally set to the minimum distance at which there is no contact, but sudden changes in engine load, surging, etc. can make the turbine blade tips touch the casing. As long as the trailing edges of the turbine tips are lightly and uniformly touching the gas outlet guide, this will have almost no effect on rotor shaft balance, and the turbocharger can continue to be used in this state.

4.9.6 Turbine blade abnormalities

If the following abnormalities are observed, discontinue the use and immediately consult with MHI.

- Excessive contact by the turbine blade tips
- Dents due to collision of the turbine blades with a foreign object
- Wave of the turbine blade trailing edges
- Turbine blade misalignment in the axial direction

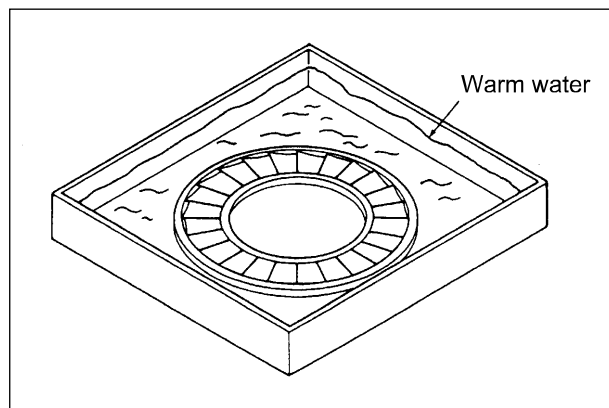
4.10 Inspection and Washing of Nozzle

NOTICE

- For disassembling / assembling the nozzles, refer to “5. Disassembly” and “6 Re-assembly.”

4.10.1 Cleaning of the nozzle

- 1 Soak the nozzle into warm water to remove fouling.**
 - Avoid striking with a chisel, hammer, etc. It will cause deformation of the nozzle blades, which is likely to induce surging and/or a reduction in performance.
- 2 Dry sufficiently after cleaning.**
- 3 Coat with rust-preventing oil for anti-rust treatment during the recovery period.**



04-023

4.10.2 Inspection of the nozzle

Inspect the nozzle with the nozzle placed horizontally and stably, in a well-lit location.

After washing, visually inspect the nozzle while observing the following:

- Uniform removal of fouling from the nozzle blades
- Formation by the nozzle blade trailing edges of a continuous line, with no bending, etc.
- Uniform evidence of contact between the nozzle outer ring and the gas outlet guide
- No cracks in the welded part

If abnormalities are discovered, consult with MHI.

If the nozzle is installed on the gas inlet inner casing, there may be clearance between the nozzle outer ring and the gas inlet casing. This is not a problem, however, as exhaust gas is sealed by the contact surface between the gas outlet guide and the nozzle outer ring.

4.11 Inspection and Washing of Air Filter

Cautions for washing the air filter (round silencer) are noted below.

4.11.1 Washing period

Conduct washing when the filter pressure loss exceeds 2.0kPaG (200mmAq), or at least once every two months.

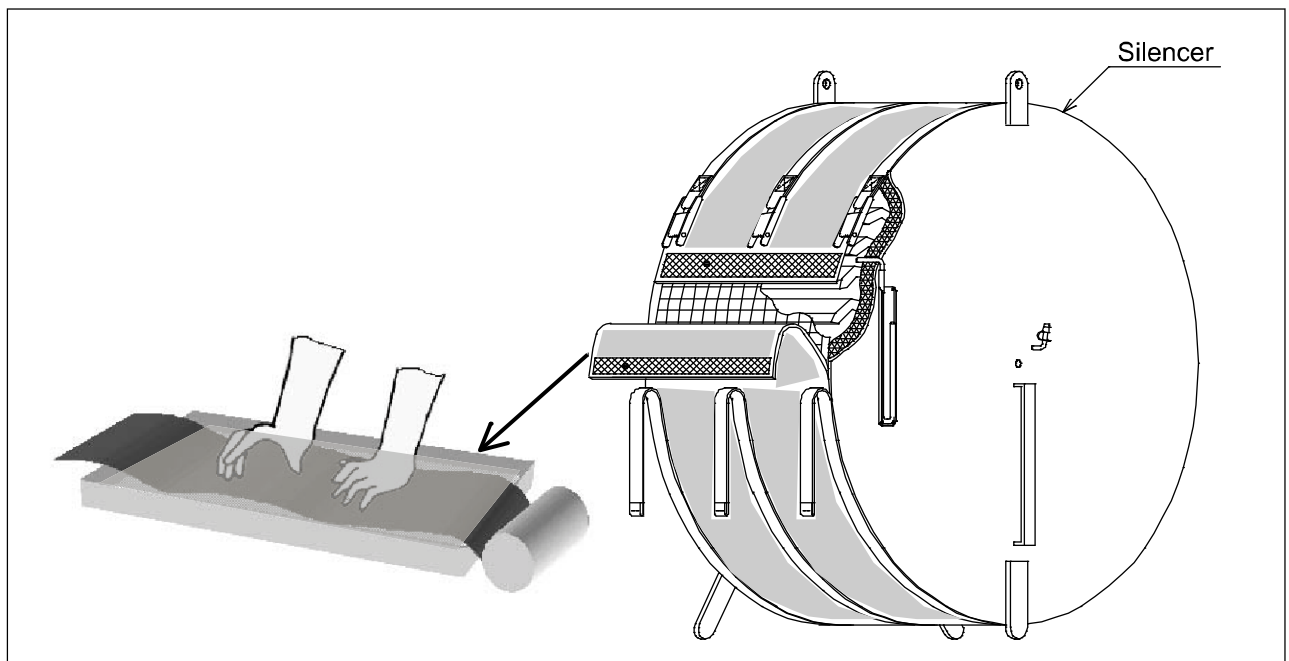
4.11.2 Washing method

1 Dissolve neutral detergent in lukewarm water, and soak the filter in for 2-3 hours.

- Using the kerosene or alkaline detergent is prohibited because of contraction.

2 Lightly wash using hands. (Refer to the figure below.)

- Do not use a washing machine, etc., as this will damage the fibers.
- Do not use a scrub brush, etc. and take care not to rub the filters each other strongly.



04-024

3 After washing, dry sufficiently in a shaded location with good airflow before reusing.

- Dust collection effectiveness may reduce if the filter is used before it has been dried fully.

4.11.3 Point for special caution

Exercise sufficient and constant caution so that the fibers do not stand up on end.

4.12 Turbine Cleaning Procedure during Operation

MET turbochargers can be equipped with a solid-particle cleaning device on the turbine side.

The introduction of this cleaning with plant solid particles is recommended as a suitable means of turbine cleaning for non-cooled MET turbochargers designed in response to these circumstances.

4.12.1 Overview of solid-particle cleaning method on turbine side

In the solid-particle cleaning method, solid particles are introduced upstream of the turbine, and are accelerated by means of exhaust gas. The impact force serves to remove deposits from the turbine nozzle, turbine blades, etc.

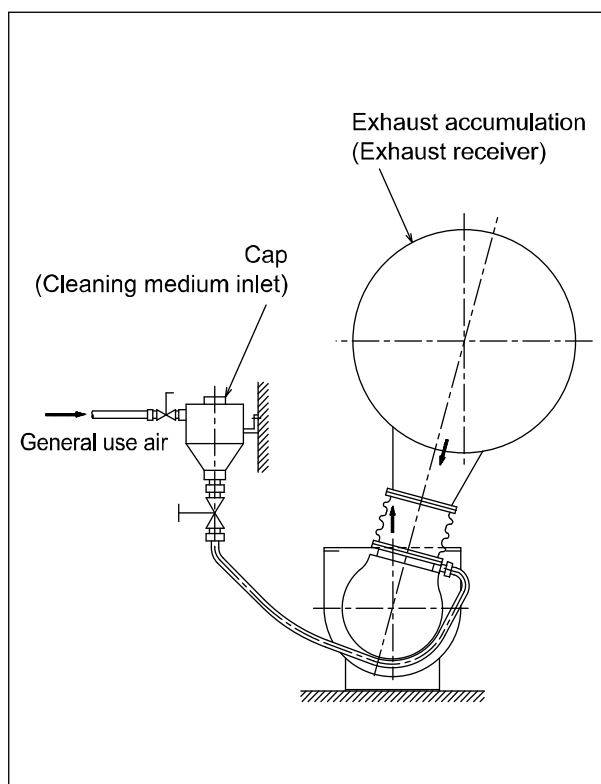
There is no need to reduce the engine load to the low speed during cleaning, and the engine can be cleaned in a short time with a normal load applied. In addition, there is no thermal shock to the casings of the exhaust gas channels.

As turbine side cleaning is for the purpose of preventing the build-up of turbine fouling, it should be performed periodically.

4.12.2 Plant solid-particle cleaning device

■ Overview of device

The figure on the right presents an overview of the plant solid cleaning device.



04-003

■ Cleaning medium

(a) Types of cleaning medium:

	Diameter
Walnut shell	2.0 - 2.8 mm (marine grit #8) NOTICE • Milled walnut shell can be sourced from Hikawa Marine Co., Ltd.
Grain (rice, wheat, etc.)	Within 3.0 mm

(b) Amount of cleaning medium to be used

Table below shows the initial recommended amount for the first cleaning, according to the turbocharger model. As an excessive amount can result in surging, the appropriate value should be determined in conjunction with the engine status/condition. In doing so, refer to Section 4.12.3, .3.

Plant solid cleaning device capacities

Frame size	53	60	66	71	83	90
Used amount of solid cleaning medium (liter/time)	1.6	2.1	2.6	3.0	3.5	3.5

4.12.3 Cleaning procedure

1. Cleaning interval

Initially, clean at least once every 100 hours (2 to 3 times a week) (for approx. 2,000 hours after initially used or cleaned after disassembly). Subsequently, the interval should be adjusted up or down in accordance with performance values such as exhaust temperature, scavenge air pressure, and turbocharger rpm (When the temperature of the exhaust gas reaches over 20°C, perform once every 24 hours).

2. Turbocharger rpm during cleaning

The following table indicates limits for turbocharger speed and turbine inlet temperature value during cleaning.

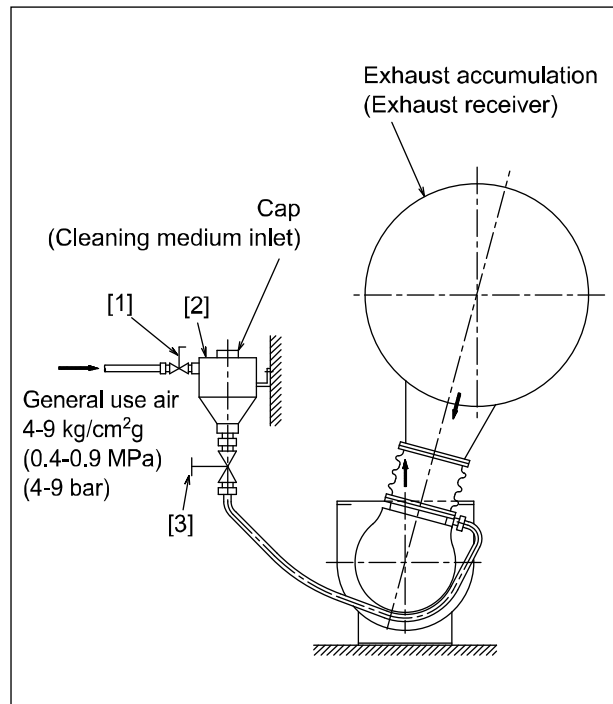
If actual values are higher at normal load, then the load should be reduced.

Allowable speed and turbine inlet temperature during cleaning

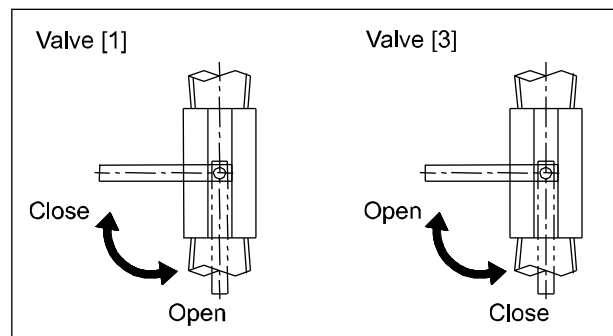
Frame size	53	60	66	71	83	90
Max. rotating speed (min ⁻¹)	14,800	13,300	11,900	11,000	9,400	8,500
Min. rotating speed (min ⁻¹)	5,700	5,100	4,600	4,300	3,640	3,300
Turbine inlet temperature	500°C or less					

3. Cleaning procedure

- 1** Open the valve [3] and then valve [1], and supply air for 1 to 2 minutes to cool down the device.
- 2** Close the valve [1] and then [3].
- 3** Open the cap of the tank [2], and put a specified amount of plant solid particle as cleaning medium.
- 4** Be sure to close the cap on tank [2].
- 5** Open the valve [1] and then valve [3] to supply air before pouring the cleaning medium into.
- 6** Close the valve [3] and then valve [1].



04-004



04-005

4. Repeat cleaning

- If the engine performance changes suddenly when the cleaning medium is put into, for example if severe surging occurs, try cleaning using about half of the recommended amount of cleaning medium in Table of the previous page.
After checking that there is no sudden engine performance change, repeat the cleaning process.
- After completion of cleaning, and assuming no improvement in performance values in exhaust temperature, scavenge air pressure and turbocharger speed, repeat the procedure described above.
If no change is observed after several repetitions, it will be necessary to perform overhaul and conventional cleaning.

4.13 Compressor Washing Procedure during Operation

MET turbochargers can be equipped with a compressor side water washing device. The compressor side water washing should always be performed within the designated turbocharger speed range. This speed is lower than for normal operation, and it is necessary during washing to reduce engine load.



CAUTION



Decrease the speed of the turbocharger when performing the compressor side water washing.

It is desirable to do this when arriving in or leaving port.

- * Compressor side water washing conducted at high speeds will result in excessive stress on the compressor impeller blades, and can cause serious damage to the blades.

4.13.1 Compressor water washing procedure

If, due to various engine conditions, it proves difficult as a result of severe compressor side fouling to maintain performance until the next scheduled overhaul, follow the procedure below for compressor side water washing.

- Observe the procedure shown in the table below for compressor side water washing.
- Water supply method must be a natural water supply method (refer to the figure below.)
- Check by running water through them if there is not any foreign object or object inside the tank and hose.
- Supply water to the tank a little at a time using a small container. Do not supply directly from a spigot or large container.

Frame size	53	60	66	71	83	90
Max. rotating speed (min^{-1})	7,000 to 9,500	6,300 to 8,500	5,500 to 7,500	5,000 to 7,000	4,500 to 6,000	4,500 to 6,000
Water supply amount (liter) Time (sec.)	2.0 40 to 80	2.25 45 to 90	2.5 50 to 100	2.75 55 to 110	3.0 60 to 120	3.0 60 to 120

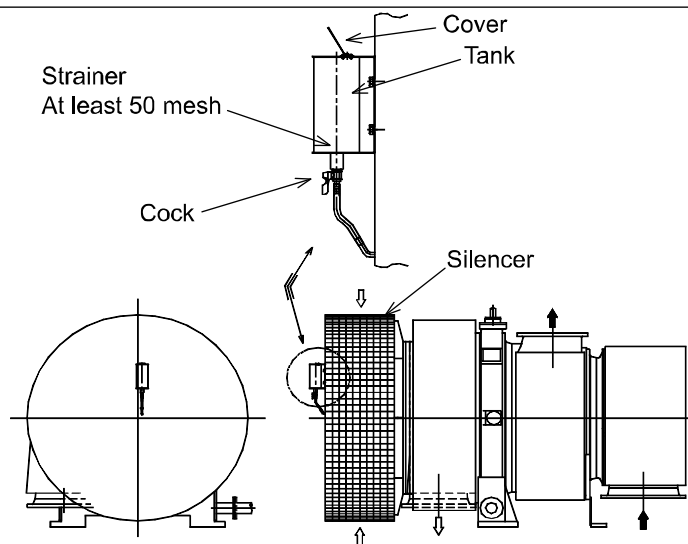
CAUTION



Be sure to keep the turbocharger speed within the designated range during cleaning.

Do NOT perform cleaning at normal turbocharger speed.

* It may cause damage to the compressor impeller.



04-006

5 Disassembly

5.1 Cautions for Disassembly

 WARNING	
	Do not disassemble or assemble the turbocharger when you are under influence of drinking, short of sleep or in poor physical condition. * It may cause unexpected accidents.
	Do not go under any equipment or part which is suspended. * The equipment or part may fall off due to failure of the lifting tool, causing accidents resulting in injury or death.
	Operation of cranes and slinging must be performed by an authorized person. The owner is obliged to give their employee who handles suspending equipment (chain block) training on safety. (Observe the national rules and regulations.) Only the persons who are trained on safety and specified by the owner may handle the suspending equipment. * If the suspended loads are unbalanced during transportation or fall off due to mis-slinging, it may cause accidents resulting in injury or death or damage of the turbocharger.
	Before using materials to suspend the machine or parts (wires, slings, tools, etc.), check the weight of the object to be suspended. Use a material of sufficient strength. * If load exceeding the allowable value of the suspending material is applied, such a material may be broken and then the suspended object may fall off, causing accidents resulting in injury or death. There also is a possibility that broken wires or slings may jump out and hit a person, causing accidents resulting in injury or death.
	Load to be applied to a suspending material will change depending on the angle of suspending. Consider it when selecting the size. Do not select the size of the suspending material unless you understand the meaning of the instruction above. * If not observed, it may cause unexpected accidents.
	Dispose of any suspending materials a part of which is broken. Use a new one. Before using the suspending material, check if it is normal. * If any abnormal material tool is used, it may break during suspending work, causing accidents resulting in injury or death.
	When suspending any equipment or part, place the hook in the center of the gravity of the suspended object. Adjust the position so that each wire is applied with the same load. * If not observed, the object may be unbalanced when suspended or a certain wire is applied with large load and then broken, causing accidents resulting in injury or death.
	To prevent accidents in disassembling and assembling, inspect required tools and exclusive tools beforehand. * If neglected, unexpected accidents may occur.
	Take care not to step off or not to drop any object during the work. If the scroll of the compressor in the turbocharger is removed, the intake of the duct for discharge air of the compressor will be turned downward. * There is a possibility of injury.

**CAUTION**

Wait until the turbocharger is cooled enough after it is stopped before disassembling.

- * There is a possibility of heat injury.

NOTICE

- The chain block should be suspended from a strong beam, etc. capable of supporting a load of at least the weight of 2 ton. Wire ropes must also be capable of withstanding the weight of 2 ton.

5.2 When the Turbocharger Rotor is Rotating in Stop of the Engine

**WARNING**

After disassembling the silencer of the turbocharger and casing at inlet of the gas, if the rotor of the turbocharger is rotating, take the following measures.

- **Never touch the impeller or turbine blade while it is rotating.**
- **Do not try to stop the rotation of the rotor by applying a piece of wood or waste cloth.**

Even when the engine is stopped, upward flow may be generated inside the duct due to afterheat of the exhaust duct or exhaust gas economizer, which makes the rotor of the turbocharger rotating. Such low rotational speed may not be detected by the gap sensor. Thus, even if the gap sensor reads "0", the rotor may not be stopped.

- * If not observed, you may get entangled in, or some foreign substances may hit the rotor.

- 1 Remove the gas inlet casing.**
- 2 Blow the edge of the turbine blade with compressed air in counterclockwise direction to stop the rotor.**
 - If the rotation of the rotor does not stop, remove the bolt of the flange at the gas outlet, and either insert a cover board or remove the inspection manhole if it is provided to the duct of the downstream of the gas outlet flange.
- 3 When the rotor stops rotating, put some soft object such as a waste cloth, etc. to the edge of the turbine blade so as not to rotate again.**

5.3 Removing the Silencer

Frame size	53	60	66	71	83	90
Weight	Approx. 320kg	Approx. 410kg	Approx. 550kg	Approx. 660kg	Approx. 860kg	Approx. 1,300kg

1 Remove the gap sensor cable from the junction box.

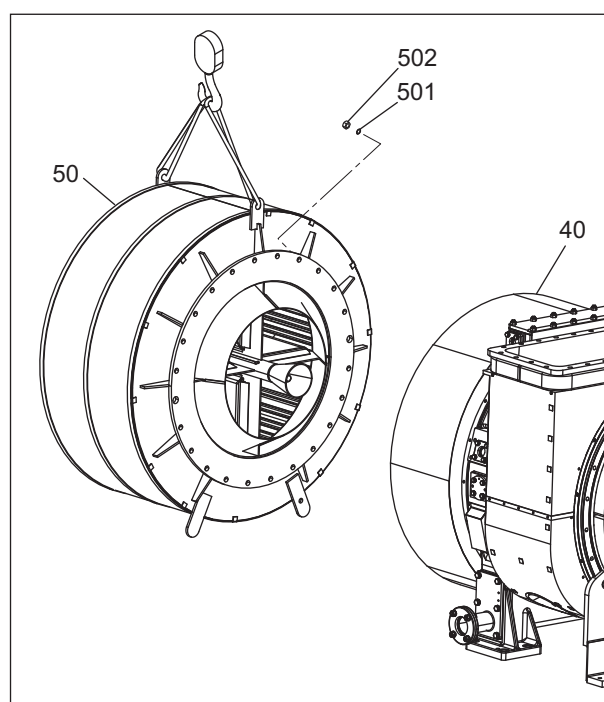
- Fix the disconnected cable with tape or other means to prevent it from getting in the way during the work.

2 Suspend the silencer 50 with a wire rope, and then remove the nuts 502 and washers 501.

3 Remove the silencer 50 from outer scroll 40 in accordance with the figure on the right.

NOTICE

- Fix the removed silencer in a safe location.
- Use rope or other means to secure the silencer so that it should not fall over.



05-037

5.4 Removing the Air Inlet Guide

Frame size	53	60	66	71	83	90
Weight	Approx. 140kg	Approx. 200kg	Approx. 270kg	Approx. 320kg	Approx. 480kg	Approx. 620kg

1 Measure the clearance (A) (refer to 9.1) between the air inlet guide 47 and the impeller with a feeler gauge at 4 points, top, bottom, left and right.

- The value will be useful as references during re-assembly.

2 Attach the slinging device T-76 to the flange on the air inlet guide 47 using bolts T-16.

3 Remove the bolt 473 and spring washer 474.

4 Attach the shackle T-39 to the arm of slinging device T-76.

5 Lift the air inlet guide 47 slowly using a wire rope suspended from a chain block.

6 While slowly screwing the lifting bolt (starting bolt) T-22 into the threaded hole on the flange of the air inlet guide 47, pull off the air inlet guide 47.

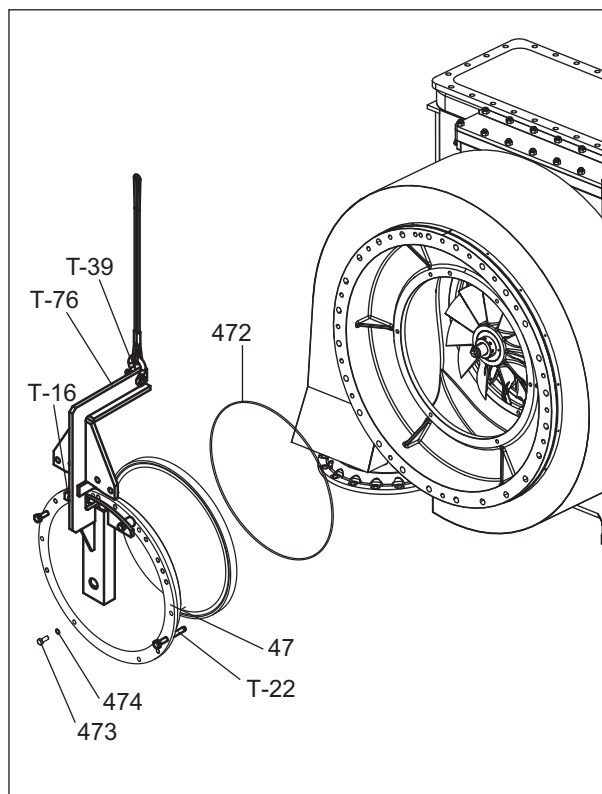
NOTICE

- Take extreme care so that the air inlet guide 47 does not touch the impeller blades.

7 Remove the O-ring 472.

NOTICE

- O-ring 472 is a consumable. Replace with a new one in reassembly.

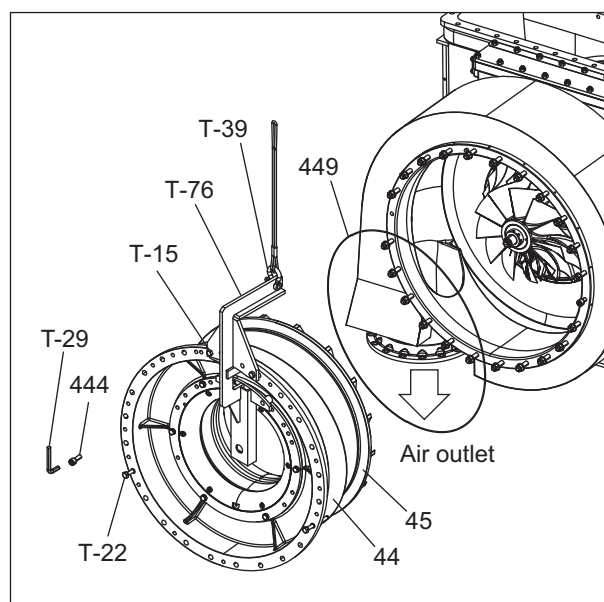


05-054

5.5 Removing the Inner Scroll

Frame size	53	60	66	71	83	90
Weight	Approx. 310kg	Approx. 410kg	Approx. 600kg	Approx. 680kg	Approx. 1,150kg	Approx. 1,520kg

- 1** Remove the hexagon-socket-headed bolt 444 using a hex. headed spanner T-29.
- 2** Attach the slinging device T-76 to the flange on the inner scroll 44 using bolt T-15.
- 3** Screw the two lifting bolts (starting bolts) T-22 into the threaded holes on the left and right of the flange at the same time.
 - Be sure that the screw depth of the bolts on the left and right is the same.



05-038

NOTICE

- Do NOT use a compressed air driven wrench or other power tool to screw in the lifting bolts.

- 4** Attach the shackle T-39 to the arm of slinging device T-76.
- 5** Lift the inner scroll 44 slowly using a wire rope suspended from a chain block.
- 6** Screw the lifting bolts T-22 into the flange, and pull out the inner scroll 44.
 - Fix the inner scroll 44 in a suitable location using a rope, etc. so that it does not roll. The diffuser 45 is installed to the inner scroll 44. When moving and/or temporarily storing the inner scroll 44, take care so as not to damage diffuser 45.

NOTICE

- Upon removal of the inner scroll 44, the air outlet leading to the engine side will be uncovered. Be sure not to drop any objects or to step inside this opening. If an object is dropped inside, refer to the engine manual in order to open the appropriate section of the engine for retrieval.

- 7** Remove the O-ring 449.

NOTICE

- O-ring 449 is a consumable. Replace with a new one in reassembly.

5.6 Removing the Gas Inlet Inner Casing

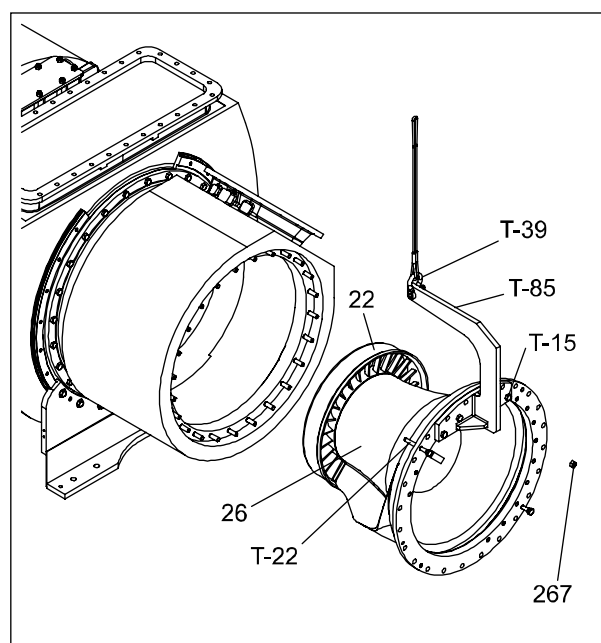
When performing inspection and cleaning only with respect to the turbine blades and nozzle, or disassembling the turbocharger completely (overhauling), please be sure to follow the instructions below.

Frame size	53	60	66	71	83	90
Weight	Approx. 360kg	Approx. 410kg	Approx. 550kg	Approx. 570kg	Approx. 780kg	Approx. 950kg

- 1** Remove the heat-resistant lagging from the mounting flange on the gas inlet inner casing 26.
- 2** Be sure to remove all of the nuts 267 from the flange for mounting the gas inlet inner casing 26.
- 3** Screw the two lifting bolts T-22 into the threaded holes on the left and right of the flange.
 - Be sure that the screw depth of the bolts on the left and right is the same (refer to the figure on the right).

NOTICE

- Do NOT use a compressed air driven wrench or other power tool to screw in the lifting screws.



05-005

- 4** When the gas inlet inner casing 26 protrudes about 10 mm, install the slinging device T-85 to the flange on the gas inlet inner casing 26 using bolts T-15.

CAUTION



Do not use any bolts longer than T-15.

* The flange may break.

- 5** Attach the shackle T-39 to the arm of slinging device T-85.
- 6** Lift the gas inlet inner casing 26 slowly using a wire rope suspended from a chain block.
- 7** Screw the lifting bolts T-22 into the flange, and pull out the gas inlet inner casing 26.

NOTICE

- Nozzle 22 is installed to the casing.
- Fix the casing in a suitable location so that it does not roll.
If removing the nozzle, place it with the flange side down.

8 Measure the clearance (L) (refer to 9.1) between the gas outlet guide 23 and the tips of the turbine blades 61 with a feeler gauge at 4 points, upper, lower, left and right.

- The value will be useful as references during re-assembly.

9 Also measure thrust clearance (H). Please refer to 6.11 for measurement procedures.

10 Attach the stay T-67 to the gas inlet outer casing 27 as shown in the figure on the right, using the nut 267, roller support T-47, nut T-1 and bolts T-14.

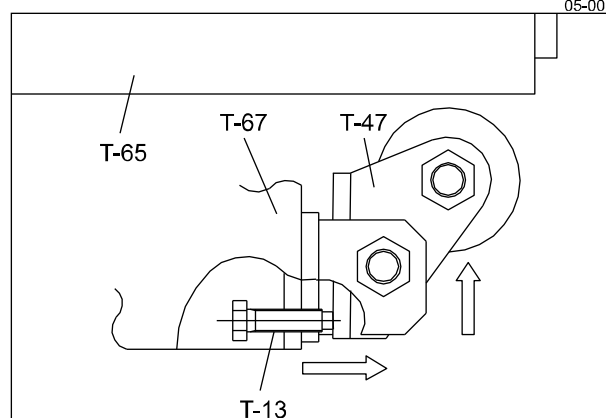
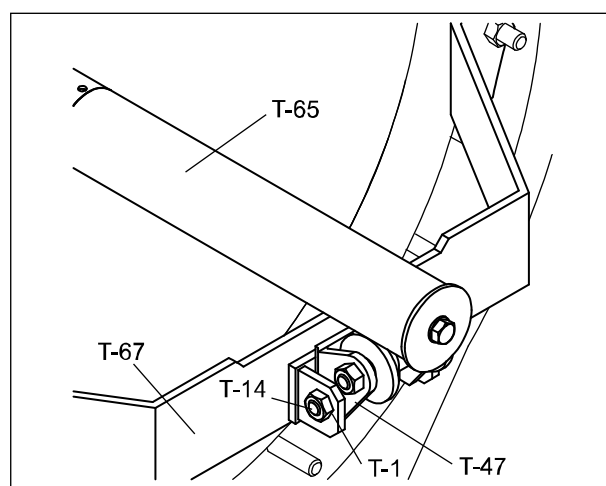
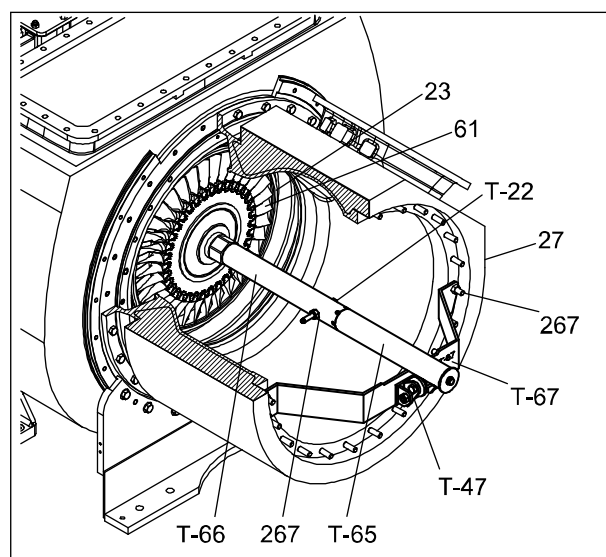
11 Remove any dirt or foreign object from the threaded hole in the end of rotor shaft using compressed air, etc.

12 Screw the pulling out tube assemblies T-65, T-66 into the end of the rotor shaft.

13 Insert the lifting bolts T-22 into the pulling out tube T-65, T-66, and fix with nut 267.

- This serves to prevent the rotor shaft from slipping in turbine-side direction when loosening the impeller.

14 Screw the screw T-13 to lift up the roller support T-47 to raise the rotor shaft a little from the journal bearing.

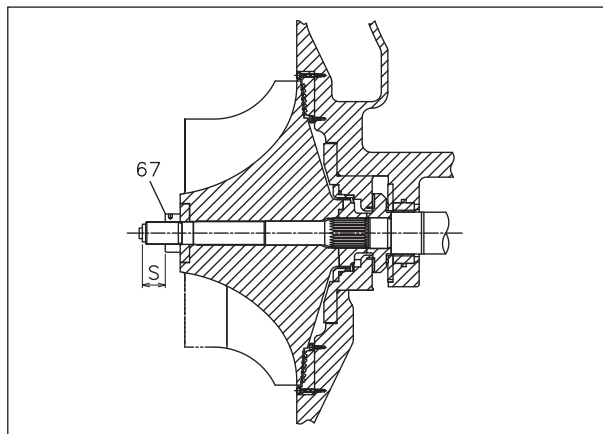


5.7 Removing the Impeller

Frame size	53	60	66	71	83	90
Weight	Approx. 110kg	Approx. 150kg	Approx. 200kg	Approx. 220kg	Approx. 370kg	Approx. 520kg

1 Measure the distance **S** from the edge of the locking nut 67 to the end of the shaft with a depth gauge, etc.

- The value will be useful as references during re-assembly.

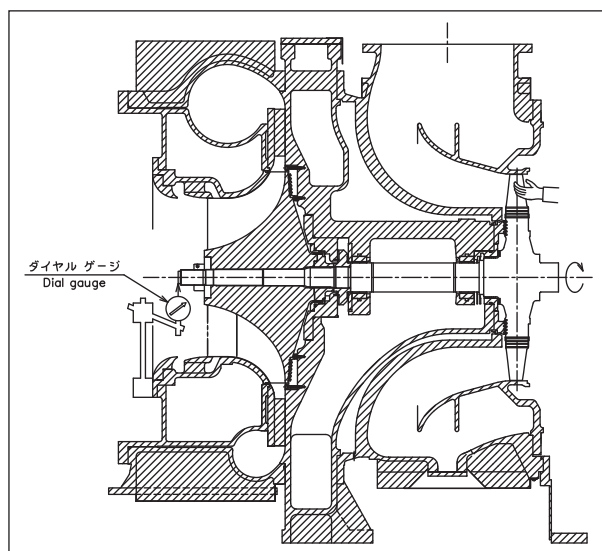


05-046

2 Put a dial gauge to the rotor shaft end.

3 Manually rotate the rotor clockwise and measure the deflection of the shaft edge with the dial gauge.

- The value will be useful as references during re-assembly.

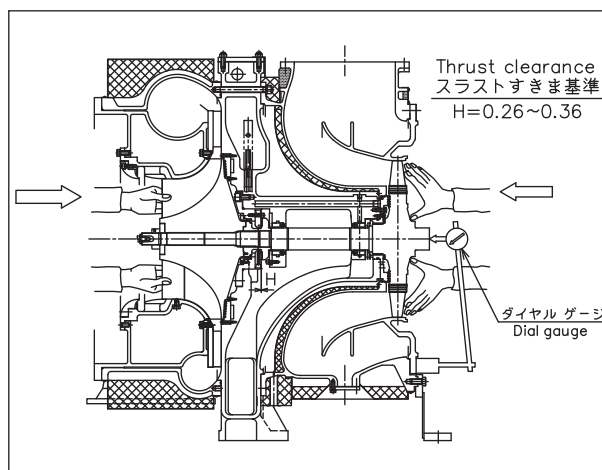


05-055

4 After checking the shaft deflection, apply the dial gauge in the axial direction.

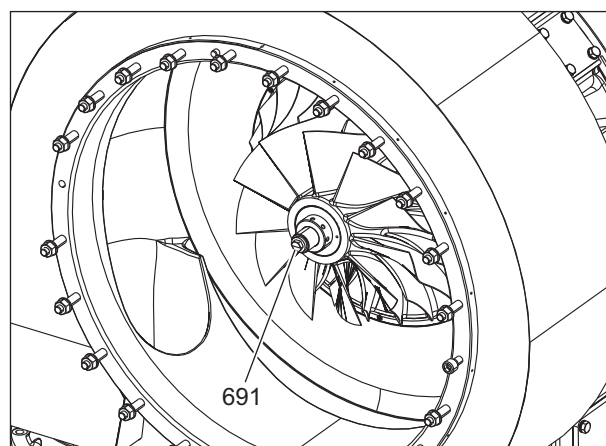
5 Measure the axial movement of the rotor when pushed by hand (the thrust clearance).

- The value will be useful as references during re-assembly.



05-044

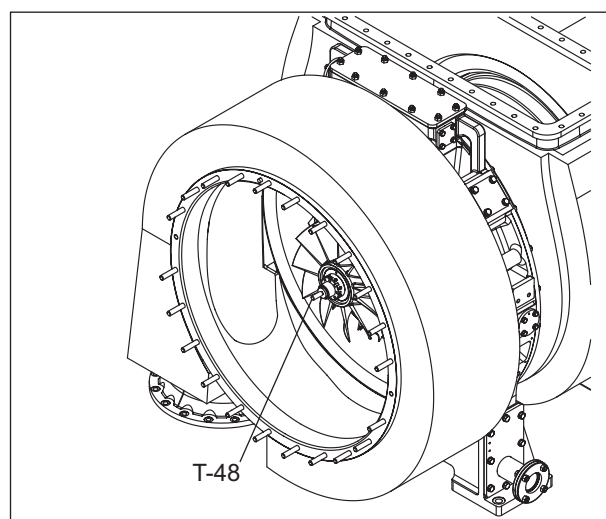
- 6** Remove the bolt 691 at the end of the shaft which detects rotating speed.



- 7** Screw the guide bar T-48 for hydraulic jack T-60 into the threaded hole in the shaft end.

- 8** Screw the hydraulic jack T-60 into the shaft end.

- Also, be sure to check that the ram of the hydraulic jack T-60 has been retracted (refer to the figure on the right).
- In order to prevent the hydraulic jack T-60 from falling and damaging the impeller, support the weight of the jack with your hands until it is fully screwed in.



- 9** After the ram of the hydraulic jack T-60 has been screwed in, be sure to give the hydraulic jack T-60 one reverse turn.

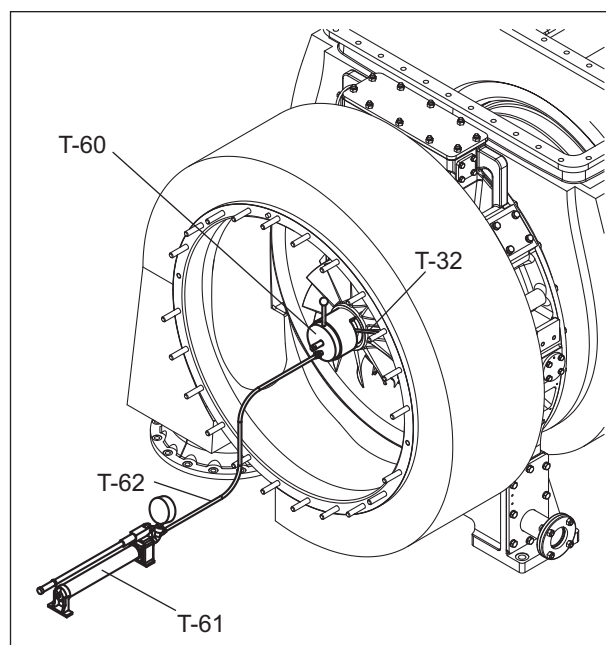
- 10** Place the hydraulic pump T-61 on a flat surface.

- 11** Connect the rubber hose T-62 to the hydraulic jack T-60.

- 12** Close the handle of the escape valve of the hydraulic pump T-61 by turning clockwise.

NOTICE

- Hydraulic pump T-61 is sometimes in common use with main engine. In this case, please use the one for main engine.



13 Move the handle of hydraulic pump T-61 up and down by hand until the hydraulic pressure reaches the specified value.

- The hydraulic pressure can be checked using the pressure gauge installed to the pump.
For the impeller tightening pressure, please refer to the table below.

Impeller tightening pressure

Frame size \ Series	MB
53	50.0 [MPa] 510 [kg/cm ²]
60	61.2 [MPa] 625 [kg/cm ²]
66	51.0 [MPa] 520 [kg/cm ²]
71	57.8 [MPa] 590 [kg/cm ²]
83	62.9 [MPa] 640 [kg/cm ²]
90	68.6 [MPa] 700 [kg/cm ²]

14 Insert the handle T-32 through the slot of the hydraulic jack T-60 into the hole in the periphery of the locking nut 67, and loosen the nut by turning counterclockwise several revolutions.

NOTICE

- There are cases in which the locking nut may not loosen even when the hydraulic pressure of the jack reaches the specified level. In such cases, first lower the pump pressure, and then raise it again to 120% of the specified level and again attempt to loosen the locking nut. Also, in the event that the engine has just been stopped and the impeller temperature is still high, it will not be possible to loosen the nut at the specified pressure due to the effect of impeller heat expansion. In this case, cool the impeller by evenly applying compressed air.

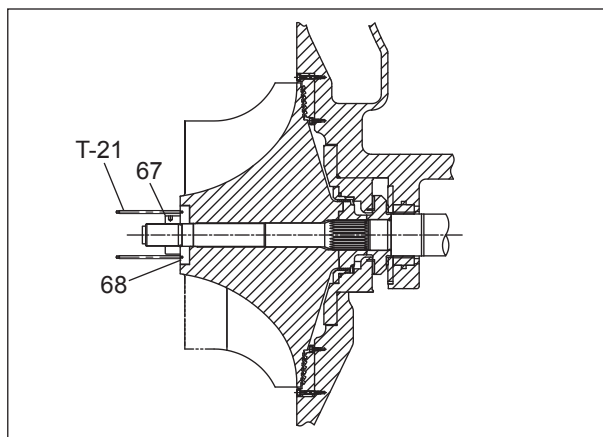
15 Open the escape valve on the hydraulic pump T-61 by turning the handle counterclockwise to lower the pressure.

16 Retract the ram of the hydraulic jack T-60 by hand.

17 Carefully remove the hydraulic jack T-60 from the shaft.

18 Remove the locking nut 67 by hand.

19 Remove the washer 68 using the threaded bar T-21.

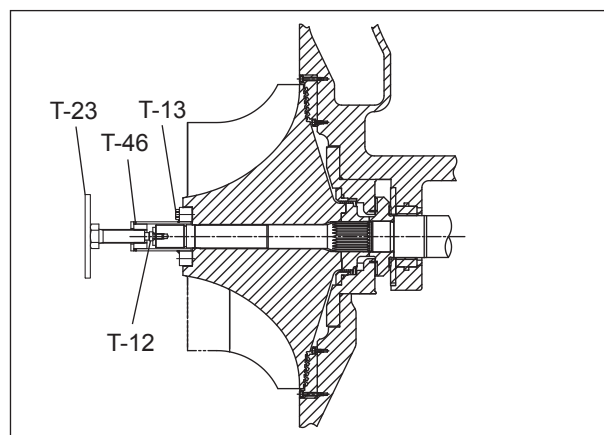


05-047

20 Screw the protection bolt T-12 into the end of the rotor shaft.

21 Use tape to thinly cover the threaded part of the rotor shaft end for protection.

22 Install the draw-out tube T-46 to the boss of the impeller 66 using bolt T-13.

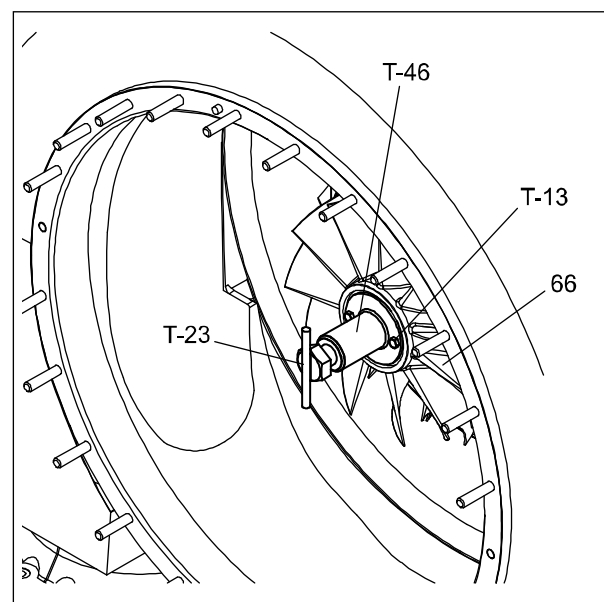


05-048

23 Install the handle (starting bolt) T-23.

24 While holding the impeller 66 with one hand, slowly turn the handle T-23 with the other hand, and pull out the impeller 66.

- When the impeller 66 has been pulled out to a certain extent using the handle T-23, it can then be pulled out the rest of the way with your hands.



05-012

25 Remove the handle T-23.

26 Use the handle T-23 to screw the slinging device T-76 into draw-out tube T-46.

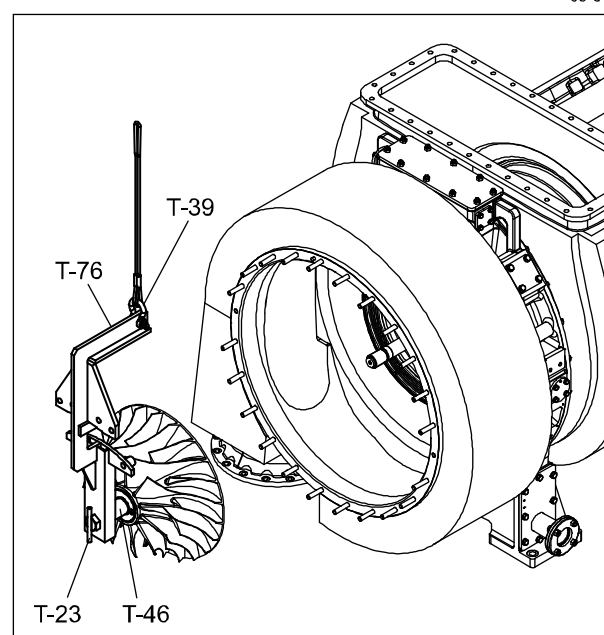
27 Attach shackle T-39 to the arm of slinging device T-76.

28 Lift the impeller slowly using a wire rope suspended from a chain block.

29 With the chain block supporting the weight, carefully remove the impeller.

- Store it horizontally in a safe location.

30 Remove the protection bolt T-12 for the rotor shaft end.

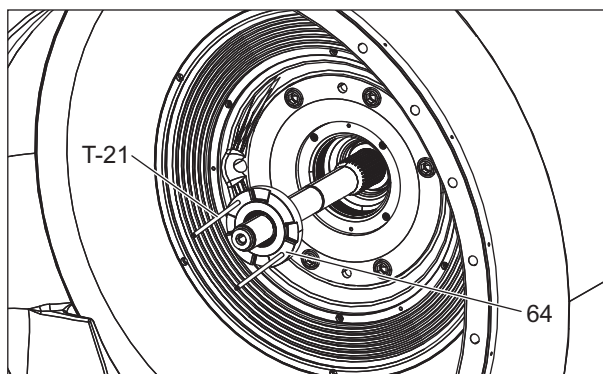


05-013

5.8 Removing the Support and Thrust Collar

The claw clutch of sleeve 64 will be visible upon removal of the impeller.

- 1** Screw threaded bar T-21 into the threaded hole in the claw clutch of the sleeve 64, and pull out sleeve 64.

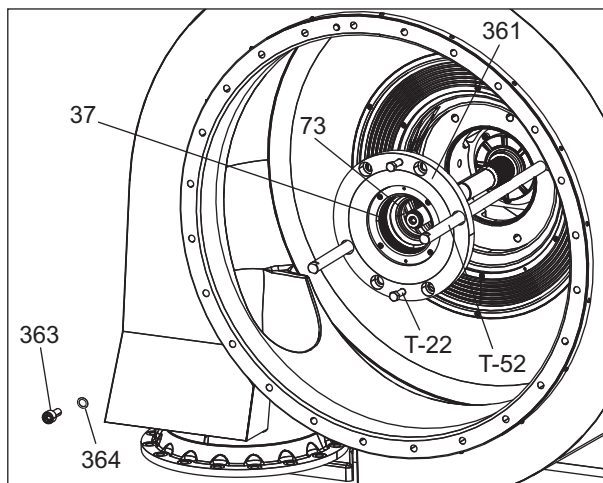


05-039

- 2** Remove the hexagon-socket-headed bolt 363 and the spring washer 364 mounting the support 361.

- 3** Attach the guide bar T-52.

- 4** Screw the lifting bolts (starting bolts) T-22 into threaded holes in the flange on the support 361, and pull out the support 361.



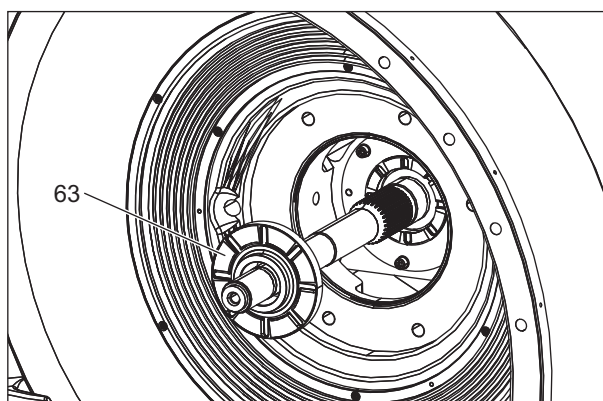
05-040

NOTICE

- Compressor side oil labyrinth 37 and compressor side thrust bearing 73 are installed to the support 361. When storing the support 361, place the thrust bearing side up, and take extreme care so as not to damage the metal surfaces of the thrust bearing during storage.

- 5** Remove the thrust collar 63.

- As the clearance between the thrust collar 63 and the shaft is narrow, remove the thrust collar 63 slowly and carefully.



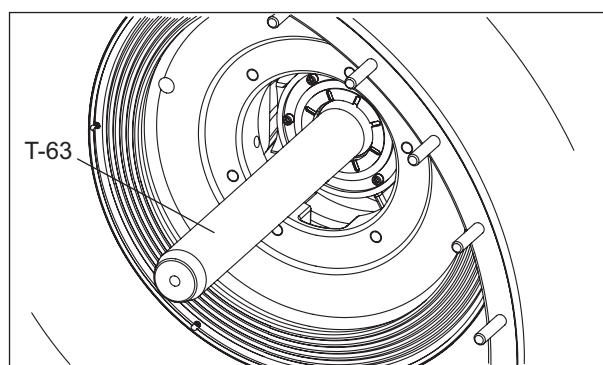
05-041

5.9 Removing the Rotor Shaft

Check that there are no damages, burrs, or dirt on the rotor guide protection tube T-63. If there are any burrs or damage, remove them.

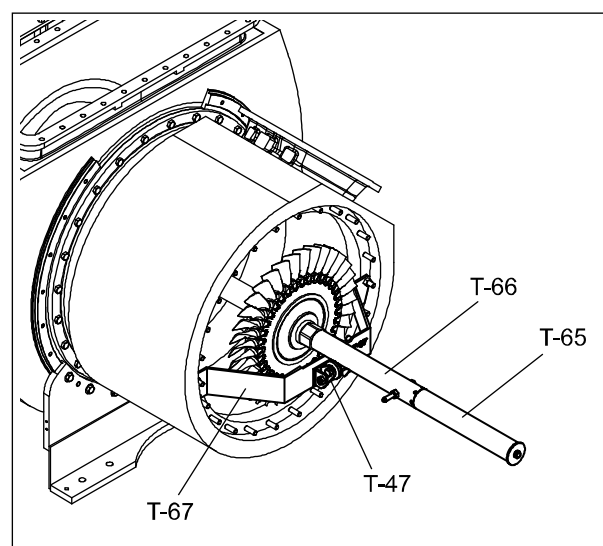
Frame size	53	60	66	71	83	90
Weight	Approx. 120kg	Approx. 170kg	Approx. 230kg	Approx. 280kg	Approx. 450kg	Approx. 610kg

- 1** Screw in the rotor guide tube T-63 to the compressor side of the rotor shaft.



05-053

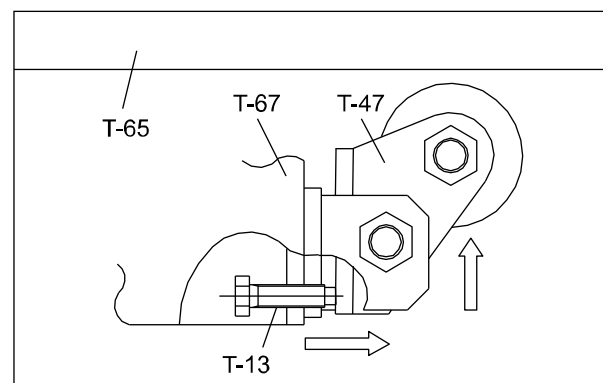
- 2** Screw the pulling out tube assemblies T-65, T-66 into rotor shaft from the turbine side.



05-018

- 3** Screw in the screw T-13 to lift up the roller support table T-47 to raise the rotor shaft a little from the journal bearing.

- 4** Pull the pulling out tube assemblies T-65 and T-66 by hand, and pull out the rotor shaft to the position of the stay T-67.



05-031

- 5** Place wire rope around the root part of the disc side of the rotor shaft.



CAUTION



Do not place the wire rope around the journal part of the shaft.

- * In case of a metal wire rope, it may damage the journal.

- 6** Suspend the wire rope using a chain block, hoist, etc.

- 7** Remove the stay T-67.

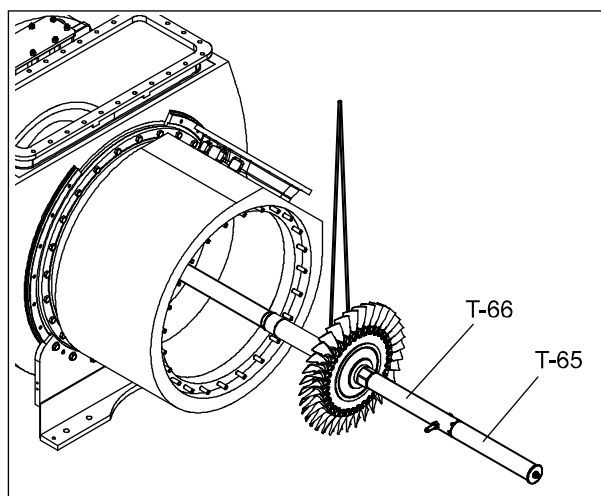
- 8** Pull out the rotor completely.

- 9** While stabilizing the rotor using your hands, move the rotor to a safe location for storage.

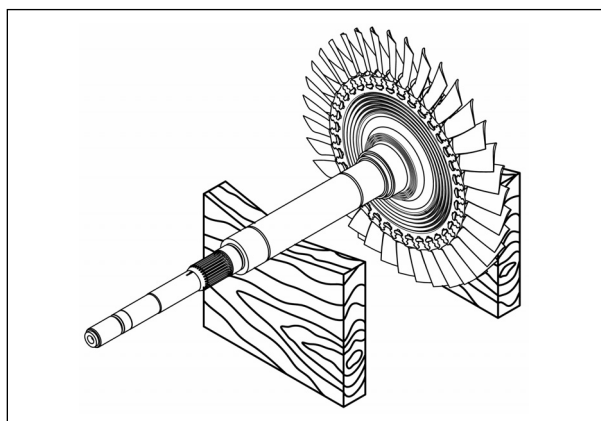
- While storing the rotor shaft, remove pulling out tubes T-65, T-66, and set the rotor on wooden blocks, etc so as to avoid contact between the turbine blades and the floor.

NOTICE

- When tilting the rotor shaft, install a nut to the end of the rotor shaft and tilt it using a nylon sling, rope, etc. so that it does not slip.



05-019



05-020



CAUTION

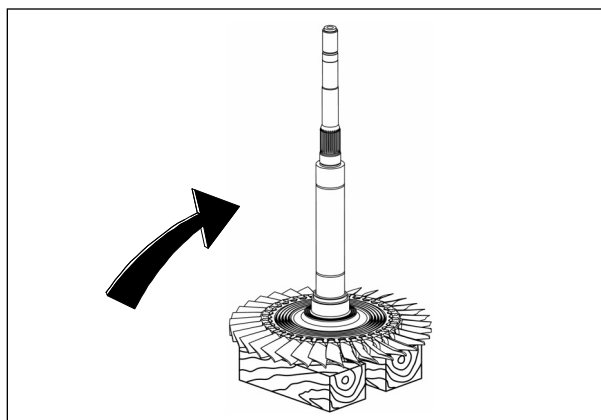


Do not use wire.

- * Wires may damage the shaft.

Do not use an eyebolt on the end of the shaft.

- * With an eyebolt, the rotor shaft may rotate when the shaft is lifted and the bolt becomes loose, which allows it to come off.



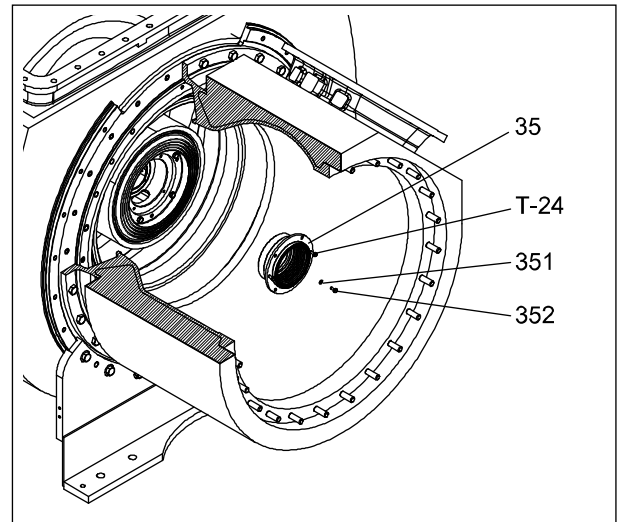
05-021

- 10** Remove the rotor guide tube T-63.

5.10 Removing the Bearing and Labyrinth

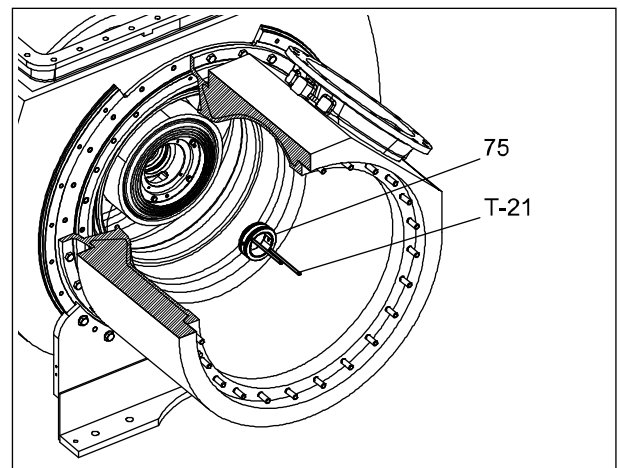
5.10.1 Turbine side oil labyrinth 35 and turbine side journal bearing 75

- 1** Remove the mounting bolts 352 and spring washer 351.
- 2** Using the lifting bolt (starting bolt) T-24, remove the turbine side oil labyrinth 35 while lifting.



05-023

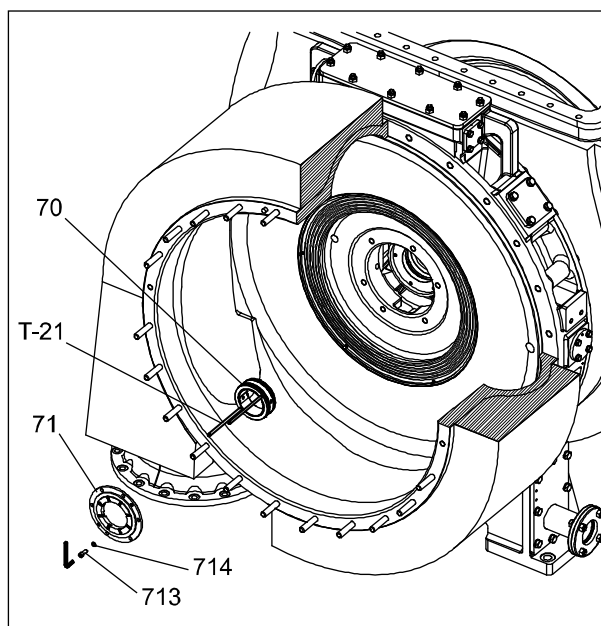
- 3** The turbine side journal bearing 75 can be removed using threaded bars T-21.



05-024

5.10.2 Turbine side thrust bearing 71 and compressor side journal bearing 70

- 1** Use hex. headed spanner (M10) to remove the hexagon-socket-headed bolt 713 and spring washer 714.
- 2** Remove the turbine side thrust bearing 71 by hand.
- 3** Remove the compressor side journal bearing 70 by using threaded bar T-21.

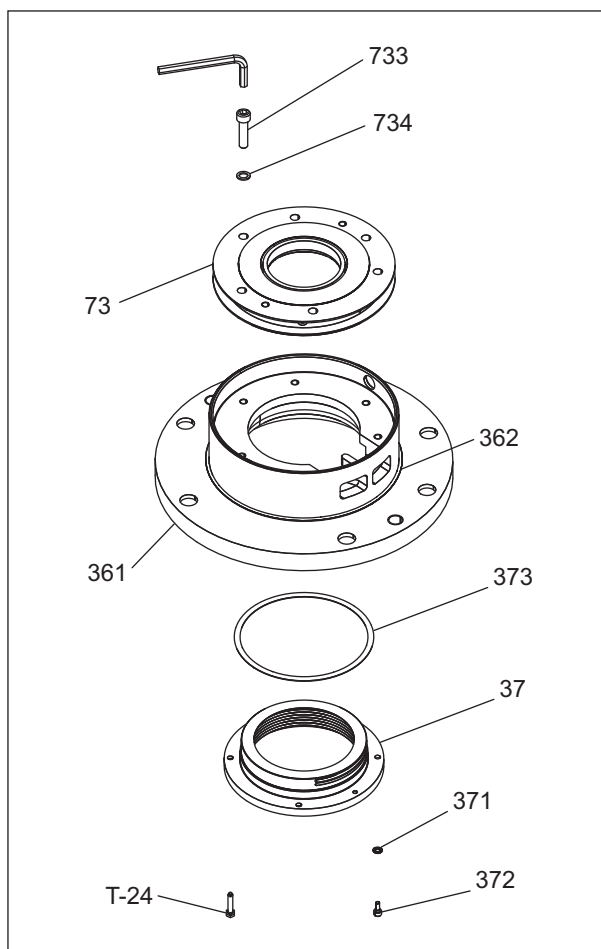


05-025

5.10.3 Compressor side thrust bearing 73 and compressor side oil labyrinth 37

Compressor side thrust bearing 73 and compressor side oil labyrinth 37 are installed to the support 361.

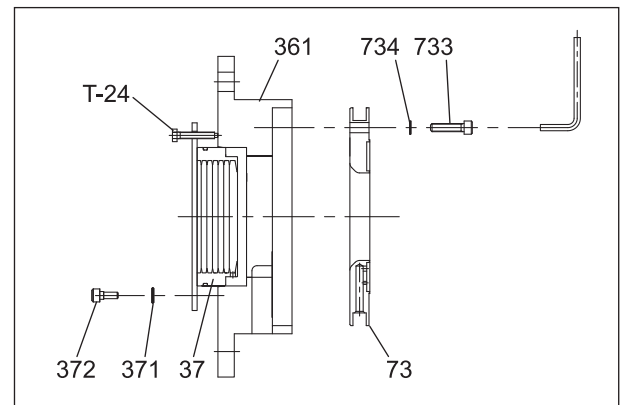
- 1** Use hex. headed spanner (M10) to remove hexagon-socket-headed bolt 733 and spring washer 734.
- 2** Screw the same bolt 733 into the threaded hole in the compressor side thrust bearing 73. Lift and remove the bearing.
- 3** Remove the compressor side thrust bearing 73.
- 4** Remove the O-ring 362.
- 5** Turn over the support 361 and remove the hexagon-socket-headed bolt 372 and the spring washer 371.



05-042

- 6** Using the lifting bolt (starting bolt) T-24, lift up and take out the compressor side oil labyrinth 37.I

- 7** Remove the O-ring 373.



05-049

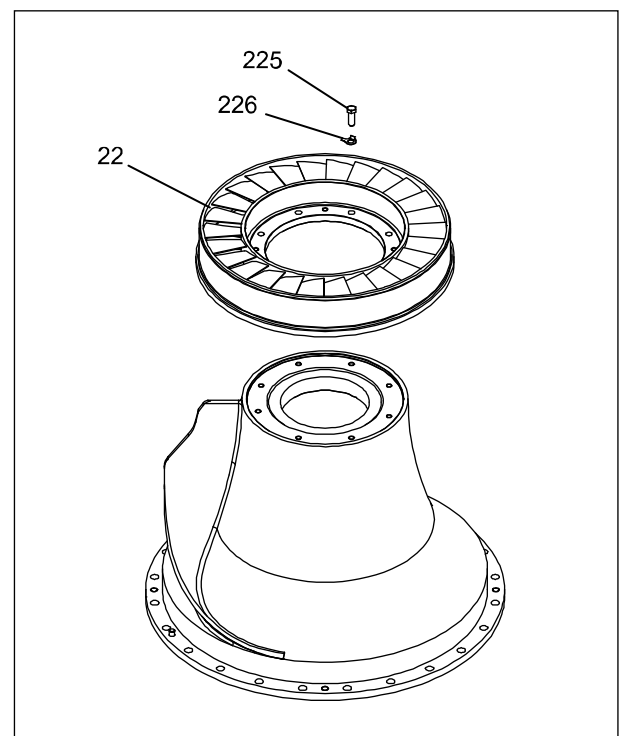
5.11 Removing the Nozzle

- 1** Remove nozzle 22 mounting bolts 225 and W-tongued washer 226.

- If the bolt 225 proves difficult to loosen, spray with commercially available penetrant, or gently heat the inner ring of the nozzle.

- 2** Screw the bolt 225 into the threaded hole for lifting located in the inner ring of the nozzle 22.

- The nozzle bolts are made of stainless steel. Be sure to store them so that they can be distinguished from other similar items.



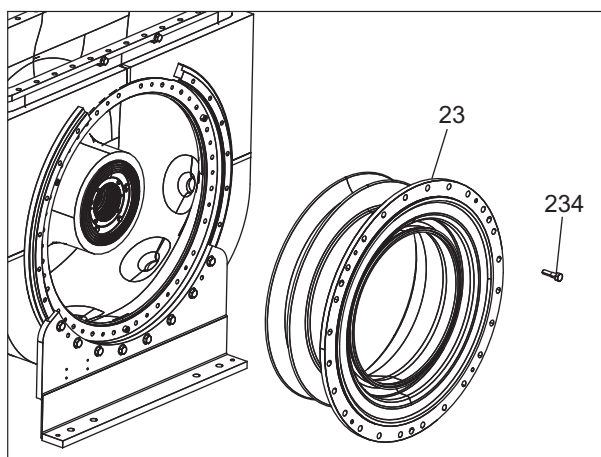
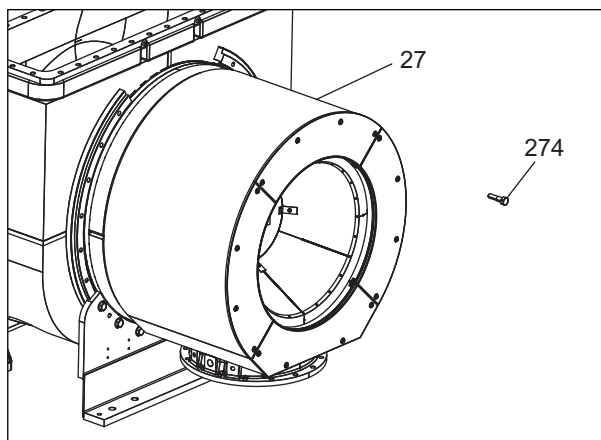
05-027

5.12 Removing the Gas Outlet Guide

It is not normally necessary to remove gas outlet guide 23 for cleaning.

When replacing the gas outlet guide due to wear, etc., follow the procedure below to pull it out.

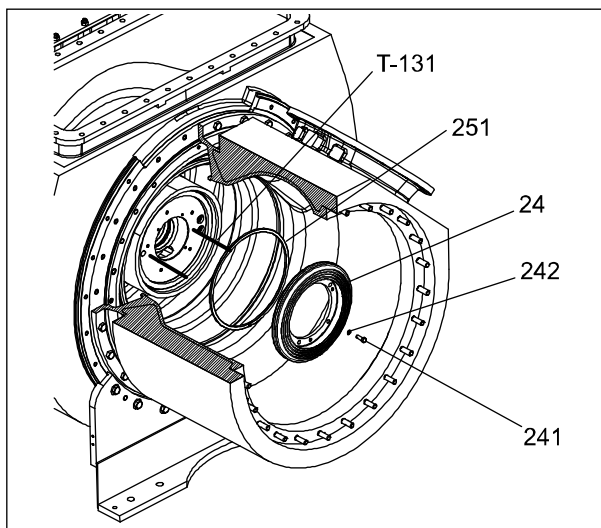
- 1** Remove the bolt 274.
- 2** Remove the gas inlet outer casing 27.
- 3** Remove the hexagon-socket-headed bolt 234.
- 4** Remove the gas outlet guide 23.



5.13 Removing the Gas Labyrinth

It is not normally necessary to remove gas labyrinth 24, however, in case removal is required, remove it in accordance with the following procedure.

- 1** Remove the mounting bolt 241 and spring washer 242.
- 2** Attach the guide bar T-131.
- 3** Screw the bolt into the threaded hole to lift off and remove the gas labyrinth 24.
- 4** Remove the gas seal ring 251.



6 Re-assembly

Refer to Section 4 for parts inspection procedures following disassembly.

The order of re-assembly is essentially the reverse of that for disassembly, however, there are points deserving of caution. Mistakes in re-assembly, use of components other than genuine MHI parts, and use of worn parts can cause not only loss of turbocharger performance, but also accidents leading to human injury.

As parts inspection procedures are listed in Section 4, use this section as a reference in determining whether parts can be reused or not.

Before starting re-assembly work, be sure to read this section carefully and understand its content. In case any point(s) is/are unclear, suspend work and contact MHI or an authorized service company for confirmation.

6.1 Cautions for Re-assembly

 WARNING	
	Do not disassemble or assemble the turbocharger when you are under influence of drinking, short of sleep or in poor physical condition. * It may cause unexpected accidents.
	Do not go under any equipment or part which is suspended. * The equipment or part may fall off due to failure of the lifting tool, causing accidents resulting in injury or death.
	Operation of cranes and slinging must be performed by an authorized person. The owner is obliged to give their employee who handles suspending equipment (chain block) training on safety. (Observe the national rules and regulations.) Only the persons who are trained on safety and designated by the owner may handle the suspending equipment. * If the suspended loads are unbalanced during transportation or fall off due to mis-slinging, it may cause accidents resulting in injury or death or damage of the turbocharger.
	Before using materials to suspend the machine or parts (wires, slings, tools, etc.), check the weight of the object to be suspended. Use a material of sufficient strength. * If load exceeding the allowable value of the suspending material is applied, such a material may be broken and then the suspended object may fall off, causing accidents resulting in injury or death. There also is a possibility that broken wires or slings may jump out and hit a person, causing accidents resulting in injury or death.
	Load to be applied to a suspending material will change depending on the angle of suspending. Consider it when selecting the size. Do not select the size of the suspending material unless you understand the meaning of the instruction above. * If not observed, it may cause unexpected accidents.

**WARNING**

Dispose of any suspending materials a part of which is broken. Use a new one.

Before using the suspending material, check if it is normal.

- * If any abnormal material tool is used, it may break during suspending work, causing accidents resulting in injury or death.

When suspending any equipment or part, place the hook in the center of the gravity of the suspended object.

Adjust the position so that each wire is applied with the same load.

- * If not observed, the object may be unbalanced when suspended or a certain wire is applied with large load and then broken, causing accidents resulting in injury or death.

To prevent accidents in disassembling and assembling, inspect required tools and exclusive tools beforehand.

- * If neglected, unexpected accidents may occur.



Take care not to step off or not to drop any object during the work.

If the scroll of the compressor in the turbocharger is removed, the intake of the duct for discharge air of the compressor will be turned downward.

- * There is a possibility of injury.

6.2 Replacement of Consumables

Replace all tongued washers, O-rings, packing, tongued (both-end) washer, and stainless steel wires with new ones. Do NOT reuse these parts.

6.3 Tightening the Nozzle Mounting Bolt

Because nozzle mounting bolt 225 is easily subject to seizure, coat it with anti-seizure agent, and take care not to over-tighten it. (Refer to table below)

Unit: kg·m

Material	SCM435			S35C, S45C			SS400		
Torque	Standard	Max.	Min.	Standard	Max.	Min.	Standard	Max.	Min.
	32	35	29	20	22	18	17	19	15

6.4 Seizing Prevention and Application of Lubricant Agent

⚠ CAUTION



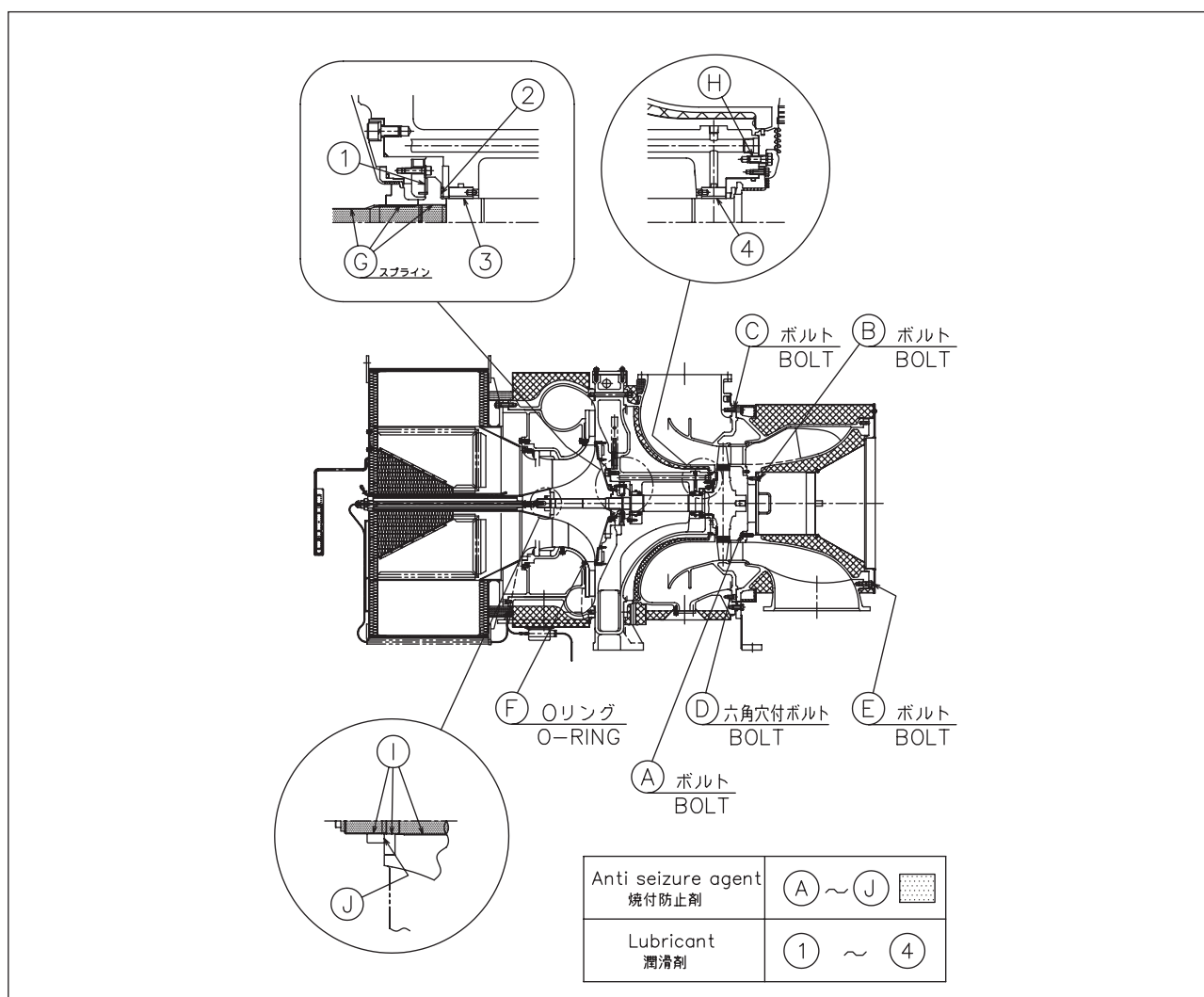
To prevent seizing, do not use any paste type agent containing solid lubricants such as copper.

- * Such agents will go into the lubricant of the turbocharger, which may result in clogging of the lubricant filter.

The following figure shows the locations to be applied with anti-seizure agent and lubricant agent. The items specified in the following table are suitable as an anti-seizure agent.

Anti-seizure agent	Coating location
MOLYKOTE 1102 GASCOCK GREASE	G, F, I, J
MOLYKOTE 1000 PASTE	A, B, C, D, E, H

Use unused lubricant agent for the turbocharger or unused regular industrial lubricant.



06-023

6.5 Bearing Re-assembly



WARNING



Prior to inserting any bearing in the turbocharger, use compressed air, etc. after cleaning to completely remove all dirt and dust from the metal surfaces and lubricant grooves.

- * If the dirt and other foreign object are not all removed, the bearing may be damaged.

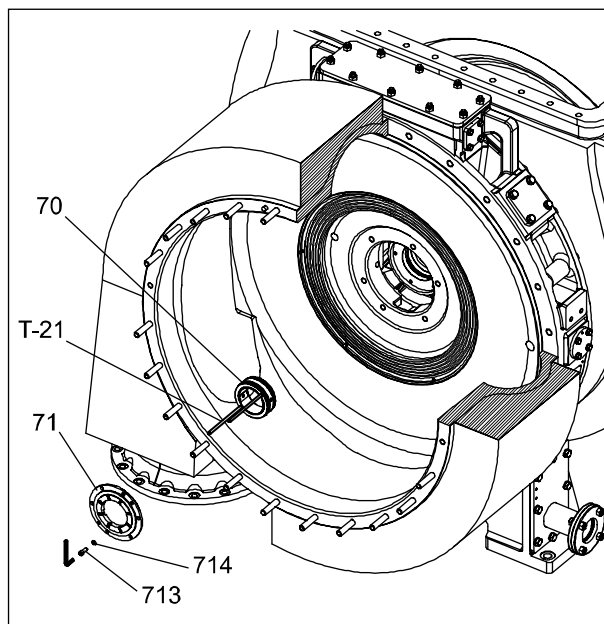
Before inserting any bearing, be sure to lightly coat them with lubricant.

- * If the bearing is not applied with lubricant, it may be damaged during re-assembly.

When inserting bearing, use clean bare hands; do not use gloves, etc.

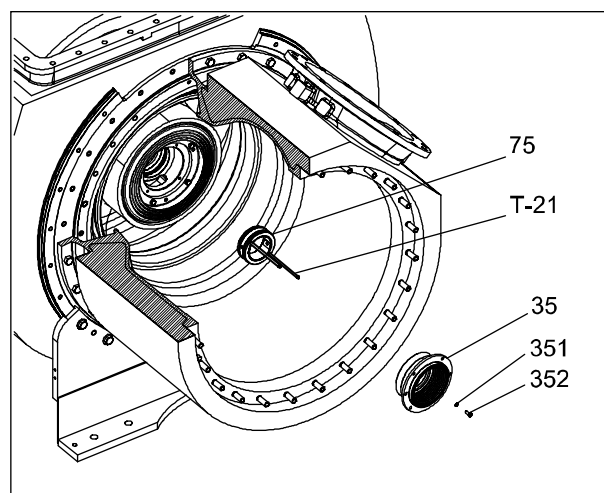
- * Dirt and dust will adhere to the bearing, which may damage the bearing.

- 1** Install the compressor side journal bearing 70 to the bearing pedestal, using the threaded bar T-21.
- 2** Install the turbine side thrust bearing 71.
- 3** Use a hex. headed spanner (M10) to install the hexagon-socket-headed bolt 713 and spring washer 714.



05-025

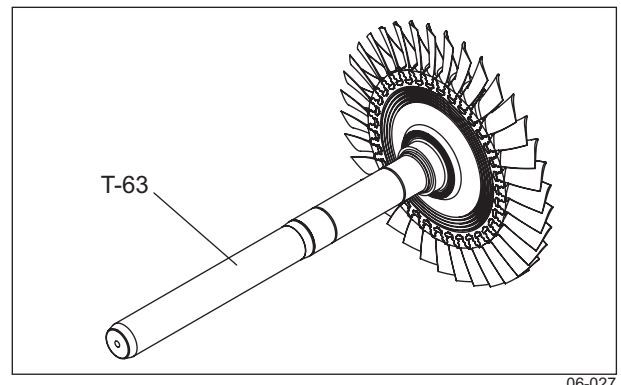
- 4** Install the turbine side journal bearing 75 to the journal pedestal, using the threaded bar T-21.
- 5** Install the turbine side oil labyrinth 35.
- 6** Install the mounting bolt 352 and the spring washer 351.



06-006

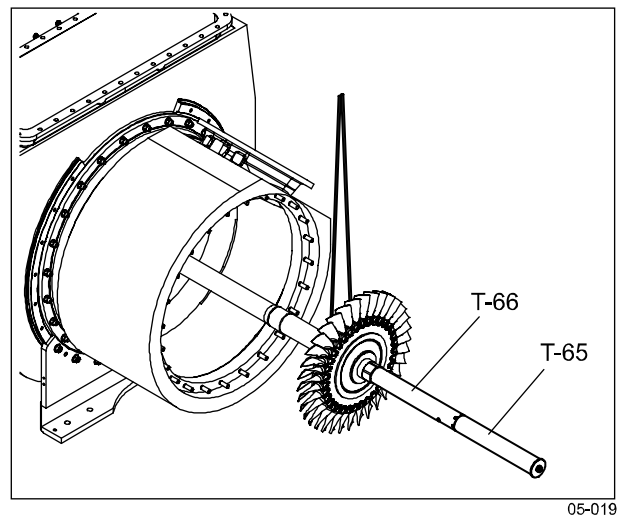
6.6 Inserting the Rotor

- 1** Install the rotor guide tube T-63 to the compressor side of the rotor shaft.



- 2** Install the pulling out tube assemblies T-65 and T-66 to the turbine side of the rotor shaft.

- 3** Completely remove all dirt and dust from the rotor guide T-63 tube and rotor shaft surface.



CAUTION



Check that the rotor guide tube T-63 is free from damages or all dirt and dust.

- * Any damage can cause damage to the journal bearing, rendering them unusable.

- 4** Sufficiently apply lubricant over the periphery surface of the rotor guide tube T-63 and the rotor shaft which penetrate the bearings.
- 5** Place wire rope around the root part of the disc side of the rotor shaft.



CAUTION



Do not place the wire rope around the journal part of the shaft.

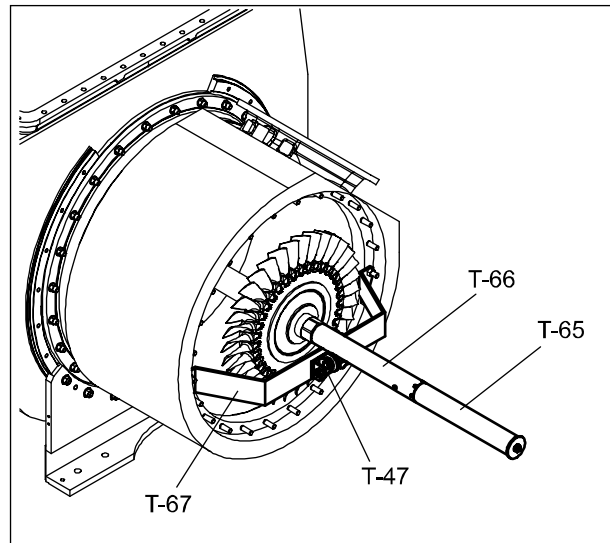
- * In case of a metal wire rope, it may damage the journal.

- 6** Suspend the wire rope using a chain block, hoist, etc.

7 Insert the rotor shaft into the pedestal.

- Take extreme care so as to avoid damage to the turbine side oil labyrinth fins when inserting the rotor.

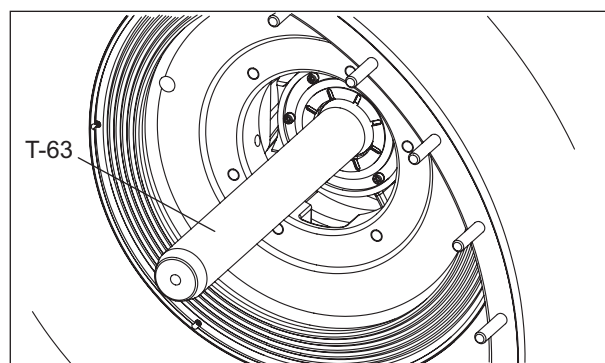
8 When insert the rotor halfway, install the stay T-67 and the roller support table T-47 in the same manner as disassembly (refer to page 5-7), and then insert the rotor completely.



05-018

6.7 Inserting the Support

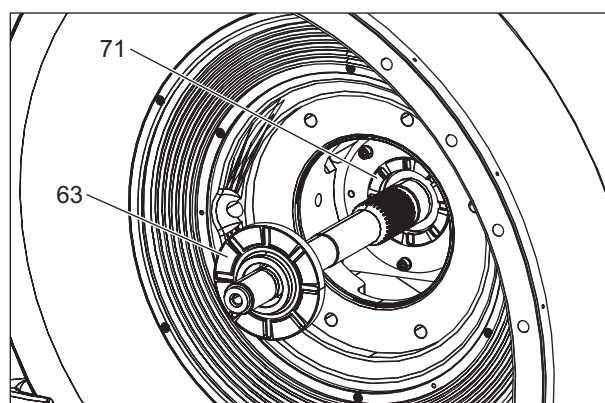
- 1** After inserting the rotor shaft into the pedestal, remove the rotor guide tube T-63.



05-053

- 2** Apply lubricant to the turbine side thrust bearing 71 and thrust collar 63.

- 3** Insert the thrust collar 63 into the rotor shaft.

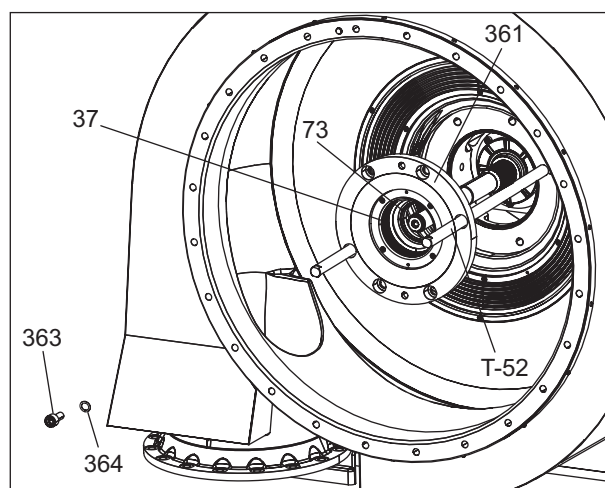


06-020

- 4** Attach the guide bar T-52.

- 5** Mount the support 361 with the compressor side thrust bearing 73 and the compressor side oil labyrinth 37 assembled into to the bearing pedestal.

- 6** Install the mounting bolt 363 and spring washer 364.

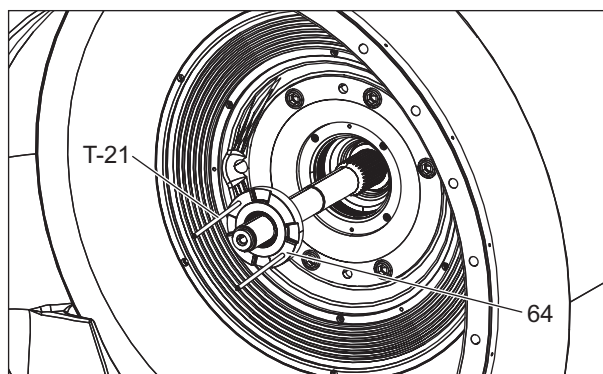


06-021

6.8 Installing the Impeller

1 Use the threaded bar T-21 to insert the sleeve 64 into the rotor shaft halfway.

2 Align the sleeve 64 with the match mark of the rotor shaft.

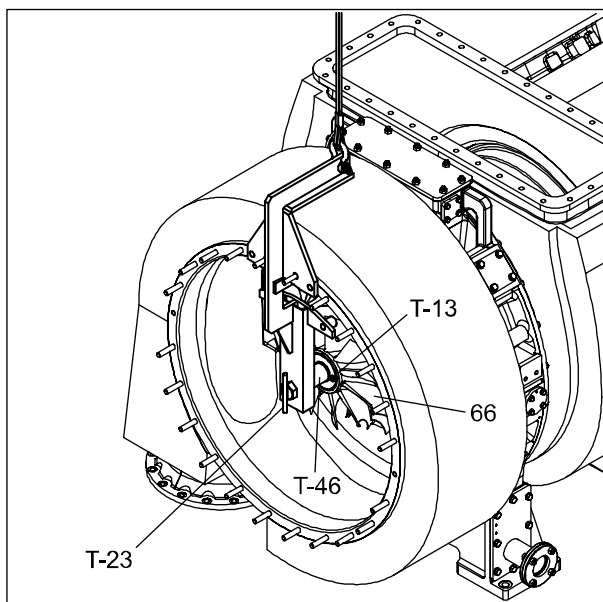


05-039

3 While supporting the weight with the chain block, install the impeller 66.

4 Remove the lifting bolt T-23.

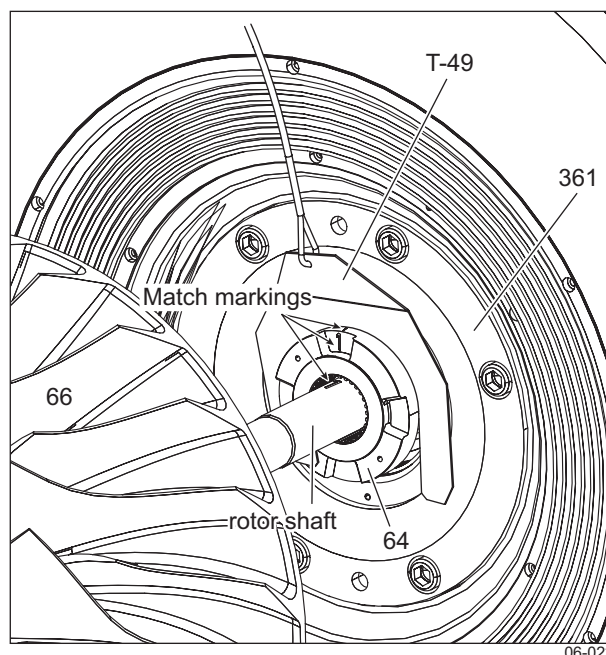
5 Remove the bolt T-13 and then draw-out tube T-46.



06-010

6 Align the claw clutch of the impeller 66 with the sleeve 64.

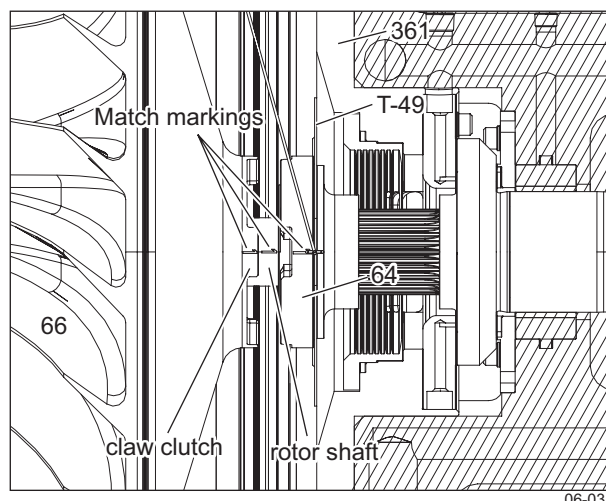
- Match marks are engraved on the rotor shaft, sleeve, and impeller. Adjust the positions of the sleeve, rotor shaft, and impeller so that these match marks are in alignment.



- In order to facilitate visual check of the engagement between the sleeve 64 and impeller 66, pull the sleeve 64 forward before placing the impeller 66 on the rotor shaft.

7 Insert the stopper T-49 between the sleeve 64 and the support 361.

- It prevents the sleeve from being pushed back when the impeller is pushed.



8 Push the impeller 66 on while observing its back surface to engage the claw clutch of the impeller and sleeve 64.

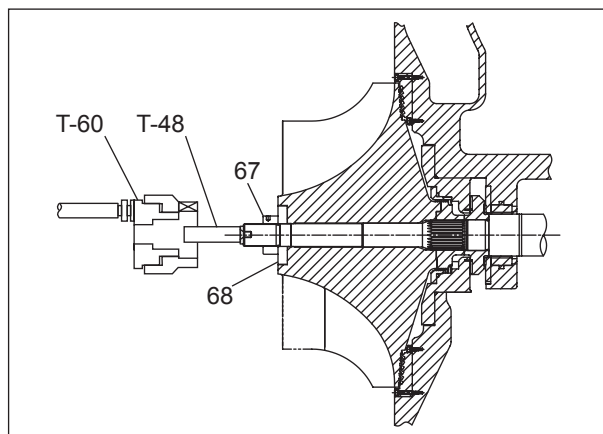
9 Pull out the stopper T-49 upon confirmation of the engagement between the claw clutch of impeller 66 and the sleeve 64.

10 Push the impeller 66 all the way and assemble it into the rotor shaft.

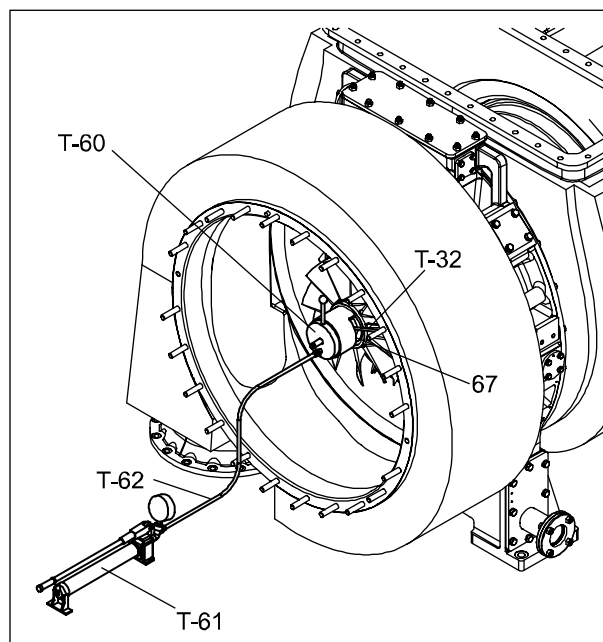
6.9 Tightening the Impeller

If the tightening force of the impeller is insufficient, the friction force of the contact face between the impeller backside and the sleeve will decrease, and shaft torque transmitted from the turbine will act drastically on the claw (claw clutch) of the impeller backside. Thereby some great stress is applied to the impeller backside, resulting in damage of the impeller. The decrease in the tightening force of the impeller will decrease the rigidity of the entire rotor, which allows the rotor to vibrate more, resulting in damages of the rotor. Thus, take care when tightening the impeller.

- 1** Install the washer 68 with hand.
- 2** Screw the locking nut 67 onto the end of the shaft by hand.
- 3** Screw the guide bar T-48 for hydraulic jack into the threaded hole in the shaft end.
- 4** Screw the hydraulic jack T-60 into the end of the shaft.
 - Here, check that the impeller is at room temperature. Tightening at a high temperature may result in insufficient tightening during operation.
- 5** After screw in completely, return the hydraulic jack T-60 by one rotation.
- 6** Connect the rubber hose T-62 of the hydraulic pump T-61 to the hydraulic jack T-60. Then, move the lever of the hydraulic pump T-61 to increase the hydraulic pressure to the specified value.
- 7** Turn the locking nut 67 from the slot of the hydraulic jack T-60 with the handle T-32 clockwise until it stops.
- 8** Open the escape valve on the hydraulic pump T-61 by turning the handle counterclockwise to lower the pressure.



06-026



05-011

NOTICE

- Hydraulic pump T-61 is sometimes in common use with main engine. In this case, please use the one for main engine.

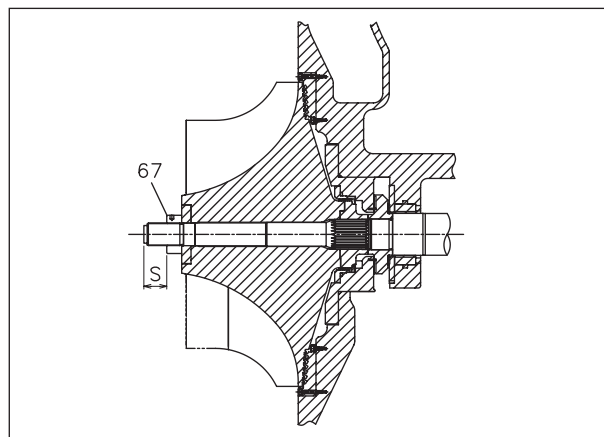
- 9** Raise the pressure again to the specified level. Check whether the nut 67 can be turned further. For the impeller tightening torque, refer to the below table.

Frame size	Sires	MB
53		50.0 [MPa] 510 [kg/cm ²]
60		61.2 [MPa] 625 [kg/cm ²]
66		51.0 [MPa] 520 [kg/cm ²]
71		57.8 [MPa] 590 [kg/cm ²]
83		62.9 [MPa] 640 [kg/cm ²]
90		68.6 [MPa] 700 [kg/cm ²]

- 10** Open the escape valve of the hydraulic pump T-61 to decrease the hydraulic pressure and pull the ram of the hydraulic jack T-60 by hand to store it.
- 11** Remove the hose T-62 of the hydraulic pump T-61, and then hydraulic jack T-60.

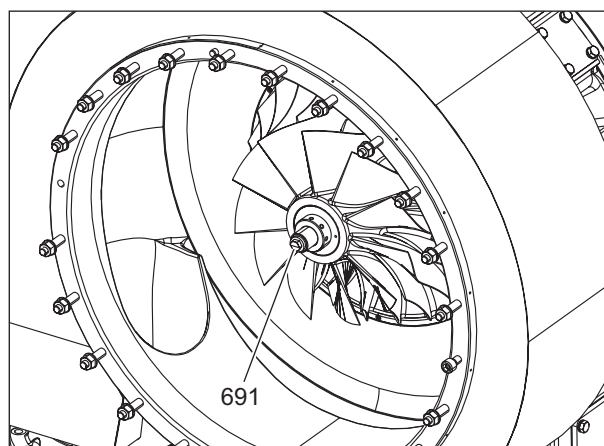
- 12** Measure the distance (S) between the edge of the locking nut 67 and the end of the shaft, using slide (vernier) calipers or a depth gauge, and compare the value with that obtained before disassembly.

- If the difference is 0.10 mm or greater, consult with MHI.



06-025

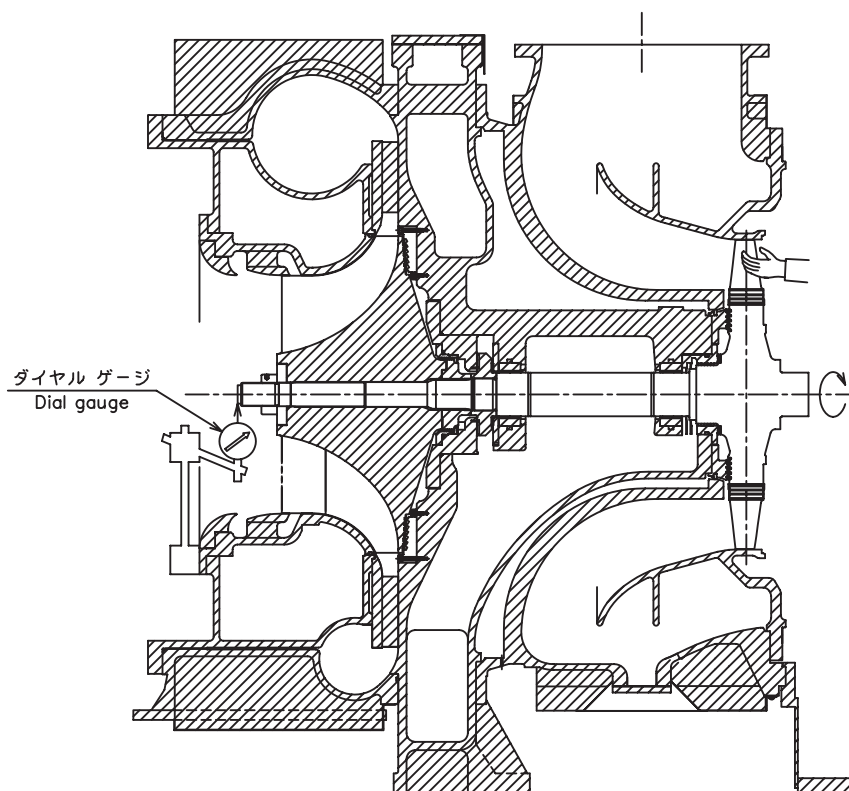
- 13** Install the bolt 691 at the end of the shaft which detects rotating speed.



05-050

6.10 Measuring the Rotor Shaft Deflection

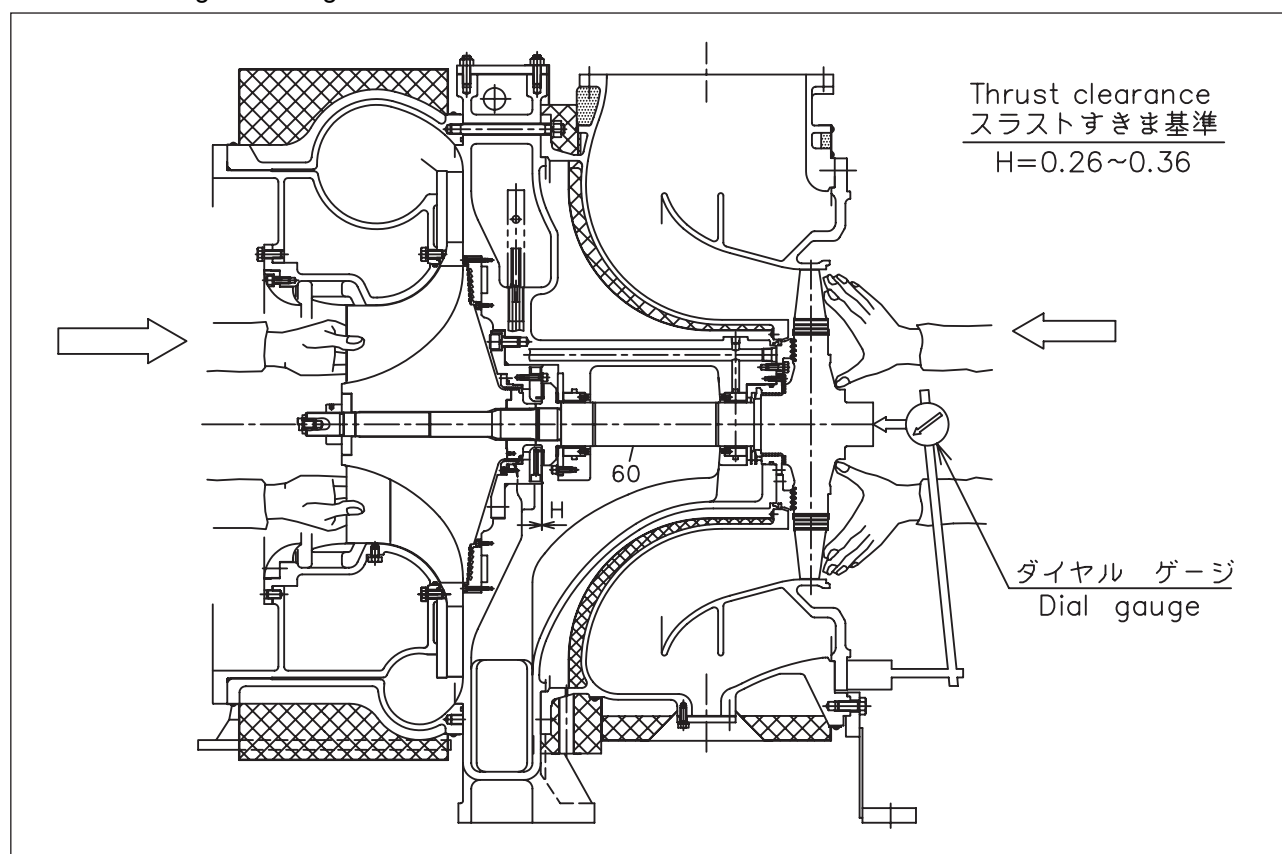
- 1** After tightening the impeller, turn the rotor shaft counterclockwise by hand.
 - Check that it rotates smoothly without any contact noise.
- 2** Measure the deflection of the end of the rotor shaft using a dial gauge.
 - Deflection of 0.10 mm or more indicates the inclusion of foreign object on the contact surfaces of the impeller, sleeve, thrust collar, and/or rotor shaft, causing inclination of the rotor shaft. Remove the impeller again, and check the above-noted contact surfaces. Re-measure the deflection of the end of the rotor shaft prior to tightening of the impeller.



06-029

6.11 Measuring the Thrust Clearance of the Rotor

- 1** After checking the shaft deflection, apply the dial gauge in the axial direction.
- 2** Measure the axial movement of the rotor when pushed by hand (the thrust clearance).
- 3** Check that the clearance is the same as before disassembly.
 - The thrust clearance should normally be in the range of 0.26 - 0.36 mm.
 - If the value is outside this range, remove the impeller, and check that there is no foreign matter on the contact surfaces of the impeller, sleeve, thrust collar, and/or rotor shaft 60. Please consult with MHI in cases where the thrust clearance value cannot be obtained in the designated range.



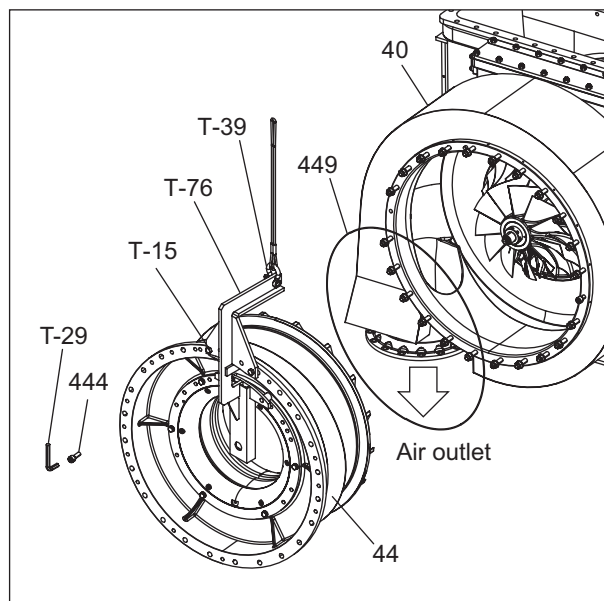
06-024

■ Measuring the respective clearances

After installing the air inlet guide, measure the impeller blade tip clearance A and the turbine blade tip clearance L. Refer to the clearance table in Section 9.1 for acceptable values.

6.12 Installing the Scroll

- 1** Install the O-ring 449.
- 2** Lift the inner scroll 44 slowly using a wire rope suspended from a chain block.
- 3** Assemble the inner scroll 44 into the outer scroll 40.
- 4** Install hexagon-socket-headed bolt 444 using hex. headed spanner T-29.
 - Take care not to allow the impeller to get contact with the scroll.
- 5** Remove the shackle T-39 from the arm of the slinging device T-76.
- 6** Remove the bolt T-15, and then the slinging device T-76.



6.13 Installing the Air Inlet Guide

- 1** Install the O-ring 472.
- 2** Lift the air inlet guide 47 using a wire rope suspended from a chain block and assemble into the scroll.



CAUTION

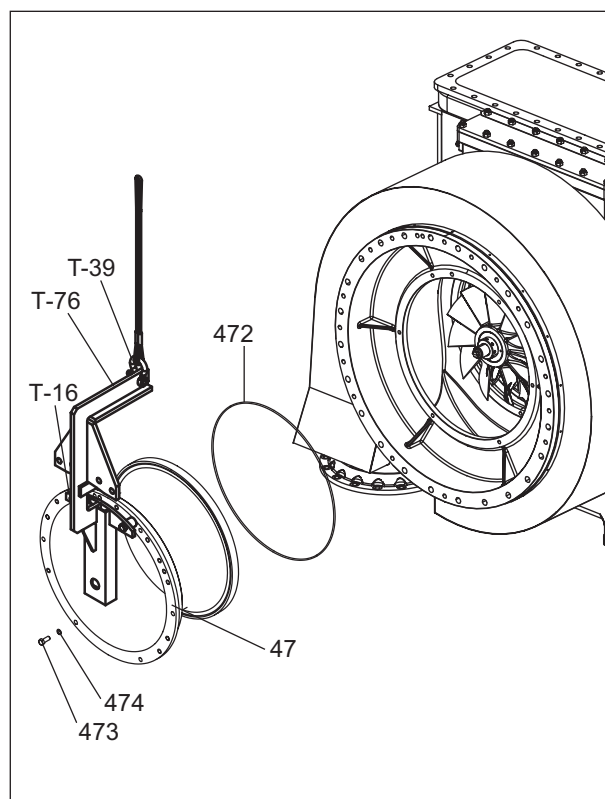


Pay attention to prevent the contacting of the impeller with the air inlet guide.

* The impeller may be damaged.

- 3** Install bolt 473 and spring washer 474.
- 4** Remove the bolt T-16, and then slinging device T-76.
- 5** Measure the clearance (A) between the air inlet guide 47 and the impeller with a feeler gauge at 4 places, upper, lower, right and left.

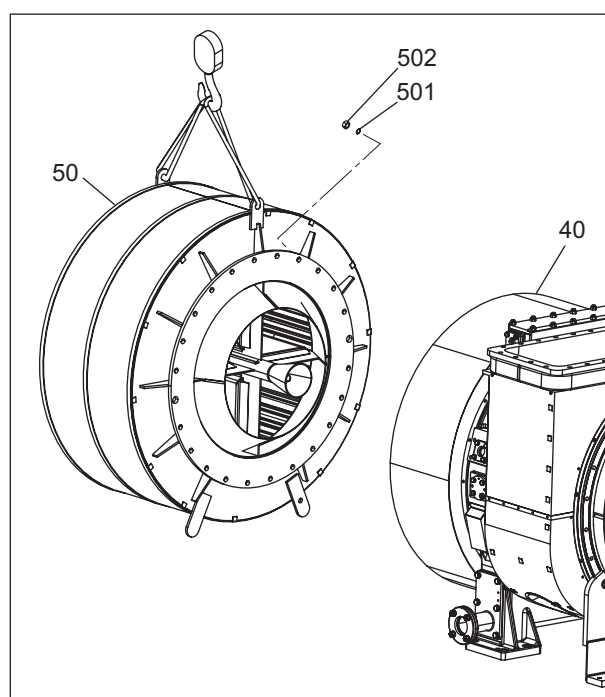
- For the standard value, refer to the clearance table in Section 9.1.



06-028

6.14 Installing the Silencer

- 1** Lift the silencer 50 with a wire rope, and assemble it to the outer scroll 40.
- 2** Install all of the washers 501 and nuts 502.
- 3** Connect the cable of the gap sensor 98 with the junction box.



05-037

6.15 Installing the Gas Inlet Inner Casing

- 1 Attach the slinging device T-85 to the flange on the gas inlet casing 26 using bolts T-15.



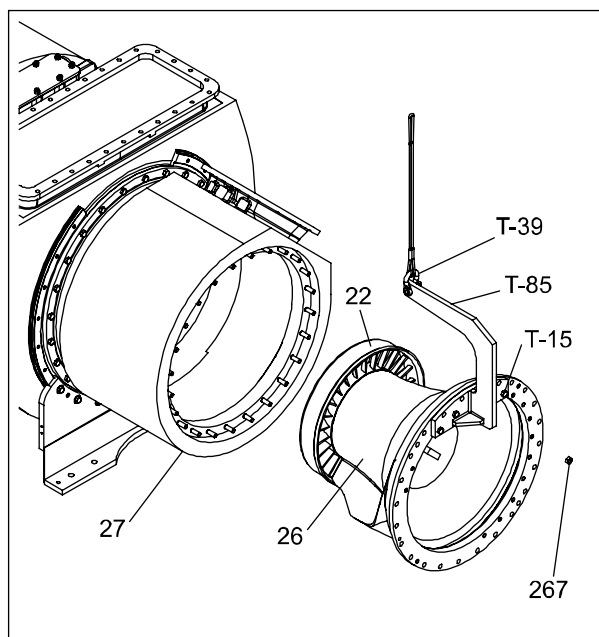
CAUTION



Do not use any bolts longer than T-15.

* The flange may break.

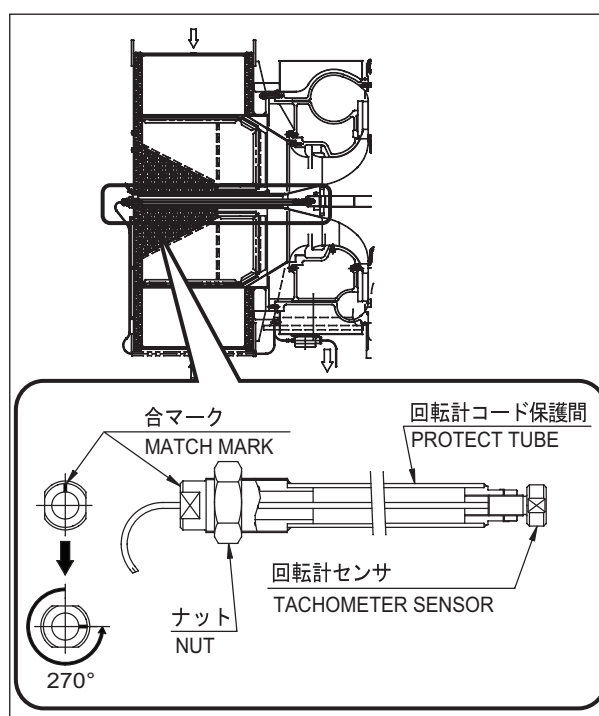
- 2 Attach the shackle T-39 to the arm of slinging device T-85.
- 3 Lift the gas inlet inner casing 26 with the chain block through wire rope and assemble to the gas inlet outer casing 27.
- 4 Install all of the nuts 267 to the flange for mounting the gas inlet inner casing 26.
- 5 Unscrew bolts T-15 and remove the slinging device T-85.



06-015

6.16 Installing the Tachometer Sensor

- 1 The tachometer sensor is installed to the end of the protect tube of the tachometer code.
- 2 Screw in the protect tube until the tachometer touches the rotor shaft.
- 3 Return it from the match mark position from the screw part by 3/4 rotations (270°), and fix with the tightening nut.



06-030

7 Turbocharger Troubleshooting

If the problem occurred during operation is not resolved by means of the action(s) recommended in the table below, or if turbocharger overhaul cannot be performed, consult with MHI.

7.1 Compressor Surging

Immediate action	Cause	Remedy	Refer to
- Reduce speed to load at which surging stops. - If necessary, open the air cooler inspection hole to stop surging (be careful of elevated exhaust temperature).	Air filter fouling	Remove and clean air filter	4.11
	Turbine side fouling	Overhaul and clean turbine side	4.4
	Turbine blade wear damage	Replace turbine blades (consult with MHI)	4.9
	Air cooler fouling	Refer to engine manual.	—
	Exhaust gas protection grill blockage	Refer to engine manual.	—
	Problem with fuel pump	Refer to engine manual.	—
	Exhaust gas boiler contamination	Refer to vessel manual.	—
	Problem with engine room ventilation	Check ventilation fan operation.	—

7.2 Oil leakage from Main Unit and/or Oil Mist Mixed with Discharged Air

Immediate action	Cause	Remedy	Refer to
- Check whether there is any abnormal vibration. - If so, reduce speed to load at which vibration is alleviated, and immediately overhaul turbocharger.	Excessive inlet lubricant pressure	Adjust oil pressure at orifice, etc.	3
	Problem with air bleeder piping	Check size of air bleeder piping. Check that there is no inclination where oil has accumulated.	—
	Loose impeller	Check whether impeller is tightened at specified pressure.	6.9
	Vacuum breaker sticking	Overhaul vacuum breaker.	4.8.2
	Oil labyrinth damage	Overhaul turbocharger, inspect parts, and clean channels.	4.4
	Bearing damage	Overhaul turbocharger, inspect parts, and clean channels. Inspect or clean L.O. filter for turbocharger.	4.5
	Sealing air channel blockage	Overhaul turbocharger, inspect parts, and clean channels.	4.8.1
	Problem with oil return tubing	Check whether interim valves are closed. Check size of oil return tubing.	—

7.3 Exhaust Gas Mixed with Discharged Air

Immediate action	Cause	Remedy	Refer to
- If amount of exhaust gas is low, continue using turbocharger until next overhaul. - If amount is high, and gas is ingested from the turbocharger silencer such that intake air temperature is higher than the engine room temperature by 10°C or more, reduce speed of engine immediately and overhaul turbocharger as soon as possible.	Gas sealing ring wear/damage	Remove rotor and replace sealing ring.	5.9
	Sealing air channel blockage	Remove rotor, check sealing air channel, and clean.	4.8.1
	Gas labyrinth damage	Remove rotor and replace gas labyrinth.	5.9

7.4 Abnormal Vibration and/or Noise from Main Unit

Immediate action	Cause	Remedy	Refer to
Reduce speed to load at which vibration is alleviated, and overhaul turbocharger as soon as possible.	Turbine blade and/or compressor impeller damage	Overhaul turbocharger	4.4
	Bearing damage	Remove rotor and inspect bearing	4.5

7.5 Abnormally High Turbocharger Speed, Speed Increases Regardless of Engine Load

Immediate action	Cause	Remedy	Refer to
- If both scavenge air pressure and exhaust gas temperature are high, or if exhaust temperature is abnormally high, reduce engine load and inspect turbocharger and engine as soon as possible. - Do not approach turbocharger.	Abnormal engine combustion	Stop engine and inspect according to engine manual.	—
	Substantial scavenge air leakage	Identify location of scavenge air leakage and perform countermeasures.	—
If scavenge air pressure and exhaust gas temperatures are normal, reduce engine load and test output signal from turbocharger tachometer.	Abnormality with tachometer	Check rpm from frequency of signal in tachometer junction box near turbocharger. Identify problem point and replace part(s).	—

7.6 High Exhaust Gas Temperature

Immediate action	Cause	Remedy	Refer to
Reduce engine load to point at which engine reaches allowable temperature, and inspect engine.	Turbocharger internal fouling	Overhaul turbocharger and clean	4.4
	Refer to section 7.5	Refer to section 7.5	—

7.7 Failure of Turbocharger to Start Up

Immediate action	Cause	Remedy	Refer to
Inspect turbocharger.	Blockage due to combustion residue on turbine blade tips	Clean turbine side.	4.9
	Blind plate for turbocharger shutdown extending into gas inlet	Remove blind plate.	—

(Blank)

8 Disposal

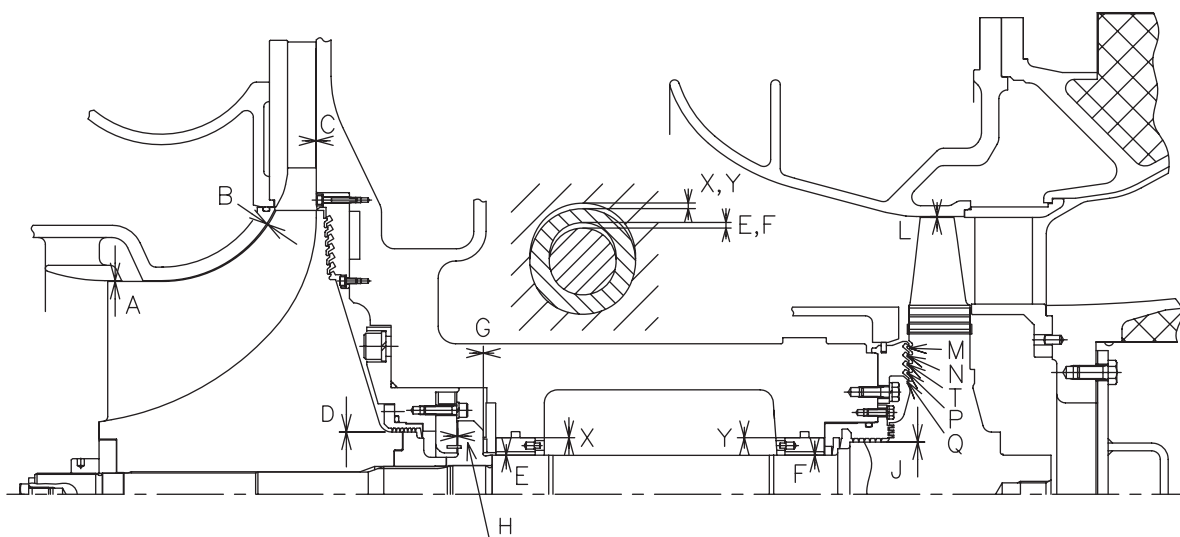
In case of disposal of the turbocharger, observe rules and regulations.

Before disposing of the turbocharger, be sure to inform MHI of the method of the disposal.

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9 Attached Diagrams and Tables

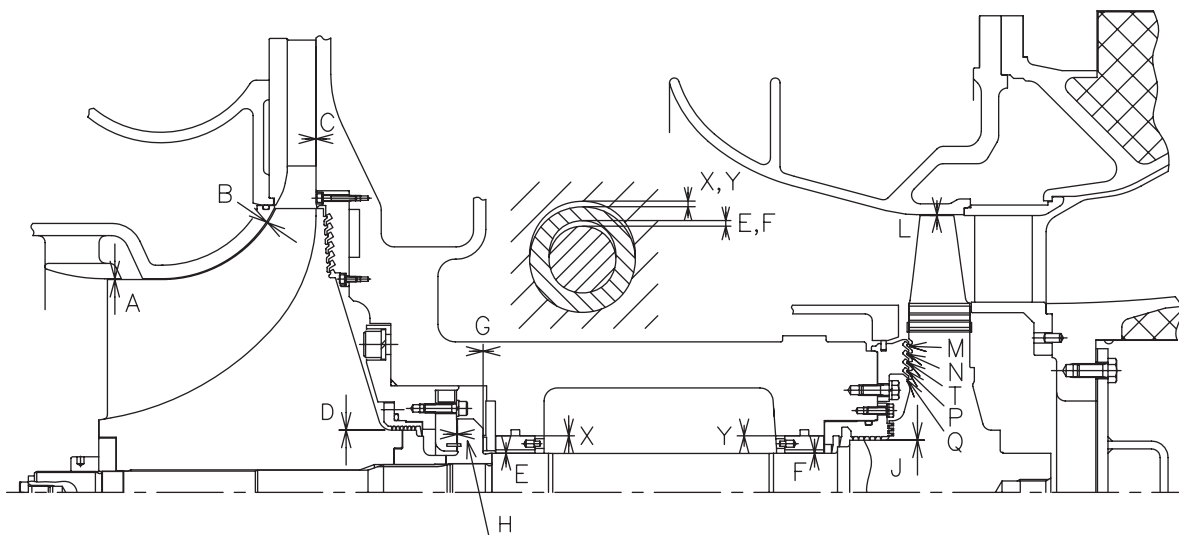
9.1 Clearance Table



POINT \ TYPE	MET53MB	
	DESIGN	LIMIT
A	0.40~1.30	1.40
B	1.40~1.60	1.70
D	0.05~0.25	0.30
E=F	0.24~0.28	0.34
G	0	—
H	0.26~0.36	—
J	0.05~0.50	0.60
L	0.50~0.80	1.00

- ・ Note: Thrust clearance H indicate the standard clearance value when renewing the thrust bearing and is not used for evaluating the bearing wear.
- ・ Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。

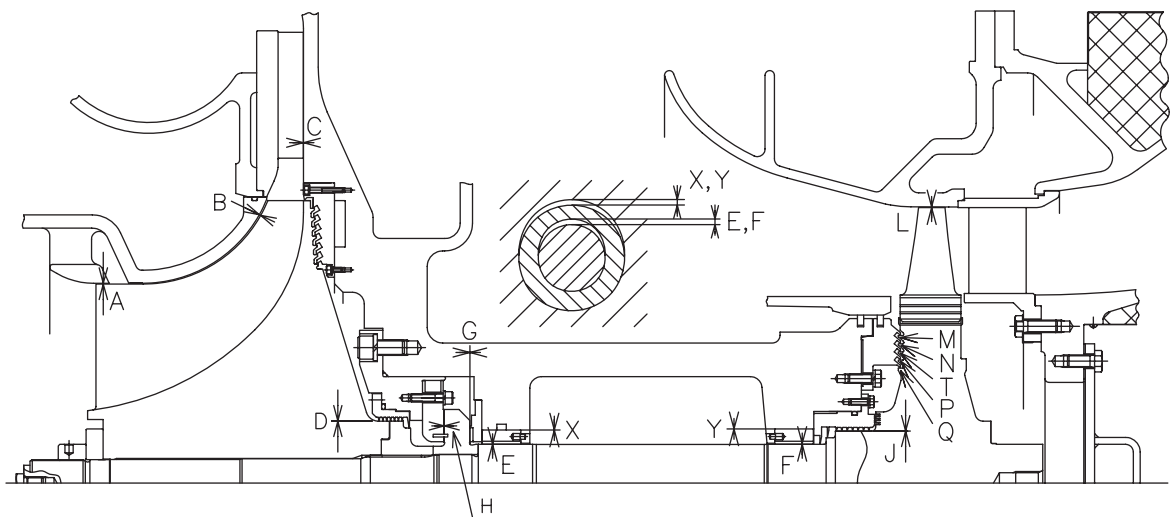
09-014



POINT \ TYPE	MET60MB	
	DESIGN	LIMIT
A	0.45~1.35	1.45
B	1.70~1.90	2.00
D	0.05~0.45	0.50
E=F	0.27~0.31	0.36
G	0	—
H	0.26~0.36	—
J	0.05~0.55	0.65
L	0.60~0.90	1.10

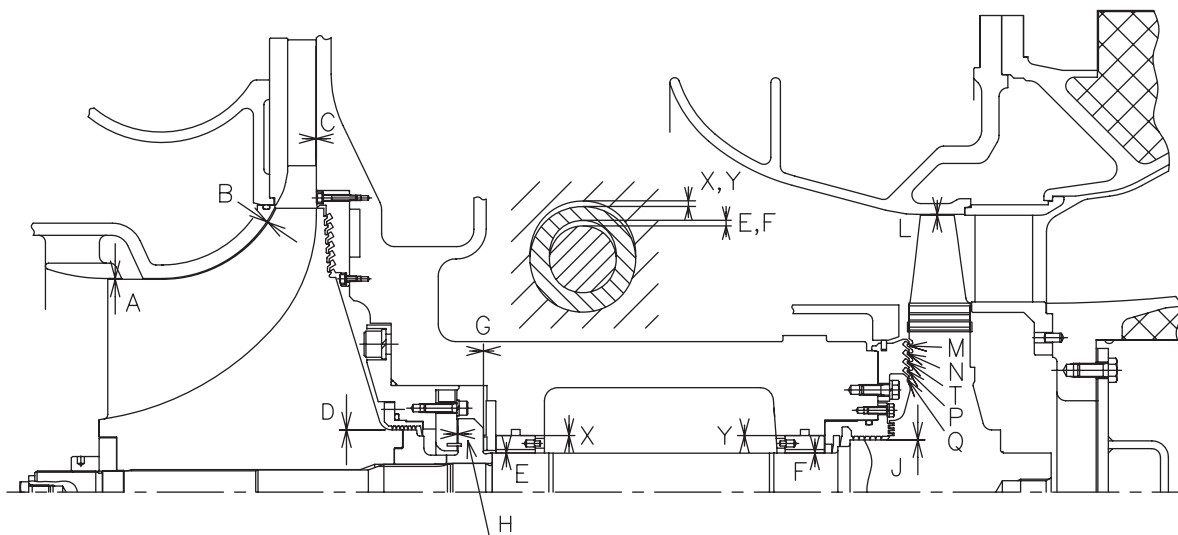
- ・ Note: Thrust clearance H indicate the standard clearance value when renewing the thrust bearing and is not used for evaluating the bearing wear.
- ・ Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。

09-015



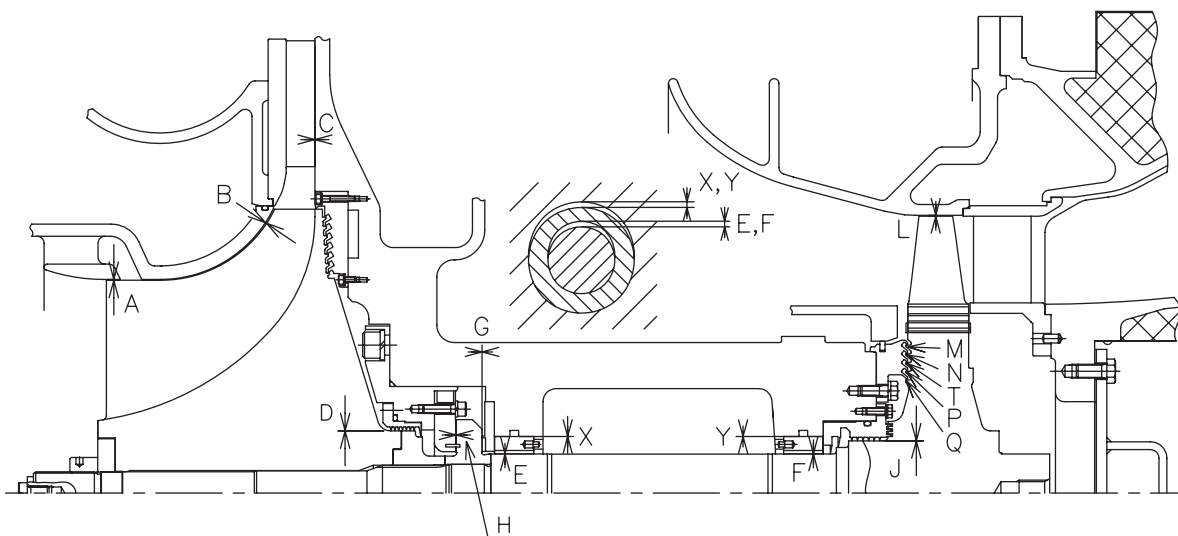
POINT \ TYPE		MET66MB	
		DESIGN	LIMIT
A		0.50~1.50	1.60
B		2.00~2.20	2.30
D		0.05~0.45	0.50
E=F		0.30~0.34	0.40
G		0	—
H		0.26~0.36	—
J		0.05~0.60	0.70
L	Top	0.60~1.00	1.20
	Starboard Port	0.70~1.10	1.30
	Bottom	0.80~1.20	1.40

- ・ Note: Thrust clearance H indicate the standard clearance value when renewing the thrust bearing and is not used for evaluating the baring wear.
- ・ Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。



POINT \ TYPE		MET71MB	
		DESIGN	LIMIT
A		0.60~1.60	1.80
B		2.40~2.60	2.80
D		0.05~0.50	0.60
E=F		0.32~0.36	0.43
G		0	—
H		0.26~0.36	—
J		0.05~0.70	0.80
L	Top	0.70~1.10	1.30
	Starboard	0.80~1.20	1.40
	Port		
	Bottom	0.90~1.30	1.50

- Note: Thrust clearance H indicate the standard clearance value when renewing the thrust bearing and is not used for evaluating the bearing wear.
- Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。



POINT \ TYPE		MET83MB	
		DESIGN	LIMIT
A		0.60~1.80	2.00
B		2.40~2.60	2.80
D		0.05~0.70	0.75
E=F		0.38~0.42	0.48
G		0	—
H		0.26~0.36	—
J		0.05~0.70	0.80
L	Top	0.80~1.20	1.40
	Starboard Port	0.95~1.35	1.55
	Bottom	1.10~1.50	1.70

- ・ Note: Thrust clearance H indicate the standard clearance value when renewing the thrust bearing and is not used for evaluating the bearing wear.
- ・ Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。

09-018

CLEALANCE RECORD

隙 間 記 録

()

MITSUBISHI HEAVY INDUSTRIES, LTD.

NAGASAKI SHIPYARD & MACHINERY WORKS

SAIWAI-MACHI PRODUCTION SHOP

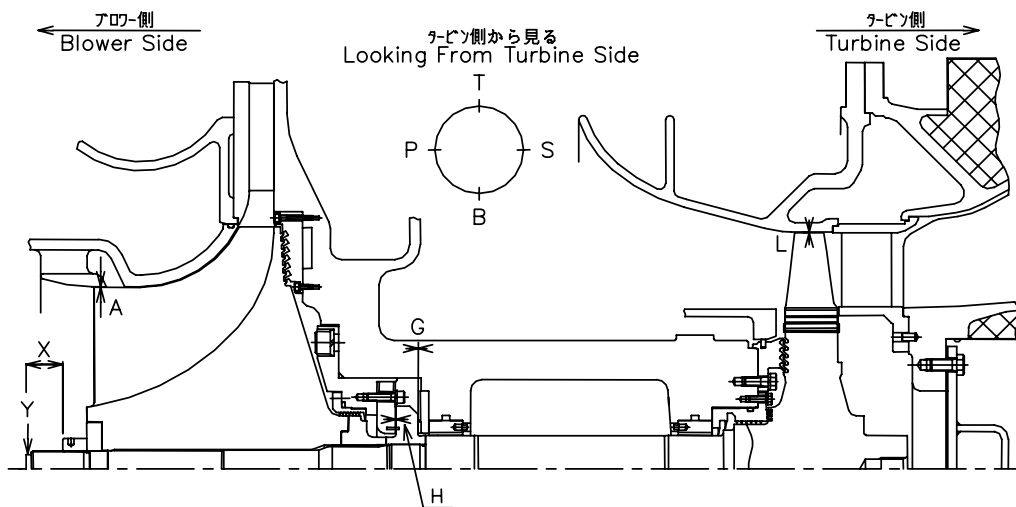
NO.1 MANUFACTURING DEPARTMENT

6-12 SAIWAI-MACHI, NAGASAKI JAPAN

Telephone: +81-95-824-3335

Teefax: +81-95-822-8092

工事番号 Order NO.		客 先 Customer		検査場所 Place	
品 名 Article		製造番号 Ser.No.		図面番号 Dwg.No.	N36-00H-0256

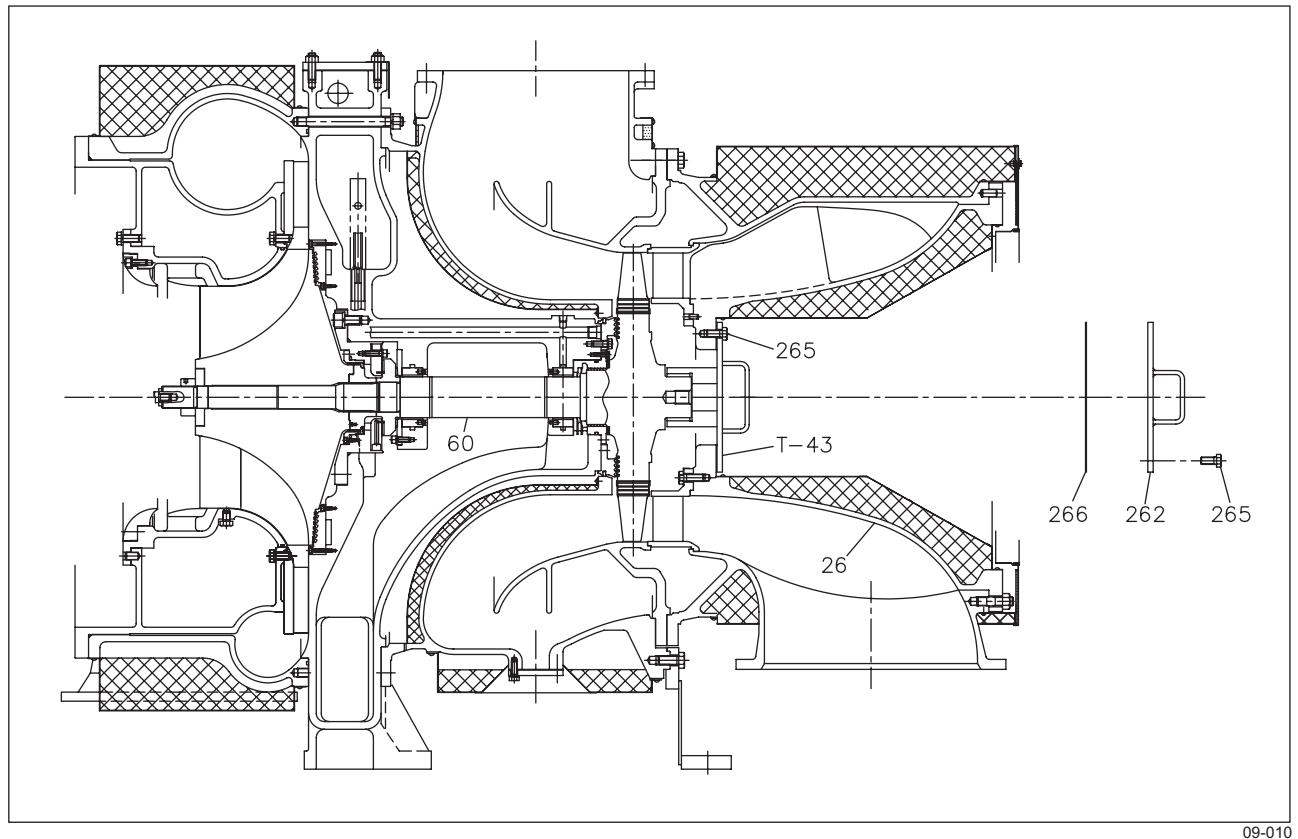


開 放 Over Haul							
Measured Point	A	G	H	L	X	Y	
計 画 値 Designed		0			—	0.10	
Limit		—	—		—	—	
T (上)		0				/100	
B (下)							
S (右)							
P (左)							

復 旧 Reassembly							
Measured Point	A	G	H	L	X	Y	
計 画 値 Designed		0			—	0.10	
Limit		—	—		—	—	
T (上)		0				/100	
B (下)							
S (右)							
P (左)							

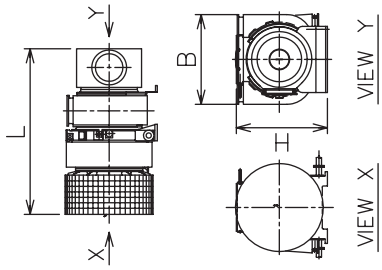
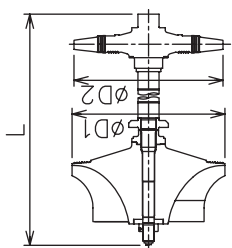
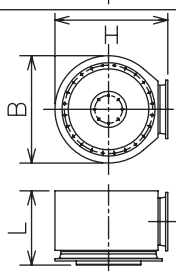
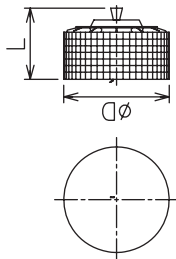
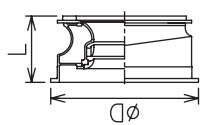
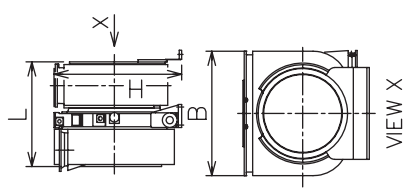
検 査 日 Inspection Date		検 査 員 Inspected By	
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9.2 Rotor Locking Procedure



09-010

9.3 Dimension and Weight Table of Main Parts

DIMENSION AND WEIGHT TABLE OF MAIN PARTS MET-MB						(mm)	
	T/C COMPLETE 過給機完備品	ROTOR COMPLETE ロータ完備品	GAS INLET CSG ガス入口ケーシング	SILENCER サイレンサ	INNER SCROLL & AIR INLET GUIDE うず内室 + 空気案内ケーシング	OTHER CSGS 残りのケーシング (うず外室+軸受台+ガス出口)	
							VIEW X
	L x B x H	L x ϕ D1 x ϕ D2	L x B x H	L x ϕ D	L x ϕ D	L x B x H	L x B x H
MET90MB	4241 x 2465 x 2410 15600kg	1794 x ϕ 1020 x ϕ 996 950kg	1110 x 1655 x 1828 2180kg	1543 x ϕ 2310 1300kg	795 x ϕ 1790 2010kg	1991 x 2465 x 2380 9160kg	
MET83MB	3776 x 2233 x 2225 12500kg	1608 x ϕ 924 x ϕ 902 750kg	1050 x 1482 x 1671 1700kg	1314 x ϕ 2130 860kg	735 x ϕ 1650 1500kg	1816 x 2233 x 2180 7690kg	
MET71MB	3143 x 1820 x 1865 8000kg	1410 x ϕ 790 x ϕ 771 480kg	849 x 1290 x 1319 1100kg	1091 x ϕ 1730 660kg	602 x ϕ 1420 950kg	1529 x 1820 x 1865 4810kg	
MET66MB	3065 x 1718 x 1780 6500kg	1327 x ϕ 730 x ϕ 712 370kg	845 x 1220 x 1284 890kg	1087 x ϕ 1730 550kg	579 x ϕ 1280 850kg	1439 x 1718 x 1720 3840kg	
MET60MB	2830 x 1530 x 1570 4500kg	1185 x ϕ 652 x ϕ 636 270kg	813 x 1106 x 1153 680kg	1013 x ϕ 1500 410kg	515 x ϕ 1150 530kg	1275 x 1530 x 1559 2610kg	
MET53MB	2499 x 1390 x 1439 4100kg	1068 x ϕ 586 x ϕ 571 210kg	671 x 940 x 1006 550kg	931 x ϕ 1380 320kg	465 x ϕ 1030 470kg	1148 x 1390 x 1439 2550kg	

09-019

9.5 Part Numbers and Names

Part No.	Part Name	Quantity	Part No.	Part Name	Quantity
10	Hxhaust gas outlet casing	1	371	Spring washer	4
114	Plug	2	372	Hexagon-socket-headed bolt	4
115	Packing	2	373	O-ring	1
13	Flange	1	38	Lube oil inlet pipe	1
131	Packing	5	381	Bush	1
132	Bolt	20	39	Escape pipe	1
134	Blank flange	5	40	Outer scroll	1
135	Spring washer	20	401	Stud bolt	22
14	Panting plate	1	402	Stud bolt	24
141	Bolt	8	403	Name plate	1
201	Nut	24	404	Number plate	1
202	Spring washer	24	405	Cross-recessed head machine screw	8
22	Nozzle	1	406	Parallel pin	1
225	Bolt	8	43	O-ring	1
226	W-Tongued washer	8	44	Inner scroll	1
23	Gas outlet guide	1	441	Plug	1
234	Hexagon-socket-headed bolt	3	443	Parallel pin	1
24	Gas Labyrinth packing	1	444	Hexagon-socket-headed bolt	2
241	Bolt	5	449	O-ring	1
242	Spring washer	5	45	Diffuser	1
251	Gas seal ring	Note 1	453	Bolt	4
26	Gas inlet inner casing	1	454	Spring washer	4
262	Blank cover	1	47	Air inlet guide	1
264	Parallel pin	Note 2	472	O-ring	1
265	Bolt	8	473	Bolt	6
266	Packing	1	474	Spring washer	6
267	Nut	24	50	Silencer	1
27	Gas inlet outer casing	1	501	Washer	22
272	Stud bolt	24	502	Nut	22
273	Parallel pin	1	503	Gum cap	1
274	Bolt	24	532	Air filter	2
275	Plug	2	54	Manometer	1
276	Plug	4	541	Vinyl tube	1
277	Packing	4	542	Oval countersunk head screw	4
30	Bearing pedestal	1	58	Band	3
305	Stud bolt	14	60	Rotor shaft	1
306	Plug	3	61	Turbine blade	35
307	Plug	2	612	Blade stopper	35
310	Plug	1	63	Thrust collar	1
35	Oil labyrinth packing(turbine-side)	1	64	Sleeve	1
351	Spring washer	4	66	Impeller wheel	1
352	Bolt	4	67	Locking nut	1
354	O-ring	1	68	Washer	1
36	Air labyrinth	1	691	Bolt	1
361	Support	1	70	Journal bearing (compressor-side)	1
362	O-ring	1	71	Thrust bearing (turbine-side)	1
363	Hexagon-socket-headed bolt	6	713	Hexagon-socket-headed bolt	6
364	Spring washer	6	714	Spring washer	6
366	Washer	12	73	Thrust bearing (compressor-side)	1
367	Hexagon-socket-headed bolt	6	733	Hexagon-socket-headed bolt	6
369	Hexagon-socket-headed bolt	6	734	Spring washer	6
37	Oil labyrinth packing (compressor-side)	1	75	Journal bearing (turbine-side)	1

Part No.	Part Name	Quantity	Part No.	Part Name	Quantity
80	Lube oil outlet flange	1	95	Cover	1
801	Packing	2	951	Cross-recessed head machine screw	4
802	Spring washer	Note 3	96	Cover	1
803	Bolt	Note 3	961	Cross-recessed head machine screw	4
804	Flange	1	98	Gap sensor	1
805	Packing	1	995	Band	2
806	Bolt	4	996	Rubber cap	2
807	Nut	4	997	Cross-recessed head machine screw	4
808	Spring washer	4	998	Spring washer	4
81	Flange	1			
83	Flange	1			
831	Packing	1			
832	U-nut	14			
833-1	Packing	3			
834-1	Flange	1			
835-1	Bolt	4			
836-1	Spring washer	8			
837	Lube oil inlet flange	1			
838	Spring pin	1			
839	Blank flange	1			
84	Flange	1			
841	Packing	2			
842	Bolt	8			
843	Spring washer	8			
844	Cover	1			
85	Blank flange	1			
853	Bolt	4			
871	Packing	1			
872	Bolt	4			
873	Spring washer	4			
874	Vacuum breaker	1			
885	Spring pin	1			
89	Flange or (Blank flange)	1			
891	Packing	2			
892	Bolt	8			
893	Spring washer	8			
894	Blank flange	1			

Note 1

Size	Quantity
53	2
60	1
66	2
71	1
83	1

Note 2

Size	Quantity
53	0
60	1
66	0
71	0
83	0

Note 3

Size	Quantity
53	12
60	12
66	16
71	16
83	20

9.6 Tool Numbers and Names

Please refer to the attached “Tool List”.

10 Where to Contact

MHI-authorized turbocharger service companies are located throughout the world. In these organizations, there are engineers who have skills and knowledge required for the maintenance of the turbocharger described in this manual. If disassembly and re-assembly should pose any difficulties, these service companies can also be called upon.

10.1 MHI Contact Information

Parts Estimations and Orders

Turbocharger Designing Section

Marine Machinery Department

Marine Machinery & Engine Division

Power Systems

Mitsubishi Heavy Industries, Ltd.

1-1 Akunoura-machi, Nagasaki 850-8610 Japan

Marine Machinery Business Section

TEL +81-95-828-6070, 7094, FAX +81-95-828-6174

MHI Marine Engineering Co., Ltd.

6F, Tamachi Center Bldg.

5-34-7 Shiba, Minato-ku Tokyo 108-0014 Japan

TEL +81-3-3798-5941 FAX +81-3-3798-5943

Technical Support

Turbocharger Designing Section

Marine Machinery Department

Marine Machinery & Engine Division

Power Systems

Mitsubishi Heavy Industries, Ltd.

6-12 Saiwai-machi, Nagasaki 850-0046 Japan

Turbocharger Designing Section

TEL +81-95-821-2145, 2179, FAX +81-95-821-2279

E-MAIL: ATRS999@mhi.co.jp

Turbo Marine Consult ApS

Strandgards Alle 68, DK-3600, Frederikssund, Denmark

TEL/FAX +45-4738-6501

E-MAIL: mail@turbomarine.dk

NOTICE

- When contacting the above, clearly state the serial No. of the turbocharger.

10.2 MET Turbocharger Authorized Service Organizations

Europe

Turbo Engineering B.V.

Nieuwe Waterweg Straat 17, 3115 HE Schiedam Portno 534
Rotterdam, **The Netherlands**
Tel.: +31-10-426-7383, Telefax: +31-10-473-3050
e-mail: info@turbo.nl
Website: <http://www.turbo.nl>

Fuji Trading B.V.

Sluisjesdijk 109, 3087 AE Rotterdam, **The Netherlands**
Tel.: +31-10-429-8833, Telefax: +31-10-429-5227
e-mail: info@fujitrading.nl
Website: <http://www.fujitrading.nl/>

Turbo-Technik Reparatur-Werft GmbH & Co. KG

Hannoversche StraBe 11, 26384 Wilhelmshaven, **Germany**
Tel.: +49-4421-3078-0, Telefax: +49-4421-305086
e-mail: info@turbotechnik.com
Website: <http://www.turbotechnik.com>

Scan-Turbo Handels-und Service GmbH

Kleiner Westring 15, 27572 Bremerhaven, **Germany**
Tel.: +49-471-971-21-21, Telefax: +49-471-971-21-23
e-mail: info@Scan-Turbo.com
Website: <http://www.scan-turbo.com/>

Turbotechniki Ltd.

2 Ilias & Tripoleos Str. 188-63 Perama, Piraeus, **Greece**
Tel.: +30-210-4002585, Telefax: +30-210-4009290
e-mail: turbotec@hol.gr
e-mail: info@turbotechniki.gr
Website: <http://www.turbotechniki.gr>

PJ Diesel Engineering A/S

Skudehavnsvej 14 DK-2100 Copenhagen Ø, **Denmark**
Tel.: +45-39-29-15-53, Telefax: +45-39-27-10-54
e-mail: Service@pjdiesel.dk
Website: <http://www.pjdiesel.dk>

Turbo Cadiz S.L.

Pol igono Industrial Pelagatos Calle del Progreso, 17A-20A,
Chiclana de la Frontera(Cadiz) 11.130, **Spain**
Tel.: +34-956-407-949, Telefax: +34-956-407-951
e-mail: tc@turbocadiz.com
Website: <http://www.turbocadiz.com>

GTS Turbo Diesel Service Ltd.

Aydinli Organize Deri Yan Sanayi 20 nolu yol blok 24-19, 34953
Tuzla, Istanbul, **Turkey**
Tel.: +90-216-591-07-23, Telefax: +90-216-591-07-27
e-mail: turbintr@superonline.com
Website: <http://www.gtsturbo.com>

Turbo Service International Ltd.

190 Commercial Road, Totton, Southampton, SO40 3AA, **U.K.**
Tel.: +44-2380-861000, Telefax: +44-2380-863000
e-mail: service@tsi.eu.com
Website: <http://www.tsi.eu.com>

La Meccanica Turbo Diesel S.r.l.

Calata Gadda 16128 Genoa, **Italy**
Tel.: +39-010-246-1111, Telefax: +39-010-246-1144
e-mail: mtd@mtd.it
Website: <http://www.mtd.it>

Africa

Majestic Engineering C.C.

186 Evans Road, Glenwood Durban 4001, **South Africa**
Tel.: +27-31-205-1041, Telefax: +27-31-205-0417
e-mail: turbocharger@telkomsa.net

North America

Turbo USA, Inc.

3005 S.W 2nd Ave Suite #105 Ft. Landerdale, FL 33315, **U.S.A.**
Tel.: +1-954-767-8631, Telefax: +1-954-767-8632
e-mail: info@turbo-usa.com
Website: <http://www.turbo-usa.com>

United World Enterprise

(1) 6310 Winfree Dr.Houston, Texas 77087, **U.S.A.**
(2) 2913 S. 47th St. Tampa Florida 33619, **U.S.A.**
Tel.: +1-713-641-1915, Telefax: +1-713-641-2717
e-mail: TOEIENG@aol.com
Website: <http://www.unitedworldenterprise.com>

Goltens New York Corp.

160 Van Brunt Street, Brooklyn, New York 11231, **U.S.A.**
Tel.: +1-718-855-7200, Telefax: +1-718-802-1147
e-mail: newyork@goltens.com
Website: <http://www.goltens.com>

Dynamic Engineering Inc.

1270 Frances Street, Vancouver, BC, V6A 1Z5, **Canada**
Tel.: +1-604-253-4427, Telefax: +1-604-253-3553
e-mail: turbo@dynamicengineering.com
Website: <http://www.dynamicengineering.com>

Marine Tech Industries Ltd.

12628, 82nd Ave., Surrey BC, V3W 3G1, **Canada**
Tel.: +1-604-507-0880, Telefax: +1-604-507-0881
e-mail: brian@marine-tech.com
e-mail: Andrew@marine-tech.com
Website: <http://www.marine-tech.com>

South America

Turbogen s.r.l.

Lugones 1851/55, RA-1430 Buenos Aires, **Argentina**
Tel.: +54-11-4521-5667/1914, Telefax: +54-11-4521-8283
e-mail: turbogenruffa@arnet.com.ar
Website: <http://www.turbogen.com>

Metalock do Brasil Ltda. (Santos)

Rua Visconde do Rio Branco 20/26, 11013-030, Santos, SP,
Brazil
Tel.: +55-13-3226-4686, Telefax: +55-13-3226-4680
e-mail: santos@metalock.com.br
Website: <http://www.metalock.com.br>

Turbodal S.A.

Baron de Juras Reales nr 5050, Conchali, Santiago, **Chile**
Tel.: +56-2-6417070, Telefax: +56-2-8994065
e-mail: autoturbos@turbodal.cl
Website:
http://www.turbodal.com/empresa/empresa_quines_somos.htm

Middle East

Nico International

P.O. Box 12068, Dubai, **U.A.E.**
Tel.: +971-4-338-2135, Telefax: +971-4-338-1832
e-mail: nicouae@nicouae.com
Website: <http://www.topazworld.com/nicoen.html>

Albwardy Marine Engineering (L.L.C.)

AL JADAF P.O. Box 6515, Dubai, **U.A.E.**
Tel.: +971-4-3241001, Telefax: +971-4-324-1005
e-mail: abmarine@emirates.net.ae
Website: www.albwardymarine.com

Asia

有限会社 秀工社 SHUKOSHA CO.,LTD

長崎県諫早市貝津町 2162-5
2162-5 Kaizu-machi, Isahaya-city, Nagasaki-pref.854-0063,
Japan
Tel:+81-957-26-3082, Telefax +81-957-26-1199
Website: <http://Website.kaizu.or.jp/emain01.html>

神戸マリーン工業株式会社 Kobe marine engineering Co. Ltd.

神戸市兵庫区鍛冶屋町 1 丁目 3 番 21 号
1-3-21,Kajiya-cyou, hyougo-ku, Kobe-city. 652-0832,**Japan**
Tel: +81-78-681-7421, Telefax: +81-78-681-7424
e-mail: k-marine@aioros.ocn.ne.jp
Website: <http://Website12.ocn.ne.jp/~k-marine/>

Jonghap Maritime Engineering Inc.

188-38, Dongsam-Dong, Yongdo-ku Pusan, **South Korea**
Tel.: +82-51-403-2381, Telefax: +82-51-403-2409
e-mail: jmepusan@jonghap-jme.co.kr
Website: <http://Website.jonghap-jme.co.kr/>

Kemklen Technical Services Ltd.

1701-02, 17F, East Town Building 41Lockhart Road, Wanchai,
Hong Kong
Tel.: +852-2861-2812, Telefax: +852-2861-1168
e-mail: lfrancis@turbokts.com
e-mail: service@turbokts.com
Website: <http://www.turbokts.com>

K & C Global Ltd.

Unit 02, 8/F., Block A, Vigor Industrial Building, Tsing Yi, **Hong Kong**
Tel.: +852-2435-7880, Telefax: +852-2432-1001
e-mail: kcservices_co@yahoo.com

Tru-Marine Pte Ltd

35 Tuas Basin Link Singapore 638769, **Singapore**
Tel.: +65-6861-8398, Telefax: +65-6861-8396
e-mail: turbo@trumarine.com.sg
Website: <http://www.trumarine.com.sg/>

Toei Engineering Singapore Pte. Ltd.

No.46 Tuas South Street 5, Singapore 637834, **Singapore**
Tel.: +65-6898-4273, Telefax: +65-6261-7371
e-mail: toeisin@singnet.com.sg
Website: <http://www.toei-eng.co.jp>

Polestar Marine Engineering Pte. Ltd.

3 Tuas Avenue 13, Singapore 638975, **Singapore**
Tel.: +65-6863-0822, Telefax: +65-6863-0688
e-mail: polestar@polestarmarine.sg
Website: <http://polestarmarine.sg>

Daikai Engineering Pte. Ltd.

128 Pioneer Road, Singapore 639586, **Singapore**
Tel.: +65-6863-2856, Telefax: +65-6863-2876
e-mail: sales@daikai.com

Turbo Exchange Service Pte Ltd

No. 49 Gul Drive Singapore 629495, **Singapore**
Tel.: +65-6897-8297, Telefax: +65-6897-8298
e-mail: sales@turboexchange.com.sg
Website: <http://www.turboexchange.com.sg>

AC Marine Pte. Ltd.

2, Bukit Batok St. 24 Sky Tech Building #02-14 Singapore 659480,
Singapore
Tel.: +65-6560-0801, Telefax: +65-6560-0835
e-mail: cheng@acmarine.com.sg

Shang Mao Engineering Ltd.

5F-1 No.363 Chung Hwa 2nd Rd, Kaohsiung, **Taiwan**
Tel.: +886-7-321-9755, Telefax: +886-7-321-9756
e-mail: shang.mao363@msa.hinet.net

IHI Turbo Int'l Trade, Inc.

15534 Valarao St., Airport Vill, Moonwalk, Paranaque City,
Philippine
Tel.: +63-2-822-4440, Telefax: +63-2-822-4440
e-mail: ihiturbophil@hotmail.com

Ras Tek Pvt. Ltd.

R-53, Rabale, M.I.D.C, Ghansoli ,Navi Mumbai-400701, **India**
Tel.: +91-22-2764 2021, Telefax: +91-22-2764 2024
e-mail: rasturboned@ras-tek.com
Website: <http://www.ras-tek.com>

Dalwin Marine Turbo Engg. Pvt. Ltd.

R-307, T.T.C. Ind.Area, Rabale, M.I.D.C, Navi, Mumbai, **India**
Tel.: +91-22-3298-5778, Telefax: +91-22-2760-2931
e-mail: powertec@dalwin.com
Website: <http://www.dalwin.com>

Tru-Marine Machinery Engineering Shanghai Co. Ltd

No. 318 Cheng Ying Road, Shanghai, 200444, **China**
Tel.: +86-21-6520-4220, Telefax: +86-21-6520-6639
e-mail: shanghai@trumarine.com.cn
e-mail: trupepsi@81890.net
Website: <http://www.trumarine.com>

Tru-Marine Machinery Engineering Guangzhou Co. Ltd.

No.20 Xin Gang Road, Guangzhou Economic Technology
Development District P.C 510730, **China**
Tel.: +86-20-822-27678, Telefax: +86-20-822-27578
e-mail: turbine@public.guangzhou.gd.cn
Website: <http://www.trumarine.com>

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**GEA (WUHU) KHI MACHINERY
COOLING CO., LTD**

基伊埃(芜湖)川崎机械制冷
设备有限公司

GEA CHARGE AIR COOLER

增 压 空 气 冷 却 器

DESCRIPTION OPERATING AND MAINTENANCE MANUAL

使 用 维 护 说 明 书

CONTENTS

1、概 要.....	/ 1
2、固定式空冷器.....	/ 1-2
概述	
空冷器的安装和拆卸	
3、可拆式空冷器.....	/ 2-3
概述	
空冷器的安装和拆卸	
4、试运行.....	/ 3-4
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1、概要

GEA 增压空冷器是一种管片式热交换器。其工作原理是:高温增压空气流散经散热片,将热量通过对流作用传递给冷却管外壁,然后经过壁的导热作用传给管内壁,再由管内水的对流作用把热量带走,以完成换热。

空冷器传热元件有椭圆管方片、圆管圆片及圆管方片等几种结构形式。管与片的连接方式通常有:钎焊式、整体轧制式和机械胀接式。

冷却管由胀管器将其两端紧紧地胀接到管板上。

侧板作为空冷器的一部分,与管板用螺栓连接紧固。

端盖(即进出水端盖和回流水端盖),作为循环水室,按设计的水流程数设置隔水筋。端盖上装有旋塞用于空冷器的放气和排水。端盖与管板间装有密封垫并用螺栓将其紧固。

端盖、管板和冷却管的材质是根据冷却水质和设计水流速来选择的。

增压空冷器安装在涡轮增压器和柴油机进气总管之间的风道中。其安装形式有两种:

1、空冷器可直接装在风道中(固定式空冷器),这时把空冷器的侧板和管板直接用螺栓安装到风道上,形成风道的一部分。

2、空冷器先装进箱体,然后把箱体用螺栓安装到风道上(可拆式空冷器)。用此法安装,在拆卸维修空冷器时可以不拆卸风道。

2. 固定式空冷器

2.1 概述

固定式空冷器“Block Cooler”直接安装在发动机的风道中,正如第1部分所述,空冷器的侧板和管板用螺栓直接固定在风道中相应的位置上。

“固定式空冷器”有两种结构形式,即单回路和双回路。回路数即指流过空冷器冷却水的循环水回路数。

双回路空冷器有两个互不相通的循环水回路,各水路有其不同的目的。例如,高温水回路用于发动机缸套冷却,低温水回路用于油的预热。

2.2 空冷器的安装和拆卸

在安装空冷器前,应先拆卸下进、出气侧和水管连接法兰上的罩盖物;并用松香水洗去用于保护气侧和水侧密封面的保护物。

空冷器既可以直接安装在发动机上,也可以悬置安装在风道中。空冷器气侧连接孔与风道连接孔用螺栓联接坚固,同时加装发动机供应商提供的密封材料。

空冷器进出水法兰与冷却水管用螺栓联接坚固,同时加装发动机供应商提供的密封材料。

为避免空冷器在安装过程中变形和产生应力,所有的连接面都应该平行,公差越小越好。所有连接点都要做到气密和水密。

拆卸固定式空冷器时要按下列程序进行:

1. 排干冷却水
2. 用适当的升降装置支撑住空冷器
3. 拆开进水管
4. 拆开气侧连接风罩,卸下空冷器。

安装时要使用如前所述新垫片。

拧紧力矩 (Nm)

适用于标准公制螺纹、强度等级为8.8级的镀锌螺栓。螺纹、螺栓和螺帽的接触面上抹油

规格	不用密封或 K L I N G E R S I L 密封垫	不用密封 或K L I N G E R S I L密封垫 用N O R D - 防松垫圈
M 8	21	25
M 10	42	51
M 12	73	87
M 14	115	138
M 16	180	216
M 18	256	307
M 20	360	432

3. 可拆式空冷器

3.1 概 述

“可拆式管组空冷器 (Removable Stack Cooler)”即可拆卸的管组连同其外壳一起安装到发动机的风道中。正如第1部分所述,用螺栓将空冷器的箱体固定在风道中,再把管组慢慢滑进箱体。用螺栓将管组上大管板(固定管板)固定在箱体上并加装垫片以气密。活动管板是通过一个O型橡胶圈和一个长方形密封法兰而形成密封,也可以使用平端盖。

要注意,所有的螺栓连接点都必须是气密的。

可拆式管组空冷器可设计为:单回路、多回路和多级空冷器。

回路数是指通过空冷器中水的回路数。双回路空冷器有两个互不相通的循环水回路,各水路有不同的目的。例如,高温水回路用于发动机缸套冷却,低温水回路用于油的预热。

多回路空冷器可设计为整体管板式。如有必要的话也可以在活动端配置非整体的管板,以适用于微差膨胀。

多级空冷器由多组管组组成,这些管组都安装进同一个箱体内部。

多级空冷器的级数是指串联在一个水回路的管组数,故级数不一定与回路数相同。

3.2 空冷器的安装和拆卸

在安装空冷器前,应先拆下进、出气侧和水管连接法兰上的罩盖物;并用松香水洗去用于保护气侧和水侧密封面的保护物。

空冷器既可以直接安装在发动机上,也可以悬置安装在风道中。空冷器气侧连接孔与风道连接孔用螺栓联接坚固,同时加装发动机供应商提供的密封材料。

空冷器进出水法兰与冷却水管用螺栓联接坚固,同时加装发动机供货商提供的密封材料。

为避免空冷器在安装过程中变形和产生应力,所有连接面都应该平行,公差越小越好。所有连接点都要做到气密和水密。

运输吊耳是用来提吊和搬运空冷器的,在管组侧板上也焊有起吊耳。

将空冷器箱体安装进风道之前,可先将管组拆下来。拆卸方法是:拧下把固定管板与箱体联接的螺栓,并拆下密封填料或活动管板上的盖板。在管组的固定端的端盖上钻有螺纹孔,该螺纹孔用于起吊和拆卸时安装吊耳或拆卸螺栓的。

箱体安装好后,用螺栓把管组的固定管板紧固到箱体上(加装新垫片),再安装密封填料或罩盖。

安装完毕后若要拆卸管组,可先将固定管板上的螺栓拧下,将活动端的密封填料或盖板,以及冷却水管卸下来(如有发动机系统的部件妨碍撤下管组,这些部件都应拆除)。最后用适当的起吊装置将管组

从箱体里抽出来。

为了使管组比较容易地从箱体内抽出,我们固定管板上钻有拆卸螺纹孔(孔径与箱体框架上的螺栓孔相同),该螺纹孔用于起吊和拆卸时安装吊耳或拆卸螺栓。

重新安装时应使用如前所述新密封垫。

4. 试运行

4.1 概述

GEA 空冷器在出厂前都进了水压试验,并检验合格。然而,我们还是建议用户在安装前按标定的测试压力对空冷器进行压力测试。

如果库存期或停用期超出了规定范围,端盖的密封垫可能会有渗漏现象。这时可通过拧紧螺栓来防止渗漏。倘若拧紧螺栓不能解决问题,就应考虑更换新密封垫。更换新密封垫后,要在规定的测试压力下再进行压力测试。

安装完毕后向空冷器内充水以排气,排气时将端盖上的放气塞卸下排气,排气完毕后再将其安装回原处。

空冷器投入使用后,要立即排气数次。把整个冷却系统的空气排出比只排出空冷器的空气效果要好些,因此最好是排出整个冷却系统的空气。

多回路或多级空冷器,每个回路和每级都要单独排气。

整个设备检测无渗漏,并保证冷却水畅流无阻后,空冷器便可投入使用。

在发动机加速到正常负载时,测量空冷器进气和出气温度,并根据性能数据表中的流量要求,调定冷却

水达到正常流量。

4.2 冷却水流速

空冷器运行时,参照下表维持冷却水流速。

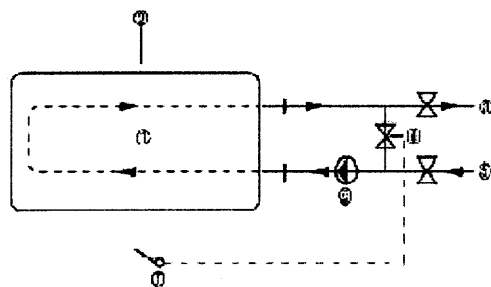
管 材	最小流速	最大流速
CuZn28Sn(SOM S71)	1.0m / s	2.0m / s
CuZn20Al(SOM S76)	1.0m / s	2.2m / s
CuNi30Fe(CuNi70/30)	1.5m / s	3.0m / s
CuNi10Fe(CuNi90/10)	1.5m / s	3.0m / s
Cu/SB or SF	1.0m / s	2.0m / s
Steel	2.0m / s	2.5m / s

空冷器决不能在最小水流速下长期工作,应按性能数据表中标定流量维持空冷器供水。

频繁改变水的流速不利于在空冷器内壁形成保护膜,而保护膜对于防腐是至关重要的。如果水流速太小,容易产生沉积物;如果水流速太大,又容易产生侵蚀。管路的节流或进水口的位置不当,都容易产生易造成腐蚀的富氧水。为了在部分负载的情况下也保持均衡的水流量、流速,就必须安装控制装置。

4.3 冷却水流速的控制

现已证明,下图所示的旁通控制装置能满足控制水流速、流量的要求。旁通装置可以这样设置:即,空冷器的出水端与冷却水泵进水端旁通,由阀门及控制装置来调节空冷器进水的冷热度和流量,以保证增压空气出口温度的恒定。这样就能在各种负荷下使冷却水流量、流速和空冷器出气温度保持在推荐的范围内变动。



旁管控制装置平面图

- ①增压空冷器
- ②增压空气进口
- ③冷却水出口
- ④流量控制阀
- ⑤冷却水进口
- ⑥泵
- ⑦感温器

5. 保护膜

确保形成结实、耐久保护膜的方法。

铜及铜合金所固有的耐腐蚀性能就在于：它们能够形成难以溶解的自然保护膜。

千万不要把污水用于未形成良好保护膜的新空冷器中，因为冷却管内表面的沉积附着物，不利于形成上述保护膜。

鉴于上述原因，空冷器进行水压测试时要用洁净的淡水。在试运行期间同样要避免使用污水。

我们建议在试运行期间往水中加入少量易溶的硫酸亚铁 ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$)，以便确保在可能使用污染水前，管子表面形成良好的保护膜。

在冷却水中加 5mg/l 硫酸亚铁，并保持每天有1小时的运行就足以形成良好的保护膜。如有可能，在正常运行期间也要反复加入硫酸亚铁，直到第一次进行维修检查。

在靠近空冷器进水口处的管路上安装适当的阀门，以用于添加硫酸亚铁。

6. 停 用

如果空冷器停用时，整个冷却水系统内的水未排放干净，那么对空冷器由铜、铜合金钢及铸铁等材料

料的部件来说是有危害的。

在保护膜形成之前，或是在诸如铵化合物和硫化氢等腐蚀性物质有可能沉积侵蚀的情况下，停用对于铜和铜合金来说是特别危险的。

如不能排干空冷器的水，那么在试运行后的头两个月内就尽量不要停止空冷器的运行。

如果由于冷却水供应出了问题导致停用，但停用不超过三天；且以后空冷器便能长期持续运行，那么停用时可以不排干空冷器的水。

一定要确保管内没有发生沉积现象。如果沉积已经发生，那么就要把空冷器的水排放干净后清洗管子，再用净水冲洗，然后吹干。我们建议用暖风或预干燥过的空气吹干管道，空冷器应保持良好通风。

假如冷却水是海水、咸水或盐水(氯化物含量 $\geq 500\text{mg/l}$)，那么冲洗就应使用含盐量低的水(饮用水质的水)。

两个月的试运行期内停用空冷器，且停用时间超过三天，为防止发生沉积现象，应排干空冷器的水，然后冲洗并吹干。

两个月的试运行期后停用空冷器，为避免停用造成的腐蚀，每次停用如期限超过两个星期都要按上述的清洗程序进行清洗。

空冷器试运行后的正常运行期间如果要停用空冷器，一定要限制停用期不排水超过三天的停用次数，并按我们建议在试运行期的条件操作。

如停用期很短，空冷器可用低水速度来运行，假如在此条件下能有效防止管内形成沉积的话，用低水速运行要比冷却水滞留在空冷器中好，因为象铵化合物和硫化氢等腐蚀成份能被冲走，不积留在管中。

冬季，霜冻会损坏空冷器，所以哪怕是最短暂的停用也要排干空冷器内的水。

7. 运行控制

7.1 概述

至于运行控制,需要在风道中及空冷器进出水管上安装温度计。我们建议在机器运行记录本上定期记下空气和水的温度。如有特殊要求,可以使用更复杂的控制装置。

如果在空冷器出气侧出现大量冷凝液,通过使用如前所述的冷却水旁管控制装置,来避免产生冷凝水或限制冷凝水的析出量。

必须保证冷凝水能及时排放掉。

7.2 性能试验

GEA 承诺的性能保证主要是指在正常运行时,冷水和冷空气之间的温差,必须要经常检测。

如在空冷器正常运行时观察到温度比保证温差高,这可能是空冷器中积存空气的原因,可用前文中所述的方法(给空冷器排气)来解决这个问题。

如按上述方法进行处理仍未能改进性能,且又没有发现其它故障的话,这台空冷器就需要清洗了。

可用压差表来检测空冷器的气侧或水侧是否需要清洗。因此我们建议在风道中和空冷器的进出水管上安装压差表。

8. 清洗

8.1 概述

水侧和气侧热交换面的清洗,对于保障空冷器长期无故障运行是非常必要的。清洗周期要根据空冷器运行方式,冷却水质及吸入空气的物性来决定。

清洗方式有:机械清洗、水力清洗和化学清洗。

8.2 水侧的清洗

水侧清洗需定期进行,其周期由冷却水质来确定。

水侧清洗不仅是为了保持空冷器的热交换性能,也消除冷却管内因结垢造成的腐蚀、或因障碍物造成侵蚀的危险。

8.2.1 机械清洗

机械清洗是通过装在刷杆上的尼龙刷来进行的。刷杆的长短由冷却水管长度而定。要选择与散热管型号相应的刷子。每台空冷器在发货时都配有带柄的清洗刷。

机械清洗可以在不挪动空冷器的情况下进行,也可以把空冷器拆卸下来进行。在清洗时,至少要卸下一个端盖。为了卸下端盖,我们在端盖上钻有与端盖法兰螺栓直径相等的螺纹孔,用以拆卸端盖之用。管子需要逐根刷洗,冲去污物直到没有一点残留物。清洗完毕后,更换新密封垫并重新装上端盖,再注入冷却水排气。

8.2.2 水力清洗

水力清洗时要将空冷器卸下进行。用装有特别喷嘴的高压喷枪来清除冷却管内的沉积物。

8.2.3 化学清洗

化学清洗可以在不挪动空冷器的情况下进行,也可以把空冷器拆卸下来进行。

8.2.3.1 不挪动空冷器进行化学清洗

为了确保空冷器运行时管内没有结垢和污物,我们建议安装一个与空冷器配套的连续运行的化学

清洗系统。

该清洗系统包括一个循环泵、一个洗涤槽、截流阀及相应的管路。清洗的水回路联接于冷却器的进水管路上,该回路位于截流阀与端盖进出水法兰之间。

清洗之前要截断冷却水流,通过空冷器的出水管将水排干。拧下排气螺塞排水。水排尽后,关闭冷却水阀。打开清洗水管的阀门,启动循环泵。排气完毕后要拧紧排气螺塞。

我们建议清洗水回路的水流方向与工作水回路流向相反。

清洗完毕后,将空冷器里的水排干,空冷器内不能留存清洗剂。关闭清洗水管的阀门,并打开冷却水阀门,用常规的冷却水冲洗。

最后空冷器需重新排气。

化学清洗也可以除去冷却水管道中的水垢沉积物。清除水垢沉积物需要用10%的盐酸加0.5%的抗氧化剂,这样清洗对有些管材特别适用。

清洗完毕后,要彻底冲洗空冷器,做到空冷器中没有一点清洁剂残留物。如果清洗以后空冷器要停用一段时间,这一点就更为重要。

如果对安装好的空冷器进行化学清洗,就不需要卸下端盖。我们建议用适当的工业洗涤剂进行化学清洗。

使用化学品清洗时,一定要按照清洗剂生产厂家提供的说明及用法指南进行。

8.2.3.2 拆下空冷器进行化学清洗

如果空冷器管路上没有安装化学清洗系统;或如果机械清洗和水压清洗都不成功的话,那么就要拆卸下空冷器进行化学清洗。

把端盖拆下后,将空冷器芯组放入洗池内浸泡清洗,浸泡的时间根据积垢程度而定。如果一次清洗

效果不理想,那么就应反复清洗。

清洗程序及清洗剂见8.2.3.1条中的说明。

8.3 气侧的清洁

8.3.1 概述

气侧的清洗应尽早进行,以避免散热片上聚集油烟(这些油烟在一段时间以后就会结一层很难清除的硬壳),以及其它腐蚀性的沉积物。如果这些腐蚀性的沉积物残留在管、片上一段时间以后,其中的一些物质就会与冷凝液化合,形成硫化物造成腐蚀。

8.3.2 水力清洗

空冷器被拆卸下后,用水力清洗是很有效的。在8.2.2节中讲到的高压喷射枪也可用于这一目的。我们建议用3mm喷嘴的喷枪,在距散热片2米处,用80~120bar的高压水垂直冲洗冷却水管(喷射水流与散热片平行)。

8.3.3 化学清洗

我们建议在空冷器拆卸下来后对空冷器气侧进行化学清洗。

清洗的程序是:拆下端盖后将空冷器管组浸入化学清洗槽中浸泡清洗(浸泡的时间根据积垢的程度而定),清洗完毕后用高压水枪冲洗空冷器。如效果不理想,那么就应反复清洗。

为了提高清洗槽的清洗效果并缩短清洗时间,我们建议洗槽内的水应循环流动。也可用喷枪喷射清洗液来清洗。我们建议使用适当的工业洗涤剂对气侧进行清洗。

使用化学品清洗时,一定要按照该清洗剂生产厂家提供的说明及用法指南进行。

9. 管 漏

9.1 概 述

腐蚀、侵蚀及错误的操作均可以导致管漏。

如果发现空冷器渗漏,先必须查出渗漏的管子。如果目测发现不了,可以对空冷器进行压力测试、也可以对每根管子分别进行压力测试,以找出发生渗漏的管子。

9.2 单根管的压力测试

压力测试前要卸下空冷器前后端盖(如果空冷器周围有足够的空间就没有必要卸下空冷器),用橡胶塞将接受测试的管子两端都塞住,其中必须有一个塞子上有空气或水的接头,然后通压力空气或水进行测试。

可以安装压力表来显示压损。施压后即使冷却水管上有很小的渗漏也会很快从表上显示出来。

如果不用压力表来检测空冷器,那么拆卸下空冷器,以便从散热片侧对渗漏进行目测。

9.3 空冷器的压力测试

如果我们不拆端盖对空冷器进行水压测试,那么就得用手电筒在散热片侧寻找显示渗漏的湿点。为了避免邻近冷却水管上的湿点影响判断,应该在检测前通过吹风使气侧干燥。

9.4 在水下进行空气压力测试

如果没有安装压力表,那么空冷器压力测试应在水下进行。我们将空冷器浸没在一个水槽中,在不拆卸端盖的情况下对水侧施加0.5bar的空气压力来测试管子,如果有渗漏就会有气泡冒出来。

但应注意,积聚在散热片上的空气也会产生气泡,这些气泡并不表明管子渗漏。

9.5 堵管

一旦我们找到了出故障的管子,就应该把管子两端用坚硬的木头,橡胶塞或铜螺塞堵起来(交货时同时提供塞子),不能用钢螺塞,因为钢螺塞会损伤管板孔。所有型号的管子无一例外地都可以堵塞。

如果有几根管子同时渗漏,我们必需当场评估堵管后的空冷器性能是否能满足要求。

9.6 个别管子的更换

(更换部分管子)

如果空冷器是单管片式,即椭圆管方片、或是圆管挤片,这时就可以更换渗漏的管子。如果是在管组中发现了渗漏管,这时要把周边邻近的管子也卸下来更换,以便能够接触到渗漏管。需要更换的管子卸下后,必须清洗管板上的孔。

用来更换的管子一端有一段光管(未装散热片)。更换时,先将管子的光管端插进一块管板的管孔内,然后回拉,再插进另一块管板相应的孔内,最后用胀管器把管子胀到管板上。

9.7 插入另一根芯管

如果是穿片、整体胀接式空冷器,要想更换一根管子是难以办到的。这时如发生渗漏现象,我们可以用直径小于渗漏管,管径全适的管子插入渗漏管中,然后内胀使替换管和渗漏管紧紧胀接在一起保证传热,再外胀把替换管胀接到管板上防止渗漏。

9.8 空冷器修理后的压力测试

空冷器修理完毕后,我们必须按规定的测试压力对空冷器进行压力测试。规定的测试压力标明在空冷器的侧板或箱体的标牌上。

修理管漏所需的芯管,工具以及其它材料都可以直接向德国 GEA 公司购买,或向基伊埃(芜湖)川崎机械制冷设备有限公司购买,也可以在我们世界各地的维修中心购买。

1. General

The GEA charge air cooler is a finned tube heat exchanger.

The hot air flows through the fins on the outside of the tubes and the cooling fluid flows through the tubes. The heat exchanger surface of the cooler consists of elliptical core tubes with rectangular threaded-on fins or round core tubes with either wound-on fins or continuous flat plate fins. The bond between fin and tube is achieved either by mechanical means or by soldering.

The core tubes are rolled into the tube sheets at each end of the tubes with roller.

Side wall form an integral part of the cooler and are bolted to tube sheets.

Water Headers (Namely connection and Return headers) are provided for water handling. The number of separation baffles conforms to the number of water passes. The headers are bolted to the tube sheets, gaskets interposed to form a seal. Plugs in the header are provided for cooler venting and draining.

The materials for headers, tube, sheets and core tubes are chosen in accordance with the specification of the cooling water to be used and the recommended water velocity in the tubes.

The charge air cooler is mounted in the air duct between the turbo charger and the diesel engine air inlet manifold. Mounting can be done as an integral part of the air duct (block cooler), the cooler side walls and tube sheets being bolted directly to the air duct. As an alternative the cooler can be mounted into casing which in turn is bolted to the air duct (Removable stack cooler), this method enables the cooler to be removed for repairing without dismantling air ducts.

2. Block cooler

2.1 General

The term, "Block cooler" refers to the design: mounted directly into the air duct of the engine. As already explained under part 1, the block cooler is bolted into the air duct at its side walls and tube sheets respectively.

There are two types of block coolers, namely single and double circuit coolers.

The number of circuits corresponds to the number of water flows passing the cooler.

The twin circuit cooler has two separate water flows which are independent from each other.

These two flows can be used for different purposes, i.e. for engine cooling, air or oil preheating etc.

2.2 Installation and removal of the cooler

Prior to installation the cooler, the transport covers at the air opening and the blanks on the water connection flanges are to be removed. The air and water side sealing surfaces, which are protected prior to shipping, must be cleaned with turpentine.

The cooler can either be mounted to the engine as a self supporting unit on a bracket, or alternatively it can be mounted in the air duct as a cantilever unit. The air side connections are bolted to the air ducts using gaskets or sealing compound provided by the engine builder.

The cooling water pipes are bolted to connection flanges on the connection header using gaskets also provided by the engine supplier.

To avoid deformation and stresses during installation all connecting surfaces must be parallel and the tolerances should be kept as small as possible.

All connections are to be air and water tight.

When removing the block cooler the following procedure should be used.

1. drain off cooling water.
2. Support cooler with suitable lifting gear.
3. Disconnect cooling water pipe.
4. Disconnect cooler from air side trunk and remove.

Installation is done by use of new gaskets as described above.

TIGHTENING TORQUE(Nm)
FOR GALVANIZED SCREWS WITH CLASS OF STRENGTH 8.8
WITH NORMAL METRIC THREADS.
THREADS AND CONNECTING SURFACES FROM SCREWS
AND NUTS ARE OILED

SIZE	WITHOUT GASKET OR KLINGERSIL- GASKET	WITHOUT GASKET OR KLINGERSIL-GASKET WITH NORD-LOCK-WASHER
M 8	21	25
M 10	42	51
M 12	73	87
M 14	115	138
M 16	180	216
M 18	256	307
M 20	360	432

3. Removable stack cooler

3.1 General

The term "Removable stack cooler" refers to a design where a cooler casing is fitted with a removable tube stack into the air duct of engine. As already explained under part 1, the cooler casing is bolted into the air duct. The tube stack is slid into the casing. The protruding tube sheet (fixed end) of the tube stack is bolted to the casing using a gasket to form an air seal. The extension end of tube sheet is seated by means of an rubber o-ring and a sealing frame which form a gland packing. Alternatively a cover plate header is used. All bolt connections are to be air tight.

Removable stack coolers are designed as single-circuit, multi-circuit and multi-stage coolers.

A multi-circuit cooler is designed with common tube sheets and if necessary can have a split tube sheet on the extension side to accommodate differential expansion. A multi-stage cooler consists of separate tube stacks which are mounted into a common casing.

The number of circuits refers to the water flows through the cooler. The twin-circuit cooler has two water flows which are independent from each other, these two flows can be used for different purposes, i.e. for engine cooling, air or oil preheating etc.

Since the tube stacks can be connected in series on the water side, the number of stages in a multi-stage cooler refers to the number of tube stacks fitted into the common casing, and need not to be identical with the number of water flows through the cooler.

3.2 Installation and removal of the cooler

Prior to installation of the cooler, the transport covers of the air side and the blanks on the water connection flanges are to be removed. The air and water side sealing surfaces, which are protected prior to shipping, must be cleaned by the use of turpentine.

The cooler can either be mounted to the engine as a self supporting unit on a bracket, or alternatively it can be mounted in the air duct as a cantilever unit. The air side connections are bolted to the air ducts using gaskets or sealing compound provided by the engine builder.

The cooling water pipes are bolted to connection flanges on the connection header using gaskets also provided by the engine builder.

To avoid deformation and stresses when installing the cooler all connecting surfaces must be parallel and the tolerances should be kept as small as possible.

All connections are to be air and water tight. Transport lugs are provided on the side walls for lifting and handling of the complete cooler. Lifting lugs are also welded to the tube stack side walls. Prior to installation of the cooler casing into the air duct the tube stack can be removed by means of unscrewing the bolts holding the protruding tube sheet to the casing frame and removal of the gland packing or cover plate at the extension end tube sheet. At the fixed end of tube stack threads are provided in the water header for eyebolts to be used when lifting and pulling out. When the casing is installed the tube stack is fitted (new gaskets interposed) by bolting the protruding tube sheet to casing frame and mounting of the gland packing or hood. When removing the tube stack after final installation the bolts holding the protruding tube sheet are unscrewed, the extension end gland packing or cover plate and cooling water pipes are removed and the tube stack is pulled out of the casing by the use of suitable lifting gear. To ease breaking the tube sheet from casing frame gasket seal, threaded holes with the same dimension as the bolts used for the

casing frame are provided in the protruding tube sheet for jacking screws. The casing bolts may be used for this purpose.

Installation is done by use of new gasket as described above.

4. Commissioning

4.1 General

The cooler is subject to a hydraulic pressure test in our factory. It is however recommended to carry out a test with the specified test pressure before installation.

If after prolonged storage or extended standstill the geared gaskets are leaking, tightening of the geared bolts might prevent further leakage. If this is not sufficient the header gaskets must be replaced. A pressure test with specified test pressure should be carried out after replacement.

After assembly of the cooler is completed the cooler is circulated with the specified cooling water quantity prior to venting.

For cooler venting, the vent plugs in the headers are removed. After the air has escaped from the cooler the plugs are fitted again. Venting should be repeated shortly after cooler is taken into operation. Venting of the complete cooling system is better than venting only the cooler and should therefore be preferred.

With multi-circuit or multi-stage coolers, each circuit or stage should be vented separately.

After a leak test has been carried out on all plant components, and the water flow has been checked to ensure there are no restrictions, the cooler can be put into operation.

Upon accelerating the engine to the nominal load the air temperature should be measured before and after the cooler and the cooling water flows set in accordance with the nominal water flows stated in the performance data sheet for the cooler in question.

4.2 Cooling water velocity

The following water velocities should be maintained during operation:

Tube material	Min.	Max.
CuZn28Sn(SOMS71)	1.0m/s	2.0m/s
CuZn20Al(SOMS76)	1.0m/s	2.2m/s
CuNi30Fe(CuNi70/30)	1.5m/s	3.0m/s

CuNi10Fe(CuNi90/10)	1.5m/s	3.0m/s
Cu/SB or SF	1.0m/s	2.0m/s
Steel	2.0m/s	2.5m/s

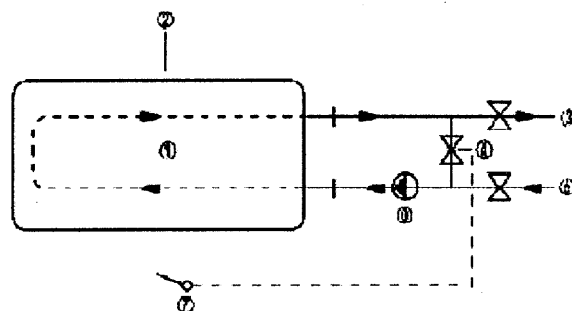
Never operate at min. Velocity for a prolonged period of time. The nominal water flow stated in the performance data sheet for the cooler in question should be maintained. Frequent fluctuation of the water velocity impede the formation of a protective film on the tube inside, which are vital for corrosion protection. A too low water velocity encourages dirt deposits and a too high velocity causes erosion. To throttle the water flow or improper position of the water intake could lead to oxygen enriched water which favours corrosion. To keep the water flow, and so the water velocity, constant also during part load operation, control devices should be installed.

4.3 Control of cooling water velocity

The bypass control as shown below has proved suitable for this requirement. Bypassing can be done in such way that the discharged warm cooling water is mixed with the cold water at the suction side of the cooling water pump to assure operation at almost constant charge air outlet temperature. Subsequently water flow, velocity and charge air outlet temperature can be kept within the recommended range at all load conditions.

Layout of a bypass control system

- ① charge air cooler
- ② charge air inlet
- ③ Cooling water outlet
- ④ Flow control valve
- ⑤ Cooling water inlet
- ⑥ Pump
- ⑦ Temperature sensor



5. Protection film

Measures to assure the formation of a strong and durable protective film.

The inherent good chemical corrosion-resistance of copper and copper alloys is due to their ability to form a natural protective film which is difficult to dissolve.

New cooler tubes lacking a sufficiently strong protective film should never be operated with contaminated water, as deposits on the material surface would prevent the formation of such a protective film.

For the above reason clean fresh water is used for the hydraulic test of the heat exchanger. The utilization of contaminated water should also be avoided during test runs. During test runs it is recommended to add small quantity of easily soluble ferrous sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) to the cooling water to make sure that a good protective film is formed before operating with contaminated water.

It is sufficient to add about 5 mg/l to cooling water during a period of one hour every 24 hours. Adding of ferrous sulphate should, if possible, be repeated during normal operation until the first inspection is carried out.

An appropriate valve for adding ferrous sulphate should be provided in the piping close to the water inlet nozzle of the cooler.

6. Standstill

A standstill of the cooling water system, leaving the cooler undrained, is hazardous for cooler parts made of copper, copper alloys, steel and cast iron.

For copper and copper alloys standstills are especially hazardous prior to the formation of a protective film or in the case that the destruction of the same must be feared for reason of deposit attacked by putrefaction products such as ammonium compounds and hydrogen sulphide.

If possible, cooler operation should not be interrupted during the first 2 months after commissioning if the cooler can not be drained.

However, if there is a failure in cooling water supply and operation is resumed within 3 days and then for a prolonged period of time kept uninterrupted, the cooler may be left undrained.

It must be then guaranteed that the tubes are free from deposits. If deposits have formed, the cooler should be

drained, the tubes cleaned and flushed with clean water prior to being dried. We recommend the use of warm or pre-dried air for blowing through the tubes. The coolers need to be vented adequately. If sea water, brackish or saline water (chloride content > 500 mg/l) is used as cooling water, water with low salinity (drinking water quality) should be used for flushing. In case of standstill within the start-up period of 2 months which is expected to last for more than 3 days, and where deposits must be feared, the cooler should be drained, flushed and dried.

To avoid standstill corrosion after the first 2 months of operation the above described cleaning procedure should be repeated by every standstill lasting longer than 2 weeks. In case of permanent service interruptions after the start-up period it may be necessary to limit the standstill where the cooler is kept undrained to 3 days and operate the unit under conditions as recommended for the start-up period. During short standstill the cooler can be operated at low cooling water velocity so formation of deposits in the tubes can be prevented. Operating with low water velocities is to be preferred to cooling water standstill in the tubes as putrefaction products, such as ammonium compounds and hydrogen sulphide are washed away from their point of origin.

During winter time standstill if frost injury to the cooler could occur the cooler should be drained also during the shortest standstill.

7. Service control

7.1 General

For service control, thermometers are to be installed in the air ducts and in the cooling water piping before and after the cooler, we recommend to keep record of the air and water temperatures in the machine log book periodically. Further control instruments can be provided in accordance with the individual requirement.

In case of the occurrence of a major amount of condensate after the cooler, further condensation can be prevented, or at least limited, by the use of a bypass control of the cooling water as previous described.

A possibility to drain the condensate must be assured.

7.2 Performance test

The performance guarantee given by GEA is mainly expressed by the temperature difference between cold water and cold air during normal operation and should be checked from time to time.

In the event that a considerable increase of the guaranteed temperature difference observed during normal operation, this might be due to accumulation of air in the cooler. To remedy the above the cooler should be vented by using the procedure previously described.

In case a performance increase cannot be achieved by proceeding as above and provided no other disturbance can be found, the cooler needs cleaning.

A differential pressure gauge can also be used to check whether or not cleaning of the air or water side of the cooler is necessary. We recommend to install differential pressure gauges in the air duct and water piping before and after the cooler.

8. Cleaning

8.1 General

Cleaning of the water and air side heat exchange surfaces is imperative for a long and trouble free operation of the cooler. The cleaning intervals vary with the mode of operation, cooling water quality, intake air characteristics etc.

Cleaning can be done by either mechanical, hydraulic or chemical means.

8.2 Cleaning of the water side

Regular cleaning is necessary. The cleaning intervals depend on the cooling water used. Cleaning of the water side is not only required to maintain the thermal performance of the cooler. Scaling increases the risk of biting corrosion and obstacles partly blocking the tubes favours erosion.

8.2.1 Mechanical cleaning

Mechanical cleaning is done by use of nylon brushes fitted to a rod. The length of the rod corresponds to the tube length of the cooler in question and the type of brush is chosen in accordance with the finned tube type. The brush with rod is part of each cooler delivery.

Mechanical cleaning can be done in-situ or with the cooler

removed. At least one header needs to be removed when cleaning. For header removal threaded holes with the same dimension as the header bolts are provided in the header flange to serve as jacking screws. The wet tubes should be thoroughly brushed clean one after the other and the dirt flushed out until no residues are left. After the cleaning is completed the headers are refitted using new gaskets. Venting must be repeated after cooling water is refilled

8.2.2 Hydraulic cleaning

Hydraulic cleaning is carried out with the cooler removed using a high pressure spray gun with special nozzle to remove dirt deposits inside the tubes.

8.2.3 Chemical cleaning

Chemical cleaning can be carried out in-situ or with the cooler removed.

8.2.3.1 Chemical cleaning -in-situ

To ensure that the cooler is always operated without fouling or scaling in the tubes we recommend an integrated and continuously operating chemical cleaning system to be fitted.

Such cleaning system comprises of a circulating pump and a detergent tank with the necessary piping and shut off valves. The detergent circuit is connected to the cooling water inlet and outlet piping between their shut off valves and the water header flanges.

Prior to cleaning, the cooling water flow is interrupted to allow the cooler to drain via the cooling water outlet piping. For draining the vent screw are removed. After draining, the cooling water valves are closed. The valves of the cleaning circuit are opened and the circulating pump switched on. The vent screws are fitted after venting completed.

It is recommended to connect the cleaning circuit to the cooling water outlet piping in such a way that the detergent flow is opposite to the normal cooling water flow.

When cleaning completed the cooler is drained leaving no detergent in the cooler. The valves of the cleaning circuit are closed and the cooling water valves opened. Flushing is done with normal cooling water. Reventing of the cooler

is necessary.

Scaling deposits in the cooling tubes can be removed by chemical cleaning as well. For removal, a 10% HCL hydrochloric, or muriatic acid is used and a 0.5% inhibitor (specifically suitable for the individual tube material) added. After cleaning, the cooler is to be flushed thoroughly, i.e. no detergent residues are allowed to be left in the cooler. This is most important in case the cooler is shut down for a short time after cleaning.

If the cooler is chemically cleaned in mounted position the headers need not be dismantled. For chemical cleaning we recommend to use suitable detergents to clean:

The instructions and handling guidelines provided by the manufacturer of the detergent in question should always be observed when using the chemical.

8.2.3.2 Chemical cleaning -Cooler removed

Chemical cleaning while the cooler is removed is required if neither mechanical or hydraulic cleaning proved successful and if the cooler is not connected to a continuously operating cleaning system.

The complete cooler with attached header will be connected by the use of blind flanges to an external cleaning circuit or filled with detergent on the water side. Time of saturation depends on the grade of deposit. If the result is not satisfying, cleaning should be repeated.

Cleaning procedure and detergents are described under 8.2.3.1.

8.3 Cleaning of the air-side

8.3.1 General

Cleaning of the air-side should be done early enough to avoid accumulations of soot and oil on the fins, which after a period of time form a hard crust that is difficult to remove, as well as the deposition of other crack products as for instance residues that form a sulphuric acid (compound with condensate) when left on the fins and tubes for some time.

8.3.2 Hydraulic cleaning

Hydraulic cleaning is effected when the cooler is removed. A high pressure spray gun as described under 8.2.2 is suitable also for this requirement. We recommend a nozzle

size of 3mm. If the water jet attacks the cooling tubes vertically, i.e. in parallel to the fins, a pressure of 120bar is suitable to be applied at a distance of 2m from the fin surface.

8.3.3 Chemical cleaning

We recommend chemical cleaning of the air side while the cooler is removed.

The water headers are detached from the cooler bundle. The tube bundle is then immersed into a chemical cleaning bath. The time of immersion is a function of the degree of fouling. When cleaning completed, the cooler is to be flushed by applying a powerful water jet. If the result is still not satisfying, cleaning should be repeated.

To intensify the cleaning effect of the bath and shorten the cleaning time, it is recommended to circulate the detergent. The chemical detergents can also be applied by spraying. The following detergents are recommended for air side cleaning.

The instructions and handling guidelines provided by the manufacturer of the detergent in question should always be observed when using the chemical.

9. Tube leaks

9.1 General

Tube leaks can be caused by corrosion, erosion or improper operation of the cooler.

If a leakage is observed, the defective tube or tubes must be identified. If this can not be done by a visual inspection, a pressure test of the cooler or an individual pressure test of each tube has to be carried out.

9.2 Pressure test of individual tubes.

Prior to pressure testing, the connection and return headers need to be removed. In case of ample free space around the cooler it is not necessary to remove the cooler. Rubber plugs can be used for pressure test. One of the plugs must have a connection for air or water supply. The tube to be tested is plugged at both ends and tested at low pressure applied via the plug having a pressure connection.

Pressure gauges can be installed to indicate a loss of pressure. Even-if there is only a small leak in the tube a pressure loss is indicated shortly after pressure application.

If the cooler is to be tested without the use of a pressure gauge it has to be dismantled to enable leakages to be found through visual control carried out from the fin side.

9.3 Pressure test of cooler

If pressure testing of the cooler is done by a hydraulic test, without removing the water headers, the fin side is searched with a flashlight for wet points indicating leaks. To avoid that damage rating being impaired by wet points on neighboring tubes, the air side should be dried by blowing with air prior to testing.

9.4 Pressure test with air under water

If no pressure gauges are installed pressure testing with air should be done under water.

The cooler is immersed into a water tank and tubes are tested by applying 0.5bar air pressure on the water-side without removing headers or by testing the tubes one by one as previous described. If a tube is defective bubbles will rise. However note that bubbles can form from air accumulated on the cooling fins and that such bubbles do not indicate leaks.

9.5 Plugging of tubes

Once the defective tube is found it can be sealed with hard wood, rubber or brass plugs which are part of each delivery. On both sides steel plugs should not be used, due to damage of the tube sheet holes.

Plugging can be done on all tube types without exception. In the case that several tubes are leaking it must be decided at location whether or not the cooler performance will be satisfactory after plugging.

9.6 Replacement of single tubes

(Partial re-tubing)

If the cooler has single fin tubes, i.e. elliptical tubes with threaded on rectangular fins or round tubes with wound-on fins, it is possible to replace single tubes. If the leaking tube is found in the middle of the tube bundle, the neighboring outer tubes must be also removed and replaced to gain access to the leaking tube. After the tubes to be replaced are removed the tube sheet holes must be cleaned. The replacement tubes are provided with an extended un-

finned portion at one end. The tube is inserted into the tube hole in one tube sheet(long unfinned end first) then retracted and slid into the corresponding tube hole in the second tube sheet. Then the new tubes are then rolled into the tube sheets.

9.7 Insertion of a second core tube

Replacement of single tubes is not possible on coolers with compact fin tube system consisting of continuous fins with several inserted and expanded core tubes. To remedy tube leaks, plain tubes of smaller diameter than the defective tube can be inserted and expanded to form thermal contact with the latter and rolled into the tube sheets.

9.8 Pressure test after repair

After repair the cooler must undergo a pressure test with the specified test pressure which is stated on the name-plate fitted to the cooler side wall or casing. Replacement tubes, tools and other materials for leak remedy can be purchased directly from GEA Germany or GEA (wuhu) KHI Machinery Cooling Co., Ltd or from our service centres world wide.

DONG BO MARINE ENGINE ROLLER CHAIN

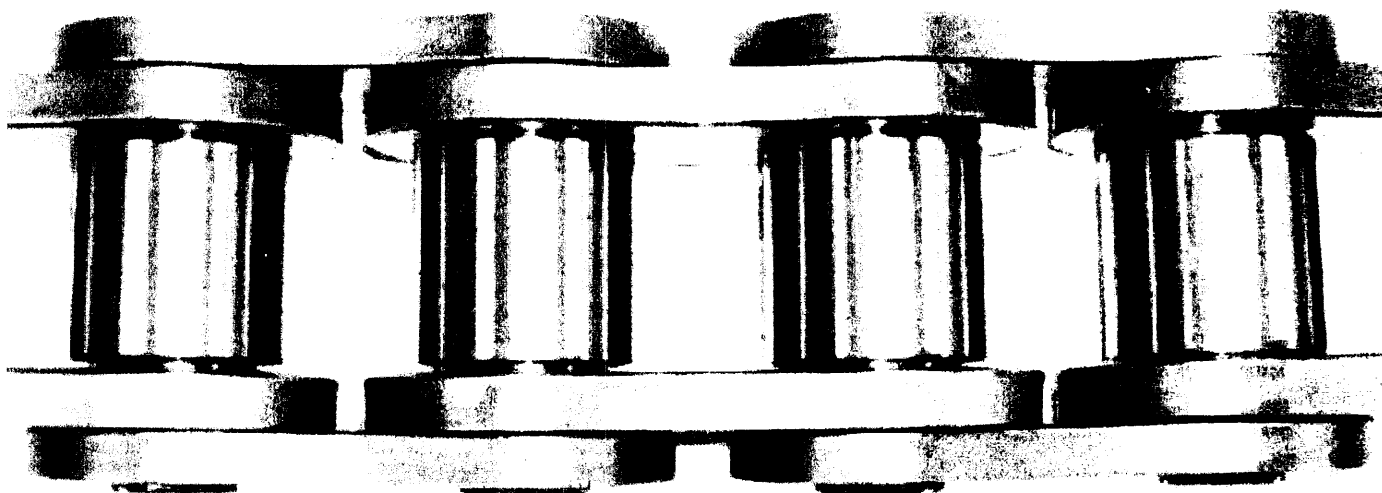
Marine Diesel Engine
Camshaft and Auxiliary Drives
maintenance manual



DONG BO CHAIN IND. CO., LTD.

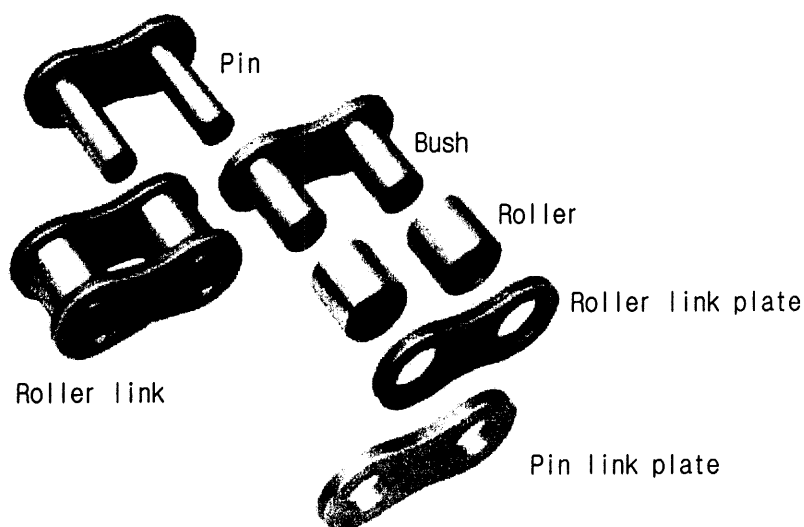
Dong Bo Marine Engine Roller Chain which meet British Standard(BS) and is uniquely designed to be capable of driving marine diesel engines is designed with most advanced manufacturing technique and the high quality steel.

Dong Bo Marine Engine Roller Chain is used for Camshaft Drives, Fuel Pump Drives and various kinds of auxiliary operated equipment. MAN B&W use it in the marine diesel engine, and Sulzer and Mitsubishi, just to name a few. This catalog shows the items that can be repaired and maintained.



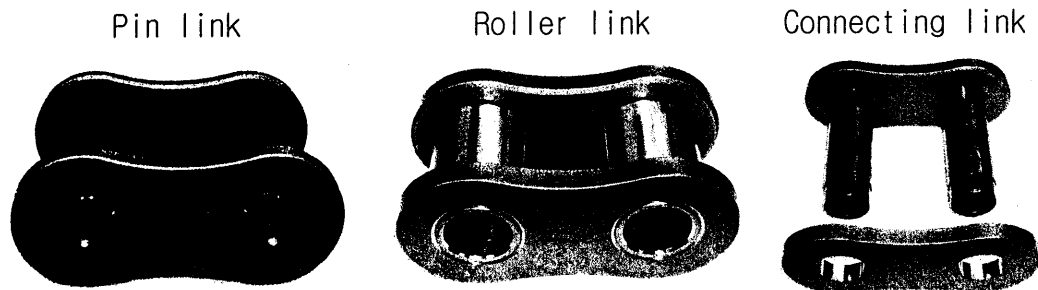
1. Composition

In picture 1. Link plate, pin, bush and rollers are the main compositions of Marine Engine Roller Chain. Link plate supports the tensile stress. Pin and bush builds up the structure of the bearing area. The roller not only absorbs the impact, which is transmitted to the bush, but also prevents the wearing of the sprocket.



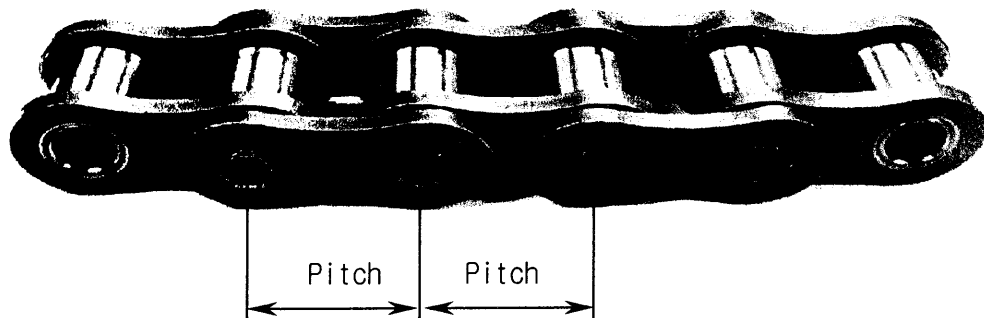
Picture 1

Chain is composed of two pins and two pin link plates as in picture 2 and pin is assembled into link plate by press-fit. In roller link two bushes are pushed into link plate, and roller is assembled into the outer bush to make roller turn freely. The connecting link is supplied a press-fit outer plate.



Picture 2

Look at the picture 3. Chain is connected and assembled into roller link and pin link plate secured by riveting. The length of chain is measured by roller centers to roller centers, the chain in picture 3 is five pitches long, commence inner link finish inner link.

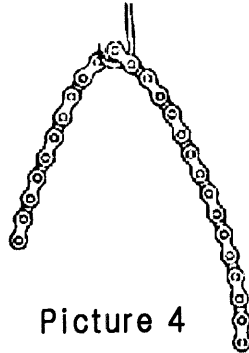


Picture 3

2. Instructions & Installation

2-1. Unpacking

The chain could be heavy, so put packing case on its side, then open and carefully lift chain out vertically by lifting device. Picture 4.

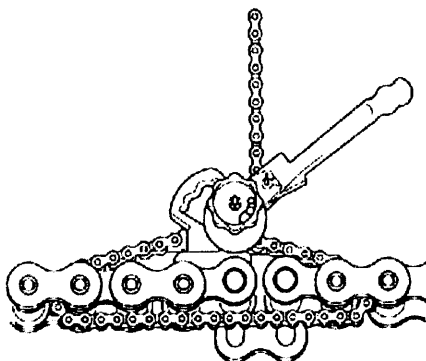


Picture 4

2-2. Installation

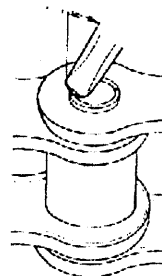
If necessary use a lifting device to put the chain on to the engine. Picture 4. It may require a pulling device, picture 5, to pull the roller links together. Put the connecting links pins into the roller link bushings and then push on connecting link top plate, push a little on each pin at a time so that the plate does not bend. The connecting link pins must then be riveted with a round punch. Picture 6.

NOTE: Do not change the connecting link plate holes or pin diameter to assembly connecting link plate and pin easily.



Picture 5

Approximately 30°



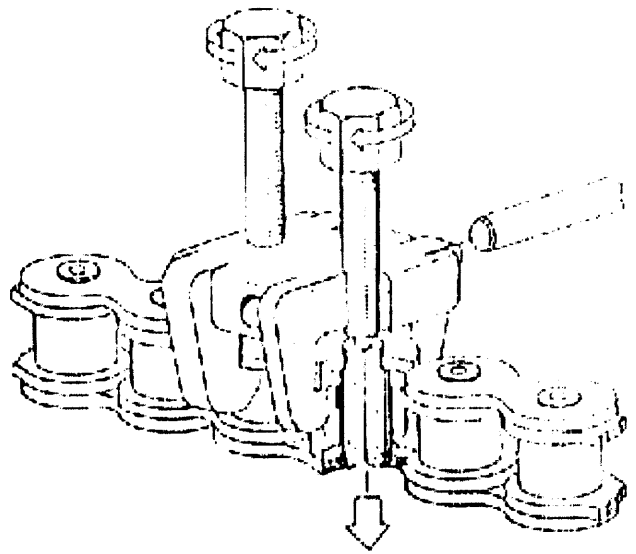
Picture 6

2-3. Disassembly

If the chain has to be disassembled, the connecting link has to be found. It is usually marked red in color. Using tool, Picture 7, tighten up the bolt on to center of the pin and tighten, pushing the pin through outer plate and into the bush. Move and put on the second pin and repeat procedure until you can pull out connecting link pins.

REMEMBER this connecting link **MUST NOT** be used again as all interference fits have been destroyed.

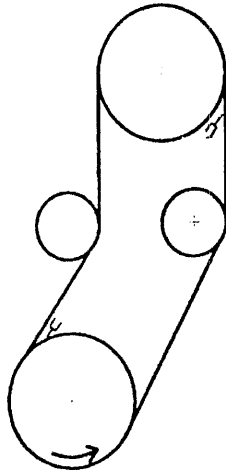
A NEW LINK MUST BE USED TO REJOIN CHAIN.



Picture 7

3. Lubrication

Lubrication is very important for High Quality Roller Chains. It helps prevent wear stretching and creates a film of oil between pin, bush and roller. It also helps reduce noise at high speed. Locate the lubrication as close to the chain entering the sprockets as possible. Picture 8.



Picture 8

See picture 9 for position of lubricating nozzles for various types of chain.

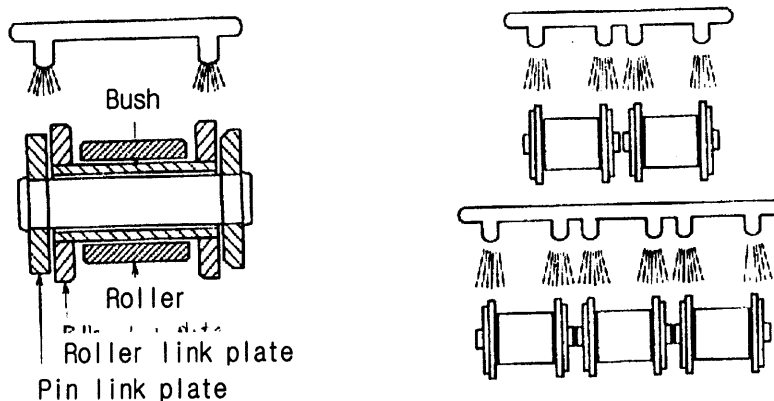
The minimum quantities of oil required for Marine Engine Roller Chain is as follows:

Single strand chain: 10 Liters(2 gals.) per inch length of chain/ hour

Double strand chain: 20 Liters(4 gals.) per inch length of chain/hour

Triple strand chain: 30 Liters(6 gals.) per inch length of chain/hour

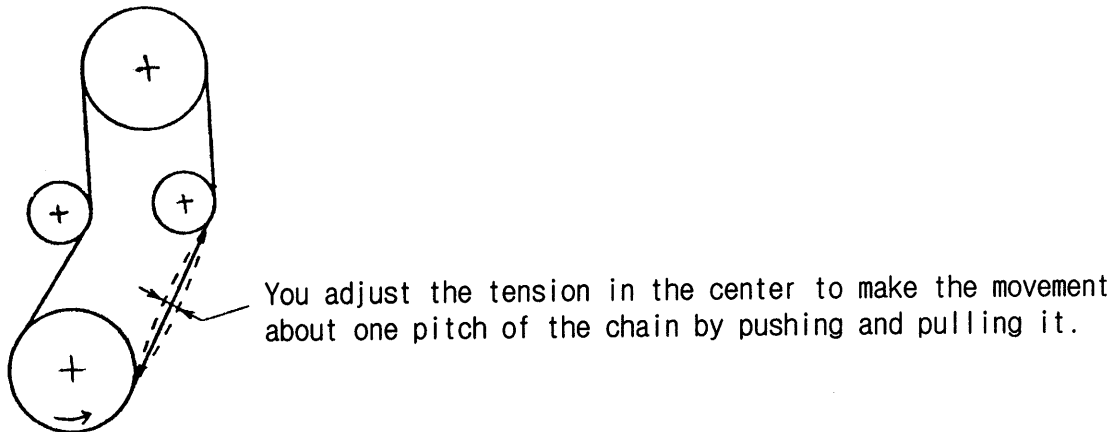
NOTE: Check nozzles and pipes regularly blockages.



Picture 9

4. Chain tension and Adjustment marine engine

Vibrations are usually caused by the chains becoming loose by stretching and wear. These vibrations can be reduced as you change the tension. Engine manufactures specifications should be checked. You should make the first tension a half of the tension, which is affected in the chain while driving. If it is difficult to measure the tension you should adjust it. See picture 10.



Picture 10

After shop test and sea trial test the chain which is used first may be expanded for about 0.02~0.05%. So you should adjust the chains tension and must not loosen it. As the tension is adjusted, you won't be able to see the loose chain, and you must tighten up the loose chain every 4000 hours.

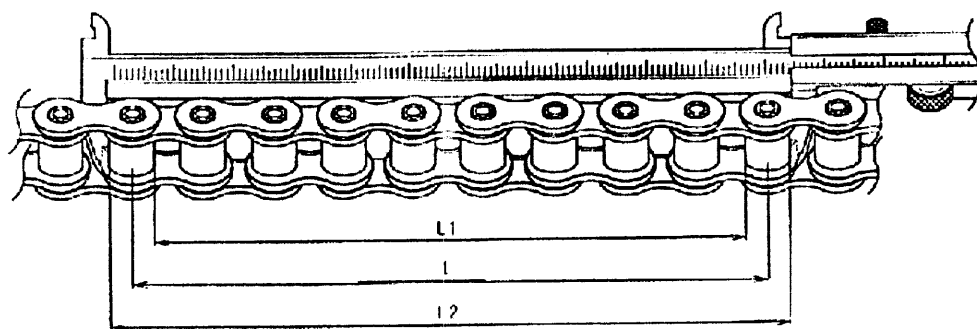
5. Inspection & Repairs

Whenever the link is bent owing to the contact of the chain and the sprocket, the chain might loosen with the wear of the pin and bush. Because Dong Bo Marine Engine Roller Chain is a much higher quality than standard manufactured roller chain the wear will be less and also run better.

The inspection and repairs is exactly needed for the complete life of the chain. As the chain loosens, you can see the wear of the pin and the surface of bush. The chain for a marine diesel engine must not be exchanged for 10 years, even though it might be loose. You must measure the loose length regularly to check the life of the chain. That's why both of them are in inverse proportion.

(1) While operating the engine slowly, you tighten up the loose chain and set up the first tension, referring to section 4. After stopping the engine, you measure the length of the chain where the tension is set up.

(2) After measuring L_1 and L_2 , you calculate the real length L of the chain. Look at picture 11.



Picture 11

(3) You measure it more than 6 pitches to minimize the measurement error.

(4) In the Table 1 the loose maximum tolerance is 1% longer than the standard length.

If the measured length exceeds the maximal allowable length you must change the chain.

Unit : mm

Chain No. Pitch(inch)	16B	20B	24B	28B	32B	40B	48B	56B	64B	72B
	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5
Standard length (Pitch x 6 Links)	152.4	190.5	228.6	266.7	304.8	381.0	457.2	533.4	609.6	685.8
Max. allowable length (For 6 Links)	153.9	192.4	230.9	269.4	307.9	384.8	461.8	538.7	615.7	692.7
Standard length (Pitch x 10 Links)	254.0	317.5	381.0	444.5	508.0	635.0	762.0	889.0	1016.0	1143.0
Max. allowable length (For 10 Links)	256.5	320.7	384.8	449.0	513.1	641.4	769.6	897.9	1026.2	1154.4

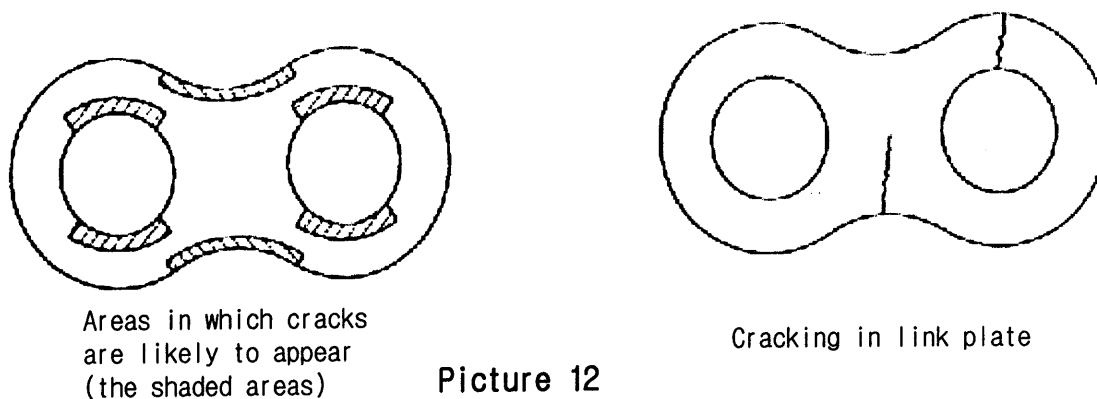
Table 1.

Every parts from Dong Bo Marine Engine Roller Chain is produced through the ultrasonic flaw detecting test(UT TEST) and the magnetic particle test (MT TEST). However, if the vibration of the chain, witch comes from the drive exceeds the fatigue(endurance) limit, the chain can be broken. In case the chain vibrates extremely, cracks can happen on the link plate.

Therefore check the chain very carefully.

The crack on the link plate shows the first sign that the fatigue limit exceeded the chain. Generally, the crack is a slow progress. So examine the link plate carefully and you will prevent an accident.

If you do find a crack on the link plate, even if it is a small one, the whole chain **MUST** be changed. That is because every link gets weakened on the same condition. Picture 12.

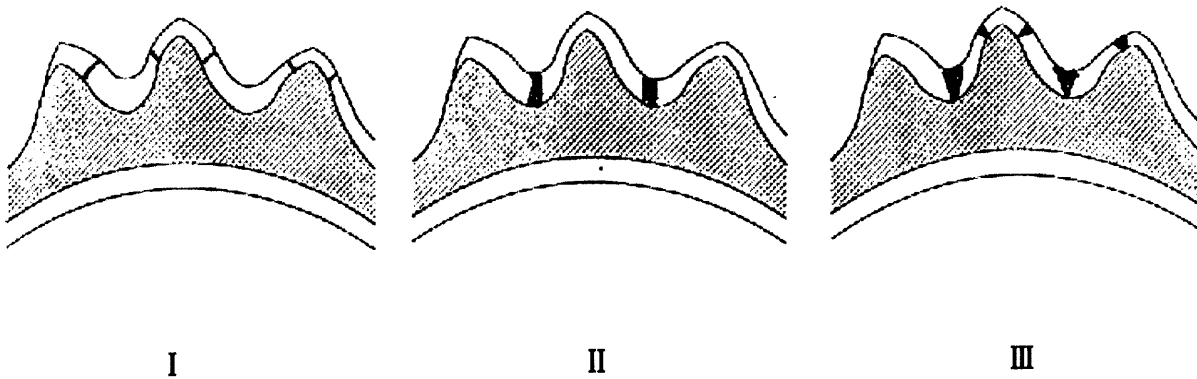


The roller doesn't cause the problem by the impact; it is the severe vibration that makes the crack happen on the rollers. You must check for cracks on the rollers often.

To prevent the fatigue fracture you must minimize the vibration of the chain as much as possible. If you adjust the tension of the chain and can not stop the vibrating, you must discuss with the engine manufacturer.

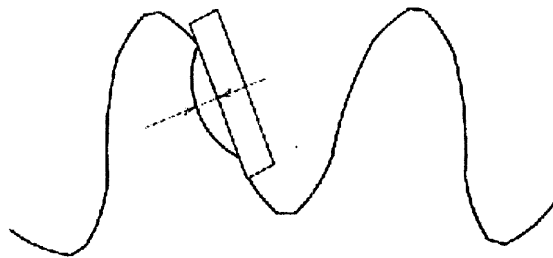
6.The Sprocket Inspection

To examine whether the chain roller and sprocket teeth exactly line up, you should check the contact trace and the part of the wear in the inner teeth after SHOP TEST. If they precisely line up, the width of the contact surface will be fixed as **I** or **II** in the Picture 13. If the contact surface isn't level the roller and sprockets are nit in a straight line as shown in **III**. Therefore you must put them in line. On the whole the roller doesn't make contact between the sprocket teeth. But if the chain roller is tensioned on the loose part, you can see the were from this. When idler or tightener is tilted, the contact point will be the bottom between the teeth as **II** in the Picture 13.



Picture 13

The sprocket teeth also can be worn while contacting the chain roller continually. Picture 14 There is a maximal wear tolerance of the teeth in the Table 2.

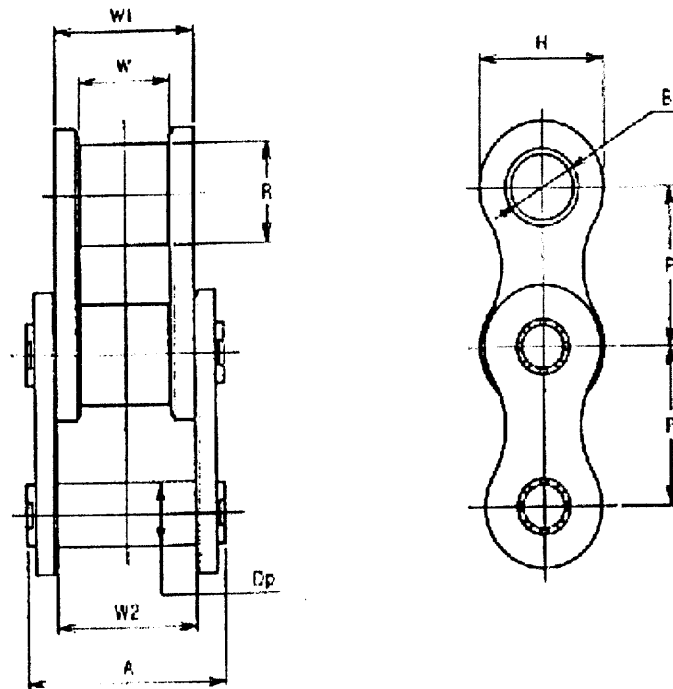


Picture 14

Chain No.	16B	20B	24B	28B	32B	40B	48B	56B	64B	72B
Pitch(inch)	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5
Maximum allowable wear(mm)	0.9	1.1	1.4	1.5	1.6	2.3	2.5	3.0	3.6	4.1

Table 2.

DIMENSIONS AND SPECIFICATIONS



CHAIN No.		Pitch	Roller Dia.	Width between roller plates	Bearing Pin dia	Bush bore	plate depth	Width over roller link plates	Width between pin link plates	Width over bearing pin	Breaking load kg(min)		Approx Weight
DONG BO	BS	P	R (Max)	W (Min)	Dp (Max)	B (Min)	H	W1	W2	A	DONG BO	BS	kg/mt
DBC 16B	16B	25.40	15.88	17.02	8.28	8.33	21.08	25.45	25.58	36.10	4,700	4,310	2.82
DBC 20B	20B	31.75	19.05	19.56	10.19	10.24	26.42	29.01	29.14	43.20	7,200	6,580	3.89
DBC 24B	24B	38.10	25.40	25.40	14.63	14.68	33.40	37.92	38.05	53.40	11,000	9,980	6.70
DBC 28B	28B	44.45	27.94	30.99	15.90	15.95	37.08	46.58	46.71	65.10	14,500	13,160	8.20
DBC 32B	32B	50.80	29.21	30.99	17.81	17.86	42.29	45.57	45.70	67.40	19,000	17,240	8.80
DBC 40B	40B	63.50	39.37	38.10	22.89	22.94	52.96	55.75	55.88	82.60	30,000	26,770	15.03
DBC 48B	48B	76.20	48.26	45.72	29.24	29.29	63.88	70.56	70.69	99.10	45,000	40,830	23.95
DBC 56B	56B	88.90	53.98	53.34	34.32	34.37	77.85	81.33	81.46	114.60	61,000	55,340	33.20
DBC 64B	64B	101.60	63.50	60.96	39.40	39.45	90.17	92.02	92.15	130.90	80,000	72,580	46.00
DBC 72B	72B	114.30	72.39	68.58	44.48	44.53	103.63	103.81	103.94	147.40	105,000	91,630	59.60



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INSTRUCTION MANUAL

FOR PLANETARY TURNING GEAR
FOR DIESEL ENGINES

선박 주추진 디젤 엔진용

터닝기아 취급 설명서 및 예비부품 공구 목록

YRTG 96-140 (6S90MC)

YURIM INDUSTRIAL CO., LTD.

#36-5 SANKYUK 2-DONG, BUK-KU DAEGU(702-012), S-KOREA
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1. 설계사양

1. 전 동 기 : 11 Kw, 6극 440V, 60 Hz
2. 브레이크 : DC 90 V
3. 감 속 비 : 1/1196.2
4. 출력 회전수 : 0.96 R.P.M.
5. 출력 토크 : 9600 Kg-M (정격)
14450 Kg-M (최대)

2. 터닝기어의 일반적 구조

유림 터닝기어는(이하 “터닝 기어”라 함) 조립도면상의 상태와 같이 기어박스 외부에서 1차로 로울러 체인과 스프라켓에 의하여 감속되며 2,3,4 차는 기어박스 내부에서, 구조가 간단하고 높은 감속비가 얻어지며 신뢰성이 높은 “유성형 감속기어” 형태로서 이루어진다. 출력축은 시계방향과 반시계방향으로 회전 가능하다.

각 기어는 고급소재와 최적의 열처리에 의한 고정밀도와 내구성을 가지며 유성기어의 초기 충격을 흡수하는 장치를 가졌다.

그리고 미숙련자도 쉽게 조작할 수 있도록 구조를 간단하게 하였으나 잘못된 조작으로 예상치 못한 문제점을 일으킬 수 있으므로 사용전에 취급 설명서를 충분히 읽어본 후 올바르게 사용하여야 한다.

터닝기어는 정격 토크 이내에서 사용하되 특수한 상황에서 단시간은 최대 토크까지 사용할 수 있다. 그리고 정격 토크 이상에서 장시간 사용할 경우는 전동기의 소손, 베어링의 파손, 기어 치면의 과다 마모등 수명 단축, 고장을 초래할 수 있다.

엔진 본체의 플라이휠 기어에 물리는 피니언 기어를 작동시키는 HAND WHEEL(6S-90MC-003 28)을 작동시킬때 필히 위치 레바(6S-90MC-003 45)를 뒤로 젖힌 후 작동하여야 한다. 기존의 타사 제품들과 달리 리이드스크류에 의하여 기어를 물렸다, 뺏다하므로 이 부분은 사용전 충분한 이해가 필요하다.

1. SPECIFICATIONS

1. M O T O R : 11 Kw, 6P 440V, 60Hz
2. B R A K E : DC 90V
3. REDUCION RATIO : 1/1196.2
4. OUTPUT SPEED : 0.96 R.P.M
5. OUTPUT TORQUE : 9600Kg-M(NORMAL)
14450Kg-M(MAXIMUM)

2. GENERAL CONSTRUCTION OF YURIM TURNING GEARS

YURIM TURNING GEAR(hereinafter referred to as TURNING GEAR) is first reduced by Roller chain and sprocket as shown Assembly Drawing. The reduction of next stage(from 2nd to 4th) is getting in the gear box. The construction of Turning Gear consists of planetary gears which has simple, high precision and reduction ratio.

The output shaft can be rotated either clockwise or anticlockwise. Each gears is manufactured in high precision with good materials and optimum heat treatments(hardening). Also, Turning Gear has device to relief first impulsion when it is started up. Even if you are an unskilled operator, you can handle it easily. however, An improper handling may be caused an unexpected trouble, herefore you must read operating manual certainly and carefully before starting Turning Gear. All the time, Turning Gear should be used at normal condition. It is righe, if only it can be used momentary at Max. tourque condition may cause the life of Turning Gear to be shorten, resulting in the damage of E-Motor & Bearing.

For engaging with Flywheel. First, extract the fixing pin(6S-90MC-003 28) and pushes the pinion gear into the Flywheel by Handwheel (6S-90MC-003 45). The pinion gear is moved forward and backward by lead screw. It should be noted that this type is different from other companies T/G.

3.유지 및 보수

수시로 볼트,너트의 이완을 점검후 조여주고 로울러 체인이 늘어지면 적절한 장력으로 조정할 것.

기어 오일은 작동전에 유면계 표시 눈금에 도달하는지 확인후 부족하면 보충할 것.

일단 작동을 시작하면 기어 박스의 소음과 진동,온도 상승에 주의를 기울일 것.

기어 박스외부의 온도는 주위보다 10~40℃ 이상 올라갈 수 있다.그러나 그것은 연속 사용시 적정 온도에 도달후 일정하게 유지되므로 이상이 없다.

과다한 열의 발생,소음이나 진동이 일어날 경우는 즉시 작동을 중지하고 원인을 조사, 제거후 사용할 것.

외부의 작동부위는 수시로 그리스및 윤활유를 주유할 것.

4.윤활유

터닝기어의 기어박스 내부는 기어 오일에 의한 침적 윤활이 적용되고 로울러 체인 및 기타 외부 작동부는 그리스 윤활이 적용된다.오일,그리스의 종류및 교체,보충시기는 윤활 목록표에 준한다.

기어박스 내부의 오일량 검사는 작동이 중지되고 5분 이상 경과하여 오일이 탱크에 고인 상태에서 유면계에 의하여 검사되어야 하며,외부는 수시로 검사하여 최소 1개월에 1회 정도는 주유하여야 한다.

기어박스 내부의 기어 오일은 통산 1년에 1회 교체를 하되,가혹한 조건에서 사용하였거나 최초에는 철분을 제거할 목적으로 6개월마다 교체하여야 한다.

(기어박스 내부에는 철분제거용 자석이 부착되어 있음.)

* 윤활유의 교환 방법

- 1.드레인 플러그(6S90MC-002 A)를 풀고
- 2.윤활유를 전부 빼낸 후
- 3.드레인 플러그에 테프론 테이프를 감아 재조립
- 4.통기구(6S-90MC-002 B)를 풀어서
- 5.배관을 통하여 새 윤활유를 주입한다.
이 때,기어박스 내부에 공기가 빠질수 있도록 조치를 취한다.

3.MAINTENANCE

Tighten loose bolts & nuts and adjust the tension of roller chain. Check the level of gear oil and supply oil if necessary.

Pay attention to noise, vibration and abnormal rise of temp. during initial start.

The temperature of T/G casing may rise more 10℃ to 40℃ than that of ambience, but it will be kept up the optimum temperature when T/G is reached a constant running. In the event of excessive heat, noise and vibration during running, stop immediately and check it. Try it again after repair.

Apply the grease and lub.oil to the outside moving part from time to time

4.LUBRICATING OIL

The oil supply method of the internal parts of gear box is self-lubricating(oil bath system) and Roller chain is adopted by Grease method.

Kinds of oil & grease and the times of exchanging oil follow "LUB OIL LIST". Before operating, supply the designated lub.oil so that oil level is just above the indication line of the oil gauge.

Apply grease to roller chain once a month at least. Renew gear oil once a year.

However, renew gear oil once a half year under the severe condition or in order to recove foreign particles after initial running.

(The magnetic bar is attached in the gear box to remove foreign particles)

Exchanging oil

1. Loosen drain plug.(6S90MC-002 A)
2. Drain out the oil thoroughly.
3. Retighten drain plug after sealing the screw with Teflon.
4. Loosen the air vent plug.(6S-90MC-002 B)
5. Renewed the oil into the gear box through the pipe.

윤활방법 교체시기

LUBRICATING METHOD AND INTERVAL

내역 Information 위치 Position	필요 윤활유양 Quantity of lub.oil	윤활 방법 Method of Lubricating	교체 시기 Interval
기어박스 내부	APPROX.18 ℓ	침적 윤활 OIL BATH	년 1 회 ONCE A YEAR
체인 및 외부 작동부 Chain and outer portion	APPROX. 250 g	그리스 GREASE	6개월에 1회 SIX MONTHS

사용가능 윤활유

Practicable Application Lub.Oil

MAKER	GEAR OIL	GREASE
CALTEX	MEROPA 460	MUL TIFAK EP2
CASTROL	ALPHA SP460	SHPEEROL EPL2
ESSO	SPARATAN EP 460	BEACON EP2
SK	SUPER GEAR 460	CROWN EP2
SHELL	OMALA 460	ALAVANLA EP2

5. 수동작동에 대한 조작순서

출력전동기에 전기공급이 되지 않거나 고장등으로 수동 비상작동이 필요할 때는 다음 방법으로 실행한다.

5-1

모터 베이스에 고정된 핸들의 고정 볼트를 제거한 후 준비한다.

5-2

브레이크 카바(6S-90MC-24 M8)의 볼트 4개를 제거한 후 벗긴다.

5-3

브레이크 해지 볼트(6S-90MC-24 B11) 2개를시계방향으로 돌려 잠그면, 밀판(B3)이 스프링(B9)을 압축시켜 브레이크가 해지된다

5-4

6S-90MC-001 도면에 가상선으로 표시한 것과 같이 핸들을 전동기 출력축에 결합시킨 후 돌린다.

5-5

수동조작이 완료된 후에는 위 작업의 역순서로 원상 복귀시킨다.

5-6

정상작동을 하기 전에는 반드시 브레이크의 해지 볼트(6S-90MC-24 B11) 2개를 반시계 방향으로 돌려 밀판(B3)과 마찰판(B2)이 완전히 밀착되었는지 확인한다. 브레이크 카바(6S-90MC-24 M8)를 반드시 조립 확인한 후 작동한다.

5-7

전동기 출력축의 핸들은 반드시 모터 베이스에 원상태로 고정시킨다.

6. 부품의 교환

6-1

기어 및 축은 유림공업(주)에서 설계된 특수 제품이므로 필요시 제작구매 요청할 것.

6-2

모든 베어링은 표준규격품을 사용하였으므로 시중구매가 가능하다.

6-3

황동 재질의 스페이스(6S-90MC-002 24) 3개는 별도 설계에 의한 제작품이므로 제작구매를 요청할 것.

6-4

오일 씰은 고무재질로서 사용 환경에 따른 고무의 열화로 성능이 저하될 수 있으므로

5. OPERATION PROCEDURE FOR MANUAL OPERATION

Operate emergency method as follows when E-MOTOR can not rotate well by damage or the failure of electric power.

5-1

Extract the fixing pin of handwheel.

5-2

Loosen and extract the bolts(4ea) of brake cover (6S-90MC-24 M8).

5-3

By tightening the bolts(6S-90MC-24 B11) to the clockwise, the pushing disc(B3) pushes the spring(B9) and the brake is released.

5-4

Turn the handle after engaging with output shaft as Drawing (6S-90MC-001).

5-5

Return to the original state in the opposite order after completing manual operation.

5-6

Check the contact between pushing disc(B3) and friction disc(B2) whether it is closely adhered(Before normal operation, the contact will be come close by tightening bolts(6S-90MC-24 B11) to the anticlockwise.) Operate T/G after re-assembling the brake cover(6S-90MC-24 M8)certainly.

5-7

Fix the handle of output shaft to the original state.

6. REPLACEMENT OF PARTS

6-1

As gears & shafts are of special design, contact us in case of their replacement.

6-2

Most of bearings are commercially available because of using standard production

6-3

Should be noted that spaces(6S-90MC-002 24) are of special made by our company, Request to our company if necessary.

6-4

With regard to the seal, A considerable deterioration may be developed owing to surrounding environ-

정기적인 교체가 필요하며, 어떤 이유로 분해했을 경우에도 새 것으로 교체한다. 교체시에는 삽입하는 입구가 벗겨지거나 기타 손상을 입지 않도록 한다.

7. 분해 및 조립

7-1 분해

- 1) 이 취급 설명서에 첨부된 도면을 완전히 이해한 후 분해할 것.
- 2) 분해의 목적을 정확히 하고, 분해할 부위를 최소로 한다.
- 3) 분해시 필히 각 부품의 위치를 표시하고 분해하는 순서에 따라 정리를 한다.
- 4) 어떤 경우에도 각 부위를 무리하게 두드리지 말고, 강제적인 힘을 가하지 말 것.
- 5) 카바등의 부품에는 분해용 암나사가 있어 분리용 볼트를 잠겨서 분해하고, 운반한다.
- 6) 만약, 분해작업이 어렵다면 도면을 재검토하여 구조를 충분히 이해한 후 다시 한다.

7-2 조립

- 1) 주위 환경을 먼지등이 없도록 청결히 한다
- 2) 각 부품은 세척유로 철저히 세척하고, 결합 부위에는 적당한 윤활유나 그리스를 바른 후에 조립한다.
- 3) 분해시에 표시한 위치를 준수한다.
- 4) 기어박스 내부의 볼트들은 진동등으로 풀리지 않도록 본드제를 나사에 도포하거나 풀림방지 와셔(TAB WASHER)를 사용한다.
- 5) 기어 박스등에는 기존의 가스켓을 완전히 제거후 다시 도포하고 조립한다.
씰링 재료 : THREE BOND NO.1215
 : FORMA GASKET NO.2
 : SILICON BOND
- 6) 조립완료후는 기어박스 외부의 입력축을 손으로 돌렸을 때 부드럽게 돌아가야 한다

8. 설치

터닝기어는 강력한 베드에 설치되어야 하며 설치 볼트는 완전히 죄어 진동이나 충격등 외력에 견딜수 있도록 한다. 부적당한 설치는 터닝기어의 수명을 극단적으로 줄일 수 있으며, 파손등 중대한 결함을 초래할 수도 있다.

ments temperature and contamination of lub.oil & other reasons. Replace the oil seal with new one periodically. Also, should be replaced the oil seal when the parts included oil seal are disassembled for some reasons or others.

During replacement, pay specially attention to the turnover of the lip and the direction of the oil seal as well.

7. DISASSEMBLE AND ASSEMBLE

7-1 Disassembly

- 1) Disassemble T/G after reading over operating manual in accordance with Assembly
- 2) Make clear the purpose of disassembly in order to minimize parts disassembled.
- 3) Disassemble Turning Gear after marking if there is no match mark on a part to be disassembled.
- 4) Neither strike parts strongly nor pull each part forcibly.
- 5) Taps are provided covers and other parts to facilitate disassembly and transportation.
- 6) In case of any trouble during disassembly, Check the drawing carefully and try it again.

7-2 Assembly

- 1) Always keep clean surrounding.
- 2) Each parts should be completely washed out with cleaning oil and made assembly after applying grease or lub.oil to defective parts.
- 3) Check and assemble parts in order after putting together the alignment mark.
- 4) Apply three bond or equivalent to threads in the gear box to prevent loose bolts from vibration and other reasons.
- 5) Renew cover gaskets when assembly.
Gear sealing : THREE BOND NO.1215
 : FORMA GASKET NO.2
 : SILICON BOND
- 6) Once assembly is completed, check if Turning rotates smoothly.

8. INSTALLATION

Turning Gear should be installed on a strong bed and mounting bolts & nuts tightened throughly. Should be noted that an improper installation may cause excessive noise or vibration, resulting in a considerable decrease in the life time and damage.

9. 유지 및 보수 일람표

9.PROCEDURE OF MAINTENANCE AND SERVICE

항목	점검내용	점검 방법	조치 방법	주기
운 활 유	양	유면계에 윤활유가 표시선까지 충만해 있는가	동일종류의 것으로 보충	상황 발생시
	온도	기어박스 표면의 온도가 80℃이하로 유지 되는가	작동을 중지하고 원인을 제거한 후 작동	상황 발생시
	청결	드레인 플러그에서 소량의 윤활유를 배출해서 오염정도를 검사한다.	열화되었거나, 쇳가루 등 이물질이 많으면 교환	6 개월
	누유	입력, 출력축의 오일 씰 부위, 카바 결합부에서의 누유	오일 씰 교환, 카바결합부는 분해후 기존 가스켓 찌꺼기를 완전히 제거후 조립	상황 발생시
볼 트 류	체결상태	체결되는 위치의 볼트가 이완되지 않는가	적당한 공구로 다시 조인다.	상황 발생시
	파손	체결된 볼트가 파손 되지는 않았는가, 미세한 균열은 없는가	파손되었거나 균열이 있는 볼트는 교체한다.	상황 발생시
체 인	장력	너무 느슨하거나 지나치게 긴장되지는 않았는가	장력 조정 볼트로서 조정할 것	6 개월
	그리스	체인 로울러 표면에 그리스가 충분 한가	부족하면 그리스를 도포한다.	6 개월
브 레 이 크	마찰판	마찰판의 마모상태, 파손 여부 확인	마찰판 교체	6 개월
	마찰판	밀판과 코일, 마찰판 사이에 이물질 (물,기름)의 유,무 확인	이물질 제거	6 개월
	동작 틈새	밀판과 코일의 틈새가 전둘레에 걸쳐 일정한가	틈새 게이지로 재 조정	6 개월
기타	소음과진동	기어박스에서 지나친 소음이나 진동이 있는가 확인	즉시 작동 중지	상황 발생시

ITEM	CHECK POINT	CHECK METHOD AND POSITION	REMEDY	INTERVAL
L U B	QUANTITY	Check the oil lever guage.	Replenish the same oil.	As occasion demands
	TEMPERATURE	Check the temp. of G/BOX casing	Keep the temp.to 80℃ Stop T/G, Operate it again after remedy in case of abnormal rise.	As occasion demands
	CLEANNESS	Take sample oil from drain plug and check the contamination of oil.	Renew the oil in case of including foreign particles or terioration.	6 month
	LEAKAGE	Oil seal parts of input & output shaft. Gasket parts of casing cover.	Replace oil seal and gasket with new one in case of leakage.	6 month
B O L T S	TIGHTENING	Check the bolts.	Retighten loose bolts	As occasion demands
	DAMAGE	Check the bolts whether damage or fine crack.	Replace bolts in case of damage or crack.	As occasion demands
C H A I N	TENSION	Check the tension of chain.	Adjust tension with adjusting bolt.	As occasion demands
	GREASE	Chain roller surface.	Apply grease to chain roller.	6 month
B R A K E	Friction disc	Check it whether damage or wear down.	Replace it with new one in case of excessive wear out or damage	6 month
	CLEARANCE	Check clearance of pushing disc & coil	Re-adjust gap of it with feeler gauge.	6 month
O t h e r s	NOISE & VIBRATION	Excessive noise or vibration is present	Stop T/G immediately.	As occasion demands

10.브레이크

10-1 구조 및 동작

도면(6S-90MC-24)의 그림처럼 상시에는 스프링(B8)이 밀판(B3)을 밀고 밀판은 마찰판(B2)과 함께 밀착되어 볼트(B5)에 의하여 회전되지 않도록 되어 있다. 코일(B4)에 전원이 가해지면 자력이 발생하여 밀판을 당겨서 마찰판을 느슨하게 하여 회전이 가능하도록 되어 있다.

10-2 취급상의 주의

밀판과 마찰판, 코일 사이에는 이물질이 들어가지 않도록 해야 한다.

10-3 틈새의 조정

도면(6S-90MC-24)에서 너트(B7) 4개를 풀어서 밀판과 코일 사이의 틈새는 0.4 mm로 조정용 게이지를 넣어서 전둘레가 일정하게 되도록 할 것.

10-4 부품의 교체

마찰판의 마모가 심하거나 파손된 경우는 교체를 하여야 하며, 교체 후 반드시 틈새 조정 작업을 해야 한다.

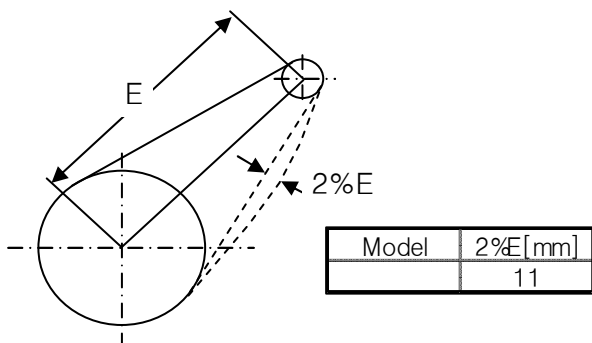
11.롤러 체인을 체크하여 적합하게 팽팽하게 해야 한다. (6개월마다 검사한다.)

11-1 롤러 체인을 위한 검사

- 만약 롤러 체인에서 소음이 발생한다면 체인카바를 분해한 후 롤러 체인을 검사하여야 한다.
- 만약 심한 소음이 여전히 사라지지 않는다면 모터와 스프로켓의 평행됨을 재정비 해야 한다.
- 체인의 각 구간 고장을 검사하라.

11-2 롤러 체인의 적합성

- 롤러 체인은 체인의 롤러가 이빨의 뿌리(끝) 접촉하도록 팽팽하게 걸쳐있어야 한다.
- 늘어짐의 양이 스프로켓의 중심 거리에서 2%가 넘어서는 안된다.



10.BRAKE

10-1 Construction and Operation

The pushing disc(B3) adhere closely together with friction disc ordinary times.

However, if electric power is supplied to the magnetic coil(B4), Friction disc(B2) is separated from Pushing disc(B3) by Magnetic power.

So, the brake is released and T/G can be turned freely.

10-2 Pay attention to handling

Check and keep clean the space of pushing disc, friction disc & coil.

10-3 Adjustment of Gap

Adjust the gap of pushing disc and coil to 0.6mm evenly.

10-4 Replacement of parts

Replace friction disc with new one when it wears out excessively. After exchanging it, be sure to readjust clearance.

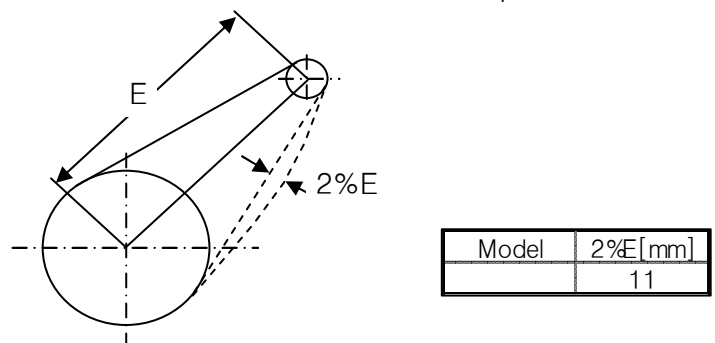
11.Check and tension adjustment for Roller Chain. (Inspect per 6 months.)

11-1 Check of Roller Chain

- If the noise occurred to the roller chain, Inspect the roller chain after removing the chain cover.
- If a heavy noise is still not disappeared, rearrange the sprockets of motor and reducer.
- Inspect a failure of each link of chain

11-2 Adjustment of Roller chain

- Roller chain has to be tensile-loaded until chain's roller contacts to the root of teeth.
- The amount of slack should not be exceeded 2% of the center to center distance of sprockets.



12.조립 도면

(별 첨)

12.ASSEMBLY DRAWING

(Seperately appendix)

13.예비 부품 목록

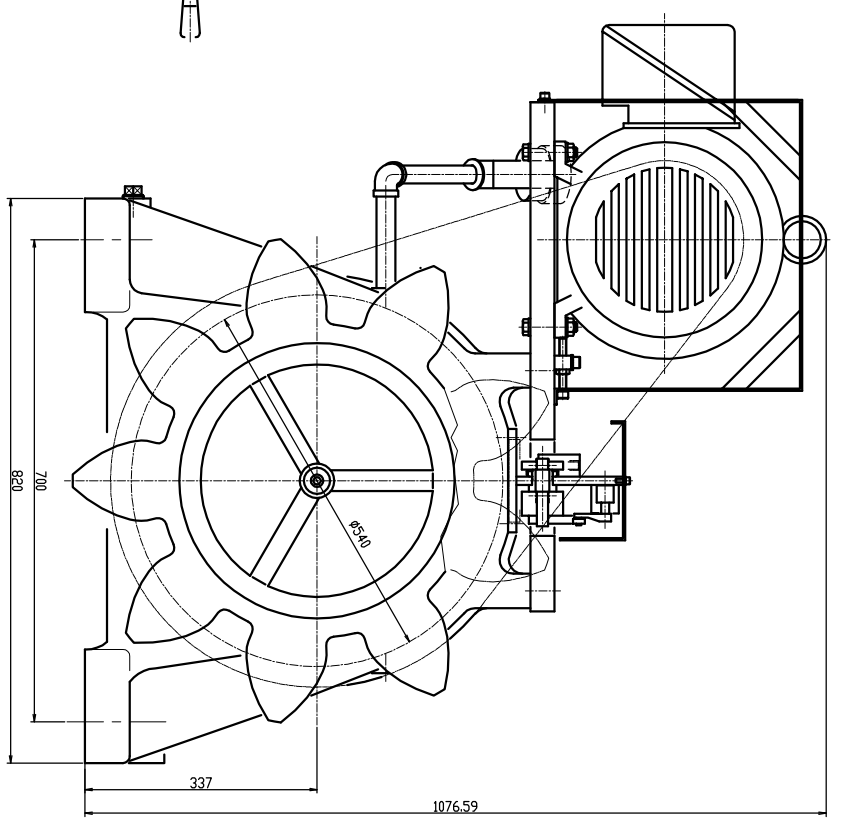
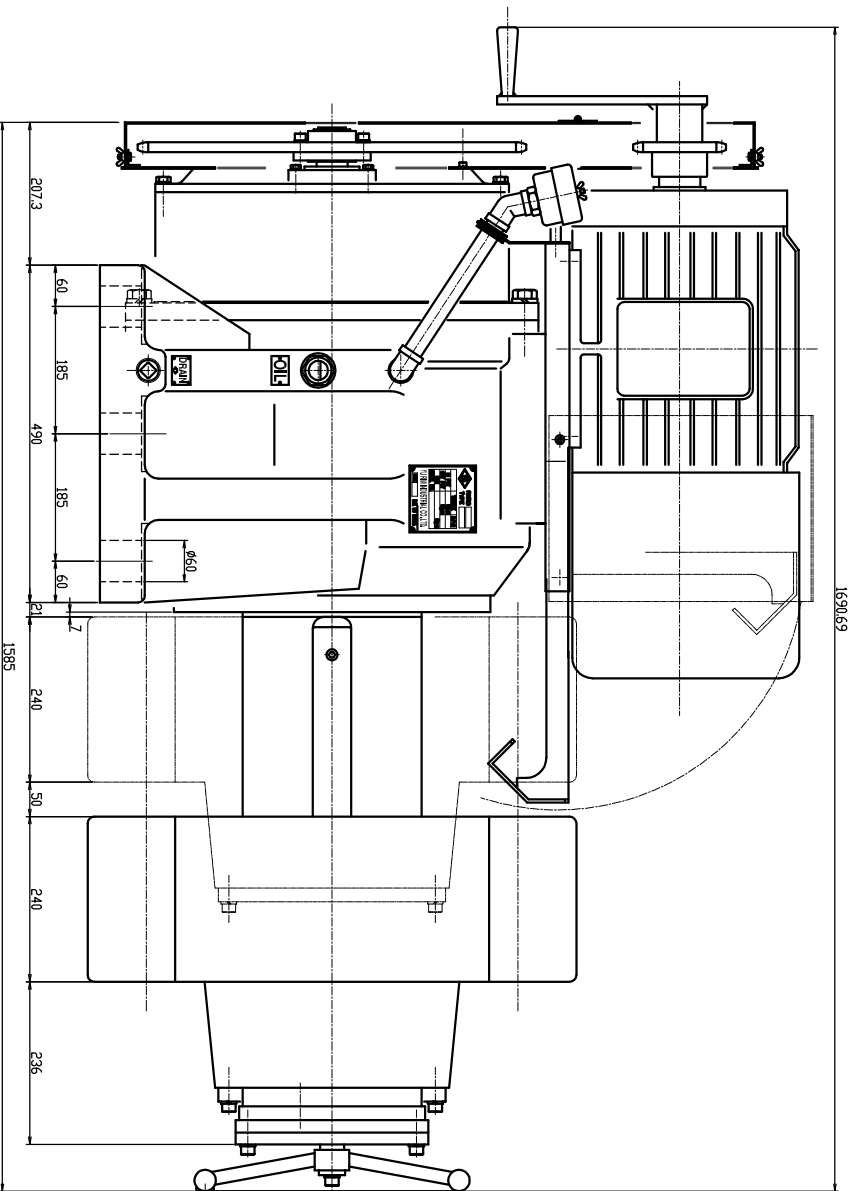
(별 첨)

13.SPARE PARTS

(Seperately appendix)

[illegible]

PROJECT	TURNING GEAR WITH MOTOR		SCALE	CHECKED BY	APPROVED BY
TITLE	YRTG 96-140		1/	DESIGNED BY	
CUSTOMER	HHI.EMD			DRAWN BY	
DATE	03.07.31		PART LIST	A1018756781	
 YU RIM INDUSTRIAL CO., LTD.			DWG. NO	65-90MC-PLST	





RATIO 1/1196.2

TYPE YRTG 96-140

IN PUT	TORQUE	R.P.M
OUT PUT	8 Kg.m	1150
MAX	9600 Kg.m	0.96
SERIAL NO.	14450 Kg.m	

YU RIM INDUSTRIAL CO.,LTD.

DATE: DNE GI KOREA

LUBRICATION OIL SPECIFICATION

회 사 명	기 품 명	비 고
CASTROL	ALPHA SP460	1US STEEL 222,224 규격 만족 2AGMA 250.04 규격 만족 3DIN 51517 PART-3 규격 만족 4CINCINNATI- MILACRON P-59 규격 만족
CASTROL	SPHEROL SX2	가방 기어, 체인휠 스크류용

001 ASSEMBLY(A)					
NO.	NAME	MATERIAL	QTY	W/H	SIZE
PROJECT		APPROVED BY		REMARKS	
TITLE		SCALE		CHECKED BY	
CUSTOMER		1/8		DESIGNED BY	
DATE		LIST NO		DRAWN BY	
07.07.20					
YU RIM INDUSTRIAL CO.,LTD.		DWG.NO		6S-90MC-001	

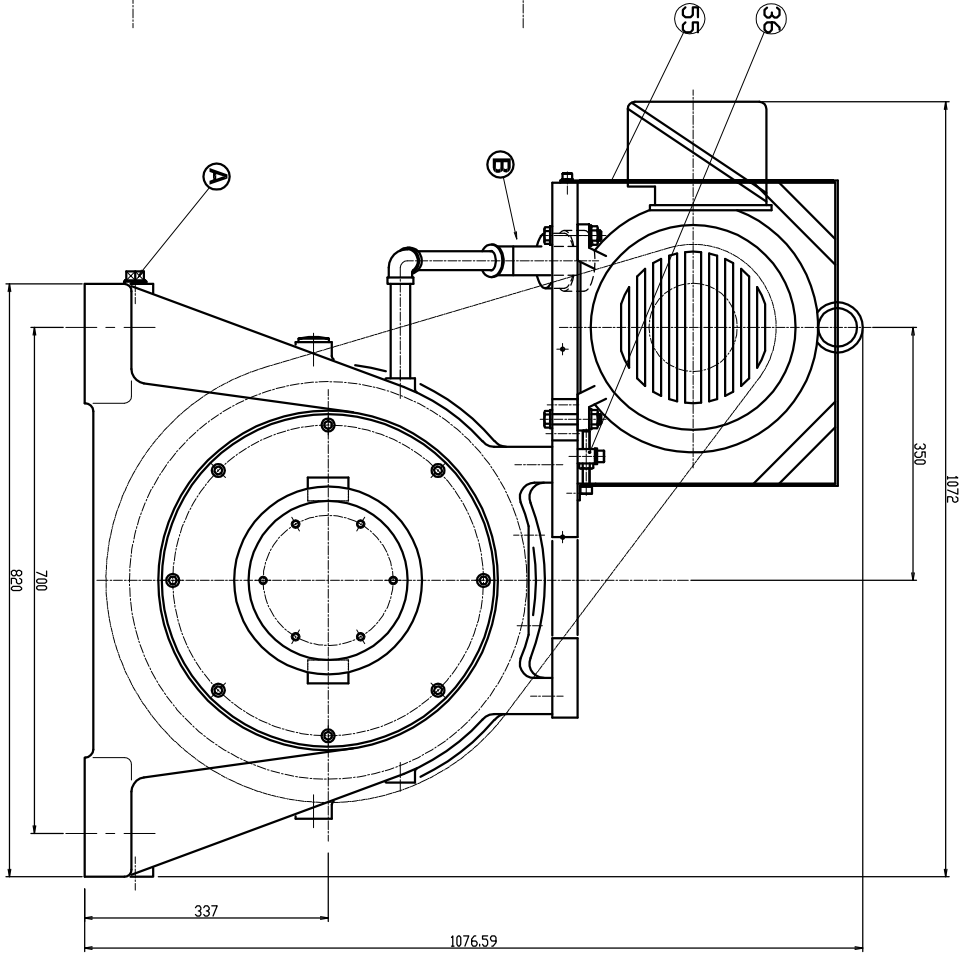
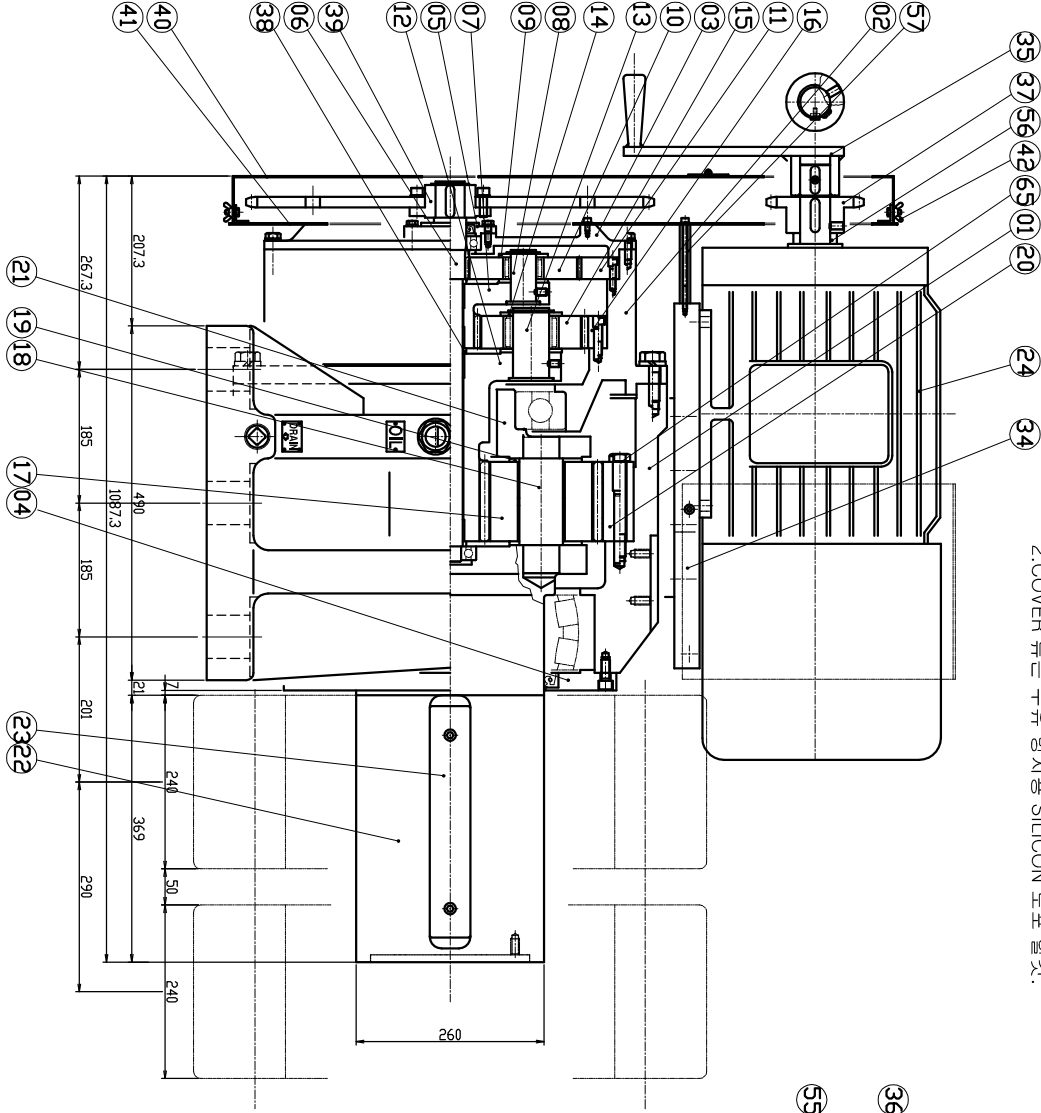


YU RIM INDUSTRIAL CO.,LTD.

6S-90MC-001

NOTE

1. 조립시 BOLT, NUT 체결은 LOCK TIGHT 도포 할것.
2. COVER 류는 누유 방지용 SILICON 도포 할것.



SPECIFICATION

MOTOR	11KW, 6P, 440V, 60Hz
BRAKE	DC 90V
REDUCTION RATIO	(15/60)X(9/19+143)X(9/19+93)X(6/16+68)=1/1196.2
OUTPUT SHAFT SPEED	1150/1196.2=0.96 R.P.M
OUTPUT TORQUE	NORMAL 19600 KG-M MAX 14450 KG-M
NAME	STEP 1 ST. 2 ND. 3 RD.
MODULE	PART SUN M2.5 M4 M6
NO. OF TEETH	19 62 143 19 37 93 16 26 68
PITCH DIAMETER	47.5 155 357.5 76 148 372 96 156 408
WIDTH OF TEETH	40 30 30 45 45 45 120 110 110

002 ASSEMBLY(B)

NO.	NAME	MATERIAL	Q'TY	W/H	SIZE	REMARKS
PROJECT	APPROVED BY					
TITLE	TURNING GEAR WITH MOTOR					
CUSTOMER	YRTG 96-140					
DATE	01.12.25					
SCALE	1/8					
CHECKED BY	DESIGNED BY					
DRAWN BY						
DWG. NO	6S-90MC-002					



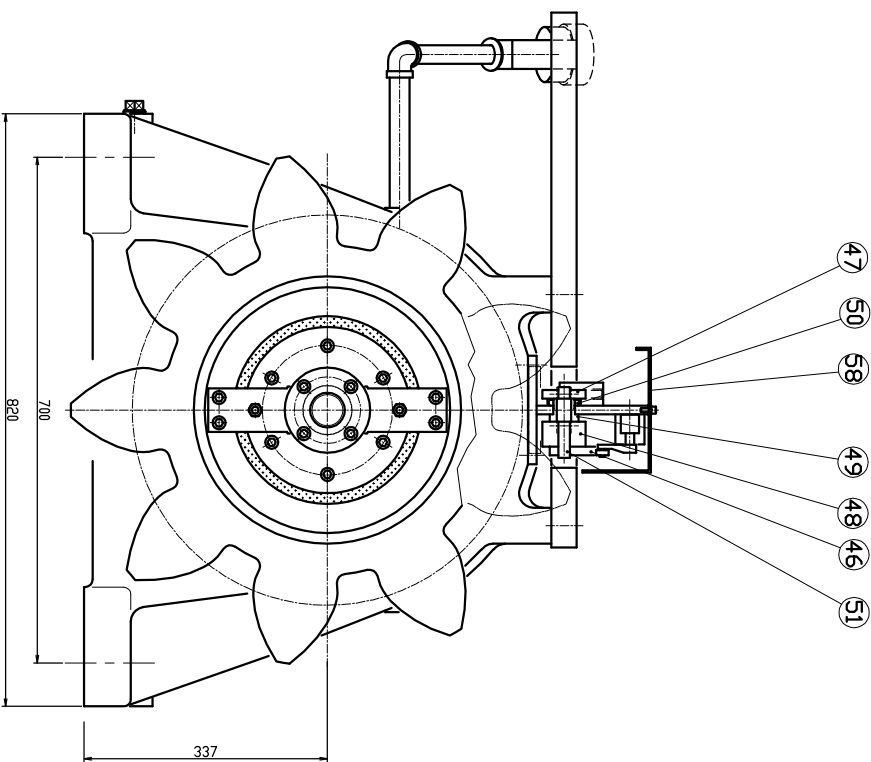
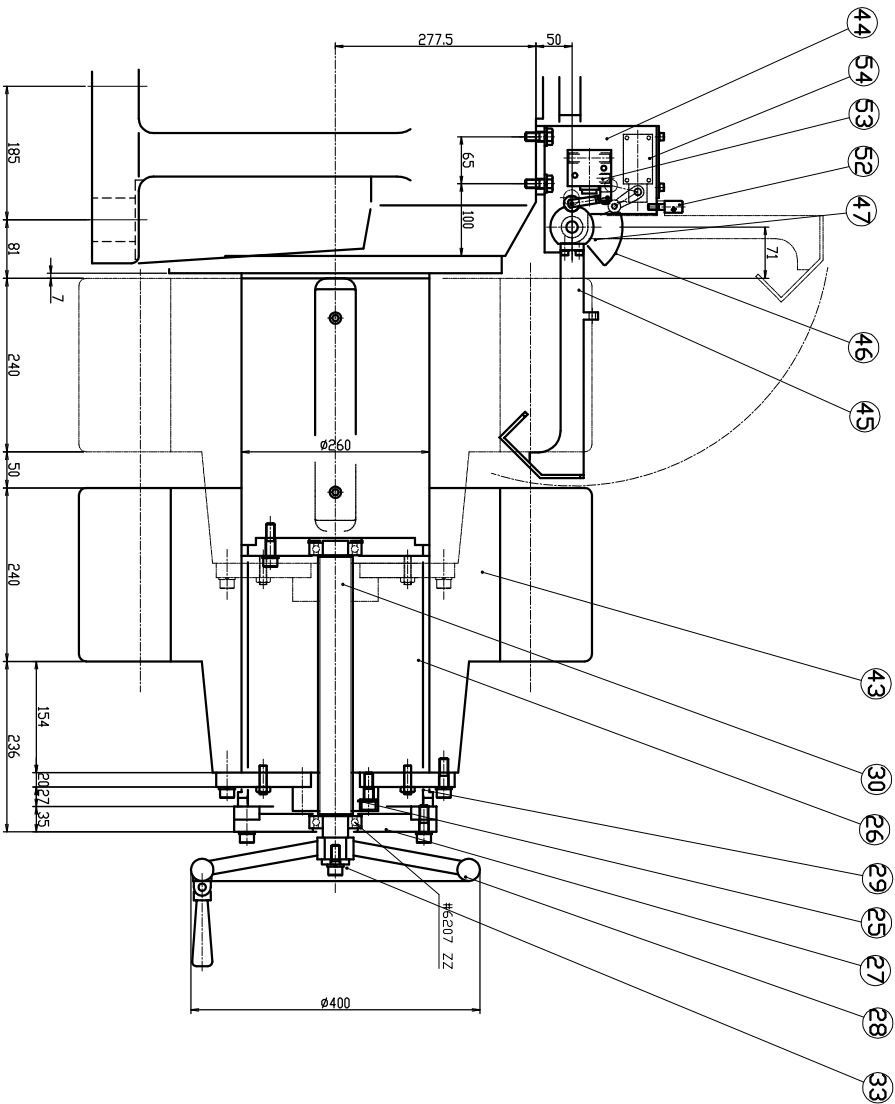
YU RIM INDUSTRIAL CO., LTD.

DWG. NO

6S-90MC-002

NOTE

- 1.조립시 BOLT,NUT 체결은 LOCK TIGHT 도포 할것.
- 2.COVER 류는 누유 방지용 SILICON 도포 할것.



003 ASSEMBLY(C)

NO.	NAME	MATERIAL	Q'TY	W*H	SIZE	REMARKS
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PROJECT	APPROVED BY
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TITLE	SCALE	CHECKED BY
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TURNING GEAR WITH MOTOR	1/8	DESIGNED BY
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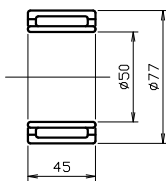
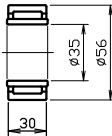
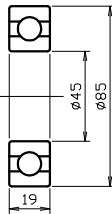
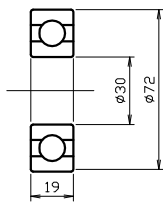
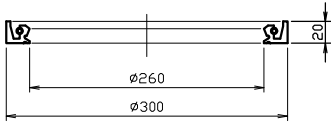
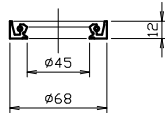
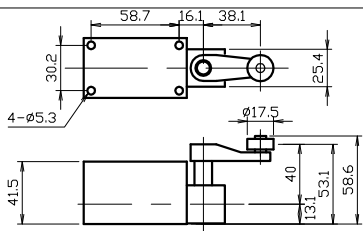
YRTG 96-140		
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CUSTOMER	HHI.EMD	DRAWNED BY
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DATE	01.12.25	LIST NO
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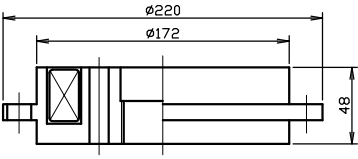
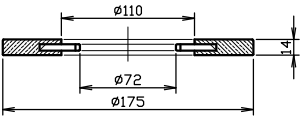
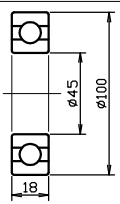
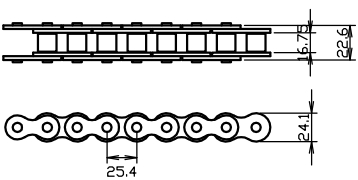
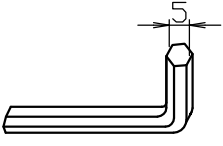
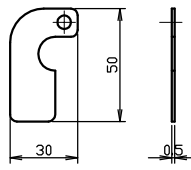
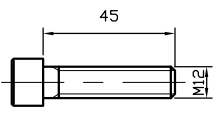
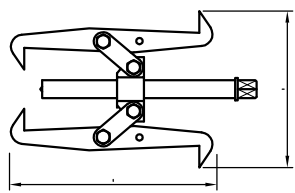
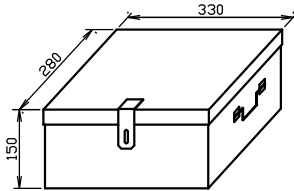
MAIN ENGINE TURNING GEAR WITH MOTOR

SPARE PARTS LIST FOR REDUCTION GEAR

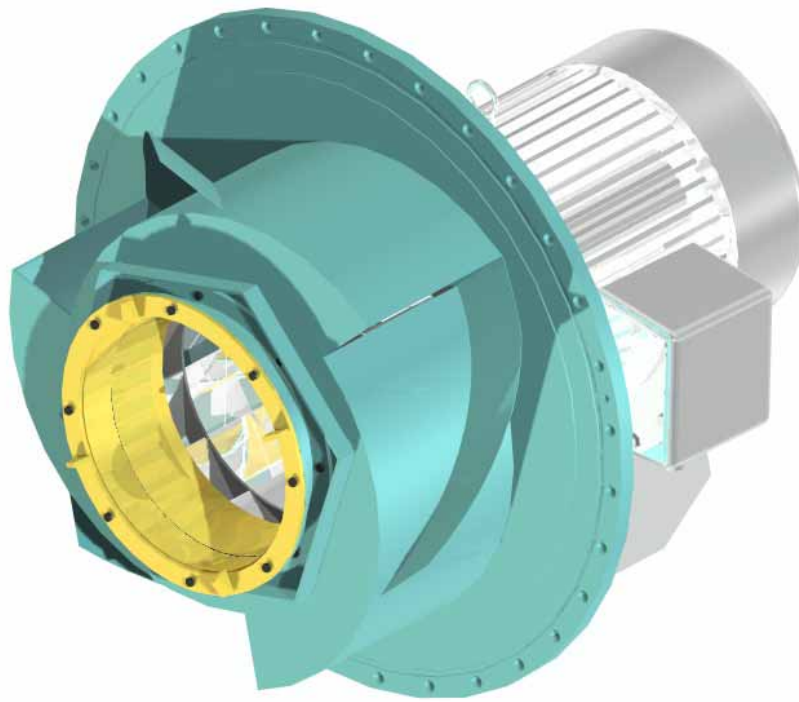
NO.	NAME	SKETCH	METERIAL	SET	SPARE	PART NO	SIZE	REMARKS
				QUANTITY	QUANTITY			
1	NEEDLE BEARING		BEARING STEEL	4	1	151	TRI #507745	PURCHASE
2	NEEDLE BEARING		BEARING STEEL	3	1	101	TRI #355630	PURCHASE
3	BALL BEARING		BEARING STEEL	1	1	061	#6209	PURCHASE
4	BALL BEARING		BEARING STEEL	1	1	062	#6306	PURCHASE
5	OIL SEAL		SYNTHETIC RUBBER	1	1	042	D TYPE 26030020	PURCHASE
6	OIL SEAL		SYNTHETIC RUBBER	1	1	052	D TYPE 456812	PURCHASE
7	LIMIT SWITCH			1	1	54	SZL-WL -A (HONEYWELL)	PURCHASE
NOTE			YRTG 96-140	 YU RIM INDUSTRIAL CO.,LTD.			6S-90MC-SPLST1	

MAIN ENGINE TURNING GEAR WITH MOTOR

SPARE PARTS LIST FOR MOTOR

NO.	NAME	SKETCH	METERIAL	SET	SPARE	PART NO	SIZE	REMARKS
				QUANTITY	QUANTITY			
1	MAGNET HOUSING			1	1	6S-90MC-24A (B4)	DB-30 (PART)	DAE KWANG ELECTRIC CO.
2	FRICTION DISC		NON-ASBESTOS / SUS304	2	2	6S-90MC-24A (B2)	DB-30 (PART)	DAE KWANG ELECTRIC CO.
3	BALL BEARING		BEARING STEEL	2	2	6S-90MC-24 (M7)	#6309	PURCHASE
4	ROLLER CHAIN		SK-5	3 M	0.5 M	(391)	RS #80	PURCHASE
5	WRENCH				1	6S-90MC-24A (B12)		PURCHASE
6	THICKNESS GAUGE		SUS304		4	6S-90MC-24A (B13)		YU RIM INDUSTRIAL
7	MANUAL BOLT				2	6S-90MC-24A (B10)		PURCHASE
8	PULLER				1			PURCHASE
9	TOOL BOX				1			
NOTE			YRTG 96-140	 YU RIM INDUSTRIAL CO., LTD.		6S-90MC-SPLST2		

INSTRUCTION MANUAL
FOR
AUXILIARY BLOWER WITH MOTOR



- C O N T E N T S -

■ AUX - BLOWER

A. OPERATION

1. PREPARATION FOR OPERATION
2. STARTING INSPECTION
3. TROUBLESHOOTING

B. MAINTENANCE

1. T/C REAR SIDE MOUNT TYPE for B&W ENGINE
2. T/C AFT SIDE MOUNT TYPE for B&W ENGINE
3. T/C REAR SIDE MOUNT TYPE for SULZER ENGINE
4. INSTRUCTION FOR DISMOUNTING & MOUNTING OF IMPELLER

■ ELECTRIC MOTOR

A. OPERATION

1. PREPARATION FOR OPERATION
2. STARTING
3. STOPPING
4. CARE AFTER STOPPING
5. TROUBLESHOOTING

B. MAINTENANCE

1. PERIODICAL MAINTENANCE CHART
2. MAINTENANCE AND REPLACEMENT OF BALL BEARING ON THE MOTOR
3. DISASSEMBLY AND REASSEMBLY OF THE MOTOR
4. DRYING
5. TRIAL RUNNING OF THE MOTOR
6. REFERENCE

■ AUXILIARY BLOWER

A. OPERATION

1. PREPARATION FOR OPERATION

After the fan is left at rest for a long time or subjected to dis - assembly and assembly, carry out the following inspection.

- (1) Make sure that there is no foreign matter in the casing.
- (2) Examine if there is a piece of cloth or another thing which may easily be sucked in, near the suction port.
- (3) Inspect the rotating parts for any contact with fixed parts.
- (4) Check the power source (Voltage, Cycle). Don't supply different cycle, power source with motor specification.

2. STARTING INSPECTION

After starting the fan, carry out the following checks.

- (1) Check to see if the rotating direction is correct.
(This check is not necessary when no reassembling has been carried out.)
- (2) Check for abnormal noise.
- (3) Check for abnormal vibration.

3. TROUBLESHOOTING

When the fan is out of order, care for the fan according to the following table.

No.	Trouble	Probable cause	Remedy
1	Impossible or difficult to start	Mechanical restraint Seizure of bearings Trouble of the motor	Inspect the impeller and related parts to locate the cause. Replace with spare bearings. Check for motor winding disconnection, insufficient voltage, cable disconnection, faulty starter connection, etc.

No.	Trouble	Probable	Remedy
2	Insufficient capacity or motor overload	Dirt and other foreign matter attached to the impeller.	Clean the impeller.
		Rotation reversed.	Correct the rotating direction.
		Air leakage.	Check the air duct connections ect.
		Impeller damaged.	Replace the impeller.
		Insufficient or excessive rotating speed.	Check the motor.
3	Abnormal vibration and noise	Abnormal speed Foreign matter Loose installing bolts Bearing damaged	Check the motor. Remove the foreign matter. Tighten the installing blots. Replace with spar parts.

4. IF YOU HAVE ANY DOUBTS, PLEASE DO NOT HESITATE TO CONTACT.

HYUNDI MARINE MACHINERY CO., LTD.

602 - 15, GAJWA - DONG, SEO - GU, INCHON CITY, KOREA. (<http://hmmco.co.kr>)

TEL : +82 - 32 - 583 - 0671

FAX : +82 - 32 - 583 - 06

B. MAINTENANCE

1. T/C REAR SIDE MOUNT TYPE FOR B & W ENGINE

(1) MOUNTING OF ELECTRIC MOTOR ON B & W AUXILIARY BLOWER

All item numbers refer to drawing No. H - REAR - 01/02

- 1) Place the motor on a table or flat so that shaft is in a horizontal position and motor shaft is sticking out of the foundation.
- 2) Remove the groove from the motor.
- 3) Lubricate the motor shaft with oil or grease.
- 4) The sealing ring to be pushed over the shaft.
- 5) The motor to be bolted onto the motor plate. The motor bolts should be packed carefully with teflon or fluid packing substance. Do not forget to place the terminal box of the motor correctly in proportion to the drain hole.
- 6) Mount the gaslock - seal (item 11) in the stuffing box (item 7) the lip towards the impeller.
If the Gaslock - seal has already been mounted - check the seal lip.
- 7) Place the Gasket (item 8) between motor plate and stuffing box (item 7) Carefully push the stuffing box over motor shaft and sealing ring without damaging the Gaslock - seal. The stuffing box will automatically centre and then be mounted by means of 6 bolts with washers made of carbon steel. Lubricate the lip carefully with grease from both sides.
- 8) The groove should be shortened to fit the projecting part of the motor shaft.
- 9) The impeller should now be carefully pushed over the shaft, while taking care that the groove and the key way are next to each other.

When the impeller cannot be pushed up any further, it should be pulled into right position by means of a bolt.

- 10) The impeller should be tightened by using a thin washer(5 - 6mm), a lock washer, and a bolt.

NB : The impeller has been dynamically and statically balanced from the factory and must not be damaged in any way

- 11) The inlet cone to be dismantled.

- 12) The GASKET (item 5) to be placed in its right position.

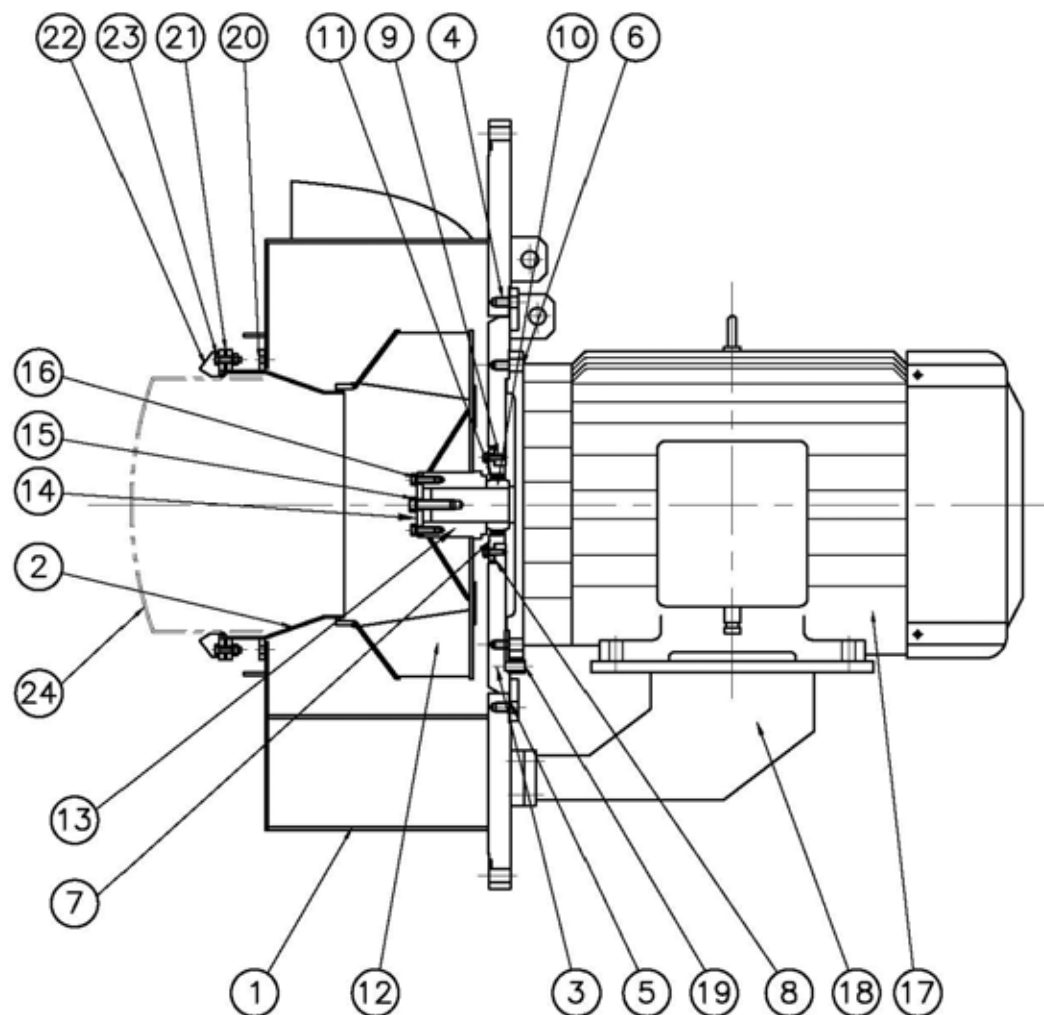
- 13) The motor plate to be lowered onto the fan housing and tightened by means of bolts with washers made of Carbon Steel.

- 14) Mount the inlet cone. Take care, however, that the distance between the impeller and the inlet cone is the same all the way round.

- 15) Turn the impeller manually in order to check that it runs smoothly.

- 16) The motor may now be started in order to check the fan for excess vibration and jarring sounds. With an accelerometer it should be checked that the motor has an effective frequency below 2 mm/sec. Measurements should be made horizontally and vertically on a level with the motor bearings. The impeller has been balanced in accordance with ISO 1940 and with quality class Q better than 6.3.

Testing period 15 - 20 minutes.



24	SUCTION DUCT		1		
23	BOLT, S/W	8.8T	8		
22	GUIDE RING	SS400	1		
21	GASKET	RUBBER	1		
20	BOLT, NUT, S/W	8.8T	8		
19	DRAIN	SS400	1		
18	MOTOR BED	SS400	1		
17	MOTOR		1		
16	BOLT, S/W, D.L/W	8.8T	2		
15	BOLT, S/W, D.L/W	8.8T	1		
14	SHAFT CAP	SS400	1		
13	IMPELLER BOSS	A6061P	1		
12	IMPELLER	A5083P	1		
11	GASLOCK SEAL	SS400	2		
10	SEALING RING	SM45C	1		
9	BOLT, S/W	8.8T	6		
8	GASKET	NON-ASBESTOS	1		
7	STUFFING BOX	SS400	1		
6	BOLT, S/W	8.8T	8		
5	GASKET	NON-ASBESTOS	1		
4	BOLT, S/W	8.8T	20		
3	MOTOR SEAT	SS400	1		
2	SUCTION CONE	SS400	1		
1	CASING	SS400	1		

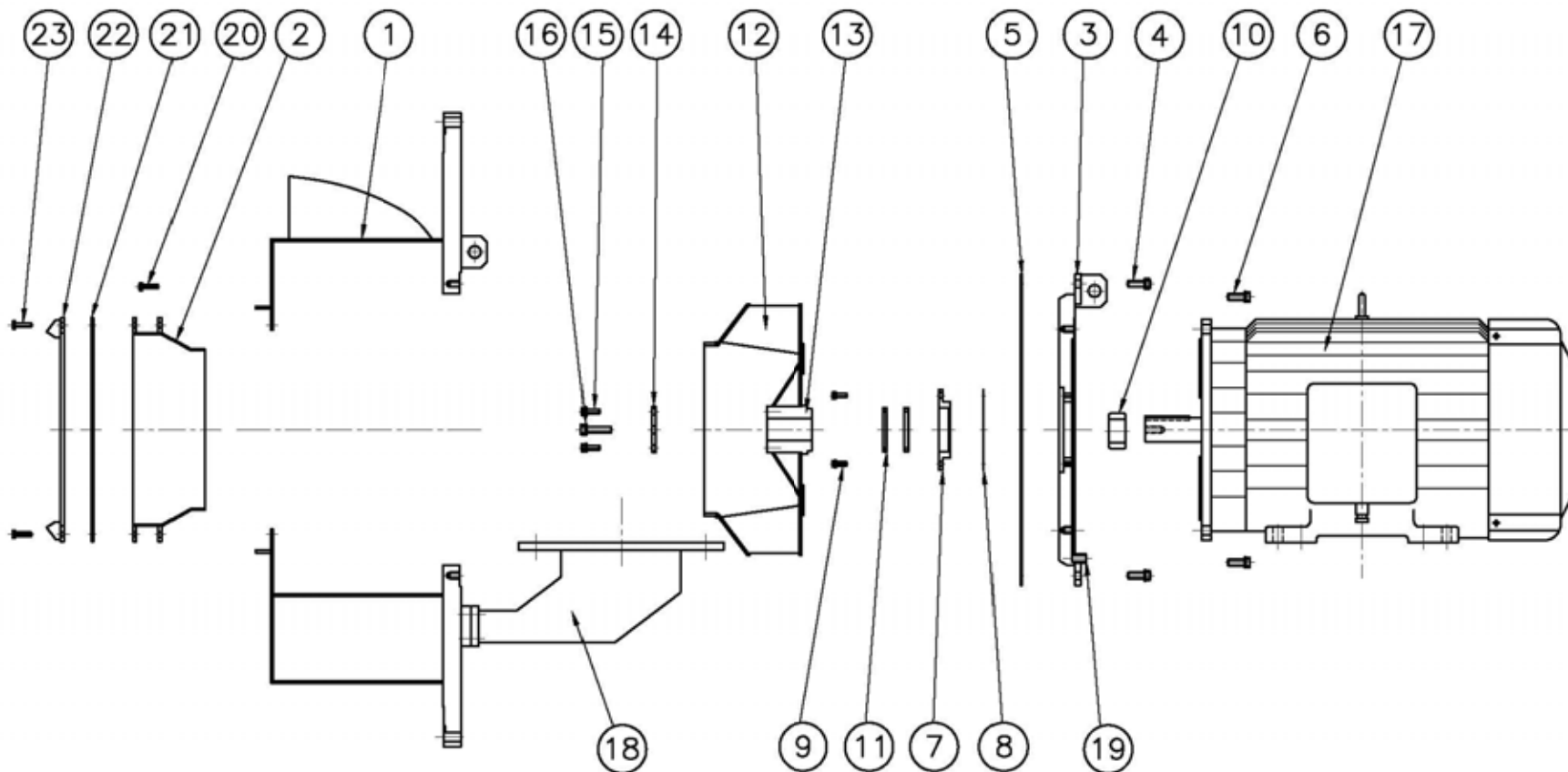
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Q'ty	SCALE	TITLE			
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DWG. NO.	3RD ANGLE	DATE			
H-REAR-01	△	4.03.22			

DATE	CODE	MEMO	SIGN
	△		
	△		
	△		

REAR

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Hyundai Marine Machinery Co., Ltd.
Inchon Korea



DATE	CODE	MEMO	SIGN
	△		
	△		
	△		

NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MPG. NO.	DATA	CUSTOMER			
	04.03.22				
Q'ty	SCALE	TITLE	MAINTENANCE DWG. OF AUX. BLOWER		
	1/15				
DWG. NO.	SRD ANGLE				
H-REAR-02					
HMMCO Hyundai Marine Machinery Co., Ltd. Inchon Korea					

2. T/C AFT SIDE MOUNT TYPE FOR B & W ENGINE

(1) MAINTENANCE OF B&W AUXILIARY BLOWERS

The auxiliary blowers usually consist of the following main components which are shown on drawing No. H - AFT - 01/02/03

- 1) Blowers.
- 2) T - connection.
- 3) Electric motors.

Your attention is drawn to the fact that some of the minor types of diesel engines do not require compensator and suction box.

1) Blower.

The blower part consists of the following.

Scroll housing made of heavy steel plate.

Impeller in special welded alu. - alloy.

Suction cone.

Tightening device, intended for pressure of up to 5 Bar

Motor plate.

Motor.

2) T - connection.

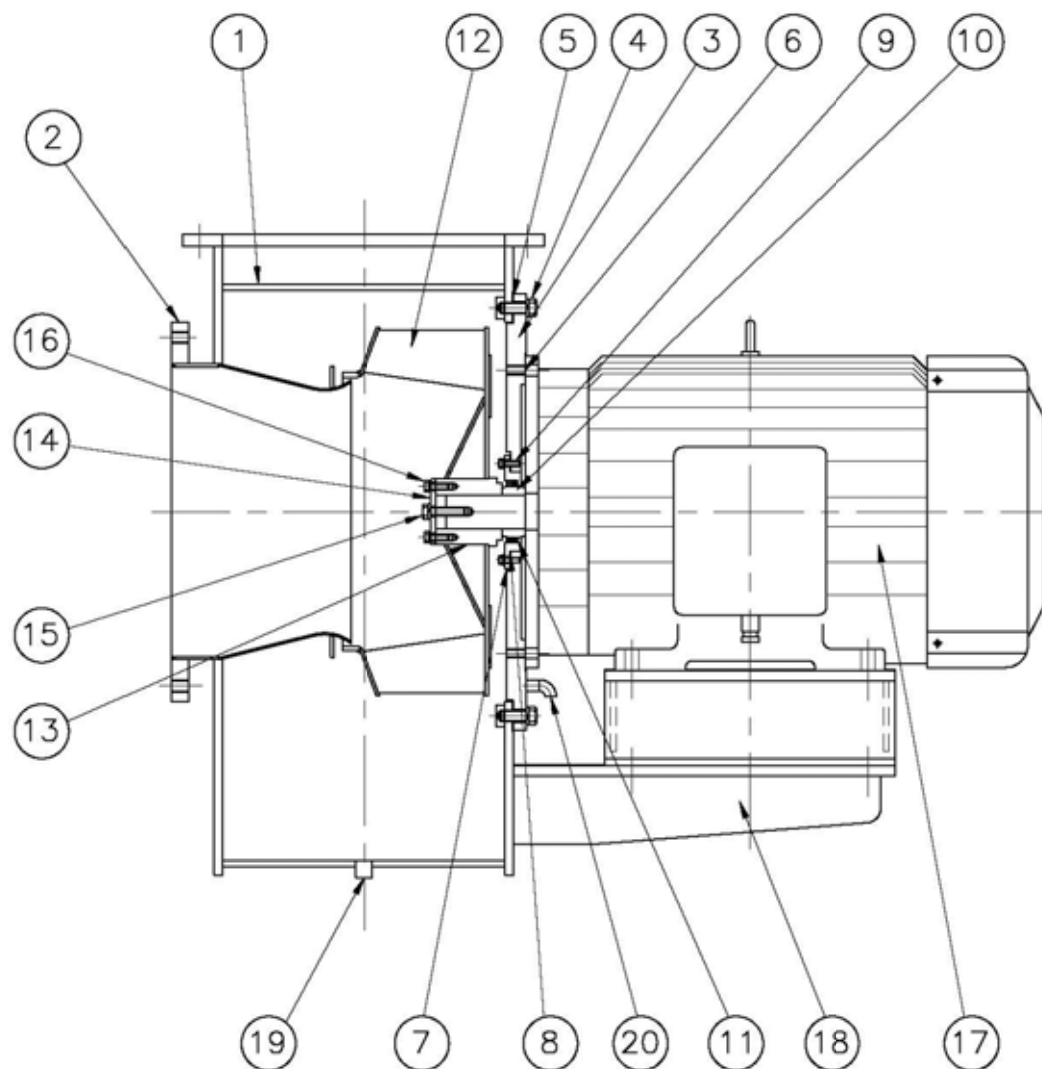
The T - connection, which is made of heavy steel plate, serves as connection piece between the two blowers as well as connection to the outlet pipe of the air cooler.

The pressure opening surfaces of the two blowers have a parallelism better than 0.1 mm. The parallelism is maintained by 8 conical guide pins, which should be treated carefully when re - mounting.

(2) MOUNTING OF AUXILIARY BLOWER

- 1) The two fans have been mounted on the T - connection from the factory and should not be separated.
- 2) Lift the whole unit to its right place.
Tighten blowers loosely onto diesel engine.
Tighten all bolts properly.
- 3) Mount the suction pipe from the air cooler.
- 4) The unit is now ready to be put into operation.
- 5) During operation the mechanical seal, which consists of Sealing ring (item 10) and Gas lock seal (item 11), will leak a bit considerable leakages indicate that the Gas lock seal is worn out and should be replaced. During this replacement the Sealing ring should be turned so that the seal gets to work at another spot on the sealing ring.

NB : The fans are in right and left position respectively, wherefore the impellers must not be reversed. The impellers are marked with the serial number of the fan.



20	DRAIN	SS400	1		
19	DRAIN	SS400	1		
18	MOTOR BED	SS400	1		
17	MOTOR		1		
16	BOLT,S/W,D.L/W	8.8T	2		
15	BOLT,S/W,D.L/W	8.8T	1		
14	SHAFT CAP	SS400	1		
13	BOSS		1		
12	IMPELLER	A5083	1		
11	GASLOCK SEAL	THERMO-ELASTIC	2		
10	SEALING RING	SM45C	1		
9	BOLT,S/W	8.8T	6		
8	GASKET		1		
7	STUFFING BOX	SS400	1		
6	MOTOR FIXING BOLT,S/W	8.8T	8		
5	GASKET		1		
4	BOLT,S/W	8.8T	20		
3	MOTOR SEAT	SS400	1		
2	SUCTION CONE	SS400	1		
1	FAN CASING	SS400	1		

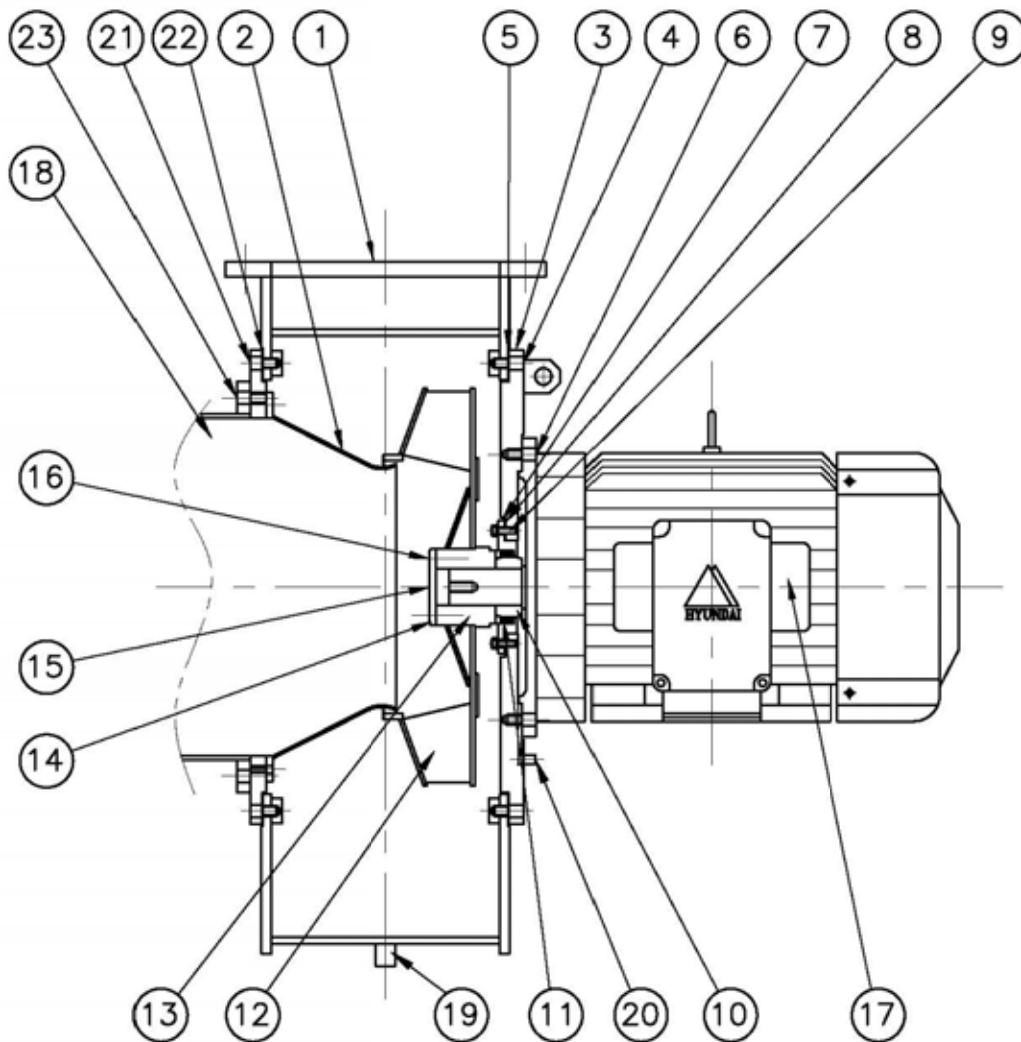
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MFG. NO.	DATA	CUSTOMER			
	04.03.22				
Q'ty	SCALE	TITLE			
	1=12	SECTIONAL DWG OF AUX. BLOWER			
DWG. NO.	3RD ANGLE	APPROVE			
H-AFT-01		04.03.22 04.03.22 04.03.22 04.03.22			

A	DATE	CODE	M E M O	SIGN
M				
E				
N				
D				

AFT

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Inchon Korea



23	HEXAGON WRENTH BOLT, S/W	8.8T	20		
22	GASKET		1		
21	BOLT, S/W	8.8T	20		
20	DRAIN		1		
19	DRAIN		1		
18	T-DUCT	SS400	1		
17	MOTOR		1		
16	BOLT, S/W	8.8T	2		
15	BOLT, S/W, D.L/W	8.8T	1		
14	SHAFT CAP	SS400	1		
13	BOSS	A6063P	1		
12	IMPELLER	A5083P	1		
11	GASLOCK SEAL THERMO-ELASTIC		2		
10	SEALING RING	SM45C	1		
9	BOLT, S/W	8.8T	6		
8	GASKET		1		
7	STUFFING BOX	SS400	1		
6	MOTOR FIXING BOLT, S/W	8.8T	8		
5	GASKET		1		
4	BOLT, S/W	8.8T	20		
3	MOTOR SEAT	SS400	1		
2	SUCTION CONE	SS400	1		
1	FAN CASING	SS400	1		

NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MPG. NO.	DATA	CUSTOMER			
Q'ty	SCALE	TITLE			
	1=10	SECTIONAL DWG OF AUX. BLOWER			
DWG. NO.	SHD ANGLE	DATE			
H-AFT-02		03.12.01 03.12.01 03.12.01 03.12.01			

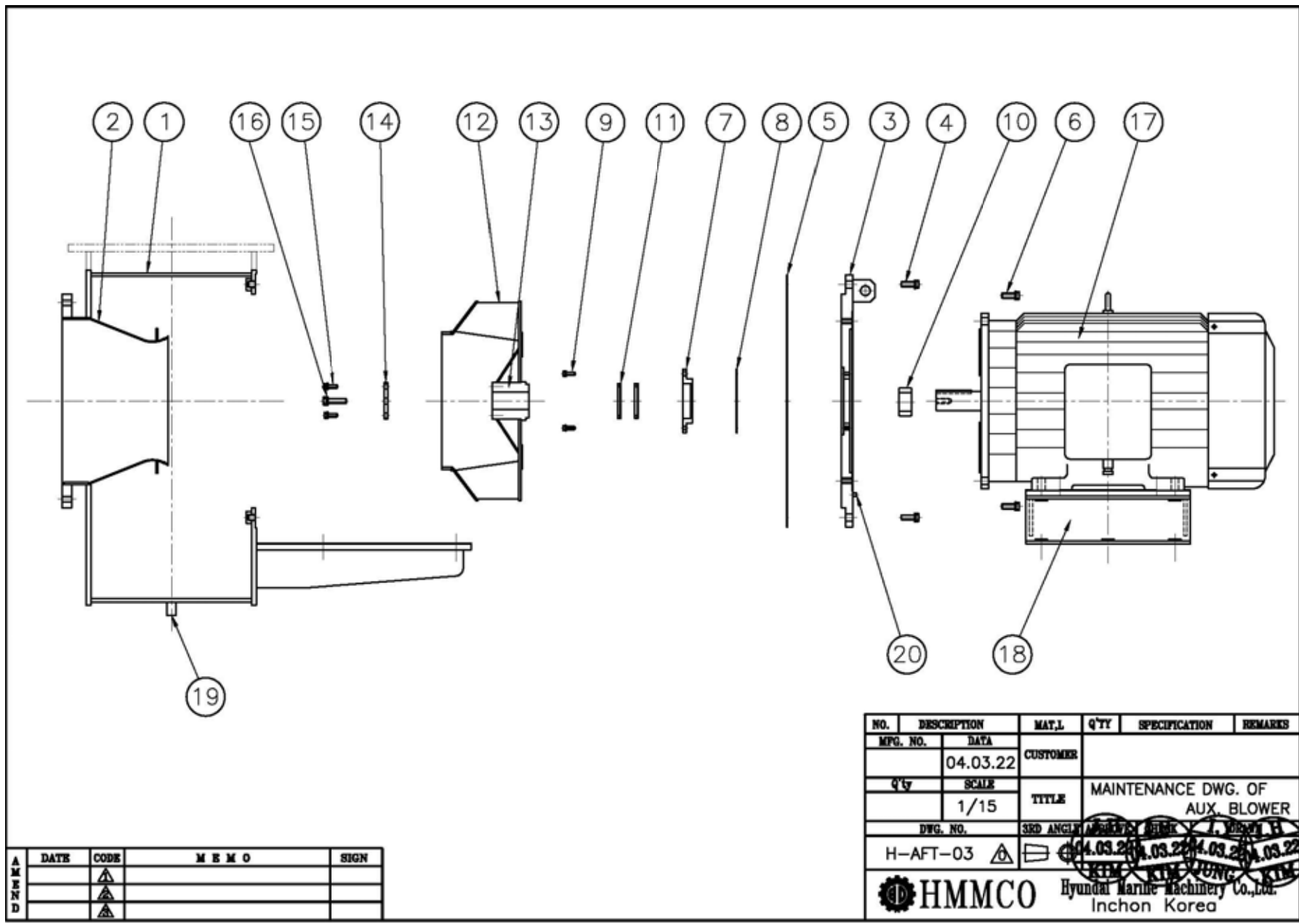
DATE	CODE	MEMO	SIGN

AFT



HMMCO

Hyundai Marine Machinery Co., Ltd.
Inchon Korea



DATE	CODE	MEMO	SIGN
	▲		
	▲		
	▲		

NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.	DATA	CUSTOMER			
	04.03.22				
Q'ty	SCALE	TITLE			
	1/15	MAINTENANCE DWG. OF AUX. BLOWER			
DWG. NO.	3RD ANGLE	PROJECT	DATE	BY	CHK
H-AFT-03	△	□	04.03.22	04.03.22	04.03.22
HMMCO Hyundai Marine Machinery Co., Ltd. Inchon Korea					

3. T/C REAR SIDE MOUNT TYPE FOR SULZER ENGINE

(1) MAINTENANCE OF SULZER AUXILIARY BLOWERS

The auxiliary blowers usually consist of the following main components which are shown on drawing No. H - WCH - 01/02/03

- 1) Blowers.
- 2) Joint duct.
- 3) Suction box.
- 4) Electric motor.

Your attention is drawn to the fact that some of the minor types of diesel engines do not require compensator and suction box.

1) Blower.

The blower part consists of the following.

Scroll housing made of heavy steel plate.

Impeller in special welded alu. - alloy.

Suction cone.

Tightening device, intended for pressure of up to 5 Bar

Motor plate.

Motor.

2) Joint duct.

The joint duct consists of two mounting flanges.

3) Suction box.

The suction box consists of a heavy steel box direct mounting onto the main motor, plus and inspection cover.

The function of the suction box is to combine outlet of the air cooler with the inlet of the auxiliary blower.

(2) MOUNTING OF AUXILIARY BLOWER

1) Mount joint duct onto suction box.

(Small flange towards suction box.)

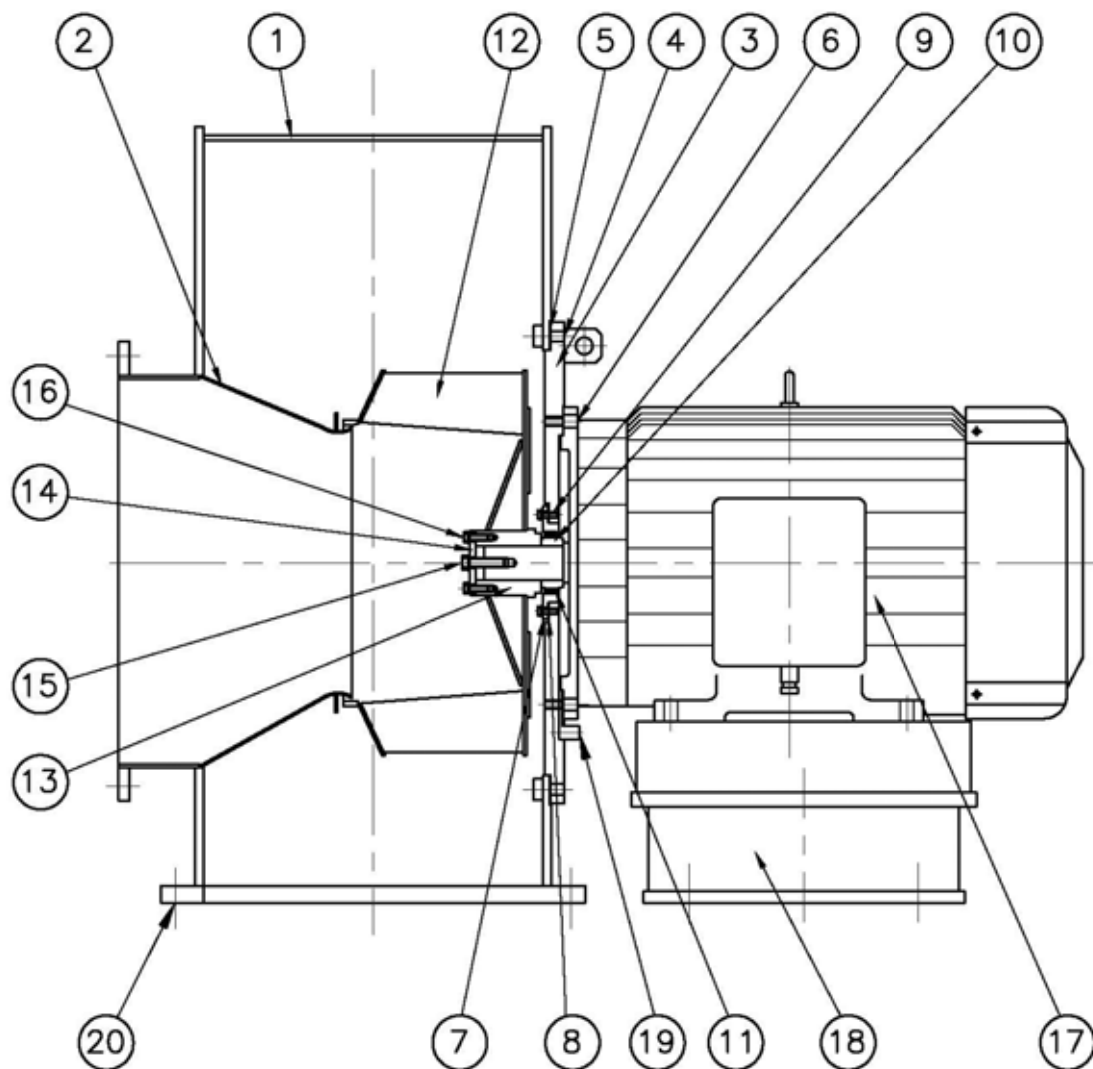
2) Mount suction box onto diesel engine.

3) Lift the blower to it's right place and push it towards the joint duct.

Tighten blower loosely onto diesel engine.

Tighten joint duct onto blower so that it does not suffer any harm.

The unit is now ready to be put into operation.



20	TAPER PIN		2		
19	DRAIN	SS400	1		
18	MOTOR BED	SS400	1		
17	MOTOR		1		
16	BOLT,S/W	8.8T	2		
15	BOLT,S/W	8.8T	1		
14	SHAFT CAP	SS400	1		
13	BOSS		1		
12	IMPELLER	A5083	1		
11	GASLOCK SEAL	THERMO-ELASTIC	2		
10	SEALING RING	SM45C	1		
9	BOLT,S/W	8.8T	6		
8	GASKET		1		
7	STUFFING BOX	SS400	1		
6	MOTOR FIXING BOLT,S/W	8.8T	8		
5	GASKET		1		
4	BOLT,S/W	8.8T	20		
3	MOTOR SEAT	SS400	1		
2	SUCTION CONE	SS400	1		
1	FAN CASING	SS400	1		

NO.	DESCRIPTION	MAT'L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.	DATA	CUSTOMER			
	04.03.22				
Q'ty	SCALE	TITLE			
2 Sets	1=12				
DWG. NO.	3RD ANGLE	SECTIONAL DWG OF AUX. BLOWER			
H-WCH-01	△				

A	DATE	CODE	MEMO	SIGN
M		△		
E		△		
N		△		
D		△		

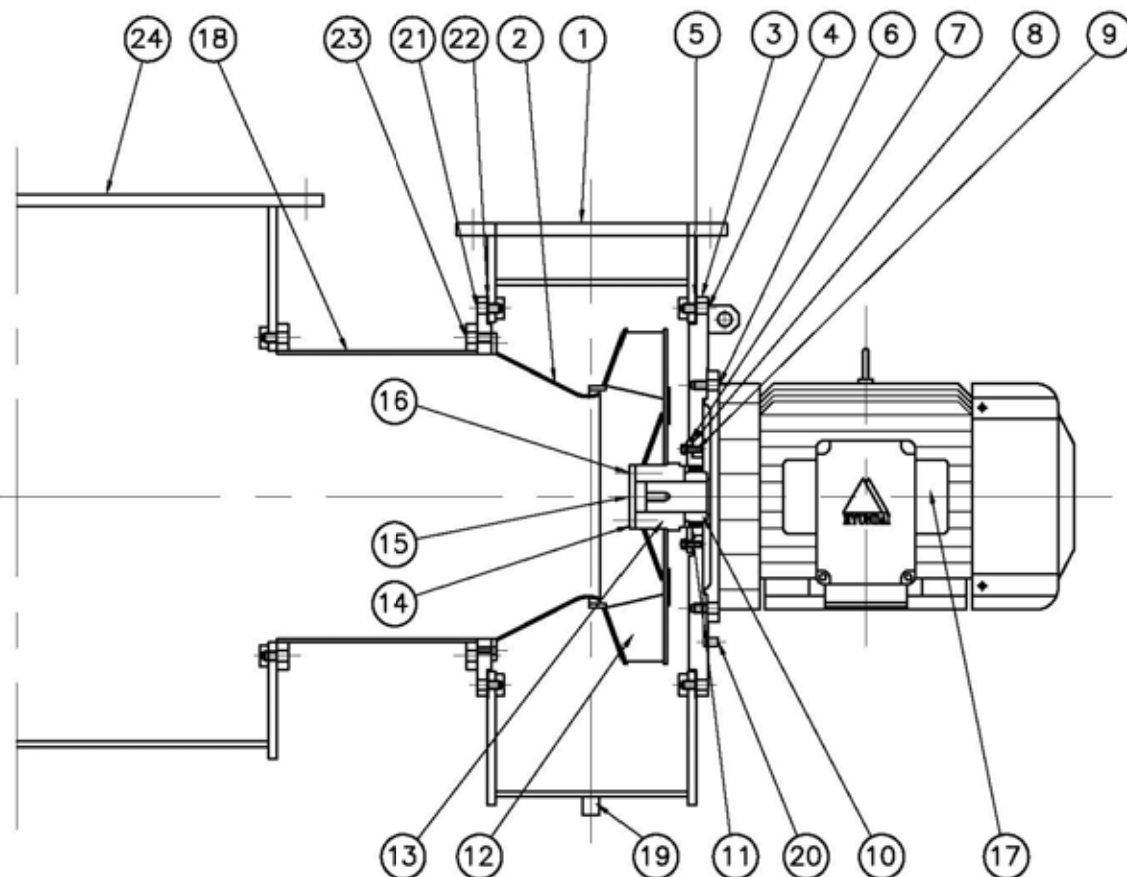
WCH



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Inchon Korea

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24	SUCTION BOX	SS400	1		
23	HEXAGON WRENTH BOLT, S/W	8.8T	20		
22	GASKET		1		
21	BOLT, S/W	8.8T	20		
20	DRAIN		1		
19	DRAIN		1		
18	SUCTION DUCT	SS400	1		
17	MOTOR		1		
16	BOLT, S/W	8.8T	2		
15	BOLT, S/W, D.L/W	8.8T	1		
14	SHAFT CAP	SS400	1		
13	BOSS	A6063P	1		
12	IMPELLER	A5083P	1		
11	GASLOCK SEAL	THERMO-ELASTIC	2		
10	SEALING RING	SM45C	1		
9	BOLT, S/W	8.8T	6		
8	GASKET		1		
7	STUFFING BOX	SS400	1		
6	MOTOR FIXING BOLT, S/W	8.8T	8		
5	GASKET		1		
4	BOLT, S/W	8.8T	20		
3	MOTOR SEAT	SS400	1		
2	SUCTION CONE	SS400	1		
1	FAN CASING	SS400	1		

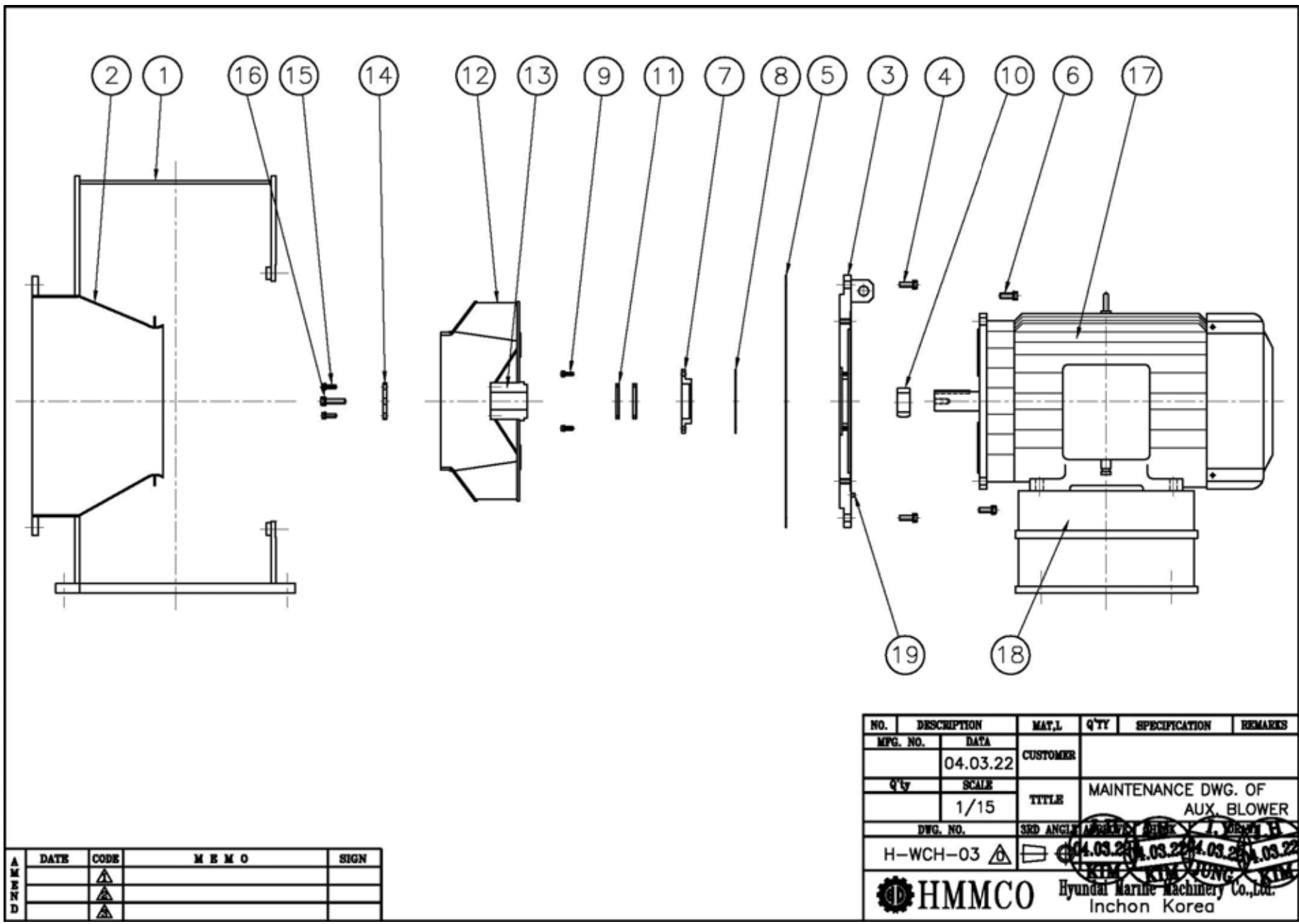
NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.	DATA	CUSTOMER			
Q'ty	SCALE	TITLE			
	1=12	SECTIONAL DWG OF AUX. BLOWER			
DWG. NO.	3RD ANGLE	DATE	DATE	DATE	DATE
H-WCH-02	△	03.12.01	03.12.01	03.12.01	03.12.01

DATE	CODE	MEMO	SIGN
	△		
	△		
	△		

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Inchon Korea



DATE	CODE	MEMO	SIGN
	△		
	△		
	△		

NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.	DATA	CUSTOMER			
Q'ty	SCALE	TITLE			
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DWG. NO.	3RD ANGLE	DATE			
H-WCH-03	△	04.03.22			
HMMCO Hyundai Marine Machinery Co., Ltd. Inchon Korea					

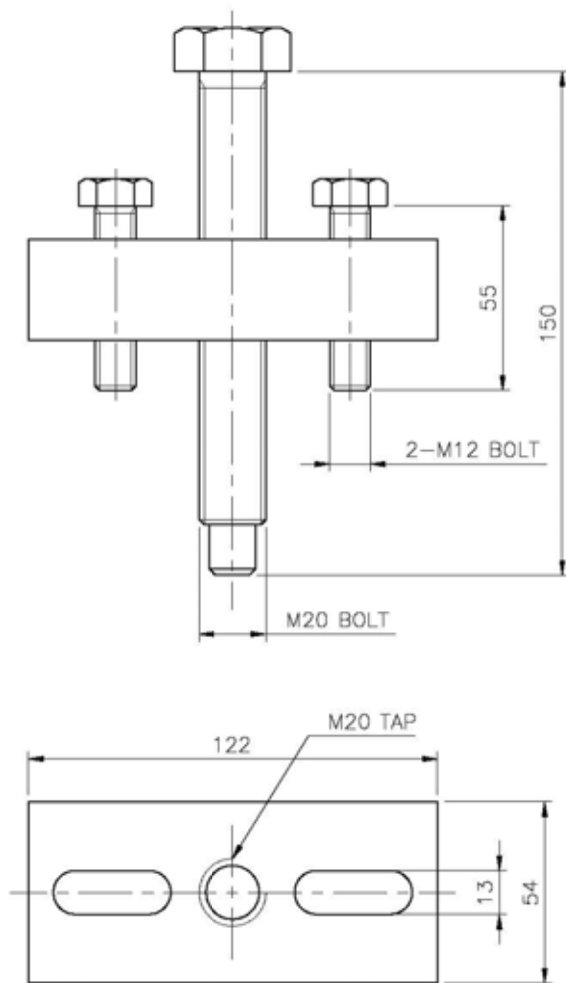
4. INSTRUCTION FOR DISMOUNTING & MOUNTING OF IMPELLER

(1) INSTRUCTIONS FOR DISMOUNTING OF IMPELLER ON AUXILIARY BLOWER

In the following it is recommended to see drawing No.

H - REAR - 01/02, H - AFT - 01/02/03, H - WCH - 01/02/03

- 1) The electric connection of the motor to be dismantled.
- 2) The bolt on the motor to be loosened, and motor, motor plate, and impeller to be raised from the scroll casing by means of a stable lifting device.
- 3) The bolt on the motor shaft to be loosened and removed together with the spring plate.
- 4) Dismounting tool - as shown on the enclosed sketch No. H - TOOL - 01 to be mounted on the hub of the impeller by means of 2 bolts which are screwed into the belonging threaded holes.
- 5) A strong disk is to be placed between the motor shaft and the dismantling tool in order not to damage the threaded hole in the motor shaft.
- 6) The impeller to be carefully drawn out by means of tightening the middle bolt.
- 7) Under normal conditions the sealing ring remains on the motor shaft. However, it comes off when dismantling the impeller, the motor plate must be dismantled from the motor and the sealing ring must be mounted on the motor shaft. The motor can now be mounted, however, please take care not to damage the sealing ring.



A M E N D	DATE	CODE	M E M O	SIGN
		△		
		△		
		△		

NO.	DESCRIPTION	MAT.L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.	DATA	CUSTOMER			
	04.03.22				
Q'ty	SCALE	TITLE	LAYOUT DWG. OF IMPELLER TOOL		
	1=2				
DWG. NO.		3RD ANGLE			
H-TOOL-01	  				
 HMMCO		Hyundai Marine Machinery Co., Ltd. Inchon Korea			

(2) INSTRUCTIONS FOR DISMOUNTING OF IMPELLER ON AUXILIARY BLOWER
FOR MAIN DIESEL ENGINES

In the following it is recommended to see drawing No.

H - REAR - 01/02, H - AFT - 01/02/03, H - WCH - 01/02/03

Please note that the new impeller has been statically and dynamically balanced from the factory, and therefore the impeller must not be exposed to thrust or other overload.

- 1) Grease the motor shaft with oil.
- 2) The impeller to be pressed over the motor shaft by means of a bolt and a washer plate. Please make sure that the groove fire opposite the key groove.
- 3) The impeller to be held by means of the original spring plate and bolt.
- 4) Motor plate to be lifted up carefully from the foundation and to be turned horizontally
- 5) The packing between the scroll casing plate and the motor plate to be examined for porosities and cracks. In case of a defect packing has to be replaced. Please use a corresponding quality.
- 6) Impeller, motor, and motor plate to be mounted on the scroll casing plate once more. Please or take precautionary measures in order not to damage motor or impeller resulting in unbalance.
- 7) The motor can now be electrically connected again.

■ ELECTRIC MOTOR

A. OPERATION

1. PREPARATION FOR OPERATION

If the motor to be operated has been at rest for a long time or disassembled and reassembled, pay attention to the following.

- (1) Check to see that rotary parts such as fan are secured positively, motor installation is satisfactory, and there is no abnormality on the machine to be driven by the motor.
- (2) Check to see that terminal connections of the motor are sufficiently tight, and insulation distance between dissimilar poles and ground is not badly small.
- (3) Check to see that there is no contact between rotary and stationary parts.
On such motor that has small gaps between the rotor and the stator, both may be brought into contact by wear of the bearing, and the stator coil burned out by the resulting heat generation.
- (4) Check to see that bearings are normal.
- (5) Check to see that there is no ingress of dust or dirt or foreign matter in the apparatus.
- (6) Check to see that there is no part of deteriorated insulation.
- (7) Measure the insulation resistance. If the measurement is lower than specified, dry by proper method.
- (8) Check to see that the machiner to be driven by the motor is ready for operation.
- (9) Check to see that the direction of rotation of the motor is correct. If the rotating direction is reverse in the case of the 3 phase motor, change the connection of wires for two phases with each other.

2. STARTING

After finishing the preparation for operation, confirm the load to be ready for starting. Then, turn on the power switch, and after signalling to the rotary part, operate the operate switch to start the motor points requiring attention during operation are as follows.

(1) The condition of load, and temperature measurement.

If the motor is provided with an ammeter, the condition of load can be known by use of meter. If no ammeter is available.

Hear sound or know the temperature of the stator frame.

Note that if an overload is sustained, the temperature of various parts exceeds the specified value.

Table 1

Temperature Rise at AC Machine Stator Windings Rated below 1,000V

(°C)

RULE	MEASURE MENT	TYPE OF MACHINE					
		Not totally enclosed			Totally enclosed		
		CLASS OF INSULATION					
		F	E	B	F	E	B
NK (1979)	T	75	55	60	80	60	65
	R	90	65	70	90	65	70
ABS (1978)	R	95	60	70	100	65	75
LRS (1979)	T	80	55	60	80	55	60
	R	90	65	70	90	65	70
NV (1980)	T	75	55	60	75	55	60
	R	90	65	60	90	65	70

T=Measurement by thermometer

R=Measurement by resistance

(2) Sound

The sound of the motor gives a good indication of the condition of rotation. Especially, the sound of the bearing part is useful in determining troubles. To hear the sound of the bearing part correctly, apply a metal bar, one end to the bearing part and the other to the ear.

(3) Vibration

The vibration gives another indication of the condition of rotation. Abnormal vibration of the motor during operation is caused either magnetically or mechanically. Probable magnetic causes are an air gap unbalance between the rotor and stator which causes a magnetic attractive force to be exerted between cores resulting in a vibration of the rotor, ground or wire break which causes a current unbalance to develop, misalignment of magnetic center, etc. Probable mechanical causes are brought about by a mechanical unbalance of the rotor, improper installation of the coupling between the motor and the load (improper centering), loosened motor mounting bolt, improper bearing part, etc. The rotor is fully balanced during manufacture, and with normal care it should not be unbalanced.

3. STOPPING

Confirm the load is ready for stopping, and after signalling, operate the operating switch to stop the motor.

4. CARE AFTER STOPPING

After stopping, pay attention to the point given in the paragraph "Preparation for operation."

5. TROUBLESHOOTING

Trouble	Cause	Remedy
Failing or difficult to start	Mechanical restriction or overload.	Disconnect the motor from the load. Try to rotate by hand and if it is difficult, the cause is a mechanical restriction. Disassemble and investigate. If the motor without the load can be started, check the load.
	Stator winding broken	Replace with a spare one.
	Switch in poor contact	Measure the motor terminal voltage and read the voltmeter on the switchboard. If it is lower than specified, raise.
	Fuse blown out	Replace with a spare one.
	Switch in poor contact	Readjust contact part or replace with a spare one.
	Connecting wire broken	Reconnect.
	Over current relay operated	Remove the cause and reset.
Overheating of bearing part	Bearing binding	Replace with a spare one.
	Grease deteriorated or contaminated	Replace with a spare one.
	Ball bearing damaged	Replace with a spare one.
Abnormal sound or abnormal vibration	Misalignment	Alignment.
	Belt too tightened	Reduce belt tension.
	Heat conducted from other part	Investigate the cause for overheating of rotor or stator.

Trouble	Cause		Remedy
Abnormal sound or abnormal vibration	Abnormal	Frequency variation	Check and adjust the line frequency to the rated value.
		Load variation	Check and adjust the machine.
	Air gap part in contact		Replace bearing with a spare part. Check for bearing of shaft.
	Ingress of foreign		Remove foreign matter.
	Vibration or rotor	Loosened mounting bolt	Retighten.
		Misalignment of direct connected machines	Realignment.
		Unbalance	Rebalance.
	Air gap in unbalance		Replace bearing with a spare part. center bracket with frame.
	Magnetic sound	Beating due to overload loosened Laminated core	Check and adjust load. Disassemble and repair.
	Abnormal sound from ball bearing	Corroision of ball with retainer	Readjust or replace bearing
		Grease deteriorated	Replace with a spare one.
		Ball surface damaged damage by electrolytic corroision	Replace with a spare one.
		Ingress of foreign matter	Clean bearing and repack with grease.

Trouble	Cause	Remedy
Overheating	Overload	Reduce load to or below rated value.
	Cooling fan defective	Disassemble and repair.
	Ventilating hole clogged	Remove dust or dirt accumulation.
	Friction between rotor and stator	Replace bearing with a spare part. Readjust air gap uniform by centering bracket with frame.
	Coil grounded	Disassemble and repair coil.
Inundation		Disassemble and water wash to remove contaminant, then reassemble and dry in the case of inundation by sea water, wash and clean in hot water at 60. C to 70. C to remove salt, then reassemble and dry.

B. MAINTENANCE

1. PERIODICAL MAINTENANCE CHART

Interval	Checking of	Standard checking procedure	Standard corrective measure
Daily	Major motor in use	Check for vibration and sound, and the temperature of bearing etc. by touching by hand.	If abnormal vibration, sound or bearing heating is noted, investigate the cause and repair. If overload or other abnormality is noted, stop at once and remove the cause.
Weekly	Major motor not in use Removal electric apparatus	Rotate the motor by hand and check for abnormality. Measure insulation resistance. Check ground connection.	If abnormality is noted, investigate the cause and repair. If insulation is deteriorated or ground connection is im and repair
Monthly	Motor and stater	Measure insulation resistance. Check stator and rotor loosened connection. Check lubrication part.	If insulation is deteriorated, investigate the cause and repair. Clean contaminated area. Add grease and replace bearing.
3 - monthly	Electric circuit	Measure insulation resistance.	If the measurement is below the allowable limit given below, dry or otherwise correct. (1) Circuit rated about 100V: 1 Mohm or greater

Interval	Checking of	Standard checking procedure	Standard corrective measure
3 - monthly	Electric circuit	Measure insulation resistance	(2) Circuit rated below 100V: 1/3 Mohm or greater
6 - monthly	Apparatus associated with motor	Check operation starter and accessory apparatus. Check contact connections.	If operation is abnormal, investigate the cause and repair. Repair defective or burned part. If necessary, replace with a spare one. Retighten loosened connection.
	Motor	Check for loosened bolt or nut in the base mounting part. joint, cover mounting part, etc. and for correction.	Retighten loosened bolt or nut. Replace defective bolt or nut with a new one.
Yearly	Motor	Measure air gap between stator and rotor. Check for abnormality in bearing part.	Replace defective bearing with a spare part, Clean shaft and bearing
	Spare part	(1) Check the number. (2) Measure insulation resistance.	(1) Check with parts list. (2) If insulation is deteriorated, investigate the cause and dry or otherwise correct.

2. MAINTENANCE AND REPLACEMENT OF BALL BEARING ON THE MOTOR

The ball bearing with grease sealing plates is packing with grease during manufacture, and should not require addition of grease during operation, unlike the conventional open type bearing.

The ball bearing requires replacement if it produces badly abnormal during operation. The procedure for bearing replacement is as given below.

After disassembling the motor by the procedure given later, remove the defective bearing from the rotor shaft by use of a bearing puller.

Anti - rust grease on the surface of the replacement bearing should be removed with a cloth. Mount the new bearing on by the shock.

During this procedure, be careful not to give shocks to the sealing plate, as the searing plate may be deformed or dropped by the shock.

However desirably the bearings may be in use, it is unavoidable for them to be damaged by fatigue. Nevertheless, an adequate operating method can reduce the fatigue or can prevent failures due to other causes. Besides, should a damage to be taken, the cause should be examined in view of the appearance and character of the damaged part. and care must be taken not to allow the same trouble to be repeated.

It is very difficult to locate the cause of a trouble, which is usually attributable to a combination of several causes.

No.	Trouble	Characteristic	Probable cause
1	Noise	Low noise (rustle or rumble)	Dents formed on the race face owing to careless installation.
			Dents formed on the race face by external vibration while the fan is at rest
		High - pitched noise	Too small clearance
		Intermittent noise	Foreign matter included
			Resonance due to careless assembly about the housing
2	Abnormal temperature		Insufficient clearance during operation
			Overload
3	Crack	Axial crack on the or outer ring	Too tight fitting
			Uneven installing surface
			Housing deformation
		Circumferential crack on the inner or outer ring	Uneven installing surface
			Extreme overload
		Irregular crack	Crack on the retainer or ball due to grease aging
4	Indentation on the race face	Indentation of the same pitch as the ball	Knock during installation
			Great blow struck on the bearing with the fan is at rest
5	Retainer damaged		Grease aging
			Ball damaged
			Rivet damaged by vibration
6	Rust	local spots on the race face	Corrosion by acid or moisture while the fan is at rest for a long time
		Surface rust	Incomplete contact (Faulty fitting)

3. DISASSEMBLY AND REASSEMBLY IF THE MOTOR]

To disassemble the motor, proceed as follows.

- (1) Disconnect the motor from the power supply.
- (2) Remove the direct coupling, and place the motor in a area suitable for disassembling.
- (3) Remove the bearing cover and the oil thrower on the direct coupled side.
- (4) Remove the bearing bracket.
- (5) Pull out the rotor as a whole in the direction toward the fan.
- (6) Place the rotor on a clean stand, and pull out the ball bearing with a tool.

Be careful not to contaminate disassembled bearing part, etc. with dust or dirt. Also, take care not to damage the insulation when pulling out the rotor.

The reassembly should be done by reversing the disassembling procedure, taking care to insure positive assembling of bearing part or other fits.

4. DRYING

Before starting the motor which has been at rest long or is suspected of moisture absorption, measure the insulation resistance of the winding and if the measurement is below the limit given below, it is necessary to dry the winding by the procedure given in the following paragraphs.

- ☐ Circuit rated above 100V:1 Mohm or greater
- ☐ Circuit rated below 100V:1/3 Mohm or greater

(1) Hot air or external heating method :

Place a well ventilated sheet over the motor.

The insulation should not be heated about 90. C

(2) Current method:

With the rotor locked, apply a low voltage to allow a short circuit current to flow in the winding. The winding is then dried by its own heat generation. Start at low current, increasing the current gradually until the temperature approaches 90. C, then keep the current

so that the insulation resistance reaches a constant value safely.

5. TRIAL RUNNING OF THE MOTOR

The motor which has been dried or disassembled and reassembled should be cleaned thoroughly, checked for loosened screw, etc. and then placed in trial running.

If the trial running is satisfactory, the motor may be directly coupled with the load.

6. REFERENCE

(1) Insulation resistance test for stator winding

Remove the cables from terminals and measure resistance between earth and stator winding by D. C. 500V megger.

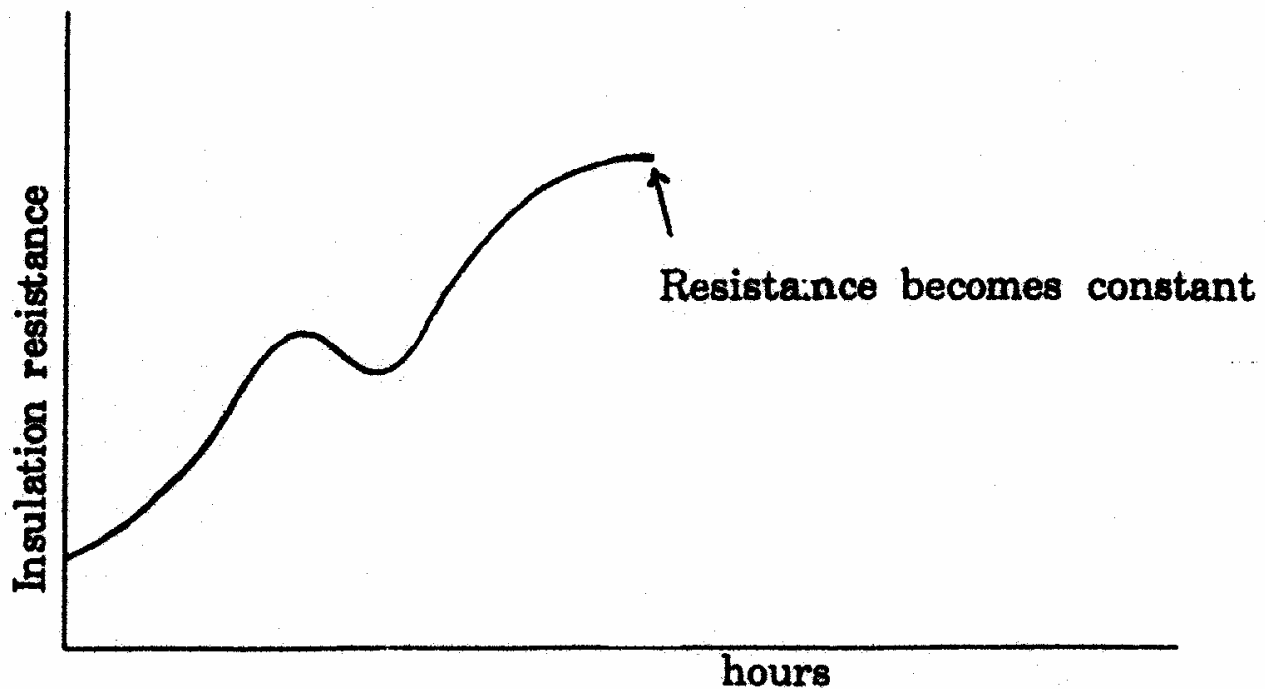
The resistance should be more than follows.

$$R = \frac{\text{Machine rated voltage} \times 3}{\text{Machine rated output(kw)} + 1000}$$

Note : R : Insulation resistance for stator winding.

If the resistance is too low (less than $1 \text{ M}\Omega$) it should be dried by the procedure of item 4.

Typical trend of insulation resistance.



Caution

1. During drying, carefully heat up to exceed 90. C at any points of winding.
2. It should be continued to dry that the resistance measured are saturate.

(2) Re - greasing

Following grease should be used. Refer to the attached Table 2.
Recommended Grease.

(3) Period of re - greasing

Operate frequently	Every 3 month
Operate intermittently	Every 6 month

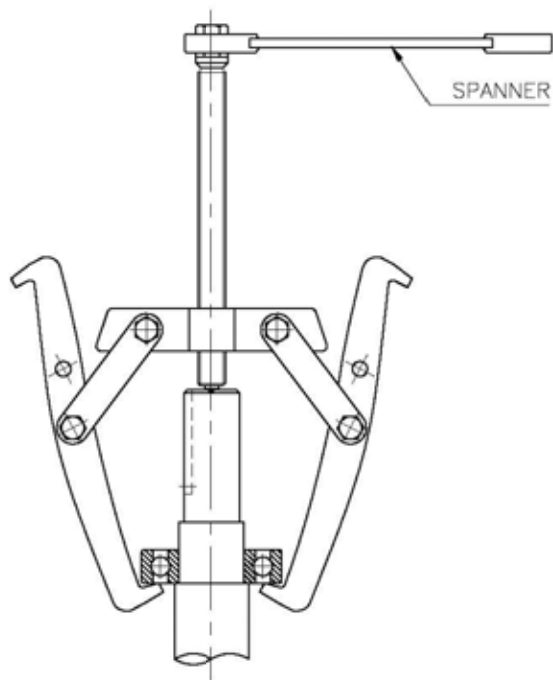
Table 2.

RECOMMENDED GREASE

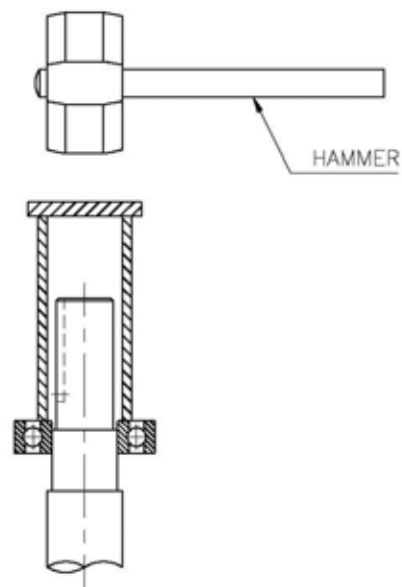
Manufacturer	Insulation Class E. B.		Insulation Class F	
	Grease	Soap	Grease	Soap
NIPPON OIL	MULTINOC NO.2	NTUM	MULTINOC WIDE 2	LITUM
MARUXXEN OIL	WR - 3	NATRIUM	WR - 3	NATRIUM
IDEMISHUKOSAN	DAPHNR CORONEK GREASE NO.2	LITUM	DAPHNE GERASE	BENTON
ESSO	REACON NO. 325	LITUM	TEMPREX N2	LITUM
SHELL	ALVANIA NO. 2	LITUM	DOLIUM GREASE 2	PORIYUA
MOBIL	MOBILUX NO. 2	LITUM	MOBIL GREASE 28	CARBURETTING HYDROCARBON
DAIKYO OIL	DAINAMIC GREASE MP - 2	LITUM	DAINMIC GREASE MP - 2	LITUM
ANTER	MULTISERVICE	LITUM		
BP	BP ENEREASE LS - 2	LITUM	BP ENERGREASE HTB 2	BENTNITE
CALTEX	REGAL STARFAL PREMIUM NO. 2			
CASTROL	CASTROL SPHEEROL AP2			
CHEVRON	DURA - LITH GREASE 2	LITUM		
TEXACO	TEXACO REGAL AFB2			
GULF	GULF CROWN GREASE N2	LITUM		
TOTAL	TOTAL MULTIS EP22			
MISHUBISHI OIL	DIAMOND MULTIPUROPOSE GREASE NO.2	LITUM	DIAMOND MULTIPUROPOSE GREASE NO. 2	

4) Assembly and re-assembly of bearing

4-1) Re-Assembly

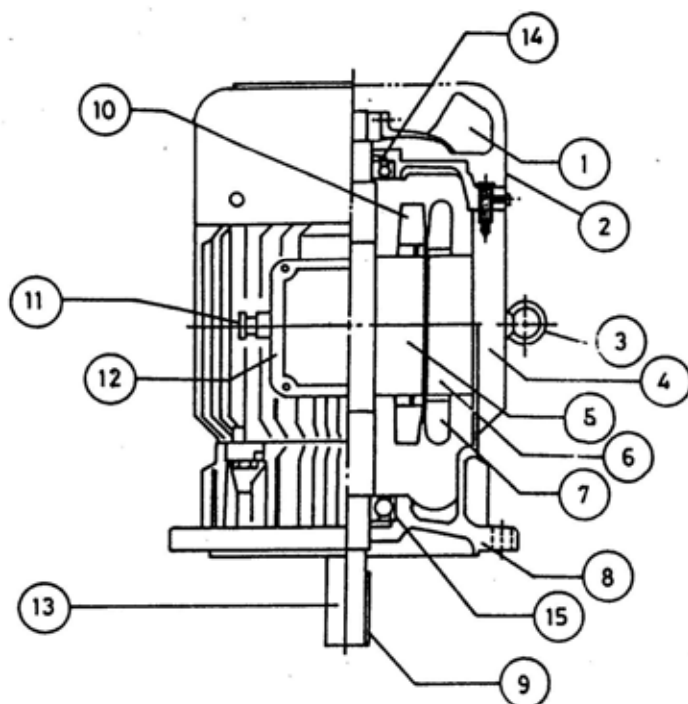


4-2) Assembly

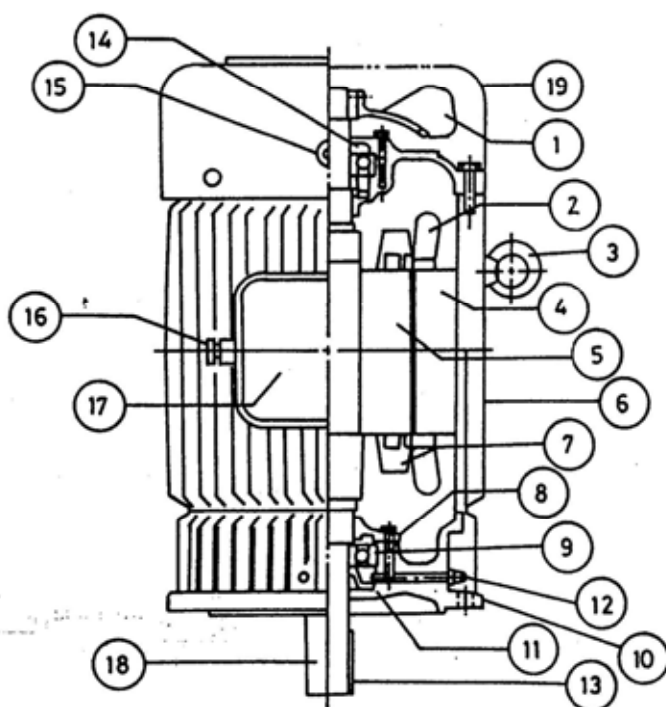


A M E N D	DATE	CODE	M E M O	SIGN
		△		
		△		
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NO.	DESCRIPTION		MAT.L	Q'TY	SPECIFICATION	REMARKS
MFG. NO.		DATA	CUSTOMER			
		04.03.22				
Q'ty		SCALE	TITLE	LAYOUT DWG OF BEARING TOOL		
		N/S				
DWG. NO.			3RD ANGLE	I. GONG		
H-TOOL-02				04.03.22 04.03.22 04.03.22 04.03.22		
		HMMCO		Hyundai Marine Machinery Co., Ltd. Inchon Korea		



NO.	NAME OF PARTS
1	EXTERNAL FAN
2	EXTERNAL FAN COVER
3	EYE BOLT
4	FRAME
5	ROTOR CORE
6	STATOR CORE
7	STATOR COIL
8	BRACKET (FLANGE)
9	SHAFT END KEY
10	END-RING FAN
11	CABLE GLAND
12	TERMINAL BOX
13	SHAFT
14	PRELOADED SPRING
15	SEALED BALL BEARING



NO.	NAME OF PARTS
1	EXTERNAL FAN
2	STATOR COIL
3	EYE BOLT
4	STATOR CORE
5	ROTER CORE
6	FRAME
7	END-RING FAN
8	HOUSING COVER
9	OPEN BALL BEARING
10	BRACKET (FLANGE)
11	GREASE RING
12	GREASE NIPPLE
13	SHAFT
14	PRELOADED SPRING
15	GREASE NIPPLE
16	CABLE GLAND
17	TERMINAL BOX
18	SHAFT-END KEY
19	EXTERNAL FAN COVER

INSTRUCTION MANUAL

FOR

A/B & T/G STARTER

Starter

Chapter 1 --- Operation

1. Preparation for operation

(1) Cleaning

On the starter which has been at rest for a long time (as spare unit, for instance), accumulation of dust or dirt or other foreign matter in contact parts is detrimental to the current carrying action and may cause overheating or single-phase operation of the motor. Clean the contact surface with a dry cloth.

(2) Insulation resistance measurement

Measure the insulation resistance of the overall connection circuit of the starter with a DC 500V megger, and if the measurement is below 0.3 Mohm, dry by the procedure given below to raise at least to 0.5 Mohm.

When using hot air or external heating, place a well ventilated sheet over the starter. The insulation should not be heated above 90°C.

(3) Checking of clamping parts

Check terminals (especially, main circuit) for loosened connection and poor contact.

2. Maintenance during operation

(1) Be sure to confirm lighting of the power pilot lamp after turning on the disconnect switch. If the pilot lamp does not light, check for burned-out lamp or fuse. Replace the defective part.

(2) Check for abnormal rise of temperature inside the case, If beating of cores of the electromagnetic contactor occurs, remove the cause by correcting the fitting between fixed and moving cores.

(3) Check for proper contact of contact pieces. If chattering due to aged or broken spring or abnormal wear of contact piece is noted, replace with a spare one.

(4) If the pilot lamp or fuse is burned out, it should be replaced, at once, as its pilot function is important for the maintenance of safe operation.

(5) If the starter is provided with an ammeter, note the reading of the ammeter to prevent overload.

3. Overload relay

This relay protects from abnormal overload of the motor and has the following operating characteristics in accordance with JIS

(Japan Industrial Standard)

(1) When applied with 500% full load current of the AC motor, this relay will operate within 45 seconds.

(2) When applied with full load current of the motor until temperature reaches an equilibrium, then applied with a current of 200% thereof, this relay will operate within 4 minutes.

(3) When applied with full load current of the motor, this relay will not operate but temperature reaches an equilibrium, and when the current is increased, this relay will operate with 125% full

load current.

When the overload relay operates, investigate and remove the cause (overload or 1-phase operation), and push RESET button before proceeding with the next operation.

If the heater is deteriorated or wire broken, remove the overload relay from the base, remove the case by removing screws on the side, and the heater can be replace.

Chapter 2 -- Troubleshooting

Trouble	Cause	Remedy
1. No voltage	Switch (NFB) on the feeder panel power distribution box or the like is not turned on.	Turn on the switch.
	Switch in poor contact.	Adjust contact part of switch, or replace with a spare part.
	Abnormal feeder	Check feeder for proper contact at switch and terminal in the feeder panel power distribution box, and repair the defective part. Also check for wire break.

2. Pilot lamp	Lamp element burned out.	Replace the lamp.
	Lamp fuse burned out.	Replace the fuse
	Lamp PT burned out or layer shorted. In the case of operation pilot lamp, contact for lighting signal in poor contact.	Replace PT Check and repair contact piece, or replace with a spare part.
3. Failing to start	Control circuit fuse burned out.	Replace with a spare part.
	Electromagnetic contact or auxiliary relay coil wire broken.	Replace coil with a spare part.
	Push button switch in poor contact.	Check and repair contact piece or replace with a spare one.
	Electromagnetic contactor or auxiliary relay contact in poor contact	Check and repair contact piece or replace with a spare one.
	Loosened wire connection.	Retighten.
	Starter outside apparatus such as PBS or is defective.	Check operation or contact condition of contact, and if necessary, replace with a spare part.

	Overcurrent relay tripped.	Trips take place in the case of the starting time longer than normal due to fault on the motor or machine side, impossible-to-rotate or locked condition. Remove the fault on the motor or machine side and reset the overcurrent relay before attempting the restarting.
4. Stopping to operate	Overcurrent relay tripped.	If the trip takes place in the course of continuous operation, the cause is overload of the motor. Remove the cause and rest before restarting.
	Same cause as for failing to start.	Take the same measure as for failing to start.
5. Insulation deteriorated		Measure insulation resistance of each part, and replace the defective part with a sprae one.

**INSTRUCTION MANUAL
FOR
RESISTANCE BULB**

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THE TABLE OF RESISTANCE VALUE -----	8

1. OUTLINE

In general, the electric resistance of the metal is variable in proportion to the temperature. So, it is possible to tell the temperature by measuring the resistance, after the investigation of the relation between the electric resistance and the temperature. There is a detector used the theory of the resistance variation in proportion to the temperature of the platinum wire in this result, and this detector is called PLATINUM RESISTANCE BULB.

The resistance bulb consists of the resistance element (the resistance wire wound to the bobbin), the internal leading wire, the protecting tube, the terminals, etc.

This resistance bulb has the high pure platinum wire as the resistance element which is put in the steel tube in order to protect against the circumstance condition such as the moisture, the vibration and the shock. Moreover, it has the terminals for the connection of the wire and the steel equipment for fixing the part of detecting the temperature.

This resistance bulb is produced so that it can demonstrate the good characteristics for the marine use, in order to be operated under the severe vibration and the shock on board.

2. CONSTITUTION

There are the resistance element and the internal leading wire inside of the resistance bulb, and the outside consists of the protecting tube, the bolts, the plugs, the terminal box, and etc.

The protecting tube --- This tube is used for protection so that the resistance element and the internal leading wire may not touch the measured thing directly.

The bolts & the plugs --- These are the steel equipments for fixing the resistance bulb to the measuring spot.

The terminal box --- This is the box to connect the resistance bulb to the outer leading wire.

Note; Please refer to the attached reference figure.

3. INSTALLATION AND WIRING

Please pay your attention for the followings in case of the installation.

- (1) It is necessary to choose the suitable place and the method for the installation which can transmit the temperature correctly and can follow the variation of the temperature as quickly as possible.
Please take care not to bend the tube in view of the construction of the resistance bulb
- (2) Please choose the suitable place which has the smallest vibration, the least dirt, and the lowest moisture. Then, please install the resistance bulb at the place which is convenient for the maintenance and the inspection.
- (3) In case of the connection of wires, please confirm the wire sign in order to avoid the mis-connection. On the treatment of the end of the wires, please connect the wires firmly by using the compression terminals to avoid the trouble such as the breaking-wire and the short-circuit.

4. MAINTENANCE AND INSPECTION

4-1 Maintenance items and Maintenance intervals

Maintenance/Inspection	Initial interval	Normal interval
* Mechanical inspection	1 month	3 month
* Electrical inspection	1 month	3 month
* Cleaning	1 month	1 year

* Refer to the item 4 and 6.

4-2 The condition for opening

- (1) Turn off the switch of the electric source.
- (2) Do taping around the end of the outer lead-wire which is taken off, in order to avoid the mis-connection.
- (3) Never open the internal resistance element at the spot.

4-3 The order of opening

- (1) Take off the cover of the terminal box.
- (2) Loosen the terminal screw of the cables.
- (3) Loosen the cable gland.

4-4 The necessary tools

- (1) A plus-driver.
- (2) A spanner.
- (3) A monkey spanner (for the cable gland)
- (4) A radio pliers.
- (5) A circuit tester.

4-5 The condition for the maintenance

Prepare the spare parts.

4-6 How to keep good conditions for the adjustment

(1) Mechanical inspection

Inspection points	Inspection method	Caution
a. Inspection of the looseness of the bolts, plugs and the outer tube.	Examine whether there is any looseness about the tightened part of the bolts, plugs and the outer tube..	
b. Inspection of the looseness of the terminals	Examine whether all the terminals are fixed firmly or not.	
c. Cable gland	Examine whether there is any looseness of the lead-in cable gland	
d. Temperature trouble	Examine whether there is any breaking of the gland cover and the wiring	

(2) Electric Inspection

Inspection Points	Inspection method	Caution
a. Inspection of running of the electric source	Examine running of the electric source with a tester.	Whether the breaking wire is or not.
b. Insulation resistance test	Examine the resistance between the terminals and the protection tube with D.C. 500V tester (more than $5M\Omega$).	

(3) Cleaning

Inspection points	Inspection method	Caution
Taking away the dirt attached with the protection tube for the high temperature	After taking off the resistance bulb, take away the dirt attached with the insert part.	Avoidance of the error generation and the burning out.

4-7 Presumption cause or Investigation method
about the trouble state

Trouble state	Presumption cause	Treatment
Breaking out of the wire	Thermal vibration and shock	Exchange the bad one for the spare part. The pointer of the tester does not move in case of breaking the wire and it shows less than $1M\Omega$ in case of the bad insulation.
Bad insulation	a. As for the low temperature, the infiltration of the sea water, fresh water and the oil, due to the badness of the instruments. b. As for the high temperature, the chemical change of the insulation, due to the high temperature.	
Short-circuit	Badness of the distance of the leading-wire.	
In case that the allowance increases gradually while using.	a. Badness of the indicator b. Badness of the resistance bulb (1) the increase of the internal resistance (2) the decrease of the internal resistance (3) the increase of the dirt attached to the protection tube.	Connect the standard resistor instead of the resistance bulb, and find which of the measuring device or the detector is bad. Exchange for the spare parts. Take off the protection tube and take away the dirt.

In case that the allowance increases suddenly while using.	a. Abnormality of the measuring device b. Badness of the resistance bulb c. Bad connection of the wire due to the looseness of the screw.	Exchange for the spare parts.
--	---	-------------------------------

4-8 Method of repairing

- (1) Do in accordance with the reverse order of that of opening.
- (2) Concerning the one for the high temperature, the protection against burning out should be carried out around the installation screws at the side of the engine.

4-9 Confirmation items

- (1) Confirm whether the leading-wire is connected correctly.
- (2) Confirm the tightness of the cover.
- (3) Confirm the fixed part of the bolts, plugs, etc.
- (4) Turn on the switch for the electric source.

CONSTRUCTION

The temperature thermal resistance bulb is composed of a resistor element, inner wires, protection tube and terminal box.

1. The resistor element is classified into two types; one for low temperature use and the other for high temperature use.

The element spools for both types are made of oxidized alumina around which a platinum wire and inner wires are wound and welded for security.

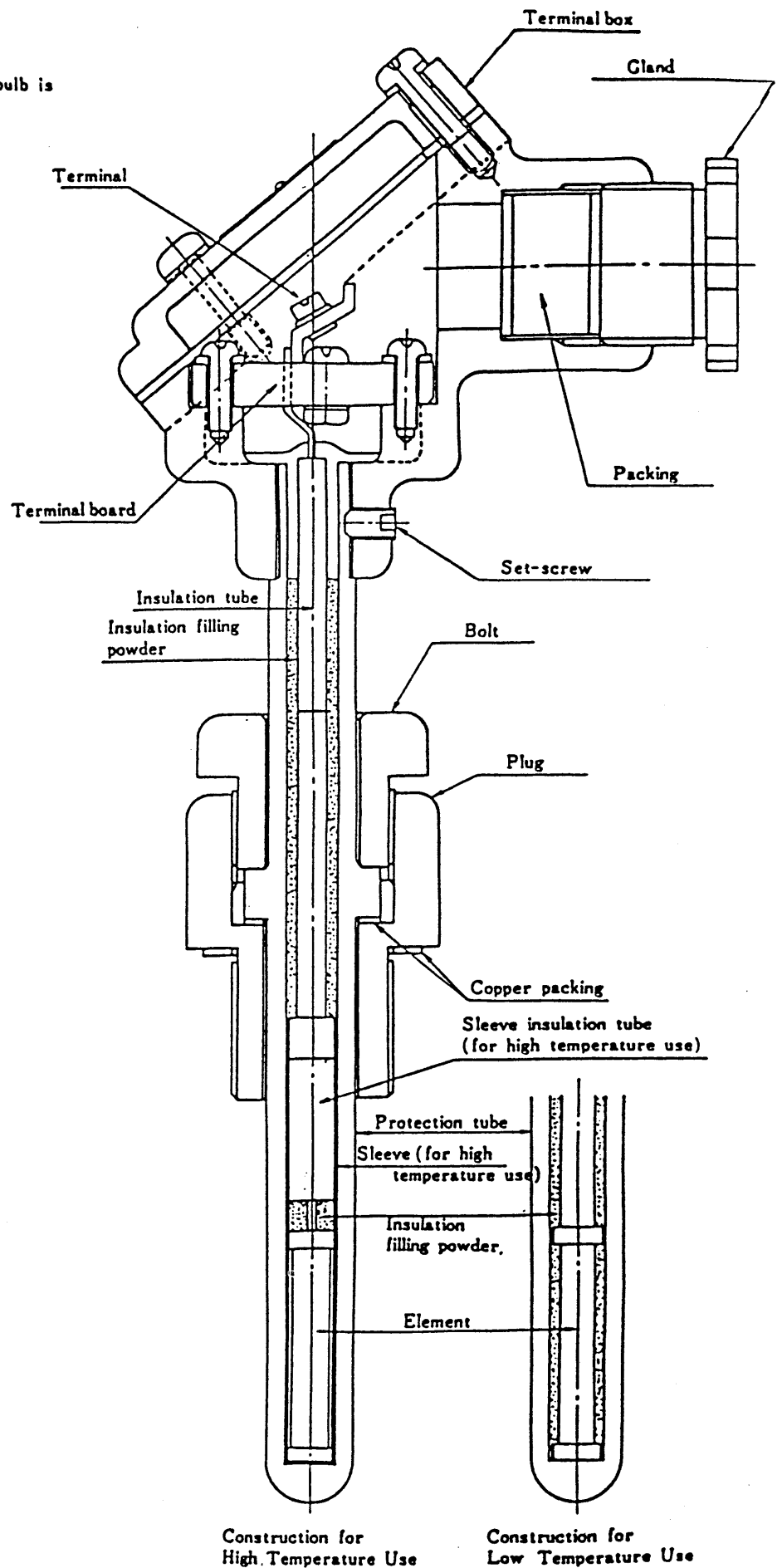
The element spool for low temperature use is provided with an insulation tube at the inner wires which are welded to the terminals through the terminal board.

The insulation tube and the terminal board use high quality ceramic as insulation material, while the terminals use selected material which is excellent in stability against oxidizing and reducing atmospheres.

The element spool for high temperature is enclosed in a sleeve type insulation tube (super-ceramic), thus it is fully protected against vibrations and shocks which may occur while in use.

2. The inner wires use nickel as material and welded to the resistor element.
3. The material of the protection tube is based on the standard of SUS 304.
4. The terminal box is made up from aluminial die-cast casing.

The wire pass-through fittings are based on the standard of JIS F8801, 20a.



THE TABLE OF PLATINUM RESISTANCE VALUE

 $R_0=50\Omega$ (at 0°C) $-200\sim 630^\circ\text{C}$ Unit: Ω

Temperature ($^\circ\text{C}$)	-100	-0	Temperature ($^\circ\text{C}$)	0	100	200	300	400	500	600
-0	29.78 ₅ 2.06 ₅	50.00 1.99	0	50.00 1.98 ₅	69.58 1.92 ₅	88.56 ₅ 1.86 ₅	106.96 ₅ 1.80 ₅	124.78 1.75	142.01 1.69	158.64 1.63
-10	27.72 2.07 ₅	48.01 2.00	10	51.98 ₅ 1.98	71.50 ₅ 1.92	90.43 1.86	108.77 1.80 ₅	126.53 1.74 ₅	143.70 1.68 ₅	160.27 1.62
-20	25.64 ₅ 2.09	46.01 2.00 ₅	20	53.96 ₅ 1.97 ₅	73.42 ₅ 1.91	92.29 1.85 ₅	110.57 ₅ 1.79 ₅	128.27 ₅ 1.73 ₅	145.38 ₅ 1.67 ₅	161.89 1.62
-30	23.55 ₅ 2.10	44.00 ₅ 2.01	30	55.94 1.96 ₅	75.33 ₅ 1.91	94.14 ₅ 1.85	112.37 1.79	130.01 1.73 ₅	147.06 1.67 ₅	163.51
-40	21.45 ₅ 2.11 ₅	41.99 ₅ 2.01 ₅	40	57.90 ₅ 1.96	77.24 ₅ 1.90	95.99 ₅ 1.84	114.16 1.78 ₅	131.74 ₅ 1.72 ₅	148.73 ₅ 1.66 ₅	-
-50	19.34 2.13	39.98 2.02 ₅	50	59.86 ₅ 1.95 ₅	79.14 ₅ 1.89 ₅	97.83 ₅ 1.84	115.94 ₅ 1.78	133.47 1.72	150.40 1.66	-
-60	17.21 2.15	37.95 ₅ 2.03	60	61.82 1.95	81.04 1.89	99.67 ₅ 1.83	117.72 ₅ 1.77	135.19 1.71	152.06 1.65 ₅	-
-70	15.06 2.16	35.92 ₅ 2.04	70	63.77 1.94	82.93 1.88 ₅	101.50 ₅ 1.82 ₅	119.49 ₅ 1.77	136.90 1.71	153.71 ₅ 1.64 ₅	-
-80	12.90 2.17	33.88 ₅ 2.04 ₅	80	65.71 1.94	84.81 ₅ 1.87 ₅	103.33 1.82	121.26 ₅ 1.76	138.61 1.70 ₅	155.36 1.64 ₅	-
-90	10.73 2.16	31.84 2.05 ₅	90	67.65 1.93	86.69 1.87 ₅	105.15 1.81 ₅	123.02 ₅ 1.75 ₅	140.31 ₅ 1.69 ₅	157.00 ₅ 1.63 ₅	-
-100	8.57	29.78 ₅	100	69.58	88.56 ₅	106.96 ₅	124.78	142.01	158.64	-

 $R_0=100\Omega$ (at 0°C) $-200\sim 630^\circ\text{C}$ Unit: Ω

Temperature ($^\circ\text{C}$)	-100	-0	Temperature ($^\circ\text{C}$)	0	100	200	300	400	500	600
-0	59.57 4.13	100.00 3.98	0	100.00 3.97	139.16 3.85	177.13 3.73	213.93 3.61	249.56 3.50	284.02 3.38	317.28 3.26
-10	55.44 4.15	96.02 4.00	10	103.97 3.96	143.01 3.84	180.86 3.72	217.54 3.61	253.06 3.49	287.40 3.37	320.54 3.24
-20	51.29 4.18	92.02 4.01	20	107.93 3.95	146.85 3.82	184.58 3.71	221.15 3.59	256.55 3.47	290.77 3.35	323.78 3.24
-30	47.11 4.20	88.01 4.02	30	111.88 3.93	150.67 3.82	188.29 3.70	224.74 3.58	260.02 3.47	294.12 3.35	327.02
-40	42.91 4.23	83.99 4.03	40	115.81 3.92	154.49 3.80	191.99 3.68	228.32 3.57	263.49 3.45	297.47 3.33	-
-50	38.68 4.26	79.96 4.05	50	119.73 3.91	158.29 3.79	195.67 3.68	231.86 3.56	266.94 3.44	300.80 3.32	-
-60	34.42 4.30	75.91 4.06	60	123.64 3.90	162.08 3.78	199.35 3.66	235.45 3.54	270.38 3.42	304.12 3.31	-
-70	30.12 4.32	71.85 4.08	70	127.54 3.88	165.86 3.77	203.01 3.65	238.99 3.54	273.80 3.42	307.43 3.29	-
-80	25.80 4.34	67.77 4.09	80	131.42 3.88	169.63 3.75	206.66 3.64	242.53 3.52	277.22 3.41	310.72 3.29	-
-90	21.46 4.32	63.68 4.11	90	135.30 3.86	173.38 3.75	210.30 3.63	246.05 3.51	280.63 3.39	314.01 3.27	-
-100	17.14	59.57	100	139.16	177.13	213.93	249.56	284.02	317.28	-

remarks) Prepared according to JIS C1604, 1974.

Pressure transmitters for marine applications

Type MBS 5100 and MBS 5150

Features



- Designed for use in severe maritime environments
- MBS 5150 with integrated pulse-snubber
- Resistant to cavitation and liquid hammer
- Pressure connection of acid-resistant stainless steel (AISI 316L)
- Pressure ranges in relative (gauge) or absolute from 0 up to 600 bar
- Output signal: 4 - 20 mA
- A wide range of pressure connections
- Temperature compensated and laser calibrated
- Accuracy 0.3% FS
- Zero and span adjustment

Description

The ship approved high accuracy block pressure transmitter is designed for use in almost all marine applications. MBS 5150 with integrated pulse snubber is designed for use in marine applications with severe medium influences like cavitation, liquid hammer or pressure peaks and offers a reliable pressure measurement, even under harsh environmental conditions. The transmitters can be easily mounted directly on the MBV 5000 block test valve or the threaded pressure connection can be used.

The flexible pressure transmitter programme covers a 4-20 mA output signal, absolute and gauge (relative) versions, measuring ranges from 0-1 to 0-600 bar with zero and span adjustment.

Excellent vibration stability, robust construction, and a high degree of EMC/EMI protection equip the pressure transmitter to meet the most stringent industrial requirements.

Ordering standard versions

Plug: Pg 11 (EN 175301-803)
Output: 4-20 mA
Pressure connection: G 1/4 with flange connection

Measuring range P_e ¹⁾ [bar]	MBS 5100		MBS 5150	
	Type no.	Code no.	Type no.	Code no.
0 - 1	MBS 5100-1011-1DB04	060N1032	MBS 5150-1011-1DB04	060N1081
0 - 2,5	MBS 5100-1411-1DB04	060N1033	MBS 5150-1411-1DB04	060N1083
0 - 4	MBS 5100-1611-1DB04	060N1034	MBS 5150-1611-1DB04	060N1084
0 - 6	MBS 5100-1811-1DB04	060N1035	MBS 5150-1811-1DB04	060N1063
0 - 10	MBS 5100-2011-1DB04	060N1036	MBS 5150-2011-1DB04	060N1064
0 - 16	MBS 5100-2211-1DB04	060N1037	MBS 5150-2211-1DB04	060N1065
0 - 25	MBS 5100-2411-1DB04	060N1038	MBS 5150-2411-1DB04	060N1085
0 - 40	MBS 5100-2611-1DB04	060N1039	MBS 5150-2611-1DB04	060N1066
0 - 60	MBS 5100-2811-1DB04	060N1040	MBS 5150-2811-1DB04	060N1086
0 - 100	MBS 5100-3011-1DB04	060N1041	MBS 5150-3011-1DB04	060N1087

¹⁾ Relative/ gauge

Technical data

Performance (EN 60770)

Accuracy (incl. non-linearity, hysteresis and repeatability)		±0.1% FS (typ.) ±0.3% FS (max.)
Non-linearity BFSL (conformity)		≤ ±0.2% FS
Hysteresis and repeatability		≤ ±0.1% FS
Thermal zero point shift		≤ ±0.1% FS/10K (typ.) ≤ ±0.2% FS/10K (max.)
Thermal sensitivity (span) shift		≤ ±0.1% FS/10K (typ.) ≤ ±0.2% FS/10K (max.)
Response time MBS 5100		< 4 ms
Response time MBS 5150	Liquids with viscosity < 100 cSt	< 4 ms
	Air and gases	< 35 ms
Overload pressure (static)		6 × FS (max. 1500 bar)
Burst pressure		> 6 × FS (max. 2000 bar)
Durability, P: 10-90% FS		> 10×10 ⁶ cycles
Zero point adjustment	0-1 to 0-10 bar measuring range	-5 to +20 % FS
	0-16 to 0-40 bar measuring range	-5 to +10% FS
	0-60 to 0-600 bar measuring range	-5 to +2.5% FS
Span adjustment	0-1 to 0-600 bar measuring range	-5 to +5% FS

Electrical specifications

Nom. output signal (short circuit protected)	4 to 20 mA
Supply voltage, U _B (polarity protected)	10 to 32 V dc
Supply voltage dependency	≤ ±0.01% FS/10 V
Current limitation (linear output signal up to 1.5 × rated range)	28 mA (typ.)
Load [R _L] (load connected to 0 V)	$R_L \leq \frac{U_B - 10 V}{0.02 A} [\Omega]$

Environmental conditions

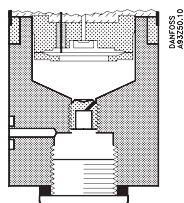
Environmental conditions			
Medium temperature range			-40 → +85 °C
Ambient temperature range (depending on electrical connection)			-40 → + 85 °C
Compensated temperature range			0 → +80°C
Transport temperature range			-50 → +85°C
EMC - Emission			EN 61000-6-3
EMC Immunity			EN 61000-6-2 ¹⁾
Insulation resistance			> 100 MΩ at 100 V
Mains frequency test			SEN 361503
Vibration stability	Sinusoidal	15.9 mm-pp, 5 Hz-25 Hz	IEC 60068-2-6
		20 g, 25 Hz - 2 kHz	
		Random 7.5 g _{rms} , 5 Hz - 1 kHz	
			IEC 60068-2-34, IEC 60068-2-36
Shock resistance	Shock	500 g / 1 ms	IEC 60068 - 2 - 27
	Free fall		IEC 60068 - 2 - 32
Enclosure (depending on electrical connection)			IP65

1) RF field 10 V/m, 26 MHz - 2 GHz deviation < 2% FS

Mechanical characteristics

Electrical connection			EN 175301-803 plug
Wetted parts, material	Versions without flange connection		EN 10088-1; 1.4404 (AISI 316L)
	Versions with flange connection	Pressure connection	AISI 316L
		Plug	Glass filled polyamid PA 6.6
		Plug gasket	W.no. 10388 Sn5
		O-ring for flange	NBR
Enclosure material			Anodized AlMgSiPb
Weight			0.4 kg

Application and media conditions, MBS 5150



Application

Cavitation, liquid hammer and pressure peaks may occur in liquid filled hydraulic systems with changes in flow velocity, e.g. fast closing of a valve or pump starts and stops. The problem may occur on the inlet and outlet side, even at rather low operating pressures.

Media condition

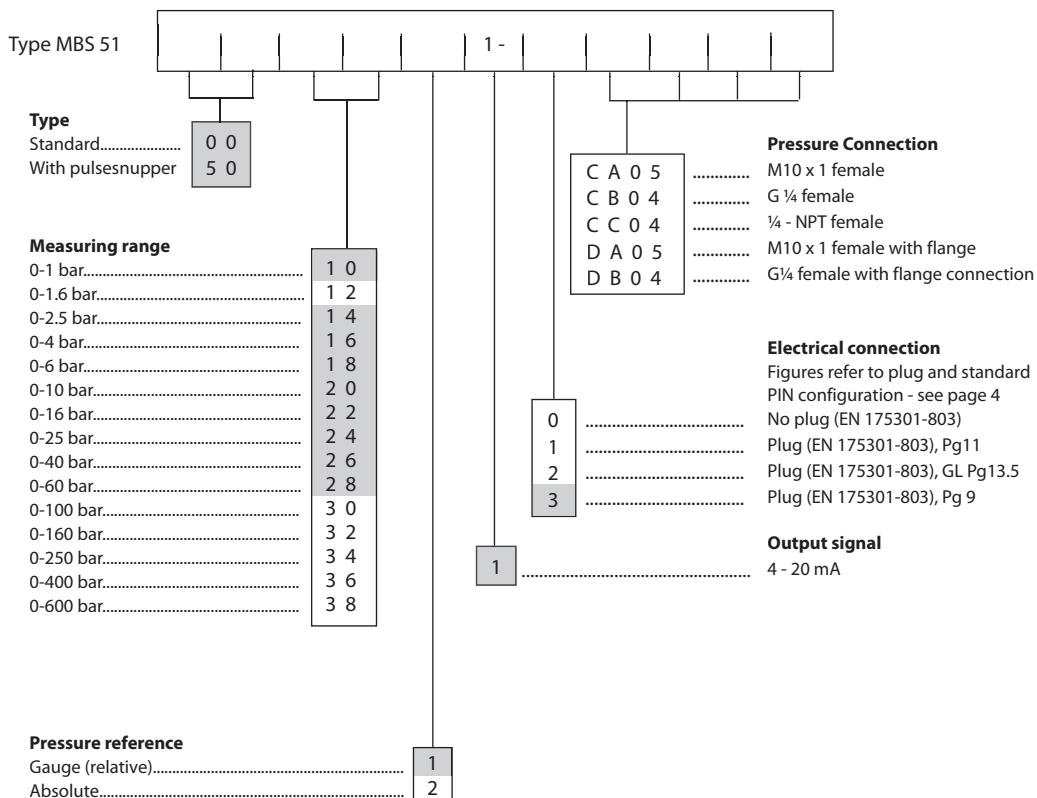
Clogging of the nozzle may occur in liquids containing particles. Mounting the transmitter in an upright position minimizes the risk of clogging, because the flow in the nozzle is restricted to the start-up period when the dead volume behind the nozzle fills, and furthermore because the nozzle orifice is relatively big (0.3 mm). The media viscosity has only little effect on the response time. Even at a viscosities up to 100 cSt, the response time will not exceed 4 ms.

Ordering of special versions

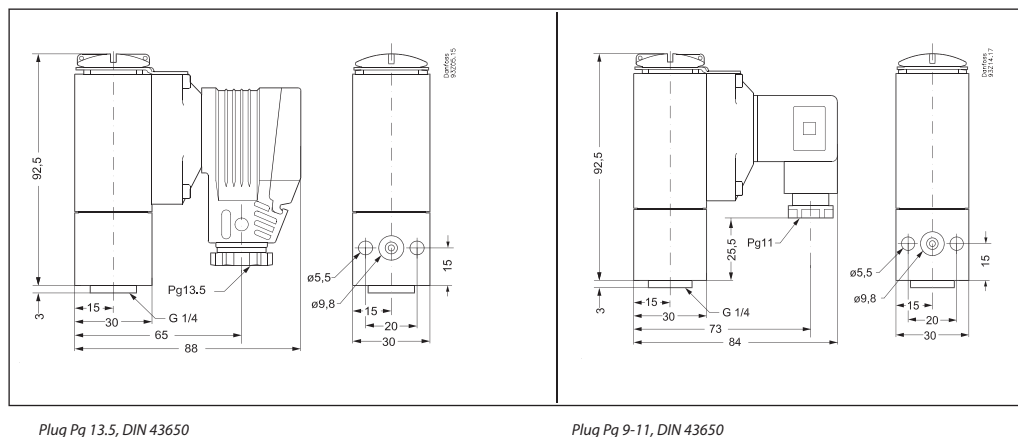
 Preferred version

Non-standard build-up combinations may be selected. However, minimum order quantities may apply.

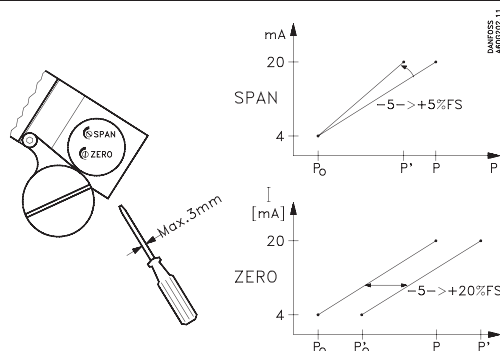
Please contact your local Danfoss office for further information or request for other versions.



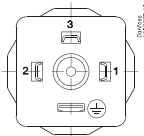
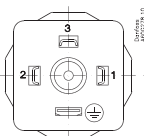
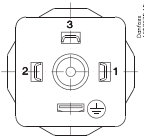
Dimensions



Adjustment

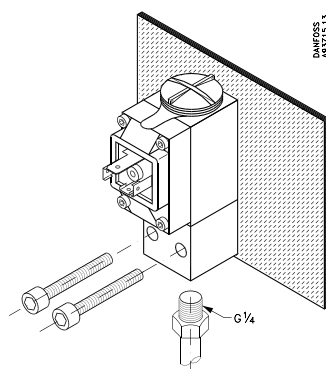


Electrical connections

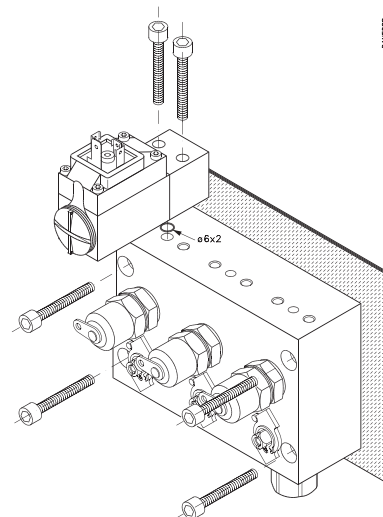
Plug type, page 3		
1	2	3
EN 175301-803, Pg 11	EN 175301-803, Pg 13.5	EN 175301-803, Pg 9
		
Electrical connection, 4 - 20 mA output (2 wire)		
Pin 1: + supply Pin 2: ÷ supply Pin 3: Function test 40 - 200 mV Earth: Connected to MBS enclosure	Pin 1: + supply Pin 2: ÷ supply Pin 3: Function test 40 - 200 mV Earth: Connected to MBS enclosure	Pin 1: + supply Pin 2: ÷ supply Pin 3: Function test 40 - 200 mV Earth: Connected to MBS enclosure

Mechanical connection

Thread



Flange



- Lloyd's Register of Shipping
- Det Norske Veritas
- Germanischer Lloyd
- RINA, Registro Italiano Navale

- American Bureau of Shipping
- Bureau Veritas
- Nippon Kaiji Kyokai
- Korean Register of Shipping

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Thermostats

Type RT

Description



A thermostat is a temperature-controlled switch. The position of the contacts depends on the temperature of the sensor and the set scale value. The RT series covers thermostats for general industrial and marine applications, including differential thermostats with room sensors, duct sensors, and capillary tube sensors

Contents

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Thermostats type RT

-50	0	50	100	150	200	250	300°C	Range p _e bar	Type
Thermostats with cylindrical remote sensor								-60 → -25	RT 10
								-45 → -15	RT 9
								-30 → 0	RT 13
								-25 → 15	RT 3,2,7
								-20 → 12	RT 8
								-5 → 10	RT 12
								-5 → 30	RT 14
								-5 → 50	RT 26
								5 → 22	RT 23
								8 → 32	RT 15
								25 → 90	RT 101
								20 → 90	RT 106
								30 → 140	RT 108
								70 → 150	RT 107
								120 → 215	RT 120
								150 → 250	RT 123
								200 → 300	RT 124
Thermostats with room sensors, duct sensor and capillary tube sensor								-50 → -15	RT 17
								-30 → 0	RT 11
								-25 → 15	RT 34
								-5 → 30	RT 4
								10 → 35	RT 115
								10 → 45	RT 103
								15 → 45	RT 140
								40 → 80	RT 141
								25 → 90	RT 102
Thermostats with adjustable neutral zone								-20 → 12	RT 8L
								-5 → 30	RT 14L
								0 → 38	RT 16L
								15 → 45	RT 140 L
								25 → 90	RT 101L
Differential thermostats								0 → 15	RT 270
								0 → 20	RT 271

Technical data and code nos.

When ordering, please state type and code number.

Types of charge

- A: Vapour charge - sensor must not be the warmest part.
- B: Adsorption charge
- C: Partial charge - the sensor must not be the coldest part



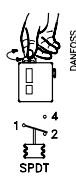
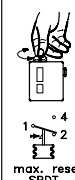
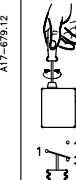
RT 107
with cylindrical remote sensor,
cover with windows and hand
setting knob



RT 106
with cylindrical remote sensor,
cover with windows and hand
setting knob

Thermostats with cylindrical remote sensor

Preferred charge

Setting range °C	Adjustable differential range*)		Max. sensor temperature °C	Type of charge	Capillary tube length m	Code no.			Type
	At lowest range setting °C	At highest range setting °C				 DANFOSS AT7-586.12	 DANFOSS AT7-586.12	 DANFOSS AT7-677.12	
-60 → -25	1.7 → 7	1 → 3	150	A	2	017-507766			RT 10
-45 → -15	2.2 → 10	1 → 4.5	150	A	2	017-506666			RT 9
-30 → 0	1.5 → 6	1 → 3	150	A	2	017-509766			RT 13
-25 → 15	2.8 → 10	1 → 4	150	A	2	017-501466			RT 3
-25 → 15	2.8 → 10	1 → 4	150	A	5	017-501666			RT 3
-25 → 15	2.8 → 10	1 → 4	150	A	8	017-501766			RT 3
-25 → 15	5 → 18	6 → 20	150	B	2	017-500866			RT 2
-25 → 15	2 → 10	2.5 → 14	150	B	2	017-505366			RT 7
-25 → 15	2 → 10	2.5 → 14	150	B	5	017-505566			RT 7
-25 → 15	2 → 10	2.5 → 14	150	B	8	017-505666			RT 7
-20 → 12	1.5 → 7	1.5 → 7	145	B	2	017-506366			RT 8
-5 → 10	1 → 3.5	1 → 3	65	B	2	017-508966			RT 12
-5 → 30	2 → 8	2 → 10	150	B	2	017-509966			RT 14
-5 → 30	2 → 8	2 → 10	150	B	3	017-510066			RT 14
-5 → 30	2 → 8	2 → 10	150	B	5	017-510166			RT 14
-5 → 30	2 → 8	2 → 10	150	B	8	017-510266			RT 14
-5 → 30	2 → 8	2 → 10	150	B	10	017-510366			RT 14
-5 → 50	2 → 9	3 → 19	150	B	2	017-518066			RT 26
5 → 22	1.1 → 3	1 → 3	85	B	2	017-527866			RT 23
8 → 32	1.6 → 8	1.6 → 8	150	B	2	017-511566			RT 15
25 → 90	2.4 → 10	3.5 → 20	300	B	2	017-500366	017-500466	017-500566	RT 101
25 → 90	2.4 → 10	3.5 → 20	300	B	3	017-500666			RT 101
25 → 90	2.4 → 10	3.5 → 20	300	B	5	017-502266	017-502366		RT 101
25 → 90	2.4 → 10	3.5 → 20	300	B	8	017-502466			RT 101
25 → 90	2.4 → 10	3.5 → 20	300	B	10	017-502566			RT 101
20 → 90	4 → 20	2 → 7	120	C	2	017-504866		017-504966	RT 106
20 → 90	4 → 20	2 → 7	120	C	3			017-505166	RT 106
20 → 90	4 → 20	2 → 7	120	C	5	017-505066			RT 106
30 → 140	5 → 20	4 → 14	220	B	2	017-506066			RT 108
70 → 150	6 → 25	1.8 → 8	215	C	2	017-513566	017-513666	017-513766	RT 107
70 → 150	6 → 25	1.8 → 8	215	C	3	017-513966			RT 107
70 → 150	6 → 25	1.8 → 8	215	C	5	017-514066	017-514166	017-514366	RT 107
70 → 150	6 → 25	1.8 → 8	215	C	8	017-514466			RT 107
70 → 150	6 → 25	1.8 → 8	215	C	10	017-514566			RT 107
120 → 215	7 → 30	1.8 → 9	260	C	2	017-520566 ¹⁾	017-521166 ¹⁾		RT 120
120 → 215	7 → 30	1.8 → 9	260	C	5	017-520666 ¹⁾			RT 120
120 → 215	7 → 30	1.8 → 9	260	C	8	017-520766 ¹⁾			RT 120
120 → 215	7 → 30	1.8 → 9	260	C	2	017-520866	017-521466 ²⁾		RT 120
120 → 215	7 → 30	1.8 → 9	260	C	5	017-520966			RT 120
150 → 250	6.5 → 30	1.8 → 9	300	C	2	017-522066	017-522466		RT 123
150 → 250	6.5 → 30	1.8 → 9	300	C	5	017-522266			RT 123
200 → 300	5 → 25	2.5 → 10	350	C	2	017-522766	017-523166		RT 124
200 → 300	5 → 25	2.5 → 10	350	C	5	017-522966			RT 124

*) See also pages 5-6

¹⁾ Thermostats fitted with neon lamp connected to terminal 4

²⁾ Thermostat with tamper-proof seal cap



Thermostat type RT 115
with room sensor



Thermostat type RT 140
with duct sensor



Neutral zone thermostat
type RT 16L with room sensor



Differential thermostat
type RT 270

Thermostats with room sensor, duct sensor and capillary tube sensor Preferred versions

Setting range °C	Adjustable differential range*)		Max. sensor temperature °C	Type of charge	Capillary tube length m	Sensor type**) Figur	Code no.	Type
	At lowest range setting °C	At highest range setting °C						
-50 → -15	2.2 → 7	1.5 → 5	100	A	-	1	017-511766	RT 17
-30 → 0	1.5 → 6	1 → 3	66	A	-	1	017-508366	RT 11
-25 → 15	2 → 10	2 → 12	100	B	-	1	017-511866	RT 34
-5 → 30	1.5 → 7	1.2 → 4	75	A	-	1	017-503666	RT 4
-5 → 30	1.5 → 7	1.2 → 4	75	A	-	1	017-503766¹⁾	RT 4
10 → 35	5)	5)	92	B	-	1	017-519766²⁾	RT 115
10 → 35	5)	5)	92	B	-	1	017-519866³⁾	RT 115
10 → 45	1.3 → 7	1 → 5	100	A	-	1	017-515566	RT 103
15 → 45	1.8 → 8	2.5 → 11	240	B	2	2	017-523666	RT 140
40 → 80	1.9 → 9	2.5 → 17	250	B	2	2	017-524166	RT 141
25 → 90	2.4 → 10	3.5 → 20	300	B	2	3	017-514766	RT 102

*) See also pages 5-6

**) See also fig. 1-5

¹⁾ Bellows with built-in heating element which reduces the thermal differential (220V)

²⁾ Can be connected to 220 V and 380 V

³⁾ Can be connected to 220 V

⁵⁾ Special thermostat for ventilation plant

Thermostats with adjustable neutral zone

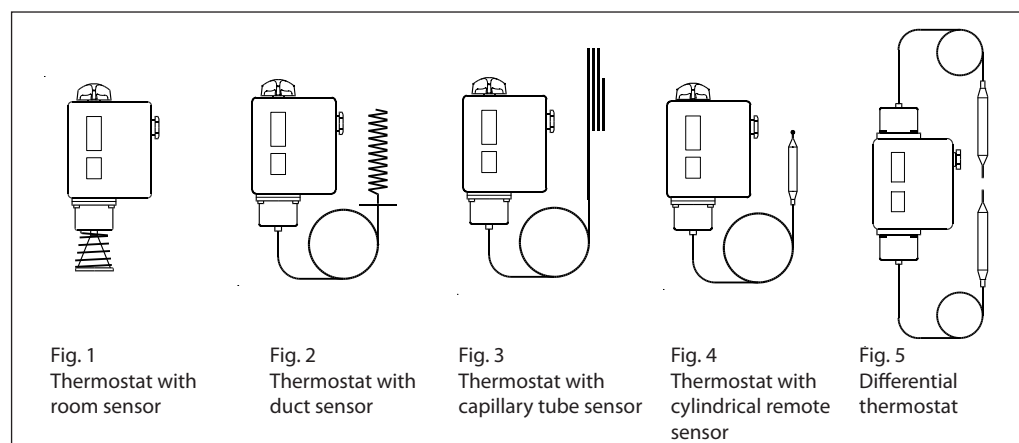
Setting range °C	Mechanical differential °C	Adjustable differential range*)		Max. sensor temperature °C	Type of charge	Capillary tube length m	Sensor type**) Figur	Code no.	Type
		At lowest range setting °C	At highest range setting °C						
-20 → -12	1.5	1.5 → 4.4	1.5 → 4.9	145	B	2	4	017L003066	RT 8L
-5 → 30	1.5	1.5 → 5	1.5 → 5	150	B	2	4	017L003466	RT 14L
0 → 38	1.5 / 0.7	1.5 → 5	0.7 → 1.9	100	A	-	1	017L002466	RT 16L
15 → 45	1.8 / 2	1.8 → 4.5	2 → 5	240	B	2	2	017L003166	RT 140L
25 → 90	2.5 / 3.5	2.5 → 7	3.5 → 12.5	300	b	2	4	017L006266¹⁾	RT 101L

*) See fig. 1-5

Differential thermostats

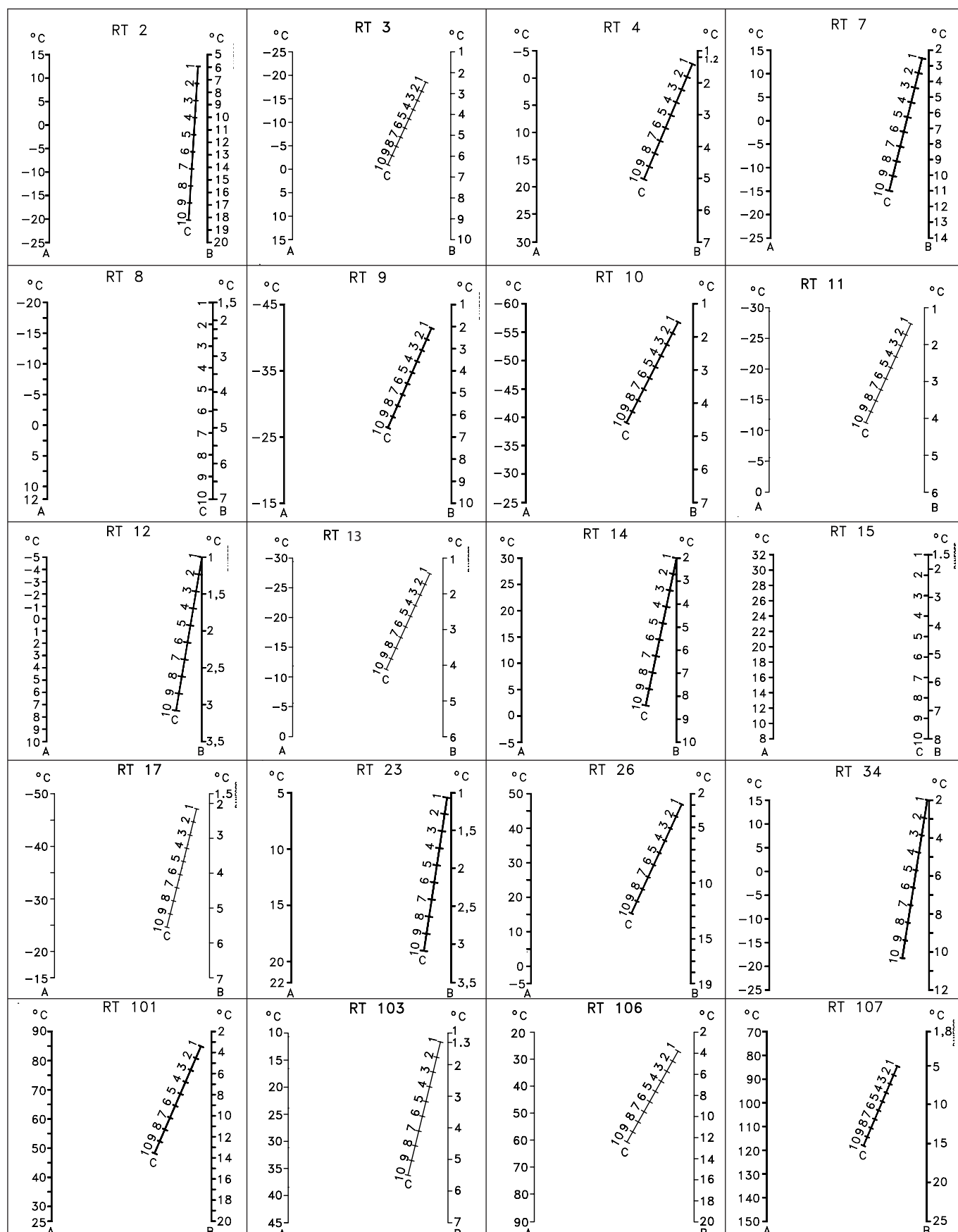
Setting range °C	Mechanical differential °C	Operating range (LT element) °C	Max. sensor temperature °C	Type of charge	Capillary tube length m	Sensor type*) Figur	Code no.	Type
0 → 20	3	20 → 100	200	B	2 × 10	5	017D004466	RT 271
0 → 15	2	-30 → 40	65	B	2 × 5	5	017D003166	RT 270

*) See fig. 1-5



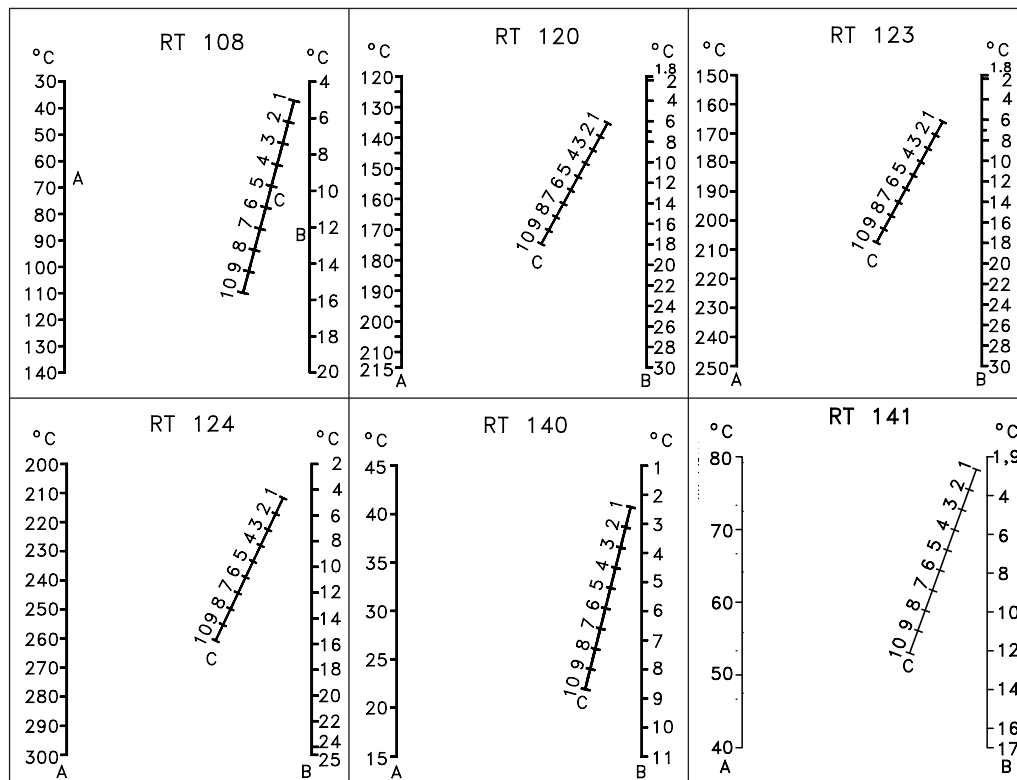
Nomograms for obtained differentials

A = Range setting
B = Obtained differential
C = Differential setting

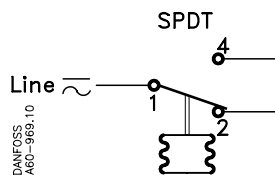
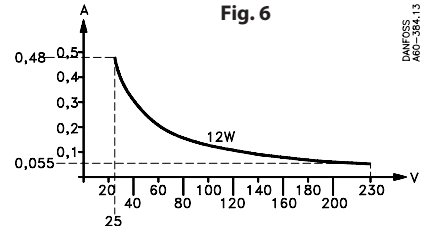


Nomograms for obtained differentials

A = Range setting
B = Obtained differential
C = Differential setting



Technical data

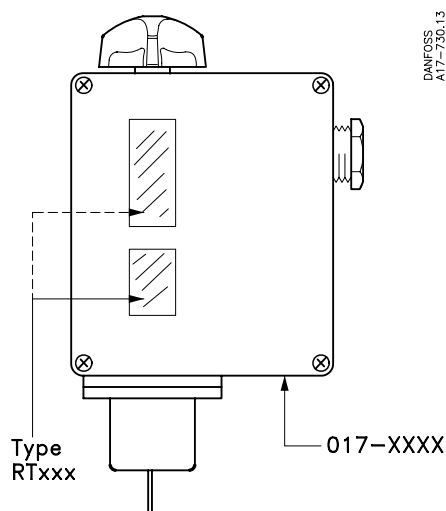
Designation	RT thermostats
Ambient temperature	-50 to 70°C . See remarks on charge types page 11
Contact system	 SPDT Line DANFOSS A60-969.10 Single-pole changeover switch (SPDT)
Contact load	Alternating current: AC-1: 10A, 400 V AC-3: 4A, 400 V AC-15: 3A, 400 V Direct current: DC-13: 12 W, 230 V (see fig. 6)
Contact material: AgCdO	 Fig. 6 DANFOSS A60-984.13
Special contact system	See "accessories" pages 15-16
Cable entry	2 PG 13.5 for 6 - 14 mm diameter cables
Enclosure	IP 66 acc. to IEC 529 and EN 60529. Units supplied with external reset. IP 54. The thermostat housing is made of bakelite acc. to DIN 53470 Cover is made of polyamide.

Approvals

RT 2 RT 23 RT 26 RT 108	RT 4 RT 10 RT 11 RT 16L RT 17 RT 140L	RT 3 RT 7 RT 8 RT 8L RT 9	RT 12 RT 13 RT 14 RT 14L RT 15	RT 16 RT 102 RT 141 RT 271 RT 270	RT 34 RT 103 RT 115 RT 140	RT 101	RT 106 RT 107 RT 123	RT 120	RT 124	Approvals
x	x	x	x	x	x	x	x	x	x	CE marked acc. to EN 60947-4/-5
						x	x	x	x	Det Norske Veritas, Norway
x	x	x	x	x	x	x	x	x	x	CCC, China Compulsory Certificate
							x			Lloyds Register of Shipping, UK
		x	x			x	x	x		Germanischer Lloyd, Germany
						x				Bureau Veritas, France
x	x	x	x	x	x	x	x	x	x	Registro Italiano Navale, Italy
x	x	x	x	x	x	x	x	x	x	RMRS, Russian Maritime Register of shipping
x		x	x			x	x	x	x	Nippon Kaiji Kyokai, Japan

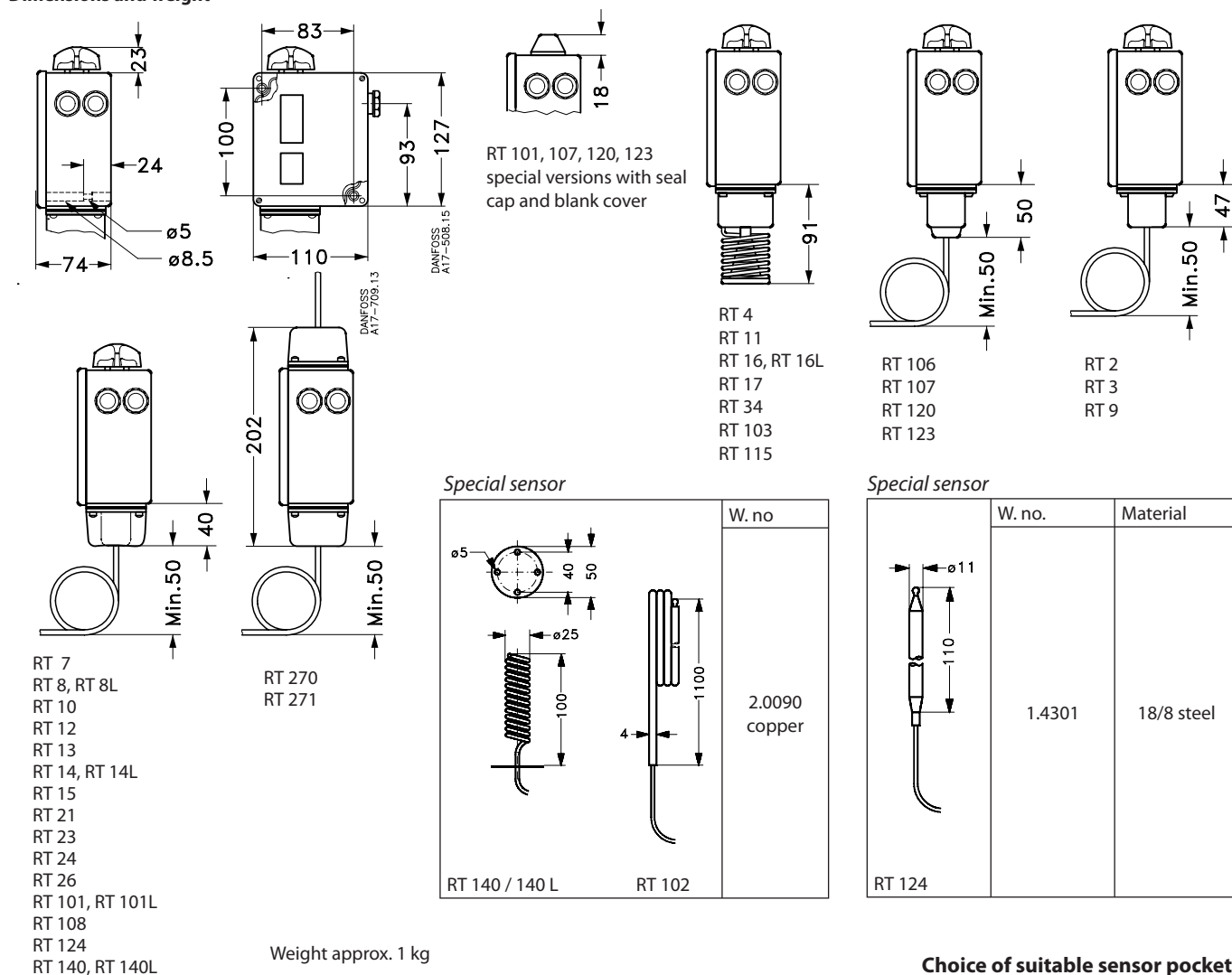
Note: In addition we refer to the certificates, the copies of which can be ordered from Danfoss.
GL approval is conditional on the use of a ship's cable entry

Identification

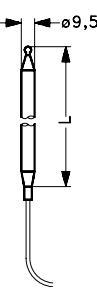
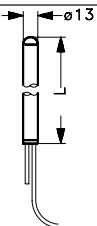


The type designation of the units is given on the setting scale. The code no. is stamped on the bottom of the thermostat housing

Dimensions and weight



Choice of suitable sensor pocket

	W. no.	Type	Capillary tube length m	L mm	Suitable sensor pocket Code no.	Material	W.no	L mm	a ₁ mm	d mm
	2.0090 copper	RT2/3/7/9 10/13/26/120	2, 3, 5 8, 10	80	017-437066 017-436966	Brass 18/8 steel	2.0321 1.4301	112	G ½	11
		RT 101/ 101L	2, 3	80	017-437066 017-436966	Brass 18/8 steel	2.0321 1.4301	112	G ½	11
		RT8/8L/14/ 14L/15/107/123, 270	2, 3, 5, 8, 10	110	017-437966 017-436966	Brass 18/8 steel	2.0321 1.4301	112	G ½	11
		RT 101	5, 8, 10	110	017-437066 017-436966	Brass 18/8 steel	2.0321 1.4301	112	G ½	11
		RT 14	10	150	017-436766	Brass	2.0321	182	G ½	11
		RT 271	10	180	017-421666			465	G ½	11
		RT 12/13	2	210	017-421666			110	G ½	15
		RT 108	2	410	017-421666			110	G ½	15
	2.0240 brass	RT 106	2.3	76	060L333066 060L332766	Brass	2.0235	110	G ½	15
			2.3	76	060L333166 060L332966	18/8 steel	1.4301	110	G ½	15
			5	86	060L333066 060L332766	Brass	2.0235	110	G ½	15
			5	86	060L333166 060L332966	18/8 steel	1.4301	110	G ½	15
					017-421866	AISI 316L	1.4435	108	G ½	15.7

Installation

RT units have two fixing holes which become accessible when the front cover is removed. Units fitted with switch 017-018166*) must be installed with the setting knob upwards. The other thermostats in the RT series can be installed in any position, except that on plant subjected to severe vibrations it is advantageous to have the screwed cable entry downwards. *) Contact system with non snap-action function. See spare parts and accessories, page 15.

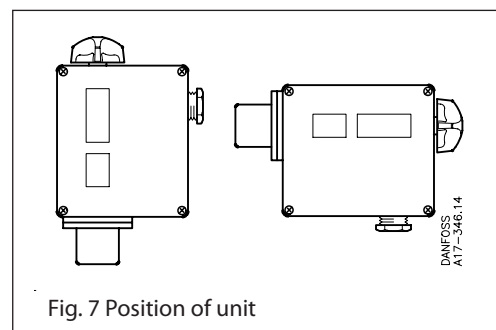


Fig. 7 Position of unit

Setting

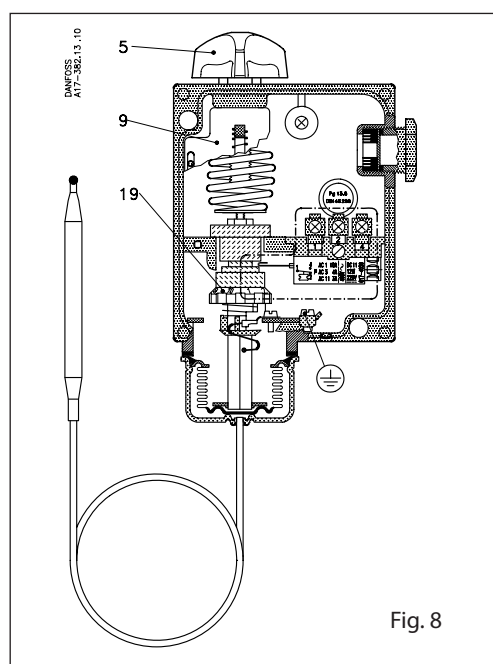


Fig. 8

- 5. Setting knob
- 9. Main scale
- 19. Differential setting disc

The range is set by using the setting knob (5) while at the same time reading the main scale (9). Tools must be used to set thermostats fitted with a seal cap. The differential is set by the differential disc (19).

The size of the obtained differential can be established by comparing the set main scale value and the scale value on the differential disc, with the help of the nomogram for the thermostat concerned (see pages 5-6)

Example

Unit: RT 120
Range setting: 160°C
Differential setting: 2

It will be seen on the nomogram on page 6 that by drawing a line from 160°C on scale A, through 2 on scale C, the value for the differential can be read from scale B: 6°C.

Selection of differential (mechanical differential)

To ensure that the plant functions properly, a suitable differential is necessary. Too small a differential will give rise to short running periods with a risk of hunting. Too high a differential will result in large temperature variations.

Differentials

The mechanical differential is the differential that is set on the differential disc in the thermostat. The thermal differential (operating differential) is the differential the system operates on. The thermal differential is always greater than the mechanical differential and depends on three factors:

- 1) flow velocity of the medium
- 2) temperature charge rate of the medium and
- 3) heat transmission

The medium

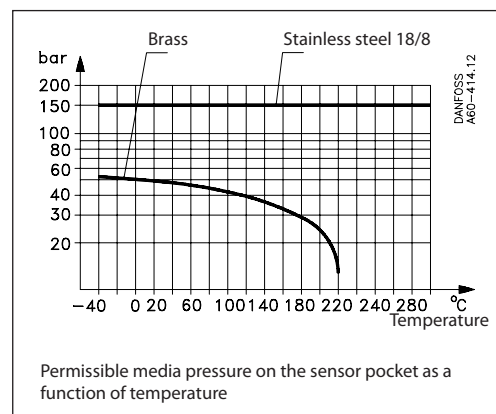
The fastest reaction is obtained from a medium having high specific heat and high thermal conductivity. It is therefore advantageous to choose a medium that fulfills these conditions (provided there is a choice). The flow velocity of the medium is also of significance. (Optimum flow velocity for liquids is approx. 0.3 m/s).

Example:

Regulation of a central heating boiler
The temperature in an oil-fired central heating boiler must be regulated by an RT 101. Max. temperature 76°C. Min. temperature 70°C. Differential 76-70 = 6°C.

1. Connect the oil burner via thermostat terminals 1-2.
2. Set the thermostat on 70°C using the hand knob (5), fig. 8.
3. Set the differential disc (19) on 3. This figure is obtained from the RT 101 nomogram, page 5.

When the plant has been operating for some time an assessment can be made of whether the thermal differential is satisfactory. If it is too large, reduce the mechanical differential of the thermostat.



Permissible media pressure on the sensor pocket as a function of temperature

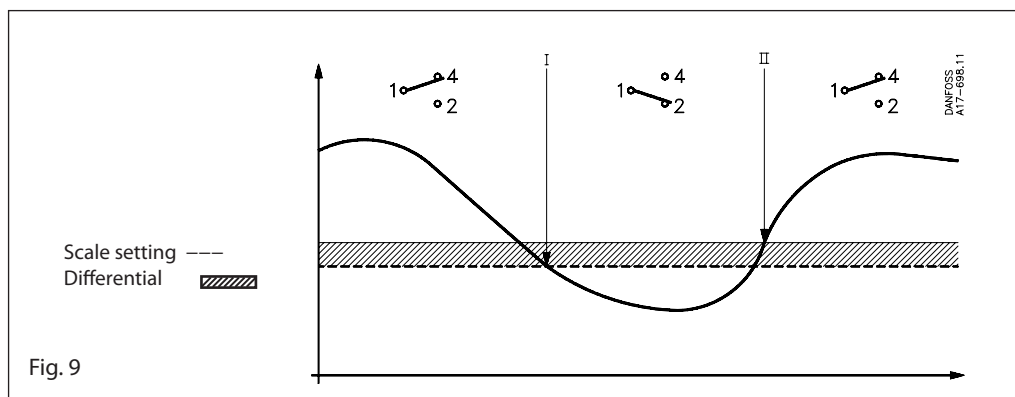
Function

a. RT thermostats with automatic reset

The RT thermostats are set according to the function required on falling temperature. Contacts 1-4 break while contacts 1-2 make when the temperature falls to the scale setting. The contacts changeover to their initial position when the temperature again rises to the scale setting plus the differential (see fig. 9).

Contact function

- I. Contact changeover for rising temperature occurs at scale setting plus differential..
- II. Contact changeover for falling temperature occurs at scale setting.

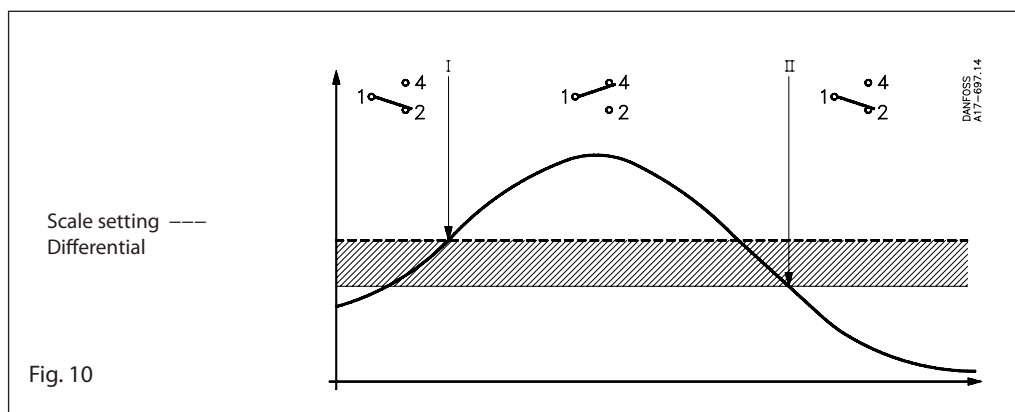


b. RT thermostats with max. reset

Contacts 1-4 make while contacts 1-2 break when the temperature exceeds the set range value. The contacts changeover to their initial position when the temperature falls to the scale value minus the differential (see fig. 10).

- I. Alarm for rising temperature given at the set value.
- II. Alarm for falling temperature given at the set value minus the differential.

Manual reset possible only when the temperature has fallen to the range setting minus differential.



RT units with vapour charge

The method of operation of these units is based on the connection between the pressure and temperature of saturated vapour. The sensor system contains just a small amount of liquid and this is brought completely to vapour form. If the sensor in this type of unit is located coldest in relation to the capillary tube and bellows housing, the ambient temperature has no influence on regulation accuracy.

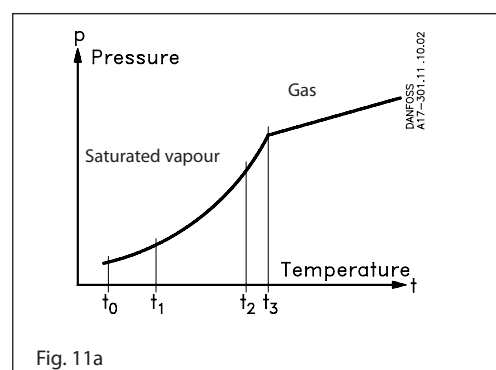


Fig. 11a

RT units with adsorption charge

The thermostatic element contains a superheated gas together with a solid substance (always in the sensor) having a large adsorption surface. This gives an advantage in that the sensor can be installed either colder or warmer than the remaining part of the thermostatic element. However, the charge is to some extent sensitive to changes in the temperature of the bellows and capillary tube.

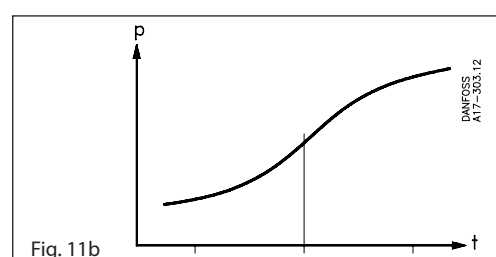


Fig. 11b

Scale correction

If the thermostat is to be used in ambient temperatures that differ significantly from the factory setting (20°C), compensation can be made for the scale deviation:

Scale correction = Z x a

Z can be found from fig. 11c, while a is the correction factor from the table.

Example:

Find the necessary scale correction for a RT 108 with a regulation range +30 to +140°C.

Setting: 85°C

Ambient temperature: 50°C

Correction:

$$\frac{\text{Set value} - \text{min. scale value}}{\text{max. scale value} - \text{min. scale value}} \times 100 = \%$$

$$\frac{85 - 30}{140 - 30} \times 100 = 50\%$$

Correction factor from table 2.0 (a)

Factor for scale deviation (see fig. 11c): +1.2 (Z)

Scale correction: Z x a = 1.2 x 2.0 = 2.4°C

Corrected setting: 85 + 2.4 = 87.4

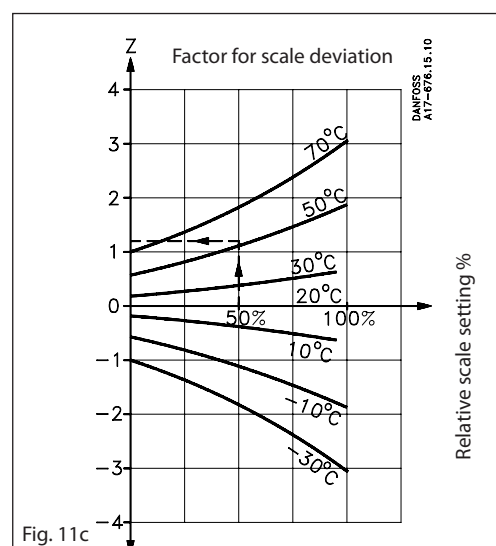


Fig. 11c

Type	Range °C	Correction factor a
RT 2	-25 → 15	2.3
RT 7	-25 → 15	2.9
RT 8/L	-20 → 12	1.7
RT 12	-5 → 10	1.2
RT 14/L	-5 → 20	2.4
RT 15	8 → 32	1.2
RT 23	5 → 22	0.6
RT 101/L	25 → 90	5.0
RT 102	25 → 90	5.0
RT 108	30 → 140	2.0
RT 140/L	15 → 45	3.1

RT units with solid charge

The method of operation of these units is based on the connection between the pressure and temperature of saturated vapour. The sensor system contains a fairly large amount of liquid, of which only a small part is brought to vapour form. If the sensor in this type of unit is located warmest in relation to the capillary tube and bellows housing, the ambient temperature has no influence on regulation accuracy.

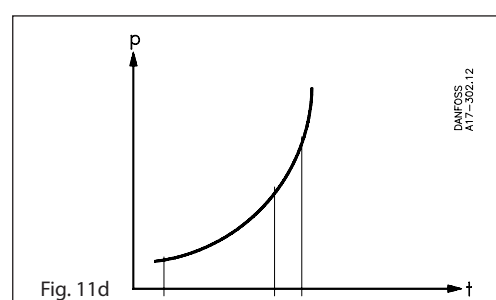
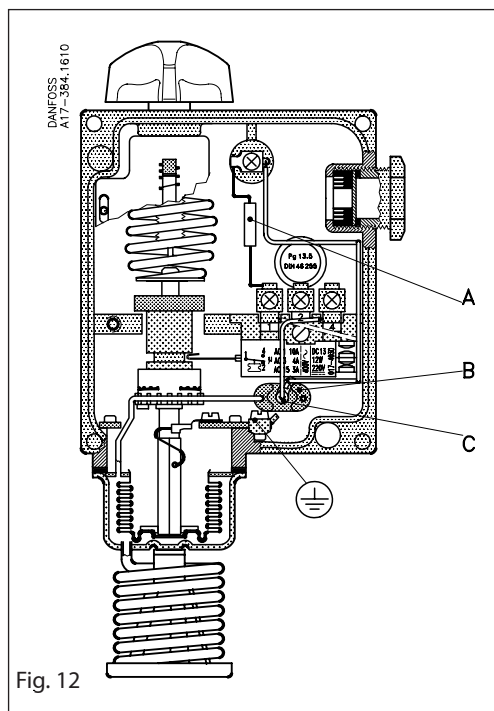


Fig. 11d

RT 115 for control of ventilation plant in livestock buildings



- A. Series resistor
- B. Bulb sensor
- C. Heating element

RT 115 has two sensors, each of which is connected to the space between bellows and bellows housing; see fig. 12. One sensor is a normal, external, rigid coiled capillary tube type, the other is a bulb sensor located in the thermostat housing.

The bulb sensor is heated by an element which is cut in when the thermostat stops the fans and is cut out when the thermostat starts the fans.

The for of operation is as follows:

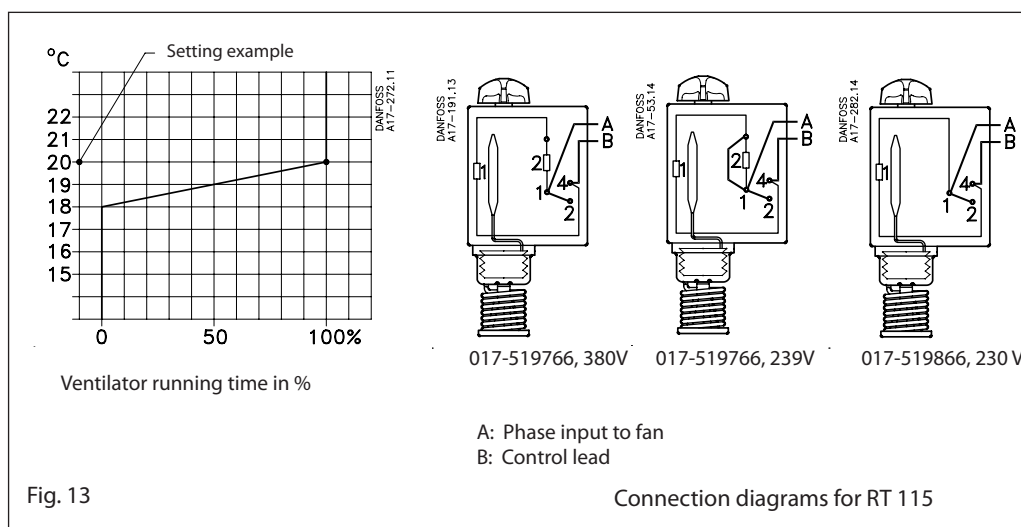
If the room temperature is more than the value set on the thermostat, 20°C for example, the fans run continuously (100% operating time). If the room temperature falls to 20°C, the switch contacts changeover, the fan stops and the bulb sensor heating element cuts in.

When the bulb sensor is heated up, pressure in the sensor system increases and after a certain time the switch changes over again thereby cutting in the fans and cutting out the element. If the room temperature falls more than 2°C under the set temperature - in this example, lower than 18°C - the fans stop completely. The heating element is cut in as usual but can no longer heat the bulb sensor sufficiently to create the required pressure increase in the thermostatic element to cut in the fans again. Thus with a room temperature of less than 18°C the operating time is 0%.

An example is shown in fig. 13.

With temperature settings other than the one shown, the inclined line in the diagram is displaced parallel. The line break point on the right of the diagram always corresponds to the set value. It is therefore possible to maintain a stable room temperature and at the same time obtain periodic ventilation where the duration of the ventilation periods depends on the difference between the actual room temperature and the set temperature.

By ensuring that the thermostat is always set at least 2°C over the lowest permissible room temperature, the thermostat will never allow the room temperature to fall below the desired level.



Application

RT-L thermostats are fitted with an adjustable neutral zone. This enables the units to be used for floating control. The terminology involved is explained below.

Floating control

A form of discontinuous control where the correcting element (e.g. valve, damper, or similar) moves towards one extreme position at a rate independent of the magnitude of the error when the error exceeds a definite positive and towards the opposite extreme position when the error exceeds a definite negative value.

Hunting

Periodic variations of the controlled variable from the fixed reference.

Neutral zone

The interval in the controlled variable in which the correcting element does not respond.

Mechanical differential

The interval between the values of the controlled variable in which the correcting element does respond.

The contact system in neutral zone units cannot be exchanged, as the contact system adjustment is adjusted to the other parts of the unit.

Neutral zone setting

5. Setting knob

9. Main scale

40. Neutral zone disc with scale

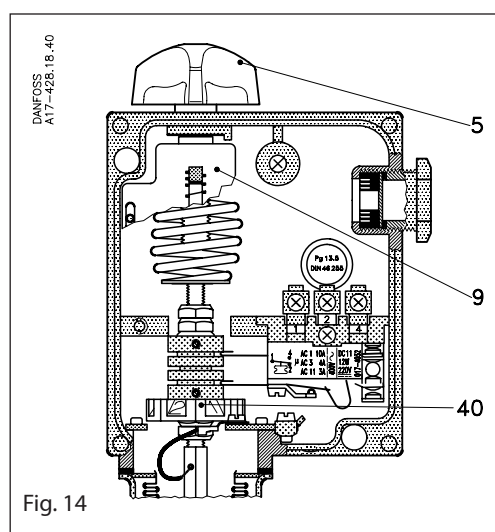


Fig. 14

The range is set using the setting knob (5), fig. 14, while reading the main scale (9). The set value is the break temperature for contacts 1-4, fig. 15. The required neutral zone can be found in the diagram for the unit concerned, fig. 16. The position at which the neutral zone disc (40) must be set can be read from the low scale in the diagram.

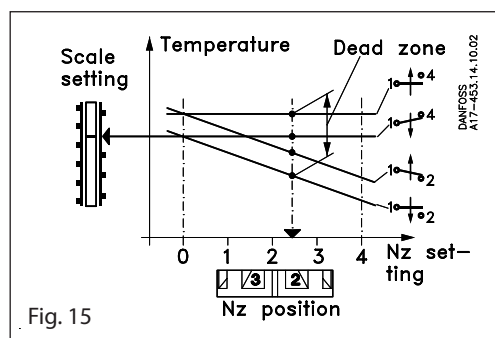


Fig. 15

Example: RT 16L

Setting temperature: +24°C

Required neutral zone: 1.9°C

Using the setting knob, set the thermostat on 24°C.

The dotted lines in the diagram for the RT 16L fig. 16 intersect each other on the curve for position 2.8 and the neutral zone setting disc (40) must be set to that position.

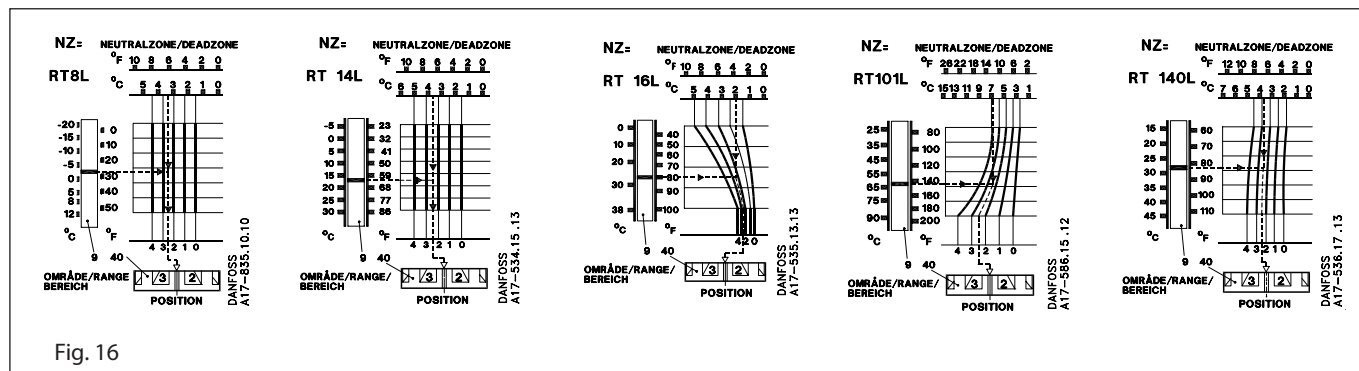


Fig. 16

Application

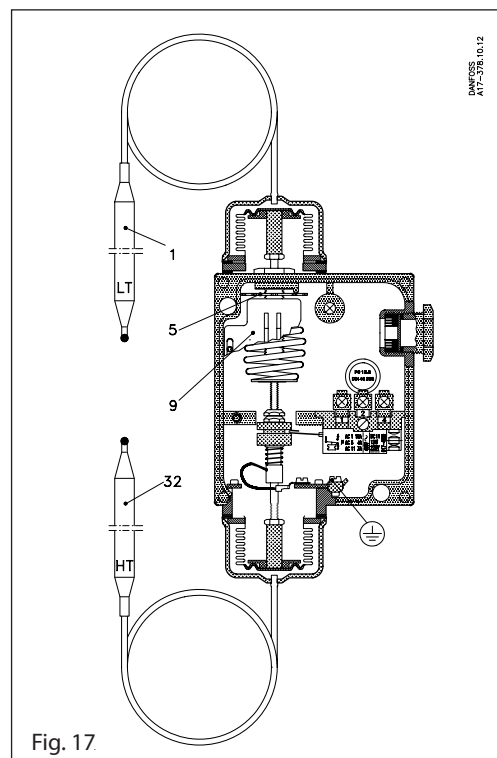
Control and monitoring of temperature differentials

An RT differential thermostat is an electric single-pole changeover switch. The position of the switch contacts is controlled by the difference in temperature between the two sensors of the thermostat.

The RT 270 is used in process plant, ventilation

plant and refrigeration and heating plant, where there is a need to maintain a certain temperature difference, from 0 to 20°C, between two media. One of the sensors is used as a reference, the other as an indirect controlled variable. (The direct controlled variable is the temperature differential).

Setting



- 1. Sensor for the lowest temperature (LT)
- 5. Setting disc
- 9. Scale
- 32. Sensor for the highest temperature (HT)

The required temperature differential between the LT sensor (1) (lowest temperature) and the HT sensor (32) (highest temperature) is set using the setting disc (5) while reading the scale (9).

Fig. 17 is a cross-sectional drawing of the RT 270. The differential thermostat has two bellows elements: an LT element whose sensor must be placed in the medium with the lowest temperature, and an HT element whose sensor must be placed in the medium with the highest temperature.

The main spring has a rectilinear characteristic. Within the differential range it can be set for different temperature differentials by means of the setting disc.

When the differential between LT and HT sensor temperatures is reduced, the main spindle moves downwards.

The contact arm is moved downwards by the guide bush so that contact 1-4 break and contacts 1-2 make when the set temperature differential is reached.

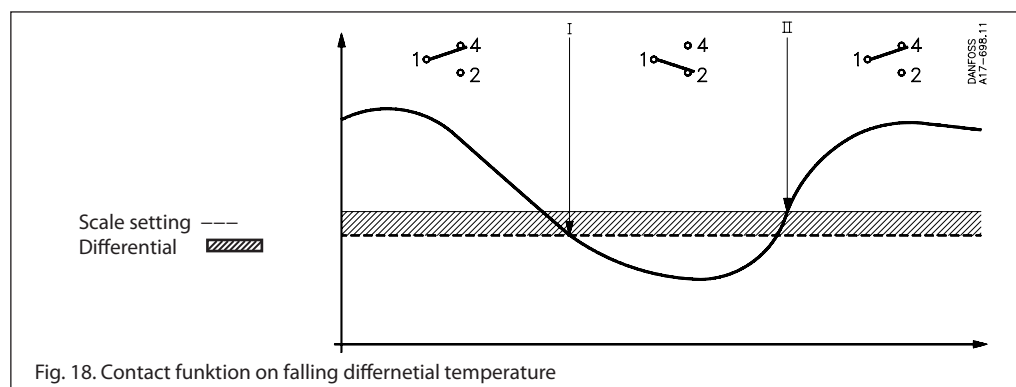
The switch contacts change back when the temperature differential has increased to the set value plus the fixed contact differential of approx. 2°C.

Function

Differential thermostats are fitted with a changeover switch (SPDT)

When the differential temperature falls below the set value, contacts 1-4 break and contacts 1-2 make. When the differential temperature rises to the set range value plus the fixed contact differential, contacts 1-2 break and contacts 1-4 make.

- I. Contacts make when differential temperature falls below the range scale setting.
- II. Contacts make when differential temperature rises above the range scale plus the fixed contact differential.



Example

The temperature rise across an air cooler must be held below 5°C. An alarm must be given when the differential temperature of the cooling water exceeds the 5°C

The choice is an RT 270 with a range of 0-15°C and a fixed contact differential of 2°C.

Range setting: 5-2°C = 3°C

When the differential temperature exceeds the range setting plus the fixed contact differential (3+2°C) an alarm will be given.

Spare parts and accessories

Version	Symbol	Description	Contact rating	Code no.
Standard		Single-pole changeover switch (SPDT) with terminal board proof against leakage current Fitted in all standard versions of type RT¹⁾. Snap action changeover contacts.		017-403066
With max. reset		For manual reset of unit after contact changeover on rising pressure For units with max. reset.	<i>Alternating current:</i> AC-1 (ohmic): 10 A, 400 V AC-3 (inductive): 4 A, 400 V AC-14/15 (coil/transformer): 3 A, 400 V Blocked rotor: 28 A, 400 V <i>Direct current:</i> DC 13/14: 12 W, 230 V	017-404266
With min. reset		For manual reset of units after contact changeover on falling pressure. For units with min. reset.		017-404166
Standard		Single-pole changeover switch (SPDT) with gold plated (oxide-free) contact surfaces. Increases cut-in reliability on alarm and monitoring systems, etc. Snap action changeover contacts. Terminal board proof against leakage current.	<i>Alternating current:</i> AC-1 (ohmic): 10 A, 400 V AC-3 (inductive): 2 A, 400 V AC-14/15: 1 A, 400 V Blocked rotor: 14 A, 400 V <i>Direct current:</i> DC-13/14: 12 W, 230 V	017-424066
Cuts in two circuits simultaneously		Single-pole changeover switch that cuts in two circuits simultaneously on rising pressure. Snap action changeover contacts. Terminal board proof against leakage current.	<i>Alternating current:</i> AC-1 (ohmic): 10 A, 400 V AC-3 (inductive): 3 A, 400 V AC-14/15: 2 A, 400 V Blocked rotor: 20 A, 400 V <i>Direct current:</i> DC-13/14: 12 W, 230 V	017-403466
Cuts out two circuits simultaneously		Single-pole changeover switch that cuts out two circuits simultaneously on rising pressure. Snap action changeover contacts. Terminal board proof against leakage current.	<i>Direct current:</i> DC-13/14: 12 W, 230 V * If current is led through contacts 2 and 4, i.e. terminals 2 and 4 connected but not 1, max. permissible load is increased to 90 W, 220 V - - -.	017-403666
With non-snap action changeover contacts		Single-pole changeover with non-snap action changeover gold plated (oxide-free) contacts.	<i>Alternating or direct current:</i> 25 VA, 24 V	017-018166

¹⁾ At load types with low currents/voltages contact failure may occur on the silver contacts because of oxidation. In systems where such a contact failure is of great importance (alarm etc.), gold plated contacts are recommended.

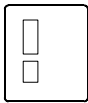
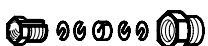
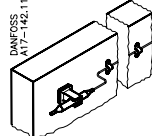
Contact systems for neutral zone units are not available as spare parts. Exchange not possible, as the contact system adjustment is adjusted to the other parts of the unit.

The switch contacts are shown in the position they assume on falling temperature, i.e. after downward movement of the RT main spindle.

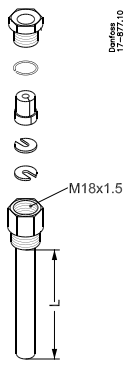
The setting pointer of the control shows the scale value at which contact changeover occurs on falling temperature. An exception is switch no. **017-403066** with max. reset where the setting pointer shows the scale value at which contact changeover occurs on rising pressure.

Switches

Version	Symbol	Description	Contact rating	Code no.
With min. reset		For manual reset of unit after contact changeover on falling pressure. Gold plated (oxide-free) contact surfaces	<i>For Alarm application</i> <i>Alternating current:</i> AC-1 (ohmic): 10 A, 400 V AC-3 (inductive): 2 A, 400 V Full load current: 2 A, 400 V AC-14/15: 1 A, 400 V Blocked rotor: 14A, 400 V	017-404766
With max. reset		For manual reset of unit after contact changeover on rising pressure. Gold plated (oxide-free) contact surfaces	<i>Direct current</i> DC-13/14: 12W, 230 V <i>For control application</i> max. 100 mA / 30 V a.c./ d.c. min. 1 mA / 5 V a.c. / d.c.	017-404866

Part		Description	Qty.	Code no.
Cover		Covers: Polyamide	5	017-436166
		Colour: Pale grey RAL 7035	5	017-436266
Setting knob		Replacement Pale grey Ral 7035	30	017-436366
Seal cap		Seal cap to replace setting knob so that Setting can only be altered with tools	20	017-436066
Seal screws for cover and seal cap			1 + 1	017-425166
Capillary tube gland		For all RT thermostats with remote sensor. G½A (pipe thread ISO 228/1), oil resistant rubber washer for max. 110°C/90 bar	5	017-422066
Capillary tube gland		For RT 106 thermostats with remote sensor. G¾A (pipe thread ISO 228/1), oil resistant rubber washer for max. 110°C/90 bar	1	003N0155
Sensor clip		For all RT units with remote sensor L = 76 mm	10	017-420366
Heat conductive compound		For RT thermostats with the sensor insert in a pocket. Tube with 3.5cm³ compound to be filled in the sensor pocket to improve heat transfer between pocket and sensor. Application range for compound: -20 to +150°C, momentarily up to 220°C	10	041E0114
Sensor holder		For RT 14, 101 and 270 Sensor holder for wall mounting incl. four capillary tube clips	20 set	017-420166

Sensor pocket for RT thermostats with cylindrical remote sensor

Used for the following types		Insertion length L mm	d mm	Material	Connection pipe thread ISO 228/1	Code no.
All except RT 12, 23, 106, 108, 124, 270		112	11	Brass	G ½A	017-437066
All except RT 12, 23, 106, 108, 124, 271		112	11	Stainless steel 18/8		017-436966
RT 106, RT 124 ²⁾		110	15	Brass		060L327166 ¹⁾
RT 106, RT 124 ²⁾		110	15	Stainless steel 18/8		060L326866 ¹⁾
RT 106, RT 124 ²⁾		160	15	Brass		060L326366 ¹⁾
RT 106, RT 124 ²⁾		160	15	Stainless steel 18/8		060L326966 ¹⁾
RT 271		182	11	Brass		017-436766
RT 108		465	11	Brass		017-421666

¹⁾ Supplied without washer set

²⁾ Unit supplied with washer set

See possibly page 8.

Heavy duty pressure controls

MBC 5000 and MBC 5100

Features



- Designed for use in severe industrial environments
- High vibration stability
- Part of the Danfoss block system, consisting of MBC pressure controls, MBS pressure transmitters and MBV test valves
- MBC 5100 with all major ship approvals
- High repeatability
- Optimal compact design for machine building purposes
- Intended for alarm indication, shut down, control and diagnostics in many applications - motors, gears, thrusters, pumps, filters, compressors etc.

Ship approvals MBC 5100

Lloyd's Register of Shipping
Germanischer Lloyd
RINA, Registro Italiano Navale
NKK, Nippon Kaiji Kyokai
DNV, Det Norske Veritas

BV, Bureau Veritas
American Bureau of Shipping
KRS, Korean Register of Shipping
RMRS, Russian Maritime Register of Shipping

Approvals

EN 60947-4-1
EN 60947-5-1

CCC, China Compulsory Certificate

Technical data

Performance

Repeatability	Bellows versions	± 0.2 % FS (typ.) ± 0.5 % FS (max.)
	Diaphragm versions	± 0.5 % FS (typ.) ± 1 % FS (max.)
	Piston versions	± 1 % FS (typ.) ± 1 % FS (max.)
Response time		< 4 ms
Max. switch frequency		10/min (0.16 Hz)
Differential		see page 3
Permissible operating pressure		see page 3
Burst pressure		see page 3
Life time	Mechanical for diaphragm and bellows	> 400,000 cycles
	Mechanical for piston type	> 1 million cycles
	Electrical at max. contact load	> 100,000 cycles

Electrical specifications

Switch	SPDT			
Contact load	AC 1	10 A, 250 V	AC 15	0.5A, 250 V
	AC 3	3A, 250 V	DC 13	12 W, 125 V

Environmental conditions

Temperature	Operation	Bellows versions Diaphragm versions Piston versions	-40 to +85 °C -10 to +85 °C -40 to +85 °C
	Transport	Bellows versions Diaphragm versions Piston versions	-50 to +85 °C -50 to +85 °C -40 to +85 °C
Enclosure			IP 65, IEC 529
Vibration stability	Sinusoidal	20 g, 25 Hz - 2 kHz	IEC 68-2-6
		piston type 4.4g, 25-200 Hz	IEC 60068-2-27

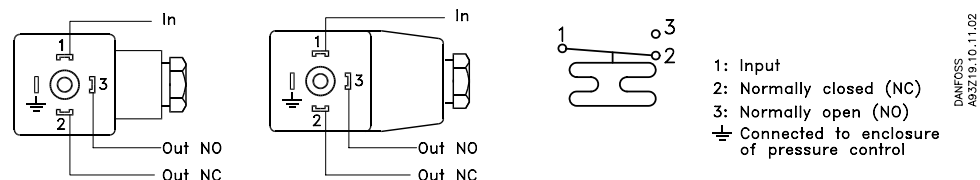
Technical data

(continued)

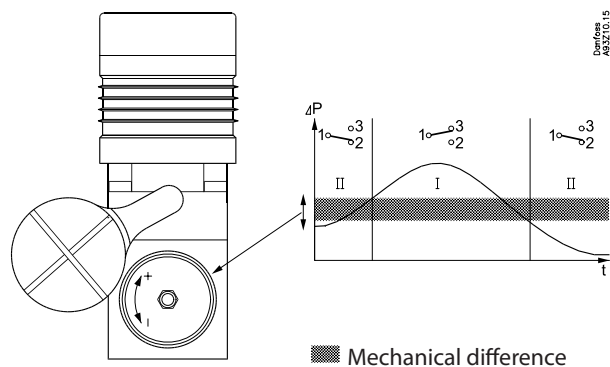
Mechanical characteristics

Pressure connection	Standard Option	G 1/4 female (ISO 228/1) or flange see specification form, page 3
Electrical connection	Plug	DIN 43650, Pg 9 / Pg 11 / Pg 13.5
Wetted parts material	Housing Bellows Diaphragm Piston O-ring	Anodized AlMgSi1 Stainless steel 1.4306 (18/8) Viton Stainless steel 1.4028 (3H13) NBR
Enclosure material	Housing Plug fixture Contact system	AlMgSi1 Glass filled polyamid, PA 6.6 Silver (AG) microprofile
Weight		0.4 kg

Electrical connection

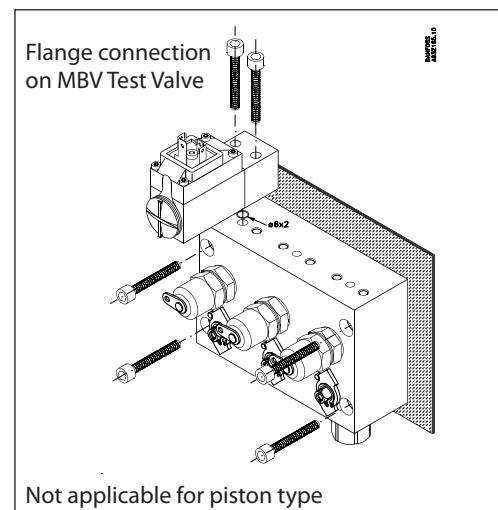
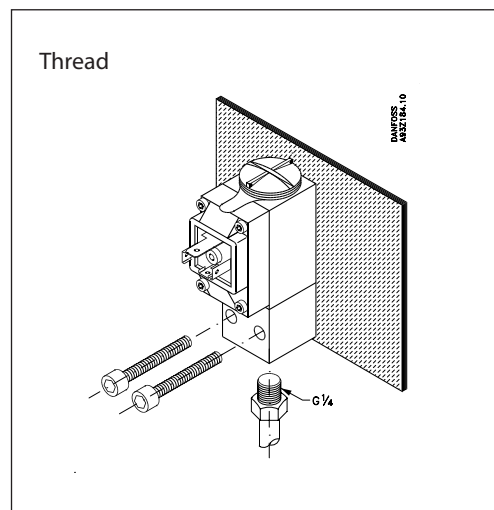


Adjustment



One full turn (360°) of MBC setting screw is approx. equal to 7% of the setting range

Mechanical connection



How to choose

To achieve the best operating conditions for MBC pressure controls, it is recommended to apply the following rules of thumb:

- Choose:
- the MBC type/types which meet the demands for the operating pressure
 - the MBC version with the lowest possible setting range
 - a diaphragm type, if pressure peaks and pulsations occur in the system (if possible)
 - bellows types, if low differential is needed
 - piston type for high pressure

Ordering standard types

Type: LP = Low pressure HP = High Pressure	Setting range Pe [bar]	Fixed differential Pe [bar] (typ)	Permissible operating pressure Pe [bar]	Min. burst pressure Pe [bar]	Type designation MBC 5000-/ MBC 5100-	MBC 5100 Ship approved Code no.	MBC 5000 Standard Code no.
LP bellows	-0.2 to 1	0.15 to 0.45 ¹⁾	15	30	1011-1DB04	061B000566	061B200566
LP bellows	-0.2 to 4	0.15 to 0.45 ¹⁾	15	30	1211-1DB04	061B000466²⁾	061B200466
LP bellows	-0.2 to 10	0.15 to 0.60 ¹⁾	15	30	1411-1DB04	061B000266²⁾	061B200266
LP bellows	-0.2 to 10	0.15 to 0.60 ¹⁾	15	30	1411-1CB04	061B000066	061B200066
LP bellows	0.5 to 3	0.15 to 0.30 ¹⁾	15	30	2011-1DB04	061B002966	
LP bellows	1 to 6	0.15 to 0.45 ¹⁾	15	30	2211-1DB04	061B000766	
HP bellows	5 to 30	0.40 to 1.5 ¹⁾	45	90	3421-1DB04	061B000366²⁾	061B200366
LP diaphragm	0.5 to 3	0.25 to 0.80 ¹⁾	150	300	2031-1DB04	061B101766	
LP diaphragm	1 to 6	0.30 to 2.0 ¹⁾	150	300	2231-1DB04	061B100966	
LP diaphragm	1 to 10	0.30 to 2.0 ¹⁾	150	300	2431-1DB04	061B100466²⁾	061B300466
LP diaphragm	5 to 20	0.4 to 2.5 ¹⁾	150	300	3231-1DB04	061B100266²⁾	061B300266
LP diaphragm	5 to 25	0.4 to 2.5 ¹⁾	150	300	3331-1DB04	061B102466	
HP diaphragm	5 to 40	1.0 to 7.0 ¹⁾	150	300	3641-1DB04	061B100566²⁾	061B300566
HP diaphragm	10 to 100	1.7 to 14 ¹⁾	150	300	4241-1DB04	061B100366²⁾	061B300366
HP piston	16 to 160	12 to 30 ¹⁾	600	1200	5251-1CB04	061B510066	061B500266
HP piston	25 to 250	12 to 40 ¹⁾	600	1200	5451-1CB04	061B510166	061B500166
HP piston	40 to 400	15 to 50 ¹⁾	600	1200	5651-1CB04	061B510266	061B500066

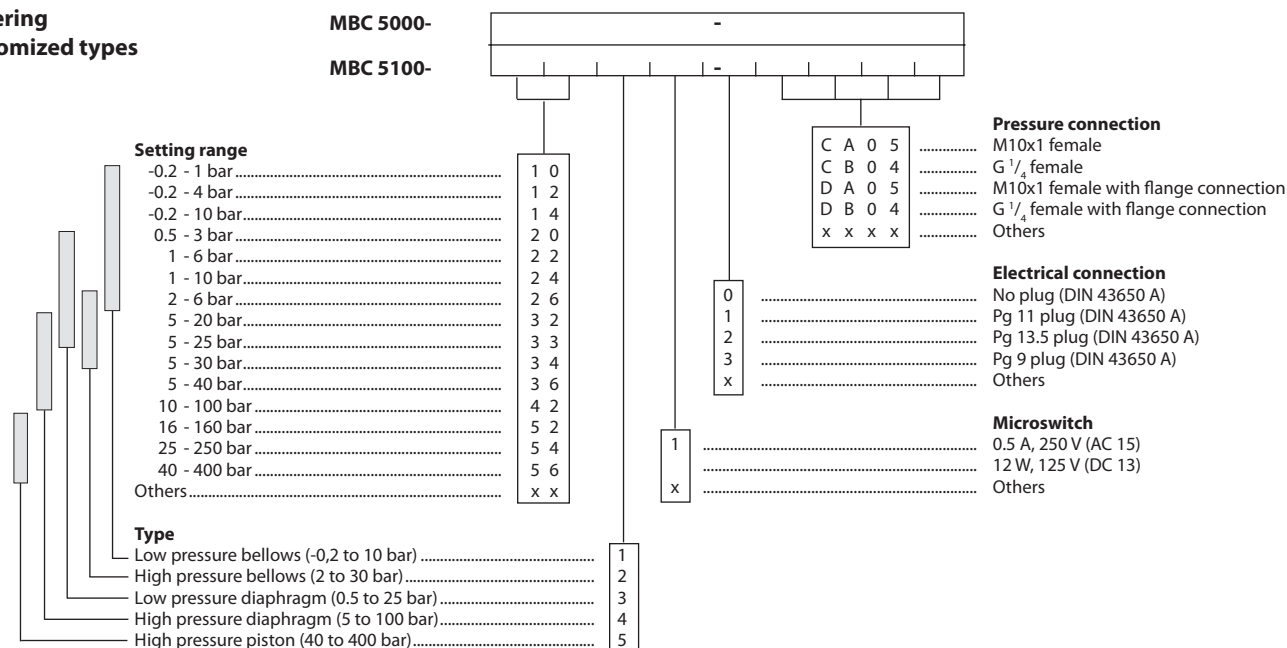
¹⁾Lowest differential at min. setting range, highest differential at max. setting range

²⁾Preferred versions

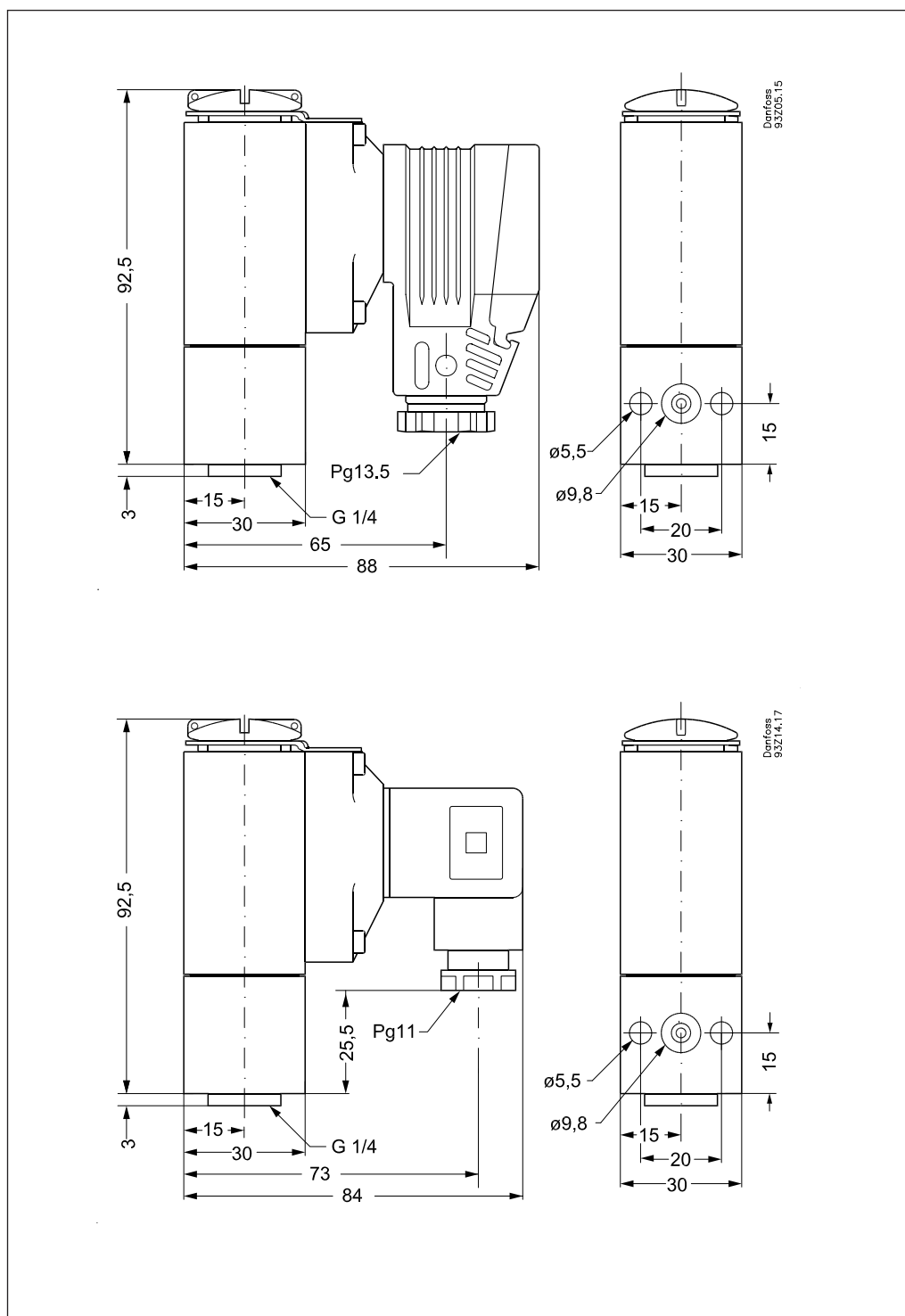
Ordering customized types

MBC 5000-

MBC 5100-



Dimensions



Pressure switches and thermostats, type CAS

Description



CAS units are pressure-controlled switches. The position of the contacts depends on the pressure in the inlet connection and the set value. In the series, special attention has been given to meeting demands for

- a high level of enclosure
- low differential
- robust and compact construction
- resistance to shock and vibration.

The CAS series covers most outdoor as well as indoor application requirements.

CAS pressure controls are suitable for use in alarm and regulation systems in factories, diesel plant, compressors, power stations and on board ship.

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Examples	11
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Approvals

CE-marked acc. to EN 60947-5-1
CCC, China Compulsory Certificate

Ship approvals

American Bureau of Shipping, USA (excl. CAS 139)
Lloyds Register of Shipping, UK
Germanischer Lloyd, Germany
Bureau Veritas, France
Det Norske Veritas, Norway

Registro Italiano Navale, Italy
RMRS, Maritime Register of Shipping,
Russia
Nippon Kaiji Kyokai, Japan

Survey

Pressure switches, type CAS

0	10	20	30	40	50	60 bar	Range P_e bar	Type
<i>Standard pressure switches</i>								
■							0 - 3.5	CAS 133
■	■						0 - 10	CAS 136
	■	■					0 - 18	CAS 137
		■	■	■	■	■	10 - 35	CAS 139
<i>Pressure switches for high pressure and strongly pulsating media</i>								
■	■	■					1 - 10	CAS 143
	■	■	■	■	■	■	4 - 40	CAS 145
		■	■	■	■	■	6 - 60	CAS 147
<i>Differential pressure switches</i>								
■	■						0.2 - 2.5	CAS 155

Thermostats, type CAS

0	30	60	90	120	150	°C	Range °C	Type
	■	■	■	■	■		20 - 80	CAS 178
		■	■	■	■		70 - 120	CAS 180
			■	■	■		60 - 150	CAS 181

ISO 9001 quality approval



Danfoss A/S is certificated by BSI in accordance with international standard ISO 9001. This means that Danfoss fulfils the international standard in respect of product development, design, production and sale. BSI exercises continuous inspection to ensure that Danfoss observes the requirements of the standard and that Danfoss' own quality assurance system is maintained at the required level.

Ordering

 Preferred version

When ordering, please state type and code no.



CAS 133, 135, 139

Standard pressure switches

Setting range p ^e (bar)	Mechanical differential (bar)	Permissible operating pressure (bar)	Max test pressure (bar)	Min. burst pressure (bar)	Pressure connection	Code no.	Type
0 → 3.5	0.1	10	10	40	G ¼	060-315066	CAS 133
0 → 10	0.2	22	22	40		060-315166	CAS 136
6 → 18	0.3	27	27	72		060-315266	CAS 137
10 → 35	0.6	53	53	100		060-315366	CAS 139



CAS 143, 145, 147

Pressure controls for high pressure and strongly pulsating media

Setting range p ^e (bar)	Mechanical differential (bar)	Permissible operating pressure (bar)	Max test pressure (bar)	Min. burst pressure (bar)	Pressure connection	Code no.	Type
1 → 10	0.2 → 0.6	120	180	240	G ¼	060-316066	CAS 143
4 → 40	0.8 → 2.4	120	180	240		060-316166	CAS 145
6 → 60	1 → 3	120	180	240		060-316266	CAS 147



CAS 155

Differential pressure switch type CAS

Setting range p ^e (bar)	Mechanical differential (bar)	Permissible operating pressure for low pressure (bar)	Max test pressure (bar)	Min. burst pressure (bar)	Pressure connection	Code no.	Type
0.2 → 2.5	0.1	0 → 8	22	42	2 x G ¼	060-313066	CAS 155

Terminology

Range setting

The pressure range within which the unit will give a signal (contact changeover).

Differential

The difference between make pressure and break pressure (see also page 6).

Permissible burst pressure

The highest permanent or recurring pressure the unit can be loaded with.

Max. test pressure

The highest pressure the unit may be subjected to when, for example, testing the system for leakage. Therefore, this pressure must not occur as a recurring system pressure.

Min. burst pressure

The pressure which the pressure-sensitive element will withstand without leaking.

Technical data

Switch

Microswitch with single pole changeover (SPDT)

Contact load

Alternating current:

220 V, 0.1 A, AC-14 and AC-15 (inductive load)

Direct current: 125 V, 12 W DC-13 (inductive load)

Temperature of medium

CAS 133-139: -40 to + 100°C

CAS 143-155: -25 to + 100°C

For water and seawater, max. 80 °C

Vibration resistance

Vibration-stable in the range 2-30 Hz
amplitude 1.1 mm and 30-100 Hz, 4 G.

Materials in contact with the medium

CAS 133	Bellows:	Stainless steel, material no. 1.4306 (DIN 17440)
CAS 136	Pressure connection:	Brass material no. 2.0401 (DIN 17660)
CAS 137		
CAS 139		
CAS 143	Diaphragm connection:	Nickel plated brass CuZn 40 Ob3 ISO R 426 (DIN 17569)
CAS 145		
CAS 147		
CAS 155	Diaphragm:	Nitrile-butadien rubber

Ambient temperature

CAS 133-139: -40 to +70°C

CAS 143-155: -25 to +70°C

Enclosure

IP 67 acc. to IEC 529 and DIN 40050.

The pressure control housing is enamelled pressure die cast aluminium (GD-AISI 12).

The cover is fastened by four screws which are anchored to prevent loss.

The enclosure can be sealed with fuse wire.

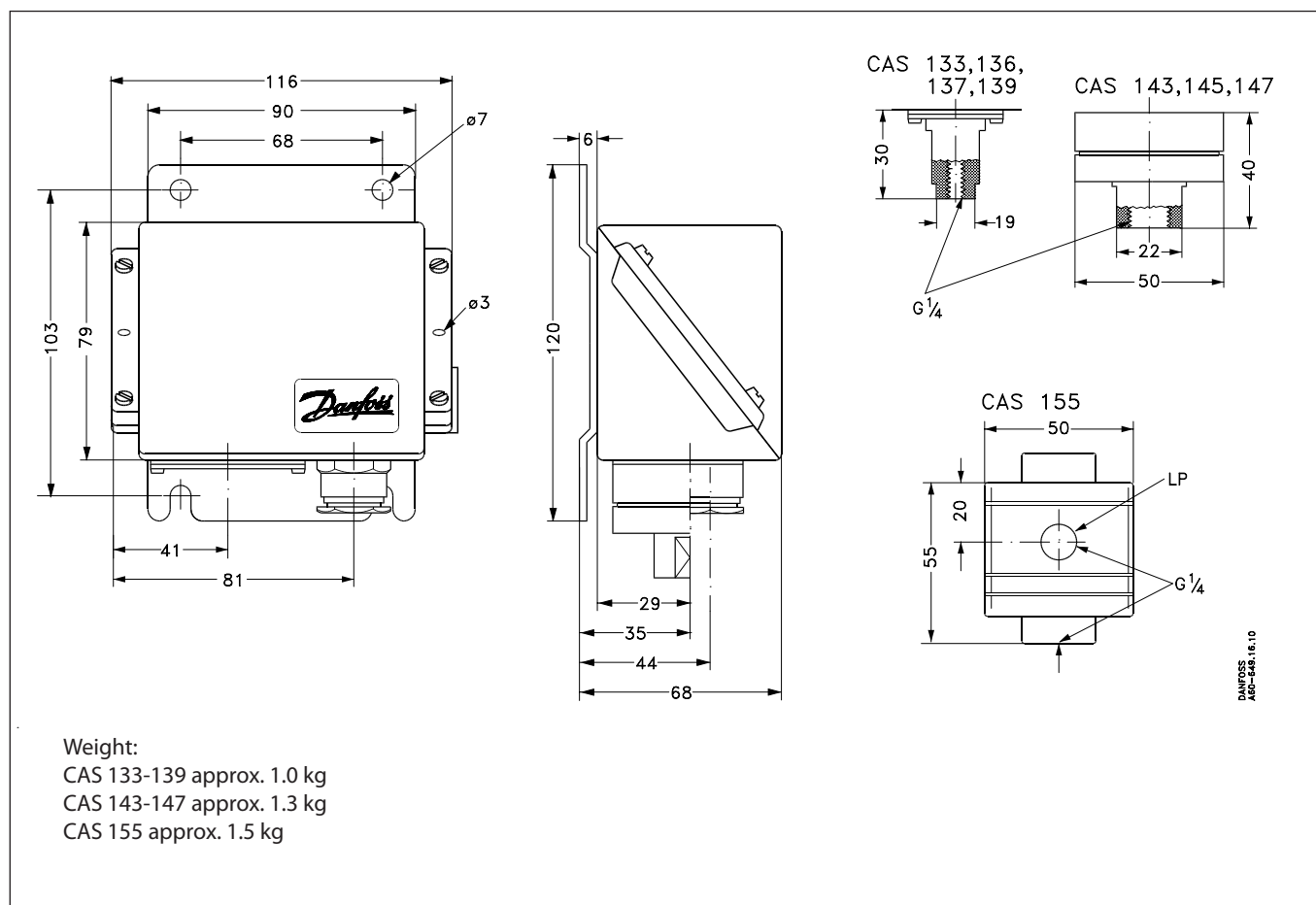
Cable entry

Pg 13.5 for cable diameters from 5 to 14 mm.

Identification

The type designation and code no. of the unit is stamped in the side of the housing.

Dimensions



Installation

Installation

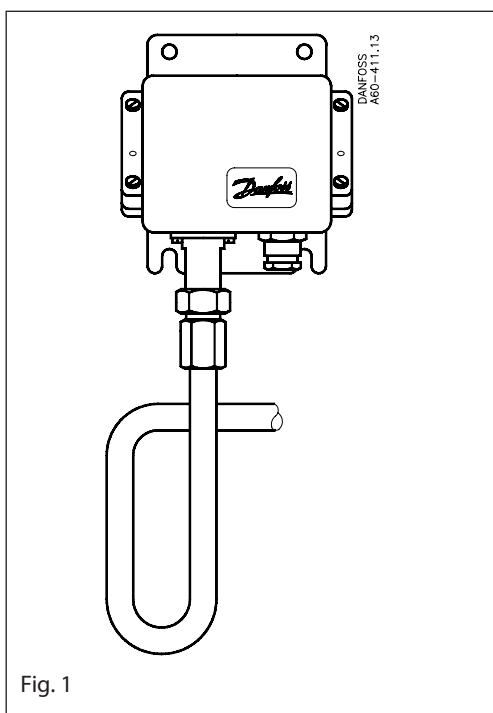
CAS pressure controls are fitted with a 3 mm steel mounting plate. The units should not be allowed to hang from the pressure connection.

Pressure connection

When fitting or removing pressure lines, the spanner flats on the pressure connection should be used to apply counter-torque.

Steam plant

To protect the pressure element from excessive heat, the insertion of a water-filled loop is recommended. The loop can, for example, be made of 10 mm copper tube as shown in fig. 1.



Water systems

Water in the pressure element is not harmful, but in case of frost a water-filled pressure element may burst. To prevent this happening, the pressure control can be allowed to operate on an air cushion.

Media resistance

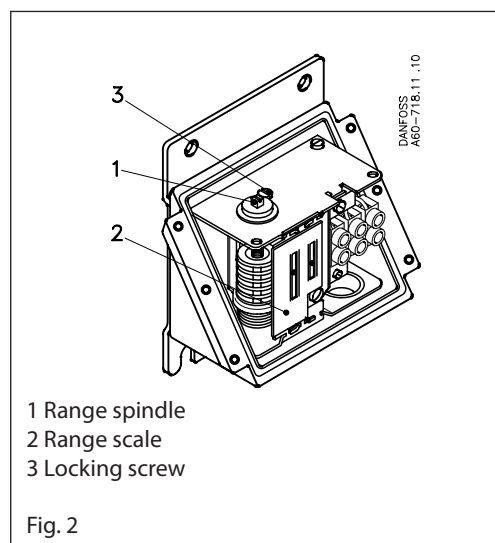
See table of materials in contact with the medium, page 4. If seawater is involved, types CAS 143, 145, 147 are recommended.

Pulsations

If the pressure medium is superimposed with severe pulsations, which occur in automatic sprinkler systems (fire protection), fuel systems for diesel motors (priming lines), and hydraulic systems (e.g. propeller systems), etc, types case 143, 145, 147 are recommended. The maximum permissible pulsation level for these types is 120 bar.

Setting

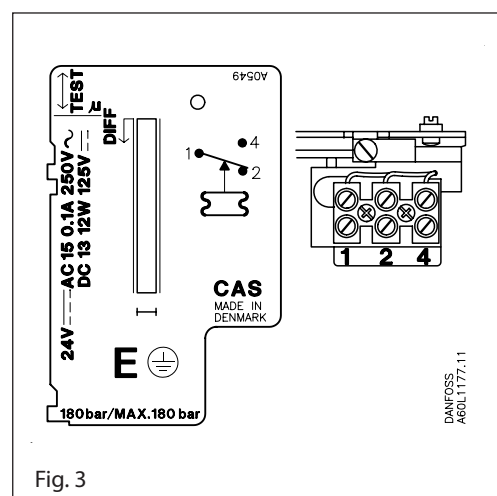
When the pressure control cover is removed, and the locking screw (3) is loosened, the range can be set with the spindle (1) while at the same time the scale (2) is being read.



Electrical connection

CAS pressure controls are fitted with a PG 13.5 screwed cable entry that is suitable for cable diameters from 5 to 13 mm.

Contact function is shown in fig. 3.



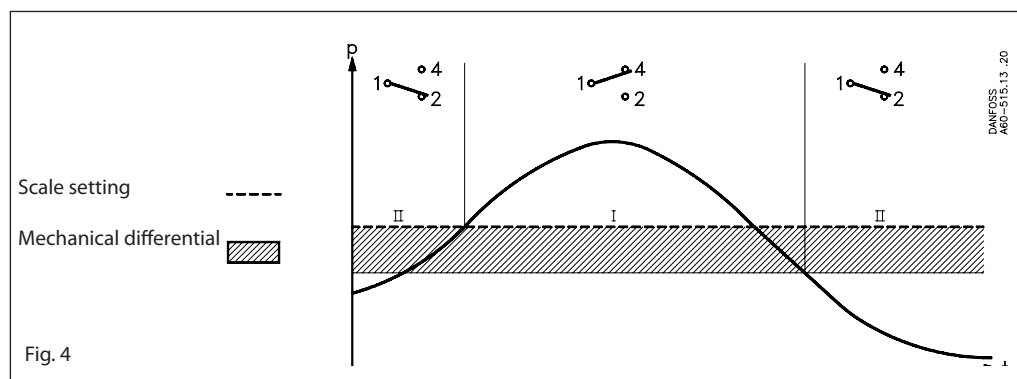
Function

a. CAS 155

Contacts 1-4 make and contacts 1-2 break when the differential pressure rises above the set range value. The contacts changeover to their initial position when the differential pressure again falls to the range value minus the differential (see fig. 4).

I. Alarm for rising differential pressure given at the set range value.

II. Alarm for falling differential pressure given at the set range value minus the differential.

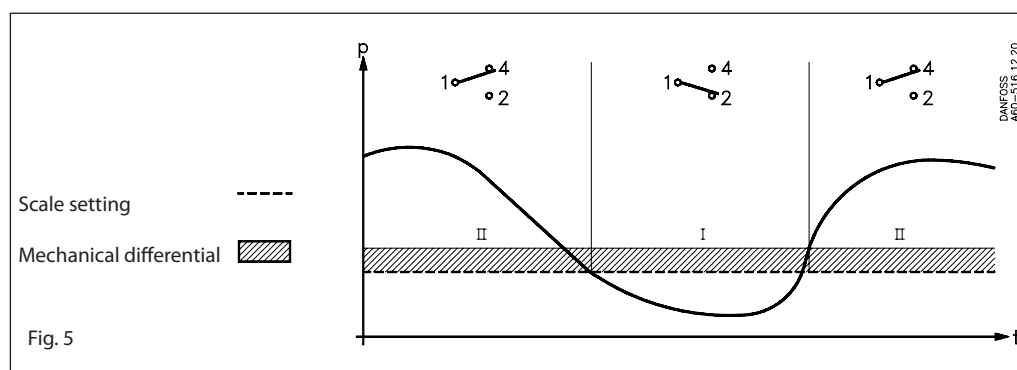


b. All other CAS pressure controls

Contacts 1-2 make and contacts 1-4 break when the pressure falls under the set range value. The contacts changeover to their initial position when the pressure again rises to the set range value plus the differential (see fig. 5).

I. Alarm for falling pressure given at the set range value.

II. Alarm for rising pressure given at the set range value plus the differential.



Example 1:

An alarm must be given when the lubrication oil pressure in a motor falls below 0.8 bar. Select CAS 133 (range 0 to 3.5 bar).

The minimum permissible lubricating oils pressure of 0.8 bar must be set using the range spindle. The differential is fixed at 0.1 bar, i.e. the alarm will not cut out before the pressure rises to 0.9 bar.

The switch break function is normally used for alarm purposes, i.e. the alarm must be connected to terminals 1 and 4.

Example 2:

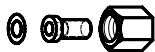
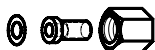
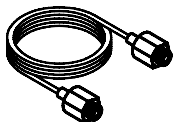
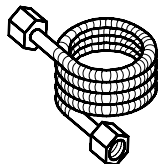
When the differential pressure exceeds 1.3 bar a filter must be cleaned.

The maximum static pressure (LP) for the CAS 155 of 8 bar must not be exceeded.

The pressure control range spindle must be set at 1.3 bar.

The alarm must be connected to terminals 1 and 2 (alarm for broken circuit).

Accessories

Part		Description	Qty.	Code no.
Connector with nipple		Pipe thread ISO 228/1, G 3/8 connector, nipple and AL washer (10 mm ext. 8 mm int. diam) for solering onto steel or copper tubing, steel span of jaws 22	5	017-436866
Connector with nipple		G 3/8 connector, nipple and washer (10 mm ext./ 6.5 mm int. diam.) for welding, steel span of jaws 22	1	017-422966
Reducer		Pipe thread ISO 228/1, G 3/8 x 7/16 - 20 UNF reducer, washer, brass span of jaws 22	5	017-420566
Adaptor		Pipe thread ISO 228/1, G 3/8 x 1/8 - 27 NPT with copper washer brass span of jaws 22	1	060-333466
Adaptor		Pipe thread ISO 228/1, G 3/8 A x 1/4 - 18 NPT with copper washer brass span of jaws 22	1	060-333566
Adaptor		Pipe thread ISO 228/1, G 3/8 x 1/4 - 18 NPT with copper washer brass span of jaws 22	1	060-333666
Adaptor		7/16 - 20UNF x R 3/8 (ISO 7/1) brass, span of jaws 19	1	060-324066
Nipple		G 1/4 A x G 3/8 A		060-333266
		G 1/4 A x ext. M10 x 1 with washer		060-333866
Damping coil		Pipe thread ISO 228/1, damping coil with G 3/8 connector and 1.5 m copper capillary tube. Standard washers are supplied.	1	060-104766
Armoured damping coil		Pipe thread ISO 228/1, damping coil with G 3/8 connector and 1 m copper capillary tube. Standard washers are supplied.	1	060-333366

Description

CAS thermostats are temperature-controlled switches. The position of the contacts depends on the temperature of the sensor and the set scale value. In this series, special attention has been given to meeting demands for a high level of enclosure, robust and compact construction, and resistance to shock and vibration.

The CAS series covers most outdoor as well as indoor application requirements.

CAS thermostats are suitable for use in monitoring and alarm systems in factories, diesel plant, compressors, power stations and on board ship.

Technical data and ordering

 Preferred version

When ordering, please state type and code number

Setting range °C	Mechanical differential adjustable / fixed °C	Max. sensor temperature °C	Suitable sensor length (see also "Accessories") mm				Capillary tube length m	Code no.	Type
20 → 80	2.0	130	65	75	110	160	2	060L315166	CAS 178
70 → 120	2.0	220	65	75	110	160	2	060L315366	CAS 180
60 → 150	2.0	250	65	75	110	160	2	060L315566	CAS 181



CAS with remote sensor, armoured capillary tube

Switch

Microswitch with single pole changeover (SPDT)

Contact load

Alternating current:

220 V, ~0,1 A, AC-14 and AC-15 (inductive load)

Direct current

125 V, 12W DC-13 (inductive load)

Ambient temperature

CAS 178,180 and 181: -25°C → +70°C

Vibration resistance

Vibration-stable in the range 2-30 Hz, amplitude 1,1 mm and 30-100 Hz, 4 G.

Enclosure

IP 67 acc. to IEC 529 and DIN 40050.

The thermostat housing is enamelled pressure die cast aluminium (GD-AISI 12). The cover is fastened by four screws which are anchored to prevent loss.

The enclosure can be sealed with fuse wire.

Cable entry

Pg 13.5 for cable diameters from 5 to 14 mm.

Identification

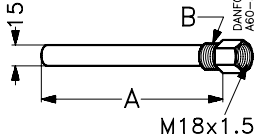
The type designation and code no. of the unit is stamped in the side of the housing.

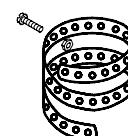
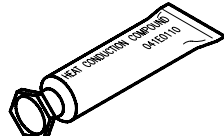
Approvals

CE marked acc. to EN 60947-5-1
CCC, China Compulsory Certificate

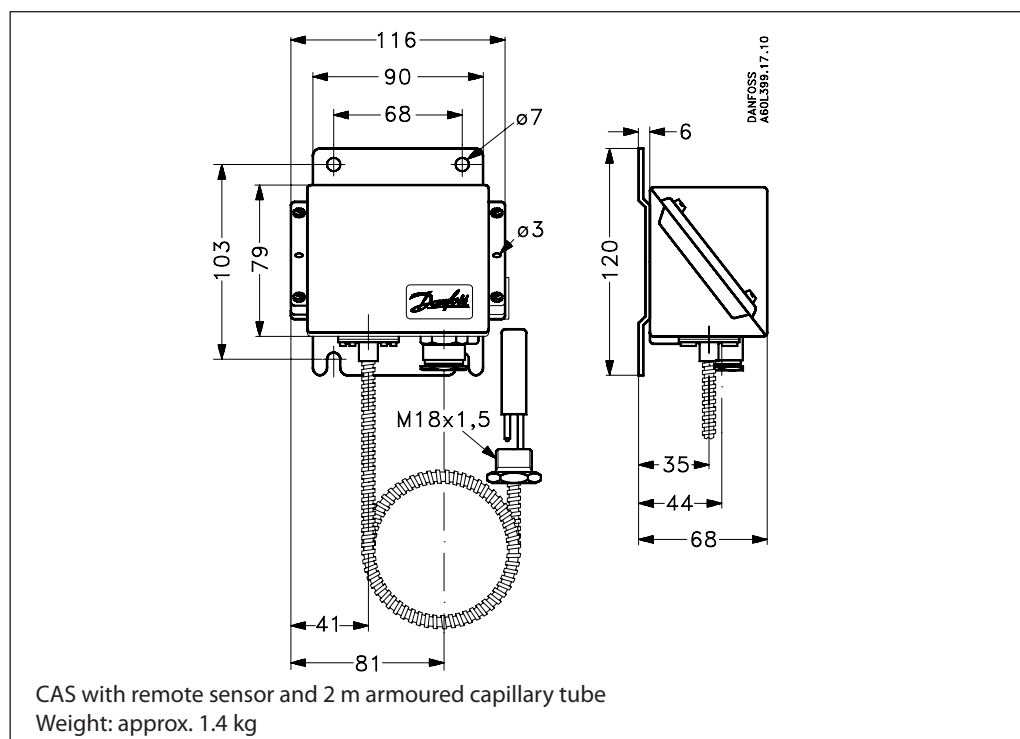
Ship approvals

American Bureau of Shipping, USA
Bureau Veritas, France
Det Norske Veritas, Norway
Germanischer Lloyd, Germany
Lloyd Register of Shipping, UK
Nippon Kaiji Kyokai, Japan
Registro Italiano Navale, Italy
RMRS, Maritime Register of Shipping, Russia

Accessories: Sensor pockets for thermostats	Sensor pocket	A mm	Thread B	Code no.	Sensor pocket	A mm	Thread B	Code no.
 Note: all sensor pockets are supplied without gland nut, gaskets and washes	Brass	65	½ NPT	060L326566				
	Brass	75 75 75 75	½ NPT G ½ A G ¾ A G ½ A (ISO 228/1)	060L326466 060L326266 060L326666 060L328166	Steel 18/8	75	G ½ A	060L326766
	Brass	110 110 110 110	½ NPT G ½ A G ½ A (ISO 228/1) G ¾ A (ISO 228/1)	060L328066 060L327166 060L340666 060L340366	Steel 18/8	110 110	G ½ A ½ NPT	060L326866 060L327066
	Brass	160 160	G ½ A G ¾ A (ISO 228/1)	060L326366 060L340566	Steel 18/8	160	G ½ A	060L326966
	Brass	200 200 200	G ½ A G ½ A (ISO 228/1) G ¾ A (ISO 228/1)	060L320666 060L340866 060L340266	Steel 18/8	200 200	G ½ A G ¾ A	060L323766 060L324866
	Brass	250	G ½ A	060L325466				
	Brass	330	G ½ A	060L325566				
	Brass	400	G ½ A	060L325666				

Other Accessories		Description	Qty./ unit	Code no.
Clamping band		For CAS thermostats with remote sensor (L = 392 mm)	10	017-420466
Heat conductive compound (Tube with 4.5 cm ³)		For CAS with sensor fitted in a sensor pocket. For filling sensor pocket to improve heat transfer between pocket and sensor. Application range for compound: -20 to +150 °C, momentarily up to 220°C	1	041E0114

Dimensions and weight



Installation

Location of unit: CAS thermostats are designed to withstand the shocks that occur, for example, in ships on compressors and in large machine installations. CAS thermostats are fitted with a base of 3 mm steel plate for fixing to bulkheads, etc.

Resistance to media

Material specifications for sensor pockets.

Sensor pocket brass

The tube is made of Ms 72 to DIN 17660, the threaded portion of So Ms 58 Pb to DIN 17661.

Sensor pocket, stainless steel 18/8

Material designation 1.4305 to DIN 17440.

Sensor position

As far as possible the sensor should be positioned so that its longitudinal axis is at right angles to the direction flow. The active part of the sensor is Ø13 mm × 47.5 mm.

The medium

The fastest reaction is obtained from a medium having high specific heat and high thermal conductivity. It is therefore advantageous to use a medium that fulfils these conditions (provided there is a choice). The flow velocity of the medium is also of significance. (The optimum flow velocity for liquids is about 0.3 m/s). For permissible media pressure see fig. 1.

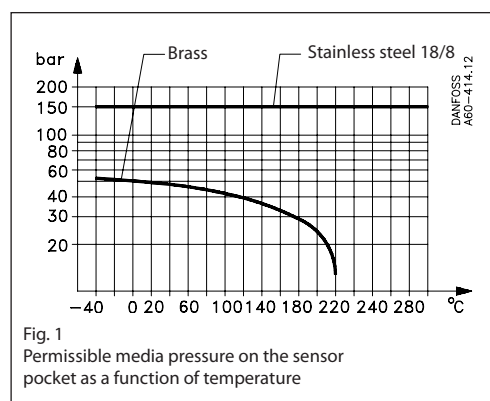


Fig. 1
Permissible media pressure on the sensor pocket as a function of temperature

Setting

When the thermostat cover is removed, and the locking screw (3) fig. 2 is loosened, the range can be set with the spindle (1) while at the same time the scale (2) is being read.

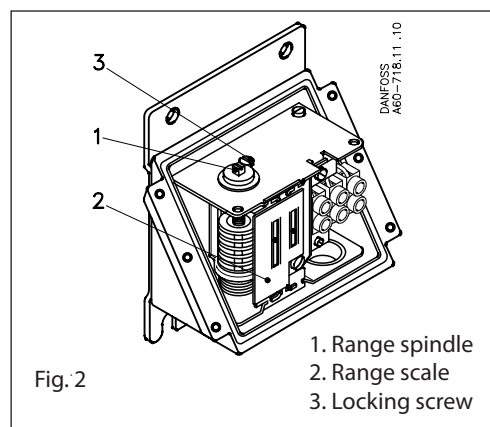


Fig. 2

- 1. Range spindle
- 2. Range scale
- 3. Locking screw

Scale correction

The sensor on CAS thermostats contains an adsorption charge. Therefore function is not affected whether the sensor is placed warmer or colder than the remaining part of the thermostatic element (bellows and capillary tube).

However, such a charge is to some extent sensitive to changes in the temperature of bellows and capillary tube. Under normal conditions this is of no importance, but if the thermostat is to be used in extreme ambient temperatures there will be a scale deviation. The deviation can be compensated for as follows:
Scale correction = $Z \times a$
Z can be found from fig. 3, while a is the correction factor from the table below. (See example, page 11).

Type	Regulation range °C	Correction factor a for thermostats
CAS 178	20 → 80	2.5
CAS 180	70 → 120	2.4
CAS 181	60 → 150	3.7

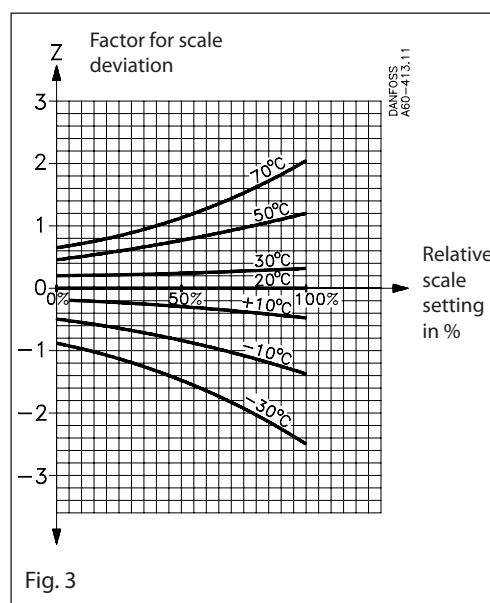


Fig. 3

Electrical connection

CAS thermostats are fitted with a Pg 13.5 screwed cable entry suitable for cables from 5 to 14 mm. Contact function, see fig. 4.

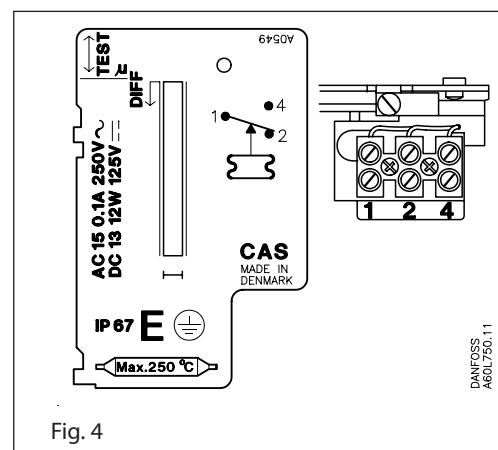


Fig. 4

Function

Differentials

The mechanical differential is the differential determined by the design of the thermostat. The thermal differential (operating differential) is the differential the system operates on. The thermal differential is always greater than the mechanical differential and depends on three factors:

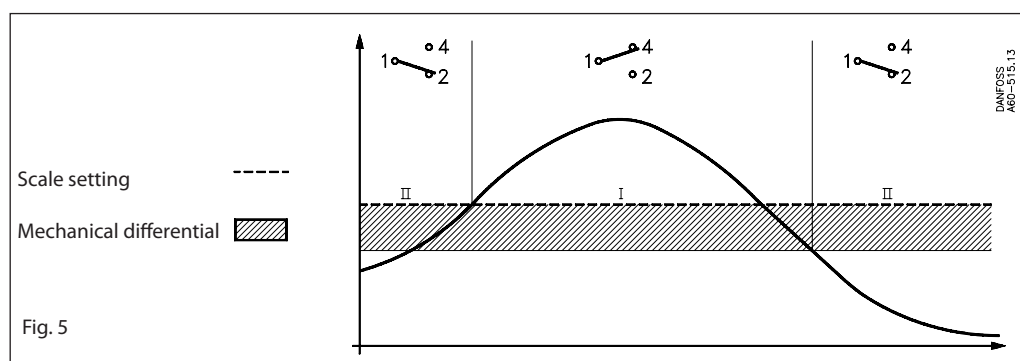
- 1) Medium flow velocity
- 2) Temperature change rate of the medium
- 3) Heat transmission to the sensor

Thermostat function

Contacts 1-4 make while contacts 1-2 break when the temperature rises above the scale setting.

The contacts changeover to their initial position when the temperature falls to the scale setting minus the differential. See fig. 5.

- I. Alarm for rising temperature given at range setting value.
- II. Alarm for falling temperature given at range setting value minus the differential



Example 1

Diesel engine with cooling water temperature of 85°C (normal). An alarm must be triggered if the cooling water temperature exceeds 95°C. Choose a CAS thermostat 180 (range +70 to 120°C). Main spindle setting: 95°C. The required alarm function is obtained by connecting to thermostat terminals 1-4.

Example 2

Find the necessary scale correction for a CAS 180. Set +95°C at +50°C ambient temperature.

The relative scale setting Z can be calculated from the following formula:

$$\frac{\text{Setting value} - \text{min. scale value}}{\text{max. scale value} - \text{min. scale value}} \times 100 = \%$$

$$\text{Relative scale setting: } \frac{95 - 70 \times 100}{120 - 70} = 50\%$$

Factor for scale deviation Z fig. 3, $Z \cong 0.7$

Correction factor a, see table page 10, fig. 3 = 2.4.

Scale correction = $Z \times a = 0.7 \times 2.4 = 1.7^\circ\text{C}$
CAS must be set at $95 + 1.7 = 96.7^\circ\text{C}$

Conversion table

	Pascal (= Newton per square metre) N/m ² PA	Pascal per square mm N/mm ²		Kilopound per square metre (mm H ₂ O) kp/m ²	Meter water gauge m H ₂ O	Technical atmosphere (kp/cm ²) at	Physical atmosphere atm	Torr (0°C) mm Hg	Inches Hg (0°C)	Poundforce per square inch (lbf/in ²) psi
1 Pa	1	10 ⁻⁶	10 ⁻⁵	0.1020	1.020 × 10 ⁻⁴	1.020 × 10 ⁻⁵	9.869 × 10 ⁻⁵	7.500 × 10 ⁻³	2.953 × 10 ⁻⁴	1.450 × 10 ⁻⁴
1 N/mm ²	10 ⁶	1	10	1.020 × 10 ⁵	102.0	10.20	9.869	7.5 × 10 ³	295.3	145.0
1 bar	10 ⁵	0.1	1	10.197 × 10 ³	10.20	1.020	0.9869	750	29.53	14.50
1 kp/m ²	9.80665	9.807 × 10 ⁻⁶	9.807 × 10 ⁻⁵	1	10 ⁻³	10 ⁻⁴	0.9678 × 10 ⁻⁴	0.07355	2.896 × 10 ⁻³	1.422 × 10 ⁻³
1 m H ₂ O	9806.7	9.807 × 10 ³	0.09807	1000	1	0.1	0.09678	73.55	2.896	1.422
1 at	98.066 × 10 ³	0.09807	0.9807	10 ⁴	10	1	0.9678	735.5	28.96	14.22
1 atm	101.325 × 10 ³	0.1013	1.013	10.333 × 10 ³	10.33	1.033	1	760	29.92	14.70
1 mm Hg	133.32	1.333 × 10 ⁻⁴	1.333 × 10 ⁻³	13.60	0.01360	1.360 × 10 ⁻³	1.315 × 10 ⁻³	1	0.03937	1.934 × 10 ⁻²
1 in Hg	3387	3.387 × 10 ⁻³	0.03387	345.3	0.3453	0.03453	0.03342	25.4	1	0.4912
1 psi	6895	6.895 × 10 ⁻³	0.06895	703.1	0.7031	0.07031	0.96804	51.71	2.036	1

No.6W61910-02E

(2002/6/17rev)

Handling Manual

Tachometer Set For Turbo-Charger (Digital)

Type73R-AC-Cset

73R-DC-Cset

APPLIED ELECTRONICS CORPORATION

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1.Introduction

73R-AC-C • 73R-DC-Ctype is high accuracy Tachometer system for Turbo-Charger. It monitors the blades value of Turbo-charger by using eddy current sensor, and is calculated by the CPU.

Output of DC4-20mA is easily available to be set Full-scale on the front panel.

It includes the protector of IN/OUTPUT of CB-1AW-05type JUNCTION BOX, and it also includes an isolator of IN/OUTPUT of the TACHOMETER.

2.Constitution

(1)PROBE	PU-05-192-302(3mCABLE)
(2)JUNCTION BOX	CB-1AW-05(Inc: CONVERTER, Protect:IP-65)
(3)TACHOMETER	73R-AC-C(Power:AC100~240V) 73R-DC-C(Power:DC+24V)

3.Specification

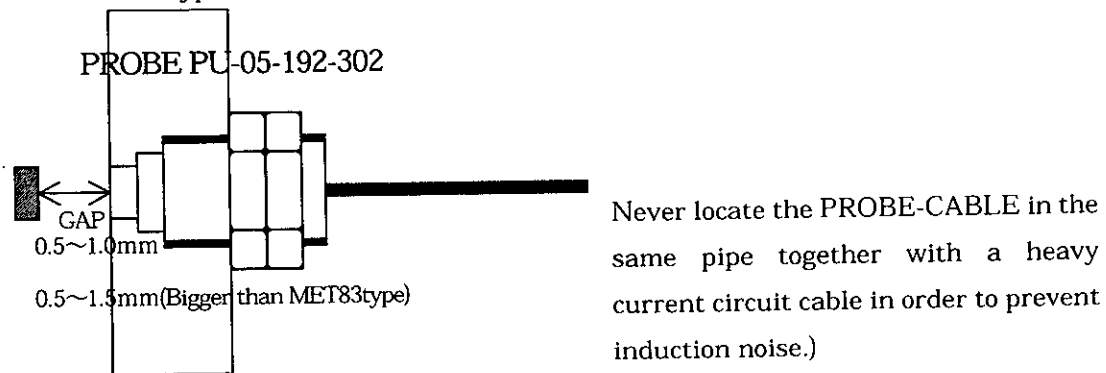
Setting GAP	0.5~1.0mm(MET83type : 1.5mm)	
Target	Aluminum alloy (more than 10t, Turbo-Blades)	
Frequency response	0.3Hz~10kHz	
Output of JUNCTION BOX	Open corrector	
Output of TACHOMETER	⑩⑪terminals	: 4-20mA
	⑫⑬terminals	: 4-20mA(*4-6)
Resistance impedance	0~500Ω (total)	
Operating temperature range	PROBE	: -20~+180℃
	JUNCTION BOX	: -5~+70℃
	TACHOMETER	: 0~+50℃
Operating humidity range	PROBE	: 20~80%
	JUNCTION BOX	: 20~80%
	TACHOMETER	: 45~85%
Vibration endurance	PROBE	: JIS E4031 3A(300Hz 5G)
	JUNCTION BOX	: JIS E4031 3A(300Hz 5G)
Water proof	PROBE (sensitive part)	: JIS C0920(IP66)
	JUNCTION BOX	: JIS C0920(IP65)
Power for JUNCTION BOX	Supplied by TACHOMETER	
Power for TACHOMETER	73R-AC-C	: AC100~240V
	73R-DC-C	: DC+24V
Power frequency	50/60Hz	approx. 5VA

4. Mounting and wiring

4-1 Mounting the PROBE

The PROBE is mounted by screwing it into the mounting hole steadily, and fixed by double nuts.

(The GAP from the top of the turbo-blades to PROBE is 0.5~1.0mm, in case of bigger than MET83type is 0.5~1.5mm)

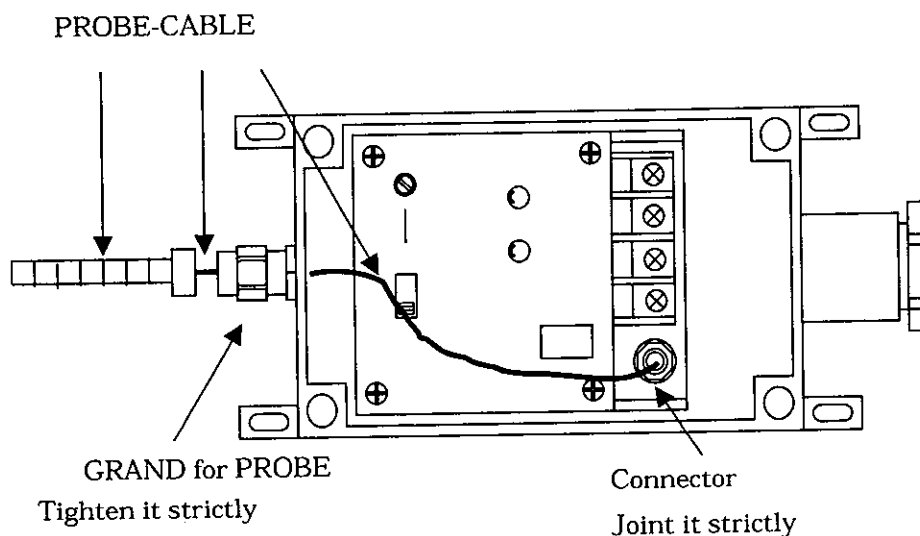


4-2 Wiring the PROBE-CABLE with the JUNCTION BOX

The PROBE-CABLE is wired with the JUNCTION BOX mounted within 3m from the PROBE.

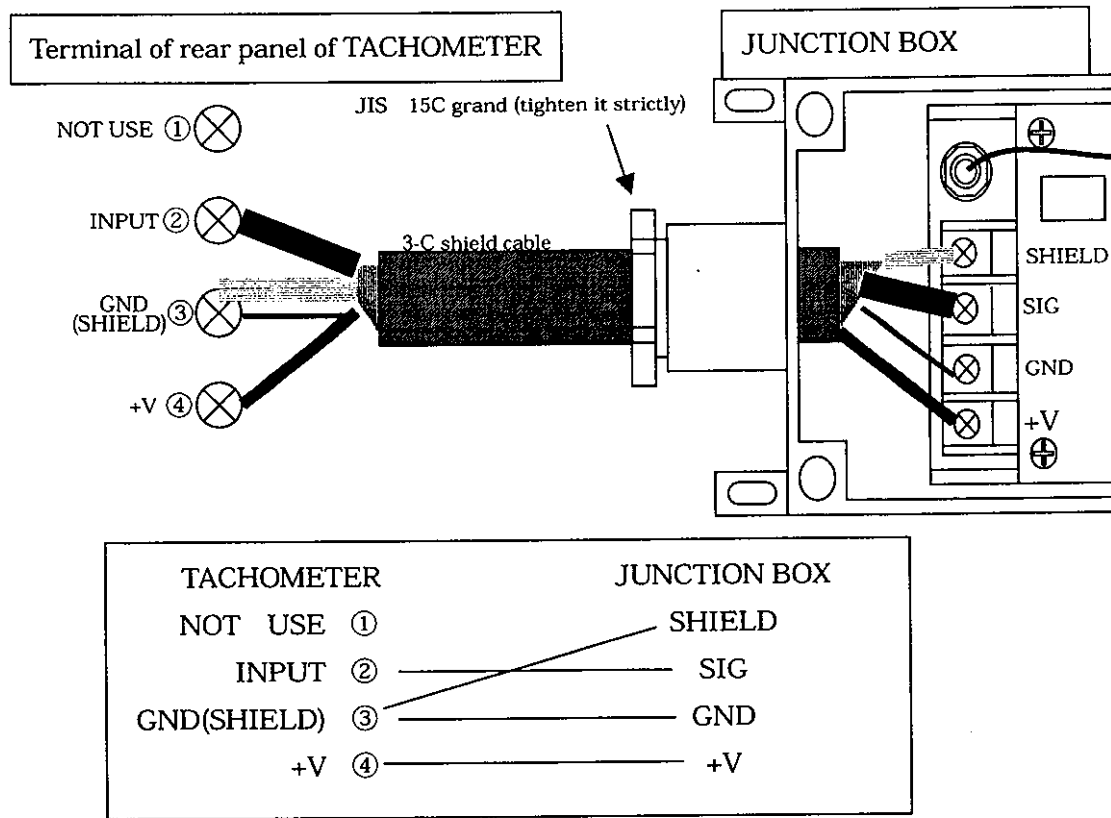
At first open the top lid of JUNCTION BOX.

Loosen the grand (smaller side) for PROBE-CABLE of JUNCTION BOX, pass the PROBE-CABLE threw the grand, and joint the connector of PROBE-CABLE strictly with the connector of converter of JUNCTION BOX. Then tighten the grand in the condition that the shrink part of the PROBE-CABLE is inside of the GRAND.



4-3 Wiring JUNCTION BOX with TACHOMETER

It must be used 3-cores shield cable for wiring JUNCTION BOX with TACHOMETER, and be isolated from the ground, not to make it to the earth.



Never locate the 3-cores shield cable in the same pipe together with a heavy current circuit cable in order to prevent induction noise.

4-4 Power supply connection

Power is supplied with ⑦⑧ terminals of rear panel of TACHOMETER.

Supply AC85~264V with ⑦⑧ terminals of rear panel of TACHOMETER, in case that TACHOMETER is AC power type(name type:73R-AC-C).

Supply DC+24 with terminals(⑦: +, ⑧: -) of rear panel of TACHOMETER, in case that TACHOMETER is DC power type(name type:73R-DC-C).

4-5 Connect to earth

Connect to earth at ⑨ terminal of rear panel of TACHOMETER.

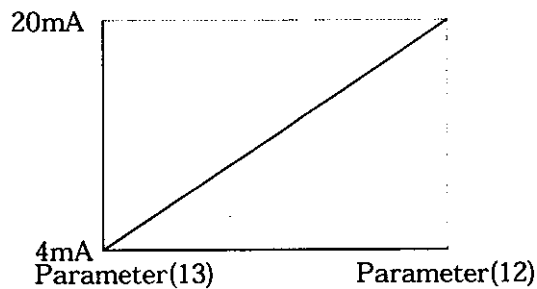
Don't connect to earth between PROBE~JUNCTION BOX~TACHOMETER except the ⑨ terminal of TACHOMETER in order to prevent induction noise.

4-6 Wiring for OUTPUT (4-20mA) of TACHOMETER

DC currents are outputted in proportion to the rotation value.

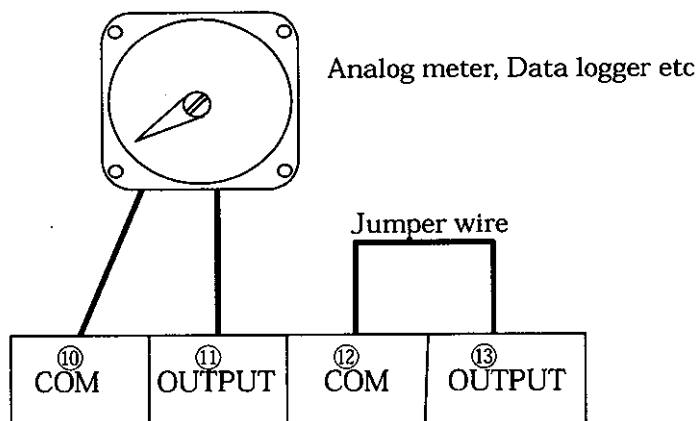
⑩⑪,⑫⑬ terminals of rear panel of TACHOMETER are pairs each other.

Parameter(12) : 20mA, Parameter(13) : 4mA(*Refer to set up parameter)

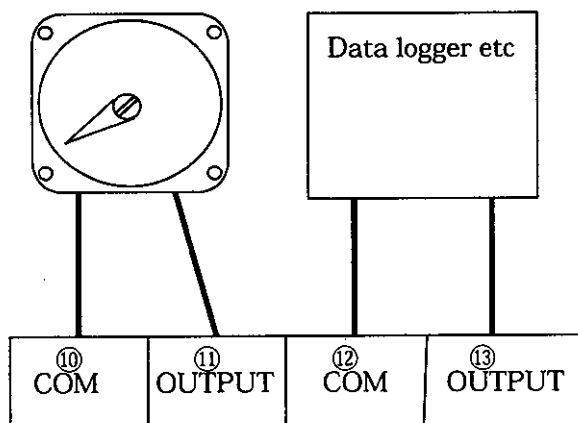


In the case that it is be used only one pair terminal(⑩⑪) of OUTPUT terminal, the other empty pair terminal(⑫⑬) must be shorted by jumper wire.

(At first shipment ⑫⑬terminal is shorted by jumper wire.)



In case that 2pair of OUTPUT terminal of TACHOMETER are used them after taking off the Jumper wire from ⑫⑬terminal.

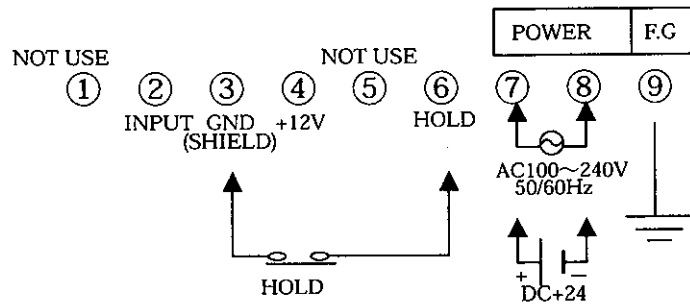


5.Terminal of rear panel of TACHOMETER

A.COM A.OUTA.COM A.OUT

⑩ ⑪ ⑫ ⑬ ⑭ ⑮ ⑯ ⑰ ⑱

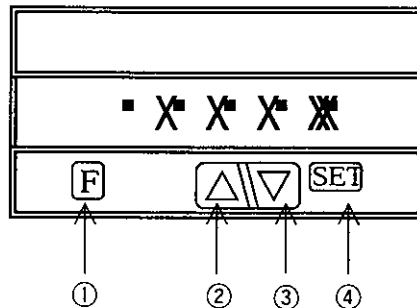
4-20mA OUT	4-20mA OUT	NOT USE
------------	------------	---------



Terminal No	Name	Contents
①	NOT USE	
②	INPUT	Input signal
③	GND (SHIELD)	GND (SHIELD)
④	+V (+12V)	Power supply for JUNCTION BOX
⑤	NOT USE	
⑥	HOLD	HOLD terminal
⑦	POWER	+
⑧		-
⑨	F.G	Frame ground
⑩	4-20mA OUT	-
⑪		+
⑫	4-20mA OUT	-
⑬		+
⑭~⑱	NOT USE	

6.Parameter(TACHOMETER)

6-1 key explain



- | | |
|----------------|---|
| ① Fkey | Push F key for 3seconds, it becomes setting parameter mode. |
| ② Δ key | It is used to increase the value at setting parameter mode. |
| ③ ∇ key | It is used to decrease the value at setting parameter mode. |
| ④ SETkey | It is used to memorize the value in memory, and step to the next parameter. |

6-2 Parameter explain

- | | |
|----------------|---|
| <Parameter 1 > | Multiplication coefficient(m)
Input "60" to express rpm(min-1) class.
Set up range : 0.0001~99999 |
| <Parameter 2 > | Multiplication coefficient (k)
Input "1" as usual.
Set up range : 1~99999 |
| <Parameter3> | Division coefficient(n)
Input the blades value of Turbo-charger. |

Calculation style

Display=(input frequency Hz)×Parameter 1 (m)×Parameter2(k)÷Parameter3(n)

- | | |
|--------------|--|
| <Parameter4> | Decimal point position
Set up for a decimal position. "0" is inputted as usual at shipment.
It simply expresses a decimal point position on a indicator.
Set up range : 0/0.0/0.00/0.000/0.0000 |
| <Parameter5> | Periodic display (sec)
Set up a time for periodic display.
"0" is inputted as usual at shipment.
Set up range : 0.1/0.2/1/2/3/ 4 /5 |

- <Parameter6> ZERO reset time(sec)
Set up time to reset value on display to ZERO
(At low rotating, the time of waiting for input next pulse)
"1" is inputted as usual at shipment.
Set up range : 1~99999
- <Parameter7> Set ZERO
It forces it [0] less than the value set up in it.
"0" is inputted as usual at shipment.
Set up range : 0~99999
- <Parameter8> HOLD function
It works in case of being shorted ⑥HOLD terminal and ③GND terminal. "0" is inputted as usual at shipment.
Set up range : 0 : Not using HOLD function
1 : Display the figure of HOLD
2 : Maxim the figure of HOLD
3 : Minimum the figure of HOLD
- <Parameter9> Prediction calculation
At low rotating, a display figure gradually approaches to ZERO as predicting next pulse for time set up on <Parameter6>
"0" is inputted as usual at shipment
Set up range 0 : Not using prediction calculation
1 : Using prediction calculation
- <Parameter12> Upper figure of output (full-scale)
Set up value for 20mA of 4-20mA output.
Set up range : 1~99999
- <Parameter13> lower figure of output
Set up value for 4mA of 4-20mA output.
"0" is inputted as usual at shipment
Set up range : 0~99999
- <Parameter14> Key protect
Prohibit to set up and change the value of parameter
"off" is inputted as usual at shipment
Set up range off : off key protect
on : on key protect

7.Troubleshooting

Check the following remarks on occurrence of troubles		
Troubles	Check points	Procedures
Display can't turn on.	Terminal of TACHOMETER	Check the power supply wiring of the terminal of rear panel of TACHOMETER. (Refer to 4-4)
	The supplied voltage is out of the rating in this device.	AC100~240V : 73R-AC-Ctype DC+24V : 73R-DC-Ctype
Only it displays [0], and display value doesn't change.	Wiring from JUNCTION BOX to TACHOMETER	Check the wiring from JUNCTION BOX(CB-1AW-05) to TACHOMETER.(Refer to 4-3)
	Connector	Check the connector of PROBE-CABLE on JUNCTION BOX
	Mounting PROBE	Check the GAP from PROBE to the top of the blade of the Turbo-charger (Refer4-1)
Rotation value is not displayed correctly.	Mounting PROBE	Check the GAP from PROBE to the top of the blade of the Turbo-charger (Refer4-1)
Output of 4-20mA is not correct.	Terminal of TACHOMETER	Check the wiring of the terminal of rear panel of TACHOMETER (Refer to 4-6)
	Parameter of TACHOMETER	Check parameter⑫and⑬. (Refer to 6-1.6-2)
	The input impedance of the device is too high.	Total impedance of going / returning cables and that of the device to be 500 Ω or less.

8.External view and wiring dialog

Please refer to Final Plan Drawing provided separately.



KEUMYANG

INSTRUCTION MANUAL

**COMBINED P.C.O SENSOR WITH ALARM MONITOR BOX
(P.C.O NON FLOW ALARM SWITCH : ELS-3000)**

KEUMYANG IND. CO., LTD.

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머릿말

INTRODUCTION

P.C.O non flow alarm switch (combined temp. & flow switch / MODEL : ELS-3000)는 2 stroke diesel engine의 P.C.O temperature를 sensing하는 Pt100Ω sensor와 non flow를 sensing하는 flow sensor가 combined로 되어 있고, 특히 non flow 시에는 relay contact를 외부로 출력한다.

P.C.O non flow elec. (combined flow & temp. sensor / MODEL : ELS-3000) is combined Pt100Ω sensor which is sensing P.C.O temp. and the flow sensor which is sensing non flow for 2 stroke diesel engine, especially it outputs the relay contact outside when it is non flow condition.

local에서 별도의 감도 조정이 필요 없으며, 제품 생산 시에 감도 및 sensor stem의 길이를 고정하여 출하한다.

It doesn't need to adjust the extra sensitivity adjustment at local, it is supplied the sensitivity and the length of the sensor stem to be fixed when the product is made.

이것은 local에서 감도 조정 및 엔진의 센서 설치 환경에 따른 오동작을 방지하고 제품 생산 시 전수 검사에 따른 제품의 품질 및 신뢰성을 향상 시킨다.

This protects malfunction due to sensitivity adjustments and the circumstances of the installed locations, and enhances the quality of the products and the reliability on them by all products inspection when the products are produced.

일반적 구상

GENERAL DESIGN

ELS-3000의 sensor element는 brass body내에 있다.
tube 내부는 mold되어 vibration, shocks 등에 보호되었다.

Sensor element of ELS-3000 is inside a brass body.

Inside the tube there is a mold for protection against vibration, shocks etc.

terminal은 alarm monitor box 내에 있고, 외부 전선은 이 terminal에
결선한다.

**Terminal are located in the alarm monitor box, and outer cables shall
be connected in these terminal.**

ELS-3000은 디젤 엔진과 기타 다른 기계등의 vibration, shock 등에 견디게
설계 되었다.

**The ELS-3000 is designed to withstand vibration, shocks etc. on diesel
engines and other machines etc.**

설치

INSTALLATION

배선

Installation wiring

설치 시에는 다음의 주의 사항을 따라야 한다.

Pay attention to the following during installation :

1. 측정하기 적합한 장소를 선택하여야 한다.

이것은 올바른 측정 장소의 선택을 위한 매우 중요한 것이며, 그것은 sensor가 P.C.O 흐름과 온도의 변화에 빠른 추종을 가능하게 한다. sensor element가 들어있는 sensor body를 휘어서는 안된다.

Choose suitable location for the measuring point.

It is of great importance to measure on the correct place, so the sensor can follow the variation in P.C.O flow and temperature as quickly as possible. Do not bend the sensor body close to sensor element.

2. 만약 ELS-3000의 설치 장소를 선택하여야 한다면, 다음의 고려사항을 따라야 한다. :

If there are alternative locations for the ELS-3000, take the following into consideration :

vibration, dirt moisture가 가장 적은 장소와 향후 보수와 검사를 고려한 장소를 선택한다.

Choose the location, which have the lowest vibration, least dirt and least moisture, take also future maintenance and inspection work into consideration.

3. Connection diagram에 따라 sensor와 alarm monitor box를 결선한다. 단선, 단락이 안되게 단단하게 내부의 terminal에 결선한다.

Connect the sensors according to connection diagram. Connect the wires firmly in the terminals in order to avoid breaking the wires or making short circuits.

기계적인 설치

Installation mechanical

1. P.C.O가 flow 상태 일 때 sensor body(brass 재질 부분)가 완전하게 P.C.O 액면 이하로 잠겨야 되고, non flow 상태 일 때는 완전하게 액면 이상으로 올라와야 된다.

When the P.C.O is flow state, the sensor part(brass) should be completely submerged into the liquid, and when NON FLOW state, this should be completely floated over the liquid surface.

정비와 검사

MAINTENANCE AND INSPECTION

정비 항목과 간격

Maintenance item and intervals

정비 / 검사 Maintenance / inspection	초기 간격 Initial interval	정상 간격 Normal interval
* 기계적인 검사 * Mechanical inspection	1 개월 1 month	3 개월 3 months
* 전기적인 검사 * Electrical inspection	1 개월 1 month	3 개월 3 months
* 청소 * Cleaning	1 개월 1 month	3 개월 3 months

*) "양호한 상태 유지를 위한 조정법" 단원을 참고할 것.

*) Refer to chapter "How to keep good condition for the adjustment"

개시 조건

Condition for opening

1. 전원을 끈다.
Turn off the electric power.
2. 결선 불량을 피하기 위하여 외부 전선 말단의 절연 테이프를 벗긴다.
Tape the ends of the outer wires which are taken off, in order to avoid misconnection.

개시 순서

The order of opening

1. alarm monitor box의 cover를 벗긴다.
Remove the cover of the alarm monitor box.
2. 케이블용 terminal 나사를 푼다.
Loosen the terminal screws of the cables.
3. cable gland를 푼다.
Loosen the cable gland.

필요한 공구

Necessary tools

1. +자 드라이버.
A plus driver.
2. 스패너.
A spanner.
3. 몽키 스패너.
A monkey spanner.
4. 라디오 플라이어.
A radio plier.
5. 멀티 테스터.
A multi tester.

정비 조건

Condition for the maintenance

예비품을 준비한다.

Prepare the spare parts.

양호한 상태 유지를 위한 조정법

How to keep good condition for the adjustment

Mechanical inspection

검사 요소 Inspection points	검사 방법 Inspection method	주의 사항 Caution
센서 몸통, 카플링의 나사 검사 Inspection of nut, sensor body or coupling	모든 부품이 잘 체결됐는가 시험한다. Examine that all parts are prpperly fixed	
전기 단자대의 연결 검사 Inspection of connection terminals	모든 단자가 잘 연결됐는가 시험한다. Examine that all terminals are fimly fixed	
전선 그랜드의 검사 Inspection of cable glands	전선이 단단히 고정됐는가 시험한다. Examine that the cable is properly fixed	
경보 감시 상자의 뚜껑 Alarm monitor box cover	뚜껑이 잘 고정됐는가 시험한다. Examine that the cover is fixed	

Electrical inspection

기능 검사 Inspection of function	검사 방법 Inspection method	주의 사항 Caution
전원 검사 Inspection of the electric power	멀티 테스터로 시험한다. Examine with a multi tester unit	오결선 주의 Broken wires
절연 저항 시험 Insulation resistance test	센서의 전선과 센서 몸통간에 50Vdc의 절연저항시험기로 시험한다. (>5Mohm) Examine the resistance between sensor wire and housing bocy with 50Vdc tester (>5Mohm)	단자대에서 센서 케이블 전부를 분리후 시험할 것. Examine after separating all sensor cable from the terminal.

Cleaning

청소 요소 Cleaning point	청소 방법 Cleaning method	주의 사항 Caution
센서 몸통의 먼지 Dirt on housing of sensor	센서 몸통의 먼지를 제거한다. Remove possible dirt on the housing of sensor	에러의 발생, 단선에 주의 Avoidance of error generation and burning out

불량 상태의 원인 추정과 조사 방법

Presumptive cause or investigation method of trouble state

고장 상태 Trouble state	고장 이유 Cause	주의 사항 Caution
전선의 단선 Broken wires	진동과 충격 Vibration and shock	불량 센서를 교체할 때, 단선에 의한 시험기의 지침바늘이 움직이지 않게 한다. Replace the malfunctioning sensor, the pointer of the tester does not move in case of broken wires.
절연 저항의 감소 Poor insulation	부적합 밀봉으로 해수, 청수, 오일 침입 Infiltration of sea water, fresh water or oil due to improper sealing.	시험기가 1Mohm 이하를 지시하면 절연 저항 감소 In case of poor insulation, the tester shows less than 1Mohm
회로의 단락 Short circuit	전선간의 거리가 지나치게 가깝다. Too short distance between wires	
운전 중 점진적으로 정도가 감소하는 경우 In case that the accuracy decreases gradually during operation	a. 지시계의 불량 Failure of the indicator b. 센서 불량 : - 내부 저항의 증가 - 내부 저항의 감소 - 센서 몸통의 이물질 증가 Sensor failure : - Increase of the internal resistance - Decrease of the internal resistance - Increase of dirt on the housing of sensor	센서 대신 표준 저항기를 연결하여 지시계 또는 센서 불량인가 찾는다. 불량 제품을 교체한다. Connect a standard resistor instead of the sensor, and find either it is an indicator or a sensor failure. Replace the malfunctioning unit.
운전 중 순간적으로 정도가 감소하는 경우 In case that the accuracy decrease suddenly during operation	a. 측정기의 이상 Abnormality of the measuring device b. 센서 불량 Sensor failure c. 나사의 풀림, 전선의 접속불량 Bad connection of wires, due to loose screw	불량 제품을 교체하고 느슨한 나사를 단단히 조인다. Replace malfunctioning unit, tighten loose screw firmly.

정비 순서

Method of repairing

1. 개시의 역순으로 한다.
Act in accordance with the reverse order of opening

확인 사항

Confirmation of items

1. 전선이 바르게 연결되었는지 확인한다.
Confirm whether the wires are connected correctly.
2. 커버가 단단하게 붙었는지 확인한다.
Confirm the tightness of the cover.
3. 너트, 센서몸통, 카플링몸통 등이 고정되었는지 확인한다.
Confirm that nuts, sensor body, coupling bodies etc. are fixed.
4. 전원을 가한다.
Turn on the electrical power.

제품 사양

SPECIFICATIONS

Specification for Temp. sensor and flow s/w

적용 범위

Scope

이 사양은 디젤엔진에 사용되는 combined temp. sensor & flow S/W에 적용된다.

This specification applies to combined temp. sensor & flow S/W which are used on diesel engine.

Specification for Temp. sensor

- | | |
|--------------------------|-----------------------|
| 1. Element type | : Platinum(Pt), 3wire |
| 2. Normal resistance | : Pt100Ω at 0℃ |
| 3. Class | : B |
| 4. Range | : 0℃ ~ +100℃ |
| 5. Insulation resistance | : >5MΩ at 50Vdc |

Specification for flow S/W

- | | |
|--------------------------|------------------------|
| 1. Element type | : Bridge type |
| 2. Bandwidth | : ±5% |
| 3. Electrical power | : DC20V ~ 32V |
| 4. Operating temp. | : 0℃ ~ +100℃ |
| 5. Output contact | : SPST X 2EA, 2A/DC30V |
| 6. Power consumption | : APROX. 3w |
| 7. Power fail voltage | : <DC 19.5V |
| 8. Insulation resistance | : >5MΩ at 50Vdc |

Environmental durability

1. Vibration durability.
2. Lubricator oil durability

구조

CONSTRUCTION

Principle <그림 1 참조 / Ref. PHOTO 1>

액체의 흐름을 검출하는 flow sensor는 내부 sensing element가 bridge circuit로 되어 있어 액체의 flow 상태에 따라 bridge circuit의 균형이 변화하면서 비례 출력하게 된다.

Flow sensor that detects the liquid flowing has a bridge circuit in the sensing element, and it is varying the balance of the bridge circuit as the liquid flowing state and outputs proportionally.

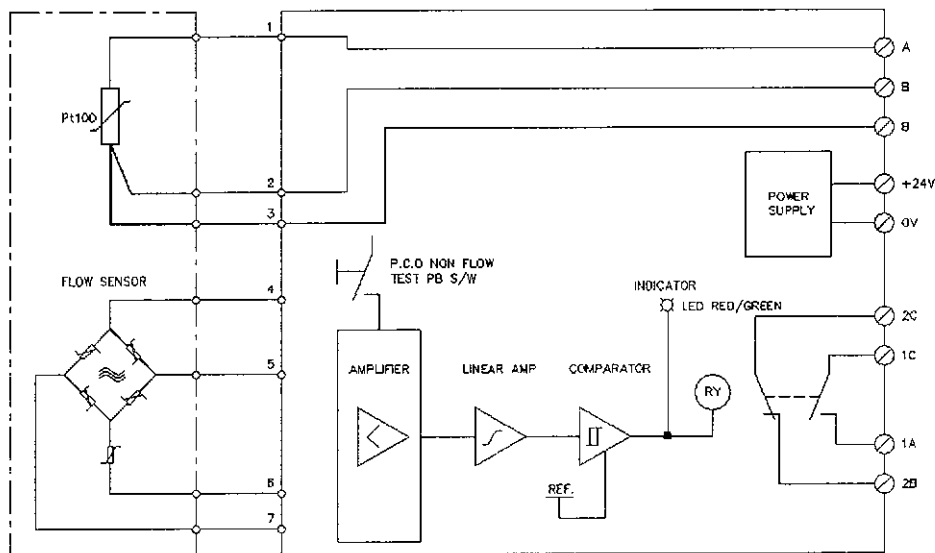
Function <그림 1 참조 / Ref. PHOTO 1>

1. flow sensor의 출력 신호는 내부의 amplifier로 증폭하여 linear amplifier를 거친 후 comparator를 relay를 구동하여 relay 접점을 외부로 출력한다.

The output signal of the flow sensor is amplified by the amplifier and passes through the linear amplifier and a comparator, and lastly activates a relay contact.

2. P.C.O가 flow 시에는 green LED가 점등이 되고 P.C.O가 non flow시에는 red LED가 점등된다.

When the P.C.O is flow state, the green LED is ON. When non flow state, the red LED is ON.



<PHOTO 1>

Test push button switch <그림 1 참조 / Ref. PHOTO 1>

1. 2 stroke 디젤 엔진의 P.C.O가 flow 시에 non flow를 인위적으로 발생하게 하여 alarm을 test 하기 위한 기능을 가졌다.

When the P.C.O of 2 stroke diesel engine is flow state, it is causing non flow state artificially and it has a function to test the alarm.

2. 2 stroke 디젤 엔진의 P.C.O가 flow 시에 test PB S/W를 누르면 non flow 의 relay contact 신호를 외부로 출력한다.

If test PB S/W is pushed down when the P.C.O of 2 stroke diesel engine is flow state, it outputs the relay contact signal in non flow state outside.



Graviner Mk 6 Oil Mist Detector

Installation, Operation & Maintenance Manual

59812-120

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CHAPTER 1

DESCRIPTION AND OPERATION

1.1 INTRODUCTION

High temperatures, in excess of 200°C that occur on bearing surfaces under initial failure conditions, can lead to a rapid generation of oil vapour. When the hot vapour contacts the relatively cooler atmosphere of the crankcase it condenses into a fine mist, with typical particle sizes of around 0.5 to 5 microns in diameter. When the density of these particles reaches between 30 to 50 mg/litre (depending upon the type of oil) an explosive condition exists.

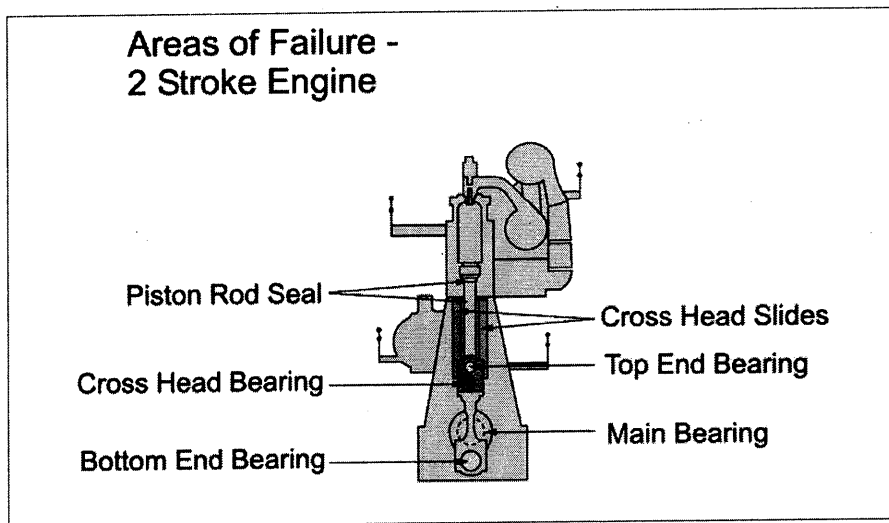


Fig 2a

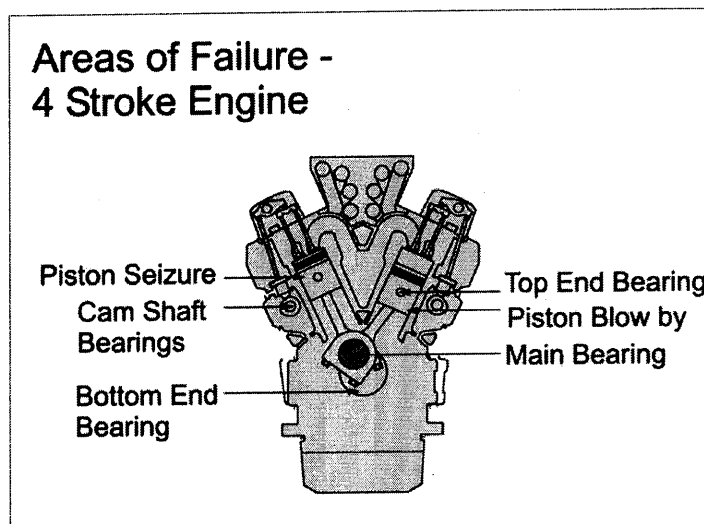


Fig 2b

A fire or explosion needs three constituents: fuel, oxygen and an ignition source. Remove one of these and no explosion will occur. Similarly, within the crankcase, the 3 constituents which could cause an explosion are air, oil mist and an ignition source, the "hot spot". Using optical measuring

techniques, oil mist density can be measured at levels as low as 0.05 mg/litre and hereby give early warning of a rise in oil mist density.

Oil Mist Detection techniques have been used to monitor diesel engine crankcases for potential explosive conditions and early detection of bearing failures. The systems available rely mainly on analysing the optical density of oil mist samples drawn from the crankcase compartments, through pipes to the detector. While these systems proved successful in the past, engine design has improved significantly over the years and oil mist detection techniques have improved substantially to maintain adequate protection.

The Mk 6 OMD provides the following benefits:

- Multi engine capability – up to 8 engines on a single system.

- Suitable for both 2 stroke and 4 stroke engines.

- Elimination of sample pipes – reduced installation costs.

- Significant reduction in scanning time – 1.2 seconds for a system of 64 detectors.

- Relocating system controls and display to the safety and comfort of control room

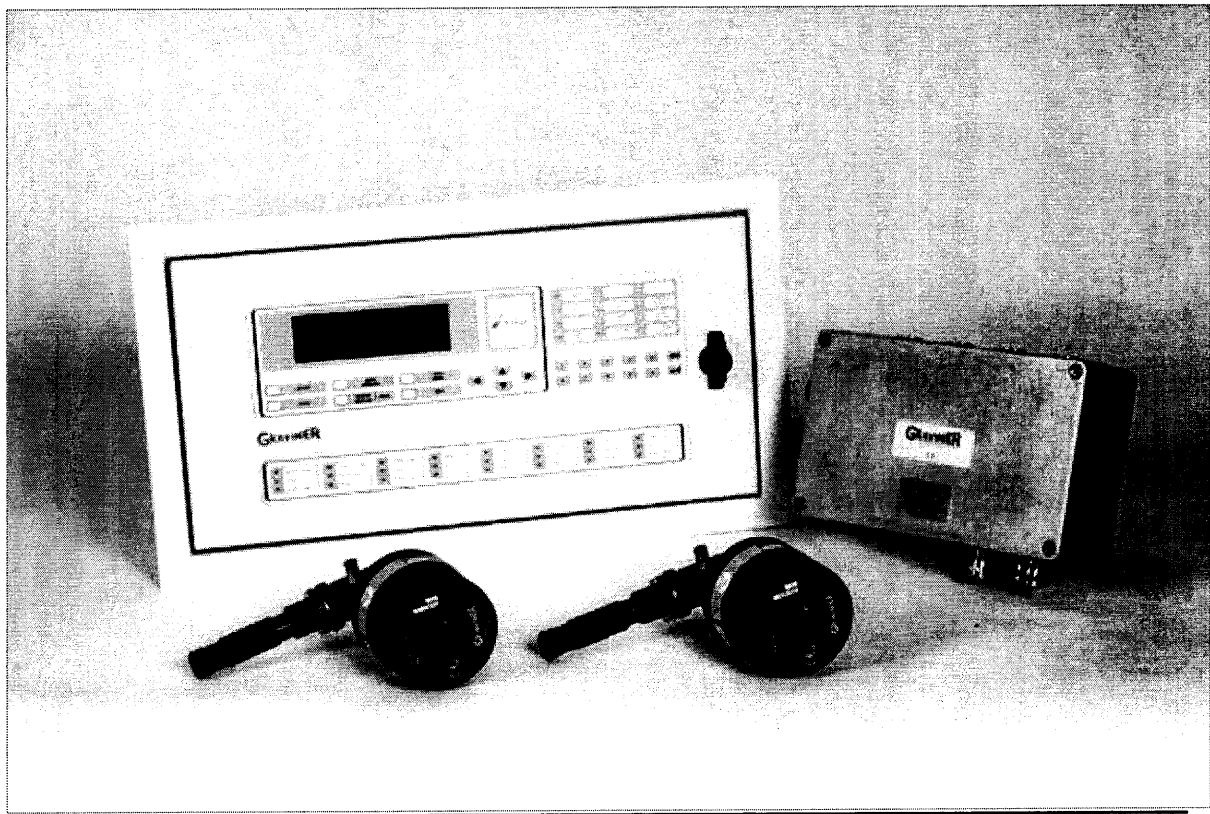


Figure 1: MK6 OMD Main Components

1.2 DESCRIPTION

The system comprises three main components (see fig. 3a):

- Detectors
- Engine Junction Boxes
- Control Unit

The Graviner Mark 6 OMD system can comprise up to 64 detectors directly mounted on the crankcases of up to 8 engines, thus allowing both main propulsion and auxiliary generators to be monitored at the same time.

Each detector communicates electronically over a serial data link via the engine mounted junction box, to the control/display unit which is designed to be mounted within the Engine Control Room. This eliminates the need to enter the machinery space in alarm conditions.

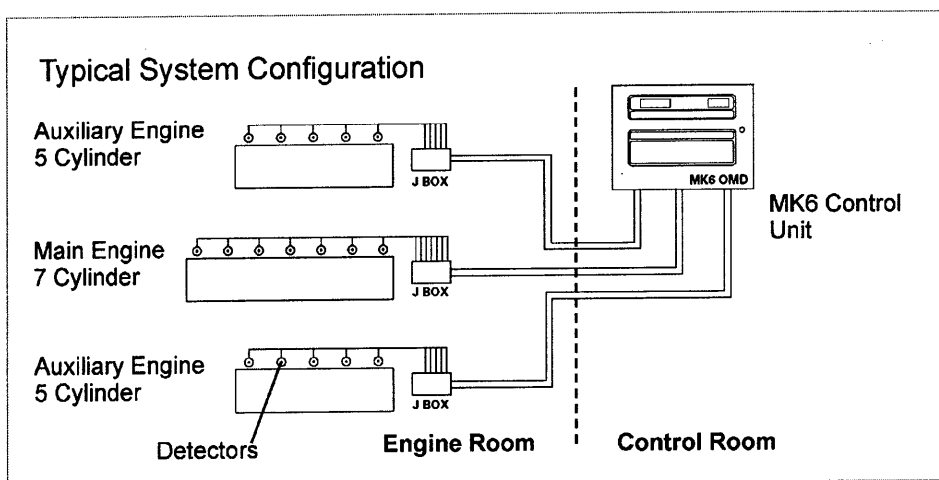


Fig 3a

1.3 TECHNICAL SPECIFICATIONS

Detector

Mounting	¾ inch BSP	
Enclosure Rating	IP65	
Address Switch	2 x 10 position (0 to 99)	
Indicators	Green	Detector On
	Red	Alarm
	Amber	Detector Fault

Electronic Replaceable Micro-Fan

Power Consumption	2.5W	
Temperature Rating	0 - 70°C	Inlet/Outlet Pipe 0 - 100°C
Height	175 mm	
Width	90 mm	
Length	205 mm	
Weight	0.6 kg	

Junction Box

Enclosure Rating	IP65	
Max detector inputs	14	
Fuse Rating	4.5 A	
Power Consumption	Zero	
Temperature Rating	0 - 70°C	
Dimensions		
Height	160 mm	(110 mm mounting centres)
	Width 260 mm	(240 mm mounting centres)
	Depth	90 mm
	Weight	2.3 kg

Control Unit

Enclosure Rating	IP32	
Scanning Time	1.2 seconds for 64 detectors	
Max No. of detectors	64	
Max No. of engines monitored	8	
Power Supply	24 V DC (+30% -25%)	
Protection	Self Re-settable fuse inside panel	
Insulation	Flash tested to 2000 V for 1 minute	
Power Consumption	5.2 W	
Temp Rating	0 - 55°C	
Dimensions		
Bulkhead Mounted:	Height	250 mm (270 mm mounting centres)
	Width	500 mm (445 mm mounting centres)
	Depth	118 mm
Panel Mounted:	Height	309 mm
	Width	559 mm
	Depth	118.5 mm
	Weight	7 kg
System Outputs:	Volt-free change over contacts rated at 30v 1amp DC	
Main Alarm	1 set (energised during normal operation)	
Fault Alarm	1 set (energised during normal operation)	
Engine Slow Down	8 sets, 1 set per engine (De-energised during normal operation)	
Alarm Ranges	Average 0.3 mg/lt to 1.3mg/lt	
	Deviation 0.05mg/lt to 0.5mg/lt	

1.4 OPERATION

The Graviner Mk 6 OMD retains the differential measuring system long established by Graviner and unique to Graviner, which enables high sensitivity to be used while maintaining the maximum false alarm rejection. It still uses optical sensing, but light scatter instead of obscuration. This enables very small detectors to be used. These are rugged and are designed to be engine mounted using standard oil mist detector ports. As they each have their own means of sample acquisition no sample pipes are required. Multiple internal light sources ensure that a single failure will not cause the loss of a detector. Modular construction means that a faulty detector can be replaced in a matter of minutes.

Each detector continually monitors the oil mist density in the crankspace to which it is connected. In addition, it self checks for any internal faults. The control unit interrogates each detector in turn, notes its address and the oil mist density value.

For each engine the average oil mist density is calculated and stored. Each detector signal is then compared in turn with the stored average. A positive difference (the Deviation) is then compared with a pre-set, but adjustable reference (the Deviation alarm level) for that engine (or detector). If it is greater than the reference a deviation alarm is given.

The stored average level is also compared with a preset reference (the average alarm level) and an average alarm is given if the reference is exceeded.

A full system has a maximum scan time of 1.2 seconds but with alarm priorities that enable the system to respond to an alarm as it occurs.

The control unit separates the information according to engine group

The control unit incorporates a Liquid Crystal Display (LCD). The Main Display constantly displays the average oil mist density reading for each engine along with both the average and deviation alarm levels for each engine. It also enables the individual readings of each detector on an engine and the average to be displayed on demand and automatically under alarm conditions.

In the interest of safety, all system controls and alarm displays/outputs are located on the control unit. However to aid fault finding each detector is fitted with 3 indicator lights:

Green power on

Red alarm

Amber fault

Each detector also has an access to its address set switches.

As all detectors operate independently, the loss of one by either failure or the need to clean does not affect the operation of the rest of the system. Individual detectors, or engine groups, can be isolated from the rest of the system for maintenance while the rest of the system remains in operation.

1.5 SYSTEM CONTROLS AND DISPLAYS

The software is menu driven and provides a logical route to all functions. It has three operating levels:

User
Engineer
Service

The User level is essentially for read only interrogation only and does not allow any adjustments to be made to alarm settings or system configuration.

The Engineer level is password protected and allows access to most functions and the full range of settings. The only function denied is resetting of the event log. When selected, a prompt for a password will appear. Enter 012345 then press the ↵ key.

The Service level is also password protected (different from the engineer menu) and allows access to all functions. This is only available to authorised Kidde Fire Protection Ltd personnel and authorised service agents.

1.5.1 Controls

The controls, situated below the display, enable the following:

THE ACCEPT KEY resets the main alarm relay, silences the internal sounder. The display will then enter the individual engine display for the engine(s) in alarm. If there is more than one engine in alarm the display will scroll between engines.

THE HOLD KEY holds the display for 15 seconds.

THE RESET KEY resets all alarms, faults and returns the system to normal.

THE TEST KEY enters the test menu at User level functions only.

The **Engine Display** control calls up the individual engine cylinder readings and the average. It also displays the deviation and average alarm settings. The cursor keys allow each engine in the system to be displayed in turn.

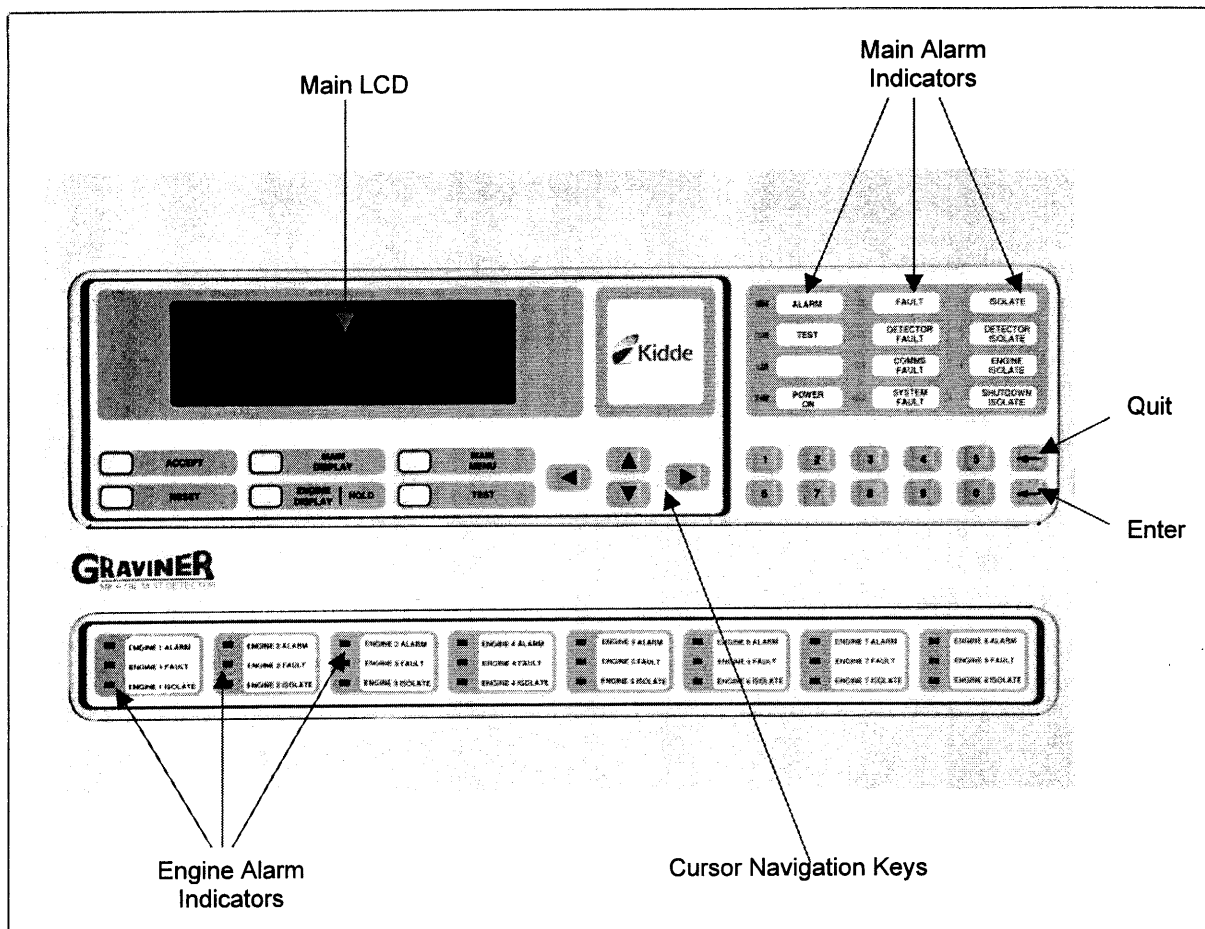
The **MAIN DISPLAY** key always returns the display to this page from anywhere in the software.

The **MAIN MENU** key allows access to all the User, Engineer and Service menus. At the bottom of each displayed page the active navigation keys for that page are shown.

The **MAIN DISPLAY** and **MAIN MENU** keys allow fast return to the normal display or the main menu from anywhere in the software. If this function is carried out from a password protected area ie Engineer or Service menu, then a **RESET** must also be carried out.

The keypad keys are:

▼	Cursor down
▲	Cursor up
◀	Cursor left
▶	Cursor right
←	Quit page
↵	Enter



Operation of the navigation keys is accompanied by an audio signal.

1.5.2 Main LCD Display

This provides visual access to all the data required to operate the system and displays the software pages for system configuration and fault analysis. On the main display and the engine display, the left hand vertical scale shows oil mist density in mg/l. In addition the main display shows the average alarm setting for each engine.

On the engine display, both the deviation alarm(s) and the average alarm settings are displayed. Under normal operating conditions, the main display page shows the average oil mist density for all engines and the relevant average alarm settings. It also shows the time, the date and **NORMAL**.

1.5.3 Engine Alarm Indicators

Each of the eight engine alarm indicator sets show the status of that engine ie. Alarm, Fault and Isolate. This display is designed to be a backup to the main LCD.

1.5.4 Main Alarm Indicators

This light display consists of alarm indicators for all the individual alarm, fault and isolate conditions. Its function is to provide back up indication in the unlikely event of the loss of the main LCD display.

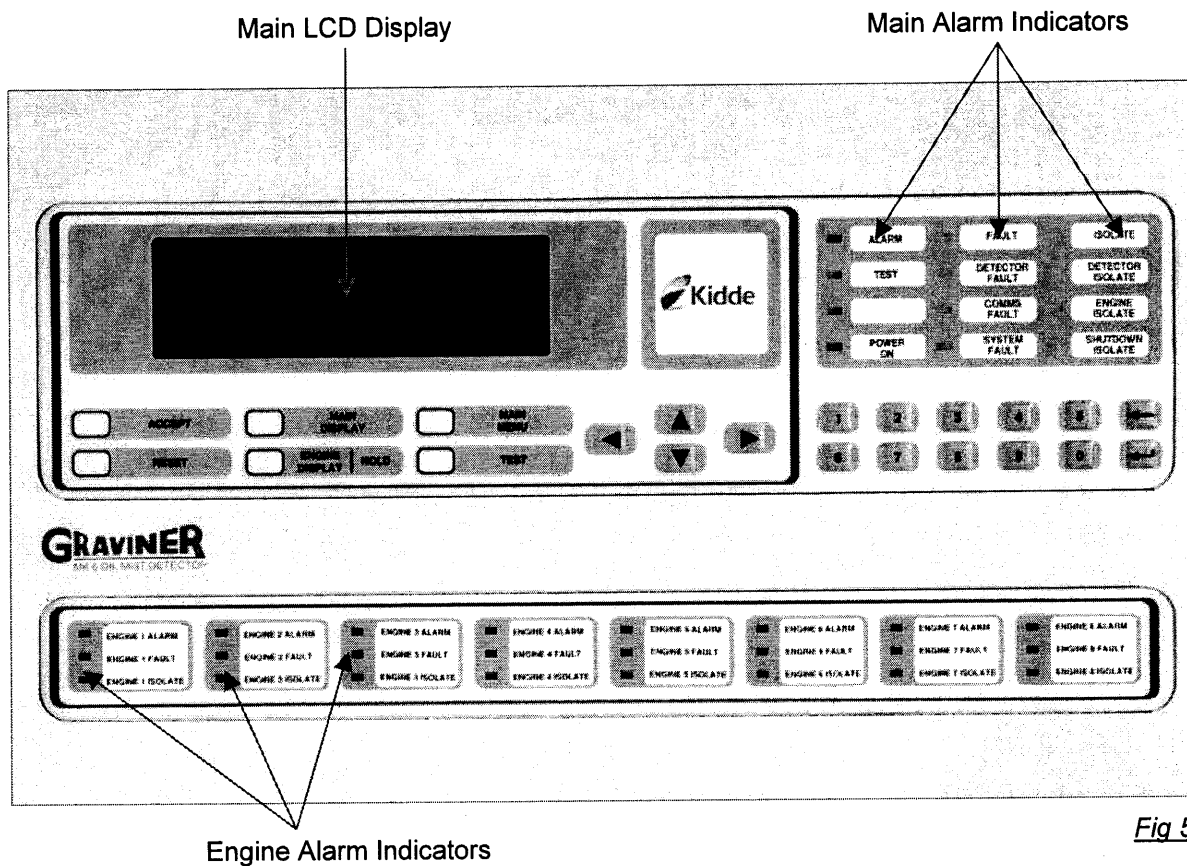


Fig 5

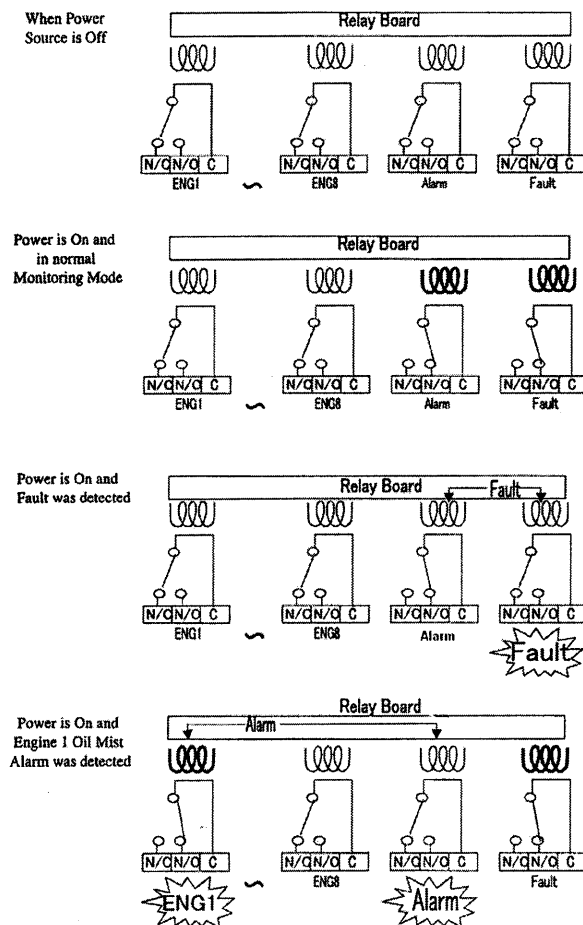
1.5.5 Alarm Outputs

The controller has the following relay outputs:

- Main Alarm.** 1 set of Volt free changeover contacts.
Operate on any Average or Deviation alarm from any of the 8 possible engines.
- Engine Slow down.** 8 sets, 1 per engine.
Operation when the correlating engine has either on Average alarm or Deviation Alarm.
- Fault Alarm.** 1 Set of volt free contacts.
Operate on any system fault.

All relays are rated 30v lamp DC. All relays can be tested for operation in the Test Menu.

OMD MK-6 Relay Function Mode



2.1 INSTALLATION

The control unit is designed for either bulkhead or flush mounting, and must be installed in a control room or similar environment.

For flush mounting a bezel, part number 35100-K187 can be supplied (refer to Figure 8).

Technical drawings of the GE 9000 Series Programmable Controller, showing front and side views with dimensions.

Front View Dimensions:

- Overall Width: 500.0
- Mounting Hole Spacing: 445.0
- Overall Height: 270.0
- Mounting Hole Diameter: 4 HOLES #7.0
- Terminal Block Spacing: 72.5 (between first two), 50.0 (between others)
- Terminal Block Width: 97.5

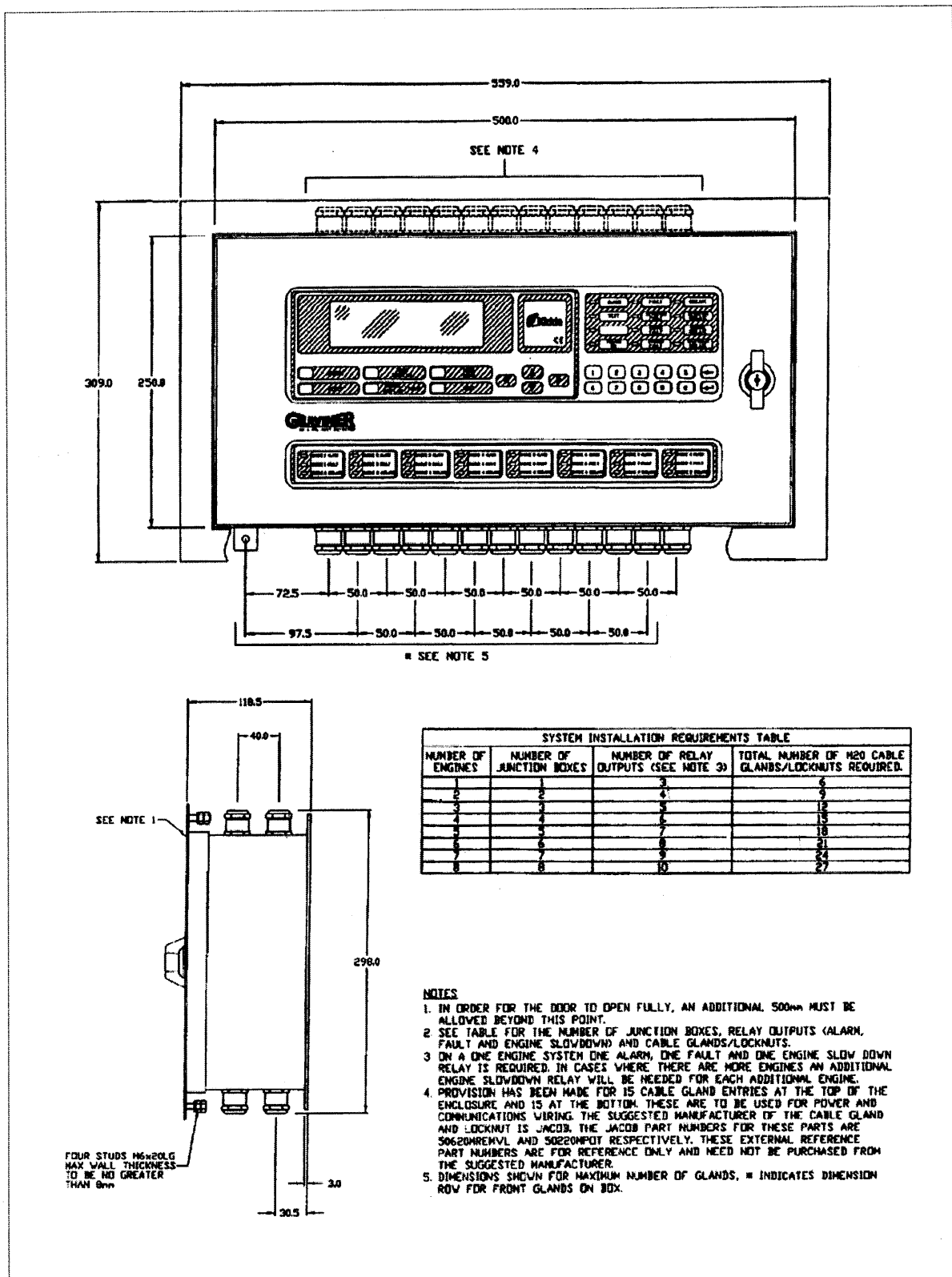
Side View Dimensions:

- Overall Depth: 118.0
- Terminal Block Spacing: 40.0
- Bottom Flange Width: 30.5
- Bottom Flange Thickness: 3.0

Notes:

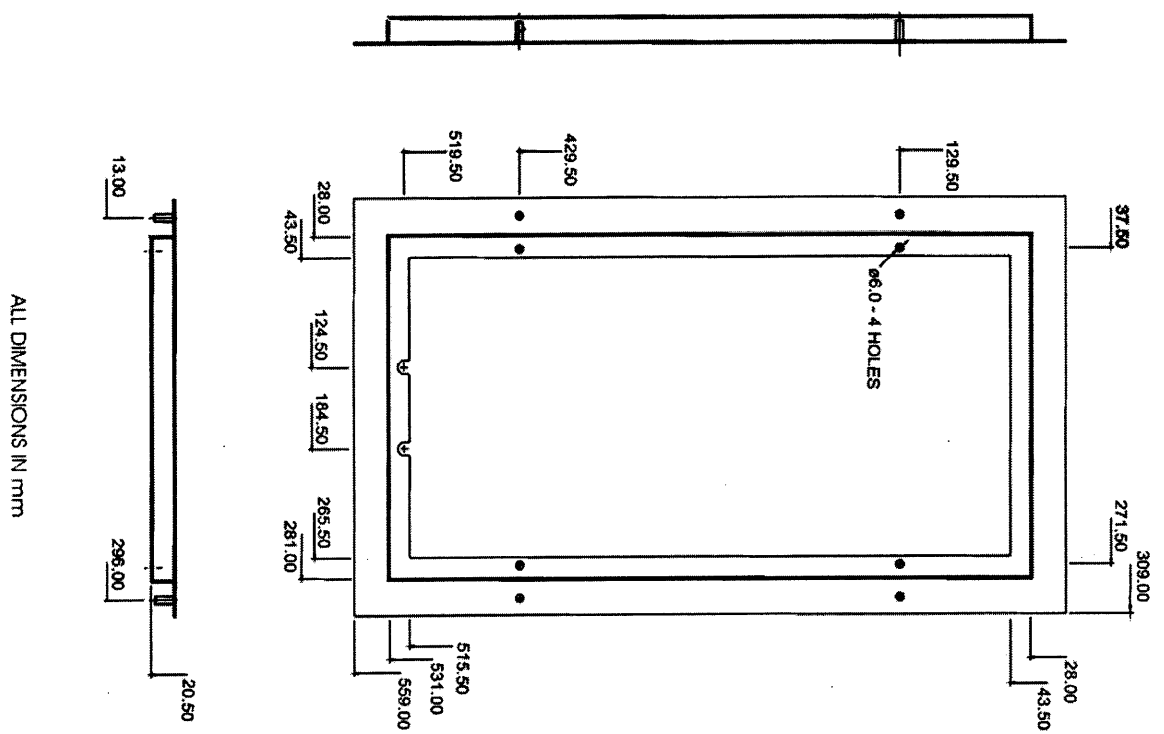
- SEE NOTE 4
- SEE NOTE 5

Fig 7



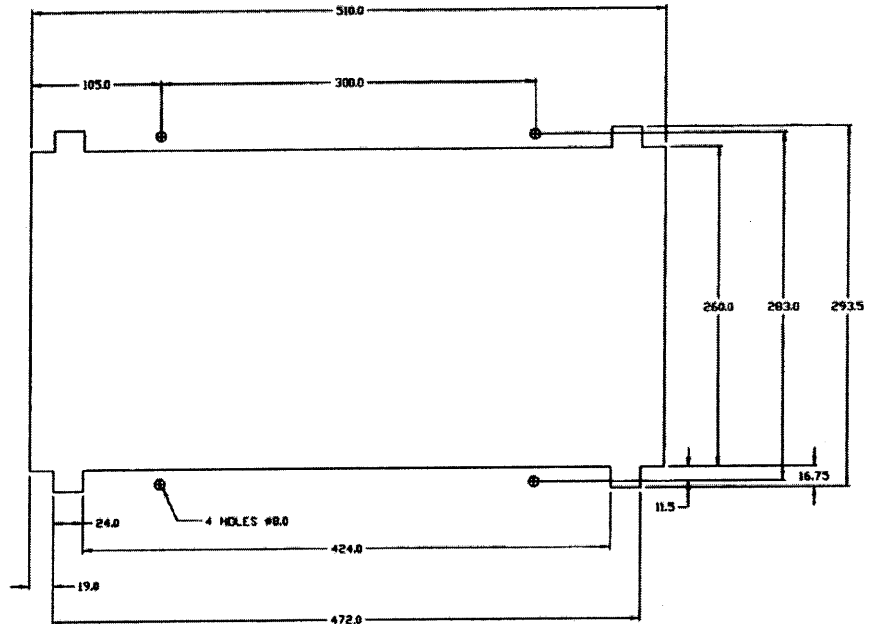
Installation Drawing for OMD Mk Panel 6 Flush Mount

Fig 8



Bezel 35100-K187

Fig 9



NOTE:
L CUTOUT TO FIT BEZEL 35100-K187

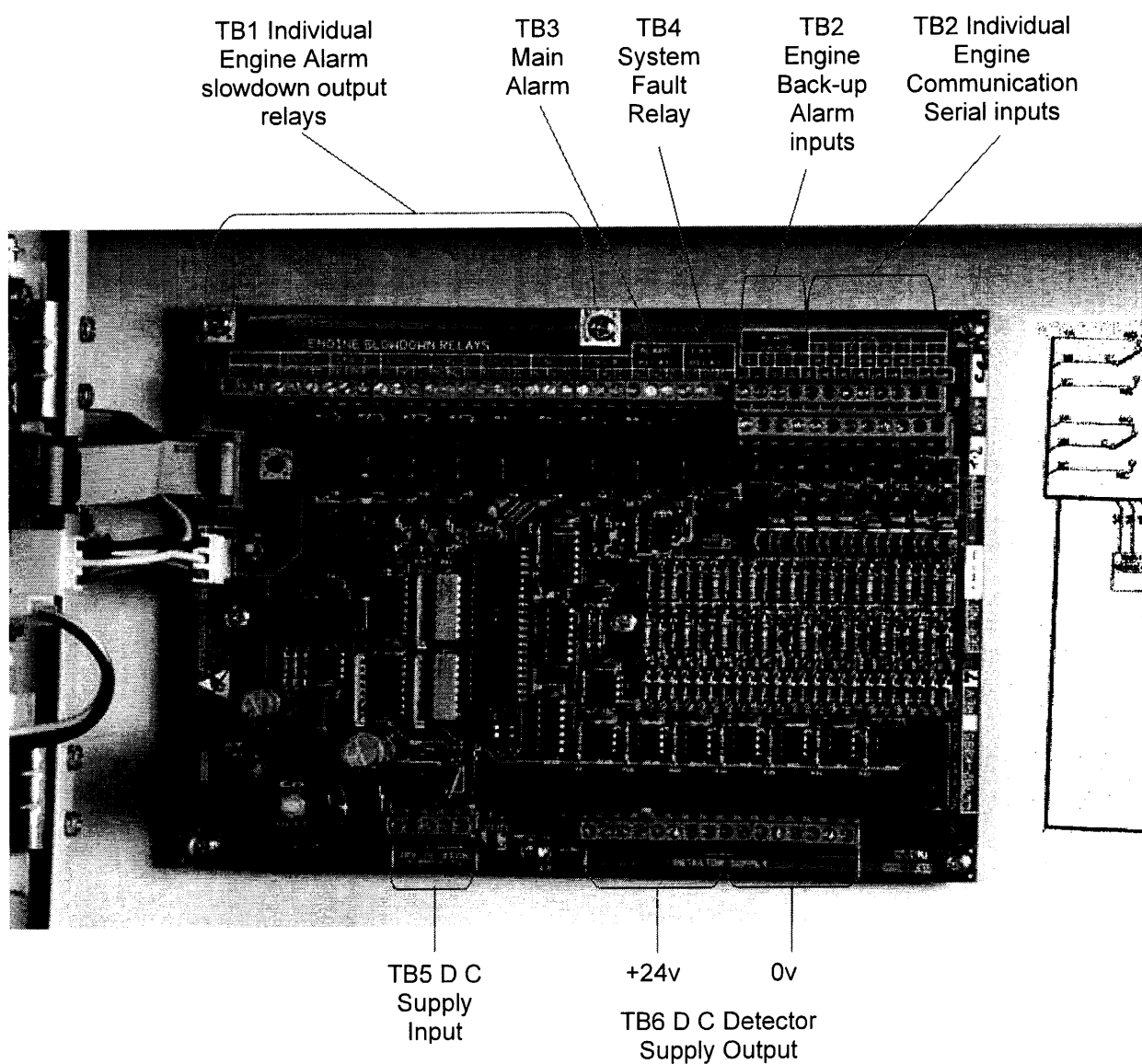
Installation Drawing for OMD Mk Panel 6 Flush Mount panel cut out details Fig 10

2.1.2 Control unit wiring

The +24 vdc and 0vdc power input cables for the controller should be terminated onto terminal block TB5.

Note the earth wire must be connected onto the Earth Stud on the side on of the control box. See Figure 12

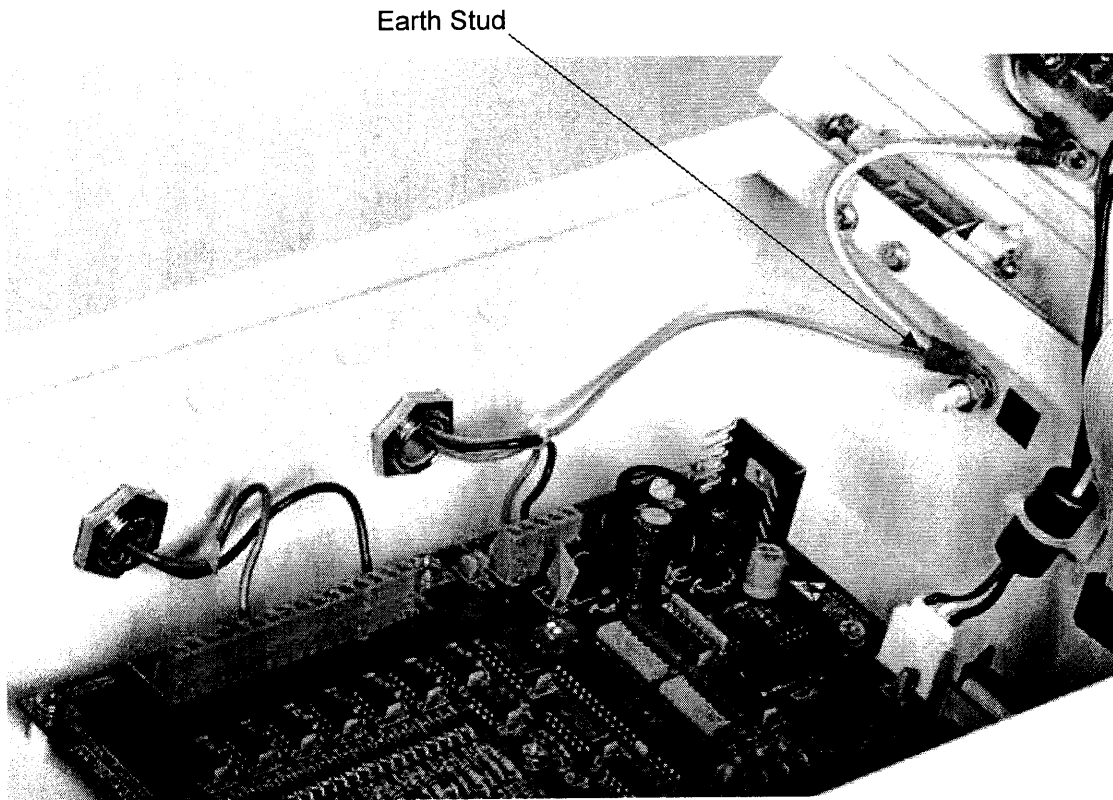
Note all terminations should be made using crimped wires.



Control Unit Interface Board

Fig 11

2.1.1.1



Power input cable earthing stud

Fig 12

2.1.3 Communication & Power Cable from Controller

The cable from the controller to each junction box should be of the following types:

Power Cable:

2 Cores + earth , CSA 2.5mm² (50/0.25mm), Flexible stranded bare copper conductors, Low smoke halogen free insulation, cores laid up, aluminium/polyester foil plus a tinned copper wire braid, low smoke halogen free sheath – grey outside diameter 9.8mm operating temperature 0°C to + 80°C

Comms Cable:

2 Twisted low capacitance pairs, 24(7) AWG tinned copper conductors, foam polyolefin insulation, each pair foil screened with a tinned copper drain wire, low smoke halogen free sheath – grey, outside diameter 8.1mm operating temperature 0°C to 70°C

Supplier – FS cables

Order code 2402PIFFH or similar.

Cable screens must be connected to the metal glands of the controller and terminals of TB9 within the junction box's, see below:

Ensure that C- (pink) and C+ (brown) of the last detector are connected to the End of Line (EOL) position at TB10.

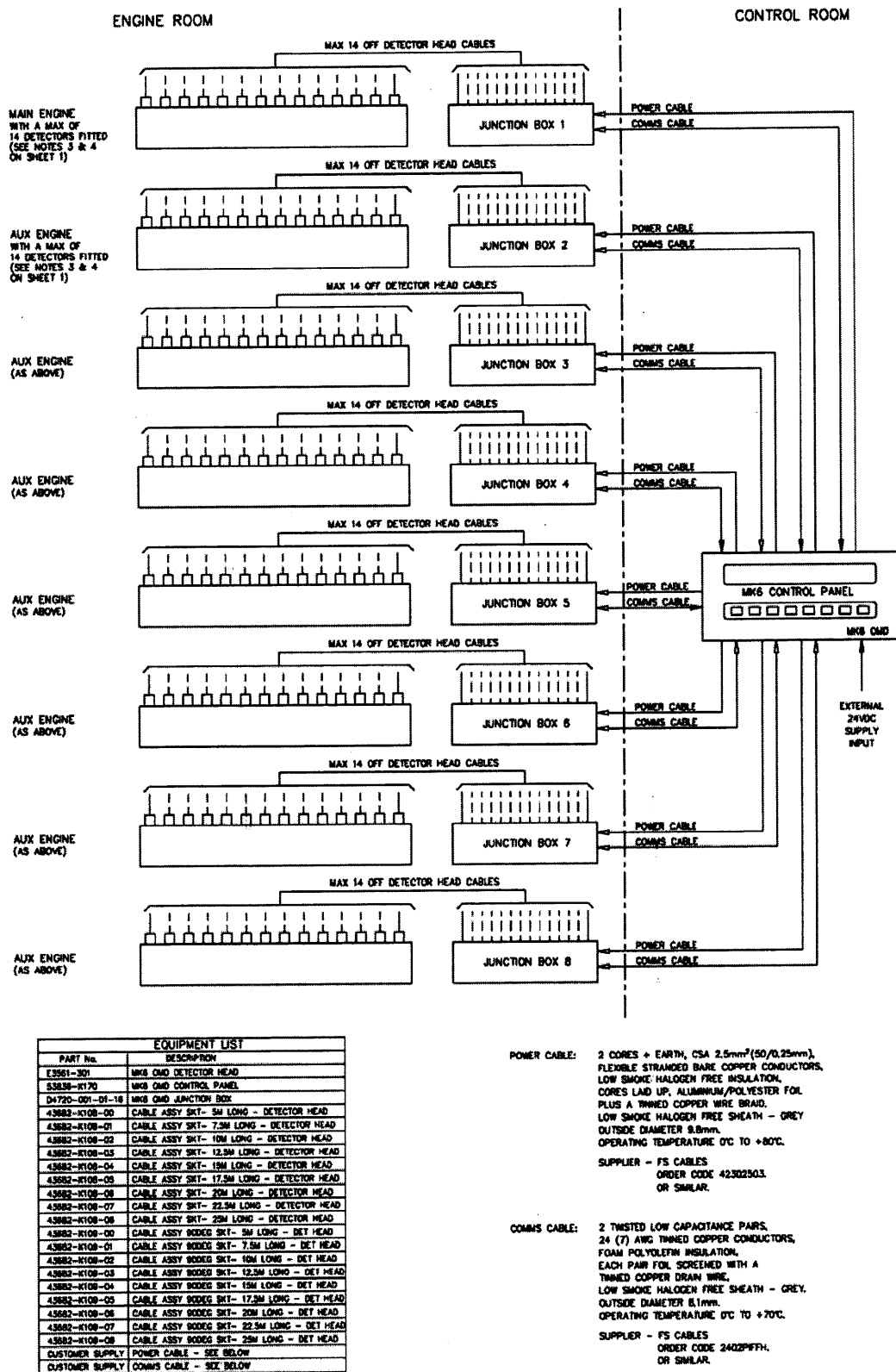
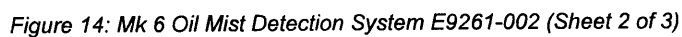


Figure 13: Mk6 Oil Mist Detection System E9261-002 (Sheet 1 of 3)



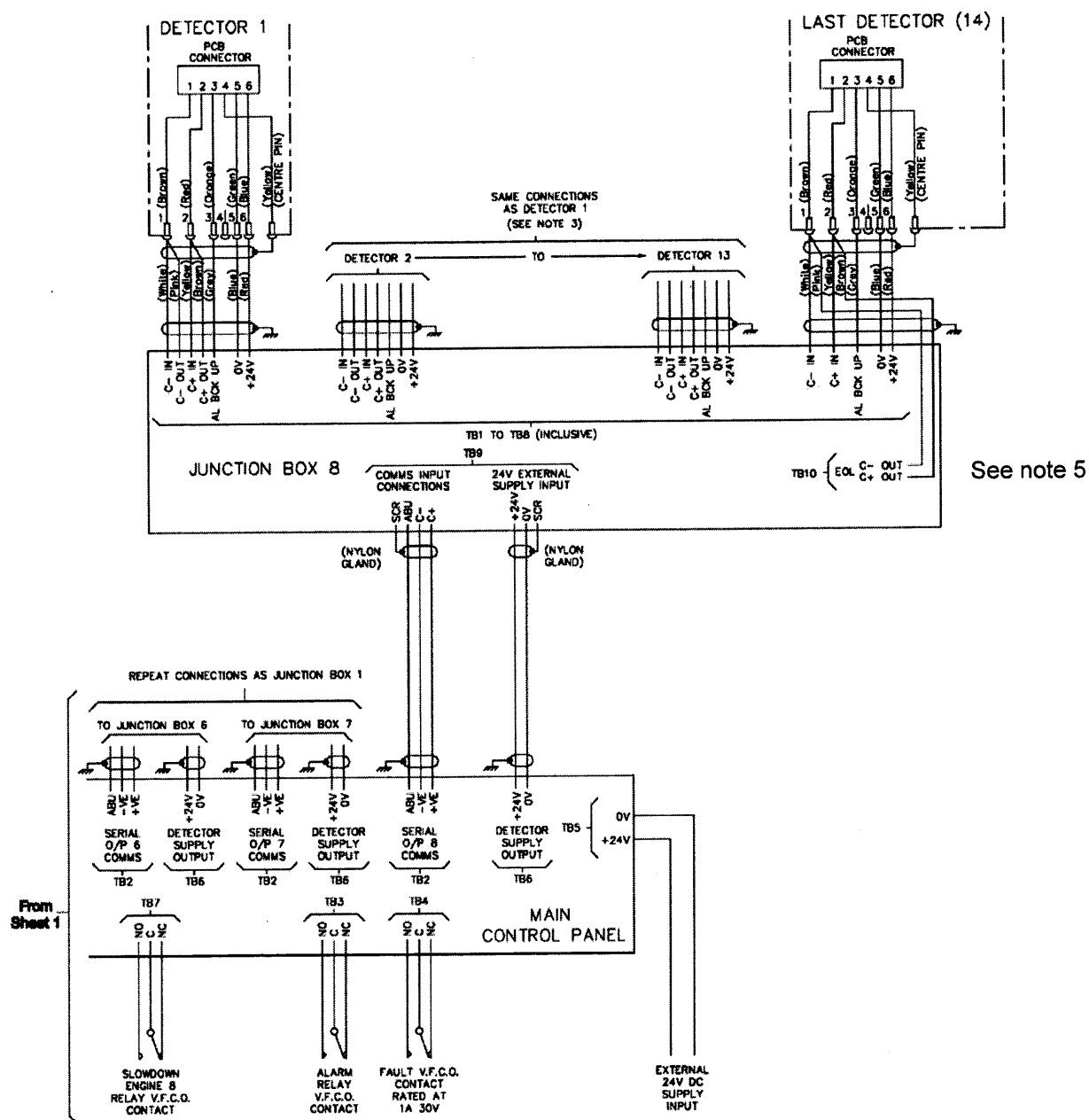


Figure 15: Mk6 Oil Mist Detection System E9261-002 (Sheet 3 of 3)

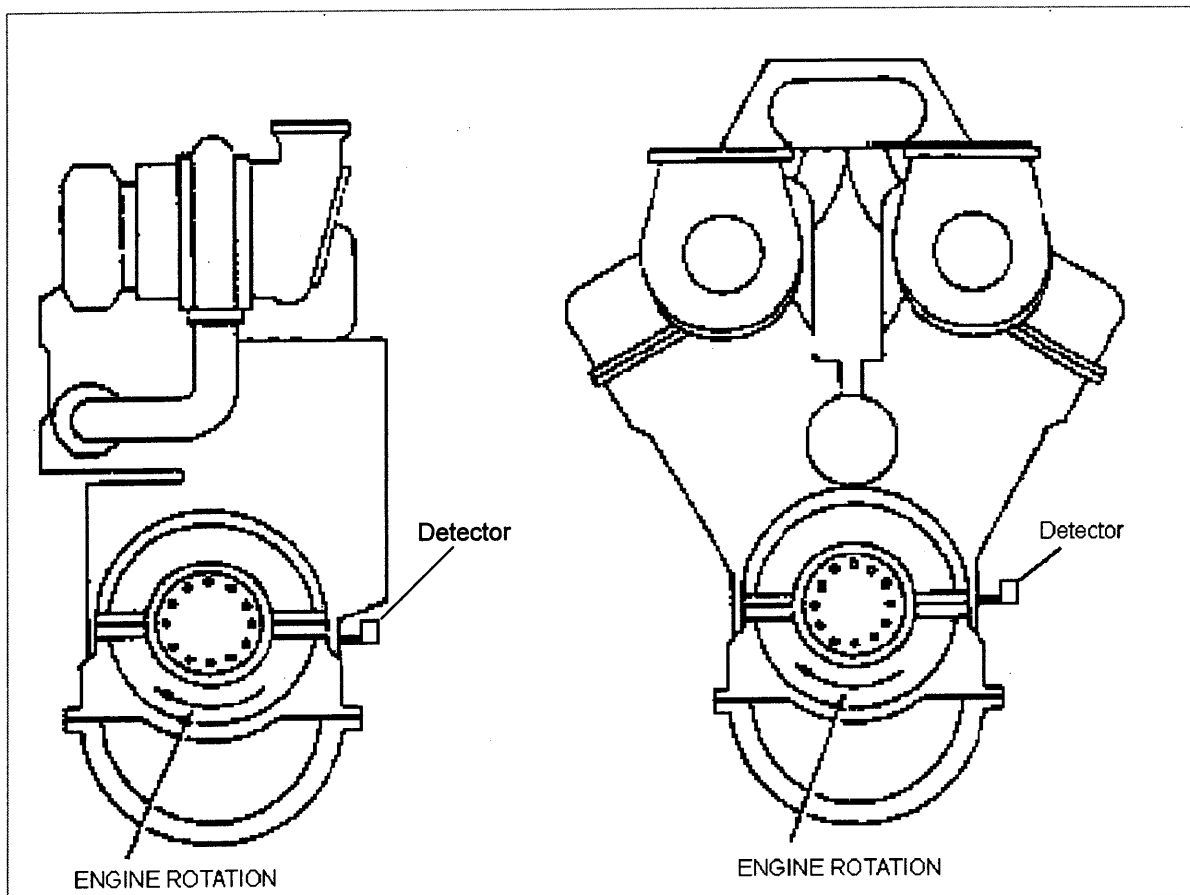
2.1.1 Detector

Each detector is mounted to an individual crankcase via a $\frac{3}{4}$ inch BSP threaded hole.

Ensure all detectors fitted to the engine are locked tightly in place by means of the lock nut supplied.

The detector should be located at the upper part of the crankcase wall NOT in the direct line of the oil throw. On smaller engines it is permissible to mount the detector on the crankcase door if desired or as installation dictates.

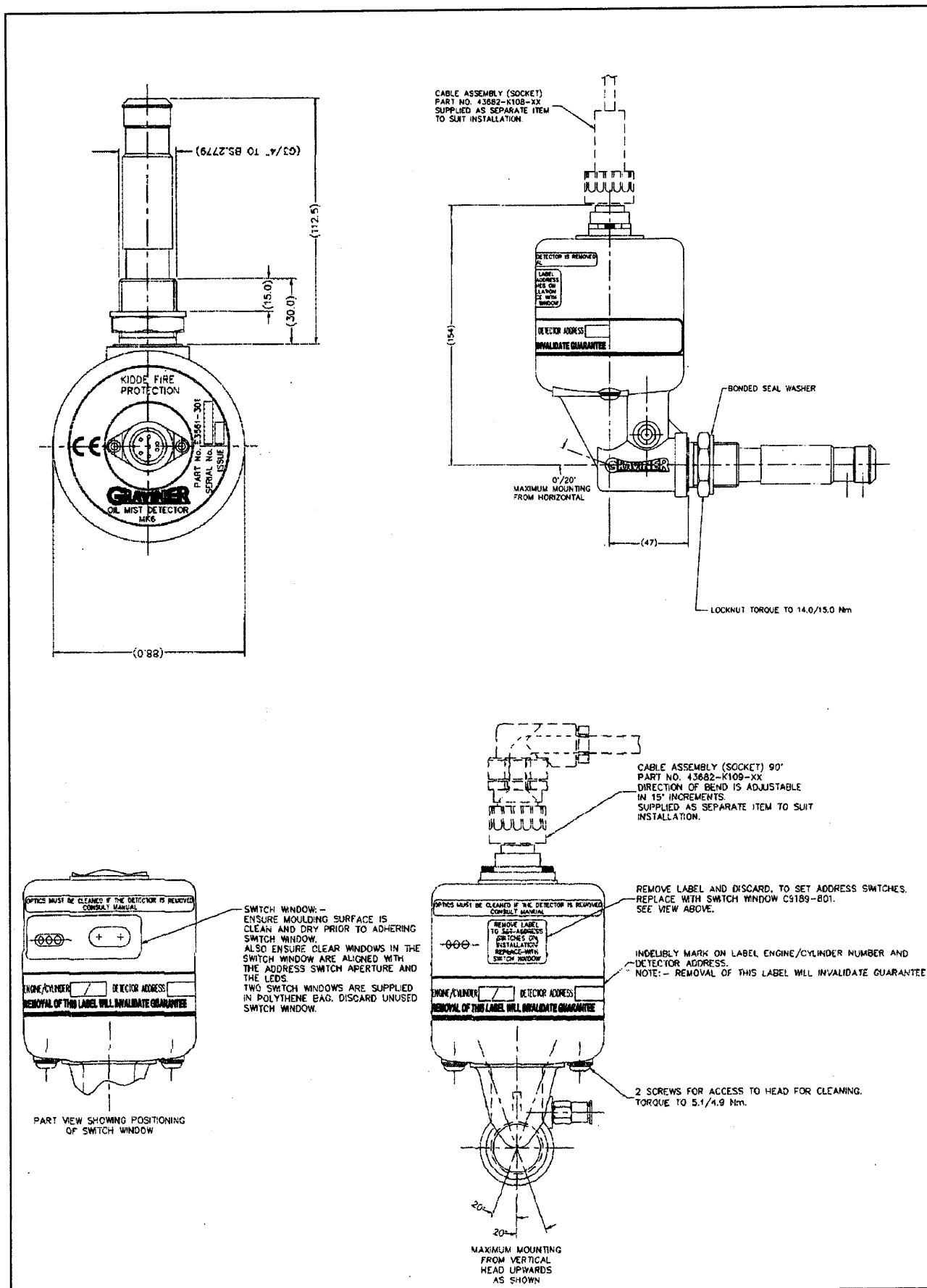
The detector should be mounted such that any oil throw comes from above the sample pipe.



Typical Mounting position

Fig 16

The detector must be fitted at a maximum of plus or minus 20 degrees from the vertical. Horizontally the detector must be mounted level or with the detector body inclined towards the engine to ensure oil drainage.



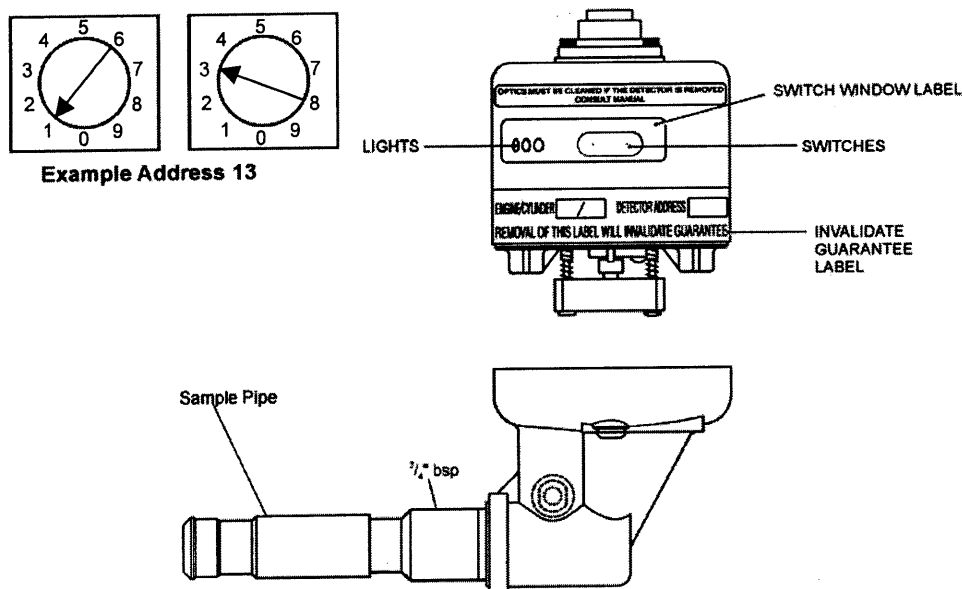
Mk 6 Oil Mist Detector Head Installation E3561-301 ID

Fig 17

Setting Detector Address

Correct operation of the system depends on all detector heads being correctly addressed. This is carried out after installation (refer to Figure 18).

1. Remove the temporary adhesive label covering the access port to the address switches.
2. Use an instrument screwdriver to set the switches.
3. The left-hand switch sets the TENS, the right hand switch sets the UNITS.



Detector Head E3561-301

Fig 18

4. Detectors are supplied with the switches set to 00 as factory default.
5. The detector addresses must be sequential and should run in sequence from engine to engine, ie if the last detector head on the first engine is address 08, then the first detector head on the second engine must be 09.
NB. It is essential that if detector heads are removed for overhaul they are returned to their original position or they are re-addressed.
6. Clean the detector head in the area around the address switches and indicator lights with wet and dry wipes to ensure any oil or grease is removed. Attach the switch window label so that both the switches and the indicator lights are visible.
7. The address should be written on the invalidate guarantee label in the position shown.

2.1.3 Detector Cables Assemblies

Each detector is then connected via a straight or 90° bend cable assembly to its relevant junction box.

Ensure all cable screens are properly made off with the junction box glands.

It is recommended that all cable terminations are made using crimp terminals.

Cable Length	Straight Connector Part No.	90° Connector Part No.
2.5m	43682-K108	43682-K109
5.0m	43682-K108-00	43682-K109-00
7.5m	43682-K108-01	43682-K109-01
10.0m	43682-K108-02	43682-K109-02
12.5m	43682-K108-03	43682-K109-03
15.0m	43682-K108-04	43682-K109-04
17.5m	43682-K108-05	43682-K109-05
20.0m	43682-K108-06	43682-K109-06
22.5m	43682-K108-07	43682-K109-07
25.0m	43682-K108-08	43682-K109-08

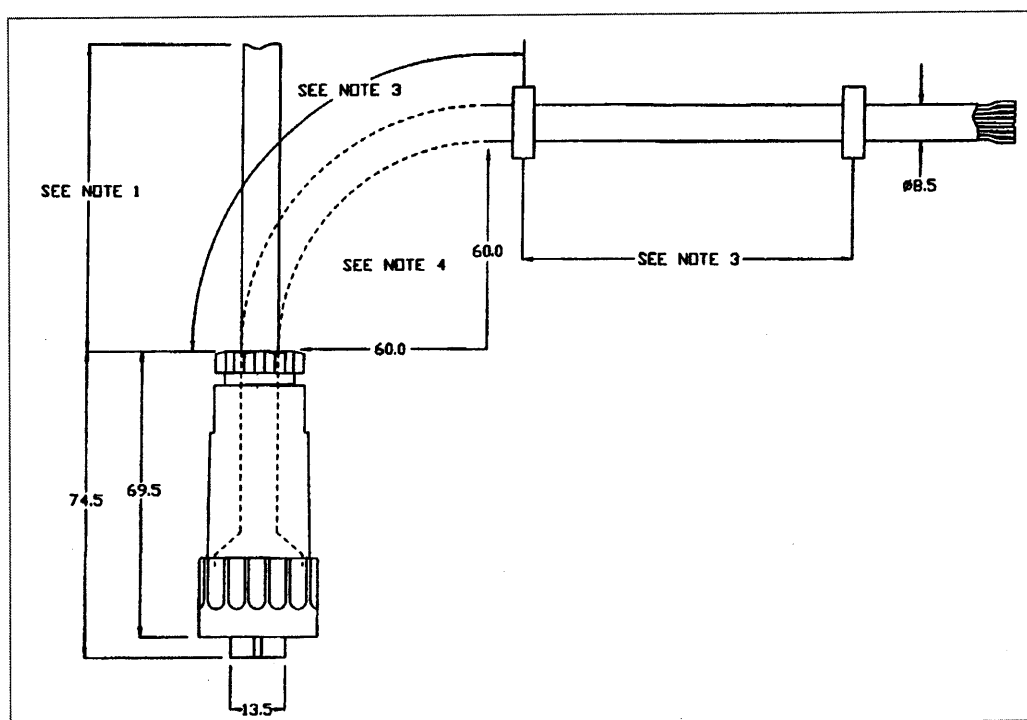


Fig 19

Notes 1:

1. Cable Spec 8-core screened (90°C) Halogen free & oil resistant.
2. Cable lengths are 'straight lengths'.
3. Clips to be secured every 0.5m (clips are not Kidde supply).
4. Do not exceed the minimum bend radius as shown.

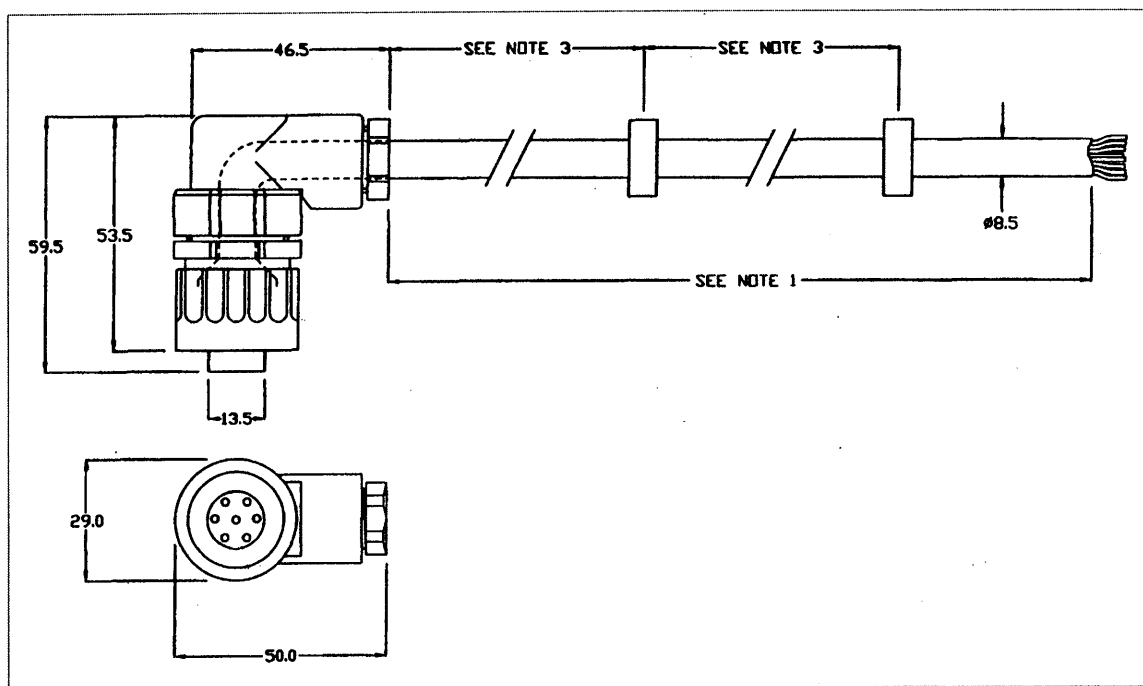
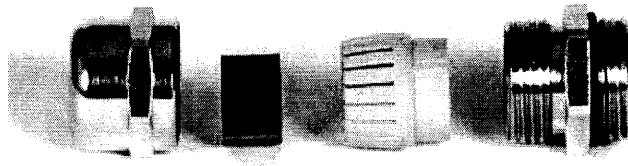


Fig 20

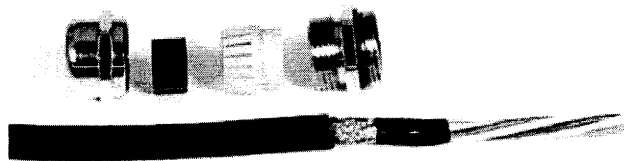
Pin Out Table

Connector Pin No.	Colour of Wire	Function	Last Detector Function
1	Pink	C -out	TB10 EOL -
1	White	C –in	C –in
2	Yellow	C +in	C +in
2	Brown	C +out	TB10 EOL +
3	Grey	Alarm Backup	Alarm Back-up
4	Not used	Not used	Not used
5	Blue	0V	0V
6	Red	+24VDC	+24V
Center	Screen		



Junction box cable gland components

Fig 21



Junction box cable gland components

Fig 22



Junction box cable gland components

Fig 23



Junction box cable gland components

Fig 24

2.1.4 Junction Box

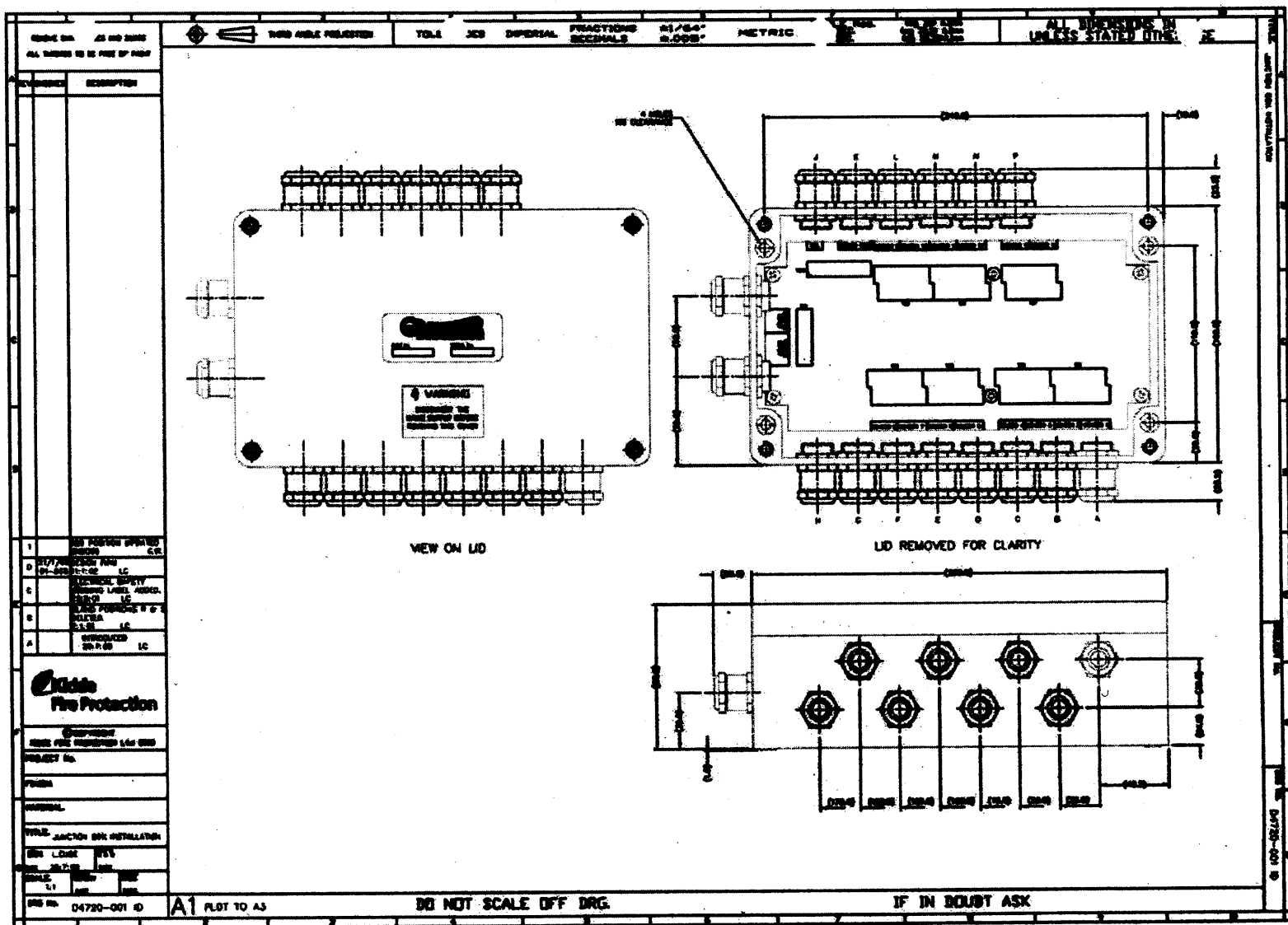
The junction box is designed for on-engine mounting and it is recommended that the box is installed as near centre of the engine as possible to minimise detector cable lengths. Mounting is via the four M6 locating holes in the box. Sufficient space must be left around the junction box to allow access to the cable glands and the routing of the cables and to facilitate easy access to all aspects of the junction box.

No of entries	Junction Box Part No. with 20mm output glands	Junction Box Part No. with 25mm output Glands
1	D4720-001-01	53836-K224-01
2	D4720-001-02	53836-K224-02
3	D4720-001-03	53836-K224-03
4	D4720-001-04	53836-K224-04
5	D4720-001-05	53836-K224-05
6	D4720-001-06	53836-K224-06
7	D4720-001-07	53836-K224-07
8	D4720-001-08	53836-K224-08
9	D4720-001-09	53836-K224-09
10	D4720-001-10	53836-K224-10
11	D4720-001-11	53836-K224-11
12	D4720-001-12	53836-K224-12
13	D4720-001-13	53836-K224-13
14	D4720-001-14	53836-K224-14

With larger 2 stroke engines, eg. 12K98MC, it may become necessary after the engine tests are complete that due to the size and weight the engine is dismantled in 2 or 3 parts for transportation purposes. To facilitate this it is possible with the MK6 OMD to use two junction boxes for one engine zone.

For connection details and the different engine types see figure 27.

Fig 25



It is recommended that all cable terminations within the junction box are made using crimp terminals

The Screens for both the communications cable & power cable from the controller must be terminated on to TB9 (see Fig 26)

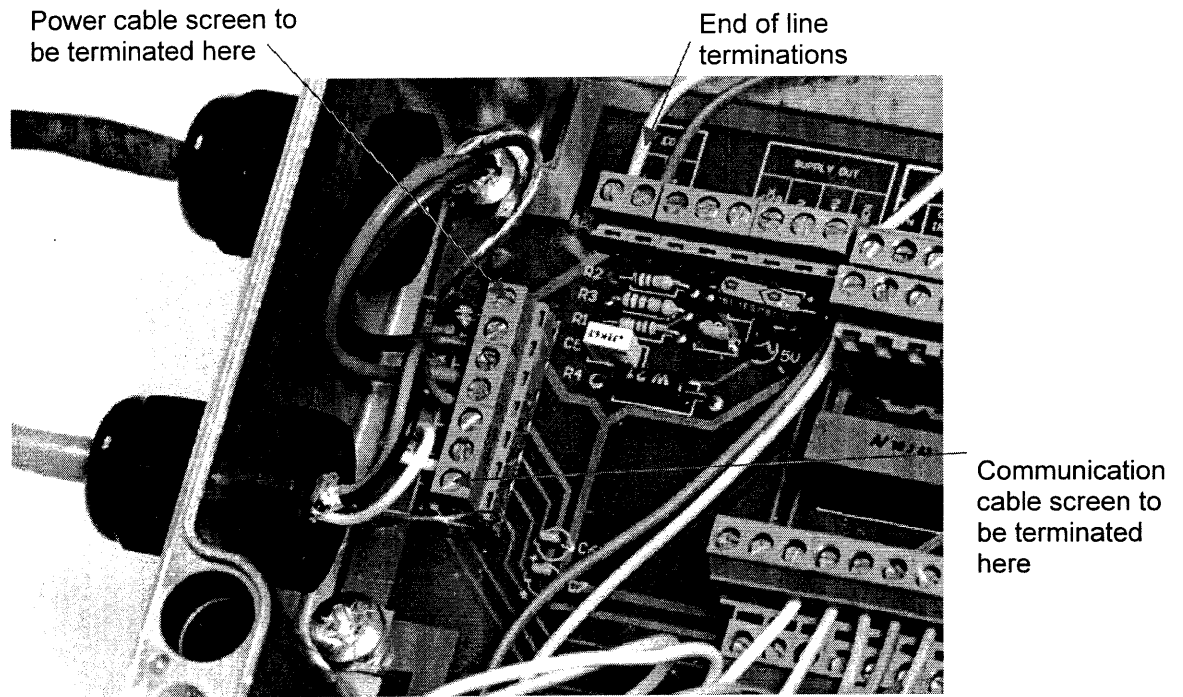
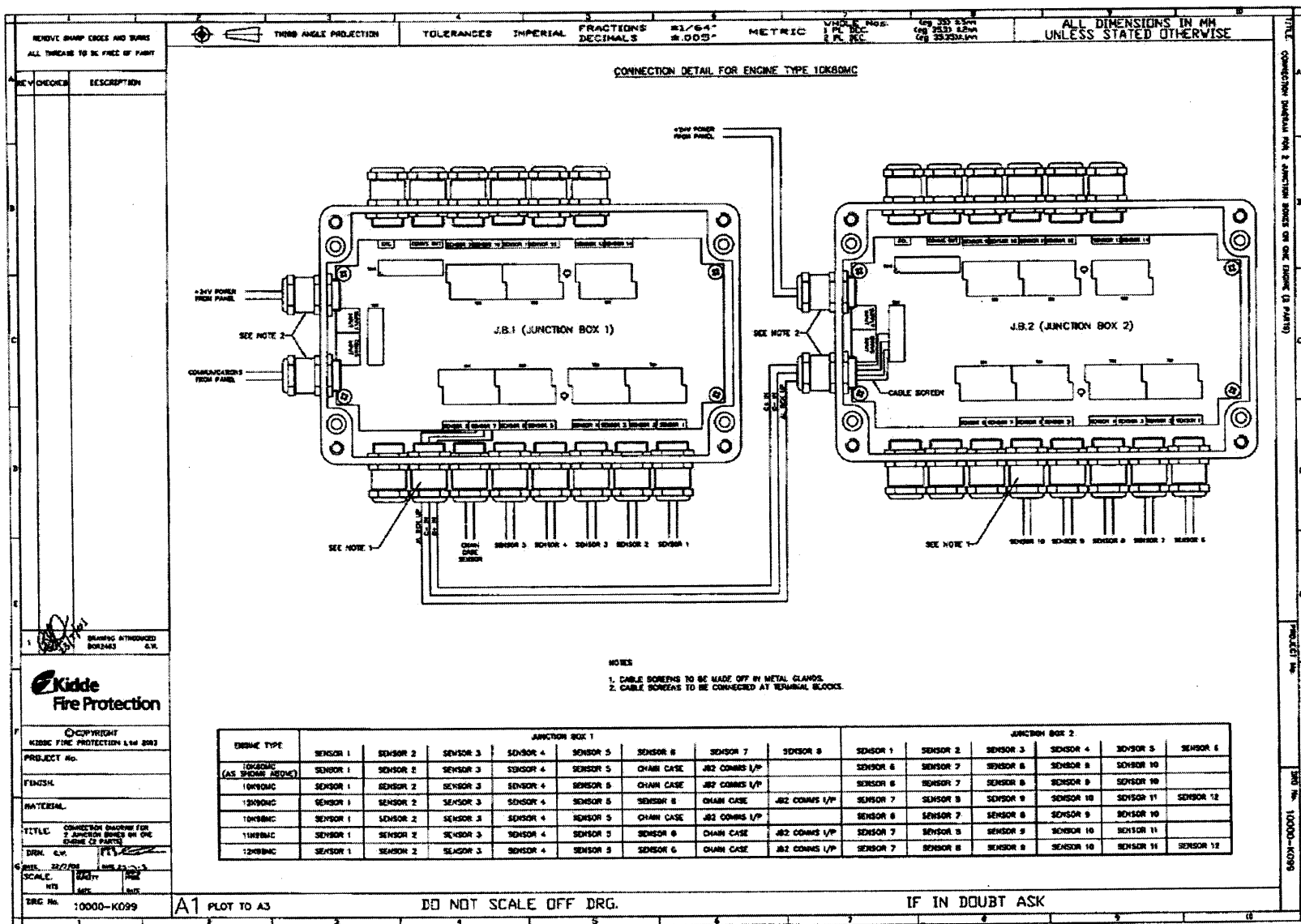
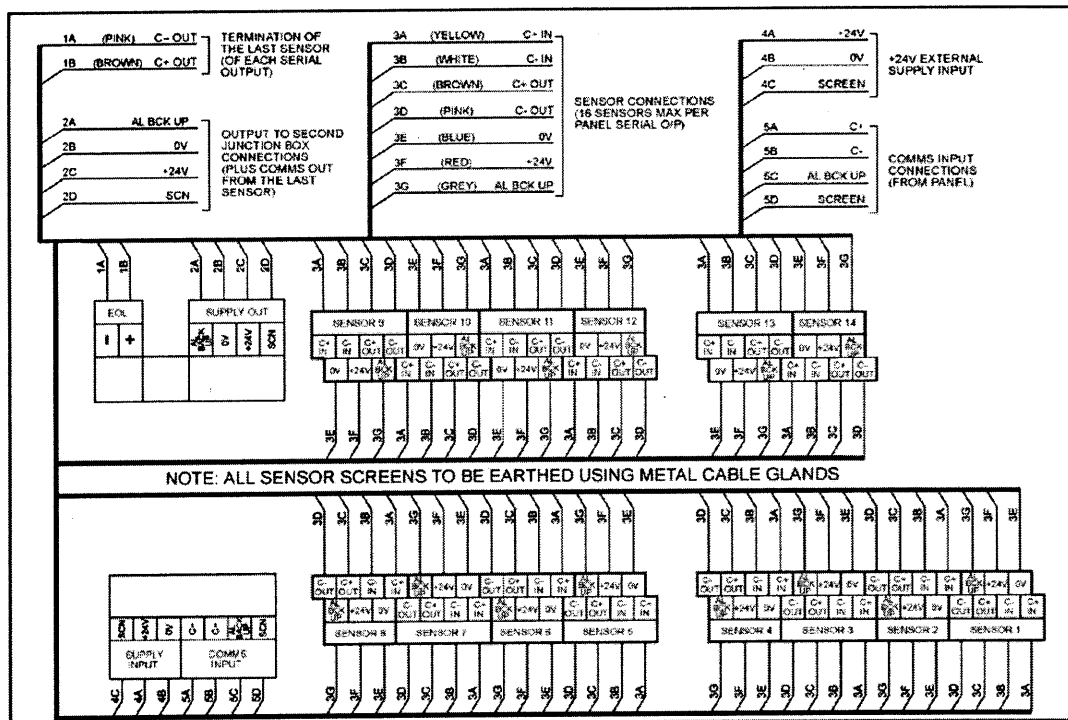


Fig 26





Junction Box External Connections Label

Fig 28:

2.2 SYSTEM CHECKS PRIOR TO SWITCH ON

- 2.2.1 Check that the detector cables are correctly terminated in the junction box and that the screens are made off correctly in the glands, e.g. the detector that is addressed 01 is connected to the detector 1 position in the junction box, and the detector addressed 02 is connected to the detector 2 position in the junction box etc. **Ensure last detector for each junction box is also terminated on TB10 EOL**
- 2.2.2 Ensure that the Communication and Junction Box power supply cables are connected correctly in the junction box (refer to Figure 14).
- 2.2.3 Check the cable run of the Communication and Junction Box power supply cables back from the junction box to the Control Unit to ensure that they are not damaged.
- 2.2.4 Ensure that the Communication and Junction Box power supply cables are connected correctly in the Control Unit (refer to Figure 14 and properly screened).
- 2.2.5 Ensure that the Engine Slowdown, Main Alarm and Fault Alarm relays are connected correctly in the Control Unit (refer to Figure 14).
- 2.2.6 Ensure that the supply input cable is connected correctly to the Control Unit (refer to Figure 14).
- 2.2.7 Ensure that the input voltage to the controller is 24V D.C. +30%, - 25%
- 2.2.8 Check the location and function of the main controls on the front of the Control Unit (refer to Figure 4).

- 2.2.9 When all of the above have been checked and are satisfactory the system is ready to switch on.

2.3 SYSTEM CONFIGURATION AND COMMISSIONING

2.3.1 Initial Actions and Settings

1. After switch on, the control unit display shows the message **SCANNING FOR DETECTORS**. Followed by a flashing **COMMS FAULT** message. The green LEDs on the detectors illuminate.
2. Press **ACCEPT** to silence the audible alarm. The **COMMS FAULT** continues to flash. Select **MAIN MENU** use the cursor to highlight **ENGINEER**. Press **↓**.
3. The display calls for password. Enter the default password **012345** press **↓**. Display shows **MAIN MENU ENGINEER**. Use the cursor to highlight option **1 CONFIGURE SYSTEM**. Press **↓**.

2.3.2 Setting Engine Details

1. Select **ENGINEER MAIN MENU**, followed by **CONFIGURATION SYSTEM** and **ENGINE/DETECTOR**.
2. In **ENGINE/DETECTOR CONFIGURATION** enter number of engines. Press **↓**.
3. Select each engine in turn using the **▲** and **▼** navigation keys.
4. For each engine enter the number of detectors. Press **↓** after each entry.
5. Press **←** to return to configuration menu.
6. Select **SET ENGINE NAME**. Select engine 1 (2, 3, 4, etc) press **↓**.
7. Enter engine description letter by letter using the **▲/▼** keys to sequence through the alphabet and the **◀/▶** keys to move to the next letter. Press **↓** to store the name. Press **←** to return to engine description page and select **NEXT ENGINE**.
8. Repeat this section to name all configured engines.

Attribute	Default	Range
Number of engines	1	User selectable - 1 to 8
Number of detectors	4	User selectable - 1 to 64
Detectors per engine	4	User selectable - 1 to 14

2.3.5 Clean Air Offset (For systems supplied before 2004 only)

Once the system is configured to the engine installation, the detectors must be set to zero. As the detectors are electro-optical devices it is normal for each of them to exhibit a small offset when first switched on. This is referred to in the configuration menu as **CLEAN AIR OFFSET**.

Note: The detectors must be set to zero prior to engine start with a cold engine and should only be carried out at the initial commissioning stage or when a replacement unit is fitted.

As each detector is set to zero the words 'Saving Configuration Data' will appear on the display for a few seconds, wait for this to disappear before proceeding to the next detector.

To zero the detectors proceed as follows:

1. Select **ENGINEER MAIN MENU** and call up **CONFIGURATION**.

2. Select **DETECTOR OFFSETS**. **CLEAN AIR OFFSET-ZERO DETECTORS** is displayed. Press $\downarrow$.
3. **DETECTOR OFFSET MENU** is displayed.
4. Type in engine number and detector number, press $\downarrow$.
5. Repeat this for each detector on each engine.
6. All detectors will now be set to zero.

2.3.6 Setting Alarm Levels

The system is supplied with default alarm settings for both average and deviation. These are based on past experience and allow the system to operate initially and gather data from the engines being monitored. To enable the alarm settings to be matched to the individual engines, the actual oil mist density readings should be taken from each engine after it has been operating at full load and reached maximum operating temperature. This could take up to 2 hours. Also clear 'Maximum Actual Average' for each engine to ensure all test readings are erased. This can be done in the **Engineer main menu** then **configuration** and then 'CLR Maximum Average'. The above should be carried out for all engines being monitored. This should also be carried out after any smoke testing

Alarm Type	Default Settings	Range
Deviation	0.3 mg/lit	0.05 to 0.5 mg/lit
Average	0.7 mg/lit	0.3 to 1.3 mg/lit

Average Alarm

1. Enter **MAIN MENU** and select **ENGINEER/SYSTEM STATUS**. Select **ENGINE 1 (2, 3, 4, etc)**. **SYSTEM STATUS ENGINE 1 (2, 3, 4, etc)** shows.
2. Read maximum actual average value (**retain this value for deviation alarm setting**).
3. Reset average alarm level to a maximum of twice the max actual average, as follows:
Return to **CONFIGURATION MENU**, select **3, ALARM LEVELS**, Select **SET AVERAGE ALARM**. Select engine number, press $\downarrow$. Enter new alarm level, as calculated from above.
4. Repeat steps 1 to 3 for all engines.

Deviation Alarm

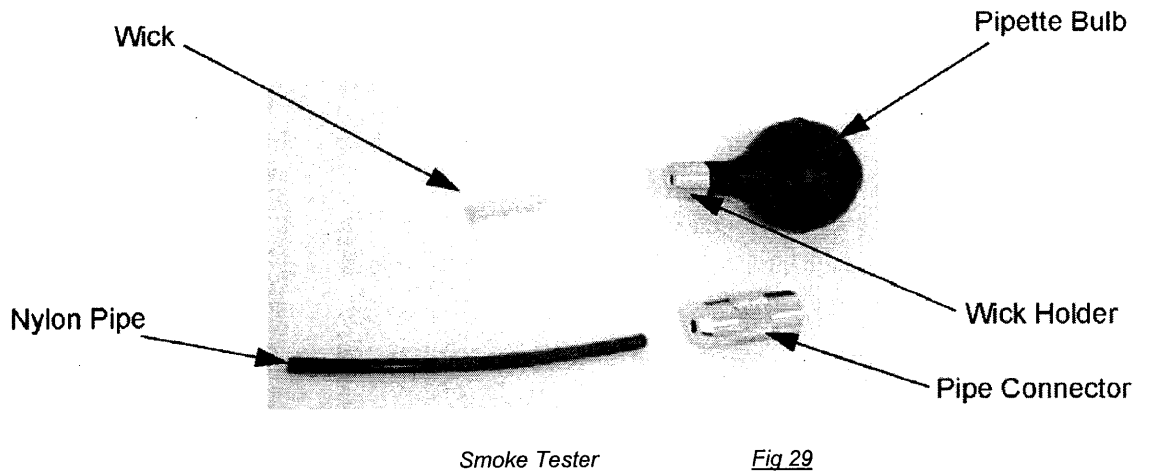
Have the max actual average for each engine to hand as used in setting the average alarm (from step (2) in 2.3.6 above).

1. Enter **MAIN MENU** and select **ENGINEER MAIN MENU**. Enter password, Press $\downarrow$.
2. Select **SYSTEM STATUS** followed by **DETECTOR**, Select **DETECTOR STATUS**, Select engine 1 then select detector 1 (2, 3, 4, etc.) in turn and read the maximum peak level on each detector. Subtract the maximum average level from each of the detector peak levels and multiply each result x 2. This becomes the deviation value entered into the panel. Deviation value = 2 x (Detector maximum peak level minus engine maximum average level).
If the deviation value calculated is less than 0.05, enter 0.05.
If the deviation value calculated is greater than 0.5, enter 0.5

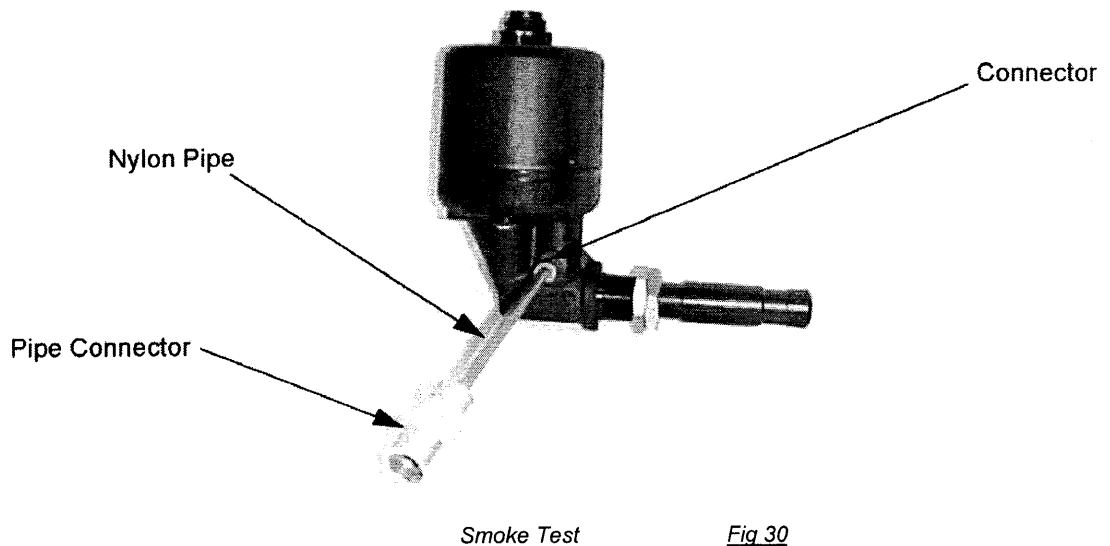
3. Repeat for each engine by using ← key to return to **DETECTOR STATUS** menu.
4. Use ← key to return to **CONFIGURATION MENU**. Select **ALARM LEVELS**.
5. Select **DEVIATION ALARM**. Select engine 1, (2, 3, 4, etc). Enter new deviation alarm level for each detector for engine 1. (2, 3, 4, etc)
- 6 It may become necessary over a period of time that due to changes in the engine's characteristics, the alarm levels need to be readjusted.

Detector Smoke Alarm Test

1. With the detector fitted, electrically connected, functioning and configured as described in the instruction manual, commence the smoke alarm test as follows:
 - a. Cut a length of wick approximately 30 mm long. Assemble the smoke tester by pushing the wick into the wick holder fitted with the pipette bulb. Press the nylon pipe into the body (refer to Figure 29).



- b. Push the nylon pipe of the smoke tester into the connector on the side of the detector base body (refer to Figure 30)



- c. Dip the Wick into the bottle of Smoke Oil and reseal the bottle firmly

Note: Only a small quantity of oil is required.

- d. Ignite the wick of the smoke tester and blow out the flame. Squeeze the pipette bulb to keep the wick smoking.
Note: Care to be taken with this activity at all times
- e. While the wick is still smouldering, insert it into the pipe connector and squeeze the pipette bulb.
- f. Observe the light is still smouldering, insert it into the pipe connector and squeeze the pipette bulb.
- g. After tests are completed the Maximum Actual Average readings should be erased. This can be done in the Engineer Main Menu then configuration and then CLR. Maximum Average.
- h. To release the pipe from the pipe connector, press in the blue plastic collar on the end of the connector at the same time as pulling the pipe out.
- i. Remove the nylon pipe from the pipe connector for stowage purposes.
- j. The wick is reusable and can be left in the wick holder. Fully extinguish the wick after use at all times.
- k. Refer to the Material Safety Data Sheet in the event of health or safety issues.

Back Up Alarm

The back up alarm is hard wired link from each detector installed on the system, this facility will allow any detector which is in a fault condition and sees an oil mist level of 1.6mg/l or greater produce a 'Backup Alarm'. This will produce operation of both the shutdown and main alarm relays, the back up alarm will also override any detector or detectors that are isolated.

Whilst any detectors are in a back up alarm condition the keypad keys are inoperative until the oil mist level drops below 1.6mg/l.

It is possible for a healthy detector to produce a back up alarm if the level of oil rises very rapidly

2.3.7 System Access Password

Access to the system is at three levels:

User

Engineer

Service

The User access level allows for READ only. No adjustments are possible but all data and settings can be read.

The Engineer access level is password protected and allows the system to be configured and read. It also allows the alarm settings to be adjusted. The system is supplied with a default password, but it can be altered to suit individual operators. The default password will always remain active for emergency.

The engineer access level, when selected, a prompt for a password will appear.

Enter 0,1,2,3,4,5, then press ↵

To change the password proceed as follows:

1. Press **MAIN MENU** and then select **ENGINEER**. Enter default password, select **1, CONFIGURE SYSTEM**.
2. In configuration menu select **5, SET PASSWORD**.
3. In set **PASSWORD MENU**, select **SET ENGINEER PASSWORD**.
4. Enter new password, (min 2 digits, max 6 digits) press **↵**, enter new password again to confirm and press **↵** key.

The new password is now active.

The Service access level is also password protected and access is for authorised service agents of Kidde Fire Protection only.

2.4 SYSTEM OPERATION

2.4.1 Action on Alarm

On receipt of either a Deviation or Average alarm the engine should, unless connected to a shutdown relay, be stopped if safe to do so and allowed to cool down so that the background oil mist levels reduce before entering the engine room. Investigations can then be carried out to find the cause of the alarm and rectify. Once the fault in the engine has been rectified the OMD system can be re-set and the display returns to the normal mode.

When a system fault alarm is received, the information on the display should be noted and then the appropriate fault finding procedure in Chapter 4 of the manual should be consulted to enable the fault to be rectified.

Note: When the engine is started from cold in Arctic conditions, a water mist can be produced that could give a false alarm.

Alarm and fault messages have an associated priority. These are detailed below:

Message	Priority
Alarm	Highest
Comms. fault	2nd highest
Sensor fault	3rd highest
System fault	4th highest

All events are stored in the alarm/fault queue in order of occurrence. The user can scroll through the queue by use of the arrow keys.

Once an event is active the event is displayed on the LCD in the appropriate format. To clear the display press the **ACCEPT** key. Once the **ACCEPT** key is pressed, the display shows the **ENGINE AVERAGES** display.

When an alarm condition exists, the following warning message is displayed regardless of other information on the display (ie alarm events have the highest priority): **DEVIATION ALARM**.

2.4.2 System Status

2.4.2.1 Engine Status

This menu will show the average alarm level as set in the engineer configuration menu, the maximum average level that has been reached, if the engine slow down relays and engine are isolated, if the engine system has any general faults and finally the number of detectors configured for this engine.

2.4.2.2 Detector Status

This menu permits the following information for each detector to be read. Detector status including peak level of oil mist in mg/lt.

The Deviation Alarm level

If the detector is isolated

If the detector has a Communication Fault, Fan Fault, LED Fault watch dog or address Fault. Plus the zero offset values per detector.

2.4.3 Isolation

If required it is possible to isolate any individual detector, a complete engine or the engine slow down relays. This allows maintenance to be carried out without effecting the remaining system. Isolation inhibits all alarms and faults for the isolated item except the Back up Alarm, which is a fixed level.

Engine Isolation

To isolate all of the detectors on one particular engine, access the **MAIN MENU** and select **ENGINEER**. Enter either the default password or own unique password if this option has been used.

1. When in the engineer menu, press key number 3 to highlight **ISOLATE** and then press the **↵** key.
2. Once in the isolate menu, select **1 ENGINE**, press the **↵** key and the display will show the number of engines configured with the word **DE-ISOLATED** beside each one.
3. Using the **▲** and **▼** keys, highlight the engine required and press the **↵** key.
4. The display will show the engine selected with the words **DE-ISOLATION - ISOLATE** beside it.
5. Press the **▶** key to highlight **ISOLATE** and press the **↵** key.
6. The display reverts to showing the number of engines configured, but the selected engine will have the word **ISOLATED** flashing beside it instead of **DE-ISOLATED**.
7. The three lights marked **ISOLATE**, **DETECTOR ISOLATE** and **ENGINE ISOLATE** all come on.

To de-isolate, repeat the above until you reach the display that shows **DE-ISOLATION - ISOLATE** (step (4)) beside the selected engine and as **DE-ISOLATED** is highlighted press the **↵** key and the detectors on the engine return to normal operation.

To return to the normal menu press the **←** key once and then the **MAIN DISPLAY** key.

Detector Isolation

To isolate a detector, access the engineer menu and then the isolate menu as above.

1. When in the isolate menu press the **▼** key and press the **↵** key.
2. The display will show the number of engines configured.
3. Using the **▲** and **▼** keys highlight the engine on which the detector is to be isolated and press the **↵** key.
4. The display changes to show the number of detectors configured on the selected engine with the word **DE-ISOLATED** beside each detector.

5. Using the ▲ and ▼ keys highlight the detector to be isolated and press the ↵ key.
6. The words beside the detector selected will change to **DE-ISO ISO**.
7. By using the ► key, highlight **ISO** and press the key.
8. The display returns to show all detectors with the word **ISOLATED** flashing by the selected detector. All other detectors still have the word **DE-ISOLATED** beside them.
9. The **ISOLATE** and **DETECTOR ISOLATE** lights will come on.
10. To de-isolate the detector ensure this detector is highlighted and press the ↵ key to return to the display showing **DE-ISO ISO** and, as **DE-ISO** is highlighted, press the ↵ key again and the screen returns to showing all detectors de-isolated and the lights will go off.
11. To return to the normal screen, press the ← key once and press the **MAIN DISPLAY** key.

Slow Down Relay Isolation

To isolate a slow down relay, access the engineer menu and the isolate menu as above.

1. In the isolate menu select **3 RELAY** and press the ↵ key.
2. The display shows the number of engines configured with the word **DE-ISOLATED** beside each one.
3. Highlight the engine of which the relay is to be isolated by use of the ▲ and ▼ keys and press the ↵ key.
4. The display shows **DE-ISOLATION ISOLATE** beside the engine selected.
5. Press the ► key to highlight **ISOLATE**.
6. Press the ↵ key and the display will show **ENGINE 1 (2 - 8)** with the word **ISOLATED** flashing beside it.
7. The **SHUTDOWN ISOLATE** light and the **ENGINE ISOLATE** lights come on.
8. To return the relay to normal operation, press the ↵ key whilst the display is showing the engine number and the word **ISOLATED** is flashing.
9. The display shows **ENGINE 1 (2 - 8) DE-ISOLATION ISOLATE**. Press ↵. The display shows **ENGINE 1 (2 - 8) DE-ISOLATED** and the two lights will go out.
10. Press the **MAIN DISPLAY** key to return to the NORMAL display.

2.5 TEST MENU

Press the TEST key pad on the control unit. The TEST MENU appears, with this menu selected eight more menu options appear on screen as follows: (the eighth option is only available through the engineer menu.)

- | | |
|------------------|---|
| 1. Alarm Relay | Checks the correct operation of the main alarm relay. |
| 2. Fault Relay | Checks the correct operation of the fault relay. |
| 3. System Test | Checks the correct operation of the system software. |
| 4. LED/LCD | Test Checks all of the lights and all segments of the LCD on the control unit and also the internal sounder. |
| 5. Back-up Alarm | Checks the Back-up alarm connection from each detector by switching the internal sounder on & off once for each detector. |
| 6. Optics | Checks the output from the detector light array to ensure it is within limits. |

7. Detector Alarm Simulates a deviation alarm without operating the slowdown relay.
8. Slowdown Relay Checks the correct operation of the slowdown relay. (Only available in password protected screen).

Warning: Carrying out this test with the engine operating will cause the engine shut/slow down system to operate if fitted.

2.5.1 Alarm Relay

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press **↵** key.
3. Display changes to:

ALARM RELAY TEST
TEST ALARM RELAY
DISABLE ENABLE

Note: **DISABLE** will be highlighted.

4. Press **▶** key to highlight **ENABLE**.
5. Press **↵** key and observe:
 - a. The display returns to the test menu.
 - b. The **TEST** light on the control unit comes on.
 - c. The main alarm relay operates. This is confirmed by any audible and visual alarms operating that are connected to this relay.

To cancel the alarm:

1. Ensure **ALARM RELAY** in the test menu is highlighted.
2. Press **↵** key.
3. Display changes to that shown in para 2.5.1 step (3) above with **DISABLE** highlighted.
4. Press **↵** key again and the alarm will reset and the display will return to the test menu.
5. When testing of the main alarm is complete either; Press the **MAIN DISPLAY** key on the control unit to return to the normal display, or select another test option.

2.5.2 Fault Relay

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 2 or the **▼** key to highlight No. 2 **FAULT RELAY**.
3. Press the **↵** key.
4. The display changes to:

FAULT RELAY TEST
TEST FAULT RELAY ?
DISABLE ENABLE

Note: **DISABLE** will be highlighted.

5. Press the ► key to highlight **ENABLE**.
6. Press ↵ and observe:
 - a. The display returns to the Test Menu.
 - b. The **TEST** light on the control unit comes on.
 - c. Fault relay changes state. This is confirmed by any audible and visual alarms operating that are connected to this relay.
 - d. To cancel the alarm repeat para 2.5.2 steps 2 & 3 above and then press the key again.
 - e. When testing of the fault relay is complete, either; Press the **MAIN DISPLAY** key to return to the normal display or select another test option.

2.5.3 System Test

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 3 or the ▼ key twice to highlight No. 3 **SYSTEM TEST**.
3. Press ↵ and observe:
4. The words **MAIN PROCESSOR POWER ON** appear for 2-3 seconds and then the display returns to the test menu.
5. This test is now complete. The operator can now either: Press the **MAIN DISPLAY** key to return to the normal display or select another test option.

2.5.4 LED/LCD Test

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 4 or the ▼ key 3 times to highlight No 4 **LED/LCD TEST**.
3. Press ↵ and observe:
 - a. All of the lights on the control unit come on.
 - b. Horizontal bars scroll down the display.
 - c. The following appears on the display after the bars scroll down

LCD AND LED TEST

OIL MIST DETECTOR MK6

VERSION: P57100-10*

(*Will depend on the software version fitted)

- d. The internal sounder operates for approximately 5 seconds.
 - e. All lights except for the green **POWER ON** light go out.
 - f. The display returns to the test menu.
4. This test is now complete. The operator can now either: Press the **MAIN DISPLAY** key to return to the normal display, or select another test option.

2.5.5 Backup Alarm

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 5 or the ▼ key four times to highlight No. 5 **BACK-UP ALARM**.

3. Press **↵** and check that the internal sounder operates the same number of times as there are detectors fitted to the system and the display shows **BACK-UP ALARM ACTIVE**.

Note: If the system has 6 detectors fitted then the internal sounder operates 6 times.

4. When the test is complete the display will return to the test menu.
5. This test is now complete. The operator can now either: Press the **MAIN DISPLAY** key and return to the normal display or select another test option.

2.5.6 Optics

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 6 or the **▼** key five times to highlight No. 6 **OPTICS**.
3. Press **↵** and the display changes to:

DETECTOR OPTICS TEST

ENABLE OR DISABLE ?

DISABLE

ENABLE

4. Press the **►** key to highlight **ENABLE**.
5. Press **↵** and observe:
 - a. The words **OPTIC TEST ENABLED** appear on the display underneath what is shown in step (3) above.
 - b. The internal sounder operates once to indicate that the test is complete and the display reverts back to the test menu.
6. This test is now complete. The operator can now either: Press the **MAIN DISPLAY** key and return to the normal display or select another test option.

2.5.7 Detector Alarm

1. Press the **TEST** key pad on the control unit. The **TEST MENU** is displayed, defaulting to No.1 **ALARM RELAY**.
2. Press key pad No. 7 or the **▼** key 6 times to highlight No. 7 **DETECTOR ALARM**.
3. Press **↵** and the display changes to:

DETECTOR ALARM TEST

ENGINE 1

ENGINE 2

Note: The number of engines shown is dependant on how many are configured up to a maximum of 8. However, **ENGINE 1** is highlighted as the default setting.

4. Press **↵** again and the display changes to:

DETECTOR ALARM TEST

ENGINE 1 DET. 1 TEST OFF

ENGINE 1 DET. 2 TEST OFF

Note: The number of detectors shown will depend on how many are configured up to a maximum of 14 per engine. However, **ENGINE 1 DET. 1** is highlighted as the default setting.

5. Press **↵** again and check the following:

- a. The internal sounder comes on immediately.
6. The display briefly shows the number of engines configured as in step (3) above.
7. The red **ALARM** and yellow **TEST** lights come on as does the **ENGINE ALARM** and **FAULT** lights. Both the red lights are flashing. The main alarm relay goes into an alarm condition.
8. The display shows:

DEVIATION ALARM

ENGINE NO	DET
TIME	DATE

9. Press the **ACCEPT** keypad and observe:
 - a. The display changes to the toggling graphics mode.
 - b. The red **ALARM** lights both change to a steady state.
 - c. The main alarm relay resets.
11. Press the **RESET** key and check:
12. The display returns to normal.
13. All lights except the **POWER ON** go out.

Repeat the complete test for each detector that is to be tested. Select the detector to be tested by use of the ▲, ▼, ◀, and ▶ keypads.

2.5.8 Slowdown Relay

Warning: Carrying out this test while the engine is running **WILL** cause it to stop or slow down.

1. Press the Main Menu key on the control unit and select **ENGINEER** by using the ▼ down key or the number 2 key.
2. Press the ↵ enter key and enter the password when prompted, when entered press the ↵ enter key again.
3. The display will show 7 menu headings defaulted to No. 1 Configure System. Press the No.4 key or the ▼ down key 3 times to highlight No.4 **TEST**.
4. Press the ↵ enter key and 8 test menus will show on the display defaulted to No.1 Alarm Relay. Press the No.8 key or the ▼ down key 7 times to highlight **SLOWDOWN RELAY**.
5. Press the ↵ enter key and the display shows the following defaulting to Engine 1 which will be highlighted:

RELAY TEST MENU

ENGINE 1	TEST OFF
-----------------	-----------------

Note: The number of engines shown is dependent on how many are configured up to a maximum of 8. However, **ENGINE 1** is highlighted as the default setting.

6. Press the ↵ enter key and the display shows the following, **DE-ACTIVATE** will be highlighted:

RELAY TEST MENU

ENGINE 1	DE-ACTIVATE	ACTIVATE
-----------------	--------------------	-----------------

7. Press the ▶ right key to highlight Activate and the press ↵ enter key, the display will show the following with the words **TEST ON** flashing.

RELAY TEST MENU

ENGINE 1 TEST ON

The slow down relay changes state and all alarms connected to the relay operate, also the test light on the control unit comes on.

8. To cancel the alarm press the  enter key and the display will be as step (6) above with **DE-ACTIVATE** highlighted.
9. Press the  enter key again and the display will be as step (5) above and the test light on the control unit will go out.
10. Press the  quit key to return to the test menus or the Main Display and **RESET** to return to the normal display.

2.6 EVENT LOG

The Event Log enables the user to interrogate the past 256 events and can be accessed via the user menu separately.

1. To access the event log press the **MAIN MENU** and when the choice of access levels appears on the screen, **USER** will be highlighted. Press the  key and press 3 **EVENT LOG** and press the  key. The display will show the last event that has occurred. With  and , scroll through the complete event log until the required entry is found.

To speed up the search for the required event it is also possible to do so by event type eg. deviation alarm or, if the approximate date of the event is known, a search from time and date is also available in the Event log sub-menu.

2. To return to the normal display press  key once and then the **MAIN DISPLAY** key.

The event log may also be downloaded onto a computer using the serial link connector on the main processor PCB.

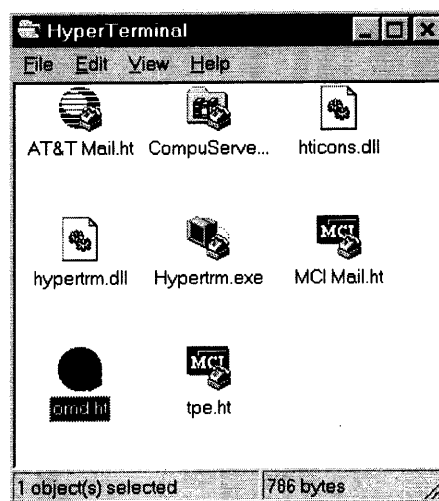
Plug serial lead into Com1 on PC and plug in to round serial connector on panel

Hyperterminal Setup

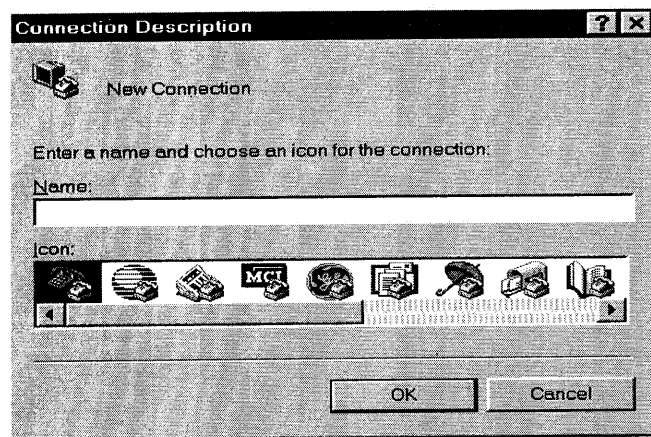
From the Windows start button choose:-

Start -> Programms -> Accessories -> Hyperterminal

This should bring up the following box or something similar depending on windows version, this one is Windows 95



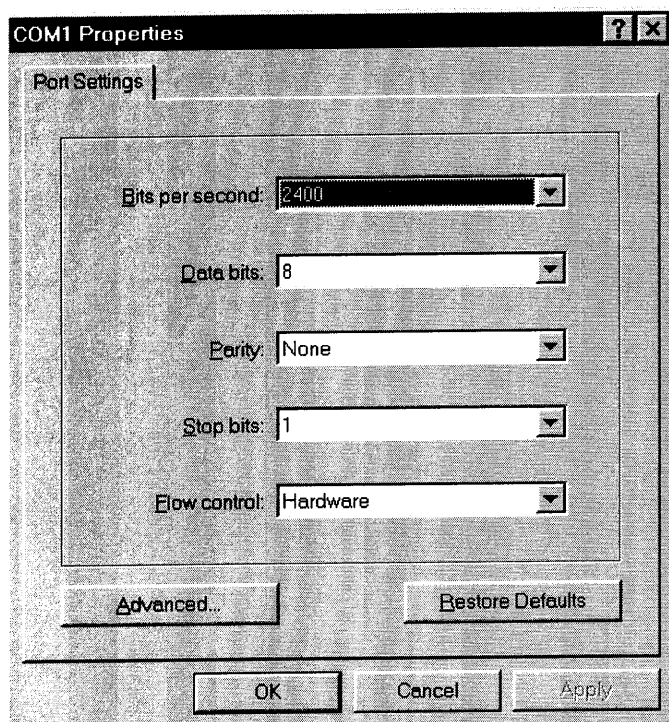
Then double click on Hypertrm.exe this should start the hyperterminal program and give the following screen



Type in a name, eg omd6, and choose one of the icons then click ok

In the next option screen select direct to Com 1 and click ok (note if com 1 is being used for another application Com 2 can be selected if the pc has 2 comms ports)

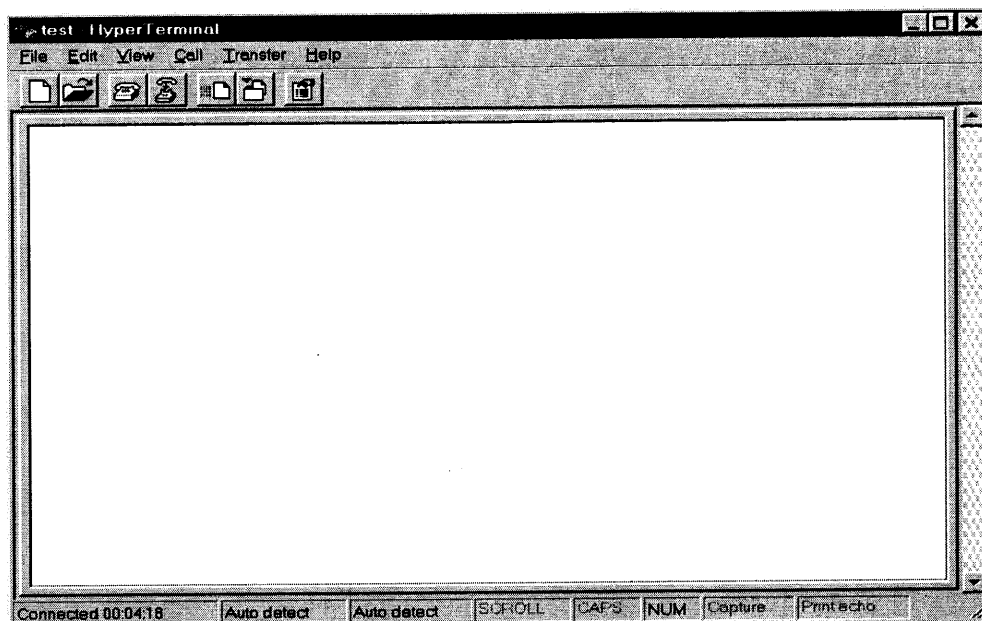
This should bring up the following settings screen



In bits per second select - 9600
Data bits - 8
Parity - None
Stop bits - 1
Flow control - None

Then click OK, this connects hyperterminal to com 1 and will take you back to the main screen

Main Screen which should say connected in the bottom left hand corner



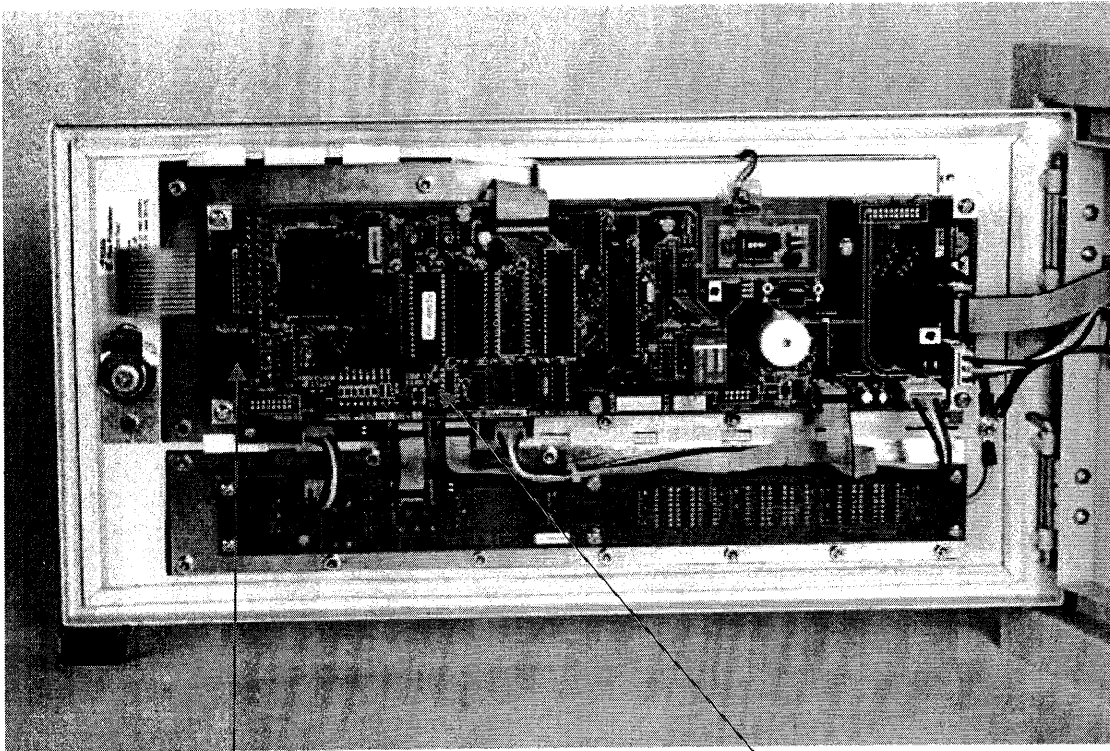
From the top level menu select Transfer -> Capture text and in the file box Type where you want the file to be saved and what name e.g. C:\omd.txt. then click on the start button

At the panel, go through the menu structure and choose Download Event Log, then hit enter. You should now see the event log downloading into the white panel of the above screen.

When the event log has finished downloading select Transfer -> capture text -> stop

Then using Word/WordPad/NotePad you can examine the event log by loading up c:\omd.txt.

If you want to do another event log download in the future. When you do, launch hyperterminal from the start bar as normal and in the first screen there should be a new icon called omd6.ht (if that is what you called it). Simply double click on this icon and hyperterminal will be launched with all the correct settings and the connection to Com port 1 already established. After that the only thing that needs setting up is the transfer capture to save the event log.



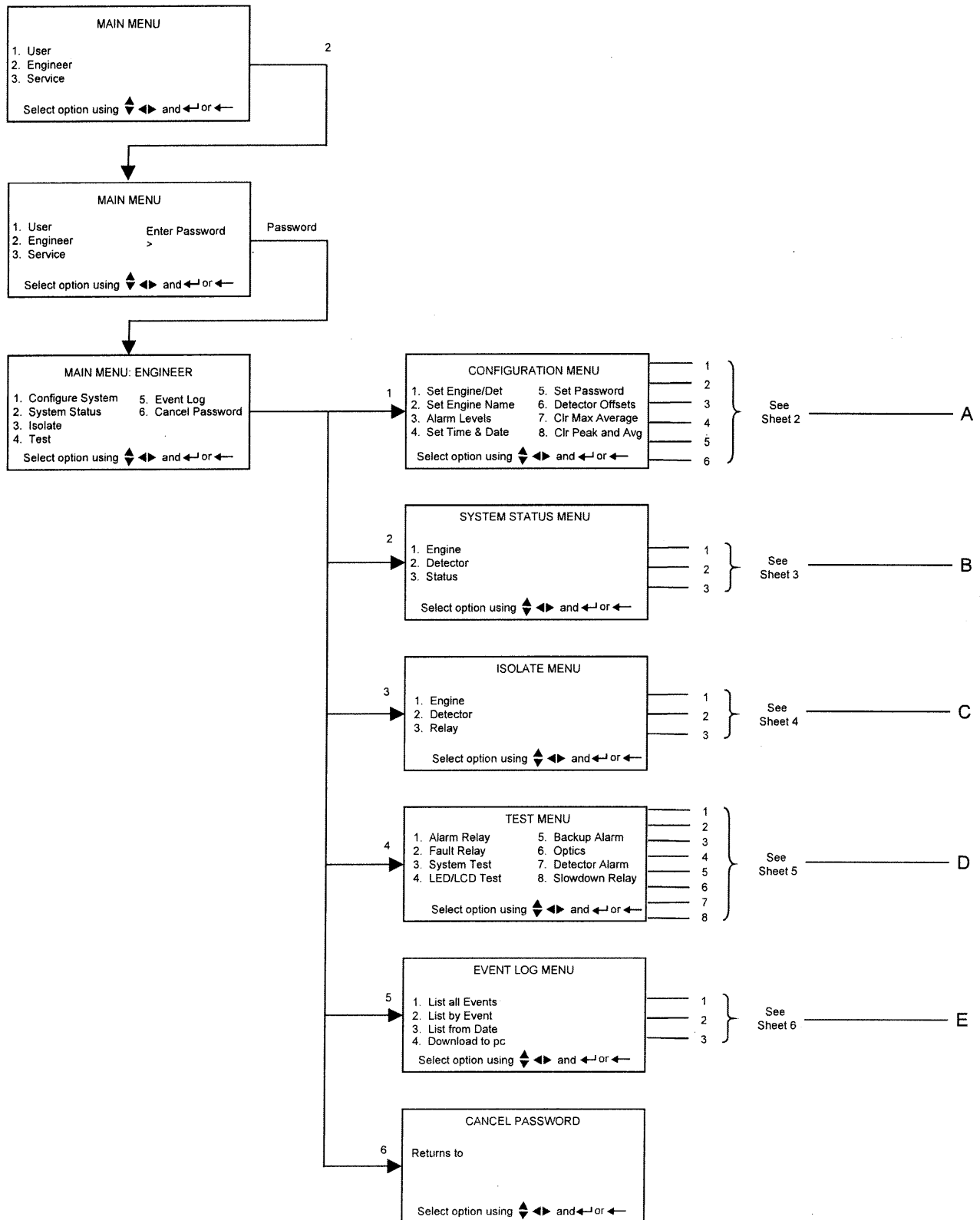
Event Log Serial Link Connector

Main Processor PCB

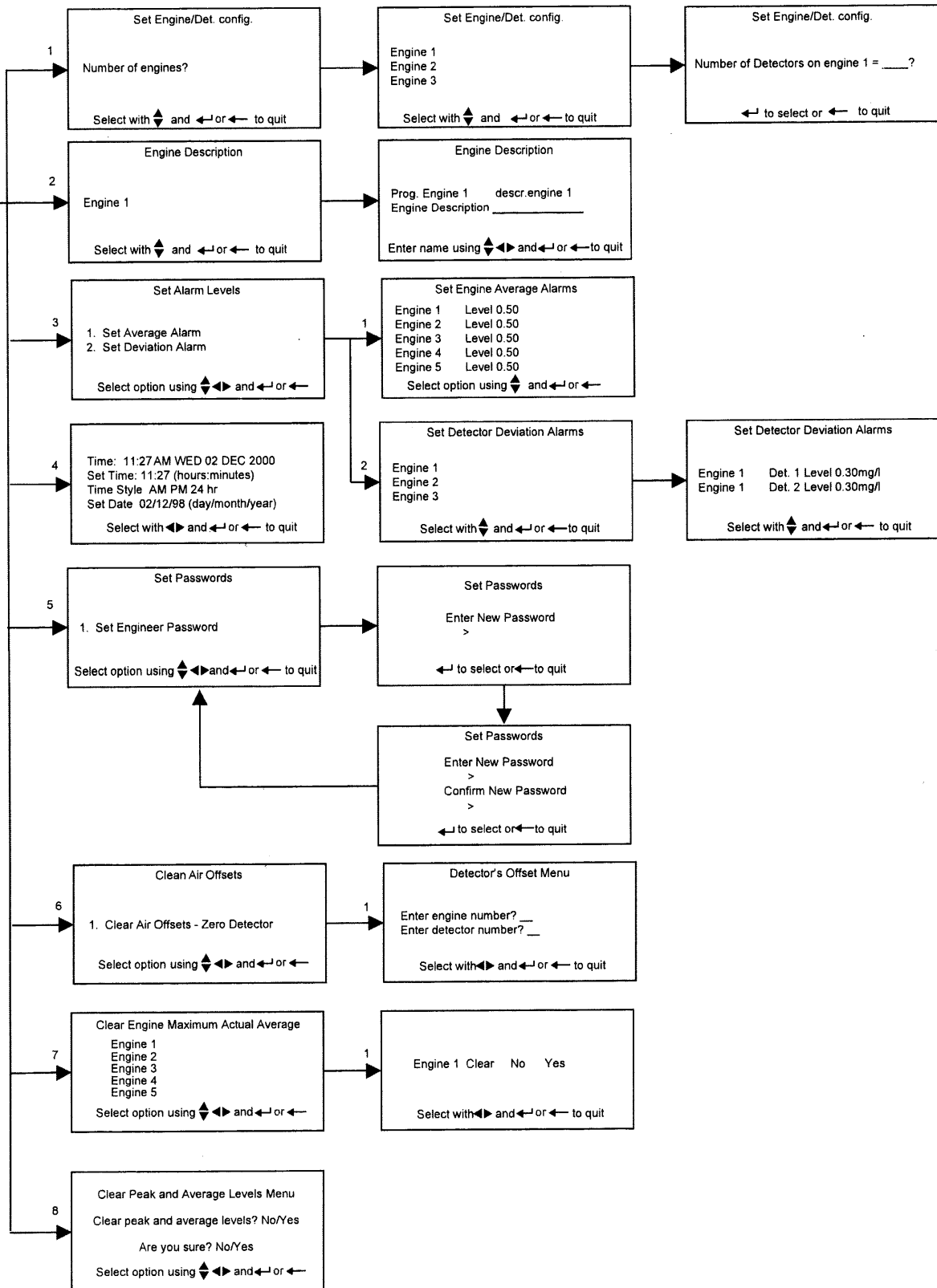
Fig 31

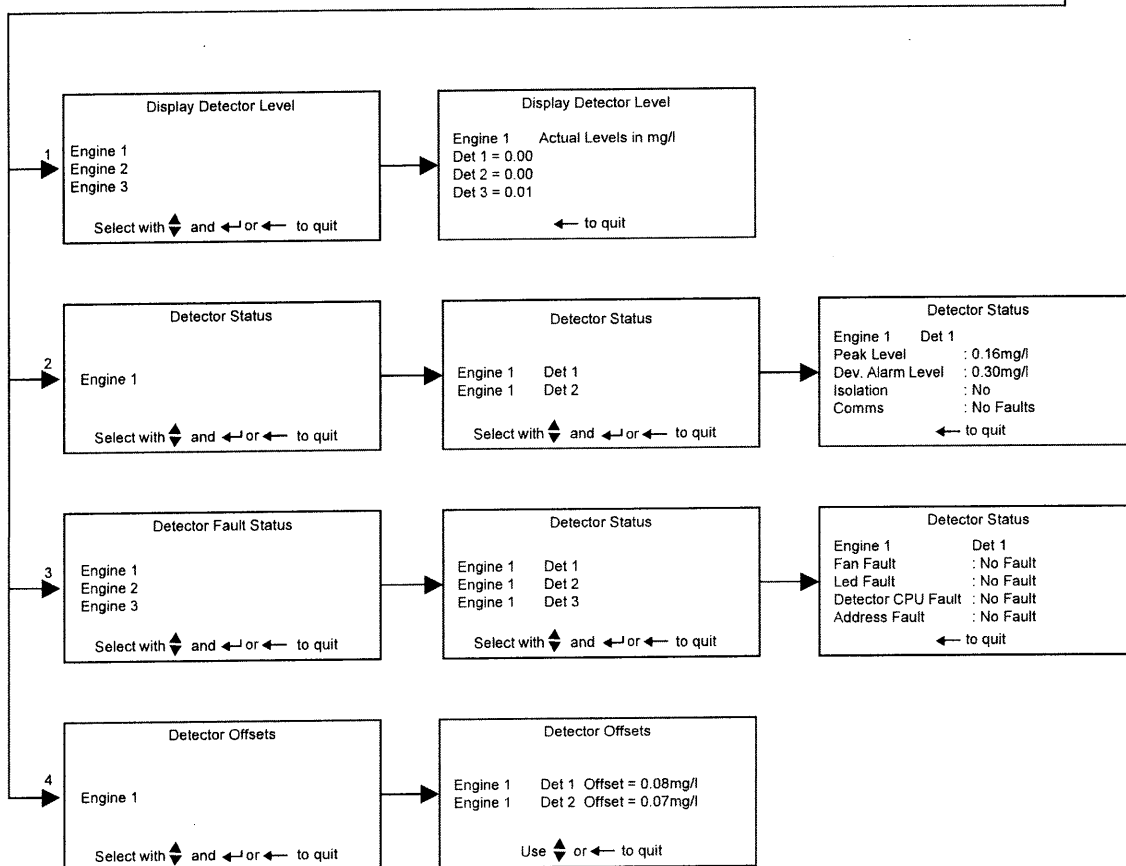
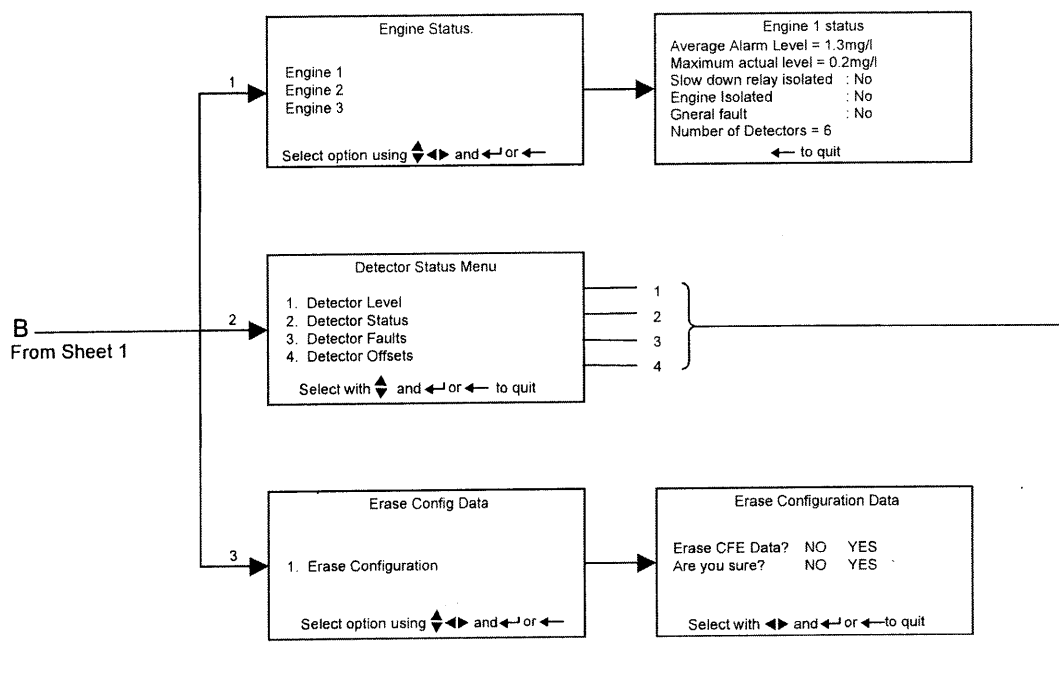
ENGINEER & USER MENU FLOWCHARTS

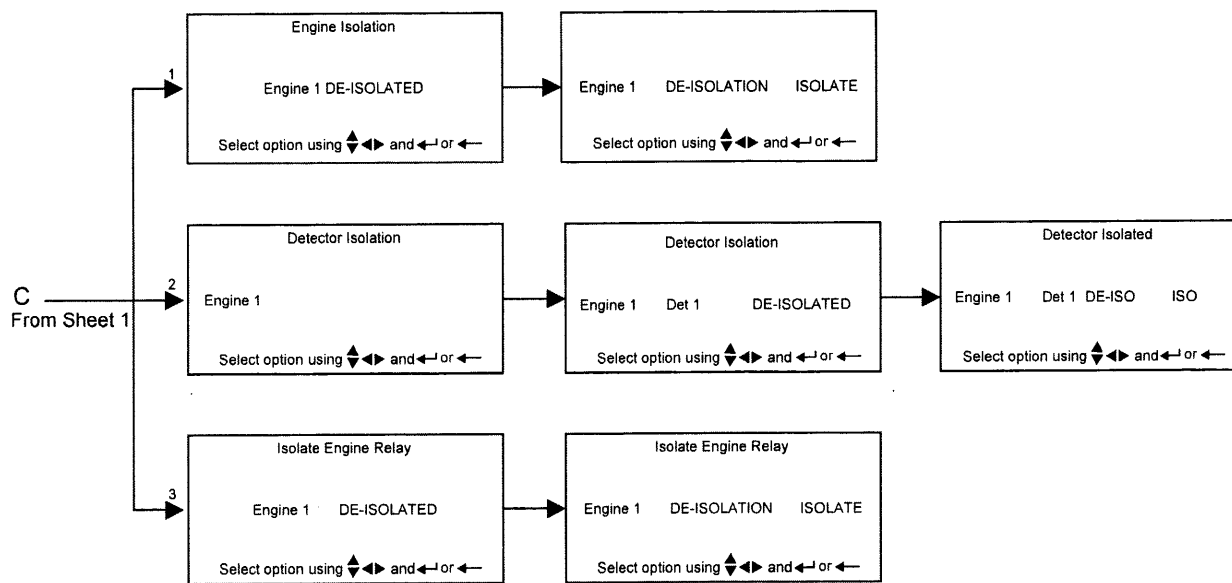
ENGINEER MENU



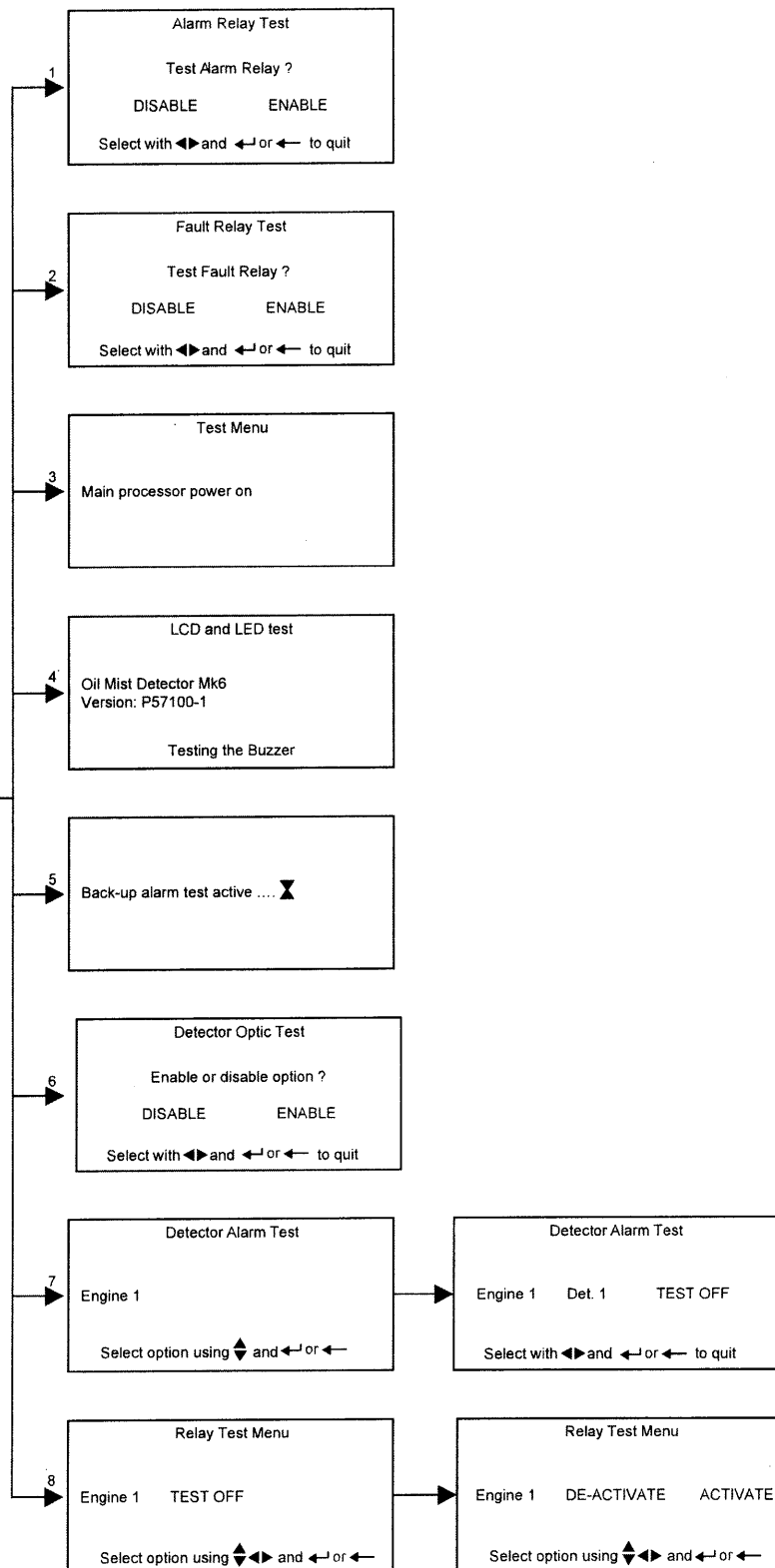
A
From Sheet 1

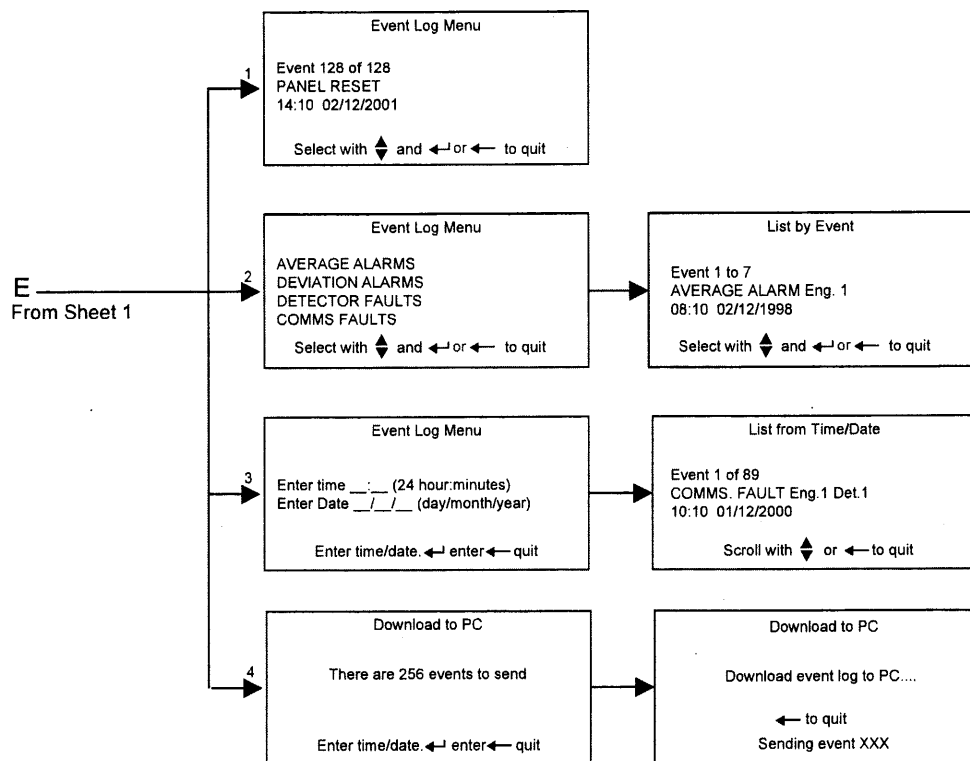




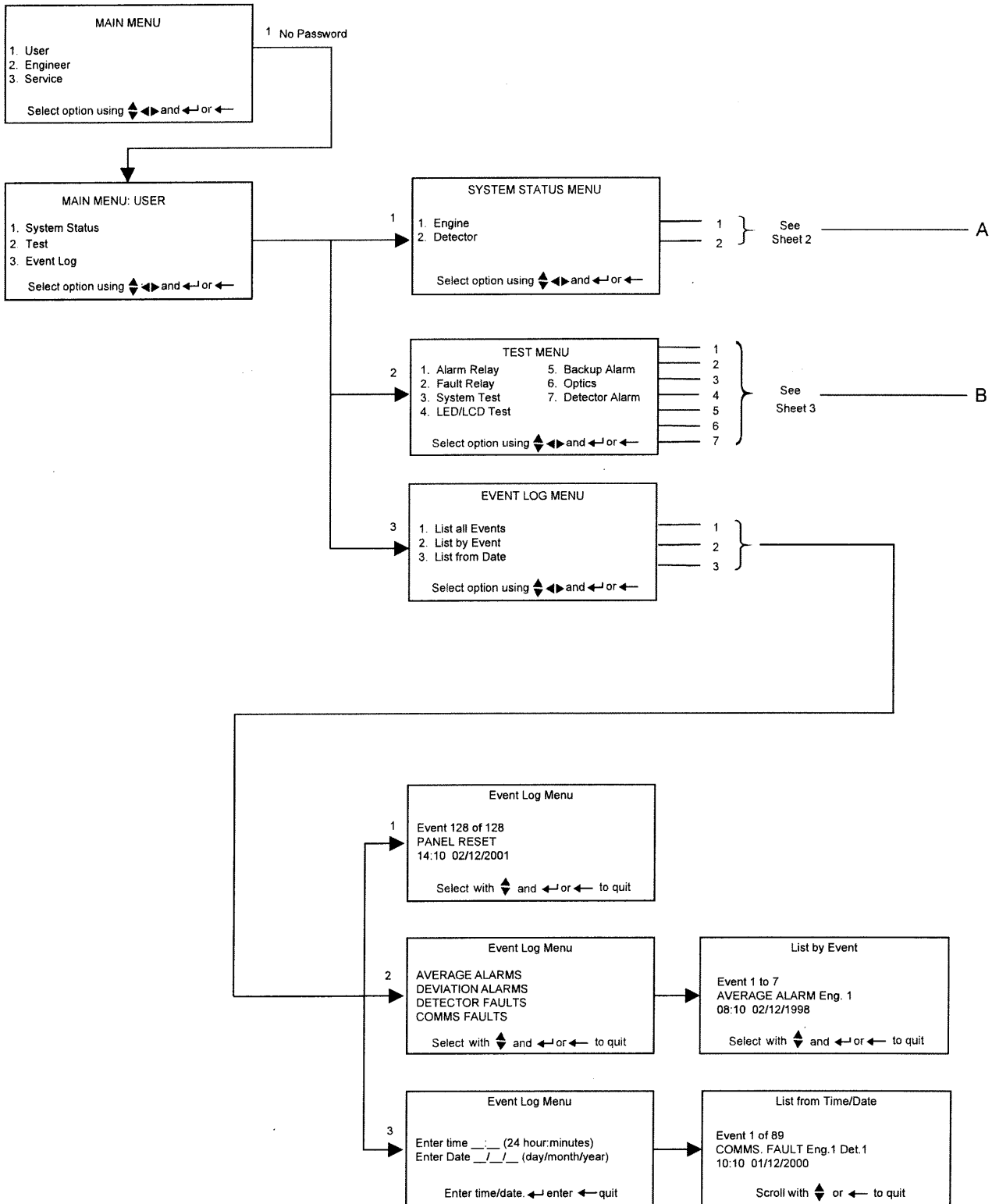


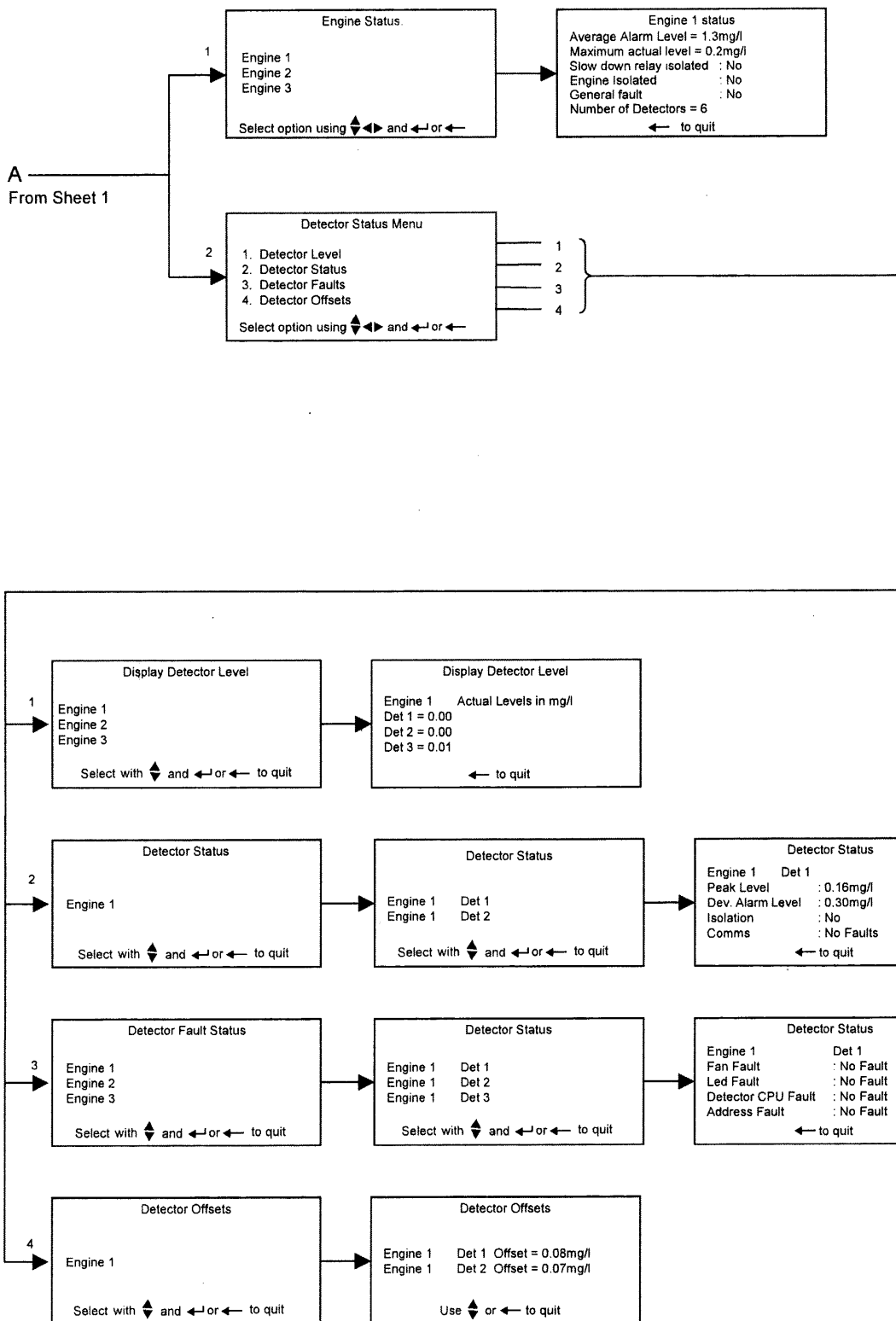
D
From Sheet 1



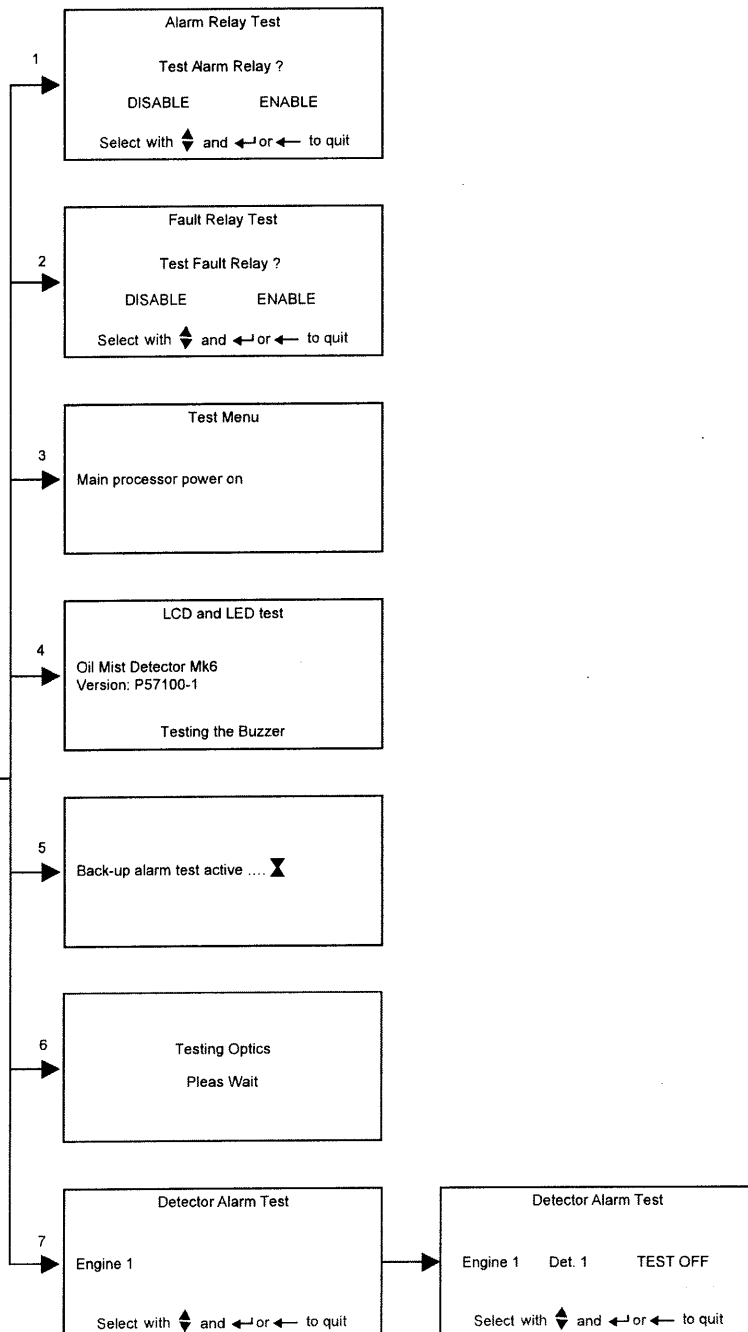


USER MENU





B
From Sheet 1



CHAPTER 3

MAINTENANCE

3.1 ROUTINE MAINTENANCE

Warning: Do not work on the system unless the power is switched off or isolated.

Caution: Ensure that anti-static handling procedures are observed where appropriate.



ATTENTION
OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

The following checks are recommended to be carried out every 6 months, with the system switched off. The checks should be carried out by competent personnel with suitable skill levels.

3.1.1 Control Unit

1. Ensure that all glands are tight and undamaged to prevent ingress of oil and moisture.
2. Check the sealing strip between the door and box is not damaged preventing a seal being made.

3.1.2 Junction Box

1. Ensure that all glands are tight to prevent ingress of oil and moisture.
2. Ensure that the lid fixing screws are tight, to prevent ingress of oil and water.

3.1.3 Cables

1. Ensure all connections in both the control unit and junction box(es) are tight.
2. Check all cables. Replace any that are found to be damaged.

3.1.4 Detectors

1. Ensure that the detector base is screwed tight into the crankcase.
2. Remove the cable connector from the detector and check for damage.

3.2 DETECTOR HEAD REPLACEMENT

Warning: Do not remove the detector base from the crankcase whilst the engine is in operation. This operation should be carried out while the engine is stopped to avoid the possibility of hot oil coming out of the base fixing hole.

Note: If an in-service detector head is removed for any reason, the detector optics must be cleaned before reassembling and replacing it.

3.2.1 To replace the detector:

1. Switch off the system (if safe to do so) or isolate the detector.
2. Remove the cable connector fitted to the top of the detector.
3. Using a 4mm hexagonal key, loosen the two fixing screws in the assembly base.

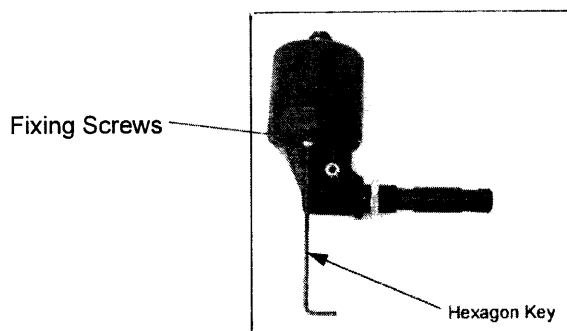
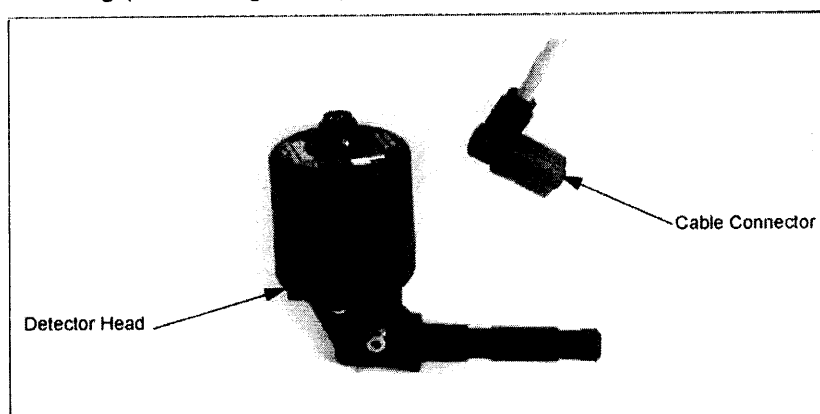


Fig 38

4. Lift out the detector head and note its address.
5. Set the address on the new detector head in accordance with para 2.1.1. The selected address must be the same as that of the detector head that has been removed.
6. Fit the detector head onto its base and tighten up the fixing screws. Affix the new switch window label.
7. Re-fit the cable to the detector head.
8. If the system was switched off, switch back on and allow the system to initialise.
9. If isolated, then de-isolate, return to main display by pressing the MAIN DISPLAY keypad and press RESET. Allow the system to initialise.

3.3 DETECTOR HEAD CLEANING

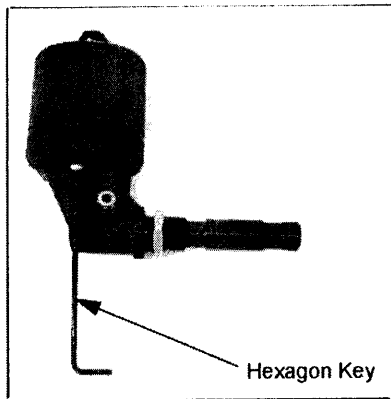
1. Isolate the detector as described in paragraph 2.4.3 of the instruction manual. If all detectors on one engine are to be serviced, then isolate the engine as described in paragraph 2.4.3 of the instruction manual.
2. Disconnect the cable from the top of the detector unit and remove the unit from the engine casing (refer to Figure 39).



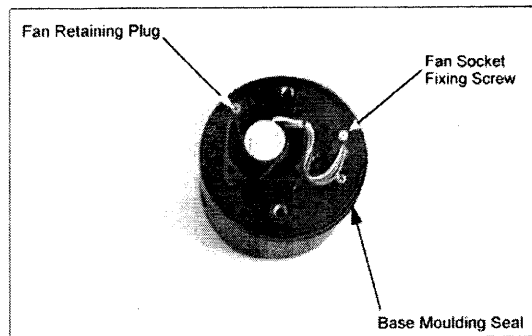
Cable Disconnect

Figure 39

3. Using a 4mm hexagon key, unscrew 2 off screws from the underside of the detector head (refer to Figure 40). The screws are self-retaining.
4. Remove and invert the top part of the detector head. Examine the base moulding seal and replace if damaged or perished (refer to Figure 41).



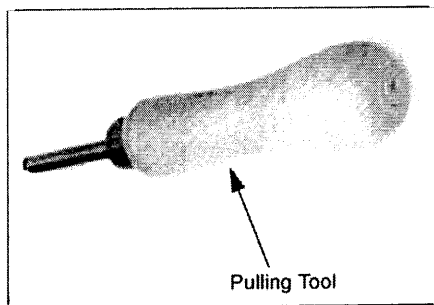
Screw Removal *Figure 40*



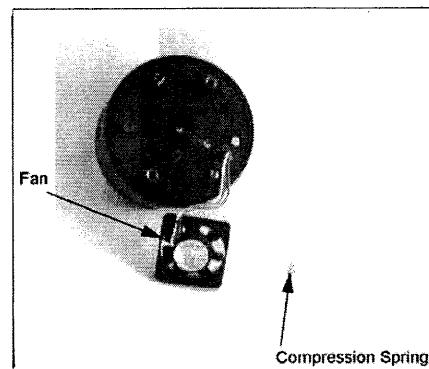
Base Moulding Seal *Figure 41*

Caution: Do not press the impeller, only handle the outer housing.

5. Using the Pulling Too (refer to Figure 42), remove the Fan Retaining Plug by capturing the shoulder and pulling. Carefully remove the Fan from its mountings (refer to Figure 41).

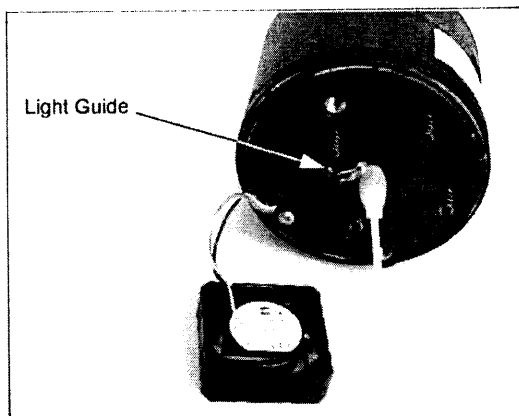


Pulling Tool *Figure 42*



Fan Removal *Figure 43*

6. Examine the 4 off compression springs and the fan retainer plug; replace any bent or damaged items from the spares.
7. Examine the fan for free running and clogging due to oil residues. If damaged, refer to paragraph 3.4 in the instruction manual. Although not necessary for service cleaning, spares of the M3 screw and the fan connector seal are included in the kit.
8. Using a foam bud with glass cleaner applied, wipe carefully around the inside of the smoke detecting orifice and the end of the light guide (refer to Figure 44).



Cleaning Light Guide

Fig 44

9. Use the Air Duster to blow away solution residue and dry the inside of the unit.
10. Examine the base body cavity and sampling tube, and wipe clean where necessary.
11. Reassemble the fan to the detector using a fan retaining plug.
Caution: Do not press the impeller, only handle the outer housing.
11. Reassemble the detector head and base body. Replace the detector and then de-isolate.
12. Repeat the procedure for all detectors to be cleaned.

Refer to the Materials Safety Data Sheet in the event of health or safety issues.

3.4 FAN REPLACEMENT

Warning: Do not remove the detector base from the crankcase whilst the engine is in operation. This operation should be carried out while the engine is stopped to avoid the possibility of hot oil coming out of the base fixing hole.

3.4.1 To replace the fan:

1. Switch off the system (if safe to do so), or isolate the associated detector.
2. Remove the cable connector from the top of the detector.
3. Using a 4mm Allen key, loosen the detector fixing screws on the base.
4. Remove the detector from its base and turn it upside down to reveal the fan.
5. Remove the fixing screw holding the fan socket to the mounting plate.
6. Using a pulling tool (Part Number D9131-002 available with service kit Part No. D9221-027), remove the fan retaining plug holding the fan onto its mounting legs.
7. Lift the fan off of its mounting legs, ensuring the springs under the fan are not lost.

Caution: Ensure a fan of the same make as that removed is fitted. If not, then a fan failure fault will occur. The correct fan can be selected by matching the detector serial number suffix (M or P) to the fan type. I.E. Papst or Micronel.

See spare parts list.

8. Discard the failed fan and fit a replacement fan in reverse order of disassembly.

3.5 CABLE REPLACEMENT

If changing a detector cable, isolating that detector will be sufficient. (see section 2.4.3 as isolation)

3.5.1 Detector Cable

1. Isolate the detector with the damaged cable.
2. Remove the cable connector on top of the detector.
3. Remove the lid from the junction box and identify the cable to be removed.
4. Disconnect the wires in the junction box, undo the cable gland and pull the cable out of the junction box. Discard the damaged cable.
5. Push the new cable through the cable gland, ensuring the gland seal and lock nut have first been put onto the cable. Strip back the outer covering of the cable as required. Make-off ends ready to connect to the terminals in the junction box.
6. Connect the wires to the terminals and make-off the screen in the gland and then tighten to ensure a good seal.
7. Connect the cable connector to the detector.
8. When satisfied that all connections are satisfactory, re-fit the junction box lid.
9. De-isolate the detector, return to the main display and press the RESET switch and allow the system to initialise.

Note: If the cable being replaced is the last in any zone, then the Pink and Brown wires must be left longer to reach the end of line terminals.

3.5.2 Junction Box Power Supply Cable Replacement

1. Switch off the system.
2. Open the door of the control unit and disconnect the damaged power supply cable. Undo the cable gland and remove the cable from the control unit.
3. Remove the lid from the relevant junction box and disconnect the wires and screen from the terminals inside. Undo the cable gland and remove the cable from the junction box.
4. Starting at the junction box, using the correct specification cable, pass it through the gland into the box. Make-off ends and connect the 2 cores and screen as indicated on the label in the junction box lid.
5. At the control unit, pass the cable through the gland and make-off the wire cable ends. Connect the two wires as indicated by the label inside of the box. Make-off the screen inside of the gland and then tighten the gland nut to ensure the gland is sealed.
6. When satisfied that all connections are correct, close and lock the door of the control unit and replace the lid of the junction box.
7. Switch the system on and allow to initialise.

3.5.3 Communications Cable Replacement

1. Switch off the system.
2. Open the door of the control unit and identify the connections of the damaged cable and disconnect from the relative terminals. Undo the cable gland and remove the cable from the control unit.
3. Remove the lid from the relevant junction box and disconnect the wires from the terminals. Undo the gland nut and pull the cable out.

4. Push the correct specification cable through the gland of the junction box. Make-off the ends of the wires and connect to the relevant terminals. Tighten the gland nut.
5. Push the other end of the cable through the cable gland of the control unit. Make-off the ends and connect to the relevant terminals ensuring that the same wire colours have been used for the Comms positive, negative and also for the alarm back up. Make-off the screens inside of the gland and then tighten the gland nut.
6. When satisfied that all connections are satisfactory, close and lock the control unit door and replace the junction box lid.
7. Switch on the system and allow to initialise.

3.6 CONTROL UNIT PCBs

3.6.1 Interface PCB Replacement - Part No. 44782-K085 (refer to Figure 46)

1. Switch off the system and replace the PCB as follows:
2. Remove and identify all external wiring.
3. Remove connectors PLG1 and PLG2 - noting the orientation.
4. Remove 8 off retaining screws and remove the board.
5. Fit the replacement board in place with the 8 off screws.
6. Re-fit connectors PLG1, PLG2 and all external wiring.
7. Switch the system back on and allow to initialise.

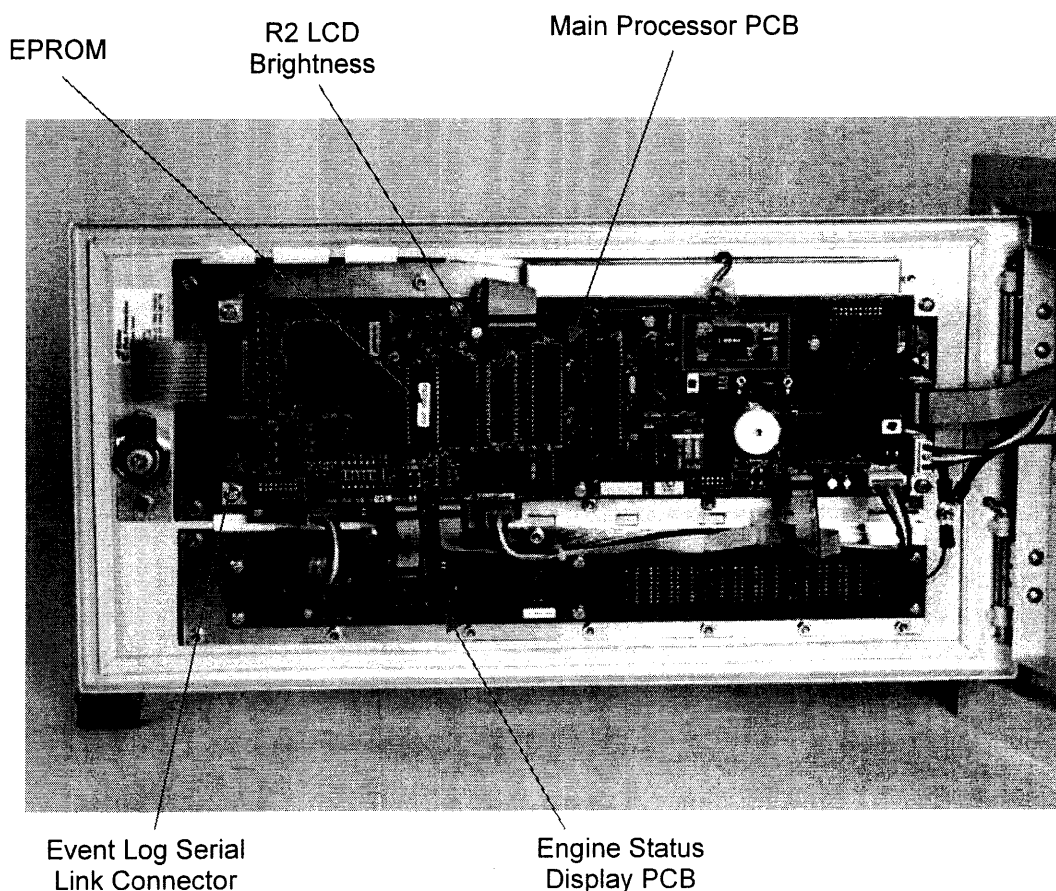
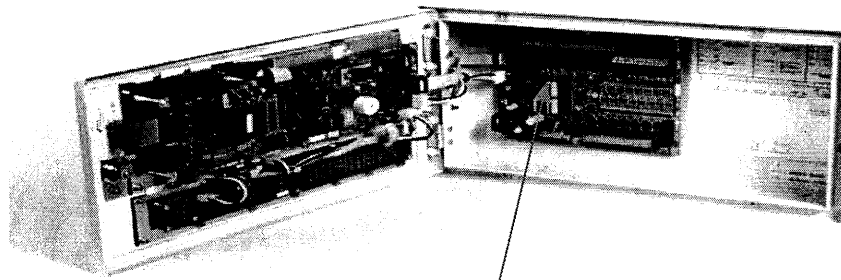


Fig 45



Interface PCB

Fig 46

3.6.2 Main Processor PCB - Part No. 44782-K071-02 (refer to Figure 45)

1. Switch off the system and replace the Main PCB as follows:
2. Remove all connectors, PLG1, PLG2, PLG4, PLG5, PLG8, PLG 9 and PLG10 noting the orientation.
3. Remove 8 off fixing screws. Remove the PCB, Remove EPROM from the failed PCB and fit to the new PCB. Remember to follow anti static precautions.
4. Fit the replacement PCB with the 8 off screws, re-fit all connectors.
5. Switch on system and allow to initialise.

Note: After changing the process PCB, it maybe necessary to adjust gain control R2 to ensure the clarity of the LCD

3.6.3 8 Engine Status Display PCB Replacement - Part No. 44782-K098 (refer to Figure 45)

1. Switch off the system and remove the 8 Engine Status Display PCB as follows:
2. Remove the two connectors located on the top left hand side of the board, noting the orientation.
3. Remove 6 off fixing screws and remove the PCB.
4. Fit the new PCB with the 6 off screws and replace the two connectors.
5. Switch the system on and allow to initialise.

3.6.4 Status Display PCB - Part No. 44782-K102-01 (refer to Figure 50)

1. Switch off the system and remove the Status Display PCB as follows:
2. Remove the Main Control Processor PCB. (Refer to para 3.6.2)
3. Remove the connectors from the Status Display PCB, noting the orientation.
4. Remove the 4 off fixing screws and remove the PCB.
5. Fit the replacement PCB with the 4 off screws and re-fit the connectors.
6. Re-fit the Main control processor PCB.
7. Switch on the system and allow to initialise.

3.6.5 Junction Box PCB Replacement - Part No. 44782-K117 (refer to Figure 51)

1. Switch off the system and remove the Junction Box PCB as follows:
2. Remove the lid from the junction box.
3. Disconnect the detector, power supply and comms cables.

4. Remove the 4 off screws securing the board in the box and remove the board, noting the position of detector 1.
5. Fit the new board ensuring that detector 1 is in the same position on the new board as the removed board and secure with the 4 off screws.
6. Reconnect the detector, power supply and comms cables and replace the lid.
7. Switch the system on and allow to initialise.

3.7 REPLACEMENT OF 8 ENGINE STATUS DISPLAY MEMBRANE

3.7.1 Replace the 8 Engine Status Display Membrane as follows:

1. Remove the 8 Engine Status Display PCB as above. (Refer to para 3.6.3)
2. Remove the seven M4 nuts and washers holding the membrane to the door unit.
3. Remove the membrane.
4. Fit the replacement 8 Engine Status Display membrane in reverse order of disassembly.

3.8 REPLACEMENT OF LCD DISPLAY

3.8.1 Replace the LCD Display as follows:

1. Remove the Main Control Processor PCB as in para 3.6.2.
2. Undo the 4 off M3 screws in the LCD cover.
3. Gently lift up the cover and unplug the LCD connection cable and feed through the slot in the end of the cover.
4. Undo and remove the 2 off studs on the left of the display and loosen the 2 off studs on the right of the display and then slide the LCD assembly out.
5. Refit in the reverse order of disassembly. Ensure the white wires from the LCD display that connect into PLG2 are located correctly in the top of the cover. Ensure the wires are not trapped when the cover is replaced.

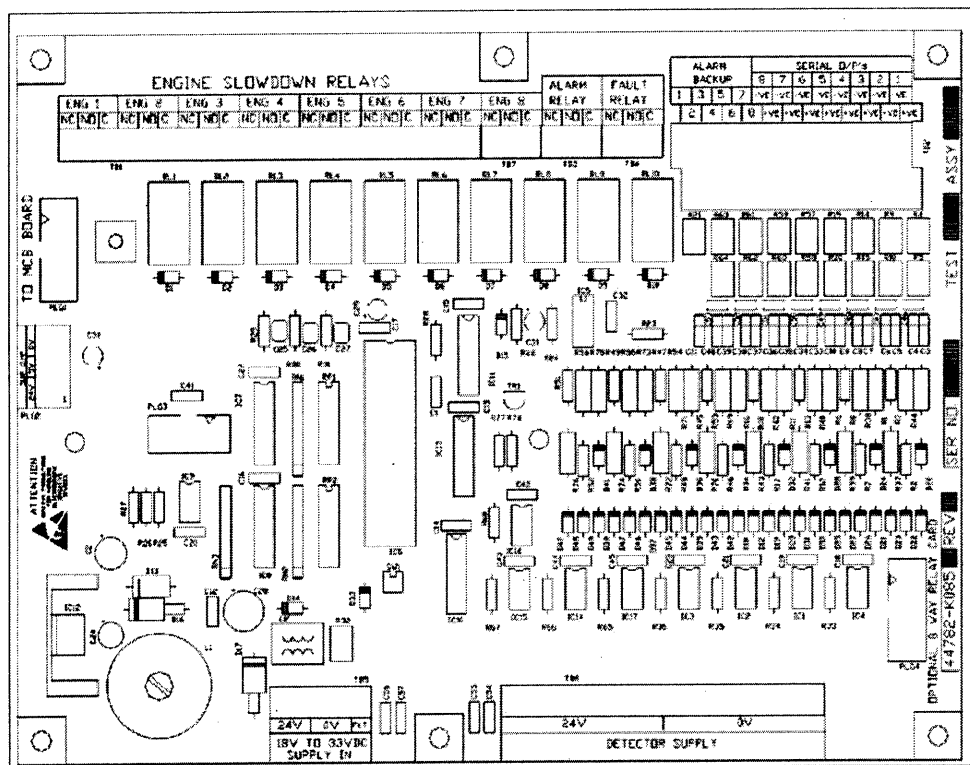
3.9 REPLACEMENT OF LCD DISPLAY MEMBRANE

3.9.1 Replace the LCD Display Membrane as follows:

1. Remove the LCD Display as above (Refer to para 3.8)
2. Remove the membrane.
3. Refit the replacement LCD Display membrane in the reverse order of disassembly.

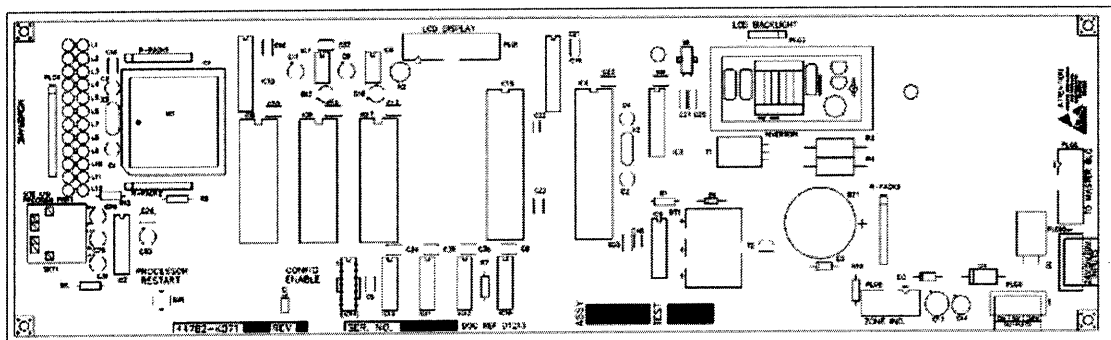
3.10 DECOMMISSIONING

All the components of the MK 6 OMD system may be disposed of as normal waste. i.e. using normal rubbish disposal methods in accordance with current and local environmental regulations.



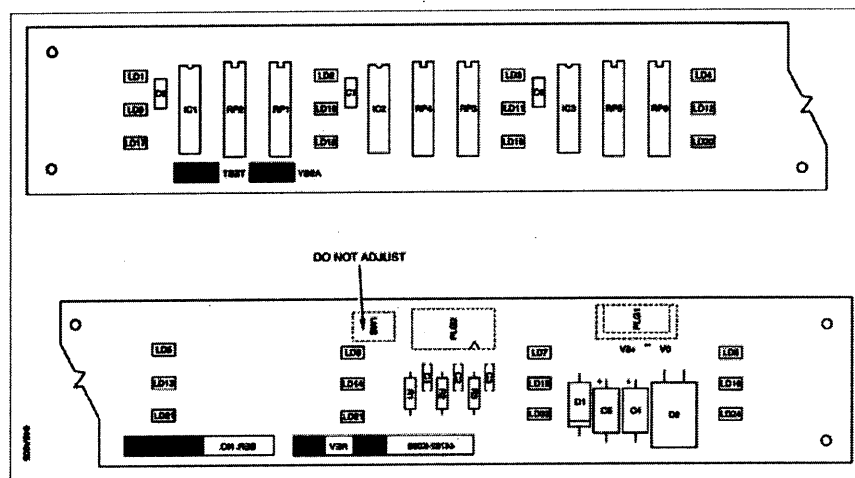
Interface PCB

Figure 47



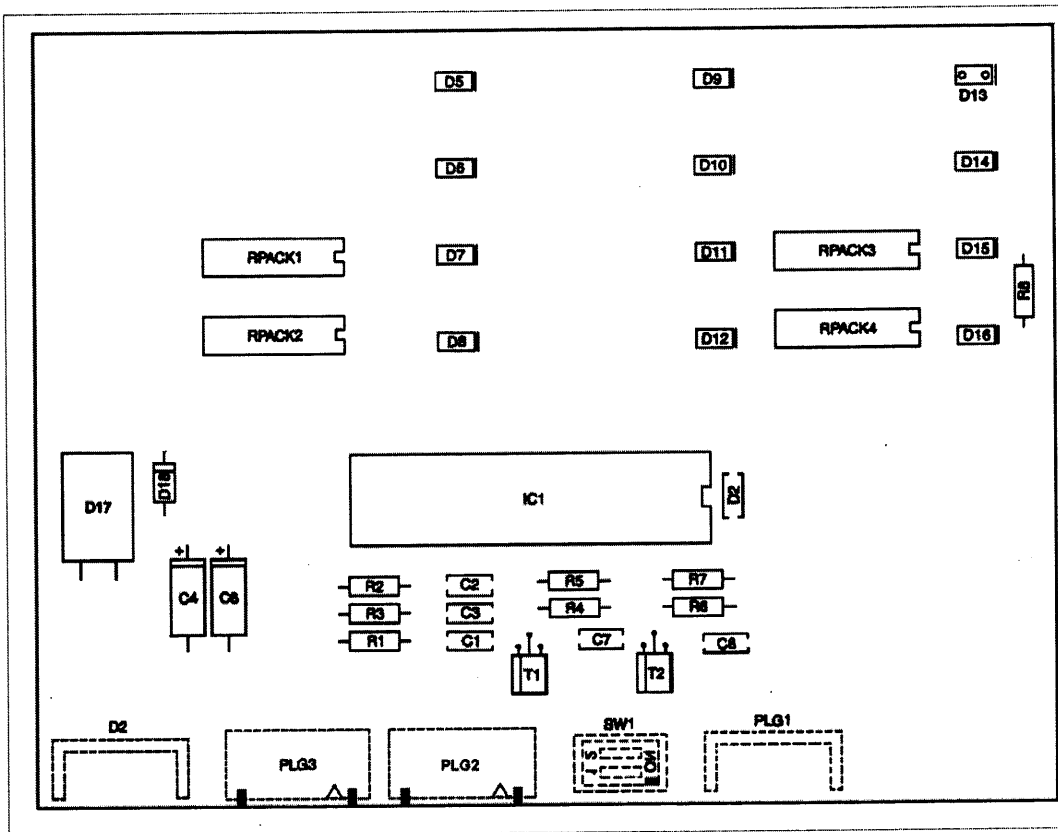
Main Control Processor PCB

Figure 48



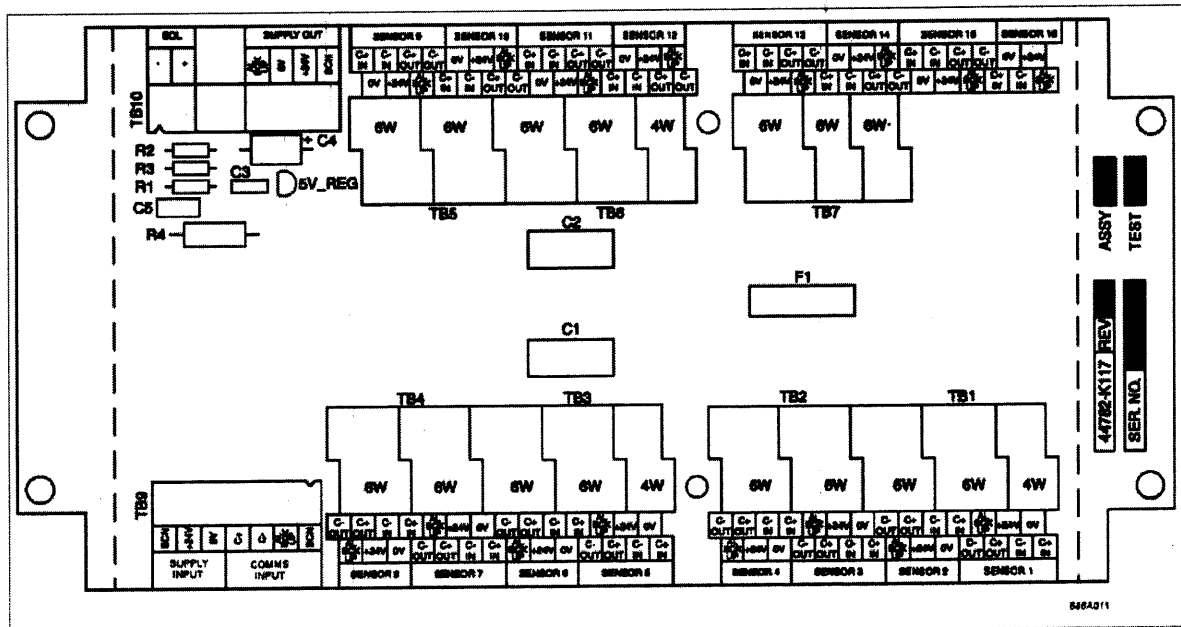
8 Engine Status Display PCB

Figure 49



Status Display PCB

Figure 50



Junction Box PCB

Figure 51

CHAPTER 4

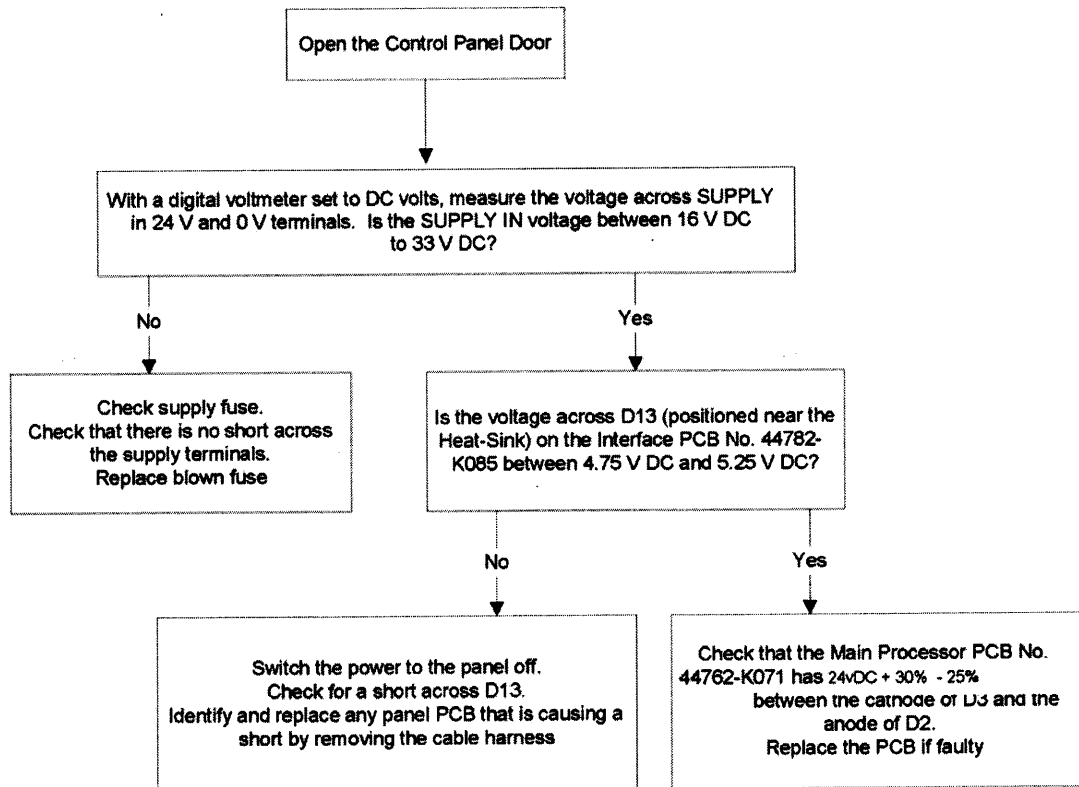
FAULT FINDING

4.1 GENERAL

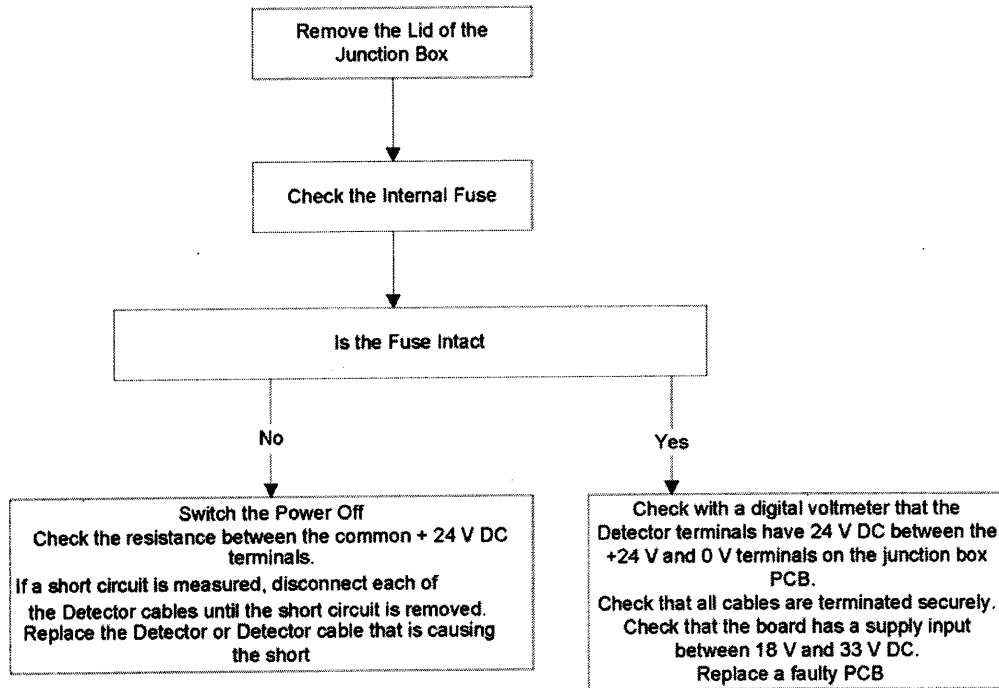
The table below lists a series of failure modes and the likely faults that would be indicated should that failure mode appear. Also listed are Actions, numbered 1 to 7, which should be followed if the associated fault appears. On the following pages, Actions 1 to 7 are shown as flow charts which will assist with fault finding on the Mk.6 OMD system.

Failure Mode	Fault	Action
Control Unit power indicator is off and the display is blank	Supply Failure.	1
The Detector Power On (Green) indicator(s) are OFF on one engine	Junction Box fuse. Faulty Detector.	2
The display shows COMMS FAULT e.g. Engine 1 det 3	Incorrect Detector address setting. Missing Detector Supply. Faulty Detector.	3
The display shows FAN FAULT e.g. Engine 2 det 3	Fan Failure.	4
The display shows LED Fault Engine 3 Det 1	Detector circular oil mist cavity needs to be cleaned. Failed LED.	5
The display shows Detector Fault e.g. Engine 4 det 2	Blocked Detector aperture. Damaged Detector light-guide. Faulty Detector	6
False Deviation Alarm	Incorrect deviation alarm setting	7

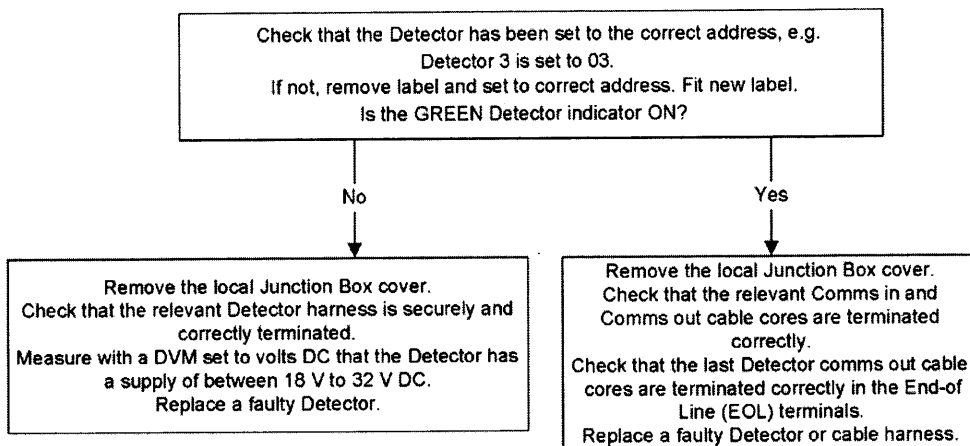
ACTION 1



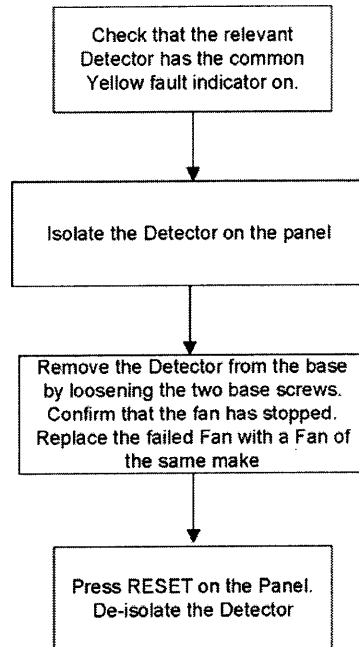
ACTION 2



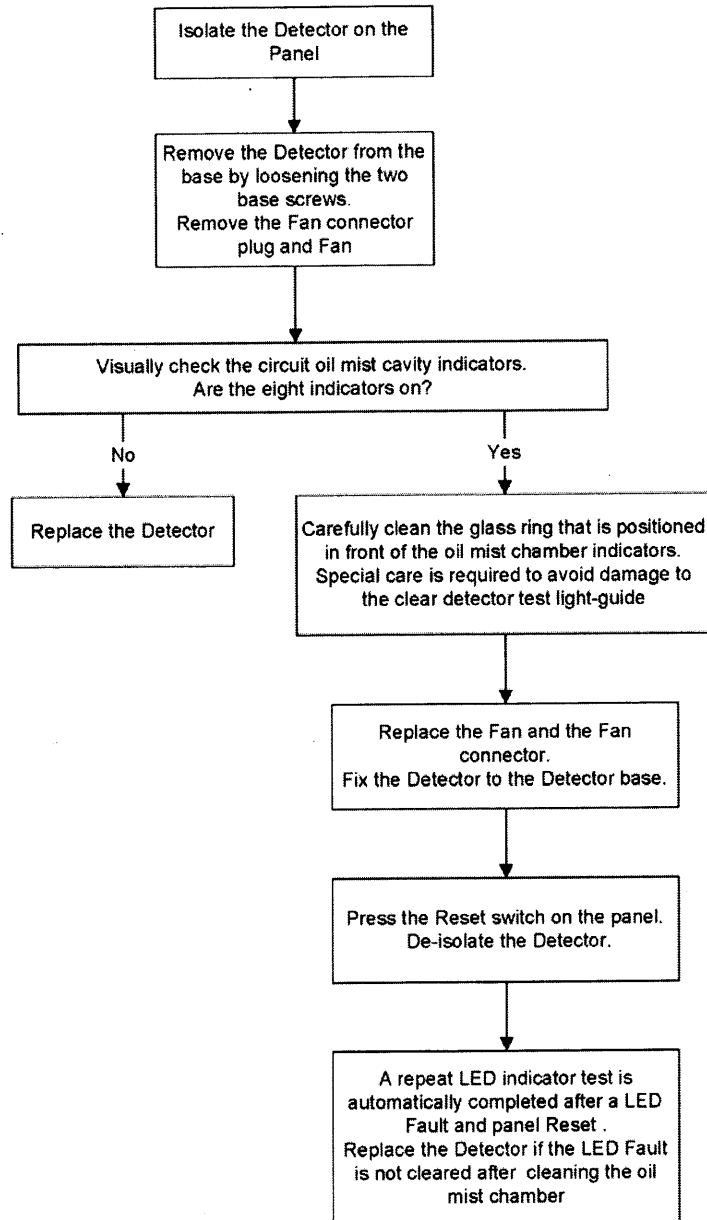
ACTION 3



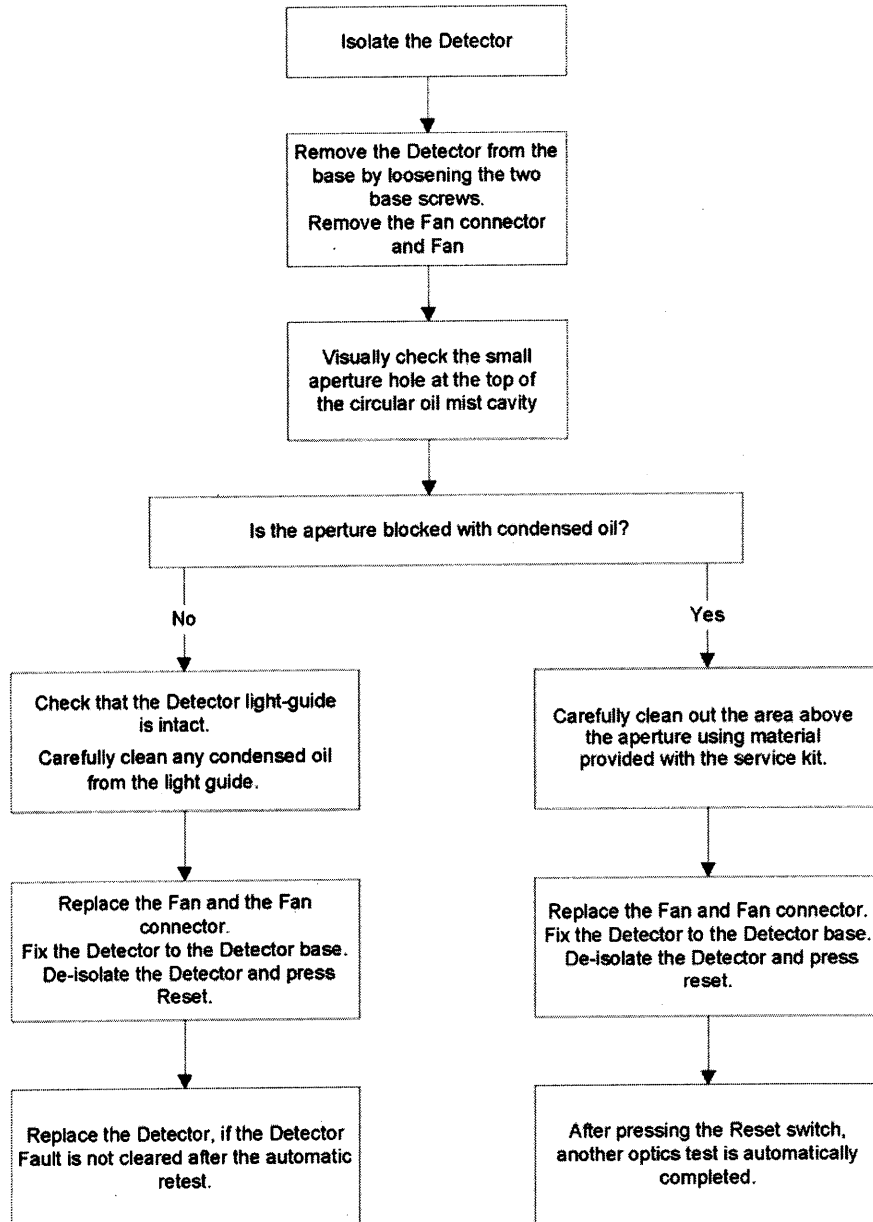
ACTION 4



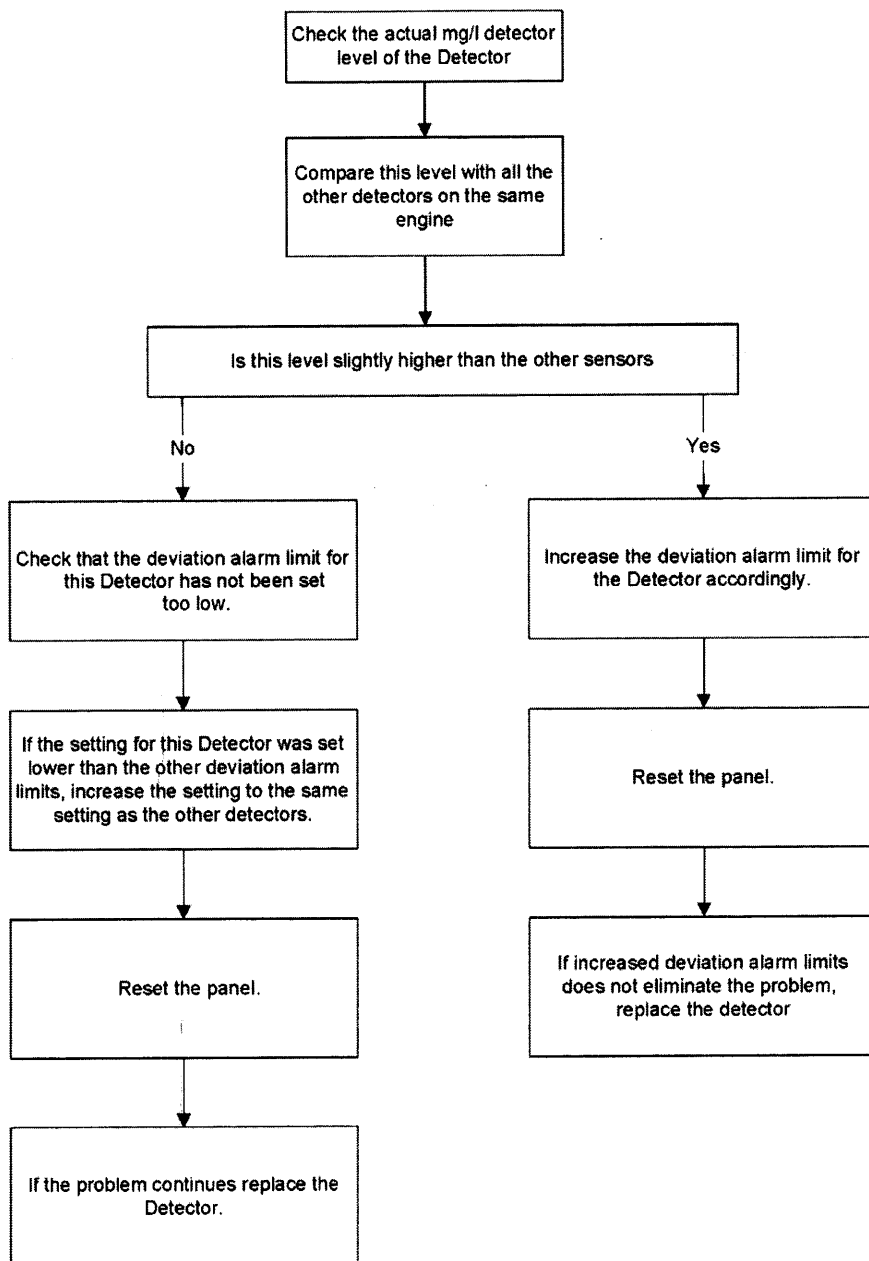
ACTION 5



ACTION 6

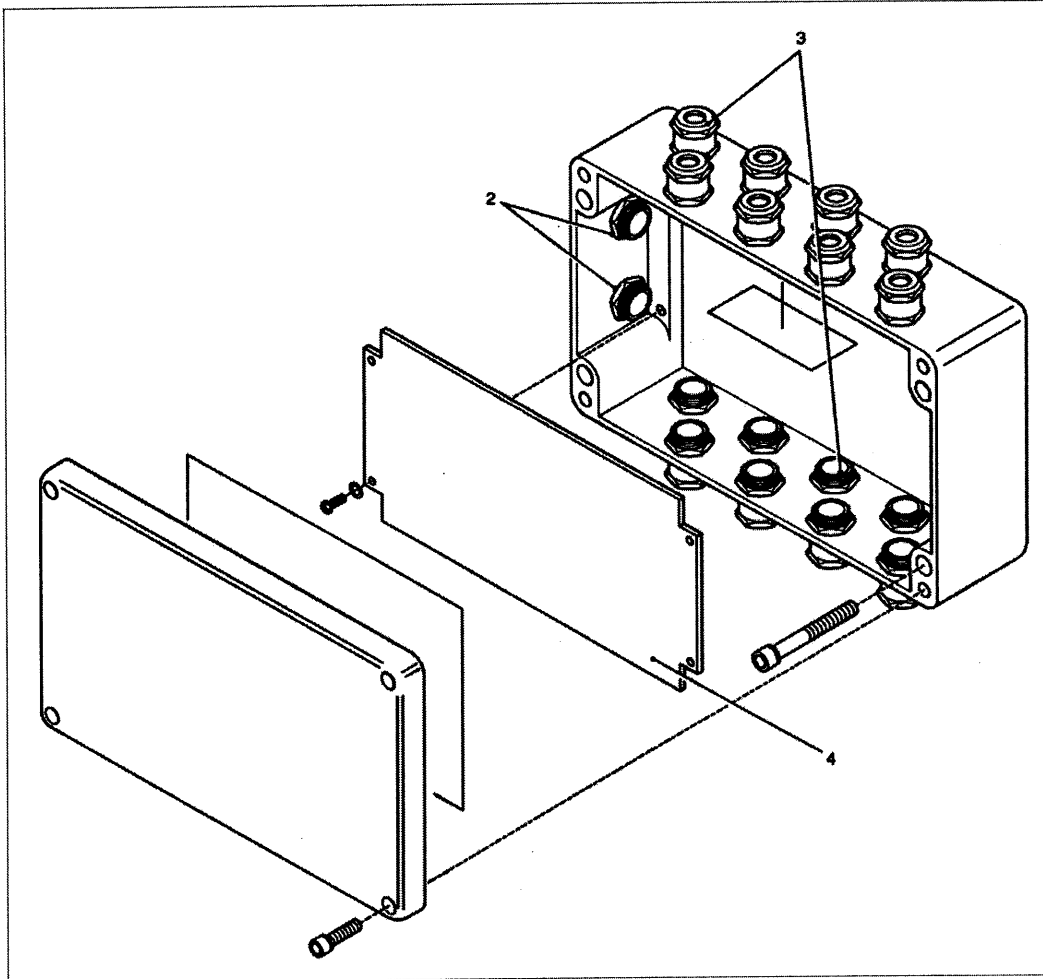


ACTION 7



CHAPTER 5

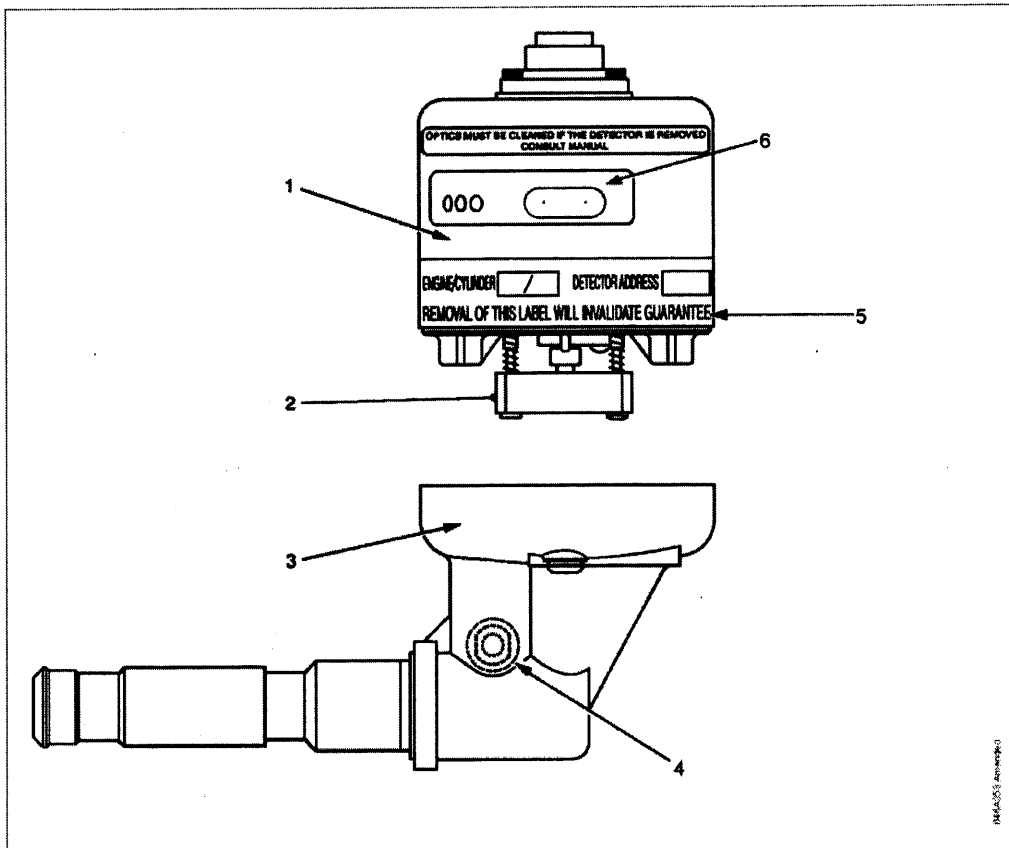
SPARE PARTS



Junction Box – D4720-001-xx

Figure 52

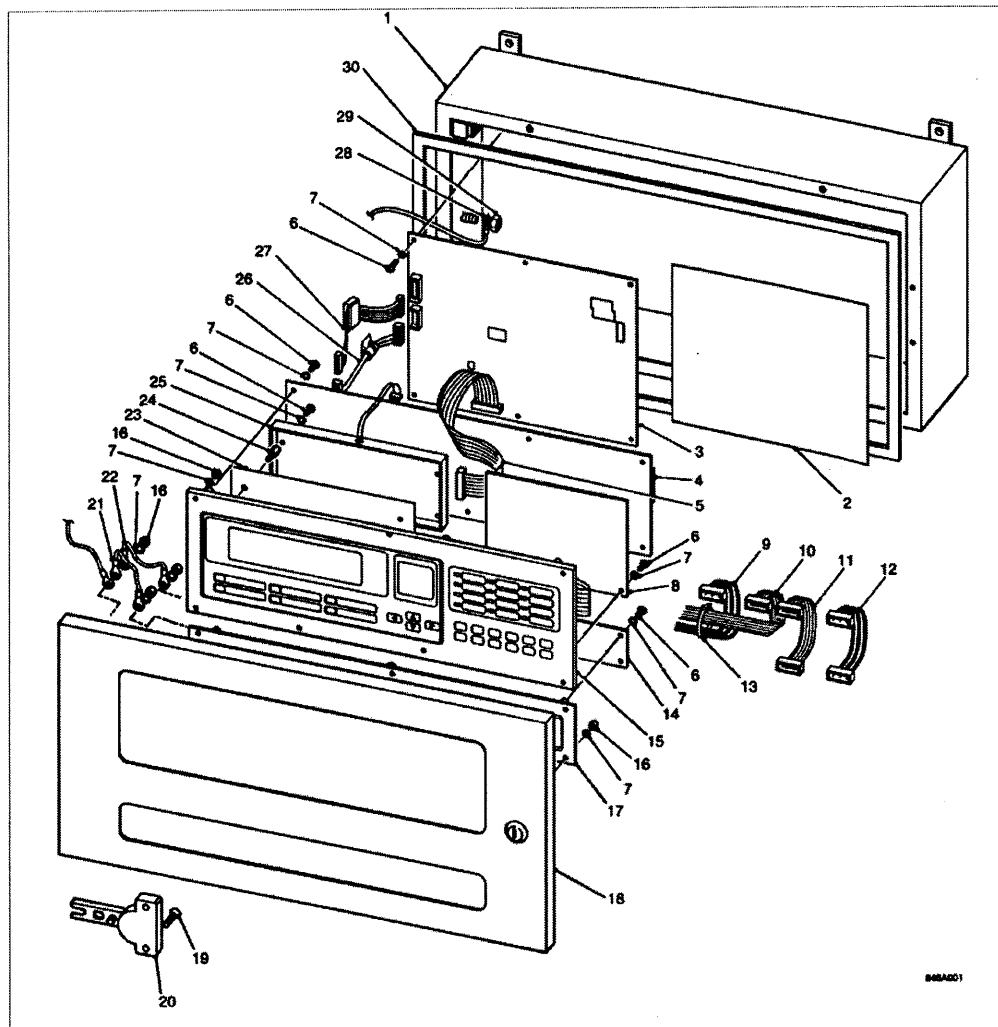
Item	Description	Part No.
	JUNCTION BOX	D4720-001-xx xx = number of Glands
2	Nylon Gland M20 Nylon Gland M25	B5151-013 21888-KO42
3	Metal Gland M20	B5151-002
4	Printed Circuit Board	44782-K117
	Fuse 4 amp, 20mm Slow Blow	27411-K001



Detector Head E3561-301

Figure 53

Item	Description	Part No.
1	Detector Head Assembly	D5622-001
2	Fan Assembly (Papst)	D5622-005
2a	Fan Assembly (Micronel)	D5622-005-02
3	Base Unit Sub-Assembly	D5622-101
4	Connector Push In	B5465-307
5	Label Invalidate Guarantee	C9175-803
6	Label Switch Window	C9189-801



Mark 6 Oil Mist Detector Control Unit

Figure 54

Item	Description	Part No.	Qty
1	Box	35333-K053	1
2	Label, Ext. Connections	36215-K147	1
3	PCB, OMD6 Interface	44782-K085	1

Item	Description	Part No.	Qty
4	PCB, Main Processor	44782-K071-02	1
5	Harness, MCP-LCD Display	43682-K033	1
6	Screw, M4 x 6	21883-D012	22
7	Washer	21177-164	36
8	PCB Status Display	44782-K102-01	1
9	Harness, MCP-Status Display PSU	43682-K067	1
10	Harness, MCP-Status Display	43682-K066	1
11	Harness, MCP-Status	43682-K030	1
12	Harness, MCP-Status PSU	43682-K036	1
13	Tie Wrap	22310-D001	2
14	PCB, 8 Engine Status Display	44782-K098	1
15	Membrane Function Key	39155-K040	1
16	Nut, M4	21883-005	14
17	Membrane Status Display	39155-K039	1
18	Door	35300-K056	1
19	Screw, M3.5 x 10	21833-D011	4
20	Hinge	27650-D009	2
21	Earth Cable	43682-K050	1
22	Earth Cable	43682-K050	1
23	LCD Display	43782-K120	1
24	Spacer	23700-K017	4
25	LCD Cover	15100-K091	1
26	Harness, PCB-MBLC PSU	43682-K037	1
27	Harness, PCB-MBLC	43682-K032	1
28	Earth Cable	43682-K015	1
29	Nut, M6	21883-D014	1
30	Seal	13455-D033	1.5m

Spares Kit (Straight Cable Connector) D9221 024 consists of:		
Description	Part No.	Qty
Interface Board	44782-K085	1
Main Processor Board	44782-K071-02	1
Detector Head Assembly	D5622-001	1
Switch Window Label	C9189-801	2
Cable, 25 metres	43682-K108-08	1

Spares Kit (90 Degrees Cable Connector) D9221-025 consists of:		
Description	Part No.	Qty
Interface Board	44782-K085	1
Main Processor Board	44782-K071-02	1
Detector Head Assembly	D5622-001	1
Switch Window Label	C9189-801	2
Cable, 25 metres	43682-K109-08	1

Commissioning Kit D9221-026 consists of:			
Description	Part No.	Qty	Category
Wipes, Wet & Dry	A7311-001	2	Consumables
Smoke Test Oil – 30 ml	D9221-028	1 Bottle	Consumables
Wick – 150 mm	17100-H06	3	Consumables
Smoke Tester	D9221-029	1	Tools
Materials Safety Data Sheet	-	2	Information

Service Kit D9221-027			
Description	Part No	Qty	Category
Fan Retainer	B3741-902	5	Spares
Compression Spring	B3721-006	5	Spares
Base Moulding Seal	C1513-802	5	Spares
Fan Connector Seal	C1413-801	5	Spares
M3 Screw	21833-H01	5	Spares
Glass Cleaner 500ml	A7311-002	1	Consumables
Air Duster	B6910-218	1	Consumables
Foam Buds Pkts	B6910-217	2	Consumables
4mm Hexagon Key	B6910-219	2	Tools
Pulling Tool	D9131-002	1	Tools
Materials Safety Data Sheet	-	2	Information



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AXIAL VIBRATION MONITOR

(MODEL : AVM-KM30-13)

USER'S MANUAL (VER 3.00)

Updated in 2011.02.25

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BUSAN, KOREA.

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SYSTEM DESCRIPTIONS

The AVM-KM30-13 (Axial Vibration Monitor with 30mm diameter probe) is a control and monitoring system capable of measuring axial crankshaft vibrations on diesel engines. The system is designed to be mounted directly onto the main engine. The system consists of a control unit based on analog and digital technology and an inductive analog proximity sensor(probe).

The AVM-KM30-13 is capable of measuring 0.00~13.00 mm peak-to-peak displacement. The probe supplied by KOMECO delivers a current signal directly proportional to the between the probe and the crankshaft to the control unit.

FUNCTIONAL DESCRIPTIONS

The control unit converts the current signal from the probe to a value of 1 volt per mm displacement of the crankshaft. This signal is sent to the "Crankshaft Position Output" primary used for test.

The sampling time is 500 μ s. So, this converted signal is real value to raw signal. The peak-to-peak value of the displacement is displayed on an internal four-digit display with a resolution of 0.01mm and sent through a voltage-to-current converter, to the "Alarm/ Monitoring Current Output", as a 4~20mA current signal. If a vibration is over than 10.00mm then a output current is 4mA. However, a indication is enable to display over 0 ~ 13.00 mm.

When the peak-to-peak displacement signal from the probe decreases, the value of the display and the "Alarm/Monitoring Current Output" will not follow immediately, but fall slowly to the actual peak-to-peak displacement. The converted signal is processed in a analytical method. This output signal is not real value to raw signal, because it is not processed on real time base.

시스템 개요

AVM-KM30-13 (지름이 30mm 프로브로 축방향 진동 측정)은 제어와 감시 시스템이 디젤 엔진의 크랭크샤프트 축의 진동을 측정하는 기능을 제공한다. 이 시스템은 메인 엔진에 바로 장착할 수 있다. 이 시스템은 아날로그와 디지털 기술의 조합으로 설계된 유닛과 인덕티브 아날로그 센서(프로브)로 조합되어 있다.

AVM-KM30-13은 0.00에서 13.00mm까지 피크-대-피크 진동을 측정할 수 있다.

KOMECO에서 제공되는 프로브는 크랭크샤프트와 프로브 사이의 거리에 직접적으로 비례하는 전류 신호를 출력하여 AVM-KM30-13 제어 유닛으로 제공된다.

기능 설명

제어 유닛은 입력된 프로브 신호를 변환해서 크랭크샤프트로부터 떨어진 거리 mm당 1V를 “크랭크샤프트 위치 출력” 단자를 통해 분석용으로 출력해준다.

이 신호는 500 μ s의 샘플링으로 출력된다. 그러므로 변환신호는 원래 신호의 실제 값이다.

진동의 피크-대-피크 값은 4자리로 디스플레이되며, 해상도는 0.01mm이고 “Alarm/Monitoring Current Output” 단자로 4~20mA 전류 신호로 출력된다. 만약 진동이 10.00mm를 벗어나면 전류는 4mA로 떨어지게 되고 진동 값 Display는 13.00mm까지 이루어진다.

만약 Probe로부터 피크-대-피크 변위(진동)가 감소할 경우에 “Alarm/Monitoring Current Output”은 즉시 떨어지지 않으며 점차적으로 실제 피크-대-피크 변위(진동) 값으로 떨어진다.

이 변환신호는 실시간으로 해석되지 않는다. 왜냐하면 피크-대-피크를 실시간으로 해석할 수 없기 때문이다.

The "Power Fail Output", an on/off signal with a potential-free contact(NO) or normal-close contact(NC), is set if the power source is lower than 18V or higher than 29V. In an occasion, "99.11" is displayed on an internal four-digit display. When the power is normal "99.11" will automatically reset and activated contact will release.

The "Vibration High Alarm Output", an on/off signal with a potential-free contact(NO) or normal-close contact(NC), is activate if the peak-to-peak signal exceeds a setpoint of the high vibration for mare than the "Slow Down Delay Time". The reset of the "VIB. HIGH" output occurs as soon as the peak-to-peak signal has dropped below the setpoint. The setpoint for "Vibration High Alarm Output" is shown on the display by pressing the "HIGH VIB. VIEW" button. Setting of the setpoint for "High Vibration Output" is done by pressing the "HIGH VIB. VIEW" and adjusting the "VIB. HIGH" potentiometer.

The "Slow Down Output", an on/off signal with a potential-free contact(NO) or normal-close contact(NC), is set if the peak-to-peak signal exceeds a setpoint for more than the "Slow Down Delay Time". The setpoint and the "Slow Down Delay Time" are internal adjustable. The reset of the "Slow Down Output" and the "Slow Down Delay Time" occurs as soon as the peak-to-peak signal has dropped below the setpoint.

The setpoint for "Slow Down Output" is shown on the display by pressing the "SLOW DOWN VIEW" button. Setting of the setpoint for "Slow Down Output" is done by pressing the "SLOW DOWN VIEW" button and adjusting the "SLOW DOWN" potentiometer.

Setting of the slow down delay time is done by setting the "SLOW DOWN TIME SETTING" switch to one of the following positions.

제어 유닛은 전원이 불안정(18V이하, 29V이상) 할 경우 노말 오픈(NO) 혹은 노말 클로즈(NC)로 신호를 출력해주고 내부 디스플레이 모듈에 "99.11"이 디스플레이 된다. 만약 정상적인 전원이 공급되면 디스플레이 되던 "99.11" 에러 메시지는 자동으로 리셋될 것이고 알람출력신호도 복귀될 것이다.

만약 사용자가 셋팅한 진동 값 이상의 피크-대-피크가 셋팅된 "Slow Down Delay Time" 시간 이상 동안 계속해서 센서로부터 검출되면 노말 오픈(NO) 혹은 노말 클로즈(NC)로 신호를 출력해준다. 이 신호의 리셋은 피크-대-피크의 신호가 셋팅한 값 이하로 떨어지자마자 즉시 이루어진다. 셋팅 값을 확인 하려면 "HIGH VIB. VIEW" 버튼을 누른 상태에서 FND에 디스플레이 값을 통해서 확인한다. 이에 필요한 값 셋팅은 "HIGH VIB. VIEW"를 누른 상태에서 "VIB. HIGH"의 가변조정부로 조정한다.

슬로우다운 출력 신호는 사용자가 셋팅한 값 이상의 피크-대-피크 진동이 "슬로우다운 시간" 이상동안 연속적으로 검출되면 노말 오픈(NO) 혹은 노말 클로즈(NC)로 동작한다. 이 신호의 리셋은 피크-대-피크의 신호가 셋팅한 값 이하로 떨어지자마자 즉시 이루어진다.

셋팅 값을 확인하려면 "SLOW DOWN VIEW"버튼을 누른 상태에서 FND에 디스플레이 값을 통해서 확인한다. 이에 필요한 값 셋팅은 "SLOW DOWN VIEW"를 누른 상태에서 "SLOW DOWN"의 가변조정부로 조정한다.

"알람 발생 지연시간" 셋팅은 "SLOW DOWN TIME SETTING" 스위치를 아래의 값에 준하도록 맞춰서 조정한다.

0 = 0 sec. 6 = 120 sec. C = 240 sec.
 1 = 20 sec. 7 = 140 sec. D = 260 sec.
 2 = 40 sec. 8 = 160 sec. E = 280 sec.
 3 = 60 sec. 9 = 180 sec. F = 300 sec.
 4 = 80 sec. A = 200 sec.
 5 = 100 sec. B = 220 sec.

Recommended initial setting : 100 sec.

User range setting provide advantage that end users can easily mount a probe(sensor) onto engine without a special mount jig. If an end user mounts a probe (sensor) closer from the crankshaft than low set value, "99.33" is displayed on an internal four-digit display. And if an end user mounts a probe(sensor) far away from crankshaft than high set value, "99.44" is displayed on an internal four-digit display. User range low or high setting can only done by KOMECO. The short-circuit/disruption of the probe cable will be indicated on the display by "99.22". The "99.33" and "99.44" error messages can be recovered by pressuring two view buttons simultaneously.

0 = 0 sec. 6 = 120 sec. C = 240 sec.
 1 = 20 sec. 7 = 140 sec. D = 260 sec.
 2 = 40 sec. 8 = 160 sec. E = 280 sec.
 3 = 60 sec. 9 = 180 sec. F = 300 sec.
 4 = 80 sec. A = 200 sec.
 5 = 100 sec. B = 220 sec.

추천하는 슬로우 다운 시간 : 100 sec.

유저 레인지 셋팅은 사용자가 프로브(센서)를 엔진에 장착할 때 설치거리를 확인하기 위한 특수한 도구 없이 수해하도록 편의성을 제공한다. 만약 사용자가 프로브를 장착할 때 로우 셋팅 값보다 더 가까이 프로브를 장착할 경우에는 "99.33"을 디스플레이하여 설치의 부적합을 알린다. 그리고 하이 셋팅 값보다 더 멀리 프로브를 장착할 경우에도 "99.44"를 디스플레이하여 설치의 부적합을 알려준다. 유저 레인지 셋팅은 KOMECO에서만 가능하다.

만약 프로브 선이 단락되거나 단선될 경우 디스플레이 상에 "99.22"가 나타날 것이다. "99.33" 그리고 "99.44"의 에러 메시지는 알람세팅 값 확인 시 쓰이는 두 버튼을 동시에 눌러 해제시킬 수 있다.

TROUBLE SHOOTING

I. Standard procedures

In case of suspected malfunction, a structured system test should be carried out. By following the below steps, a complete system test is carried out, and an identification of the problem should be possible.

II. Check of power supply to probe

Connect the power supply to K11(+), K13(-).

The display will indicate version "ver3.0" and after ten second, the control unit will indicate type "t.30" on FND. And "SdSU", "HUSU" will be indicated on scanning set values.

고장 점검

I. 절차

만약 정상동작이 되지 않는다고 의심되면 체계적인 테스트가 이루어져야 한다. 제품에 대해서 다음과 같은 단계로 테스트가 이루어진다면 문제점을 확인할 수 있을 것이다.

II. 프로브에 대한 전원 공급 체크

K11(+)와 K13(-)에 전원을 공급한다. 전원을 공급하면 처음에 version "ver3.0"이 디스플레이 되고, 약 10초 후에 type "t.30"이 디스플레이 된다. 그리고 약 10초 후에 셋팅값을 스캔하기 위해 "SdSU"와 "HUSU"가 표시된다.

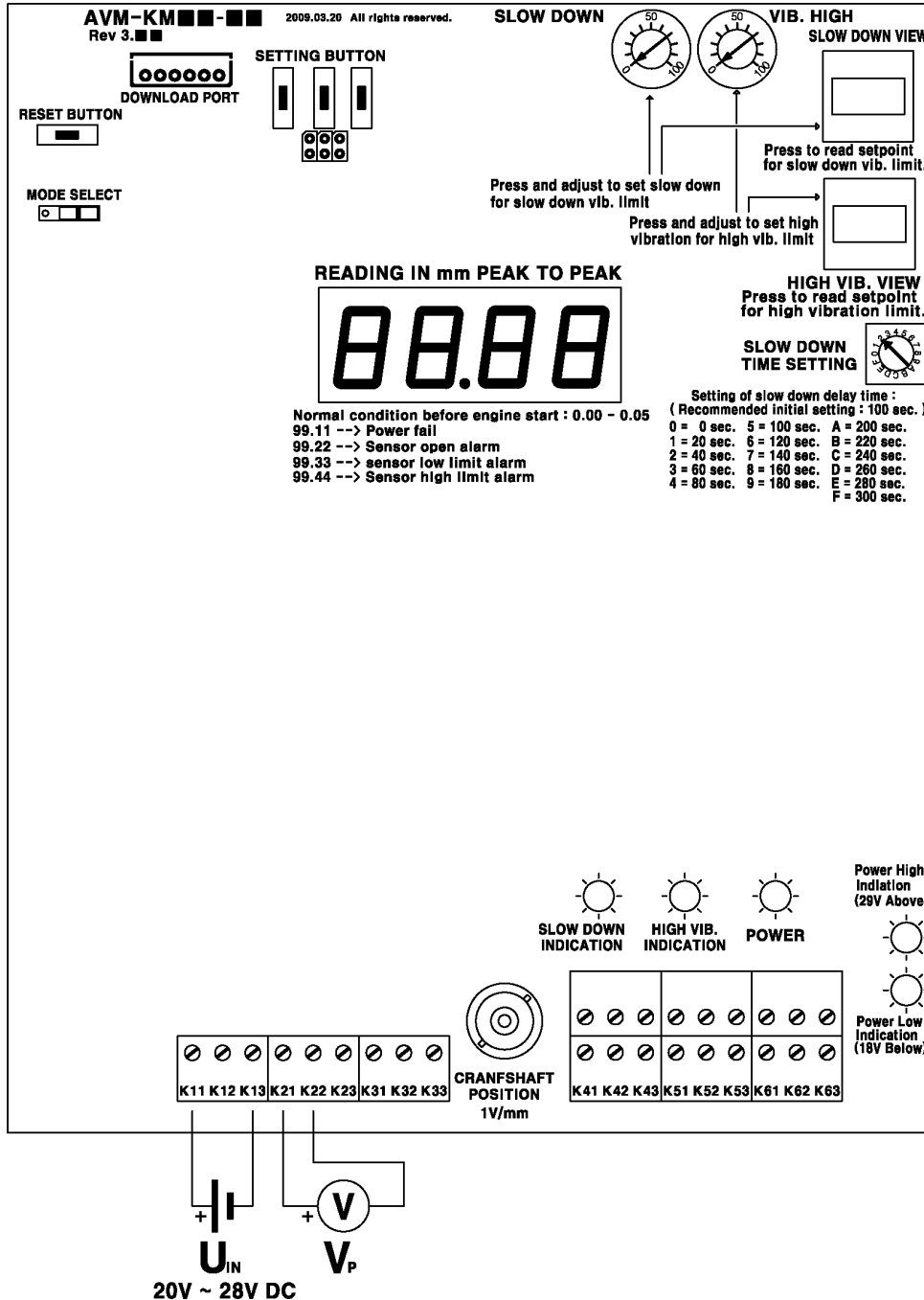
Check the voltage on K21(+), K23(-).

For the AVM-KM30-13 the V_p readout should be 14.5~15.5 V.

If not, the circuit board may be defective and should be replaced.

K21(+)와 K23(-)에 전압을 체크한다.

V_p 의 값이 14.5~15.5V이면 정상이며 만약 그렇지 않으면 제어 유닛을 바꿔야 한다.



III. Check of the electronic cabinet during power on

Connect resistor Res1 to K21 and K22(Res1 = 2k2 = 2.2k Ω , not part of KOMECO A/S scope of supply)

When the power is turned, the control will scan the value user's of setting.

After the scanning is terminated the display will return to normal condition and indicate 0.00~0.05mm.

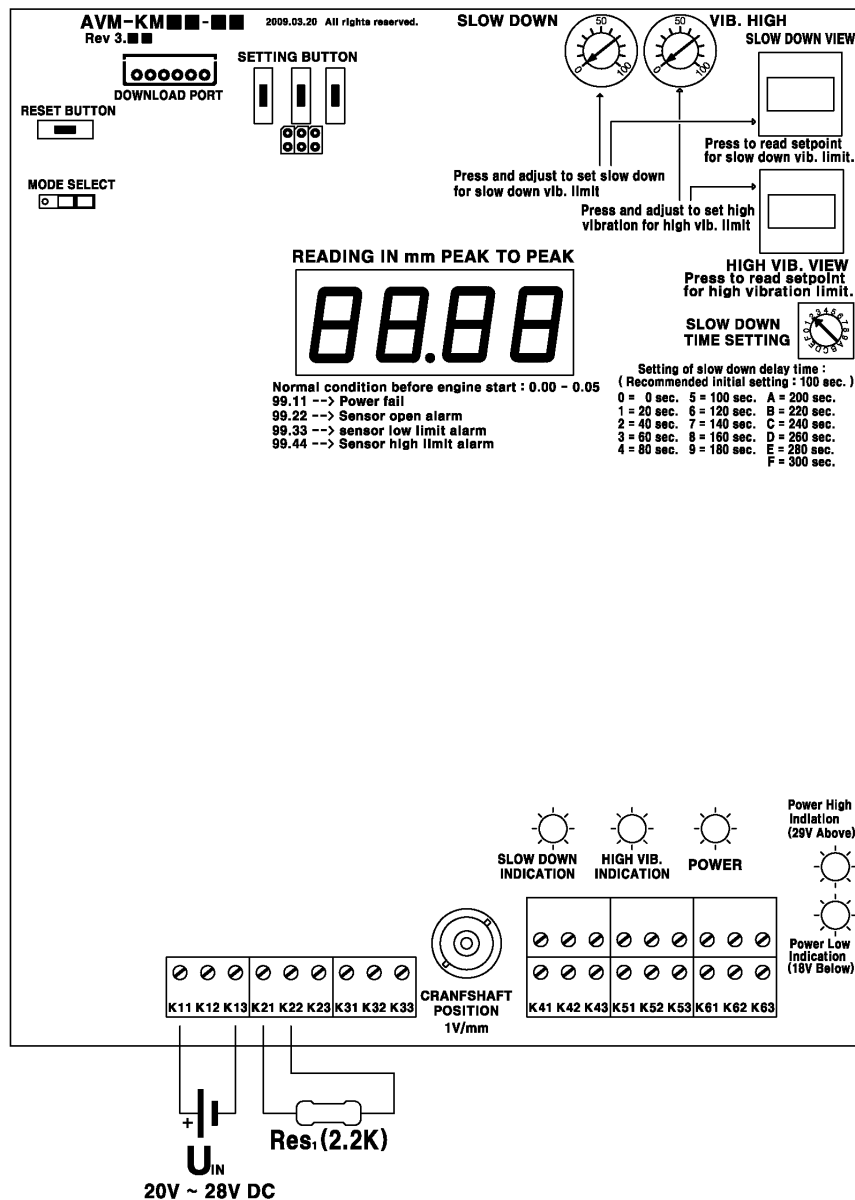
If not, the circuit board may be defective and should be replaced.

III. 전원을 공급했을 경우 증상 체크

K21과 K22에 저항 Res1을 연결하라(Res1 = 2k2 = 2.2k, 이것은 KOMECO의 A/S 영역이 아니다).

전원이 공급되면 셋팅 값을 스캔하고, 스캔하는 데는 약 20초 정도 소요된다. 그 후 정상적인 동작이 이루어지면 디스플레이는 0.00~ 0.05mm가 될 것이다.

만약 위와 같은 동작이 이루어지지 않는다면 제어 유닛을 바꿔야 한다.



IV. Check of the electronic cabinet for probe input & display

Connect Res1 and Res2 in parallel to K21 and K22.

By continuously connecting and disconnecting Res2 the display will change indication.

For the AVM-KM30-13 the readout will be 3.00~4.00mm.

By permanently disconnecting or connecting Res2 the display will return slowly to indicating 0.00~0.05mm.

If not, the circuit board may be defective and should be replaced.

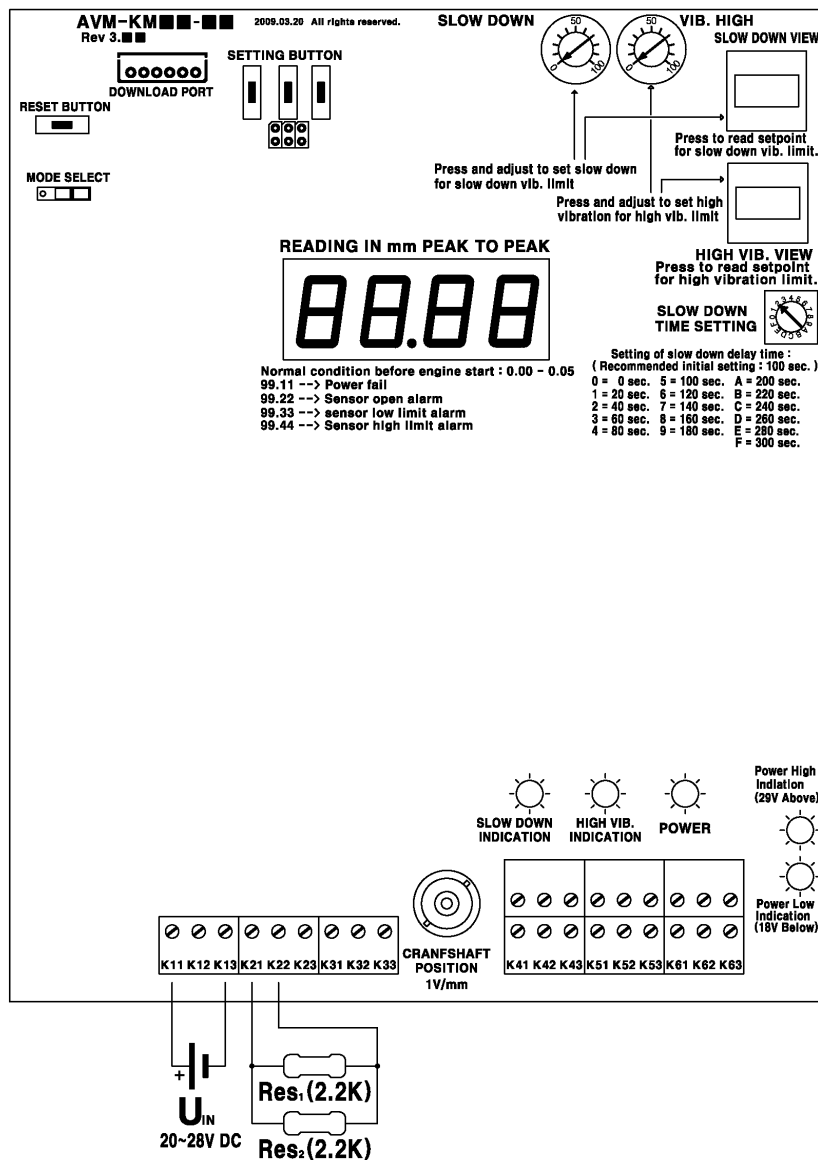
IV. 프로브 입력과 디스플레이 증상 체크

Res1과 Res2를 K21, K22에 병렬로 연결한다.

Res2를 계속적으로 접속과 분리를 반복하면 디스플레이가 변하고 그 값은 3.00~4.00mm 사이의 값이 된다.

계속적으로 접속시켜 놓든지 분리시켜 놓으면 디스플레이 값은 점차적으로 0.00~0.05mm로 된다.

만약 정상적으로 동작하지 않으면 제어 유닛을 바꿔야 한다.



V. Check of the electronic cabinet for current output

Connect an amp-meter to K31 and K32.

By continuously disconnecting and connecting Res2 the display will change indication.

I_{out} will follow the value in the display according to the following formula:

$I_{out}[mA] = 1.6 \times (\text{display indication}[mm]) + 4$,
where a display indication is lower than 10.00.

If I_{out} differs significantly from the above formula, the circuit board may be defective and should be replaced.

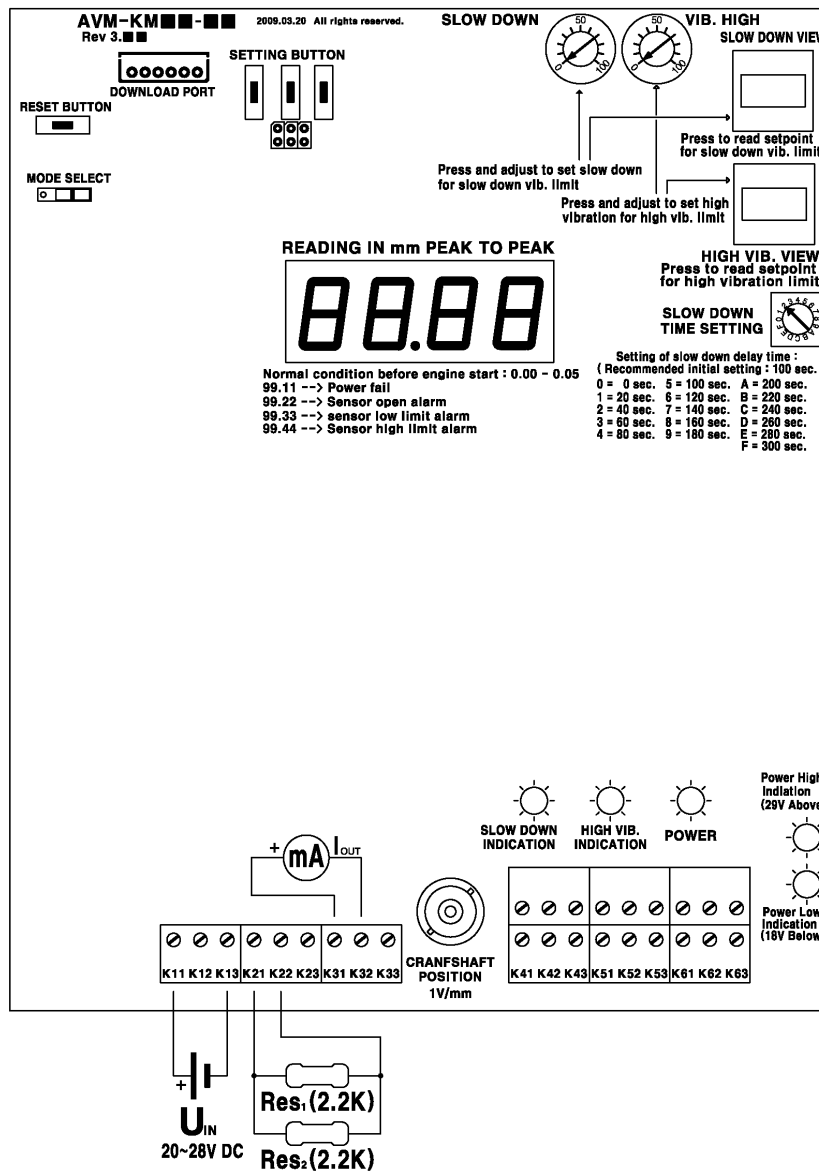
V. 전류 출력 증상 체크

전류 메타를 K31과 K32에 연결한다.

Res2를 계속적으로 접속과 분리를 반복하면 디스플레이가 변한다. I_{out} 은 아래의 공식에 의해 디스플레이된 값에 따라서 변한다.

$I_{out}[mA] = 1.6 \times (\text{디스플레이 값}[mm]) + 4$,
단, 디스플레이 값이 10.00mm 이하인 경우.

만약 I_{out} 의 출력이 공식에 따라서 변하지 않으면 제어 유닛을 바꿔야 한다.



VI. Check of the electronic cabinet for Slow Down Output

Connect an ohm-meter to K42 and K43 for Normal-Open(NO), to K41 and K42 for Normal-Close(NC).

Adjust the "SLOW DOWN TIME SETTING" to position "0".

Connect the power source to K11(+) and K13(-).

Adjust the "SLOW DOWN" to approximately 2.0mm.

By continuously disconnecting and connecting Res2 the display will change indication.

By permanently disconnecting or connecting Res2 the display will return slowly to an indication of 0.00-0.05mm.

VI. 슬로우 다운 출력 증상 체크

저항 측정기를 K42와 K43(노말 오픈, NO), K41과 K43(노말 클로즈, NC)에 연결한다.

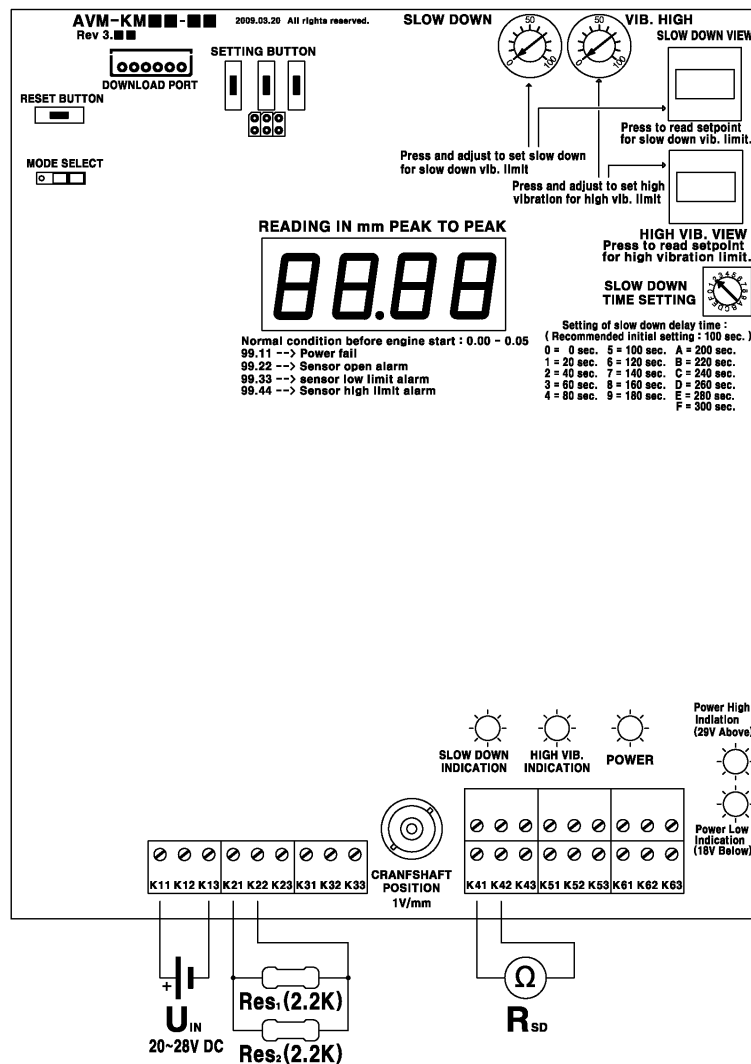
SLOW DOWN TIME SETTING을 "0"으로 맞춘다.

전원을 공급한다.

SLOW DOWN을 약 2.00mm에 맞춘다.

Res2를 계속적으로 접속과 분리하면 디스플레이가 변한다.

계속적으로 접속시켜 놓든지 분리시켜 놓으면 디스플레이 값은 점차적으로 0.00-0.05mm로 된다.



At display indications higher than the adjusted SLOW DOWN the Slow Down Output relay will be activated:

$$R_{sd} = 0\Omega$$

for Normal-Open(NO),

$$R_{sd} = \infty\Omega$$

for Normal-Close(NC).

At display indications lower than the adjusted SLOW DOWN the Slow Down Output relay will be deactivated :

$$R_{sd} = \infty\Omega$$

for Normal-Open(NO),

$$R_{sd} = 0\Omega$$

for Normal-Close(NC).

If not, the circuit board may be defective and should be replaced.

VII. Check of the electronic cabinet for Vibration High Alarm Output

Connect an ohm-meter to K52 and K53 for Normal-Open(NO), to K51 and K52 for Normal-Close(NC).

Connect the power source to K11(+) and K13(-).

Adjust the HIGH VIB. to approximately 2.00 mm.

By continuously disconnecting and connecting Res2 the display will change indication.

By permanently disconnecting or connecting Res2 the display will return slowly to an indication of 0.00-0.05mm.

At display indications higher than the adjusted HIGH VIB. the Vibration High Alarm Output relay will be activated:

$$R_{sd} = 0\Omega \text{ for Normal-Open(NO),}$$

$$R_{sd} = \infty\Omega \text{ for Normal-Close(NC).}$$

At display indications lower than the adjusted HIGH VIB. the Vibration High Alarm Output relay will be deactivated :

$$R_{sd} = \infty\Omega \text{ for Normal-Open(NO),}$$

$$R_{sd} = 0\Omega \text{ for Normal-Close(NC).}$$

If not, the circuit board may be defective and should be replaced.

만약 표시 값이 SLOW DOWN에서 셋팅한 값보다 높으면 슬로우 다운 출력 릴레이가 동작한다:

$$R_{sd} = 0\Omega$$

노말 오픈(NO) 에 대하여,

$$R_{sd} = \infty\Omega$$

노말 클로즈(NC) 에 대하여.

만약 표시 값이 SLOW DOWN에서 셋팅한 값보다 낮은 값으로 떨어지면 릴레이는 동작을 멈춘다.

$$R_{sd} = \infty\Omega$$

노말 오픈(NO) 에 대하여,

$$R_{sd} = 0\Omega$$

노말 클로즈(NC) 에 대하여.

만약 정상적으로 동작하지 않으면 제어 유닛을 바꿔야 한다.

VII. 과진동 알람 증상 체크

저항 측정기를 K52와 K53(노말 오픈, NO), K51과 K53(노말 클로즈, NC)에 연결한다.

전원을 공급한다.

HIGH VIB.를 약 2.00mm에 맞춘다.

Res2를 계속적으로 접속과 분리를 반복하면 디스플레이가 변한다.

계속적으로 접속시켜 놓든지 분리시켜 놓으면 디스플레이 값은 점차적으로 0.00-0.05mm로 된다.

만약 표시 값이 HIGH VIB.에서 셋팅한 값보다 높으면 바이브레이션 하이 알람 출력 릴레이가 동작한다:

$$R_{sd} = 0\Omega, \text{ 노말 오픈(NO) 에 대하여,}$$

$$R_{sd} = \infty\Omega, \text{ 노말 클로즈(NC) 에 대하여.}$$

만약 표시 값이 HIGH VIB.에서 셋팅한 값보다 낮은 값으로 떨어지면 릴레이는 동작을 멈춘다.

$$R_{sd} = \infty\Omega, \text{ 노말 오픈(NO) 에 대하여,}$$

$$R_{sd} = 0\Omega, \text{ 노말 클로즈(NC) 에 대하여.}$$

만약 정상적으로 동작하지 않으면 제어 유닛을 바꿔야 한다.

VIII. Check of the electronic cabinet for Power Fail Output

Connect an ohm-meter to K62 and K63 for Normal-Open(NO), to K61 and K62 for Normal-Close(NC).

Connect the power source to K11(+) and K13(-).

By falling the power source down below 18V or raising it up above 29V the readout will be "99.11" and the Power Failure Alarm Output relay will activated:

$R_{sd} = 0\Omega$ for Normal-Open(NO), $R_{sd} = \infty\Omega$ for Normal-Close(NC).

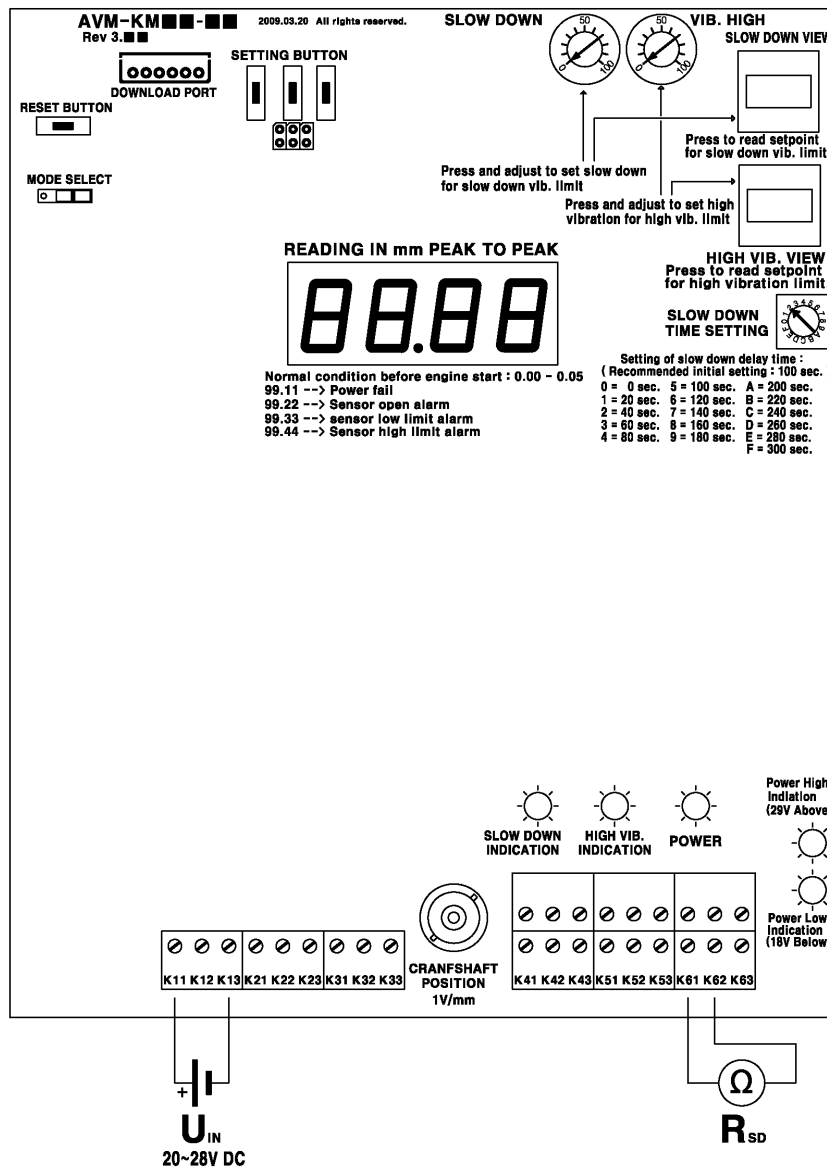
VIII. 전원 불안정 증상 체크

저항 측정기를 K62와 K63(노말 오픈, NO), K61과 K63(노말 클로즈, NC)에 연결한다.

전원을 공급한다.

전원을 18V 이하로 떨어뜨리거나 29V 이상으로 올리면 "99.11"이 디스플레이 되고 전원 불안정 알람 출력 릴레이가 동작한다.

$R_{sd} = 0\Omega$, 노말 오픈(NO), $R_{sd} = \infty\Omega$,노말 클로즈(NC).



By setting the power source between 18V and 29V the display will return to an indication of 0.00~0.05mm and the Power Failure Alarm Output relay will be deactivated : $R_{sd} = \infty\Omega$ for Normal-Open (NO), $R_{sd} = 0\Omega$ for Normal-Close(NC).

If not, the circuit board may be defective and should be replaced.

IX. Check of the Probe

Connect the power supply and an amp-meter to the probe.

First, check the connection by moving a piece of metal back and forth in front of the probe. If no variation in I_p is found, the probe or the probe cable may be defective.

If I_p varies, check I_p vs. the distance to the metal. If measurements(mA vs. mm) differ significantly from the calibration data found on the probes calibration sheet, the probe should be replaced.

전원이 18V에서 29V사이로 공급되면 디스플레이 값은 0.00~0.05mm로 되며, 릴레이는 동작을 멈춘다.

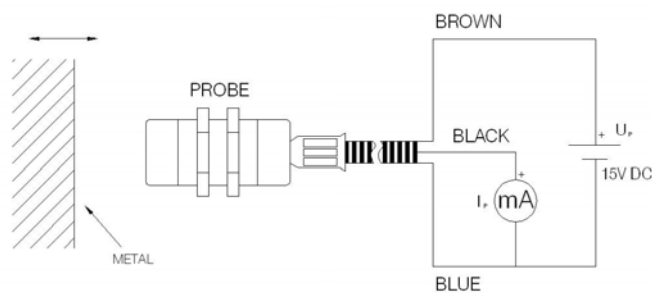
$R_{sd} = \infty\Omega$, 노말 오픈(NO), $R_{sd} = 0\Omega$,노말 클로즈(NC).

만약 정상적으로 동작하지 않으면 제어 유닛을 바꿔야 한다.

XI. 프로브 증상 체크

전원을 공급하고 전류 메타를 프로브에 연결한다. 프로브에 쇠 조각을 움직이면서 이동하면 I_p 가 변동한다. 만약 I_p 가 변동하지 않으면 프로브나 프로브 선에 이상이 있는 것이다.

만약 I_p 가 표준 값과 전혀 다르면 프로브를 바꿔야 한다.



X. Check of the electronic cabinet for Voltage Output

Connect the probe cable to K21,22,23.

Connect an voltmeter to the BNC.

By connecting Res1 the voltage output will be 7.40V. By connecting Res1 and Res2 the voltage output will be 10.60V.

By continuously connecting and disconnecting Res2 the voltage output will change from 7.4 to 10.6V.

The measurement range is from 0.00 to 13.00 V and the value is linear on the range from 3.50 to 13.0V. If V_p is not significantly proportional to the distance the circuit board may defective and should be replaced.

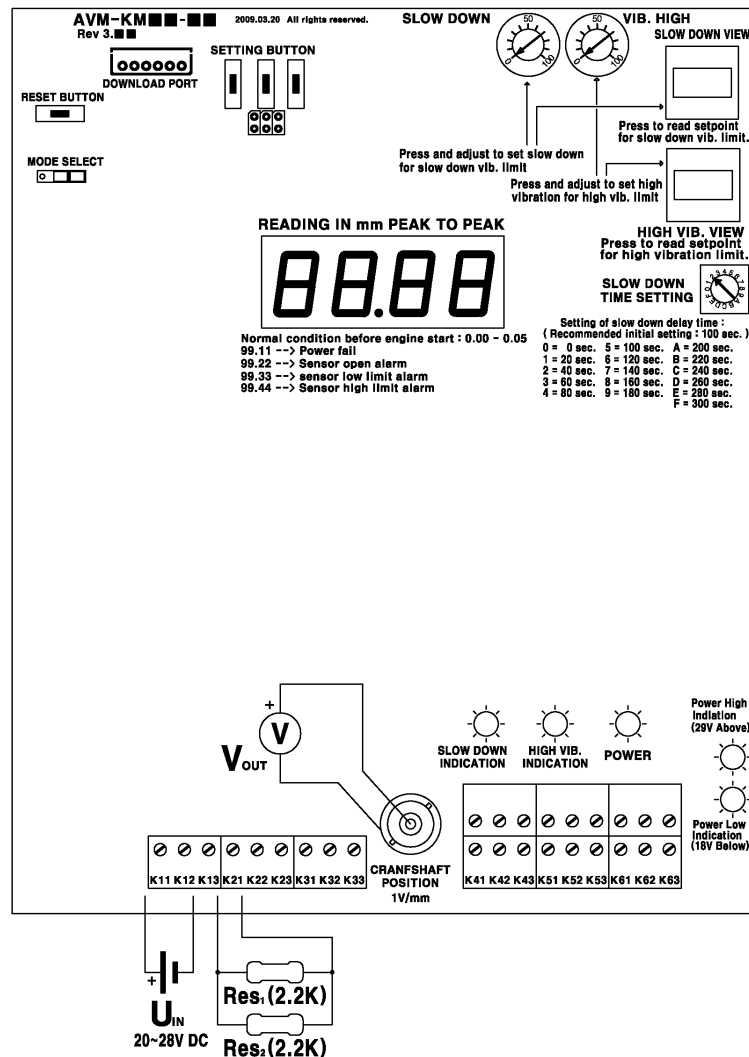
X. 출력 전압 증상 체크

K21, 22, 23에 프로브 선을 연결한다.

전압계를 BNC 단자에 연결한다.

Res1을 계속적으로 접속해 놓으면 출력 전압은 7.40V가 될 것이다. Res1과 Res2를 계속적으로 접속해 놓으면 출력 전압은 10.60V가 될 것이다. 만약 접속과 분리를 계속적으로 반복하면 디스플레이가 변하고 V_{out} 은 7.40에서 10.60V까지 변한다. 0.00에서 13.00V 까지 측정 가능하고 3.50 ~13.00 범위에서는 선형성이 유지된다.

정상적으로 동작이 되지 않으며 제어 유닛을 바꿔야 한다.



DOWN LOAD PORT

This port is used for down load the monitor program to PCB. This port can't used by only maker.

REST BUTTON

This button is added to new type PCB(Ver 3.00). Operator can use the button to restart a unit. If an operator re-adjust the slow down time, he must reset a unit by pressing.

SETTING BUTTON

This button is used for only maker to set a unit. However, it can be used only for maintenance.

다운로드 포트

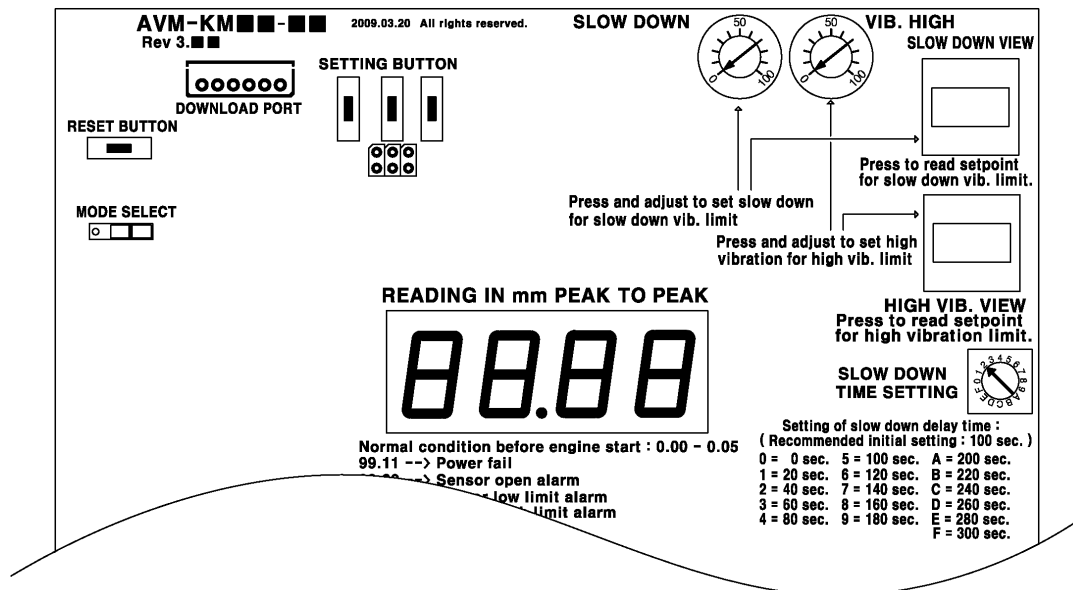
PCB 제작 후 모니터 프로그램 다운로드를 위해 사용되며 이는 유닛 공급자에 의해서만 사용되는 포트이다.

리셋 버튼

이 기능은 버전 3.00에서 새롭게 추가 되었으며 유닛을 리셋할 때 사용된다. 만약 슬로우 다운 시간을 조정하였다면 반드시 이 버튼을 이용하여 유닛을 리셋하여야 한다.

셋팅 버튼

이 버튼은 유닛 공급자에 의해서만 사용되며, 유지보수를 위하여 사용될 수 있다.

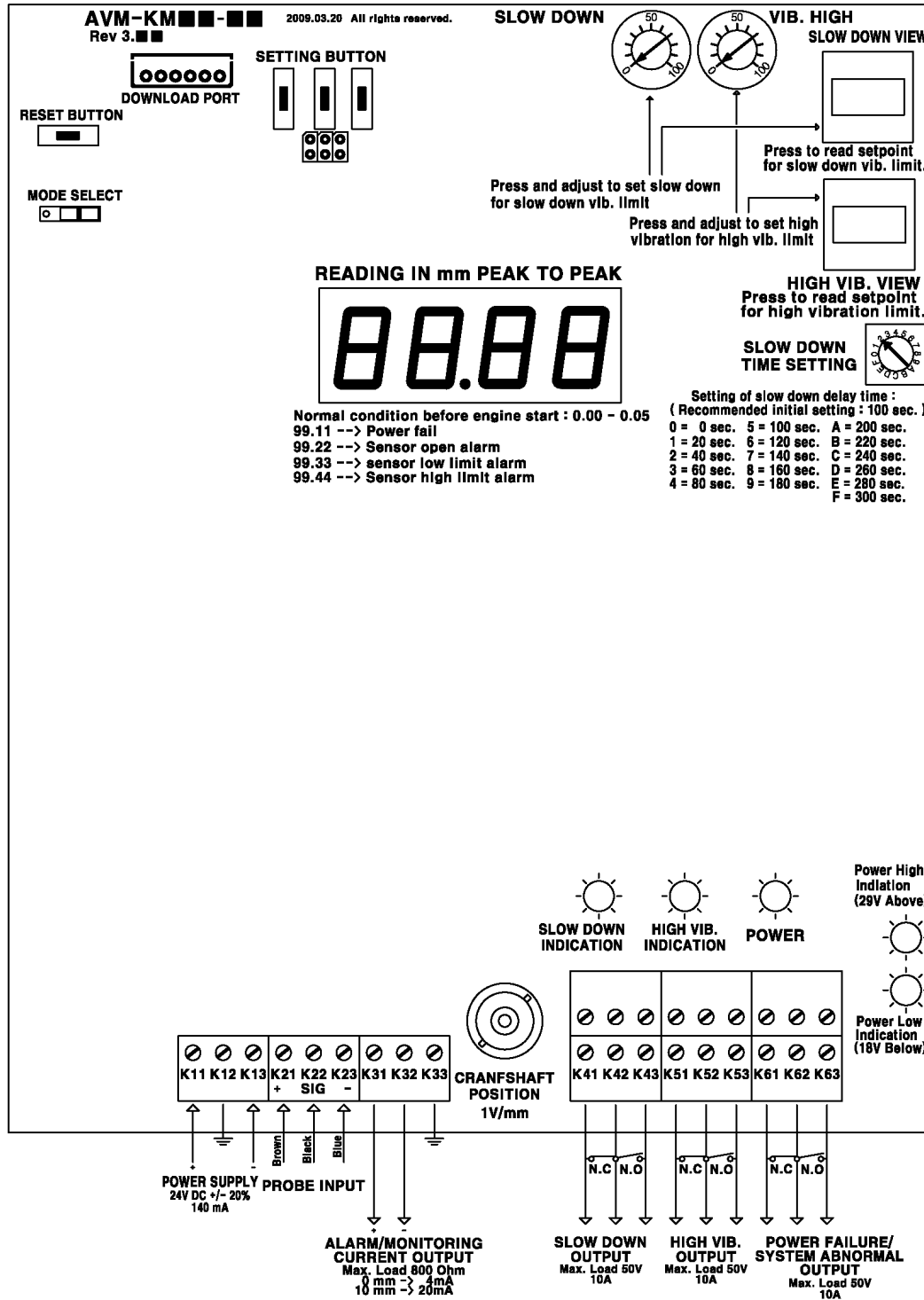


SYSTEM SET-UP

After mounting the probe and connecting the circuit board, the Axial Vibration Monitor is ready for set-up.

시스템 셋업

프로브를 장착한 후에 제어 유닛에 연결하면 시스템 셋업을 위한 준비가 된 것이다.



The installation procedure is following:

First, mount the axial vibration monitor (display unit) on an diesel engine.

Second, mount a sensor(probe) at desired mounting position properly, that is a distance from the target on engine crank case

Third, connect a sensor cable to monitor.

Fourth, turn on the power.

Fifth, read a current mounted position displayed on the monitor by pressing the both view buttons simultaneously.

Finally, please move the sensor just as much as difference between the desired mounting position and the current mounted position.

Please, repeat fifth and final procedures until a sensor is mounted at desired point.

설치 절차는 다음과 같다:

첫째, 모니터를 엔진 사이드에 설치한다.

둘째, 엔진크랭크 케이스에 센서를 적절한 위치에 설치한다. 즉 측정 대상물(크랭크샤프트)와 센서 사이의 거리를 2.5~15.5mm 범위 안에 적당히 설치한다.

셋째, 센서를 모니터에 결선한다.

넷째, 모니터에 전원을 공급한다.

다섯째, 두개의 셋팅값 확인 버튼을 동시에 누른 상태에서 센서설치를 확인한다.

마지막으로 원하는 위치와 설치된 센서와의 차이만큼 센서를 이동하여 원하는 위치에 센서를 설치한다.

SPECIFICATIONS

OPERATING TEMPERATURE RANGE	:	-10℃ to 60℃
OPERATING HUMIDITY	:	Less than 95% RH(Non-Condensing)
PROTECTION	:	IP67
MEASURING RANGE	:	Max. : 13.00 mm Peak to Peak(+/- 6.50 mm) Linearity : 13.00 mm Peak to Peak(+/- 6.50mm)
POWER SUPPLY	:	Supply voltage : 24 Volt DC +/- 20 % Max. current consumption : 140mA
PROBE	:	Type : Balluff BAW-030-PF-1-K Mounting distance ¹⁾ : 8.50 mm
ALARM/MONITORING CURRENT OUTPUT	:	Output : 4 ~ 20 mA Max. load : 200 Ohm 0 mm Peak to Peak → 4 mA 10 mm Peak to Peak → 20 mA > 10 mm Peak to Peak → 4 mA $I_{out}[mA] = 1.6 \times (\text{displacement in mm Peak to Peak}) + 4$ where, a displacement is lower than the 10 mm
SLOW DOWN OUTPUT	:	Potential free contact(NO, NC) Max. load : 24 Volt 1A
VIBRATION HIGH ALARM OUTPUT	:	Potential free contact(NO, NC) Max. load : 24 Volt 1A
POWER SOURCE&SYSTEM FAILURE OUTPUT	:	Potential free contact(NO, NC) Max. load : 24 Volt 1A
SLOW DOWN ADJUSTMENT	:	0.00 to 10.00 mm
VIBRATION HIGH ADJUSTMENT	:	0.00 to 10.00 mm
SLOW DOWN DELAY TIME	:	0 ~ 300 sec. adjustable in step of 20 sec.
CRANKSHAFT POSITION OUTPUT	:	Output voltage : 0 ~ 13 Volt Max. output current : 10 mA Output : 1.0 volt change per mm displacement of the crankshaft
ACCURACY	:	Probe input to display, crankshaft position output and alarm monitoring current output : +/- 5 % Slowdown delay time : +/- 2 %
WEIGHT	:	3.3kg
DIMENSION	:	157(W) × 195(H)

Note

- 1) : The user can install a probe at wanted mounting distance only if a distance between the crankshaft and the probe is not absolutely over the normal range. For example, it is 8.50 mm for an Man B&W diesel engine and is 7.00 mm for a sulzer type diesel engine. It is at user's option to select a cable length of the probe.

APPENDICES

AXIAL VIBRATION LIMITS FOR SAFE ENGINE OPERATION

1. AVM-KM18-XX
S26MC, L35MC, S35MC, L42MC, S42MC,
2. AVM-KM30-XX
S46MC-C, L50MC, S50MC, S50MC-C, L60MC,
L60MC-C, S60MC, S60MC-C, L70MC, L70MC-C,
S70MC, S70MC-C, K80MC-C, S80MC, S80MC-C,
K90MC, K90MC-C, S90MC-C, K98MC, K98MC-C,
S50ME-C, L60ME-C, S60ME, S60ME-C, S65ME-C,
L70ME-C, S70ME-C, K80ME-C, S80ME-C, K90ME,
K90ME-C, S90ME-C, K98ME, K98ME-C, K108ME-C,
K80ME-C9, S80ME-C9,

S35ME-B(Applied since Nov. 18, 2009).

(2011.02.25)

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Axial vibration limits for safe engine operation

All limits are PEAK to PEAK, actual values, in mm.

S26MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S26MC	0.62	0.82	1.03
5S26MC	0.77	1.02	1.28
6S26MC	0.92	1.22	1.53
7S26MC	1.08	1.44	1.80
8S26MC	1.23	1.64	2.05
9S26MC	1.38	1.84	2.31
10S26MC	1.54	2.05	2.56
11S26MC	1.69	2.25	2.82
12S26MC	1.84	2.46	3.07

L35MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L35MC	0.65	0.86	1.08
5L35MC	0.80	1.06	1.33
6L35MC	0.96	1.28	1.60
7L35MC	1.13	1.50	1.88
8L35MC	1.29	1.72	2.15
9L35MC	1.44	1.93	2.41
10L35MC	1.60	2.14	2.68
11L35MC	1.76	2.35	2.94
12L35MC	1.93	2.57	3.21

S35MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S35MC	0.94	1.25	1.56
5S35MC	1.17	1.56	1.95
6S35MC	1.40	1.87	2.34
7S35MC	1.64	2.18	2.73
8S35MC	1.88	2.50	3.13
9S35MC	2.11	2.81	3.51
10S35MC	2.34	3.12	3.90
11S35MC	2.57	3.43	4.29
12S35MC	2.81	3.74	4.68

L42MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L42MC	0.77	1.02	1.28
5L42MC	0.96	1.28	1.60
6L42MC	1.14	1.52	1.90
7L42MC	1.34	1.78	2.23
8L42MC	1.53	2.04	2.55
9L42MC	1.71	2.29	2.86
10L42MC	1.91	2.54	3.18
11L42MC	2.10	2.79	3.49
12L42MC	2.29	3.05	3.81

S42MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S42MC	1.15	1.53	1.91
5S42MC	1.44	1.92	2.40
6S42MC	1.73	2.30	2.88
7S42MC	2.01	2.68	3.35
8S42MC	2.30	3.07	3.84
9S42MC	2.59	3.45	4.31
10S42MC	2.87	3.83	4.79
11S42MC	3.16	4.22	5.27
12S42MC	3.45	4.60	5.75

S46MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S46MC-C	1.23	1.64	2.05
5S46MC-C	1.52	2.03	2.53
6S46MC-C	1.82	2.43	3.03
7S46MC-C	2.11	2.82	3.52
8S46MC-C	2.50	3.34	4.17

L50MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L50MC	0.92	1.22	1.53
5L50MC	1.14	1.52	1.90
6L50MC	1.37	1.82	2.28
7L50MC	1.59	2.12	2.65
8L50MC	1.82	2.42	3.03

S50MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S50MC	1.23	1.64	2.05
5S50MC	1.55	2.06	2.58
6S50MC	1.85	2.46	3.08
7S50MC	2.16	2.88	3.60
8S50MC	2.46	3.28	4.10

S50MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S50MC-C	1.26	1.69	2.11
5S50MC-C	1.56	2.09	2.61
6S50MC-C	1.87	2.50	3.12
7S50MC-C	2.17	2.90	3.62
8S50MC-C	2.55	3.41	4.26
9S50MC-C	2.87	3.83	4.78

L60MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L60MC	1.08	1.44	1.80
5L60MC	1.35	1.80	2.25
6L60MC	1.62	2.16	2.70
7L60MC	1.89	2.52	3.15
8L60MC	2.16	2.88	3.60

L60MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L60MC-C	1.20	1.60	2.00
5L60MC-C	1.49	1.99	2.48
6L60MC-C	1.77	2.37	2.96
7L60MC-C	2.07	2.76	3.45
8L60MC-C	2.36	3.15	3.93
9L60MC-C	2.65	3.54	4.42

S60MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S60MC	1.47	1.96	2.45
5S60MC	1.85	2.46	3.08
6S60MC	2.21	2.94	3.68
7S60MC	2.58	3.44	4.30
8S60MC	2.94	3.92	4.90

S60MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S60MC-C	1.52	2.03	2.53
5S60MC-C	1.88	2.51	3.13
6S60MC-C	2.25	3.00	3.75
7S60MC-C	2.61	3.49	4.36
8S60MC-C	3.07	4.10	5.12

L70MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L70MC	1.28	1.70	2.13
5L70MC	1.59	2.12	2.65
6L70MC	1.91	2.54	3.18
7L70MC	2.22	2.96	3.70
8L70MC	2.54	3.38	4.23

L70MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L70MC-C	1.41	1.88	2.35
5L70MC-C	1.74	2.32	2.90
6L70MC-C	2.08	2.78	3.47
7L70MC-C	2.42	3.23	4.03
8L70MC-C	2.76	3.68	4.60

S70MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S70MC	1.71	2.28	2.85
5S70MC	2.15	2.86	3.58
6S70MC	2.57	3.42	4.28
7S70MC	3.00	4.00	5.00
8S70MC	3.42	4.56	5.70

S70MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S70MC-C	1.77	2.36	2.95
5S70MC-C	2.19	2.92	3.65
6S70MC-C	2.62	3.50	4.37
7S70MC-C	3.05	4.07	5.08
8S70MC-C	3.58	4.78	5.97

K80MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K80MC-C	1.73	2.30	2.88
7K80MC-C	2.03	2.70	3.38
8K80MC-C	2.31	3.08	3.85
9K80MC-C	2.61	3.48	4.35
10K80MC-C	2.90	3.86	4.83
11K80MC-C	3.18	4.24	5.30
12K80MC-C	3.47	4.62	5.78

S80MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S80MC	1.95	2.60	3.25
5S80MC	2.45	3.26	4.08
6S80MC	2.93	3.90	4.88
7S80MC	3.42	4.56	5.70
8S80MC	3.90	5.20	6.50
9S80MC	4.40	5.86	7.33
10S80MC	4.88	6.50	8.13
11S80MC	5.37	7.16	8.95
12S80MC	5.87	7.82	9.78

S80MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6S80MC-C	2.99	3.98	4.98
7S80MC-C	3.45	4.59	5.74
8S80MC-C	4.06	5.40	6.75

K90MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4K90MC	1.44	1.92	2.40
5K90MC	1.80	2.40	3.00
6K90MC	2.16	2.88	3.60
7K90MC	2.54	3.38	4.23
8K90MC	2.90	3.86	4.83
9K90MC	3.26	4.34	5.43
10K90MC	3.62	4.82	6.03
11K90MC	3.98	5.30	6.63
12K90MC	4.34	5.78	7.23

K90MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K90MC-C	1.95	2.60	3.25
7K90MC-C	2.28	3.04	3.80
8K90MC-C	2.61	3.48	4.35
9K90MC-C	2.94	3.92	4.90
10K90MC-C	3.26	4.34	5.43
11K90MC-C	3.59	4.78	5.98
12K90MC-C	3.92	5.22	6.53

S90MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6S90MC-C	3.24	4.33	5.41
7S90MC-C	3.78	5.04	6.30
8S90MC-C	4.32	5.76	7.20
9S90MC-C	4.86	6.48	8.10

K98MC

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K98MC	2.28	3.05	3.81
7K98MC	2.66	3.55	4.43
8K98MC	3.03	4.05	5.06
9K98MC	3.41	4.55	5.68
10K98MC	3.78	5.05	6.31
11K98MC	2.77	3.70	4.62
12K98MC	4.54	6.06	7.57
14K98MC	5.30	7.06	8.83

K98MC-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K98MC-C	1.88	2.51	3.13
7K98MC-C	2.19	2.92	3.65
8K98MC-C	2.49	3.33	4.16
9K98MC-C	2.80	3.74	4.67
10K98MC-C	3.11	4.15	5.18
11K98MC-C	3.42	4.56	5.70
12K98MC-C	3.72	4.97	6.21
14K98MC-C	4.34	5.79	7.24

S50ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S50ME-C	1.27	1.70	2.12
5S50ME-C	1.57	2.10	2.62
6S50ME-C	1.88	2.51	3.13
7S50ME-C	2.23	2.98	3.72
8S50ME-C	2.55	3.40	4.25
9S50ME-C	2.87	3.83	4.78

L60ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L60ME-C	1.20	1.60	2.00
5L60ME-C	1.49	1.99	2.48
6L60ME-C	1.77	2.37	2.96
7L60ME-C	2.07	2.76	3.45
8L60ME-C	2.36	3.15	3.93
9L60ME-C	2.65	3.54	4.42

S60ME

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S60ME	1.47	1.96	2.45
5S60ME	1.85	2.46	3.08
6S60ME	2.21	2.94	3.68
7S60ME	2.58	3.44	4.30
8S60ME	2.94	3.92	4.90

S60ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S60ME-C	1.52	2.03	2.53
5S60ME-C	1.88	2.51	3.13
6S60ME-C	2.25	3.00	3.75
7S60ME-C	2.61	3.49	4.36
8S60ME-C	3.07	4.10	5.12

S65ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S65ME-C	1.84	2.46	3.07
5S65ME-C	2.28	3.04	3.80
6S65ME-C	2.72	3.63	4.53
7S65ME-C	3.17	4.23	5.28
8S65ME-C	3.61	4.82	6.02

L70ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4L70ME-C	1.41	1.88	2.35
5L70ME-C	1.74	2.32	2.90
6L70ME-C	2.08	2.78	3.47
7L70ME-C	2.42	3.23	4.03
8L70ME-C	2.76	3.68	4.60

S70ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4S70ME-C	1.77	2.36	2.95
5S70ME-C	2.19	2.92	3.65
6S70ME-C	2.62	3.50	4.37
7S70ME-C	3.05	4.07	5.08
8S70ME-C	3.58	4.78	5.97

K80ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K80ME-C	1.73	2.30	2.88
7K80ME-C	2.03	2.70	3.38
8K80ME-C	2.31	3.08	3.85
9K80ME-C	2.61	3.48	4.35
10K80ME-C	2.90	3.86	4.83
11K80ME-C	3.18	4.24	5.30
12K80ME-C	3.47	4.62	5.78

S80ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6S80ME-C	2.99	3.98	4.98
7S80ME-C	3.45	4.59	5.74
8S80ME-C	4.06	5.40	6.75

K90ME

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
4K90ME	1.44	1.92	2.40
5K90ME	1.80	2.40	3.00
6K90ME	2.16	2.88	3.60
7K90ME	2.54	3.38	4.23
8K90ME	2.90	3.86	4.83
9K90ME	3.26	4.34	5.43
10K90ME	3.62	4.82	6.03
11K90ME	3.98	5.30	6.63
12K90ME	4.34	5.78	7.23

K90ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K90ME-C	1.95	2.60	3.25
7K90ME-C	2.28	3.04	3.80
8K90ME-C	2.61	3.48	4.35
9K90ME-C	2.94	3.92	4.90
10K90ME-C	3.26	4.34	5.43
11K90ME-C	3.59	4.78	5.98
12K90ME-C	3.92	5.22	6.53

S90ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6S90ME-C	3.24	4.33	5.41
7S90ME-C	3.78	5.04	6.30
8S90ME-C	4.32	5.76	7.20
9S90ME-C	4.86	6.48	8.10

K98ME

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K98ME	2.28	3.05	3.81
7K98ME	2.66	3.55	4.43
8K98ME	3.03	4.05	5.06
9K98ME	3.41	4.55	5.68
10K98ME	3.78	5.05	6.31
11K98ME	2.77	3.70	4.62
12K98ME	4.54	6.06	7.57
14K98ME	5.30	7.06	8.83

K98ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K98ME-C	1.88	2.51	3.13
7K98ME-C	2.19	2.92	3.65
8K98ME-C	2.49	3.33	4.16
9K98ME-C	2.80	3.74	4.67
10K98ME-C	3.11	4.15	5.18
11K98ME-C	3.42	4.56	5.70
12K98ME-C	3.72	4.97	6.21
14K98ME-C	4.34	5.79	7.24

K108ME-C

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K108ME-C	2.10	2.80	3.50
7K108ME-C	2.45	3.26	4.08
8K108ME-C	2.79	3.72	4.65
9K108ME-C	3.13	4.18	5.22
10K108ME-C	3.48	4.64	5.80
11K108ME-C	3.82	5.10	6.37
12K108ME-C	4.17	5.56	6.95
14K108ME-C	4.86	6.48	8.10

K80ME-C9

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6K80ME-C9	2.28	3.03	3.79
7K80ME-C9	2.65	3.53	4.41
8K80ME-C9	3.02	4.03	5.03
9K80ME-C9	3.39	4.52	5.65
10K80ME-C9	3.77	5.02	6.28
11K80ME-C9	4.14	5.52	6.90
12K80ME-C9	4.51	6.02	7.52

S80ME-C9

Engine Type	Normal Value	Vib. High Alarm	Slow-Down
6S80ME-C9	3.46	4.62	5.77
7S80ME-C9	4.03	5.37	6.71
8S80ME-C9	4.59	6.12	7.65
9S80ME-C9	5.16	6.88	8.60

S35ME-B * *This type was applied since Nov. 18, 2009.*

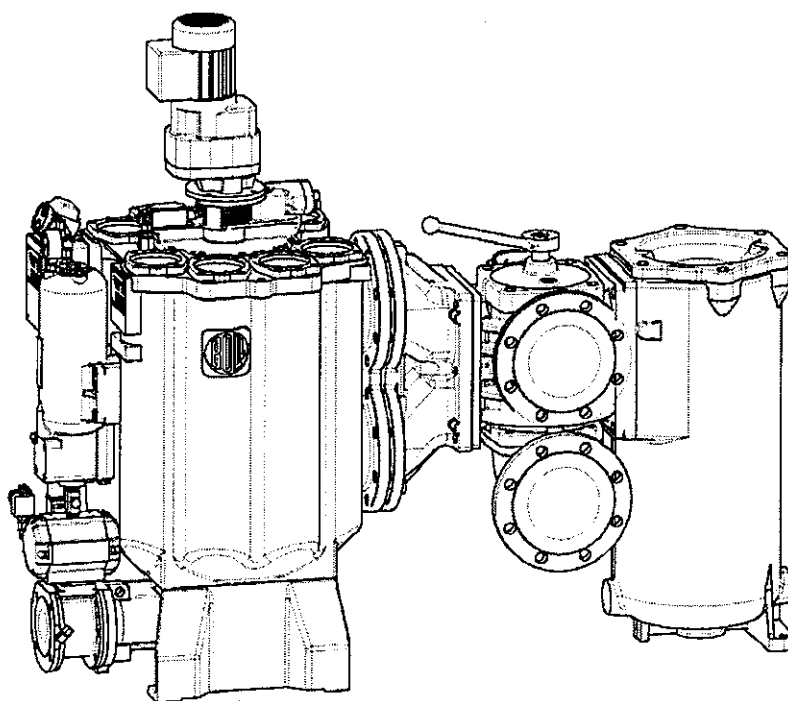
Engine Type	Normal Value	Vib. High Alarm	Slow-Down
5S35ME-B	1.14	1.51	1.89
6S35ME-B	1.36	1.81	2.26
7S35ME-B	1.57	2.10	2.63
8S35ME-B	1.80	2.40	3.00



BOLLFILTER
Protection Systems

Operating instructions for automatic filter

Type	6.64.1
Nominal diameter	DN 100 - DN 150
Filter element	Candle insert



BOLL & KIRCH
Filterbau GmbH

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Germany
www.bollfilter.de

Date	Version	Language	Order No.	Item No.
09.2008	001	GB	3899341	01



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1 Preamble

1.1 General

These operating instructions are designed to make it easier to get to know the BOLL & KIRCH filter and make use of its proper intended uses.

The operating instructions contain all important instructions on how to operate the filter safely, properly and economically. Adherence to the operating instructions helps to prevent hazards, repair costs and reduce down times and increase the reliability and even the serviceable life of the filter. Read the operating instructions carefully and attentively.

Supplement the operating instructions with any instructions required due to existing national and international regulations for the prevention of accidents and environmental protection. Make sure that the operating instructions are always available in the place of use for the filter. The operating instructions must be read and applied by every person given the task of performing the following work:

- transportation,
- installation,
- operation,
- maintenance and servicing,
- disposal of consumables.

1.2 Warranty and liability

The "General Terms and Conditions" of BOLL & KIRCH Filterbau GmbH apply.

BOLL & KIRCH Filterbau GmbH shall not recognise any warranty or liability claims for personal and material damages if they can be attributed to one or more of the following causes:

- improper use of the filter,
- failure to comply with the information and instructions in the operating instructions,
- arbitrary constructional modifications to the filter,
- insufficient monitoring of parts which are subject to wear and tear,
- maintenance/repair work performed improperly or too late,
- disasters caused by external influences or an act of God.

All the information in these operating instructions is provided to the best of our knowledge based on our prior experience. We reserve the right to make technical changes as part of further technical development.

The text and graphic illustrations do not necessarily correspond exactly to the actual delivery. Reference to any deviations is made in the respective place if required for comprehension. The graphic illustrations are not true to scale.

A list of spare parts is enclosed with the operating instructions for spare parts orders.



1.3 Copyright

These operating instructions are a certified document as per the terms of the law against unfair competition.

The copyright of the document is held by
BOLL & KIRCH Filterbau GmbH
Siemensstraße 10 - 14
50170 Kerpen
Germany

These operating instructions are for the user of the filter and the user's staff. They contain text and drawings which, without the express permission of the manufacturer must not be

- reproduced,
- distributed or
- otherwise made available to others, either in full or in part.

Failure to comply will require compensation.



2 Basic safety instructions

2.1 Proper use

The filter is constructed with state-of-the-art technology and according to the recognised rules of safety. However, use of the filter may result in risks to the life and limb of the user or third parties and/or damage to the filter or other objects of material value.

Only use the filter if it is in a technically perfect condition and only use it properly; paying due attention to safety and hazards, and in adherence to the operating instructions. It is particularly important to remedy any faults (or have them remedied), which may compromise safety.

The filter is designed for filtering liquid media only. The filter is intended for installation in pipes. The type of medium agreed in the order, and the limit values for operating pressure and temperature as set out in the technical data sheet, must be adhered to. Any other type of use or use going beyond this use, is regarded as improper use. The manufacturer/supplier shall not be liable for any damage caused as a result of improper use. The user bears the sole risk.

Proper use includes observance of the operating instructions and adherence to the inspection and maintenance conditions.

Operationally safe function is only ensured if all the instructions, settings and performance limits for the filter, are adhered to.

2.2 Warnings and symbols

The following designations and symbols are used in the operating instructions to denote particularly important information:



DANGER!

Denotes immediate hazard with high risk which will cause death or serious physical injury if not avoided.



WARNING!

Denotes possible hazard with medium risk which may cause death or serious physical injury if not avoided.



CAUTION!

Denotes a hazard with low risk which could cause light or medium physical injury or material damages if not avoided.



NOTE

Denotes special user tips and other particularly useful or important information.



DISPOSAL

Denotes special measures for environmental protection.



2.3 Target group

The operating instructions apply for use by qualified specialist staff only.

2.4 Obligations of the user/operator

- Always keep the operating instructions at hand at the place of use of the filter.
- Adhere to general legal and other binding regulations for the prevention of accidents and environmental protection, and provide supplementary instructions in the operating instructions accordingly. This type of obligation can apply to the handling of hazardous substances or the provision/wearing of personal safety clothing and equipment, for instance.
- Supplement the operating instructions with your own instructions, including supervision and reporting obligations for specific operational matters, e.g. with regard to organisation of work, working sequences and the appointed staff.
- Observe all existing safety instructions and hazard warnings on the filter.
- Keep all existing safety instructions and danger signs on the filter complete (in number) and in a legible condition.
- Do not make modifications of any kind to the filter which may compromise safety, without the permission of the manufacturer.
- The spare parts which are used must comply with the technical requirements set out by the manufacturer. This is always guaranteed by the use of original spare parts.
- The user is responsible for the selection of materials and the chemical resistance of the installed components, internal linings and coatings. The user must specify the technical details when ordering the filter.

2.5 Selection and qualifications of staff

- All work on the filter must be performed exclusively by reliable staff. Staff must not be under the influence of drugs or medication. Adhere to the legal minimum age requirement.
- Only appoint trained staff or staff who have received appropriate instruction. Clearly delegate the areas of responsibility of staff for installation, operation and maintenance and servicing.



2.6 Organisational measures

2.6.1 General

- Follow the respective valid national and international regulations for the prevention of accidents.

2.6.2 Maintenance and servicing

- Adhere to the maintenance tasks and intervals set out in the operating instructions, including instructions on the replacement of parts/equipment.
- Only use original spare parts.
- If the installed type of filter is subject to a regular inspection by an inspection and testing organisation, with regard to temperature, steam pressure and the dangerousness of the medium, the inspection periods must be adhered to by the user.

2.7 Consumables

- Observe the regulations for environmental protection. Make sure that consumables are disposed of properly and in an environmentally friendly manner.

2.7.1 Filtered media

- When handling media which are to be filtered, make sure you follow the respective safety regulations for the media.

2.7.2 Cleaning agents

- When handling the cleaning agents, make sure you follow the respective safety regulations for the cleaning agents.



3 Transportation and storage

3.1 Transportation



DANGER!

Risk of accidents from falling loads

During transportation of the filter, accidents may occur due to sizes and weights.

- Exercise extreme caution when transporting the filter in order to prevent damage to or deformation of the filter.
- Only use suitable means of transport and lifting gear with sufficient load-bearing capacity.
- Do not stand underneath suspended loads. Do not work underneath suspended loads.
- Wear the appropriate safety equipment and clothing.

3.2 Storage



CAUTION!

Improper storage will cause damage to the filter and filter elements

If stored incorrectly and improperly, moisture and contamination, for example, may cause damage to the filter and the filter elements.

- Protect the filter and filter elements from moisture and contamination during storage.
- Do not store the filter below the frost line.
- If the filter has been stored for more than one year, check that all seals are fully functional before installation.

3.3 Packaging material



CAUTION!

Risk of explosion from electrostatic charge

Packaging material, such as paper or plastic, can become statically charged and generate sparks when discharged.

- Remove the packaging material before transportation into an explosion protected zone.



DISPOSAL

Observe the regulations for environmental protection. Make sure that the packaging material is disposed of properly and in an environmentally friendly manner.



4 Scope of delivery

Immediately after receiving the delivery, check that the content is not damaged and that it corresponds to the scope of the order. In case of discrepancies, contact the manufacturer.



5

Technical data



NOTE

The filter described in these operating instructions is a combination of an automatic filter and a bypass filter. The switchover between the two filters is performed using a segmented plug valve.



NOTE

You will find the technical data in the appendix of these operating instructions.

5.1

Type plate

The type plate is on the filter. You can read the maximum permitted operating pressure and the maximum / minimum operating temperature from the type plate.



NOTE

When making enquiries or ordering spare parts, always provide the information on the type plate.

5.2

Overview of automatic filter assembly group



NOTE

The description of assembly groups can be found in the "Operation" chapter of these operating instructions.

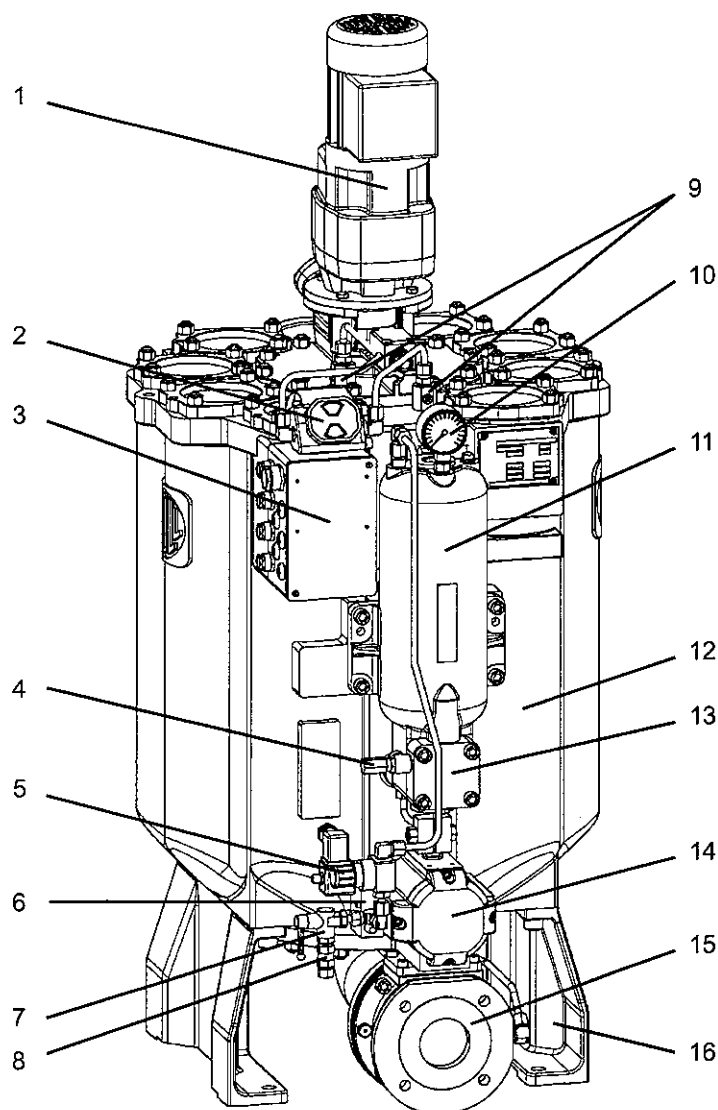


Fig. 5-1 Overview of assembly groups (exterior view I)

1	Gear motor	9	Shut-off valve
2	Differential pressure monitoring system	10	Pressure gauge
3	Junction box	11	Air tank
4	Safety valve	12	Housing
5	Pressure control valve	13	Air valve
6	Solenoid valve	14	Pivoting actuator
7	Ball valve	15	Flushing valve
8	One-way restrictor valve	16	Floor fastening

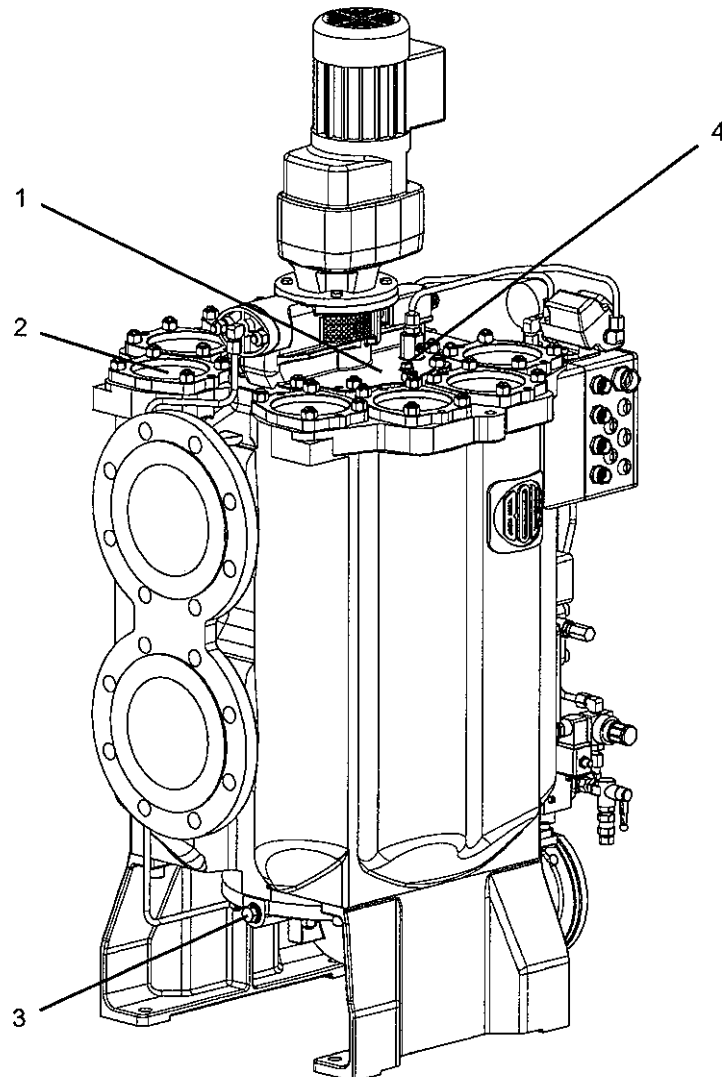


Fig. 5-2 Overview of assembly groups (exterior view II)

1	Change-over housing cover	3	Draining
2	Cover	4	Vent



NOTE

On filters 6.64 DN 100 and DN 125, the vent is located on the housing above the air tank.

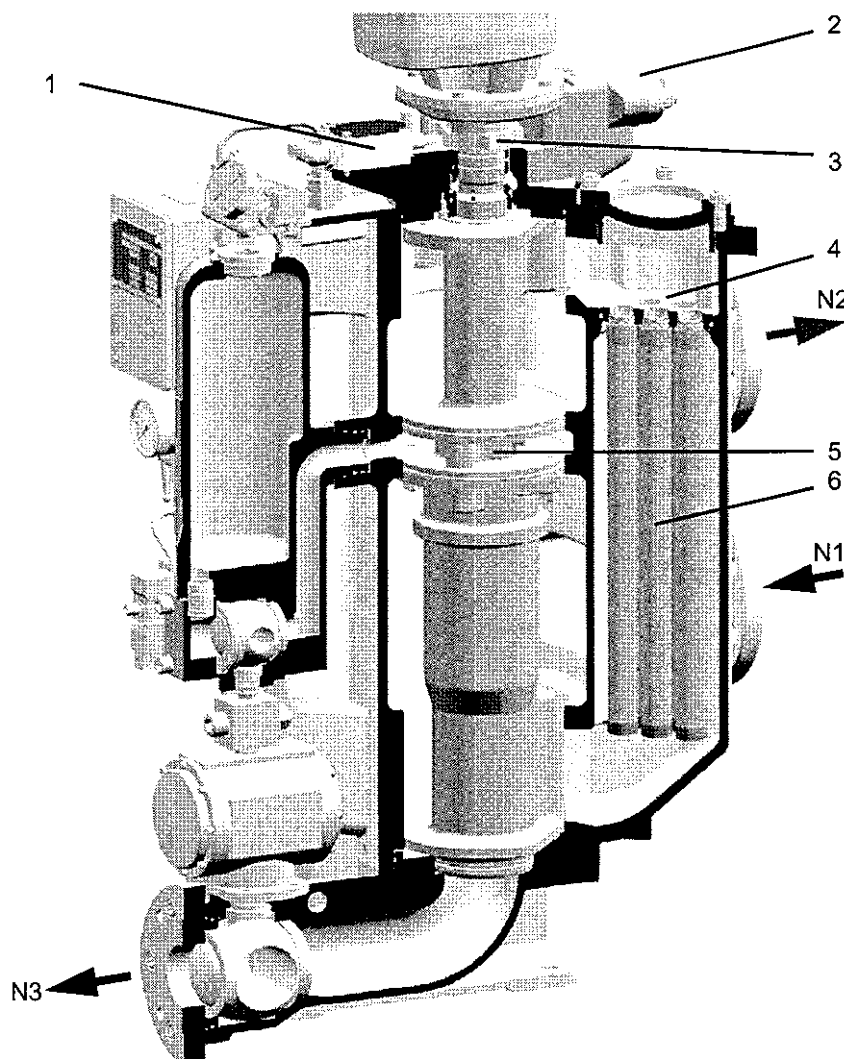


Fig. 5-3 Overview of assembly groups (cross sectional view)

- | | | | |
|---|------------------|----|---------------------|
| 1 | Limit switch | 6 | Filter candle |
| 2 | Vent (automatic) | N1 | Filter inlet |
| 3 | Cam disc | N2 | Filter outlet |
| 4 | Sieve plate | N3 | Flushing oil outlet |
| 5 | Plug valve | | |



5.3 Overview of segmented plug valve assembly group

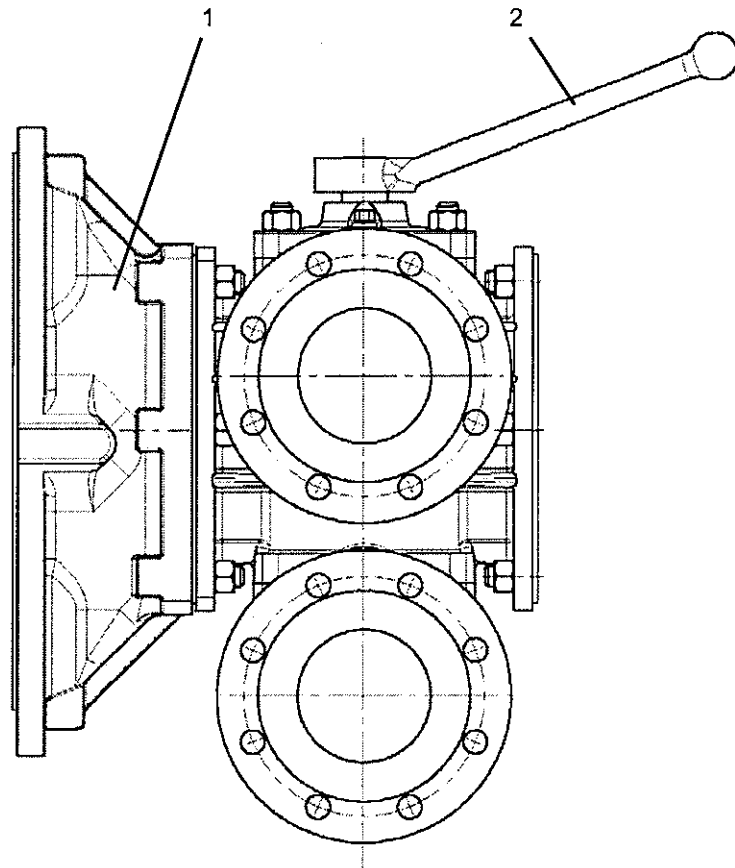


Fig. 5-4 Overview of assembly groups (view)

- 1 Intermediate piece
- 2 Wrench

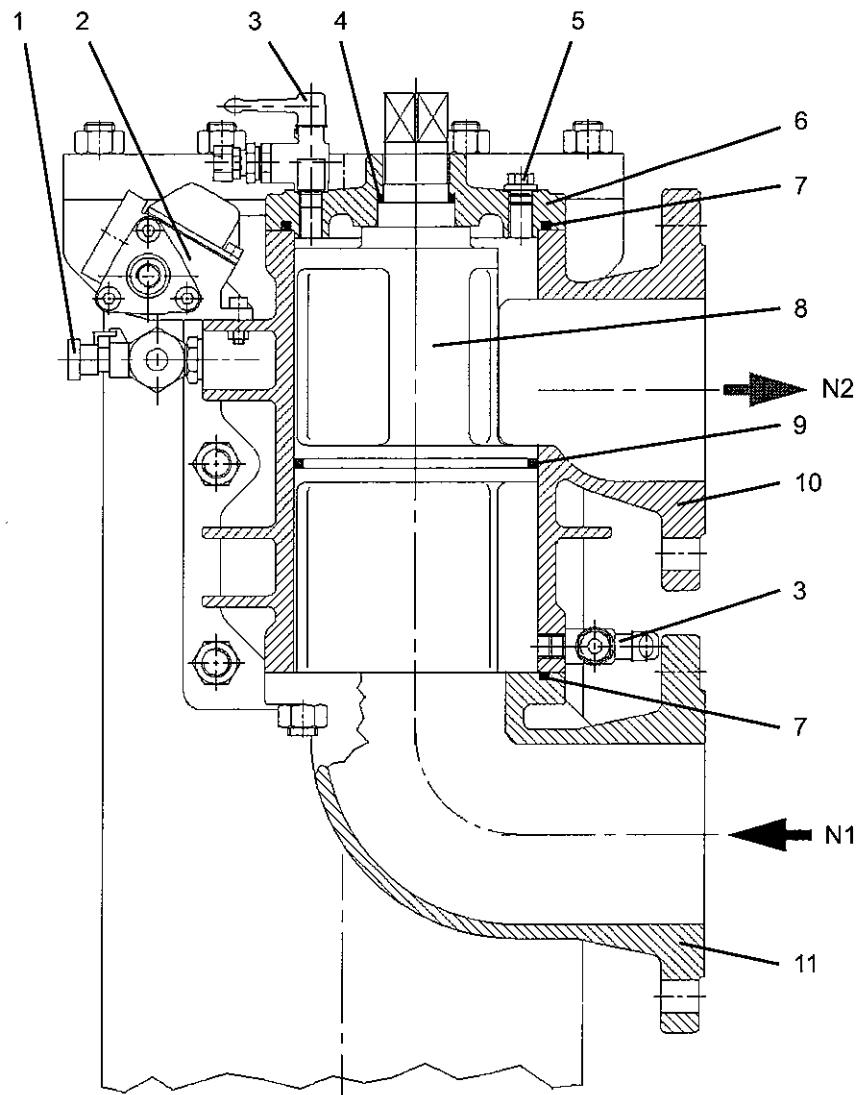


Fig. 5-5 Overview of assembly groups (cross sectional view)

1	Pressure compensation	8	Plug valve
2	Differential pressure monitoring system	9	Seal
3	Ball valve	10	Valve housing
4	Seal	11	Angled inlet
5	Vent	N1	Filter inlet
6	Valve housing cover	N2	Filter outlet
7	Seal		



NOTE

The differential pressure monitoring system is used to monitor the bypass filter.



5.4 Overview of bypass filter assembly group

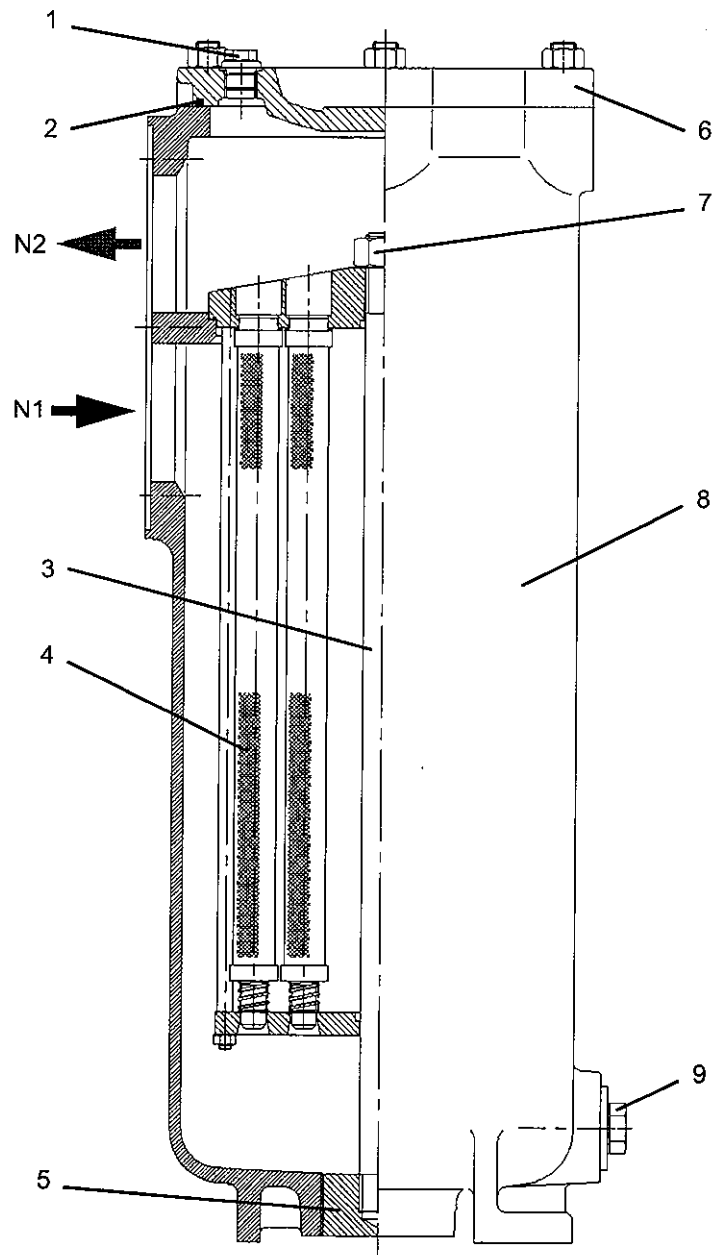


Fig. 5-6 Overview of assembly groups

1	Vent	7	Nut
2	Seal	8	Housing
3	Filter element anchor	9	Draining
4	Filter element	N1	Filter inlet
5	Threaded plug	N2	Filter outlet
6	Cover		



6 Installation

6.1 Special safety instructions



DANGER!

Risk of accidents from improper installation

Incorrect installation and failure to observe the listed safety instructions can lead to accidents and material damage.

Make sure of the following:

- The filter must be installed by qualified specialist staff or persons who have received appropriate instruction.
- Wear the appropriate safety equipment and clothing.
- Only use suitable lifting gear with sufficient load-bearing capacity.
- Only use lifting gear on the provided suspension points (if available).
- Use lifting gear in such a way that the filter does not become damaged.
- Raise the filter evenly. Avoid tilting.
- Do not stand underneath suspended loads. Do not work underneath suspended loads.
- Additional devices to prevent maximum temperatures being exceeded and temperatures dropping below the minimum and for compensation and relief of overpressure, must be provided by the user throughout the entire system of the plant. Observe the minimum and maximum permitted operating temperatures and pressure values for the filter.
- Additional devices for monitoring the ambient temperature of the filter must be provided by the user throughout the entire system of the plant.
- Install a ground cable with a cross section of at least 10 mm² as a potential equalisation for the filter.



NOTE

Contact the manufacturer with any special questions you may have regarding installation. The contact data for the respective national subsidiaries can be found in the appendix of the operating instructions.



6.2 Filter installation



CAUTION!

Risk of damage to the filter housing

The filter housings are only designed for internal overpressure.

- The housing and connection flanges of the filter must not be exposed to any external force or moment.

6.2.1 Floor fastening

- ▶ Make sure the foundation has sufficient load bearing capacity.
- ▶ Make sure that there is sufficient space in the vicinity of the filter for maintenance and servicing work and replacing filter elements.
- ▶ Align the filter.
- ▶ Screw the filter housing to the fastening points. When fastening the filter in place, the filter housing must not be twisted.

6.2.2 Identifying the flow direction



NOTE

- The filter inlet/outlet and flushing oil outlet are indicated by the inscriptions (Ein/In), (Aus/Out) and (Spülölaustritt/Flushing oil).
- The direction of flow is also shown in the technical data sheet which is included in the appendix of these operating instructions.

6.2.3 Filter inlet/outlet pipe connections

- ▶ Establish the connections between the filter and piping.
- ▶ Use the appropriate seals.
- ▶ The pipes for the filter inlet and outlet may need to be provided with additional supports, depending on the installation conditions. When installing the piping, the filter housing must not be twisted.

6.2.4 Flushing oil outlet pipe connection

- ▶ Establish the connection between the flushing oil outlet and piping.
- ▶ Use the appropriate seal.
- ▶ Select a pipeline cross section which is at least equal in size to the pipeline cross section shown in the technical data sheet. A cross section which is too small may cause backpressure. The pipe must also be laid with an inclination and without any counterpressure.
- ▶ The pipeline may need to be provided with additional supports, depending on the installation conditions. When installing the piping, the housing must not be twisted.



6.2.5 Filter heater (optional)

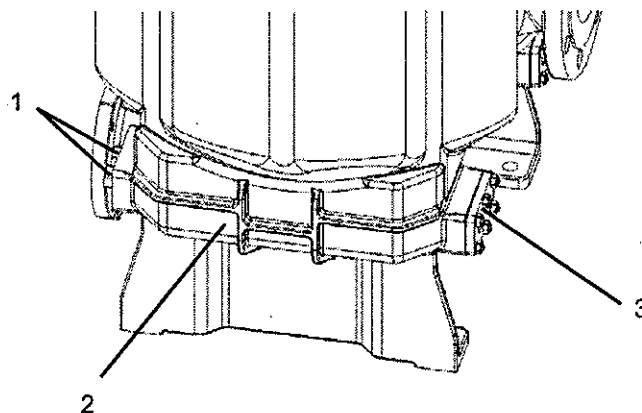


Fig. 6-1 Automatic filter heater (optional)

- 1 Piping connection
- 2 Filter heater (optional)
- 3 Screw plug

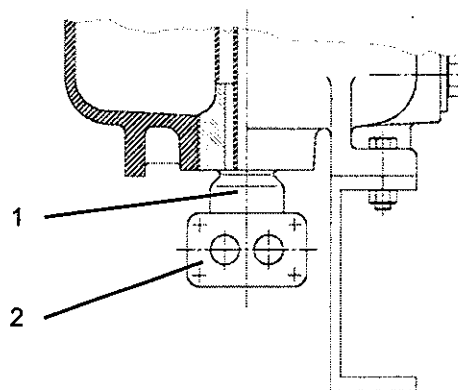


Fig. 6-2 Bypass filter heater (optional)

- 1 Threaded plugs with filter heater (optional)
- 2 Piping connection

The filter heating is used during the filtering process to cover heat loss in the filter and before starting up the plant in order to heat up the medium in the filter. The filter can be heated with water vapour, warm water or thermal oil.



DANGER!

Risk of accidents from expelled hot medium

Too much pressure in the heating system can cause hot medium to be expelled and lead to damage to the filter and accidents.

- Adhere to the maximum permitted operating temperature and operating pressure for the filter heater.

- Connect the medium-carrying pipes to the filter heater on the plant side. Welded joints must be made in line with the valid regulations.

6.2.6

Connection of compressed air supply

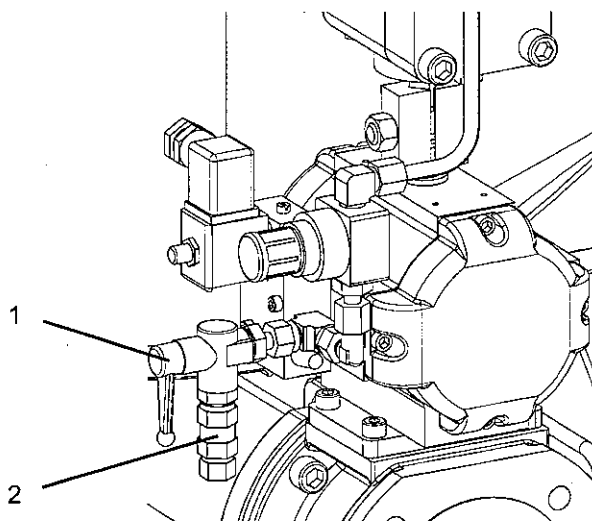


Fig. 6-3 Connection of compressed air supply

- 1 Ball valve
- 2 One-way restrictor valve

- Connect the plant's compressed air supply line to the one-way restrictor valve on the ball valve.



6.2.6.1 Pneumatic diagram

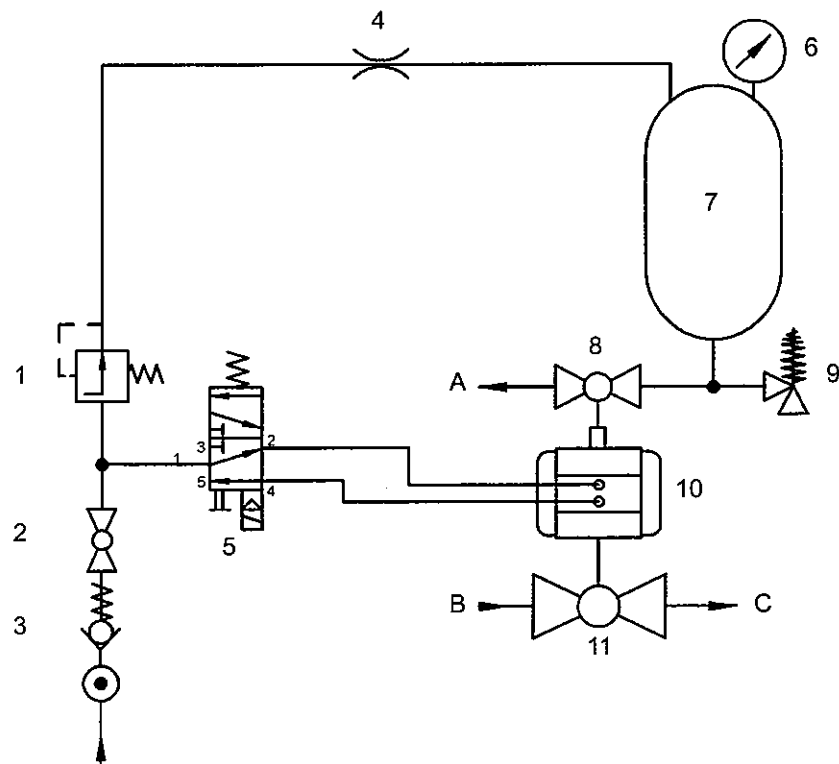


Fig. 6-4 Pneumatic diagram

- | | | | |
|---|--------------------------|----|---------------------|
| 1 | Pressure control valve | 8 | Air valve |
| 2 | Ball valve | 9 | Safety valve |
| 3 | One-way restrictor valve | 10 | Pivoting actuator |
| 4 | Nozzle | 11 | Flushing valve |
| 5 | Solenoid valve | A | to the filter |
| 6 | Pressure gauge | B | from the filter |
| 7 | Air tank | C | Flushing oil outlet |



6.2.7

Electrical connections



DANGER!

Risk of accidents from electric shock

When connecting to the power supply, the supply voltage can cause accidents from electric shock.

- All the electrical connections on the filter must be made by a qualified electrician and in line with the rules of electrical engineering.

Controller



NOTE

If you are using a BOLL & KIRCH Filterbau GmbH controller, you will find more detailed information in the documentation for the controller.

If you are using your own controller or another manufacturer's controller, the respective documentation must be followed.

Differential pressure monitoring system, electrical



NOTE

You will find more detailed information on the differential pressure monitoring system in the appendix of these operating instructions or in the manufacturer's documentation.



NOTE

BOLL & KIRCH Filterbau GmbH differential pressure indicators have potential-free contacts.

6.2.8

Potential equalisation

- For potential equalisation, install a ground cable with a cross section of at least 10 mm² on the filter.
- Connect the ground cable to the fastening screw on the filter. If necessary, prior to the installation of the ground cable, remove the paint from the fastening point to ensure sufficient electrical contact.



7 Operation

7.1 Functional description of the automatic filter

The filter is used to filter particles from media in order to protect the downstream parts of the plant.

The filter candles are cleaned automatically so that the plant does not have to be switched off for cleaning.

7.1.1 Filter housing

The filter housing contains all the pipe connections and assembly groups of the backflushing device, the vent, drain hole and the connection points for the pressure monitoring system.

The filter chambers are arranged in a circle around the central drilled hole for fitting the plug valve. The filter chambers are sealed by a single cover.

7.1.2 Controller

The controller regulates and monitors all automatic filter functions.



NOTE

If you are using a BOLL & KIRCH Filterbau GmbH controller, you will find more detailed information in the documentation for the controller.

If you are using your own controller or another manufacturer's controller, the respective documentation must be followed.

7.1.3 Differential pressure monitoring system

The differential pressure monitoring system measures the differential pressure between the filter inlet and filter outlet. As the contamination increases, the differential pressure in the filter also increases.

The controller processes the electrical signals from the differential pressure monitoring system and triggers backflushing when the set maximum value is reached.



NOTE

- You will find more detailed information on the differential pressure monitoring system in the appendix of these operating instructions or in the manufacturer's documentation.
- The differential pressure can also be displayed optically on the differential pressure monitoring system.
- The control line to the differential pressure monitoring system can be fitted with optional shut-off fittings, e.g. shut-off valves.



7.1.4 Air tank

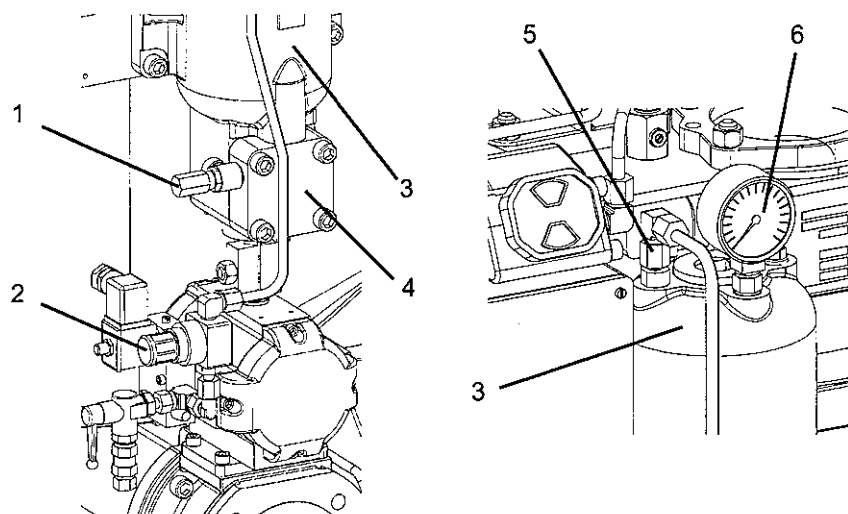


Fig. 7-1 Overview of the air tank

- | | | | |
|---|------------------------|---|----------------|
| 1 | Safety valve | 4 | Air valve |
| 2 | Pressure control valve | 5 | Nozzle |
| 3 | Air tank | 6 | Pressure gauge |

The compressed air in the air tank expands explosively when the air valve is opened. The flow which this causes, pushes the medium on the clean side of the filter candles through the mesh of the filter candles in the counterflow direction at high speed. The pressure level in the air tank can be read from the pressure gauge and set using a pressure control valve. The air tank is equipped with a safety valve to prevent the air tank from being damaged by excess pressure.

7.1.5 Gear motor with limit switch

If the pressure gradient between the dirty side and the clean side reaches a set value due to the growing layer of dirt on the filter mesh, the automatic filter chamber regeneration is triggered. The gear motor turns the plug valve so that the flow to one of the contaminated filter chambers is shut off and, at the same time, the stand-by filter chamber is activated. Once the plug valve reaches the filter chamber which is to be cleaned, a cam and limit switch stop the turning movement.

7.1.6 Backflushing line

The particles flushed out of the filter candles are discharged via the backflushing line. The flushing valve opens or seals off the backflushing line.



7.1.7 Filtration stage

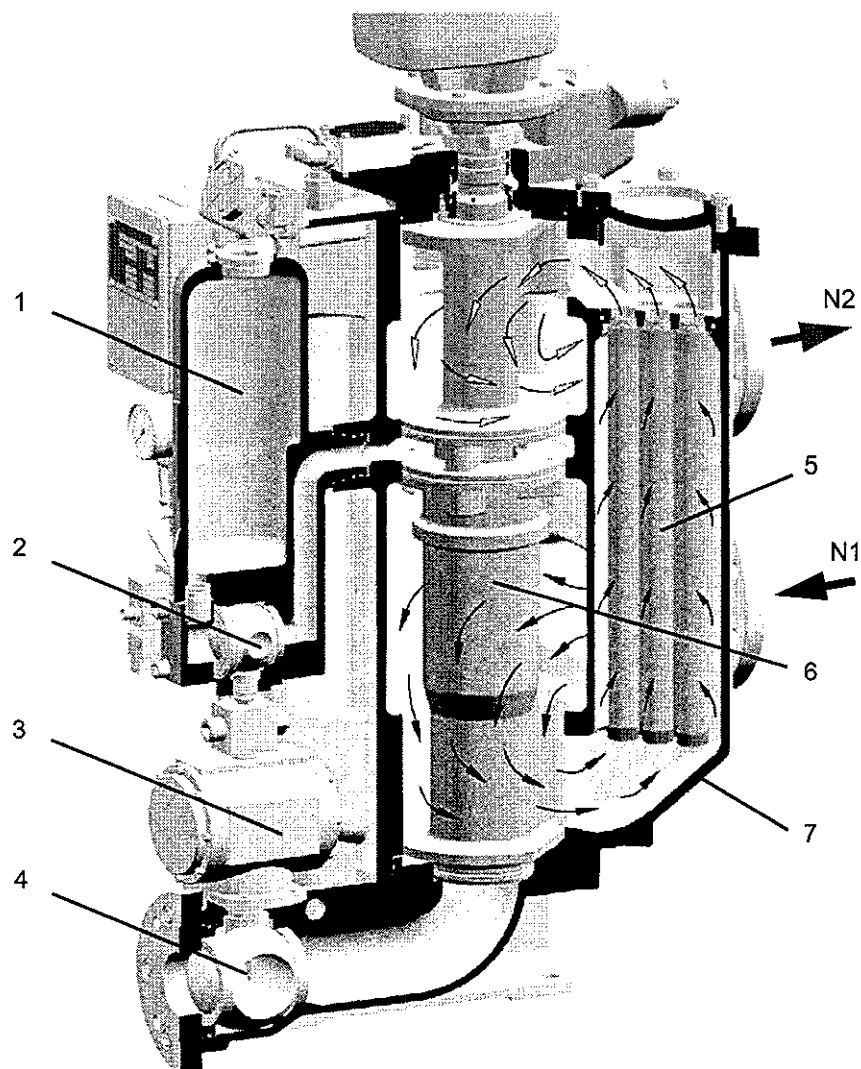


Fig. 7-2 Filtration stage

- | | | | |
|---|-------------------|----|---------------|
| 1 | Air tank | 6 | Plug valve |
| 2 | Air valve | 7 | Housing |
| 3 | Pivoting actuator | N1 | Filter inlet |
| 4 | Flushing valve | N2 | Filter outlet |
| 5 | Filter candle | | |



The medium being filtered flows through the lower inlet flange into the housing, from where it flows into the individual filter chambers and to the filter candles. The medium flows through the filter candles from the outside to the inside and the particles in the medium are held back on the mesh of the filter candles.

The cleaned medium proceeds to the filter outlet above.

The solenoid valve is switched so that the pivoting actuator keeps the air valve and the flushing valve closed.

The plug valve isolates one of the cleaned filter chambers.

In the air tank, compressed air is available for the next backflushing.



7.1.8 Backflushing stage

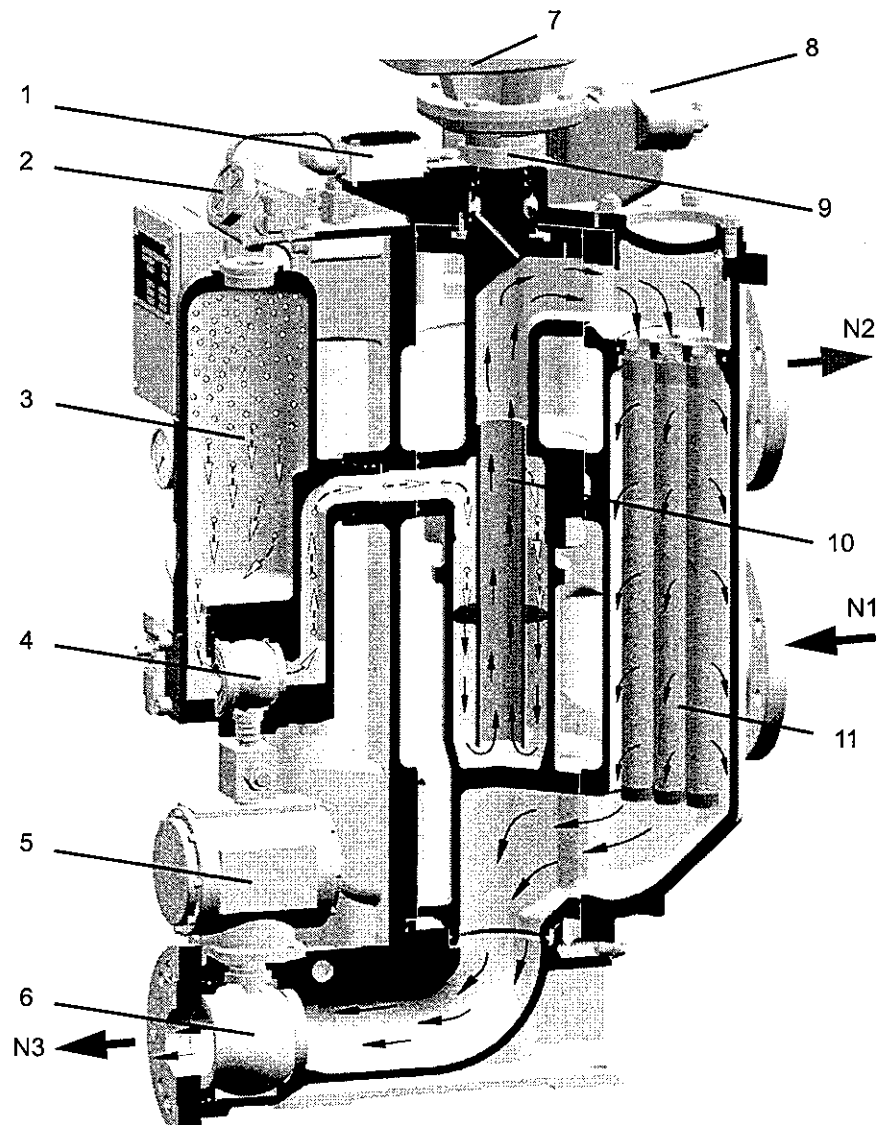


Fig. 7-3 Backflushing stage

1	Limit switch	8	Vent (automatic)
2	Differential pressure monitoring system	9	Cam disc
3	Air tank	10	Plug valve
4	Air valve	11	Filter candle
5	Pivoting actuator	N1	Filter inlet
6	Flushing valve	N2	Filter outlet
7	Gear motor	N3	Flushing oil outlet



The foreign substances held back on the filter candles generate a growing differential pressure between filter inlet and outlet.

Backflushing is triggered by the controller when the differential pressure reaches a certain value.

When backflushing is triggered the gear motor is switched on and the plug valve is turned from the filter chamber on stand-by to the nearest contaminated filter chamber.

The activation of the stand-by filter housing with the clean filter candles causes an immediate differential pressure relief. Once the plug valve reaches the filter chamber which is to be cleaned, a cam disc and limit switch stop the turning movement.

The solenoid valve is then switched over electrically and the air valve and the flushing valve are opened simultaneously by the pivoting actuator. The compressed air in the air tank is expelled abruptly into the internal cavity in the plug valve and pushes the medium through the filter candles at high speed, in the opposite direction to the direction of filtration. This dislodges deposited particles of dirt from the mesh and discharges them through the flushing valve with the fluid in the filter chamber.

The flushing valve and the air valve are then closed by the pivoting actuator. The air tank is re-filled with compressed air.

The filter chamber is filled with cleaned medium through a drilled hole on the clean side of the plug valve. In the process, the air in the filter chamber is discharged by an automatic vent. During this filling time, a further backflushing process cannot be started because the controller disables this action. The backflushing process is completed; the cleaned filter chamber remains shut off from the filtration process until the next backflushing process.



CAUTION!

Risk of damage to the filter from improper flushing

Flushing an only partially filled filter causes increased strain on the filter candles.

- Never perform backflushing due to installation or control circumstances in an only partially filled filter. A completely empty filter can be flushed for test purposes without any restrictions.
-



7.2 Functional description of segmented plug valve

The segmented plug valve circuit is used to switch between the connected automatic and bypass filter.

The special shape of the plug valve prevents interruptions in the flow of medium and pressure surges when switching over and, at the same time, guarantees freedom of movement due to lower levels of frictional force.

The plug valve only requires seals in two positions; on the large washer and on the plug valve neck.

The switch-over is performed manually using the attachable lever. The mark sawn into the neck of the plug valve shows the direction of flow and indicates which filter is in operation. The construction of the circuit prevents both filter from being shut down at the same time. A pressure compensation valve is fitted to the segmented plug valve to compensate pressure between the two connected filters. It is opened and closed manually. The valve housing can be bled through the vent. The attached differential pressure monitoring system is the filter's contamination indicator of the connected bypass filter.

7.2.1 Plug valve circuit

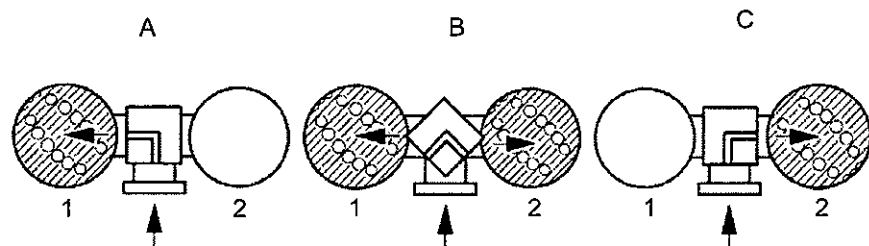


Fig. 7-4 Position of segmented plug valve

- 1 Automatic filters
- 2 Bypass filter
- A Automatic filter in operation
- B Automatic filter and bypass filter in operation
- C Bypass filter in operation



7.2.2

Pressure compensation



CAUTION!

Risk of damage or expelled medium if the pressure compensation is positioned incorrectly

Depending on the operating stage, if the pressure compensation valve is in the wrong position, medium may be expelled or damage may be caused.

- The pressure compensation valve must always remain open during operation.
- Before opening a filter the pressure compensation valve must be closed so that no medium flows when the filter is open.

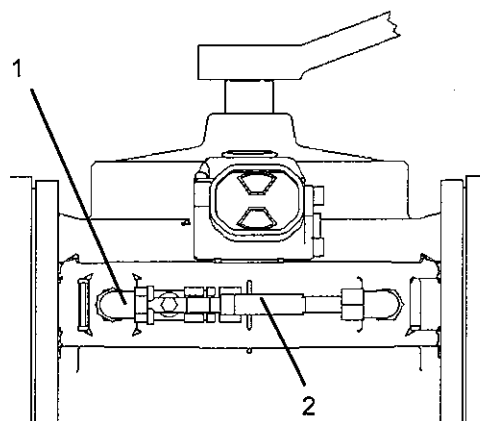


Fig. 7-5 Pressure compensation

- 1 Pressure compensation
- 2 Pressure compensation valve

Lever pointing
lengthways along the line

Pressure compensation valve open

Lever pointing across the
line

Pressure compensation valve closed



7.3 Functional description of the bypass filter

The bypass filter is used to filter particles from media in order to protect the downstream parts of the plant. The bypass filter is used in situations in which the filtering process must not be stopped even whilst maintenance or repairs are being performed on the automatic filter.

The medium being filtered flows through the lower inlet flange into the housing, from where it flows into the filter chambers. The medium flows through the filter element from the outside to the inside and the particles in the medium are held back on the mesh of the filter element.

The cleaned medium proceeds to the filter outlet above.

The bypass filter is monitored by the differential pressure monitoring system on the segmented plug valve.

7.3.1 Differential pressure monitoring system

The differential pressure monitoring system measures the differential pressure between the filter inlet and filter outlet. As the contamination in the filter element increases, the differential pressure in the filter also increases.

The differential pressure monitoring system indicates the differential pressure optically and/or provides electrical signals for further processing.



NOTE

- You will find more detailed information on the differential pressure monitoring system in the appendix of these operating instructions or in the manufacturer's documentation.
 - The control line to the differential pressure monitoring system can be fitted with optional shut-off valves, e.g. ball valves.
-



7.3.2 Housing cover safety device (optional)

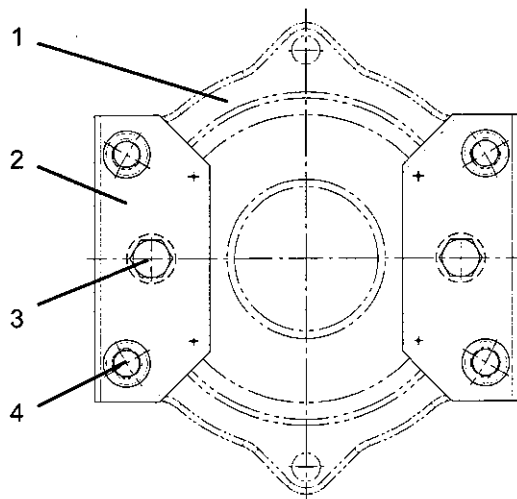


Fig. 7-6 Housing cover safety device (optional)

- 1 Cover
- 2 Housing cover safety device (optional)
- 3 Vent
- 4 Cover screw

The housing cover safety device has the task of preventing pressurised medium from being expelled uncontrolled in case of incorrect operation. The cover sheet covers a minimum number of cover screws so that the cover cannot be removed without opening the vent to bleed the system.

The filter chamber is relieved via the vent. When the filter is shut off, the operating pressure is immediately relieved and hardly any medium is expelled. Otherwise, close the vent immediately and the expulsion of medium is limited.



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the vent.

- Proceed with extreme caution.
- Wear the appropriate safety equipment and clothing.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.



7.4 Filter element (Automatic filter)

7.4.1 Candle insert

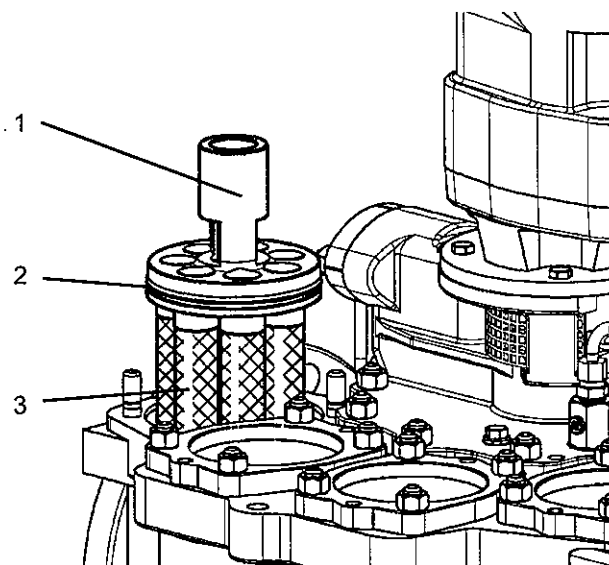


Fig. 7-7 Candle insert construction

- 1 Sieve plate
- 2 Seal
- 3 Filter candle

7.4.2 Functional description of candle insert

Candle inserts are used for filtration. The flow runs from the outside to the inside into the individual filter candles.

Particles of dirt in the flow are thus filtered off by the filter candles. The cleaned medium exits from the top of the filter candles and is fed back into the plant.

The candle insert comprises several filter candles arranged in parallel. The filter candles all have the same dimensions; they are interchangeable and can also be removed separately. They are screwed into the sieve plate.

The type of filter candles used depends on the medium being filtered.

For media with a high ferrite content, a filter candle in the middle of the candle insert can be replaced with an optional magnetic primary filter.

The sieve plate secures the filter candles and thus protects the mesh of the filter candles from damage during removal and installation.

The dirty side is sealed off from the clean side by seal on the sieve plate.

7.5 Bypass filter filter element



7.5.1 Star-pleated filter element

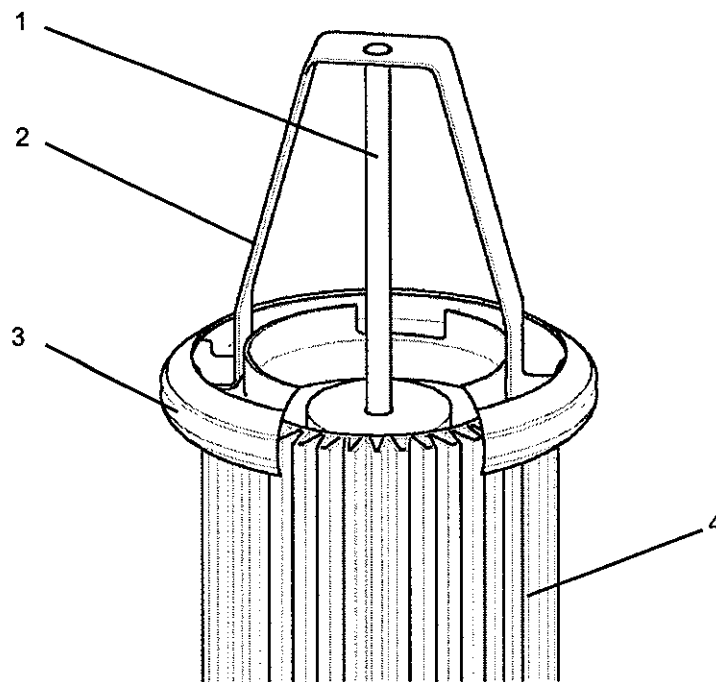


Fig. 7-8 Construction of star-pleated filter element

- 1 Magnetic insert (optional)
- 2 Filter element clamp
- 3 Seal
- 4 Sieve mesh



7.5.2 Functional description of the star-pleated filter element

Star-pleated filter elements are used for filtration. The flow runs from the outside to the inside.

Particles of dirt in the flow are thus filtered off by the star-pleated filter element and held back in the sieve mesh outside. The cleaned medium then exits from the star-pleated filter element and is fed back into the plant.

The filter element clamp fastens the star-pleated filter element in the filter chamber.

The dirty side is sealed off from the clean side by a seal.

Construction and function of the magnetic insert (optional)

For media with a high ferrite content, it is recommendable to equip the star-pleated filter element with a magnetic insert.

The magnetic insert comprises a cylinder-shaped magnet which is mounted on a metal bar. The top end of the magnetic insert has a thread for connecting it to the filter element clamp.

The magnetic insert is removed for cleaning and the collected dirt particles can be easily removed.



7.6

Commissioning



NOTE

If you are using a BOLL & KIRCH Filterbau GmbH controller, you will find more detailed information in the documentation for the controller.

If you are using your own controller or another manufacturer's controller, the respective documentation must be followed.

- ▶ Check whether all connections have been made properly.
- ▶ Check that the segmented plug valve circuit moves freely. Attach the lever and move it several times from one limit stop position to the other.
- ▶ Attach the lever to the segmented plug valve and set the plug valve to the "Automatic filter in operation" position.
- ▶ Open the shut-off valves (if available) in the control lines to the differential pressure monitoring systems.
- ▶ Open the pressure compensation valve (lever pointing lengthways along the line).
- ▶ Make sure that there is compressed air with sufficient operating pressure on the filter's ball valve.



CAUTION!

Risk of damage to the filter if operated without compressed air supply

If the controller is switched on and the filter is commissioned without compressed air supply, the solenoid valve may become damaged.

- Always open the filter's ball valve first when commissioning in order to ensure that compressed air is supplied.
-
- ▶ Open the ball valve on the filter.
 - ▶ Check the set pressure on the air tank's pressure gauge. If necessary, adjust the pressure on the pressure control valve.
 - ▶ Put the filter into operation using the controller. Backflushing is automatically performed in one of the filter chambers.
 - ▶ Check that the controller is functioning by performing backflushing manually.
 - ▶ Open the filter outlet shut-off valve
 - ▶ Slowly open the filter inlet shut-off valve. Avoid pressure surges.



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the vent.

- Proceed with extreme caution.
 - Wear the appropriate safety equipment and clothing.
-



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ Carefully open the vent on the bypass filter. The bypass filter is filled via the open pressure compensation valve.
 - ▶ Close the vent as soon as medium is expelled from a vent without any bubbles.
 - ▶ Then perform another backflushing process.
 - ▶ The filter is ready for operation.
-



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ After each time you put the filter into service, check the filter for leaks and eliminate them as necessary.
-



NOTE

After backflushing is complete, the next backflushing cycle (manual or triggered by the differential pressure monitoring system) can only be started with a time delay. This time delay is the time set on the time relay or the preset time on the controller. It is needed to ensure that the cleaned filter chamber can be filled.

7.6.1

Determination of time interval for time-controlled backflushing

- ▶ Allow the filter to operate for 24 hours with differential pressure and record the number of flushes from the flushing cycle counter or the controller. In order to allow the filter to operate for 24 hours with differential pressure, you have to deactivate the intervals for forced flushing on the controller.
- ▶ Calculate the average of all flushing intervals.
- ▶ Reset the flushing interval time (which should be 30 % shorter) on the controller.



7.7 Removal from service

7.7.1 Short-term removal from service



NOTE

When using the filter in watery media, it is imperative to adhere to the following:

- Do not allow the filter to run to empty after switching off the supply pump. Dirt may otherwise be allowed to harden.
- If the above condition cannot be met, set the controller so that backflushing is triggered every 2 hours even if the supply pump is switched off.

7.7.2 Longer term removal from service / removal



NOTE

When removing the filter and taking it out of service for longer periods, pay attention to the following points:

- Disconnect all connections from the filter.
- The filter must be completely emptied.
- The filter must be thoroughly cleaned.
- If necessary, seal the filter by applying a suitable anti-corrosive.
- The connection flange openings must be sealed with plastic (or similar) dummy plugs.

7.7.3 Disposal



DISPOSAL

Make sure that when the filter or individual components and consumables are finally disposed of that all components are disposed of in an environmentally friendly manner.



8 Maintenance and servicing

8.1 Special safety instructions



DANGER!

Risk of accidents from improper maintenance and servicing

Incorrect maintenance and servicing and failure to observe the listed safety instructions can lead to accidents and material damage. Make sure of the following:

- Maintenance and servicing work must only be carried out by qualified specialist staff or persons who have received appropriate instruction.
 - When performing any work on the filter, always wear the appropriate safety equipment and clothing.
 - Only perform maintenance and servicing work when the filter is cooled, depressurised and empty. Depending on the operating temperature, there may be a risk of burns.
 - Ensure the highest levels of cleanliness when opening the filter. No foreign substances, e.g. tools, cleaning cloths, impurities etc., must be allowed to remain in the filter.
 - Visually inspect all seals during maintenance and replace them as necessary.
 - On completion of the maintenance work, re-fit all available safety equipment properly.
 - Filling the filter against the indicated direction of flow of the filter elements is not permitted.
 - Remove the filter from service if the inspection periods (if indicated) have elapsed.
 - Always exercise extreme caution when installing and removing the filter elements. Before installation, check all filter elements/seals and replace any damaged filter elements/seals as necessary.
-



8.2

Cleaning agents



CAUTION!

Risk of damage to the filter from incorrect use of cleaning agents

The components of the filter may become damaged if cleaning agents are used incorrectly. The correct cleaning agent is selected in accordance with the type of medium being filtered and the associated contaminations.

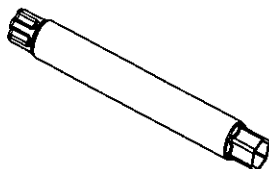
- BOLL & KIRCH Filterbau GmbH recommends BOLL CLEAN 2000 cleaning agent. For more detailed information, see the appendix of these operating instructions.

8.3

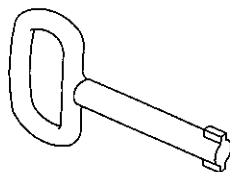
Special tools

The manufacturer provides the following special tools for the filter:

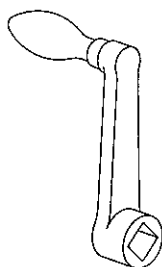
Wrench for removing the filter candles from the sieve plate



Key for opening the junction box



Hand winch for actuating the filter in case of mains power failure





8.4 Maintenance intervals

Even automatic filters have to undergo regular checks and maintenance.

It is particularly important to note that the mesh on the filter candles may become blocked over time despite regular backflushing. This depends largely on the quality of medium and the available partial flow cleaning function. The contamination in the mesh can be removed by cleaning the filter candles by hand using a suitable cleaning agent.



NOTE

BOLL & KIRCH Filterbau GmbH recommends BOLL CLEAN 2000 cleaning agent. For more detailed information, see the appendix of these operating instructions.

You can tell that the filter candles are becoming increasingly blocked because the flushing intervals become shorter and shorter.

The number of backflushing cycles performed is recorded by the controller.



CAUTION!

Risk of damage to the filter and the plant from damaged filter candles

If the flushing intervals suddenly become longer, this may indicate that the filter candles are damaged.

- In such an event, check all filter candles for damage immediately. Replace any damaged filter candles as necessary.

In order to make sure the automatic filter continues to operate properly, observe the following points for maintenance:

- Regularly check:
 - the differential pressure,
 - the leak tightness of the automatic filter, especially all connections and seals and
 - the automatic filter for corrosion and other damage,
 - the condition of the filter elements and
 - the condition of all screw connections and whether they are firmly tightened.
- The automatic filter must be inspected annually for leaks.
- Check all filter candles for contamination after the first 500 flushes, then after a further 5,000 and afterwards, every 10,000 flushes. To do so, remove the filter element and clean the filter candles. If the backflushing intervals shorten considerably beforehand, you must carry out checks and cleaning earlier.
- Replace all seals at least every 2 years and when overhauling.



NOTE

The filter candles are subject to wear from two-way strain. It is therefore recommendable to keep a complete set of filter candles in stock.



In order to make sure the bypass filter continues to operate properly, observe the following points for maintenance:

- Regularly check:
 - the differential pressure,
 - the leak tightness of the bypass filter, especially all connections and seals and
 - the bypass filter for corrosion and other damage,
 - the condition of the filter element and
 - the condition of all screw connections and whether they are firmly tightened.
- The bypass filter must be inspected annually for leaks.
- If the differential pressure reaches the preset maximum value, the filter has to be cleaned.
- Replace all seals at least every 2 years and when overhauling.

In order to make sure the segmented plug valve circuit continues to operate properly, observe the following points for maintenance:

- Regularly check:
 - the freedom of movement of the plug valve,
 - the leak tightness of the complete segmented plug valve, especially all connections and seals and
 - the segmented plug valve for external corrosion and any other damage and
 - the condition of all screw connections and whether they are firmly tightened.
- The segmented plug valve circuit must be inspected annually for leaks.
- Replace all seals at least every 2 years and when overhauling.



NOTE

When filtering media which can leave deposits on the segmented plug valve, it is recommendable to activate the segmented plug valve as often as possible and at regular intervals in order to prevent it from seizing up.



8.5

Filter element replacement on the automatic filter



NOTE

If you are using a BOLL & KIRCH Filterbau GmbH controller, you will find more detailed information in the documentation for the controller.

If you are using your own controller or another manufacturer's controller, the respective documentation must be followed.

Even the filter elements on automatic filters have to undergo regular checks and maintenance. To change the filter element, proceed as follows:



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the vent.

- Proceed with extreme caution.
- Wear the appropriate safety equipment and clothing.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ Carefully open the vent on the bypass filter to check whether it is full.
- ▶ Close the vent once medium starts to be expelled.
- ▶ Attach the lever to the segmented plug valve and set the plug valve to the "Bypass filter in operation" position.
- ▶ Close the pressure compensation valve (lever pointing across the line).
- ▶ Using the controller, trigger one backflushing for each filter chamber but one.
- ▶ Afterwards, close the ball valve for the filter's compressed air supply.
- ▶ Then, carry out manual backflushing for the filter chamber which has not yet been flushed.
- ▶ Switch off the controller.
- ▶ Check the pressure gauge to establish whether the air tank is genuinely depressurised.
- ▶ The filter chambers are now empty and depressurised.



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the filter chamber.

- Depressurise and lower the level of medium before removing the filter element.
- It is not necessary to empty the filter completely. Make sure that the medium level is below the filter element before removing the filter element. However, BOLL & KIRCH Filterbau GmbH recommends that you empty the filter in the manner described.



NOTE

Unlike valve and ball valve circuits, the segmented plug valve circuit cannot be fully sealed off. Flowing medium can be drained during the cleaning process as necessary using the drain hole. Afterwards, close the drain hole again.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ Remove the covers from the filter chambers. If necessary, use jacking bolts.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ Remove the filter elements from the filter chambers by pulling them vertically upwards. You will find further information here:

Installed filter element:	See page
Candle insert	55

- ▶ Allow the filter elements to drip dry in a suitable container. Clean the filter elements. You will find further information here:

Installed filter element:	See page
Candle insert	56

- ▶ Clean any contamination which has collected on the inside of the filter.
- ▶ Re-install the filter elements in the filter chambers. You will find further information here:

Installed filter element:	See page
Candle insert	59

- ▶ Fit the covers to the filter chambers. Check the seals for damage. Replace any damaged seals as necessary. Tighten the screw connection evenly, gradually tightening opposite screws step-by-step.
- ▶ Put the filter back into operation. See the section "Commissioning".



8.5.1 Removing the candle insert

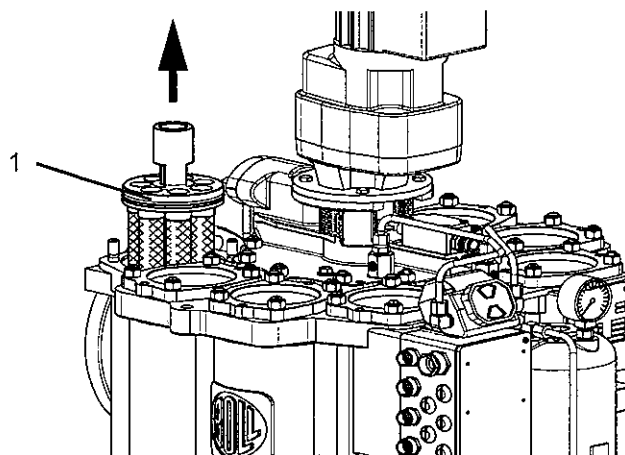


Fig. 8-1 Removing the candle insert

1 Filter element



CAUTION!

Risk of damage to the filter elements from incorrect removal

Filter elements are sensitive to pressure and impact.

- Proceed with extreme care when removing filter elements.

- Remove the filter elements from the filter chambers by pulling them vertically upwards.



8.5.2

Cleaning the candle insert



CAUTION!

Risk of damage to the candle insert from improper cleaning

If the candle insert is cleaned or handled improperly, the candle's wire mesh may become damaged. Observe the following safety instructions:

- Proceed with extreme caution when performing all cleaning work.
- The soaking time for the candle insert and the filter candles in "BOLL CLEAN 2000" cleaning agent must not exceed 24 hours.
- The cleaning temperature, when using "BOLL CLEAN 2000" must not exceed 60 °C.
- When cleaning using a high-pressure cleaner, the pressure must not exceed a maximum of 60 bar. When cleaning with the high-pressure cleaner, keep a sufficient distance (at least 20 cm) from the mesh in order to avoid damaging or displacing the mesh wires.
- Particles of dirt must not be allowed to enter the clean side of the filter element.
- Do not place the filter candles on top of each other as you may otherwise cause damage.

- ▶ Place the candle insert in a container with cleaning agent, with the opening of the filter candles facing downwards. This way, particles detaching from the filter candles can sink to the bottom.
- ▶ Remove loose particles which float on the top of the cleaning agent during the soaking stage.
- ▶ After soaking, remove the candle insert from the container and place it on a suitable surface (e.g. perforated plate) with the filter candle openings facing downwards. Allow the cleaning agent to drip dry.
- ▶ Turn the candle insert around and place it down with the openings facing upwards.
- ▶ Blow out the filter candles with compressed air from the inside to the outside.
- ▶ Then dip the candle insert in the container with fresh cleaning agent again, with the opening of the filter candles facing downwards. Rinse the candle insert through again by turning it and moving it up and down in the cleaning agent.
- ▶ Allow the candle insert to drip dry again.
- ▶ Blow out the filter candles with compressed air from the inside to the outside.
- ▶ Then check all filter candles for damage. Replace any damaged seals as necessary.



NOTE

Sufficient cleaning results (approximately 60 %) have been achieved using the described manual cleaning process for filter candles in similar applications.

In our experience, a cleaning effect of almost 100 % can only be achieved manually by using the type 5.04 filter element cleaning device with BOLL CLEAN 2000.

- In case of heavier contamination, you can clean using the high-pressure cleaner procedure mentioned above. Use water or water with cleaning agent (e.g. BOLL CLEAN 2000) as the fluid.

8.5.3

Cleaning the filter candles in case of stubborn contamination

In case the filter candles are heavily contaminated (lacquer contamination, incrustation, tar residue, fibres, chippings), the individual filter candles will have to be removed and cleaned.



NOTE

BOLL & KIRCH Filterbau GmbH recommend the use of the BOLL & KIRCH cleaning unit with rotating nozzle and flat-jet nozzle for cleaning purposes.

If you do not have a filter element cleaning unit available, proceed as follows:

- Place the candle insert in a container with cleaning agent, with the opening of the filter candles facing upwards.



NOTE

BOLL & KIRCH Filterbau GmbH recommends BOLL CLEAN 2000 cleaning agent. For more detailed information, see the appendix of these operating instructions.

- Remove the candle insert from the cleaning agent. Allow the candle insert to drip dry with the openings pointing downwards.

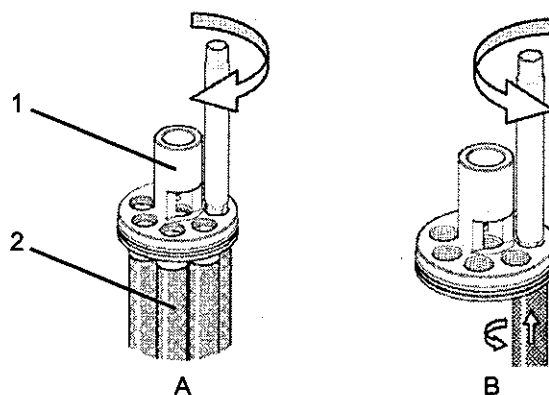


Fig. 8-2 Removing and installing the filter candles

- | | | | |
|---|---------------|---|-------------------------------|
| 1 | Sieve plate | A | Removing the filter candles |
| 2 | Filter candle | B | Installing the filter candles |

- Unscrew and remove the filter candles from the sieve plate using the key included in the scope of delivery.

NOTE

BOLL & KIRCH Filterbau GmbH recommends BOLL CLEAN 2000 cleaning agent. For more detailed information, see the appendix of these operating instructions.

- Then spray the filter candles through using the high-pressure cleaner with suitable cleaning agent. First clean from the inside to the outside, then from the outside to the inside. Repeat the process several times as necessary. Finally, spray the filter elements from the inside to the out.
- Carefully rinse out the filter candles in fresh cleaning agent and allow the filter candles to drip dry.
- Blow out the filter candles with compressed air from the inside to the outside.
- Remove any particles collected on the magnetic primary filter (if fitted).
- Re-assembly is performed by carrying out the steps for disassembly in reverse order.

CAUTION!

Risk of damage to the filter candles from incorrect installation

Improper installation can cause damage to the filter candles.

- Adhere to the recommended tightening torque values for filter candles: 25 Nm for filter candles with a candle diameter of 28 mm or 50 mm.



8.5.4

Installing the candle insert



CAUTION!

Risk of damage to the filter elements from incorrect installation

Filter elements are sensitive to pressure and impact.

- Proceed with extreme care when installing the filter elements.

-
- ▶ Check all the seals for damage. Replace any damaged seals as necessary.
 - ▶ Insert the filter elements vertically into the filter chambers from above.
 - ▶ Make sure that the seals are properly in place.



8.6

Filter element replacement on the bypass filter

If the permitted differential pressure between the filter inlet and filter outlet is exceeded, the filter element needs to be cleaned/replaced.

- ▶ Attach the lever to the segmented plug valve and set the plug valve to the "Automatic filter in operation" position.
- ▶ Close the pressure compensation valve (lever pointing across the line).



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the vent.

- Proceed with extreme caution.
- Wear the appropriate safety equipment and clothing.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

-
- ▶ Carefully open the vent on the bypass filter. This depressurises the filter chamber and allows you to check whether the bypass filter is properly shut off by the segmented plug valve.



NOTE

Unlike valve and ball valve circuits, the segmented plug valve circuit cannot be fully sealed off. Flowing medium can be drained during the cleaning process using the drain hole.



DANGER!

Risk of accidents from expelled medium

Hot medium may be expelled when opening the drain hole.

- Proceed with extreme caution.
- Wear the appropriate safety equipment and clothing.
- Collect the expelled medium in a suitable container.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

-
- ▶ Carefully open the drain hole.
 - ▶ First remove the cover, first removing the housing cover safety device (if included in the scope of your delivery).



- ▶ Remove the filter element from the filter chamber by pulling it vertically upwards. You will find further information here:

Installed filter element:	See page
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Star-pleated filter element	62
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- ▶ Allow the filter element to drip dry in a suitable container. Clean the filter element. You will find further information here:

Installed filter element:	See page
----------------------------------	-----------------

Star-pleated filter element	63
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- ▶ Clean any contamination which has collected on the inside of the bypass filter.
- ▶ Place the filter element in the housing. You will find further information here:

Installed filter element:	See page
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Star-pleated filter element	64
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- ▶ Fit the cover. Check the seal for damage. Replace any faulty seals as necessary. Tighten the screw connection evenly, gradually tightening opposite screws step-by-step.
- ▶ Fit the housing cover safety device (if included in the scope of your delivery). Whilst you do so, the vent remains open.
- ▶ Close the drain hole.



DANGER!

Risk of accidents from expelled medium

When putting the plant into service, hot medium may be expelled from the vent.

- Proceed with extreme caution.
- Wear the appropriate safety equipment and clothing.



DISPOSAL

Leaks must be caught immediately. Make sure that expelled medium is disposed of properly and in an environmentally friendly manner.

- ▶ Open the pressure compensation valve (lever pointing lengthways along the line).
- ▶ Close the vent as soon as medium is expelled from the vent without any bubbles.
- ▶ The cleaned bypass filter is on stand-by and can be put into operation as required.



8.6.1 Removing the star-pleated filter element



NOTE

One or more star-pleated filter elements can be inserted into the filter chamber depending on the size of the bypass filter.



CAUTION!

Risk of damage to the filter elements from incorrect removal

Filter elements are sensitive to pressure and impact.

- Proceed with extreme care when removing filter elements.

- ▶ Remove the filter element from the housing by pulling it vertically upwards by the filter element clamp.

8.6.1.1 Removing and attaching the filter element clamp

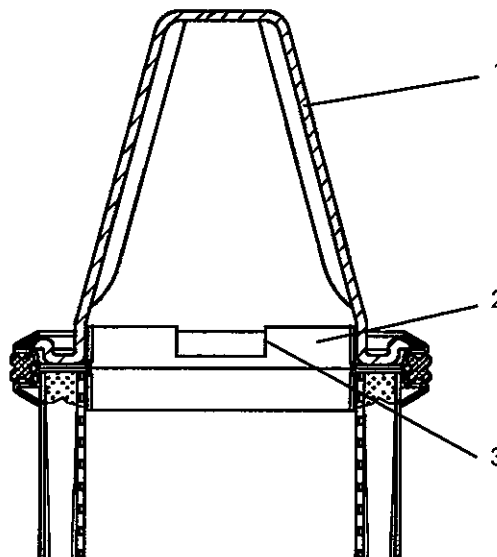


Fig. 8-3 Removing and attaching the filter element clamp

- 1 Filter element clamp
- 2 Sieve ring
- 3 Recess

- ▶ Turn the filter element clamp so that one end of the clamp aligns with the recess in the sieve ring.
- ▶ Press the ends of the filter element clamp together so that the end of the filter element clamp on the recess no longer reaches into the sieve ring.
- ▶ Remove the filter element clamp from the sieve ring by pulling it upwards.
- ▶ It is attached by carrying out the steps in reverse order.
- ▶ Clean the magnetic insert (if available) before installing.
- ▶ Finally, secure the filter element clamp by turning it so that none of the ends of the clamp align with the recess in the sieve ring.



8.6.2

Cleaning the star-pleated filter element



NOTE

Filter cartridges must not be cleaned. Always use new star-pleated filter cartridges. The filter element clamp must be removed from the contaminated filter cartridge and fitted to the new one.



CAUTION!

Risk of damage to the star-pleated filter element from improper cleaning

If the star-pleated filter element is cleaned or handled improperly, the star-pleated filter element wire mesh may become damaged. Observe the following safety instructions:

- Proceed with extreme caution when performing all cleaning work.
- The soaking time for the star-pleated filter element in the cleaning agent is 1 - 4 hours, depending on the level of contamination. Check the progress of cleaning whilst the element is soaking.
- The cleaning temperature must not exceed 60 °C.
- When cleaning using a high-pressure cleaner and flat nozzle, the pressure must not exceed a maximum of 60 bar. When cleaning using a high-pressure cleaner, keep a sufficient distance from the mesh (minimum of 20 cm).
- Particles of dirt must not be allowed to enter the clean side of the filter element.

- ▶ Shake the star-pleated filter element to remove the coarsest dirt.



NOTE

BOLL & KIRCH Filterbau GmbH recommends BOLL CLEAN 2000 cleaning agent. For more detailed information, see the appendix of these operating instructions.

- ▶ Place the star-pleated filter element in a container of suitable cleaning agent with the opening pointing upwards.



NOTE

BOLL & KIRCH Filterbau GmbH recommend the use of the BOLL & KIRCH cleaning unit with rotating nozzle and flat-jet nozzle for cleaning purposes.

- ▶ Then spray the star-pleated filter element with a filter cleaning unit. First clean the star-pleated filter element from the inside to the outside, then from the outside to the inside. Repeat the process several times as necessary. Finally, spray the star-pleated filter element from the inside to the out.
- ▶ Rinse the star-pleated filter element carefully and allow it to drip dry.
- ▶ Afterwards, check the sieve mesh for damage and to establish whether it is clean. The cleaning effect can be assessed by holding the filter element up to the light. Use a torch for finer meshes. The mesh is properly clean if the light shines through evenly. Repeat the cleaning process as necessary.



8.6.3

Installing the star-pleated filter element



CAUTION!

Risk of damage to the filter elements from incorrect installation

Filter elements are sensitive to pressure and impact.

- Proceed with extreme care when installing the filter elements.



CAUTION!

Insufficient filter performance may cause damage to downstream components

If the star-pleated filter element is not fastened in the filter chamber, the filter performance will be reduced. Reduced filter performance over longer periods of operation can cause damage to downstream components.

- Only insert the filter elements into the housing with the filter element clamps fitted.

- ▶ Check that the filter element clamp is firmly in place in the sieve ring.
- ▶ Check all the seals for damage. Replace any damaged seals as necessary.

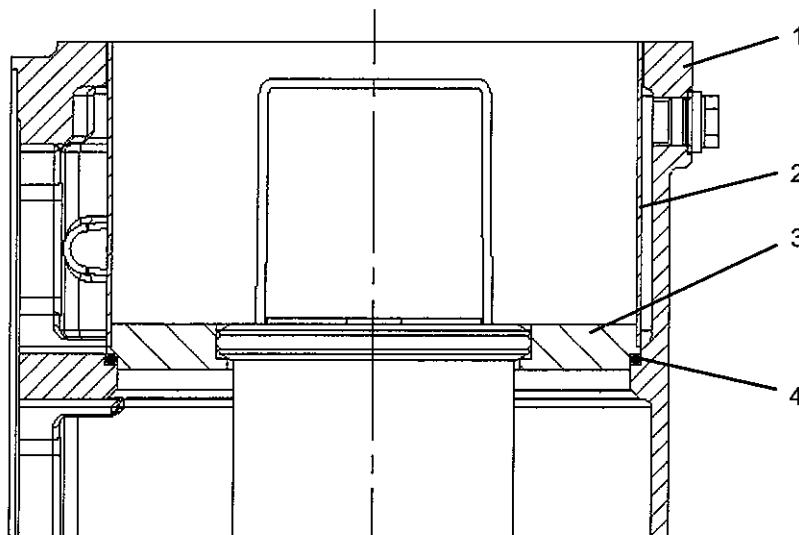


Fig. 8-4 Installing the star-pleated filter element

1	Housing	3	Sieve plate
2	Perforated sheet mantle	4	Seal

- ▶ Check that the seal, sieve plate and the perforated sheet mantle are firmly in place in the housing. Make sure the sieve plate is installed in the correct position.
- ▶ Insert the filter element vertically into the sieve plate from above.



8.7

Manual activation of backflushing after electrical mains failure



CAUTION!

Risk of accidents caused by the filter starting back up

When the electrical power returns, the filter may start up again and the rotating movement of the hand winch attached to the drive may injure you.

- Before manually actuating the filter, first switch off the controller.
- Before switching on the controller, remove the hand winch from the shaft end of the drive.

- ▶ Attach the hand winch (included in the scope of delivery) to the shaft end of the electric gear motor.
- ▶ By turning the electric gear motor the plug valve is turned to the next switch point (to the next filter chamber).

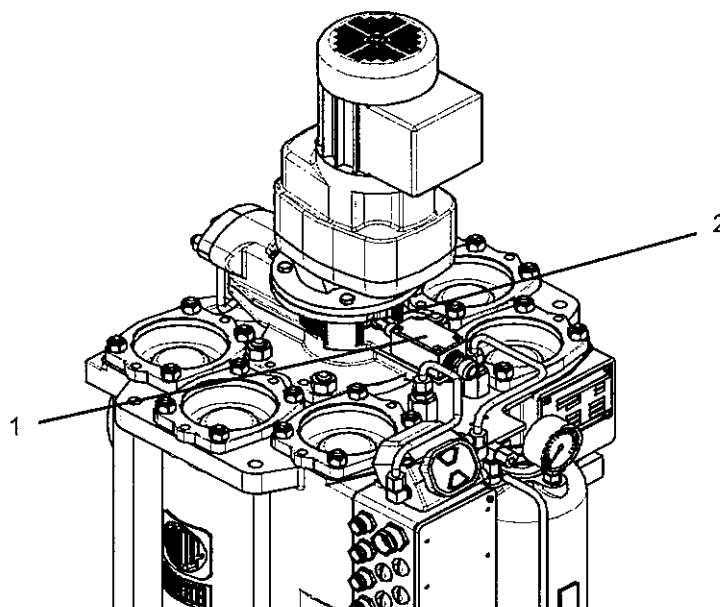


Fig. 8-5 Position of cam disc / limit switch

- 1 Limit switch
- 2 Cam disc

- ▶ Cams and limit switches must be aligned exactly opposite each other.

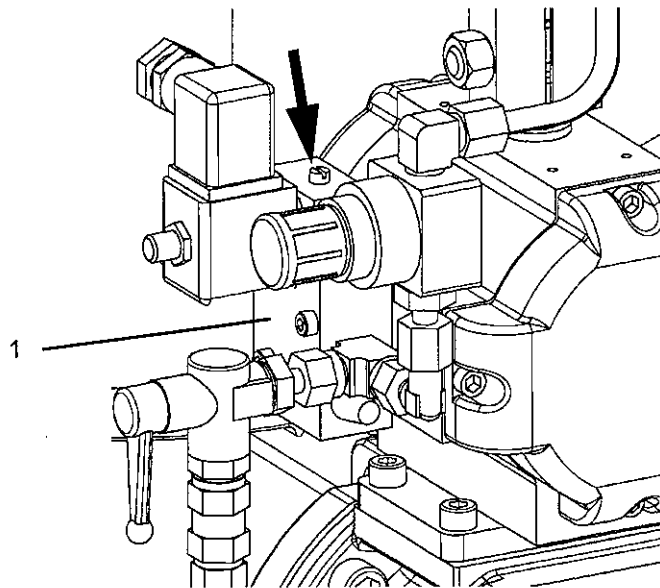


Fig. 8-6 Manual triggering of backflushing

1 Solenoid valve

- ▶ Trigger backflushing directly by manually actuating (arrow) the solenoid valve (using a screwdriver). Manual actuation must last for at least 8 s.
- ▶ Move the solenoid valve's manual actuator back into the initial position.
- ▶ The automatic venting process in the filter chamber is not completed until the filling time has elapsed. You can then turn to the next filter chamber using the hand winch.



8.8 Remedying faults



NOTE

In case of any faults or repairs which are not listed here, contact the BOLL & KIRCH customer services department.

8.8.1 Trouble shooting

Fault	Possible cause	Remedy
Differential pressure too high, no flushing	Air pressure too low	Check the compressed air supply on the filter connection (see respective operating instructions for the entire plant)
Flushing performed often	High level of contamination in the medium	Determine the cause of contamination in the plant
	Filter elements blocked	Change / clean the filter elements
	Air pressure too low	Check the compressed air supply on the filter connection (see respective operating instructions for the entire plant)
	Piping on the flushing oil outlet blocked	Clean the piping (see respective operating instructions for the entire plant)
	Solenoid valve or pneumatic pivoting actuator is stuck	Replace the solenoid valve or the pneumatic pivoting actuator
The electric gear motor is not turning	Plug valve is stuck	Open the filter and remove the cause of the blockage
	The filling hole is blocked	Clean the filling hole in the filter housing
	No power supply	Check the power supply to the electric gear motor
Differential pressure will not reduce	Piping on the flushing oil outlet blocked	Clean the piping (see respective operating instructions for the entire plant)
	Filter elements blocked	Change / clean the filter elements

Fault	Possible cause	Remedy
No differential pressure indicator	Shut-off valves in control line closed	Open shut-off valves
	Differential pressure monitoring system faulty	Check / replace the differential pressure monitoring system



9 Appendix

9.1 Filter

9.1.1 Technical data

Filter type	6.64.1
Nominal connection diameter	DN 100
Connection flanges as per	DIN 2501 PN 10

Permitted operating pressure	10.00 bar
Min. permitted operating temperature	0 °C
Max. permitted operating temperature	100 °C

Compressed air connection (air, clean and dry) 4 - 10 bar

Motor output	0.090 kW
Operating voltage	3 ph 440 V
Frequency	60 Hz
Control voltage	24 V DC

Filter elements

Automatic filters:	Candle insert
Number of filter chambers	4
Number of filter elements per filter chamber	3
Bypass filter:	Star-pleated element
Number of filter elements	1



NOTE

If you are using a BOLL & KIRCH Filterbau GmbH controller, you will find more detailed information in the documentation for the controller.

If you are using your own controller or another manufacturer's controller, the respective documentation must be followed.

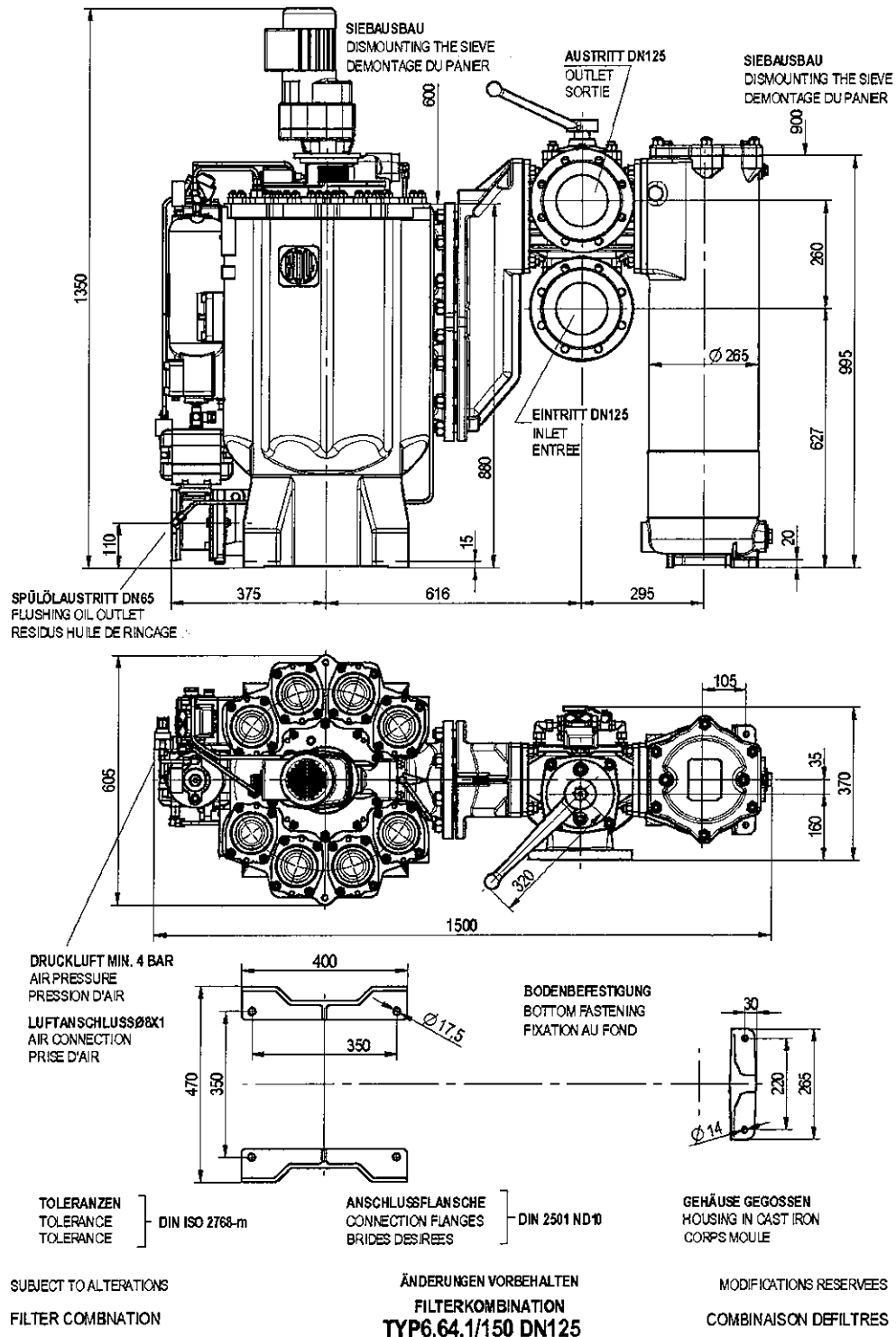


9.1.2 Technical data sheet

Z114764

TYP 6.64.1

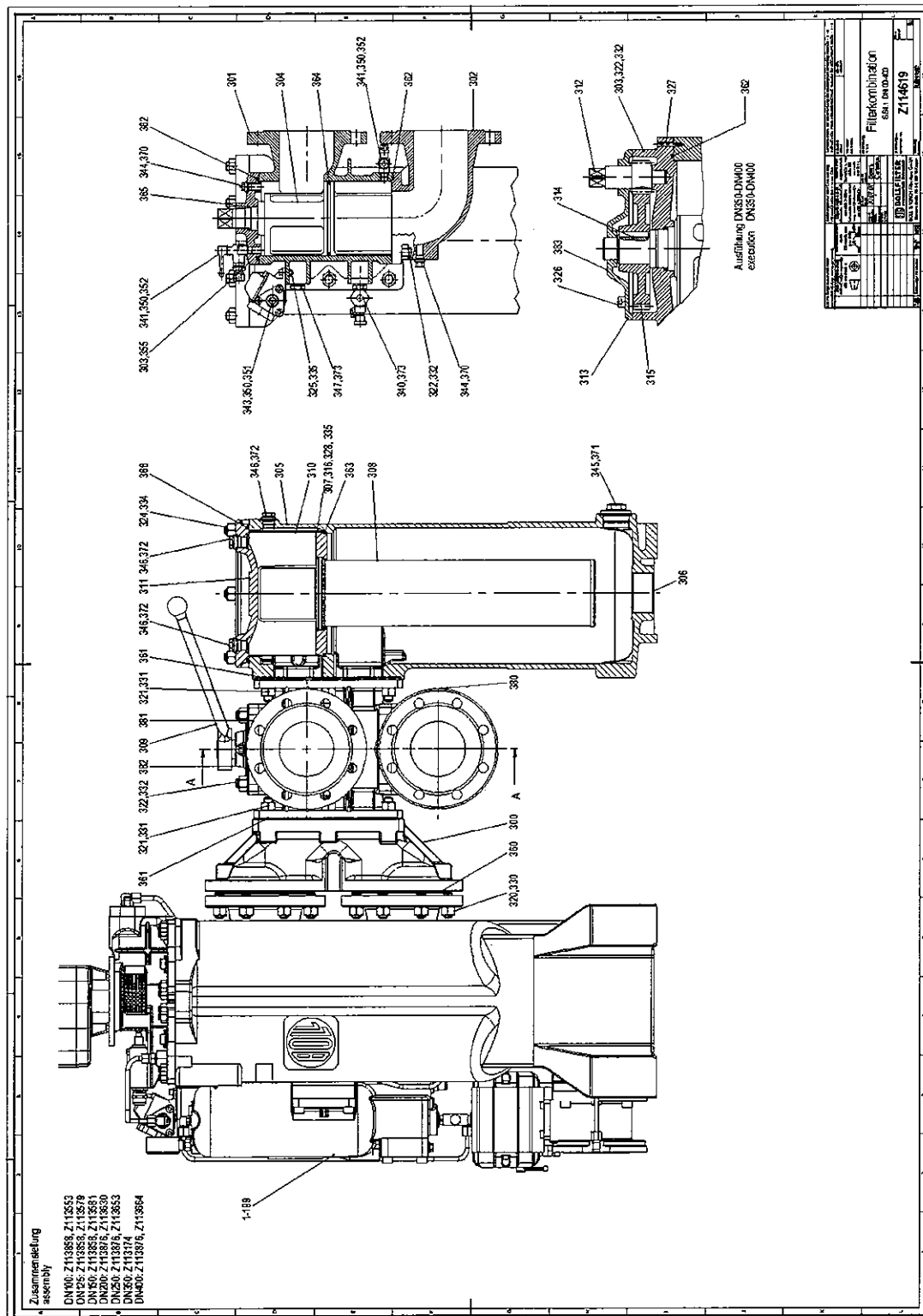
01.08.2007

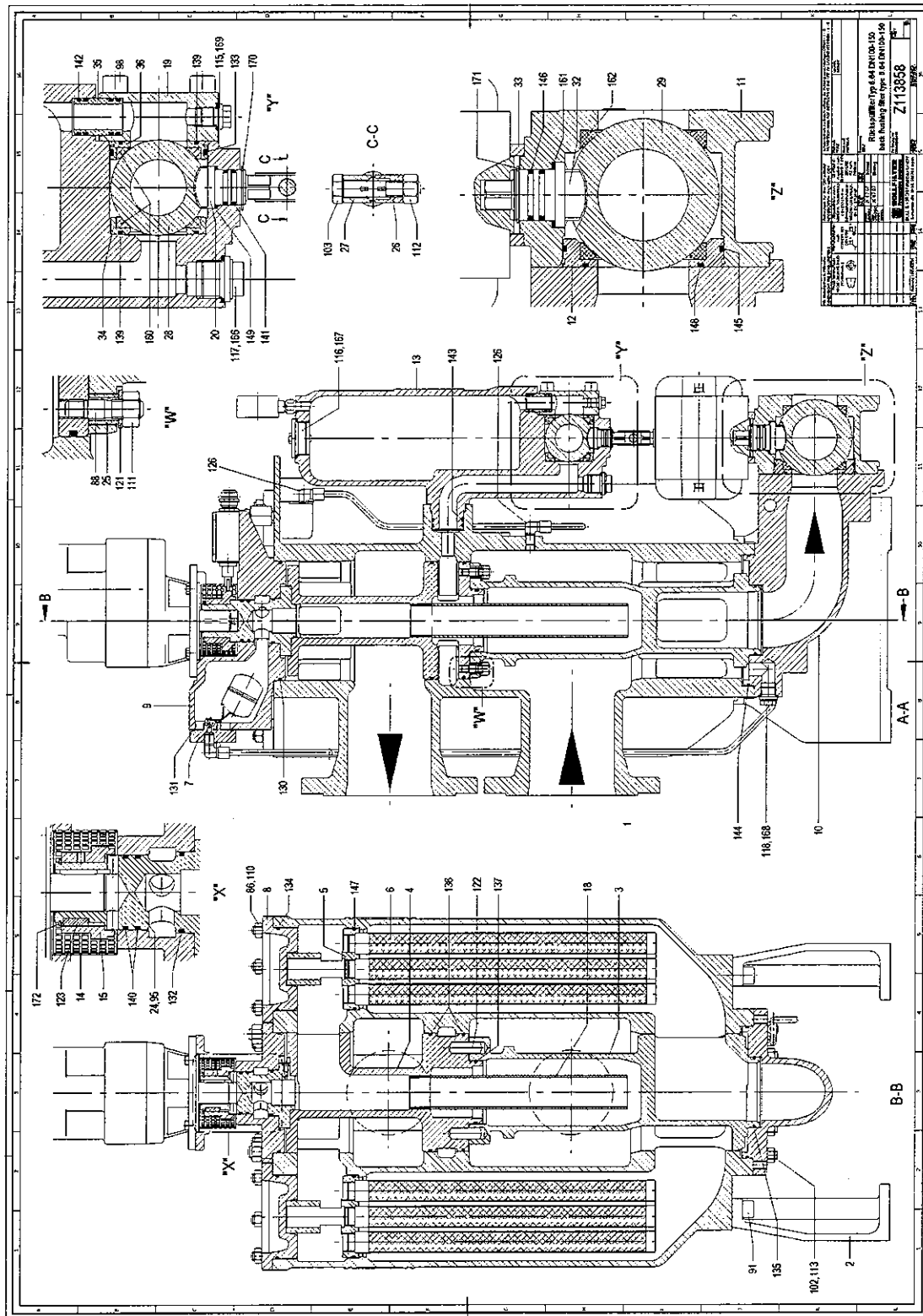


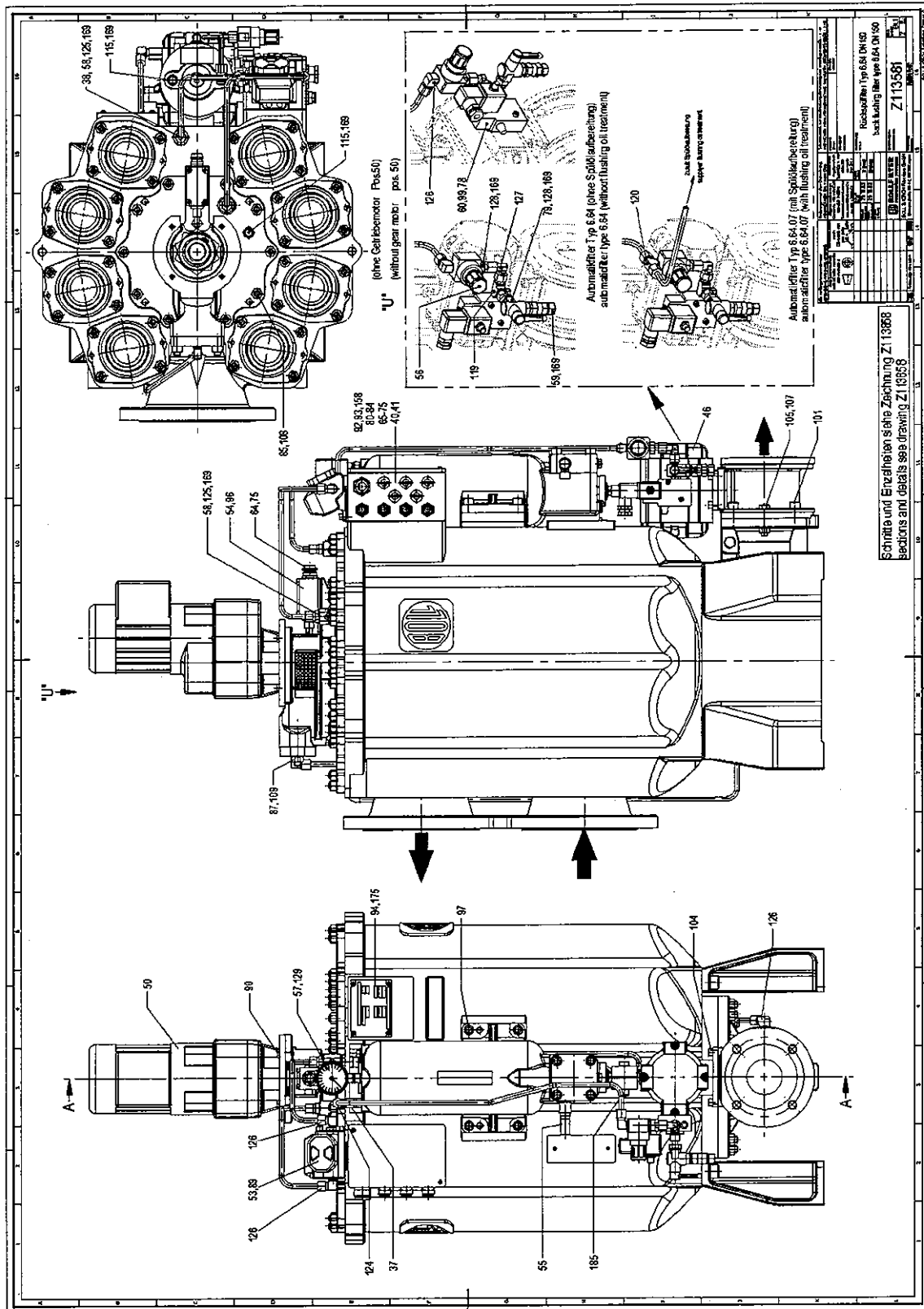


9.1.3 Spare parts

9.1.3.1 Spare parts drawing









9.1.3.2 Spare parts list

Document	Description	Date
0630293	automatic filter	19.01.09
	Dimension drawing: Z114764	
	Assembly: Zusammenstellung: Z114619, Z113858, Z113581 Bl.1	

Item	ID no.	Description	Quantity	Unit
00001	6530070	housing	1	pcs.
00002	6820002	bottom fastening	2	pcs.
00003	5420019	cock	1	pcs.
00004	5420033	cock	1	pcs.
00005	5030028	sieve plate for 3 candles	8	pcs.
00006	9905005	star-pleated element according t	24	pcs.
00007	0603957	air escape aggregate	1	pcs.
00008	5230014	housing cover	8	pcs.
00009	5230009	cover change over housing	1	pcs.
00010	6830016	connection flush valve	1	pcs.
00011	6830011	housing flush valve	1	pcs.
00012	5100046	support ring	1	pcs.
00013	6530101	air reservoir	1	pcs.
00014	6700187	guard plate	1	pcs.
00015	5330001	Control Disc	1	pcs.
00018	5100033	riser pipe	1	pcs.
00019	5200008	air valve cover	1	pcs.
00020	5400003	selector shaft	1	pcs.
00024	5400040	coupling	1	pcs.
00025	5310041	distance bush	2	pcs.
00026	5600135	Coupling	1	pcs.
00027	5600136	Coupling	1	pcs.
00028	2300089	ball air valve	1	pcs.
00029	2300092	ball flushing valve	1	pcs.
00032	5400004	selector shaft	1	pcs.
00033	5600062	adapter plate	1	pcs.
00034	5100076	support ring	1	pcs.
00035	5100032	connector	1	pcs.
00036	5106541	support ring	1	pcs.
00037	6703846	nozzle	1	pcs.
00038	5300148		1	pcs.
00040	5950197	connection box	1	pcs.
00041	8450198	cover for connection box	1	pcs.



Item	ID no.	Description	Quantity	Unit
00046	4500058	Double Piston Part Turn Actuator	1	pcs.
00050	4500099	gear motor	1	pcs.
00053	9902572	DPI acc. to order	1	pcs.
00054	4200062	limit switch	1	pcs.
00055	2660005	safety valve	1	pcs.
00056	2600251	high pressure control device	1	pcs.
00057	2616316	pressure gauge	1	pcs.
00058	2600272	shock absorber for pressure gang	2	pcs.
00059	2608775	non return valve	1	pcs.
00060	4105912	connector plug	1	pcs.
00060	2656655	solenoid valve	1	pcs.
00060	4206553	coil	1	pcs.
00060	2600264	sound absorber	2	pcs.
00060	3040224	o-ring	2	pcs.
00064	4100097	cable gland	3	pcs.
00065	4105805	mounting rail	1	pcs.
00066	4105616	clamp	17	pcs.
00067	4105617	clamp	7	pcs.
00068	4100015	distance plate	3	pcs.
00070	4100097	cable gland	6	pcs.
00071	4100098	cable gland	1	pcs.
00073	4870017	plug	4	pcs.
00078	2614171	sound absorber	2	pcs.
00079	2560356	angle ball valve	1	pcs.
00084	2000121	hexagon socket head cap screw	4	pcs.
00085	2000004	stud bolt	10	pcs.
00086	2000004	stud bolt	32	pcs.
00087	2009095	stud bolt	2	pcs.
00088	2009097	stud bolt	2	pcs.
00089	2000122	hexagon socket head cap screw	2	pcs.
00090	2006963	hexagon screw	4	pcs.
00091	2000167	hexagon socket head cap screw	4	pcs.
00092	2000263	slotted cheese head screw	2	pcs.
00093	2000261	slotted cheese head screw	2	pcs.
00094	2003587	threaded flange screw	4	pcs.
00095	2000131	hexagon socket head cap screw	4	pcs.
00096	2002155	hexagon socket head cap screw	2	pcs.
00097	2000155	hexagon socket head cap screw	4	pcs.
00098	2013300	hexagon socket head cap screw	4	pcs.
00099	2002155	hexagon socket head cap screw	2	pcs.
00101	2000156	hexagon socket head cap screw	4	pcs.

Item	ID no.	Description	Quantity	Unit
00102	2009095	stud bolt	10	pcs.
00103	2000036	hexagon screw	1	pcs.
00104	2000132	hexagon socket head cap screw	8	pcs.
00105	2000318	hexagon fits bolt	2	pcs.
00107	2100005	hexagon nut	2	pcs.
00108	2100006	hexagon nut	10	pcs.
00109	2100006	hexagon nut	2	pcs.
00110	2100006	hexagon nut	32	pcs.
00111	2115515	lock nut	2	pcs.
00112	2100006	hexagon nut	1	pcs.
00113	2100006	hexagon nut	10	pcs.
00115	2000656	screwed sealing plug	3	pcs.
00116	2001772	screwed sealing plug	1	pcs.
00117	2000190	screwed sealing plug	1	pcs.
00118	2000910	screwed sealing plug	1	pcs.
00119	2507461	screwing	1	pcs.
00121	2200007	disc	2	pcs.
00122	2310005	grooved pin	2	pcs.
00123	2401230	feather key	1	pcs.
00124	2506980	screwing	1	pcs.
00125	2500024	screwing	2	pcs.
00126	2500025	screwing	6	pcs.
00127	2500119	angle screwing	1	pcs.
00128	2500083	screwed socket	2	pcs.
00129	2510239	screwing extension	1	pcs.
00130	3040075	o-ring	1	pcs.
00131	3142316	o-ring	1	pcs.
00132	3030164	o-ring	1	pcs.
00133	3046821	o-ring	1	pcs.
00134	3041058	o-ring	8	pcs.
00135	3042106	o-ring	1	pcs.
00136	3040131	o-ring	2	pcs.
00137	3042236	o-ring	1	pcs.
00139	3048178	o-ring	2	pcs.
00140	3031743	o-ring	2	pcs.
00141	3040157	o-ring	2	pcs.
00142	3041070	o-ring	4	pcs.
00143	3043763	o-ring	2	pcs.
00144	3040131	o-ring	1	pcs.
00145	3040105	o-ring	1	pcs.
00146	3040099	o-ring	2	pcs.



Item	ID no.	Description	Quantity	Unit
00147	3040105	o-ring	8	pcs.
00148	3040103	o-ring	1	pcs.
00149	3324251	PTFE ring	1	pcs.
00158	3380199	flat gasket	1	pcs.
00160	3522906	ball gasket	2	pcs.
00161	3328072	flat gasket	1	pcs.
00162	3521600	ball gasket	2	pcs.
00166	3270005	gasket	1	pcs.
00167	3274855	gasket	1	pcs.
00168	3270010	gasket	1	pcs.
00169	3270002	gasket	9	pcs.
00170	2205949	locking ring	1	pcs.
00171	2203318	locking ring	1	pcs.
00172	2203398	locking ring	1	pcs.
00175	9401690	type plate	1	pcs.
00176	9407569	label	1	pcs.
00176	9400997	label	1	pcs.
00176	9407396	label: "mud drain"	1	pcs.
00176	9402898	label	1	pcs.
00176	9403614	label: "compressed air connectio	1	pcs.
00176	9404642	label: "Delta P differential pre	1	pcs.
00176	9808492	label	1	pcs.
00180	4300000	control box according to order	1	pcs.
00185	0600064	Pipe	1	pcs.
00197	6700379	key for unscrewing the filter el	1	pcs.
00197	2300808	crank handle	1	pcs.
00300	5130027	adapter	1	pcs.
00301	6234075	cock casing	1	pcs.
00302	5432012	angle inlet	1	pcs.
00303	6434344	cock casing cover	1	pcs.
00304	6320015	cock plug	1	pcs.
00305	6139216	housing	1	pcs.
00306	5300478	threaded plug	1	pcs.
00307	5500019	sieve plate	1	pcs.
00308	150879	star-pleated element according t	1	pcs.
00309	8650481	key	1	pcs.
00310	7110495	tube	1	pcs.
00311	6430053	cover	1	pcs.
00316	5700130	covering plate	1	pcs.
00320	2000011	stud bolt	16	pcs.
00321	2009088	stud bolt	12	pcs.

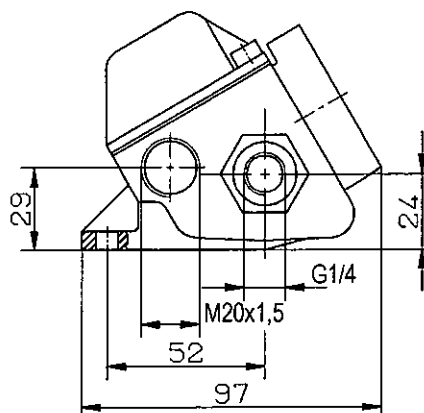
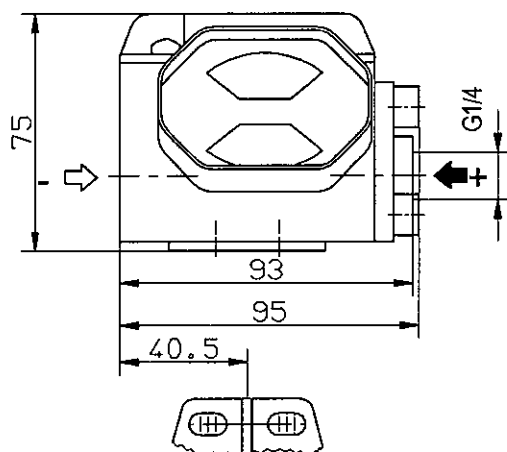
Item	ID no.	Description	Quantity	Unit
00322	2009088	stud bolt	8	pcs.
00324	2009088	stud bolt	6	pcs.
00325	2000123	hexagon socket head cap screw	2	pcs.
00328	2000130	hexagon socket head cap screw	4	pcs.
00330	2100008	hexagon nut	16	pcs.
00331	2100007	hexagon nut	12	pcs.
00332	2100007	hexagon nut	8	pcs.
00334	2100007	hexagon nut	6	pcs.
00335	2100003	hexagon nut	2	pcs.
00340	0203221	pressure compensation	1	pcs.
00341	2560356	angle ball valve	2	pcs.
00343	0550001	differential pressure indicator	1	pcs.
00344	2000187	screwed sealing plug	4	pcs.
00345	2000193	screwed sealing plug	1	pcs.
00346	2000189	screwed sealing plug	3	pcs.
00347	2000188	screwed sealing plug	2	pcs.
00350	2500024	screwing	3	pcs.
00351	2500025	screwing	1	pcs.
00352	2564886	removeable double nibble	2	pcs.
00355	2300023	Spring Type Straight Pin	1	pcs.
00360	3380074	high pressure gasket	2	pcs.
00361	3540022	frame	2	pcs.
00362	3040163	o-ring	2	pcs.
00363	3041064	o-ring	1	pcs.
00364	3040653	o-ring	1	pcs.
00365	3040159	o-ring	1	pcs.
00366	3040131	o-ring	1	pcs.
00370	3270002	gasket	4	pcs.
00371	3270008	gasket	1	pcs.
00372	3270004	gasket	3	pcs.
00373	3270003	gasket	4	pcs.
00380	9800300	label: "inlet"	1	pcs.
00381	9800301	label: "outlet"	1	pcs.
00382	9404402	label: "change over position"	1	pcs.



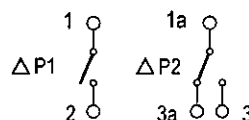
9.2 Differential pressure indicator

9.2.1 Technical data sheet

Z45550
TYP 4.36.2
09.01.06



CIRCUIT DIAGRAM



SPECIFICATION:
PROTECTION CLASS: IP 65

ELECTR. DATA: SWITCHING VOLTAGE $V \approx$ MAX.= 250
FREQUENCY HZ MAX.= 0-60
SWITCHING CURRENT A MAX.= 1
MAKING AND/OR BREAKING CAPACITY WVA MAX.= 60/60

220
0-60
0.8
40/60

MATERIAL : GD - ALUMINIUM
RATING : MAX. PRESSURE 100 BAR
MAX. TEMPERATURE 150°C

RANGES OF PRESSURE DIFFERENTIAL: DELTA P =
0 - 0.5 BAR
0 - 0.8 BAR
0 - 1.2 BAR
0 - 2.0 BAR
0 - 3.0 BAR
TO BE SPECIFIED WHEN ORDERING

DESCRIPTION:
THE PURPOSE OF THIS DEVICE IS THE MEASUREMENT, AND VISUAL INDICATION OF THE DIFFERENCE IN PRESSURE BETWEEN TWO POINTS, AND THE ESTABLISHMENT OF AN ELECTRICAL CONTACT WHEN THE PRESSURE DIFFERENTIAL ATTAINS A SPECIFIED FIGURE.

METHOD OF OPERATION:
A PLUNGER SEALED BY A DIAPHRAGM SEPARATES THE SPACE UNDER PRESSURE INTO TWO CHAMBERS. A PRE-LOADED SPRING CAUSES THE PLUNGER TO TAKE UP ITS ZERO POSITION WHEN THE PRESSURE DIFFERENCE DELTA P IS ZERO. AS THE PRESSURE DIFFERENCE INCREASES (DELTA P > 0), THE PLUNGER IS FORCED TO MOVE AGAINST THE SPRING. AT THE SAME TIME, AN INDICATOR DISC IS MOVED MAGNETICALLY, AND THEREFORE VIRTUALLY WITHOUT FRICTION, AND THE TWO REED CONTACTS ARE ACTUATED.

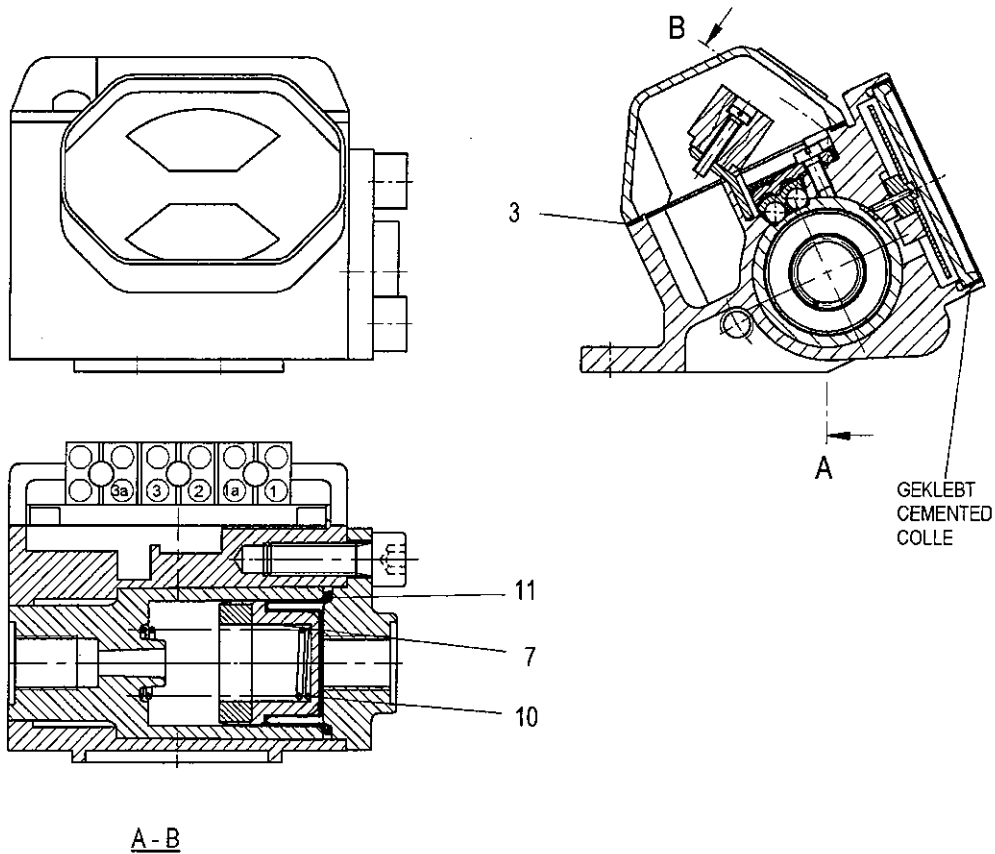
THE RED SEGMENT OF THE INDICATOR DISC IS VISIBLE OVER A PRESSURE RANGE EQUAL TO APPROX. 50-100% DELTA P. THE FIRST REED CONTACT IS ACTUATED AT 75% DELTA P1, AND THE SECOND AT 100% DELTA P2.

DIFFERENTIAL PRESSURE CONTACT INDICATOR TYPE 4.36.2



9.2.2 Spare parts list

Z21434
TYP 4.36.2+4.46.2
11.02.94



BEI BESTELLUNG ANGEBEN
TO BE MENTIONED IN CASE OF ORDER
A MENTIONNER LORS DE LA COMMANDE

AUFTR.NR.:
ORDER NO.
NO DE COMMANDE

TYP 4.36.2

11	ROLLMEMBRAN	DIAPHRAGM	DIAPHRAGME	
10	FEDER	SPRING	RESSORT	
7	KOLBEN	PISTON	PISTON	
3	DICHTUNG	GASKET	JOINT	
POS.NR.	BEZEICHNUNG	DESIGNATION	DESIGNATION	

SPARE PARTS
DRAWING

ERSATZTEILZEICHNUNG
ZUM TYP 4.36.2 UND 4.46.2

PLAN DES PIECES
DE RECHANGE



9.3 Supplier's documentation



NOTE

Documentation for any components or assembly groups purchased externally by BOLL & KIRCH Filterbau GmbH is enclosed with these operating instructions. Adhere to the information contained, in particular information on the subject of safety.

9.4 Cleaning devices

For particularly good cleaning results, BOLL & KIRCH Filterbau GmbH recommends the filter element cleaning unit type 5.04 with rotating nozzle and flat jet nozzle or optionally, the type 5.05 ultrasonic cleaning unit.



9.5 BOLL CLEAN 2000 cleaning agent product information

Product description:

BOLL CLEAN 2000 is a liquid cleaning and degreasing agent with a broad range of applications. It can be used practically for all cleaning and degreasing needs.

BOLL CLEAN 2000 cleans quickly and thoroughly and is extremely economical.

The use of BOLL CLEAN 2000 renders all safety precautions unnecessary.

BOLL CLEAN 2000 has all these excellent characteristics without the disadvantages of solvent-based cleaners.

BOLL CLEAN 2000 is:

- not inflammable
- not subject to compulsory identification markings
- not strong smelling
- not corrosive
- physiologically harmless
- biodegradable
- Umweltbundesamt (Federal German Ministry of Environment) reg. no. 04860019

BOLL CLEAN 2000 can be overcooled or overheated during storage but is then fully useable when at normal temperature again.

Sieve mesh contaminated with heavy oil:

Sieve meshes which are contaminated with heavy oil must be soaked in normal, commercially available solvent. After soaking, the sieves are cleaned in the BOLL & KIRCH cleaning device type 5.04 with BOLL CLEAN 2000 and high-pressure pump.

Instructions for use:

BOLL CLEAN 2000 is not processed for any specific cleaning method. BOLL CLEAN 2000 can be used in a soaking bath, in a spray unit, in a steam jet cleaner or be applied by hand, using a cloth, brush or sponge, depending on the operational conditions.

It can be used cold or warm.

BOLL CLEAN 2000 can be mixed with water - even with sea water.

- Concentration for mesh cleaning: 1 : 2,5
- Maximum temperature up to 60 °C

The concentration depends on the type and extent of the collected dirt particles which have to be removed. When using a concentration of 1 : 30 and above, rinsing is usually not necessary. No visible film is left on the surface.



9.6

Worldwide sales and service network, subsidiaries and representatives

If you require service or spare parts, please contact the main site or our subsidiaries, representatives or service points.

Deutschland

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- | | | |
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| 2 | Lager | Stockist |
| 3 | Service | Service |

November 2008

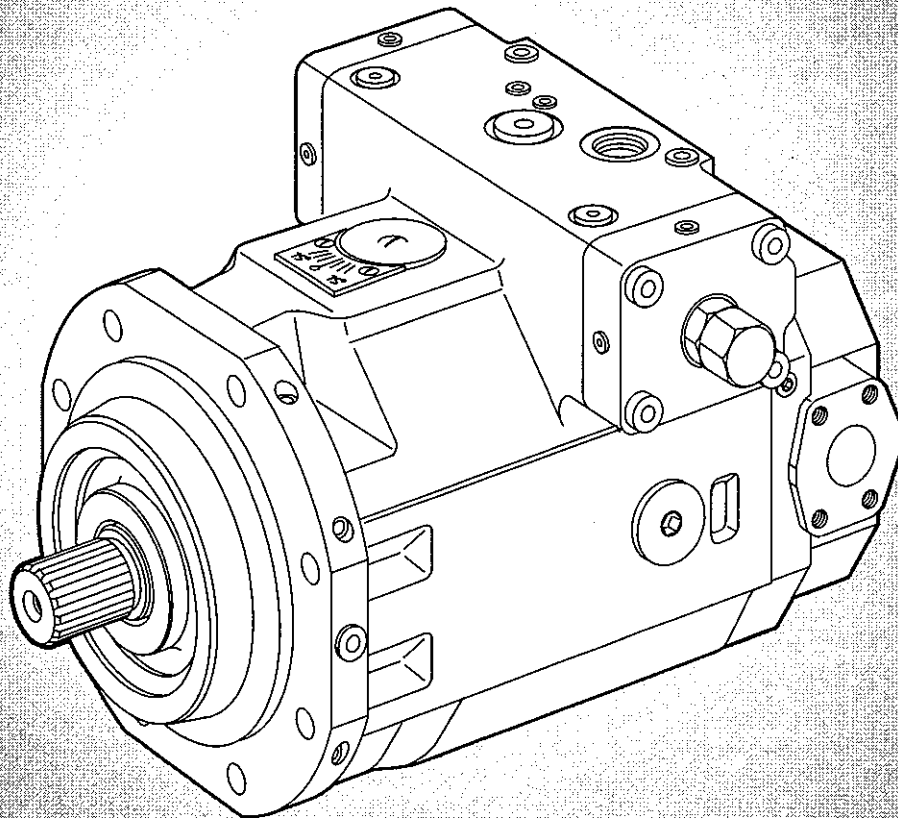
Axial Piston Variable Pump A4VSO

Series 1, 2 and 3

RE 92050-01-B/03.08

Replaces: 03.05
English

Operating Instructions



The data specified above only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

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An example configuration is shown on the title page. The delivered product may, therefore, differ from the product which is pictured.

The original operating instructions were created in the German language.

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About this document

1 About this document

These instructions contain important information on the safe and appropriate assembly, transport, commissioning, maintenance, disassembly and simple troubleshooting of the A4VSO series 1, 2 and 3 axial piston variable pump.

- Read these instructions completely, especially chapter "2 General safety instructions" on page 6, before working with the A4VSO axial piston variable pump.

1.1 Related documents

The A4VSO axial piston variable pump is a system component. Also observe the instructions for the other system components.

Further information on the A4VSO axial piston variable pump, its installation and operation can be found in the Rexroth documents listed in the following table.

Table 1: Related documents

Related documents	Contents
Order confirmation	Contains the preset technical data of your A4VSO axial piston variable pump.
Installation drawing	Contains the outer dimensions, all connections and the hydraulic circuit diagram for your A4VSO axial piston variable pump.
Data sheet RE 92050	Contains the permissible technical data for the A4VSO series 1, 2 and 3 axial piston variable pump. Depending on the control unit of your axial piston pump, the following seven data sheets apply:
Data sheet RE 92056	Speed control DS1, secondary control
Data sheet RE 92060	Control devices DR, DP, FR and DFR
Data sheet RE 92064	Power control LR2, LR3, LR2N and LR3N
Data sheet RE 92072	Control units MA and EM
Data sheet RE 92076	Control systems HM, HS, HS4 and EO
Data sheet RE 92080	Hydraulic control, pilot pressure related HD
Data sheet RE 92088	Electro-hydraulic control system DFE1
Data sheet RE 92053	Contains the permissible technical data for the A4VSO axial piston variable pump with HFC hydraulic fluids.
Data sheet RE 92020	Describes the requirements on a mineral-oil based hydraulic fluid for operation with Rexroth axial piston units and assists you in selecting a hydraulic fluid for your system.
Data sheet RE 92021	Describes the requirements on an environmentally acceptable hydraulic fluid for operation with Rexroth axial piston units and assists you in selecting a hydraulic fluid for your system.
Data sheet RE 92023	Contains additional information on the use of Rexroth axial piston units with HF hydraulic fluids.
Data sheet RE 90300-03-B	Contains additional information on the use of Rexroth axial piston units at low temperatures.

Also observe the generally applicable, legal or otherwise binding regulations of the European and national legislation and the rules for the prevention of accidents and for environmental protection applicable in your country.

1.2 Abbreviations used

As umbrella term for "A4VSO axial piston variable pump", the designation "axial piston unit" will be used in the following.

Table 2: Abbreviations

Abbreviation	Meaning
A4VSO	Axial piston variable pump, open circuits
DR	Pressure control
DP	Pressure control for parallel operation
FR	Flow control
DFR	Pressure and flow control
LR2	Power control with hyperbolic characteristic
LR3	Power control with remotely controllable power characteristic
LR2N/LR3N	Hydraulic control, pilot pressure related, basic setting $V_{g \min}$
MA	Manual control
EM	Electric motorized control
HD	Hydraulic control, pilot pressure related
HM1/2	Hydraulic control, volume related
HS, HS4	Control system with servo or proportional valve
EO1/2	Control system with proportional valve
DS1	Speed control, secondary control
DFE1	Electro-hydraulic control system
RE	Rexroth document in the English language

2 General safety instructions

The axial piston unit has been manufactured according to the generally accepted rules of current technology. There is, however, still a danger of personal injury or damage to equipment if the following general safety instructions and the warnings before the steps contained in these instructions are not complied with.

- Read these instructions completely and thoroughly before working with the axial piston unit.
- Keep these instructions in a location where they are accessible to all users at all times.
- Always include the operating instructions when you pass the axial piston unit on to third parties.

2.1 Intended use

Axial piston units are components in terms of the EU machine directive 98/37/EC (sub units). Axial piston units are not ready-to-use machines for the purpose of the EU machine directive. The product/component is exclusively intended for being integrated in a machine or system or for being assembled with other components to form a machine or system. The product may only be commissioned after it has been installed in the machine/system for which it is intended.

The axial piston variable pump generates, controls and regulates a hydraulic-fluid flow. It is approved for use as a hydraulic pump in hydrostatic drives in open circuits.

- Observe the technical data, operating conditions and performance limits as specified in the data sheet and order confirmation.

The axial piston unit is not designed for private use.

Intended use includes having read and understood these instructions, especially chapter "2 General safety instructions".

2.2 Improper use

The axial piston unit may not be used in explosive environments.

In addition, any use of the axial piston unit other than described in chapter "2.1 Intended use" is considered to be improper.

2.3 Personnel qualifications

Assembly, commissioning and operation, disassembly, maintenance and repair require basic mechanical, hydraulic and electrical knowledge, as well as knowledge of the appropriate technical terms. For transporting and handling the product, additional knowledge is necessary with regard to working with a crane and the corresponding attachment equipment. In order to ensure operating safety, these activities may therefore only be carried out by qualified personnel or an instructed person under the direction and supervision of qualified personnel.

Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant conditions pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area.

2.4 Safety instructions in this document

In this manual, there are safety instructions before the steps whenever there is a danger of personal injury or damage to equipment. The measures described to avoid these hazards must be observed.

Safety instructions are set out as follows:

SIGNAL WORD!	Type of danger!
	Consequences ➤ Precautions

- **Safety sign:** (warning triangle): draws attention to the danger
- **Signal word:** identifies the degree of the danger
- **Type of danger:** identifies the type or source of the danger
- **Consequences:** describes what occurs if the safety instructions are not complied with
- **Precautions:** states how the danger can be avoided.

The signal words have the following meaning:

Signal word!	Application
DANGER! 	Indicates an imminently hazardous situation which, if not avoided, will certainly result in death or serious injury.
WARNING! 	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION! 	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or damage to equipment.
	If this information is disregarded, the operating procedure may be impaired.

2.5 Adhere to the following instructions

General instructions

- Observe the regulations for accident prevention and environmental protection for the country where the product is used and at the workplace.
- Only use Rexroth axial piston units in good technical order and condition.
 - Inspect the product for obvious defects.
- Do not modify or retrofit the axial piston unit.
- Only use the product within the performance range provided in the technical data.
- Persons who assemble, commission, operate, disassemble or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- The warranty only applies to the delivered configuration.
- The warranty is rendered void if the product is incorrectly assembled, commissioned or operated, as well as if not used as intended and/or handled improperly.
- Do not expose the product to any mechanical loads under any circumstances. Never use the product as a handle or step. Do not place/lay any objects on it.

General safety instructions

- The noise emission of axial piston units depends on speed, operating pressure and installation conditions. The sound pressure level may rise above 70 dBA during normal operating conditions. This can cause hearing damage.
 - Always wear hearing protection while working in the vicinity of the operating axial piston unit.

- The axial piston unit heats up considerably during operation. The solenoids of the axial piston unit get so hot during operation that you may burn yourself:
 - Allow the axial piston unit to cool down sufficiently before touching it.
 - Wear heat-resistant protective clothing, e.g. gloves.

- During transport**
- Make certain that the lifting gear has adequate lifting capacity. The weight can be found in chapter "5 Transport and storage".

- During assembly**
- Before assembling, make sure that all fluids have been completely removed from the axial piston unit to prevent mixing with the hydraulic fluid used in the system.
 - Make sure the relevant system component is not under pressure or voltage before assembling the product or when connecting and disconnecting plugs. Protect the system against being switched on.
 - Lay cables and lines so that they cannot be damaged and no one can trip over them.
 - Before commissioning, make sure that all hydraulic connections are tight and that all the connection seals and plugs are installed correctly to ensure that they are leakproof and fluids and contaminants are prevented from penetrating the product.
 - When assembling, provide for absolute cleanliness in order to prevent contaminants such as welding beads or metal cuttings from getting into the hydraulic lines and causing product wear or malfunctions.

- During commissioning**
- Ensure that all electrical and hydraulic connections and ports are occupied or plugged. Only commission a completely installed product.

- During cleaning**
- Plug all openings with the appropriate protective equipment in order to prevent detergents from penetrating the system.
 - Never use solvents or aggressive detergents. Use only water and, if necessary, a mild detergent to clean the axial piston unit.
 - Do not point the high-pressure cleaner at sensitive components such as, e.g. shaft seal ring, electrical connections and electrical components.

- During maintenance and repair**
- Perform the prescribed maintenance work at the intervals specified in the operating instructions (see chapter "9.3 Maintenance").
 - Make sure that no lines, connections or components are disconnected as long as the system is under pressure. Protect the system against being switched on.

- Disposal**
- Dispose of the product and the hydraulic fluid in accordance with the currently applicable national regulations in your country.

2.6 Operator's obligations

The operator of the axial piston unit from Rexroth must provide personnel training on a regular basis regarding the following subjects:

- Observation and use of the operating instructions and the legal regulations
- Intended use and operation of the axial piston unit
- Observation of the instructions from the factory security offices and of the work instructions from the operator



Rexroth offers training support for special fields. You can find an overview of the training contents on the Internet at:

<http://www.boschrexroth.de/didactic>.

Delivery contents

3 Delivery contents

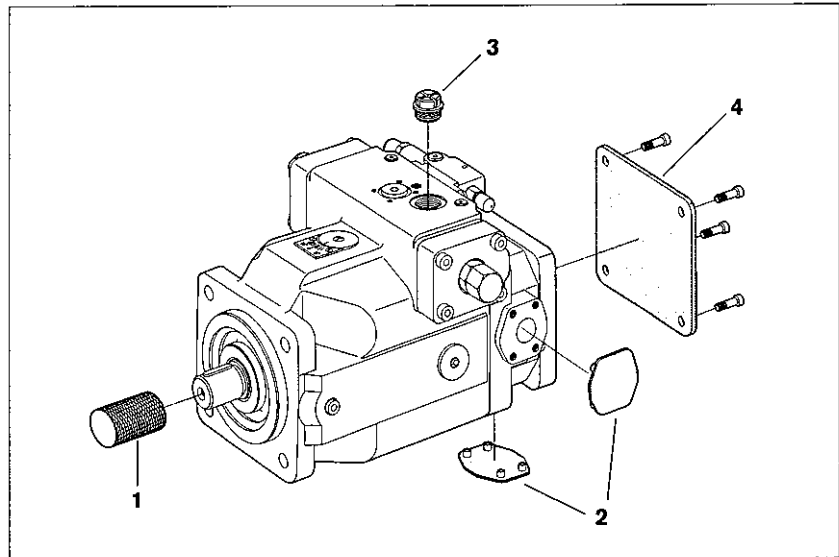


Fig. 1: Axial piston unit

Included in the delivery contents are:

- 1 Axial piston unit

The following parts are also assembled on delivery:

- Transport protection for drive shaft end (1).
- Protective covers (2).
- Plastic plugs / locking screws (3).
- Flange cover and fixing screws (4) (optional for versions with through drive).

4 Product description

4.1 Performance description

The axial piston unit is designed and built for the generation, the control and the regulation of a hydraulic fluid flow. It is designed for stationary or mobile applications.

Please refer to the data sheet and order confirmation for the technical data, operating conditions and operating limits of the axial piston unit.

4.2 Device description

The A4VSO is an axial piston variable pump with swashplate design for hydrostatic drives in open circuits. Flow is proportional to drive speed and displacement. The flow can be steplessly changed by controlling the swashplate.

Open circuit

With an open circuit, the hydraulic fluid flows from the tank to the variable pump and is transported from there to the consumer via a directional valve. From the consumer, the hydraulic fluid flows back to the tank via the directional valve.

4.2.1 Assembly of the axial piston unit

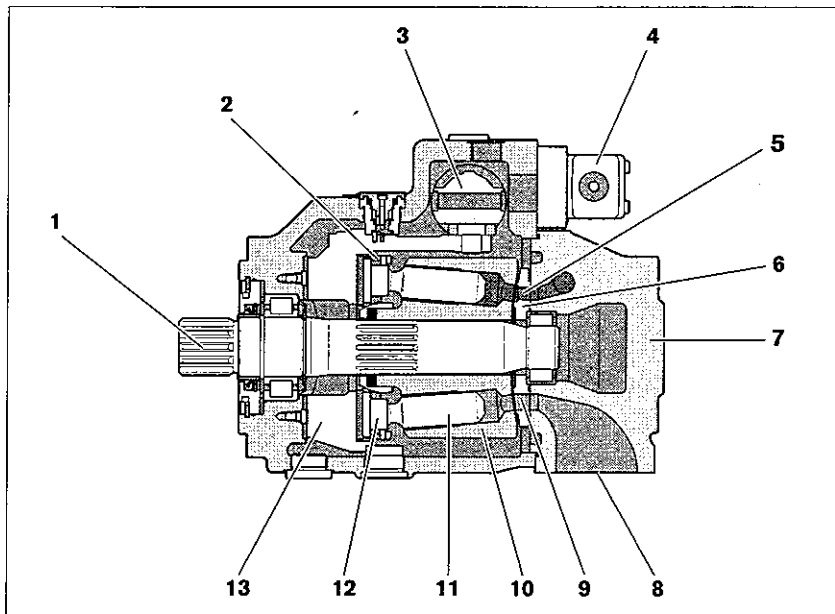


Fig. 2: Assembly of the A4VSO series 1, 2 and 3

- | | | |
|--|----------------------|----------------|
| 1 Drive shaft | 5 High-pressure side | 10 Cylinder |
| 2 Retaining plate | 6 Control plate | 11 Piston |
| 3 Stroke piston | 7 Port plate | 12 Slipper pad |
| 4 Control unit
(here using the DR
as an example) | 8 Suction port | 13 Swashplate |
| | 9 Low-pressure side | |

Product description

For axial piston units with swashplate design, the pistons (11) are arranged axially with respect to the drive shaft (1). They are guided in the rotating cylinder (10) and support themselves with the slipper pads (12) on the non-rotating swashplate (13). The drive shaft (1) and cylinder (10) are connected to one another by means of gearing.

4.2.2 Functional description

Pump Torque is applied to the drive shaft (1) by an engine. The cylinder (10) turns with the drive shaft (1), turning with it the pistons (11). On each rotation, the pistons (11) perform a stroke movement which is defined by the pitch of the swashplate (13). The slipper pads (12) are held on and guided along the glide surface of the swashplate (13) by the retaining plate (2). During a rotation, each piston (11) moves over the bottom and top dead centers back to its initial position. During this action, the fluid volume defined by the piston surface and the stroke is fed in or removed through the two control slits in the control plate (6). On the low-pressure side (9), fluid flows into the enlarging piston chamber via the suction port (8). At the same time, on the high-pressure side (5) the fluid is pushed out of the cylinder chamber into the hydraulic system by the pistons.

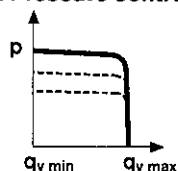
Control The swivel angle of the swashplate (13) is infinitely variable. By changing the swivel angle, the piston stroke and, therefore, the displacement change. The swivel angle is controlled hydraulically via the stroke piston (3). The swashplate (13) is mounted for easy motion in swivel bearings. Increasing the swivel angle increases the displacement; reducing the angle results in a corresponding reduction in displacement.

The swivel angle can never be swiveled completely to zero because a minimum amount of hydraulic fluid is necessary for

- cooling the pistons,
- supplying the control,
- compensating for case drain fluid and
- lubricating all moving parts.

4.2.3 Control devices

DR Pressure control



The DR pressure control serves to maintain a constant pressure in a hydraulic system within the control range of the pump. The pressure can be steplessly set on the control valve (setting range 20 to 350 bar).

For further information, see data sheet RE 92060.

Optional:

with remote-controllable pressure control (DRG)

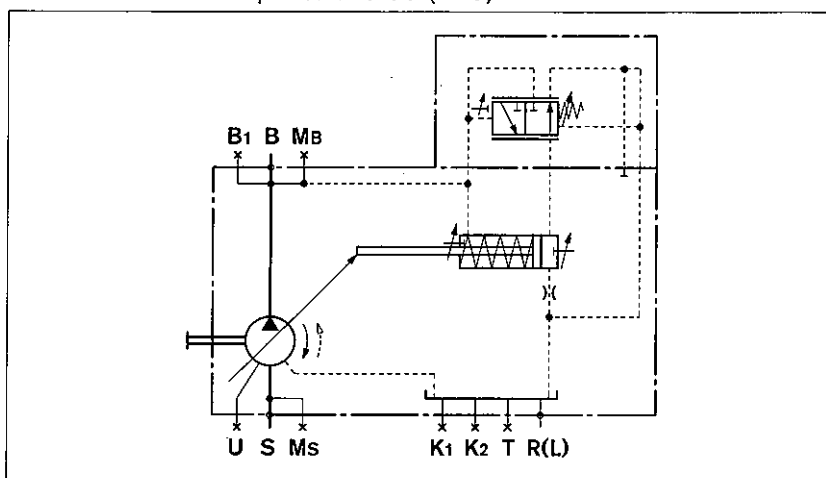
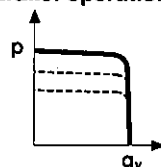


Fig. 3: Circuit diagram of A4VSO with DR pressure control

DP Pressure control for parallel operation

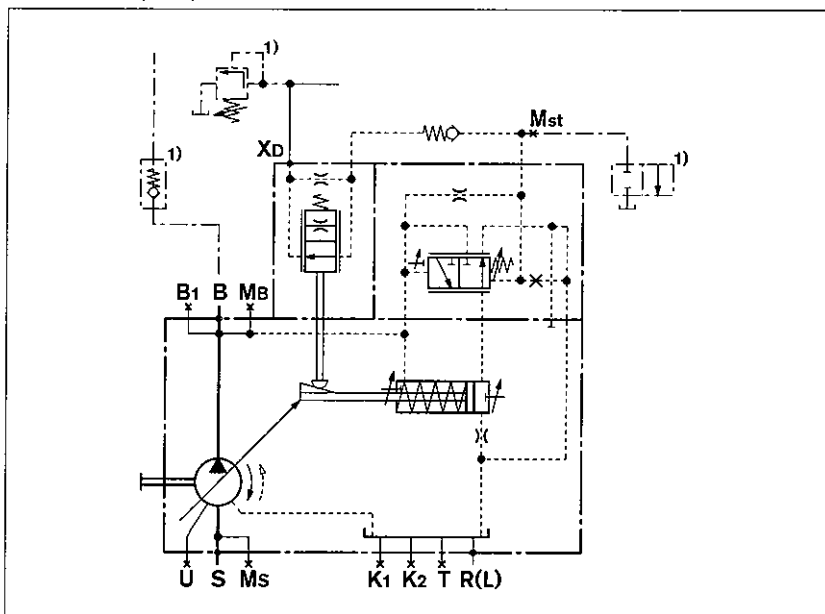


Suitable for pressure control of multiple A4VSO axial piston units in parallel operation.

For further information, see data sheet RE 92060.

Optional:

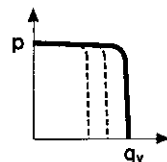
Flow control (DPF)



¹⁾ Not included in the delivery contents

Fig. 4: Circuit diagram of A4VSO with DP pressure control for parallel operation

Product description

FR Flow control

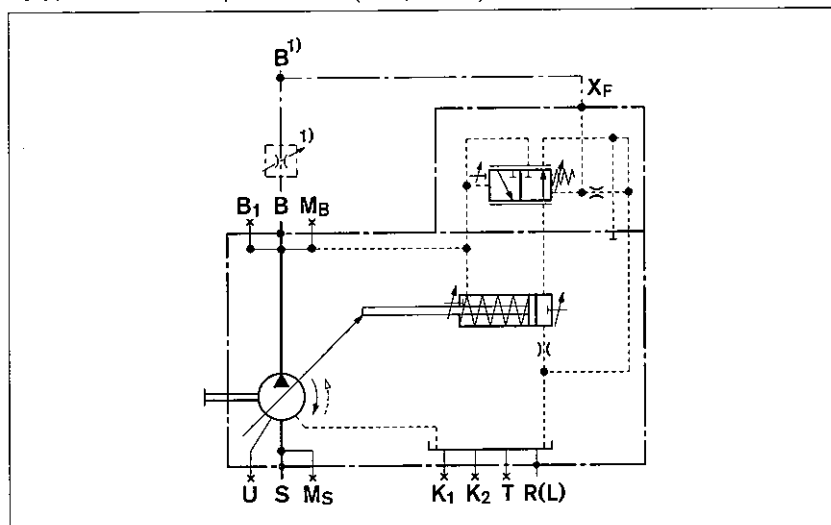
Maintaining a constant flow in a hydraulic system.

For further information, see data sheet RE 92060.

Optional:

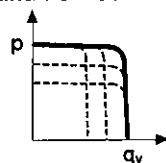
With remote-controllable pressure control (FRG),

no connection from X_F to the tank (FR1, FRG1)



¹⁾ Not included in the delivery contents

Fig. 5: Circuit diagram of A4VSO with FR flow control

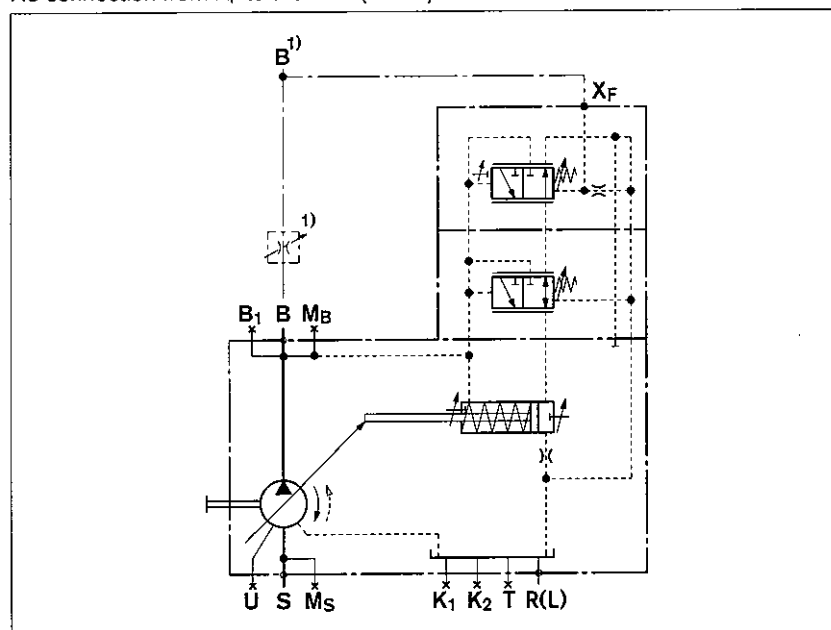
DFR Pressure and flow control

This controller keeps the flow of the pump constant even under changing operating conditions. A mechanically adjustable pressure controller overrides the flow control.

For further information, see data sheet RE 92060.

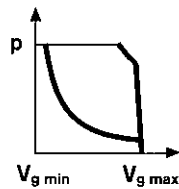
Optional:

No connection from X_F to the tank (DFR1)



¹⁾ Not included in the delivery contents

Fig. 6: Circuit diagram of A4VSO with DFR pressure and flow control

LR2 Power control with hyperbolic characteristic

The hyperbolic power control keeps the specified drive power constant at the same drive speed.

For further information, see data sheet RE 92064.

Optional:

With pressure control (LR2D), remote-controllable pressure control (LR2G);

with flow control (LR2F, LR2S);

with hydraulic stroke limiter (LR2H);

with mechanical stroke limiter (LR2M);

with hydraulic two-point control (LR2Z);

with electric relief valve as start assistance (LR2Y).

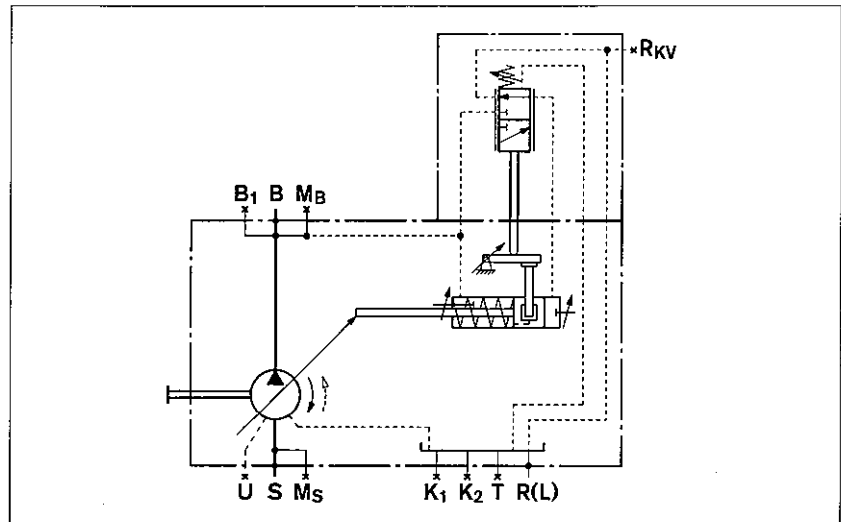
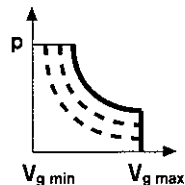


Fig. 7: Circuit diagram of A4VSO with LR2 power control

Product description

LR3 Power control with remote-controllable power characteristic

This hyperbolic power control keeps the specified drive power constant, whereby the power characteristic can be controlled remotely.

For further information, see data sheet RE 92064.

Optional:

With pressure control (LR3D), remote-controllable pressure control (LR3G);
 with flow control (LR23, LR3S);
 with hydraulic stroke limiter (LR3H);
 with mechanical stroke limiter (LR3M);
 with hydraulic two-point control (LR3Z);
 with electric relief valve as start assistance (LR3Y).

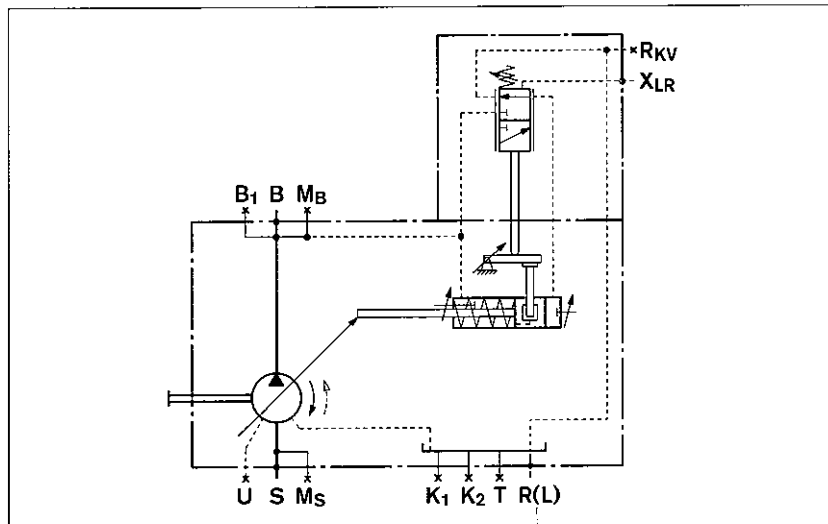


Fig. 8: Circuit diagram of A4VSO with LR3 power control

**LR2N and LR3N Hydraulic control,
pilot pressure related,
basic setting $V_{g \min}$**

With overriding power control.

The displacement is increased in proportion to the pilot pressure in P_{St} .

The additional hyperbolic power control overrides the pilot pressure signal and keeps the specified drive power constant.

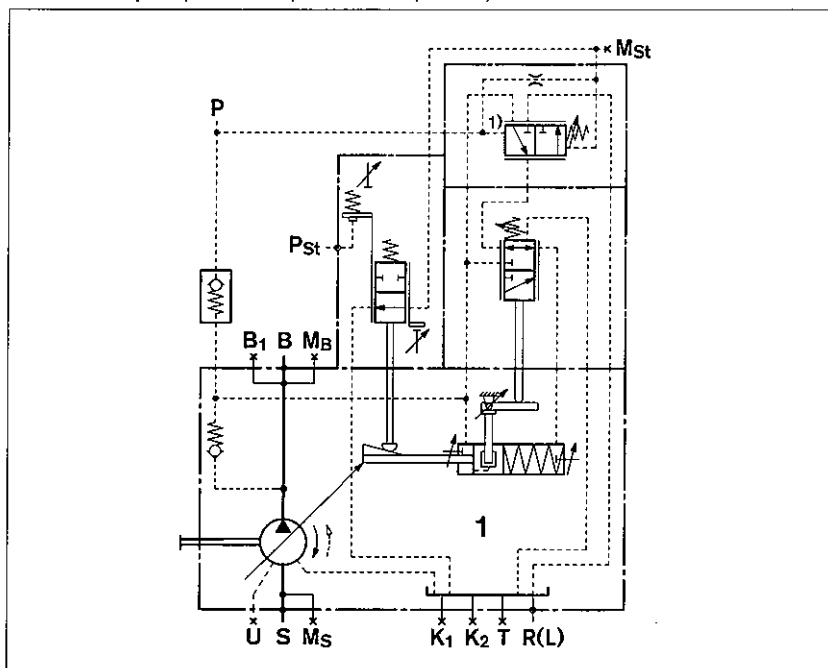
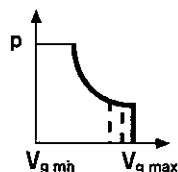
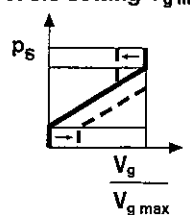
For further information, see data sheet RE 92064.

Optional:

remote controllable power characteristic (LR3N)

with pressure control (LR.DN), remote controllable pressure control (LR.GN);

with electric pilot pressure specification (LR.NT)



¹⁾ Shown in switched position, i.e. P pressurized

Fig. 9: Circuit diagram of A4VSO with LR2N hydraulic control

MA Manual control

The displacement is steplessly adjustable via a handwheel.

For further information, see data sheet RE 92072.

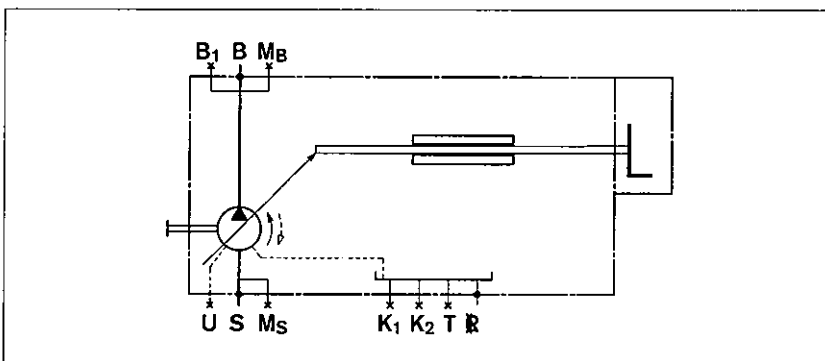
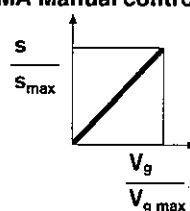
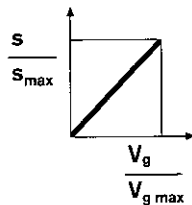


Fig. 10: Circuit diagram of A4VSO with MA manual control

Product description

EM Electric motorized control

The displacement is steplessly controlled via an electric variable motor.

With a programmed sequence control, various intermediate displacements can be selected by means of built-on limit switches or a potentiometer for swivel-angle feedback.

For further information, see data sheet RE 92072.

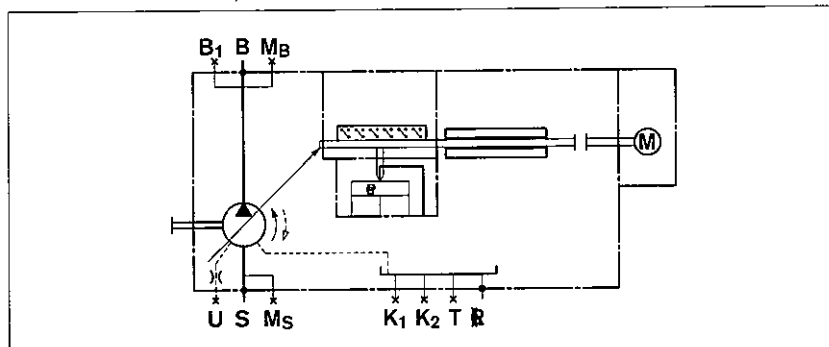
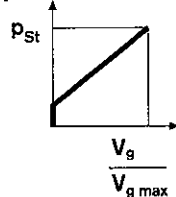


Fig. 11: Circuit diagram of A4VSO with EM electric motorized control

HD Hydraulic control, pilot pressure related

Stepless adjustment of the pump displacement according to the pilot pressure. The control is proportional to the specified pilot pressure setpoint.

For further information, see data sheet RE 92080.

Optional:

Control characteristics (HD1, HD2, HD3)

with pressure control (HD.B), remote controllable pressure control (HD.GB)

with power control (HD1P)

with electric pilot pressure specification (HD1T)

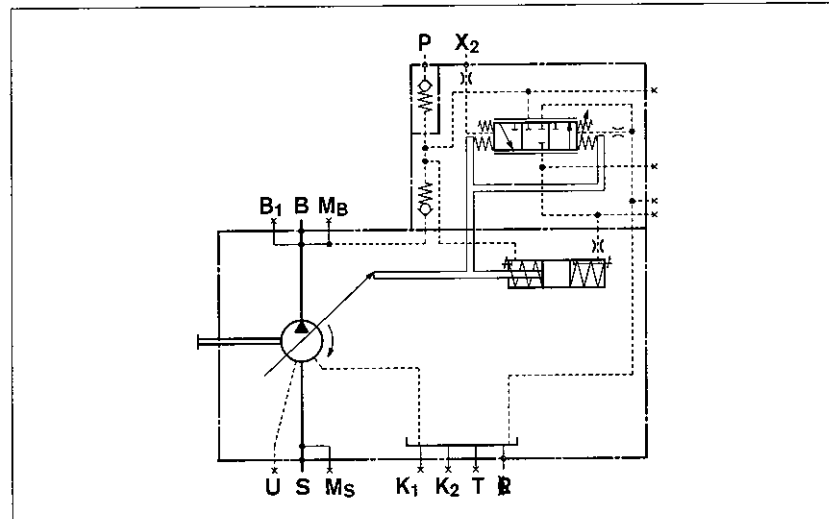


Fig. 12: Circuit diagram of A4VSO with HD hydraulic control

**HM1/2 Hydraulic control,
volume related**

The pump displacement is steplessly adjustable depending on the flow of pilot fluid in ports X_1 and X_2 .

For further information, see data sheet RE 92076.

Application:

- 2-point switching
- Base device for servo or proportional controls

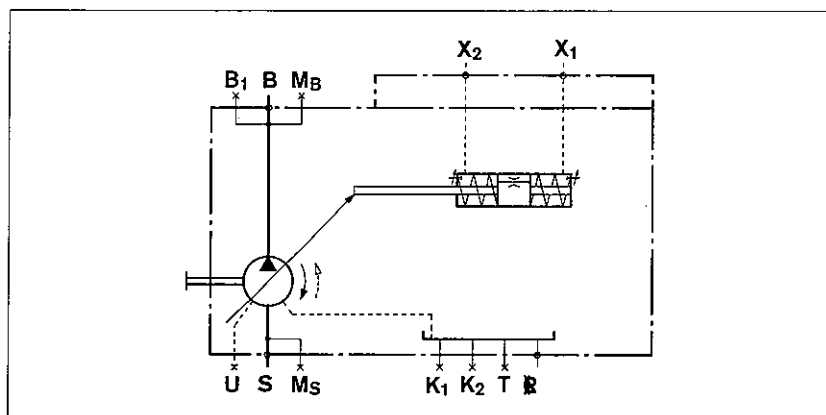
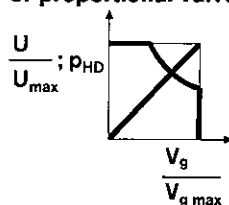


Fig. 13: Circuit diagram of A4VSO with HM1/2 hydraulic control

**HS, HS4 Control system with servo
or proportional valve**

The displacement is steplessly controlled via a servo or proportional valve and electric swivel-angle feedback.

Electrically or electronically controllable.

For further information, see data sheet RE 92076.

Optional:

- With servo valve (HS);
- with proportional valve (HS4);
- with short-circuit valve (HSK, HS4K, HS4KP);
- without valves (HSE, HS4E);
- suitable for tank installation (HS4M)

The HS4P control system is equipped with mounted pressure transducer, which means that it can be used for electric pressure and power control.

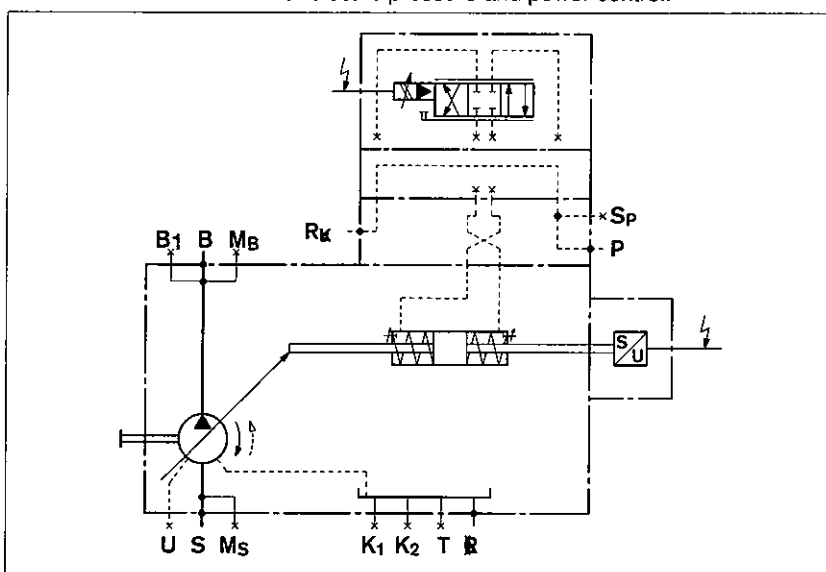
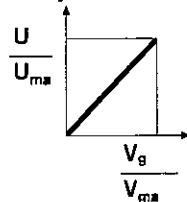


Fig. 14: Circuit diagram of A4VSO with HS, HS4 control system

Product description

Control system EO1/2



The displacement is steplessly controlled via a servo or proportional valve and electric swivel-angle feedback.

Electrically controllable.

For further information, see data sheet RE 92076.

Optional:

With short-circuit valve (EO1K, EO2K)

without valves (EO1E, EO2E)

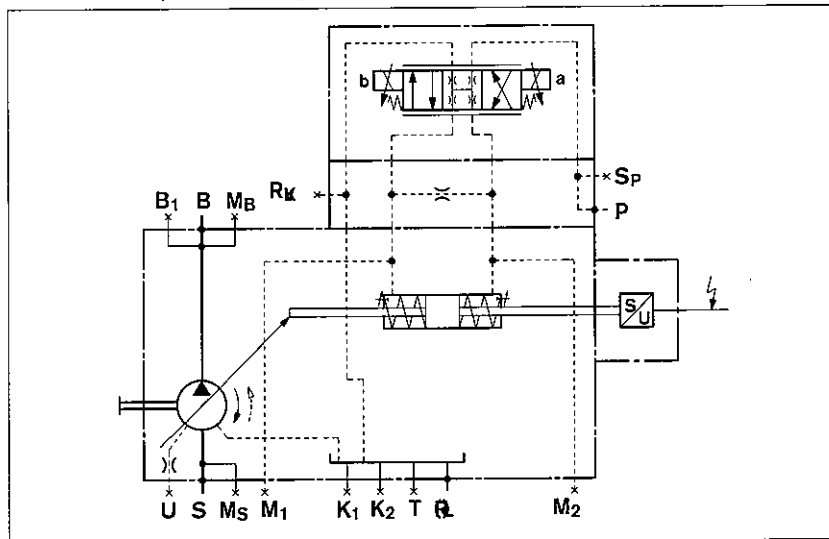
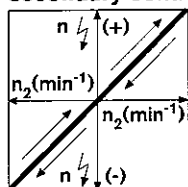


Fig. 15: Circuit diagram of A4VSO with EO1/2 control system

DS1 Speed control, secondary control



The DS1 speed control controls the secondary unit in such a way that the necessary torque is available for the required speed. When connected to a constant pressure system, this torque is proportional to the displacement and thus also proportional to the swivel angle.

For further information, see data sheet RE 92056.

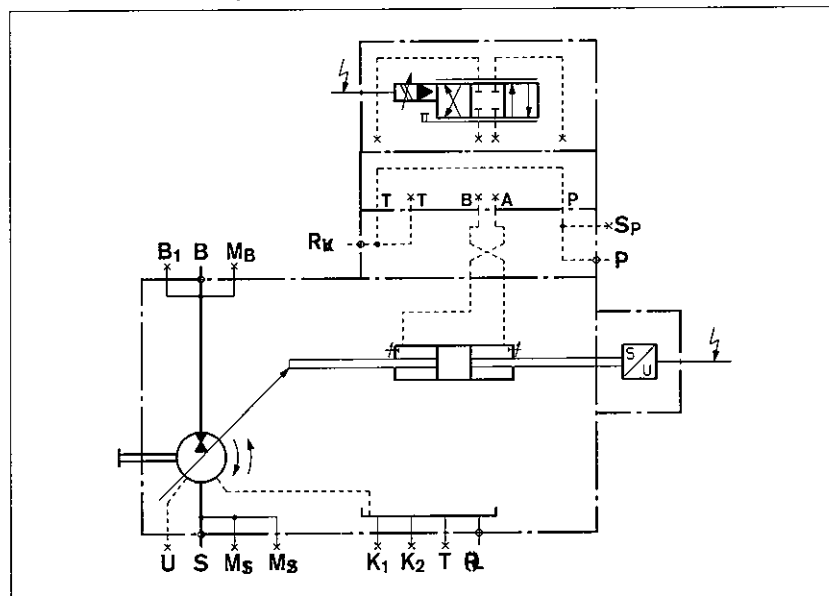
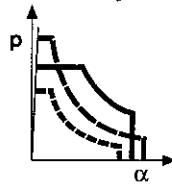


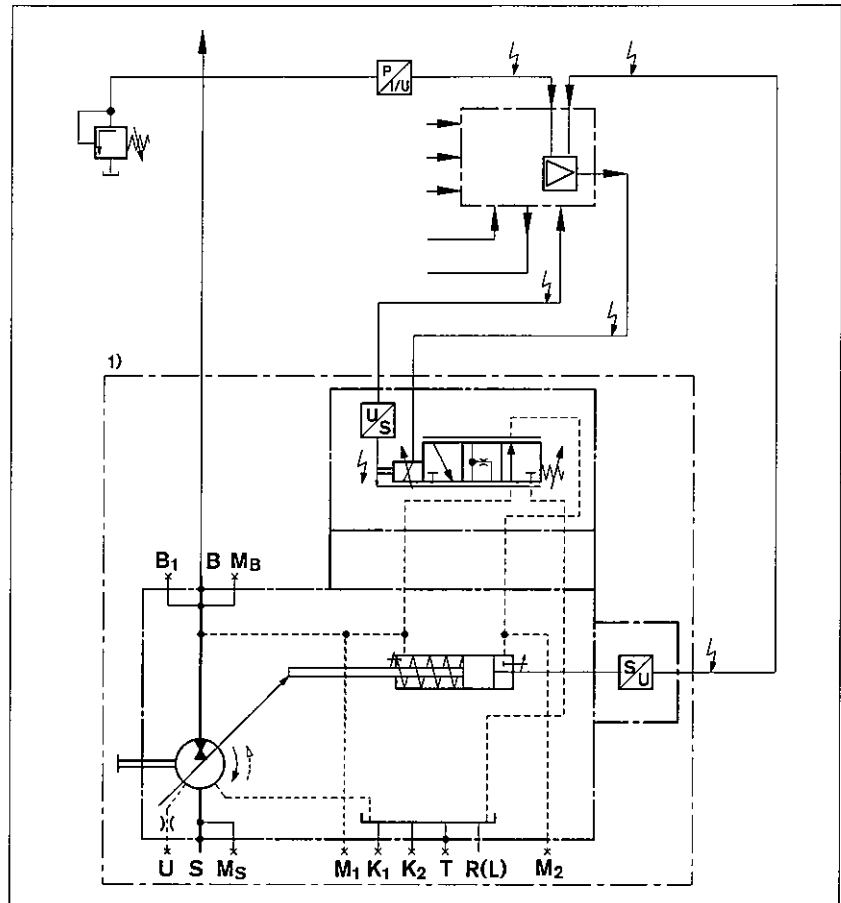
Fig. 16: Circuit diagram of A4VSO with DS1 speed control

DFE1 Electro-hydraulic control system

The power, pressure and swivel angle control of the A4VSO...DFE1 variable pump is performed by means of an electrically controllable proportional valve. The flow at the proportional valve determines the position of the swashplate – and thus the pump flow – via the stroke piston and the displacement pick-up.

When the electric engine is switched off and the actuator system is depressurized, the pump swivels to maximum displacement by means of spring force ($V_{g \max}$).

For further information, see data sheet RE 92088.



¹⁾ Delivery contents

Fig. 17: Circuit diagram of A4VSO with DFE1 electro-hydraulic control system

Product description

4.3 Product identification

The axial piston unit can be identified with the name plate. The following example shows an A4VSO name plate:

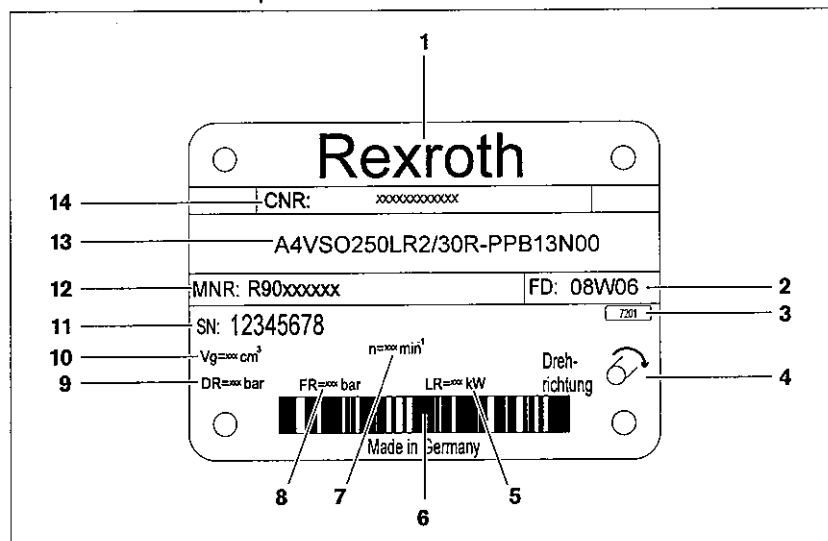


Fig. 18: A4VSO name plate

- | | |
|--|---|
| 1 Manufacturer | 9 Pressure control setting (optional) |
| 2 Production date | 10 Displacement |
| 3 Internal plant designation | 11 Serial number |
| 4 Direction of rotation (looking at drive shaft) – here: clockwise | 12 Material number of the axial piston unit |
| 5 Power setting (optional) | 13 Ordering code |
| 6 Barcode | 14 Customer number |
| 7 Rotational speed | |
| 8 Flow setting (optional) | |

5 Transport and storage

5.1 Transporting the axial piston unit

CAUTION!



Risk of damage!

Hitting or impulsive forces on the drive shaft can damage the axial piston unit.

- Do not hit the coupling or drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft.
- Details on the permissible axial and radial forces can be found in the data sheet.

Axial piston units can be transported with a fork lift truck or with a lifting device.

- Make certain that the fork lift truck or lifting device has adequate lifting capacity.

Dimensions and weights

Table 3: Dimensions and weights

Size		40	71	125	180	250	355	500	750	750 ¹⁾	1000
Weight	kg	39	53	88	102	184	207	320	460	490	605
Width	mm	The dimensions vary with the unit type. The values applicable to your axial piston unit can be found in the installation drawing.									
Height	mm										
Depth	mm										

¹⁾ With charge pump

5.1.1 Transporting with lifting device

For transporting, the axial piston unit can be connected to a lifting device via a ring screw or a lifting strap.

Transport with ring screw

The drive shaft can be used to transport the axial piston unit as long as only outward axial forces occur. Thus, you can suspend the axial piston unit from the drive shaft.

- To do this, screw a ring screw completely into the thread on the drive shaft. The size of the thread is stated in the installation drawing.
- Make sure that each ring screw can bear the total weight of the axial piston unit plus approx. 20 %.

You can hoist the axial piston unit as shown in Fig. 19 using the ring screw screwed into the drive shaft without any risk of damage.

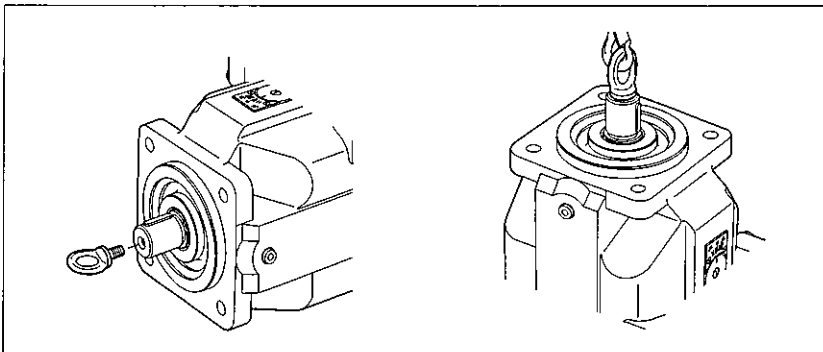


Fig. 19: Fixing the ring screw

Transport and storage

Transport with lifting strap

- Place the lifting strap around the axial piston unit in such a way that it passes over neither the attachment parts (e.g. valves) nor such that the axial piston unit is hung from attachment parts (see Fig. 20).

WARNING!



Risk of injury!

During transport with a lifting device, the axial piston unit can fall out of the lifting strap and cause injuries.

- Hold the axial piston unit with your hands to prevent it from falling out of the lifting strap.
- Use the widest possible lifting strap.

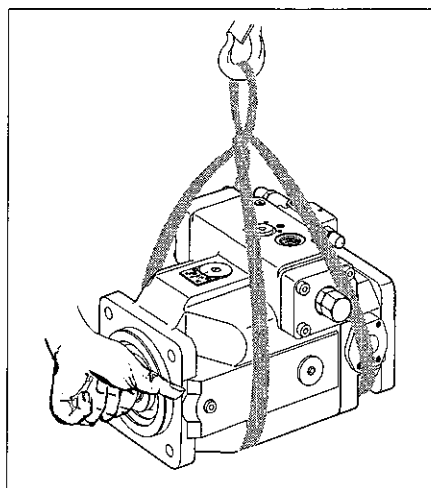


Fig. 20: Transport with lifting strap

5.2 Storing the axial piston unit

Requirement

- The storage areas must be free from corrosive materials and gasses.
- The storage areas must be dry.
- The ideal temperature for storage lies between +5 °C and +20 °C.
- Avoid intense lights.
- Do not stack axial piston units and store them shock-proof.
- For other storage conditions, see Table 4.

- Check the axial piston unit monthly to ensure proper storage.

After delivery

The axial piston unit is provided ex-works with a corrosion protection packaging (corrosion protection film).

Listed in the following table are the maximum permissible storage times for an originally packed axial piston unit.

Table 4: Storage time with factory corrosion protection

Storage conditions	Standard corrosion protection	Long-term corrosion protection
Closed, dry room, uniform temperature between +5 °C and +20 °C. Undamaged and closed corrosion protection film.	Maximum 12 months	Maximum 24 months

Transport and storage

The warranty is rendered void if the requirements and storage conditions are not adhered to or after expiration of the maximum storage time (see Table 4).

Procedure after expiration of the maximum storage time:

1. Check the entire axial piston unit for damage and corrosion prior to installation.
2. Check the axial piston unit for proper function and leaks during a test run.
3. Replace the shaft seal ring if the storage time of 24 months is exceeded.



After expiration of the maximum storage time, we recommend that you have the axial piston unit inspected by your responsible Rexroth Service partner.

In the event of questions regarding spare parts, contact your responsible Rexroth Service partner or the service department of the manufacture's plant for the axial piston unit, see chapter "9.5 Spare parts" for further information.

After disassembly

If a dismantled axial piston unit is to be stored, it must be conserved against corrosion for the duration of the storage.



The following instructions only refer to axial piston units which are operated with a mineral-oil based hydraulic fluid. Other hydraulic fluids require conservation methods that are specifically designed for them. In such a case, consult with Rexroth Service (see chapter "9.5 Spare parts" for address).

Rexroth recommends the following procedure:

1. Clean the axial piston unit, see chapter "9.1 Cleaning and care" for further information.
2. Completely empty the axial piston unit.
3. For storage time up to 12 months: Moisten the inside of the axial piston unit with mineral oil and fill with approx. 100 ml mineral oil.
For storage time up to 24 months: Fill the axial piston unit with corrosion protection VCI 329 (20 ml).
Fill via case drain port **K₁** or **K₂**,
see chapter "6.4 Assembling the axial piston unit", Fig. 28.
4. Seal all ports airtight.
5. Moisten the unpainted surfaces of the axial piston unit with mineral oil.
6. Package the axial piston unit airtight together with desiccant in corrosion protection film.
7. Store the axial piston unit so that it is protected against jolts. See "Requirement" in this chapter for further conditions.

6 Assembly

Prior to assembly, the following documents must be available:

- Installation drawing for the axial piston unit (available from Rexroth)
- Hydraulic circuit diagram for the axial piston unit (in the installation drawing)
- Hydraulic circuit diagram for the system (available from the system manufacturer)
- Order confirmation (contains the preset data of the axial piston unit)
- Data sheet for the axial piston unit (contains the technical data)

6.1 Unpacking

The axial piston unit is delivered in a corrosion protection film made of polyethylene material.

- Dispose of the packaging according to the national regulations of your country.

CAUTION!**Risk of parts falling out**

If the packaging is not opened correctly, parts may fall out and damage the parts or even result in injury.

- Place the packaging on a flat and solid surface.
 - Only open the packaging from the top.
-

6.2 Installation conditions

- The installation location and position of the axial piston unit essentially determine the procedures during installation and commissioning (such as when filling the axial piston unit).
 - Note that you can expect certain installation positions to affect the control device. Because of gravity, dead weight and case pressure, minor characteristic displacements and actuating time changes may occur.
- Adhere to all limits specified in the data sheet regarding temperature, viscosity, cleanliness of the hydraulic fluid.
 - Make certain that the case of the axial piston unit is filled with hydraulic fluid during commissioning and operation. This is also to be observed following relatively long standstill periods as the axial piston unit may empty via the hydraulic lines.
 - The case drain fluid in the case interior must be directed to the tank via the highest case drain port. Use the line size which is appropriate for the port.
 - A check valve in the case drain line is only permissible on a case-by-case basis upon request.
 - To achieve favorable noise values, decouple all connecting lines from all vibration-capable components (e.g. tank) using elastic elements.
 - Make certain that the suction line, case drain line, and return line flow into the tank below the minimum fluid level in all operational states.

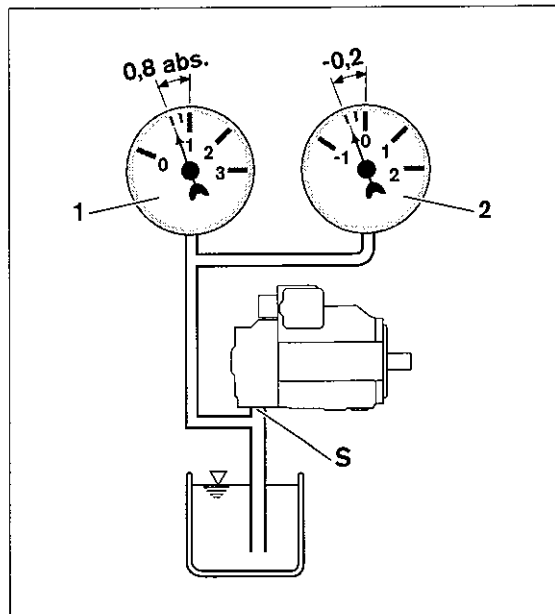


Fig. 21: Suction pressure

- 1 Absolute pressure gauge
- 2 Standard pressure gauge

- Make certain that a minimum suction pressure of 0.8 bar absolute is present at port "S" during operation and on cold starts in all installation positions and installation locations for the axial piston pump, see Fig. 21. See data sheet for additional values.
- Absolute cleanliness is required. The axial piston unit must be installed in a clean condition. Contamination of the hydraulic fluid can have a considerable impact on the service life of the axial piston unit.
- Do not use any cotton waste or linty cloths for cleaning.
- Use suitable liquid detergents to remove lubricants and other difficult-to-remove contamination. Detergents must not penetrate the hydraulic system.

CAUTION!**Risk of damage by air inclusions!**

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the pump case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
- During commissioning and during operation, the suction line must be filled with hydraulic fluid.

CAUTION!**Risk of damage by hydraulic fluid loss!**

With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.

- Check the hydraulic fluid level in the case interior regularly; if necessary, recommission.

6.3 Installation position

The following installation positions are permissible. The shown piping layout illustrates the basic layout.

6.3.1 Below-tank installation

Below-tank installation is when the axial piston unit is installed outside of the tank below the minimum hydraulic fluid level.

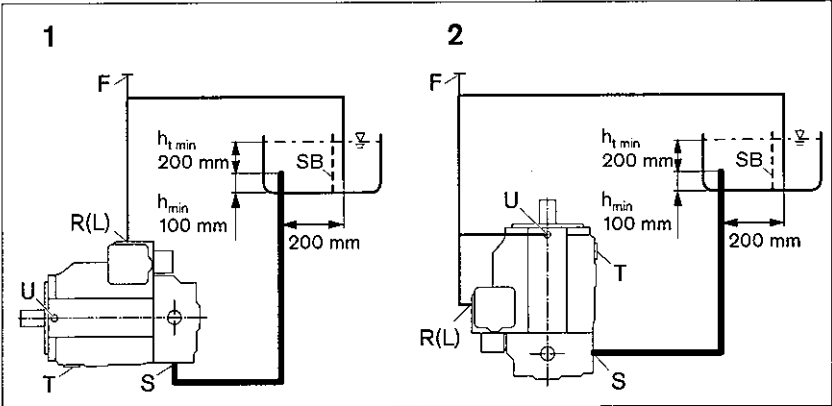


Fig. 22: Below-tank installation with horizontal installation position 1 and vertical installation position 2

- | | | | |
|-------------|------------------------|--------------------------|--|
| F | Filling / air bleeding | U | Flow port |
| R(L) | Fluid filling | SB | Baffle (baffle plate) |
| T | Fluid drain | h_{t min} | Min. permissible immersion depth |
| S | Suction port | h_{min} | Min. permissible distance from suction port to tank base |

Table 5: Below-tank installation

Installation position	Air bleeding	Filling
1 (drive shaft, horizontal)	R(L) (F)	S + R(L) (F)
2 (drive shaft, vertical)	R(L) (F)	S + T

6.3.2 Tank installation

Tank installation is when the axial piston unit is installed in the tank below the minimum hydraulic fluid level. The axial piston unit is completely below the hydraulic fluid.

CAUTION!



Risk of damage during tank installation

To prevent damages to the axial piston unit, all plastic parts (e.g. protective caps, covers) must be removed prior to installation in the tank.

- ▶ Remove all plastic parts before installing the axial piston unit in the tank. Make certain that no pieces of these parts remain in the tank.
- ▶ Axial piston units with electrical component must not be installed below the hydraulic fluid level.

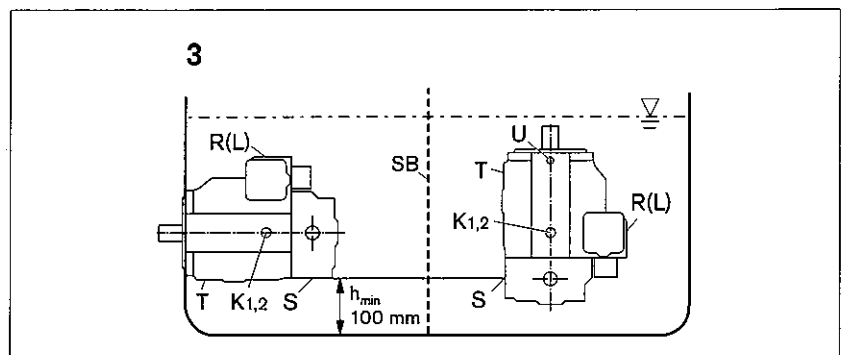


Fig. 23: Tank installation with horizontal and vertical installation position 3

R(L)	Air bleed port	K₁, K₂, U	Flow port
T	Fluid port	SB	Baffle (baffle plate)
S	Suction port	h_{min}	Min. permissible distance from lower edge of suction port to tank base

Table 6: Tank installation

Installation position	Air bleeding	Filling
3	via the highest opened port T, K ₁ , K ₂ , R(L), U	via all opened ports T, K ₁ , K ₂ , R(L), U and S automatic, due to position below hydraulic fluid level

Assembly

6.3.3 Above-tank installation

Above-tank installation is when the axial piston unit is installed above the minimum fluid level of the tank.



For vertical installation (shaft end upward), Rexroth recommends the use of a bearing flushing at port "U" in order to ensure lubrication of the front bearing and of the shaft seal ring.

CAUTION!



Risk of damage to the product!

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the pump case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
- Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.
- Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation.

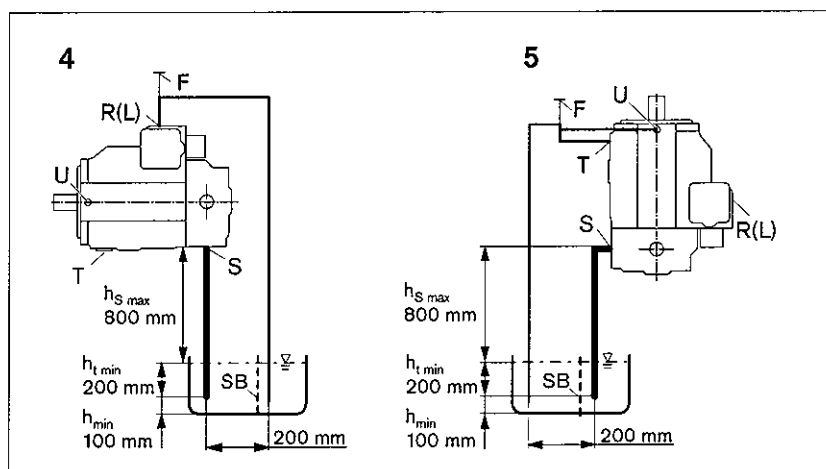


Fig. 24: Above-tank installation with horizontal installation position 4 and vertical installation position 5

F	Filling / air bleeding	SB	Baffle (baffle plate)
R(L)	Fluid filling	$h_{s \max}$	Max. permissible suction height
T	Fluid drain	$h_{t \min}$	Min. permissible immersion depth
S	Suction port	$h_{\min}$	Min. permissible distance from suction port to tank base
U	Flow port		

Table 7: Above-tank installation

Installation position	Air bleeding	Filling
4 (drive shaft, horizontal)	R(L) (F)	R(L) (F)
5 (drive shaft, vertical)	U (F)	T (F)

6.4 Assembling the axial piston unit

DANGER!



Systems which are in operation pose a risk of injury!

Working on operating systems poses a danger to life and limb. The work steps described in this chapter must only be performed on systems which are at a standstill. Before beginning work:

- ▶ Ensure that the engine cannot be switched on.
- ▶ Ensure that all power-transmitting components and connections (electric, pneumatic, hydraulic) are switched off according to the manufacturer's instructions and are secured against being switched on again. If possible, remove the main fuse for the system.
- ▶ Ensure that the system is completely hydraulically relieved and depressurized. Please follow the system manufacturer's instructions.
- ▶ Only qualified personnel (see chapter "2.3 Personnel qualifications" on page 6) are authorized to assemble the axial piston unit.

6.4.1 Preparation

1. Check the delivery contents for completeness and transport damages.
2. Compare the material number and designation (ordering code) with the details in the order confirmation.



If the material number for the axial piston unit does not correspond to the one in the order confirmation, contact Rexroth Service for clarification, see chapter "9.5 Spare parts" for address.

3. Before assembling, completely empty the axial piston unit to prevent mixing with the hydraulic fluid used in the system.
4. Check the direction of rotation of the axial piston unit (on the name plate) and make sure that this corresponds to the direction of rotation of the engine.

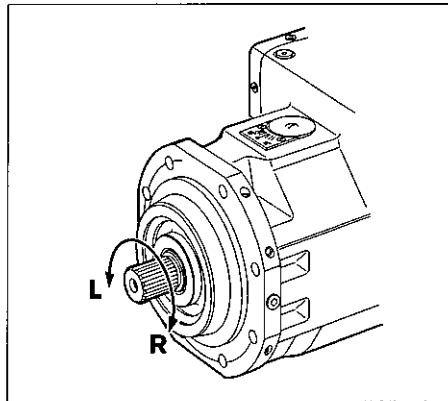


Fig. 25: Direction of rotation

- L Counter-clockwise
R Clockwise



The direction of rotation as specified on the name plate determines the direction of rotation of the axial piston unit as viewed on the drive shaft. For information on the direction of rotation of the engine, please refer to the engine manufacturer's operating instructions.

Assembly

5. Check the swivel angle indicator on the axial piston unit.

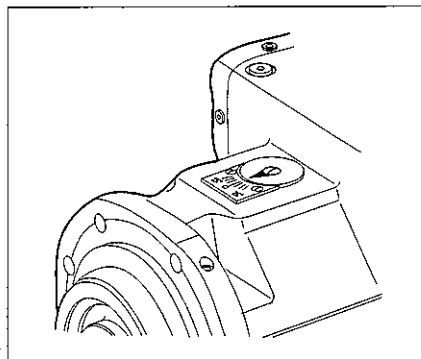


Fig. 26: Swivel angle indicator



Note that if the swivel angle indicator is not on "0", the axial piston unit will automatically transport hydraulic fluid on the initial commissioning.

6.4.2 Dimensions

The installation drawing contains the dimensions for all ports on the axial piston unit. Also observe the instructions provided by the manufacturers of the other components when selecting the required tools.

6.4.3 General instructions

During assembly (and disassembly) of the axial piston unit, observe the following general instructions and handling instructions:

- After a short operating time, toothed belts lose a major portion of their pre-tension and thus cause speed variations and torsional vibrations. Torsional vibrations may cause leakages on the shaft seal ring or increased rotary angle accelerations of the rotary group of the driven axial piston unit. Particularly at risk are diesel drives with a small number of cylinders and low flywheel mass.
 - V-belt drives without automatic tensioning device are also critical with regard to speed variations and torsional vibrations. These can also lead to leakages on the shaft seal ring.
An automatic tensioning device can lessen the speed variations and vibrations and thus avoid consequential damage.
 - When driving an axial piston unit with the aid of a cardan shaft, vibrations may occur which may result in leakages on the shaft seal ring of the axial piston unit depending on the temperature and frequency.
- When driving with toothed belts or v-belts, always use an automatic tensioning device.
 - Fix the axial piston unit so that the expected forces and torques can be transferred without any danger.
 - The permissible axial and radial loading of the drive shaft, the permissible torsional vibration, the optimum direction of load force, as well as the limit speeds can be found in the data sheet.
 - Observe the permissible radial forces on the drive shaft when driving with radial loading (belt drives). If necessary, the belt pulley must be separately mounted.

WARNING!**Risk of damage!**

Hitting or impulsive forces on the drive shaft can damage the axial piston unit.

- Do not hit the coupling or drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft.
- Details on the permissible axial and radial forces can be found in the data sheet.

How to assemble the axial piston unit depends on the connecting elements to the drive side. The following descriptions explain the installation of the axial piston unit:

- with a coupling
- on a gearbox
- with cardan shaft

6.4.4 Installation with coupling

How to assemble the axial piston unit with a coupling is described in detail in the following:

1. Assemble the specified coupling half onto the drive shaft of the axial piston unit according to the instructions of the coupling manufacturer.



The drive shaft end of the axial piston unit is provided with a threaded bore. Use this threaded bore to pull the coupling element onto the drive shaft. Refer to the installation drawing for the dimensions of the threaded bore.

2. Make sure that the installation location is clean and free from dirt and contaminants.
3. Clamp the coupling hub onto the drive shaft or ensure permanent lubrication of the drive shaft. This prevents the formation of frictional corrosion and the associated wear.
4. Transport the axial piston unit to the installation location.
5. Assemble the coupling onto the drive according to the instructions of the coupling manufacturer.



The axial piston unit must not be tightened down until the coupling has been correctly assembled.

6. Fix the axial piston unit at the installation location.
7. If necessary, details on the required tools and tightening torques for the fixing screws are available from the machine or system manufacturer.
 - For bell housing installation, check the coupling axial play through the bell window according to the manufacturer's instructions.
 - For flange installation, align the support for the axial piston unit with the drive.
8. When using flexible couplings, check that the drive is free of resonance after completing the installation.

Assembly**6.4.5 Installation on a gearbox**

How to assemble the axial piston unit on a gearbox is described in detail in the following:

After installing on a gearbox, the axial piston unit is covered and is difficult to access:

- Therefore, before installing, make sure that the centering diameter centers the axial piston unit (observe tolerances) and that no impermissible axial or radial forces act on the drive shaft of the axial piston unit (installation length).
- Protect the spline of the drive shaft from frictional corrosion by providing permanent lubrication.

6.4.6 Installation with cardan shaft

To connect the axial piston unit to the engine via a cardan shaft:

1. Position the axial piston unit close to the specified installation point. It should allow enough space for the cardan shaft to fit through on both sides.
2. Position the cardan shaft on the output shaft of the engine.
3. Push the axial piston unit to the cardan shaft and position the cardan shaft on the drive shaft of the axial piston unit.
4. Bring the axial piston unit to the installation position and secure. If necessary, details on the required tools and tightening torques for the fixing screws can be obtained from the system manufacturer.

6.4.7 Completing assembly

1. Remove any mounted transport screws.
2. Remove the transport protection.
The axial piston unit was delivered with protective covers and plastic plugs or locking screws. These must be removed before connecting. Use appropriate tools.
3. Make certain that the sealing and functional surfaces are not damaged.



Ports which are intended for connecting lines are provided with plastic plugs or locking screws which serve as transport protection. If no connection is made, these ports must be plugged with a suitable metal locking screw since the plastic plugs are not pressure-proof.

CAUTION!



Risk of damage to persons and property!

Operating the axial piston unit with plastic plugs can result in injuries or damage to the axial piston unit.

- Before commissioning, remove all plastic plugs and replace them with suitable, pressure-proof, metal locking screws.

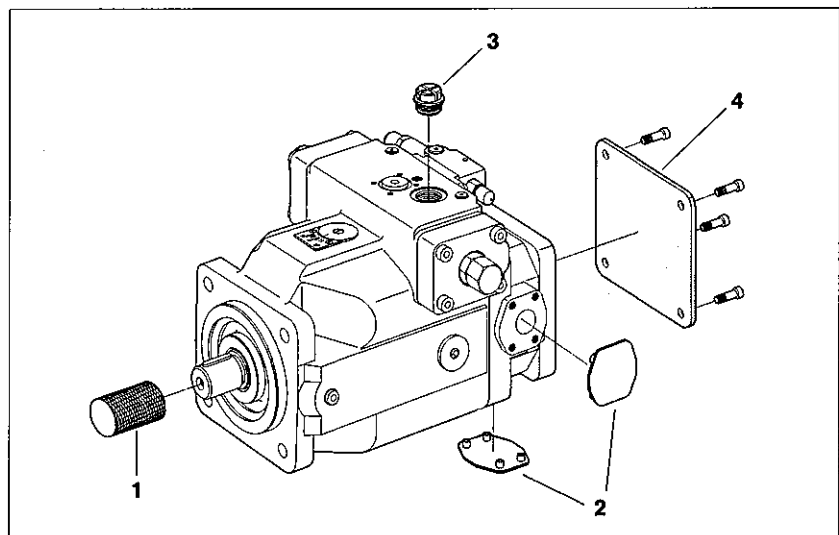


Fig. 27: Removing transport protection

- | | |
|--------------------------------------|--|
| 1 Transport protection for shaft end | 4 Flange cover and fixing screws
(optional for versions with through drive) |
| 2 Protective covers | |
| 3 Plastic plugs / locking screws | |



The adjusting screws are protected against unauthorized resetting by means of protective caps. Removal of the protective caps will void the warranty. If you need to modify the setting, please contact your responsible Rexroth Service (address as to chapter "9.5 Spare parts").

4. For versions with through drive, assemble the auxiliary pump according to the pump manufacturer's instructions.

Assembly

6.4.8 Hydraulically connecting the axial piston unit

The machine or system manufacturer is responsible for dimensioning the lines. The axial piston unit must be connected to the rest of the hydraulic system in accordance with the hydraulic circuit diagram of the machine or system manufacturer.

CAUTION!**Damage to the axial piston unit!**

When installing hydraulic lines and hoses under mechanical stress, they are exposed to additional mechanical forces during operation which reduce the service life of the axial piston unit and the entire machine or system.

- Assemble hydraulic lines and hoses without mechanical stress.

CAUTION!**Risk of damage!**

Generally, a minimum permissible suction pressure at port "S" is specified for axial piston pumps in all installation positions. If the pressure at port "S" drops below the specified values, damage may occur which may lead to destruction of the axial piston pump.

- Make certain that the necessary suction pressure is achieved.
This is influenced by:
 - appropriate piping of the suction cross-section
 - appropriate pipe diameters
 - appropriate position of the tank
 - appropriate viscosity of the hydraulic fluid



Only connect hydraulic lines to the service and function ports.

CAUTION!**Wear and malfunctions**

The cleanliness of the hydraulic fluid has a considerable impact on the cleanliness and service life of the hydraulic system. Any contamination of the hydraulic fluid leads to wear and malfunctions. In particular, contaminants like e.g. welding beads or metal cuttings in the hydraulic lines may damage the axial piston unit.

- Absolute cleanliness is required.
- The axial piston unit must be installed in a clean condition.
- Make sure that all ports, hydraulic lines and add-on units (e.g. measuring devices) are clean.
- Make sure that no contaminants penetrate when sealing the ports.
- Make sure that no detergents enter the hydraulic system.
- Do not use any cotton waste or linty cloths for cleaning.
- Do not use hemp as sealant under any circumstances.

Notes on routing the lines

Observe the following notes when routing the suction, pressure and case drain lines.

- Make certain that the suction line (pipe or hose) is as short and straight as possible.
- The line cross section of the suction line is to be measured so that the minimum permissible pressure at the suction port is not dropped below and the maximum permissible pressure is not exceeded.
- Observe the air tightness of the junctions and the pressure resistance of the hose, also with respect to the external air pressure.
- With the pressure lines, make certain that the pipes, hoses and connecting elements are approved for the operating pressure range.
- Always route the case drain lines so that the housing is constantly filled with hydraulic fluid and to ensure that no air gets through the shaft seal ring even during extended standstill periods. The case internal pressure must not exceed the limit values listed for the axial piston unit in the data sheet under any operating conditions. The case drain line in the tank must end up below the minimum fluid level under all conditions (see chapter "6.3 Installation position").



The ports and fixing threads are designed for the operating pressures specified in the data sheet. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified operating conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

Procedure

To connect the axial piston unit to the hydraulic system:

1. Remove the locking screws at the ports at which the connections are to be made according to the hydraulic circuit diagram.
2. Use only clean hydraulic lines.
3. Connect the lines according to the hydraulic circuit diagram.
Either pipes or hoses must be connected to all ports according to the installation drawing and machine or system circuit diagram or the ports plugged using suitable locking screws.



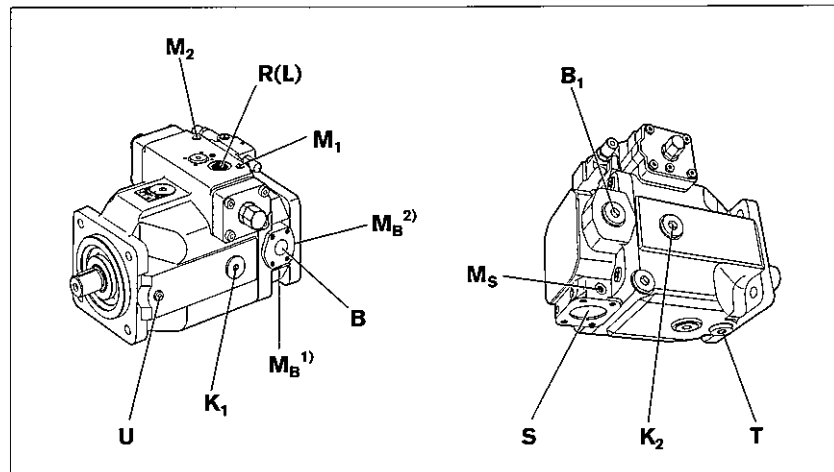
The installation drawing contains the dimensions for all connections and ports on the axial piston unit. Also observe the instructions provided by the manufacturers of the other hydraulic components when selecting the required tools.

4. Make sure

- that the cap nuts are correctly tightened on the fittings and flanges (observe tightening torques!). Mark all checked fittings using e.g. a permanent marker
- that the pipes and hose lines and every combination of connecting piece, coupling or connecting point with hoses or pipes have been inspected by a technically qualified person for safe working condition.

Assembly

Port overview



¹⁾ Version MB below: valid for sizes 40, 71, 125, 250 and 500

²⁾ Version MB rear: valid for sizes 180, 355, 750 and 1000

Fig. 28: Port overview of A4VSO series 1, 2 and 3 (standard ports)

Table 8: Ports of A4VSO series 1, 2 and 3

Designation	Function	Control device (optional)	Standard	Peak pressure (bar) ¹⁾	State
B	Pressure port (high pressure series) Fixing thread		SAE J518 ²⁾ DIN 13	400	O
B ₁ ³⁾	Additional port		DIN 3852	400	X
B ₁ ⁴⁾	2. Pressure port (high pressure series) fixing thread		SAE J518 ²⁾ DIN 13	400	X ⁵⁾
S	Suction port Fixing thread		SAE J518 ²⁾ DIN 13	30	O
K ₁	Flow port		DIN 3852	4	X
K ₂	Flow port		DIN 3852	4	X
U	Flow port		DIN 3852	4	O ⁶⁾
T	Fluid drain		DIN 3852	4	X
R(L)	Fluid filling and air bleeding		DIN 3852	4	O
M _B	Gauge port		DIN 3852	400	X
M _S	Gauge port		DIN 3852	30	X
M ₁ , M ₂ ⁷⁾	Gauge port for control pressure		DIN 3852	400	X
M _{St}	Gauge port for pilot pressure	DP	DIN 3853	400	X
M _{St}	Gauge port for pilot pressure	LR.H., LR.N.	DIN 3853	100	X
X _D	Pilot pressure port for pressure control	DP, DRG, FRG(1)	DIN 3852	400	O
X _F	Pilot pressure port for flow control	DPF, FR.(1), DFR(1)	DIN 3852	400	O
R _{KV}	External control fluid return (sizes 40–355)	LR..	DIN 3852	400	X
R _{KV}	Control fluid return	HS.	DIN 3852	5	O
R _{KV}	Control fluid return	EO1 (sizes 125, 250), EO2	DIN 3852	5	X
R _{KV}	Pilot oil return (pipes)	DS1	DIN 3852	30	X
X _{LR}	Pilot pressure port Remote adjustment for power control	LR3	DIN 3852	100	O
P _{St}	Pilot pressure port	LR.H., LR.N.	DIN 3852	100	X
P _{St}	Gauge port for pilot pressure	LR.NT	DIN 3853	100	X

Designation	Function	Control device (optional)	Standard	Peak pressure (bar) ¹⁾	State
X ₁ , X ₂	Pilot pressure port	HD.P/T/U (sizes 40–71, sizes 500–1000)	DIN 3853	100	O ⁸⁾
X ₁ , X ₂	Pilot pressure port	HD.P/T/U (sizes 125–355)	DIN 3852	100	O ⁸⁾
X ₁ , X ₂	Pilot pressure port	HD	DIN 3852	100	O ⁸⁾
X ₁ , X ₂	Pilot pressure port	HM1	DIN 3852	100	O
X ₁ , X ₂	Pilot pressure port	HM2, HS4M	DIN 3852	350	O
S _P	Control pressure port, accumulator port	EO1 (size 125, 250)	DIN 3852	100	X
S _P	Control pressure port, accumulator port	EO2	DIN 3852	315	X
S _P	Control pressure port, accumulator port	HS., DS1	DIN 3852	350	X
P	Control pressure port	EO1	DIN 3852	100	O
P	Control pressure port	EO2	DIN 3852	315	O
P	Control pressure port	HS.	DIN 3852	350	O
P	Control pressure port	HD (sizes 40–355)	DIN 3853	400	O
P	Control pressure port	HD (sizes 500–1000), HD.P/T/U (sizes 125–355)	DIN 3852	400	O
P	Pilot pressure port (pipes)	DS1	DIN 3852	350	X
R ₂ – R ₇	Air bleeding of positioning chamber	EO2	DIN 3852	315	X
R ₂ – R ₇	Air bleeding of positioning chamber	HM. (sizes 125–1000), HS. (sizes 125–1000)	DIN 3852	350	X

¹⁾ Brief pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and armatures.

²⁾ Only dimensions according to SAE J518

³⁾ Version 13: available for sizes 40 to 355

⁴⁾ Version 25: available for sizes 40 to 1000

⁵⁾ Sealed with flange plate

⁶⁾ Must be connected for version for HFC hydraulic fluids

⁷⁾ Only present for series 3

⁸⁾ Condition and availability dependent on version and size

O = Must be connected (plugged with plastic plugs on delivery)

X = Plugged (in normal operation)

Assembly

Tightening torques The following tightening torques apply:

- Threaded hole in the axial piston unit:
The maximum permissible tightening torques M_{Gmax} are the maximum values of the threaded holes and must not be exceeded. For values, refer to the following table.
- Armatures:
Observe the manufacturer's instruction regarding tightening torques for the used armatures.
- Fixing screws:
For fixing screws according to DIN 13/ISO 68, we recommend checking the tightening torque in individual cases as per VDI 2230.
- Locking screws:
For the metal locking screws supplied with the axial piston unit, the required tightening torques of locking screws M_V apply. For values, refer to the following table.

Table 9: Tightening torques of the threaded holes and locking screws

Threaded size of the ports		Max. permissible tightening torque of the threaded holes M_{Gmax}	Required tightening torque of the locking screws M_V	WAF hexagon socket
M10x1	DIN 3852	30 Nm	12 Nm	5 mm
M12x1.5	DIN 3852	50 Nm	25 Nm	6 mm
M14x1.5	DIN 3852	80 Nm	35 Nm	6 mm
M16x1.5	DIN 3852	100 Nm	50 Nm	8 mm
M18x1.5	DIN 3852	140 Nm	60 Nm	8 mm
M22x1.5	DIN 3852	210 Nm	80 Nm	10 mm
M26x1.5	DIN 3852	230 Nm	120 Nm	12 mm
M27x2	DIN 3852	330 Nm	135 Nm	12 mm
M33x2	DIN 3852	540 Nm	225 Nm	17 mm
M42x2	DIN 3852	720 Nm	360 Nm	22 mm
M48x2	DIN 3852	900 Nm	400 Nm	24 mm
5/16-24 UNF-2B	ISO 11926	10 Nm	7 Nm	1/8 in
3/8-24 UNF-2B	ISO 11926	20 Nm	7 Nm	5/32 in
7/16-20 UNF-2B	ISO 11926	40 Nm	15 Nm	3/16 in
9/16-18 UNF-2B	ISO 11926	80 Nm	25 Nm	1/4 in
3/4-16 UNF-2B	ISO 11926	160 Nm	62 Nm	5/16 in
7/8-14 UNF-2B	ISO 11926	240 Nm	127 Nm	3/8 in
1 1/16-12 UN-2B	ISO 11926	360 Nm	147 Nm	9/16 in
1 5/16-12 UN-2B	ISO 11926	540 Nm	198 Nm	5/8 in
1 5/8-12 UN-2B	ISO 11926	960 Nm	320 Nm	3/4 in
1 7/8-12 UN-2B	ISO 11926	1200 Nm	390 Nm	3/4 in

Risk of mix-ups with threaded connections

The axial piston units are used in application areas with metric as well as with Imperial systems of units.

Both the system of units as well as the size of threaded hole and threaded plug (e.g. locking screw) must match.

Due to the lack of options for visually detecting differences, there is a risk of mix-ups.

WARNING!**Risk of damage to persons and property!**

If a threaded plug which is of a different measurement system and size with respect to the threaded hole is pressurized, the threaded plug may loosen itself or even be ejected from the hole in a projectile-like manner.

This can result in serious injury and damage to equipment. Hydraulic fluid can be discharged from this leakage point.

- Use the drawings (installation drawing/data sheet) to determine the required threaded plug for each fitting.
- Make certain that there are no mix-ups when assembling armatures, fixing screws and locking screws.
- For all threaded holes, use a threaded plug from the same system of units and of the correct size.

6.4.9 Electrical connection of axial piston unit

The machine or system manufacturer is responsible for the layout of the electric control.

For electrically controlled axial piston units, the electric control must be connected according to the circuit diagram of the system manufacturer.

CAUTION!**Short circuit in event of penetrating hydraulic fluid!**

Fluid can penetrate the product and cause a short circuit.

- Do not install electrically controlled axial piston units in a tank below the tank fluid level (tank installation).

1. Switch off power supply to the relevant system component.
2. Electrically connect the axial piston unit (12 or 24 V).

7 Commissioning

WARNING!**Danger while working in the danger zone of a machine or system!**

It is not permissible to work in the danger zone of a machine or system.

- The machine or system must only be operated if safe working is ensured.
- Pay attention to and rectify potential danger sources before commissioning the machine or system.
- Nobody may stand in the danger zone of the machine or system.
- The emergency stop button for the machine or system must be within the operator's reach.
- Always follow the instructions of the machine or system manufacturer during commissioning.

CAUTION!**Risk of damage to persons and property!**

Commissioning of the axial piston unit requires basic mechanical and hydraulic knowledge.

- Only qualified personnel (see chapter "2.3 Personnel qualifications" on page 6) are authorized to commission the axial piston unit.

WARNING!**Risk of toxication and injury!**

Contact with hydraulic fluids may damage your health (e.g. eye injuries, skin damage, toxication upon inhalation).

- Always check the lines for wear and damage before each commissioning.
- While performing these checks, wear safety gloves, safety glasses and suitable working clothes.
- If hydraulic fluid should, nevertheless, come into contact with your eyes or penetrate your skin, consult a doctor immediately.
- When working with hydraulic fluids, strictly observe the safety instructions provided by the hydraulic fluid manufacturer.

WARNING!**Fire hazard!**

Hydraulic fluid is easily flammable.

- Keep open flames and ignition sources from the axial piston unit.

CAUTION!**Missing seals and connections lead to noncompliance with the protection class!**

Fluids and contaminants may penetrate and damage the product.

- Prior to assembly, make sure that all seals and connectors are tight.

7.1 First commissioning

CAUTION!**Risk of damage to the product!**

Any contamination of the hydraulic fluid leads to wear and malfunctions. In particular, contaminants like e.g. welding beads or metal cuttings in the hydraulic lines may damage the axial piston unit.

- Ensure utmost cleanliness during commissioning.
 - Make sure that no contaminants penetrate when sealing the gauge ports.
-

CAUTION!**Risk of damage to the product!**

If you commission the axial piston unit without or with insufficient hydraulic fluid, the axial piston unit is damaged immediately or even destroyed.

- When commissioning or recommissioning a machine or system, make sure that the case interior and the suction and service lines of the axial piston unit are filled with hydraulic fluid and remain filled during operation.
-



When commissioning the axial piston unit, observe the basic safety instructions and intended use provided in chapter "2 General safety instructions".

7.1.1 Filling the axial piston unit

You will require an approved hydraulic fluid:

The machine or system manufacturer can provide you with precise details on the hydraulic fluid. Details on minimum requirements for mineral-oil based hydraulic fluids, environmentally acceptable hydraulic fluids or HF hydraulic fluids for the axial piston unit are available in the Rexroth publications RE 90220, RE 90221 and RE 90223, respectively.

To ensure the functional reliability of the axial piston unit, cleanliness level 20/18/15 according to at least ISO 4406 is necessary for the hydraulic fluid. For permissible temperatures, see the data sheet.

CAUTION!**Risk of damage to the product!**

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the pump case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
 - Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.
 - Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation.
-

Commissioning



The axial piston unit should be filled with a filling unit (10 μm filter grade).
The axial piston unit must not be operated while it is being filled.

CAUTION!**Danger of environmental contamination!**

The discharge or spillage of hydraulic fluid while filling the axial piston unit can lead to environmental pollution and contamination of the groundwater.

- » When filling and changing the hydraulic fluid, always place a catch pan under the axial piston unit.
- » Observe the information in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.

1. Fill and air bleed the axial piston unit via the appropriate ports, see chapter "6.3 Installation position". The hydraulic lines of the system must also be filled.
2. Test the direction of rotation of the engine. To do this, rotate the engine briefly at the lowest rotational speed (inching). Make sure that direction of rotation of the axial piston unit matches the details on the name plate, see also chapter "4.3 Product identification", Fig. 18: Name plate.
3. Operate the axial piston pump at a lower speed (starter speed for internal combustion engines or inching operation for electric engines) until the pump system is completely filled and bled. To inspect, drain the hydraulic fluid at the case drain port and wait until it drains without bubbles.
4. Make certain that all ports are either connected to pipes or plugged according to the general circuit diagram.

7.1.2 Testing the hydraulic fluid supply

The axial piston unit must always have a sufficient supply of hydraulic fluid. For this reason, the supply of hydraulic fluid must be ensured at the start of the commissioning process.

When you test the hydraulic fluid supply, constantly monitor the noise development and check the hydraulic fluid level in the tank. If the axial piston unit becomes louder (cavitation) or the case drain fluid is discharged with bubbles, this is an indication that the axial piston unit is not being sufficiently supplied with hydraulic fluid.

Notes on troubleshooting can be found in chapter "14 Troubleshooting".

To test the hydraulic fluid supply:

1. Allow the engine to run at the slowest speed. The axial piston unit must be operated without load. Pay attention to leakage and noise.
2. Check the axial piston unit's case drain line during the test. The case drain fluid should not contain any bubbles.
3. Check the suction pressure at port "S" of the axial piston pump. Refer to data sheet RE 92050 for the permissible value.
4. Check the case drain pressure at connected port "K₁" or "K₂". Refer to data sheet RE 92050 for the permissible value.

7.1.3 Performing functional test

WARNING!**Risk of injury in case of incorrectly connected machine or system!**

Any change of the connections will lead to malfunctions (e.g. lift instead of lower) and thus represents a corresponding danger to persons and equipment.

- When connecting hydraulic components, observe the specified piping according to the hydraulic circuit diagram of the machine or system manufacturer.

Once you have tested the hydraulic fluid supply, you must perform a functional test on the machine or system. The functional test should be performed according to the instructions of the machine or system manufacturer.

The axial piston unit is checked for functional capability before delivery according to the technical data. During commissioning, it must be ensured that the axial piston unit was installed in accordance with the design of the machine or system. Use the swivel angle indicator to check whether the axial piston unit swivels in and out correctly during operation.

The position of the swivel angle indicator and the assignment of the swivel direction to the direction of rotation and control can be found in the corresponding technical data sheets.

7.1.4 Performing flushing cycle

In order to remove foreign bodies from the system, Rexroth recommends a flushing cycle for the entire system.



During the flushing cycle, the axial piston unit must be operated without load. The flushing cycle can be performed, e.g. by using an additional flushing unit. Follow the instructions of the flushing unit's manufacturer for the exact procedure during the flushing cycle.

7.2 Recommissioning after downtime

Depending on the installation conditions and ambient conditions, changes may occur in the system which make recommissioning necessary.

Among others, the following criteria may make recommissioning necessary:

- Air in the hydraulic system
- Water in the hydraulic system
- Old hydraulic fluid
- Other contamination

- Before recommissioning, proceed as described in chapter "7.1 First commissioning".

Commissioning

7.3 Running-in phase

The bearings and sliding surfaces are subject to a running-in phase. The increased friction at the start of the running-in phase results in increased heat development which decreases with increasing operating hours. The volumetric and mechanical-hydraulic efficiency increases as well through the conclusion of the running-in phase of approx. 10 operating hours.

CAUTION!**Risk of damage by insufficient viscosity!**

The increased temperature of the hydraulic fluid during the running-in phase can cause the viscosity to drop to impermissible levels.

- Monitor the operating temperature during the running-in phase.
 - Reduce the loading (pressure, rpm) of the axial piston unit if impermissible operating temperatures and/or viscosities occur.
-

8 Operation

The product is a component which requires no settings or changes during operation. For this reason, this chapter of the manual does not contain any information on adjustment options. Only use the product within the performance range provided in the technical data. The machine or system manufacturer is responsible for the proper project planning of the hydraulic system and its control.

9 Maintenance and repair

9.1 Cleaning and care

CAUTION!

Damage to the surface caused by solvents and aggressive detergents!

Aggressive detergents may damage the seals on the axial piston unit and cause them to age faster.

- Never use solvents or aggressive detergents.

CAUTION!

Damage to the hydraulic system and the seals!

A high-pressure cleaner's water pressure could damage the electronics and the seals of the axial piston unit.

- Do not point the high-pressure cleaner at sensitive components such as, e.g. shaft seal ring, electrical connections and electrical components.

For cleaning and care of the axial piston unit, observe the following:

- Plug all openings with suitable protective caps/devices.
- Check whether all seals and plugs of the plug connections are securely seated to ensure that no moisture can penetrate into the axial piston unit during cleaning.
- Use only water and, if necessary, a mild detergent to clean the axial piston unit.
- Remove coarse dirt from the outside of the machine and keep sensitive and important components, such as solenoids, valves and displays, clean.

9.2 Inspection

In order to enable long and reliable operation of the axial piston unit, Rexroth recommends testing the hydraulic system and axial piston unit on a regular basis and to document the following operating conditions:

Table 10: Inspection schedule

Task to be carried out		Interval
Hydraulic system	Check level of hydraulic fluid in the tank.	daily
	Check operating temperature (comparable load state).	weekly
	Check quality of the hydraulic fluid.	yearly or every 2000 h (which ever occurs first)
Axial piston unit	Check axial piston unit for leakage. Early detection of hydraulic fluid loss can help identify and rectify faults on the machine or system. For this reason, Rexroth recommends that the axial piston unit and system always be kept in a clean condition.	daily
	Check axial piston unit for noise development.	daily
	Check fixing elements for tight seating. All fixing elements have to be checked when the system is switched off, depressurized and cooled down.	monthly

9.3 Maintenance

The axial piston unit is low maintenance when used as intended.

The service life of the axial piston unit is heavily dependent on the quality of the hydraulic fluid. For this reason, we recommend changing the hydraulic fluid at least once per year or every 2000 operating hours (whichever occurs first) or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use.

The service life of the axial piston unit is limited by the service life of the built-in bearings. The service life can be requested on the basis of the load cycle from the responsible Rexroth Service partner, see "9.5 Spare parts" for address. Based on these details, a maintenance period is to be determined by the system manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system.

9.4 Repair

Rexroth offers a comprehensive range of services for the repair of Rexroth axial piston units.

Repairs of the axial piston unit may only be performed by authorized, skilled and instructed staff.

- Only use genuine spare parts from Rexroth for repairing the Rexroth axial piston units.

Tested and pre-assembled original Rexroth assembly groups allow for successful repair requiring only little time.

9.5 Spare parts

CAUTION!**Damage to persons and property due to faulty spare parts!**

Spare parts that do not meet the technical requirements specified by Rexroth may cause damage to persons or property.

- Use only original spare parts from Rexroth.
-

The list of spare parts for axial piston units are order specific. When ordering spare parts, please quote the material and serial number of the axial piston unit as well as the material numbers of the spare parts.

Please address all questions regarding spare parts to your responsible Rexroth Service partner or the service department of the manufacture's plant for the axial piston unit.

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For the addresses of foreign subsidiaries, please refer to
www.boschrexroth.com/addresses

10 Decommissioning

The axial piston unit is a component that does not require decommissioning. For this reason, this chapter of the manual does not contain any information. For details about how to disassemble or replace your axial piston unit, please refer to chapter "11 Disassembly and replacement".

11 Disassembly and replacement

11.1 Required tools

Disassembly can be performed with standard tools. No special tools are necessary.

11.2 Preparing disassembly

WARNING!**Risk of injuries due to disassembling under pressure and voltage!**

If you do not switch off the pressure and power supply before disassembling the product, you may get injured or the device or system components may be damaged.

- Make sure that the relevant system components are not under pressure or voltage.

-
1. Decommission the entire system as described in the overall manual for the machine or system.
 2. Relieve the hydraulic system according to the instructions of the machine or system manufacturer.

11.3 Disassembling the axial piston unit

Proceed as follows to disassemble the axial piston unit:

1. Make sure that the hydraulic system is depressurized.
2. Check whether the axial piston unit has cooled down far enough so that it can be disassembled without danger.
3. Place a catch pan under the axial piston unit to collect any hydraulic fluid that may escape.

CAUTION!**Danger of environmental contamination!**

The discharge or spillage of hydraulic fluid while filling the axial piston unit can lead to environmental pollution and contamination of the groundwater.

- When filling and changing the hydraulic fluid, always place a catch pan under the axial piston unit.
- Observe the information in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.

-
4. Loosen the lines and collect the escaping hydraulic fluid in the collector.

5. Remove the axial piston unit. Use an appropriate lifting device.
6. Completely empty the axial piston unit.
7. Plug all openings.

11.4 Preparing the components for storage or further use

- Proceed as described in section "5.2 Storing the axial piston unit".

12 Disposal

Observe the following points when disposing of the axial piston unit:

1. Completely empty the axial piston unit.
2. Dispose of the hydraulic fluid according to the national regulations of your country.
3. Disassemble the axial piston unit into its individual parts and properly recycle these parts.
4. Separate parts by:
 - Cast parts
 - Steel
 - Nonferrous metal
 - Electronic waste
 - Plastic
 - Seals.

12.1 Environmental protection

Careless disposal of the axial piston unit, the hydraulic fluid and the packaging material could lead to pollution of the environment.

- » Therefore, dispose of the axial piston unit, the hydraulic fluid and the packaging material in accordance with the currently applicable regulations in your country.
- » Dispose of hydraulic fluid residues according to the applicable safety data sheets for these hydraulic fluids.

13 Extension and conversion

Do not convert the axial piston unit. This also includes a modification of the adjusting screws.



The warranty from Rexroth only applies to the delivered configuration. In case of extensions or conversions, the warranty will become void.



The adjusting screws are protected against unauthorized resetting by means of protective caps. Removal of the protective caps will void the warranty. If you need to modify the setting, please contact your responsible Rexroth Service (address as to chapter "9.5 Spare parts").

14 Troubleshooting

The following table may assist you in troubleshooting. The table makes no claim for completeness.

In practical use, problems which are not listed here may also occur.

14.1 How to proceed for troubleshooting

- ▶ Always act systematically and targeted, even under pressure of time. Random and imprudent disassembly and readjustment of settings might result in the inability to ascertain the original error cause.
- ▶ First obtain a general overview of how your product works in conjunction with the entire system.
- ▶ Try to determine whether the product worked properly in conjunction with the entire system before the troubles occurred.
- ▶ Try to determine any changes of the entire system in which the product is integrated.
 - Were there any changes to the product's operating conditions or operating range?
 - Were there any changes or repairs on the complete system (machine / system, electrics, control) or on the product? If yes, which?
 - Was the product or machine used as intended?
 - How did the malfunction appear?
- ▶ Try to get a clear idea of the error cause. Directly ask the (machine) operator.
- ▶ If you cannot rectify the error, contact one of the contact addresses which can be found under: www.boschrexroth.com/addresses.

Troubleshooting

14.2 Malfunction table

Table 11: Malfunction table for variable pumps

Fault	Possible cause	Remedy
Unusual noises	Drive speed too high.	Machine or system manufacturer.
	Wrong direction of rotation.	Ensure correct direction of rotation.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Improper fixing of the axial piston unit.	Check fixing of the axial piston unit according to the specifications of the machine or system manufacturer. Observe tightening torques.
	Improper fixing of the attachment parts, e.g. coupling and hydraulic lines.	Fix attachment parts according to the information provided by the coupling or armature manufacturer.
	Pressure-relief valves of the axial piston unit.	Air bleed axial piston unit Check viscosity of the hydraulic fluid Contact Rexroth Service.
No or insufficient flow	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Faulty mechanical drive (e.g. defective coupling).	Machine or system manufacturer.
	Drive speed too low.	Machine or system manufacturer.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Hydraulic fluid not in optimum viscosity range.	Use suitable hydraulic fluid (machine or system manufacturer).
	External control of the control device defective.	Check external control (machine or system manufacturer).
	Insufficient pilot pressure.	Check pilot pressure, contact Rexroth Service.
	Malfunction of the control device or controller of the axial piston unit.	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.

Table 11: Malfunction table for variable pumps

Fault	Possible cause	Remedy
No or insufficient pressure	Faulty mechanical drive (e.g. defective coupling).	Machine or system manufacturer.
	Drive power too low.	Machine or system manufacturer.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Hydraulic fluid not in optimum viscosity range.	Use suitable hydraulic fluid (machine or system manufacturer).
	External control of the control device defective.	Check external control (machine or system manufacturer).
	Insufficient pilot pressure.	Check pilot pressure, contact Rexroth Service.
	Malfunction of the control device or controller of the axial piston unit.	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Output unit defective (e.g. hydraulic motor or cylinder).	Machine or system manufacturer.
Pressure/flow fluctuations	Axial piston unit not or insufficiently air bled.	Completely air bleed axial piston unit.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
Hydraulic fluid temperature too high	Excessive inlet temperature at the axial piston unit.	Machine or system manufacturer: inspect system, e.g. malfunction of the cooler, insufficient hydraulic fluid in the tank.
	Malfunction of the pressure control valves (e.g. high-pressure relief valve, pressure cut-off, pressure control).	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.

Technical data

15 Technical data

The technical data of your axial piston unit can be found in data sheet "RE 92050" or "RE 92053" (for HFC hydraulic fluids). Depending on your axial piston pump's control unit, other technical data sheets apply: RE 92056, RE 92060, RE 92064, RE 92072, RE 92076, RE 92080 and RE 92088.

The data sheet can be found on the Internet under

www.boschrexroth.com/ics

The preset technical data of your axial piston unit can be found in the order confirmation.

16 Appendix

16.1 Address directory

For the addresses of foreign subsidiaries, please refer to

www.boschrexroth.com/addresses

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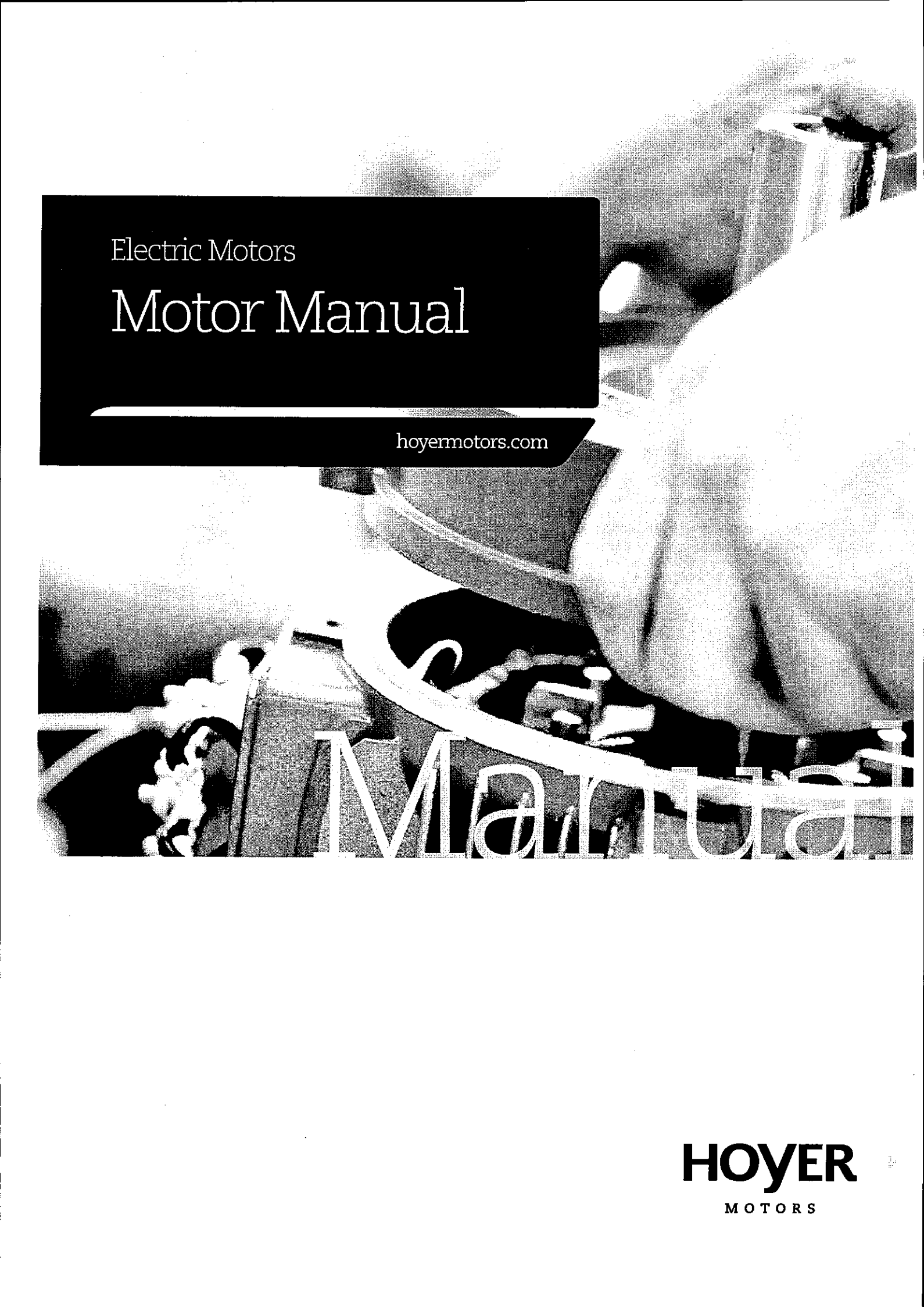
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Electric Motors

Motor Manual

hoyermotors.com

MANUAL

HOYER
MOTORS

1. General

This manual concerns the following types of standard induction motors from Hoyer:

HMA2, HMC2, HMD, HMT, MS, Y2E1, Y2E2, YDT

These motors are manufactured in accordance with IEC/EN 60034-4 and IEC/EN 60072.

Motors are rated for the ambient temperature range -20°C to +40°C and site altitudes ≤1000 m above sea level.

Low-voltage motors are components for installation in machinery. They are CE marked according to the Low Voltage Directive 2006/95/EC

2. Transport and storage

Check the motor for external damage immediately upon receipt and, if found, inform the forwarding agent right away. Check all rating plate data, and compare it with the requirement of the motor.

Turn the shaft by hand to check free rotation, remove transport locking if used.

Transport locking must be used again for internal transport also. It is also important that transport locking is used when motors are transported mounted on equipment.

All motors should be stored indoors, in dry, vibration- and dust-free conditions.

Lifting eyebolts must be tightened before use. Damaged eyebolts must not be used, check before use. Lifting eyes at motor must not be used to lift the motor when it is attached to other equipment.

Before commissioning, measure the insulation impedance. If values are ≤ 10M Ω at 25°C, the winding must be oven dried. The insulation resistance reference is halved for each 20°C rise in motor temperature.

It is recommended that shafts are rotated periodically by hand to prevent grease migration.

3. Installation

The motor must be fixed on a stable, clear and flat foundation. It must be sufficiently rigid to withstand possible short circuit forces.

It is important to ensure that the mounting conditions do not cause resonance with the rotational frequency and the doubled supply frequency.

Only mount or remove drive components (pulley, coupling, etc.) using suitable tools, never hit the drive components with a hammer as this will cause damage to the bearing.

The motor are balancing with half key, ensure that the drive components are also the same.

Correct alignment is essential to avoid bearing, vibration and shaft failure.

Use appropriate methods for alignment.

Re-check the alignment after the final tightening of the bolts or studs.

Check that drain holes and plugs face downwards. We recommend opening the drain hole for motors placed outdoors and not running 24 hours / day, so that the motor can breathe, thus ensuring a dry motor.

4. Electrical connection

Work is only permitted to be carried out by qualified specialists and must to be carried out in accordance with local regulations.

Before work commences, ensure that all power is switched off and cannot be switched on again. This also applies to the auxiliary power circuits, e.g. anti-condense heaters.

Check that supply voltage and frequency are the same as rated data.

Motors can be used with a supply deviation of ± 5% voltage and ± 2% frequency, according to IEC60034-1

Connection diagrams for main supply and accessory as PTC or heater are located inside the terminal box.

Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and the earth connection.

We recommend that crimped connections are made in accordance with IEC 60352-2.

Tightening torques for terminal board screws:

Thread	M5	M6	M8	M10	M12	M16	M20
T.(Nm)	2.5	3.5	7	12	18	35	55

Ensure that the terminal box is clean and dry.

Unused glands must be closed.

Check the terminal box gasket before it is remounted.

5. Maintenance

Inspect the motor at regular intervals, keep it clean and ensure free ventilation air flow, check the condition of shaft seals and replace if necessary. Both electrical and mechanical connections must be checked and tightened if necessary.

Bearing size and type are specified on the rating plate. Motor types HMA2 and HMC2 is as standard with lifetime greased bearing with motor size ≤ 225 . Motor types MS and Y2E is as standard with lifetime greased bearing with motor size ≤ 160 .

Typical duty hours for lifetime lubricated bearings.

Frame size	Poles	Typical lifetime
56 – 160	2 – 8	40.000h
180	2	35.000h
200	2	27.000h
225	2	23.000h
180 – 225	4 – 8	40.000h

Motors with a re-greasing system must be lubricated with high quality lithium complex grease, NLGI grade 2 or 3, with a temperature range of between -40°C to $+150^{\circ}\text{C}$.

Motors are normal fitted with a data plate with greasing information; if it is missing use the following re-greasing intervals.

Frame size	Grease (g)	2 pole (h)	4 pole (h)	6 pole (h)	8 pole (h)
160	20	4200	7000	8500	8500
180	20	4200	7000	8500	8500
200	25	3100	6500	8500	8500
225	25	3100	6500	8500	8500
250	35	2000	6000	7000	7000
280	35	2000	6000	7000	7000
315	50	1500	5500	6500	6500
355	60	1000	4000	5000	6000
400	80	800	3000	4000	6000

Grease the motor while running, open the grease outlet plug and let the motor run 1-2 hours before the outlet grease plug is closed again.

Grease the motor for the first time during commissioning.

The following applies in general for both lifetime lubricated and re-lubricated bearings:

At 60Hz the time will be reduced by app. 20%.

Data for vertically mounted motors are half of the above values.

The table values are based on an ambient temperature of 25°C . The values must be halved for every 15K increase in bearing temperature.

Higher speed operations, e.g. frequency converter drive will require shorter greasing intervals. Typically, doubling the speed will reduce the values by 50%.

6. Special note for Atex Zone 22 motors.

Notice for the use of electrical equipment in areas with combustible dust.

Designation of motor according to EC directive:

Ex II 3D T125 $^{\circ}\text{C}$, IP55.

The dust hazardous 3-phase asynchronous motors are in accordance with European standard EN 50281-1-1. Combustible dust areas will be found in agricultural areas and in industrial environments.

Only one electrical installation may be installed in one specified area (zone).

Only certificated cable glands for category 2D may be used. Unused glands must be closed.

Connections must be made in such a way as to ensure that a permanently safe electrical connection is maintained, both for the main supply and earth connection.

Installations must be in accordance with actual standards for installation in the Zone 22 area.

It is recommended that EN 50281-2 is followed according temperature and dust on the motor surface.

The use of motors with so much surface dust that the motor temperature increases is not permitted.

Regularly cleaning is recommended.

The radial shaft sealing ring is part of the ATEX certification. It is important that the ring is always intact.

The shaft sealing must be regularly checked, and if dry it must be lubricated. It is recommended that the seal is re-lubricated regularly.

Always use the original seal ring when replaced.

Replacing bearings also means replacing the seals.

All machines must be inspected regularly for mechanical damage.

The user is responsible for changing parts in accordance with the lifetime of parts, in particular:

bearings, grease and lubrication of shaft sealing.

Maintenance, repairs and replacement on zone 22 motors must only be carried out by qualified specialists.

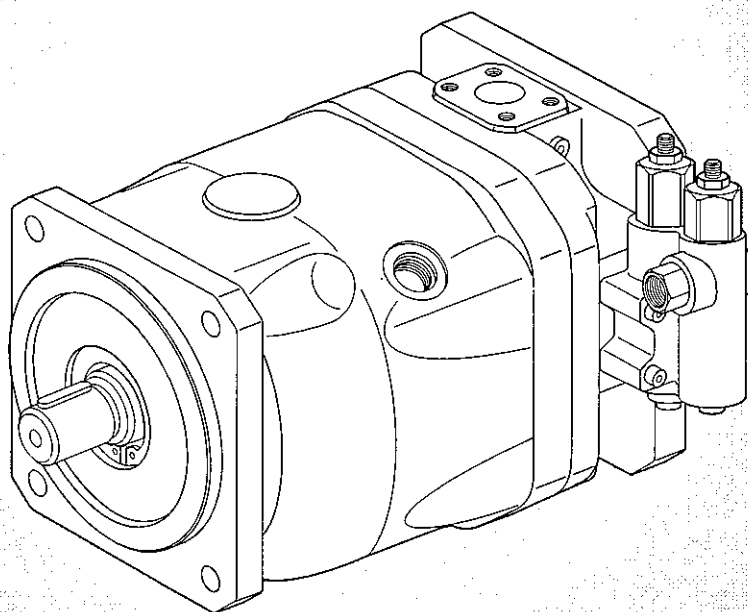
Axial Piston Variable Pump A10VSO

Series 32

RE 92714-01-B/11.08

Replaces: 09.06
English

Operating Instructions



The data specified above only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

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An example configuration is shown on the title page. The delivered product may, therefore, differ from the product which is pictured.

The original operating instructions were created in the German language.

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1 About this document

These instructions contain important information on the safe and appropriate assembly, transport, commissioning, maintenance, disassembly and simple troubleshooting of the axial piston variable pump A10VSO series 32.

- Read these instructions completely, especially chapter "2 General safety instructions", before working with the axial piston variable pump A10VSO.

1.1 Related documents

The axial piston variable pump A10VSO is a system component. Also observe the instructions for the other system components.

Further information on the axial piston variable pump A10VSO, its installation and operation can be found in the Rexroth documents listed in the following table.

Table 1: Related documents

Related documents	Contents
Order confirmation	Contains the preset technical data of your axial piston variable pump A10VSO.
Installation drawing	Contains the outer dimensions, all connections and the hydraulic circuit diagram for your axial piston variable pump A10VSO.
Data sheet RE 92714	Contains the permissible technical data for the axial piston variable pump A10VSO series 32.
Data sheet RE 92707	Electro-hydraulic pressure control ED
Data sheet RE 95581	Universal through drive
Data sheet RE 90220	Describes the requirements on a mineral-oil based hydraulic fluid for operation with Rexroth axial piston units and assists you in selecting a hydraulic fluid for your system.
Data sheet RE 90221	Describes the requirements on an environmentally acceptable hydraulic fluid for operation with Rexroth axial piston units and assists you in selecting a hydraulic fluid for your system.
Data sheet RE 90223	Contains additional information on the use of Rexroth axial piston units with HF hydraulic fluids.
Data sheet RE 90300-03-B	Contains additional information on the use of Rexroth axial piston units at low temperatures.

Also observe the generally applicable, legal or otherwise binding regulations of the European and national legislation and the rules for the prevention of accidents and for environmental protection applicable in your country.

1.2 Abbreviations used

As umbrella term for "axial piston variable pump A10VSO", the designation "axial piston unit" will be used in the following.

Table 2: Abbreviations

Abbreviation	Meaning
A10VSO	axial piston variable pumpAxial piston variable pump, open circuits
DG	Twin-point adjustment, directly controlled
DIN	Deutsche Industrie Norm (German Institute for Standardization)
DR	Pressure controller
DRF/DRS	Pressure flow control
DRG	Pressure controller, remotely controlled
ED	Electro-hydraulic pressure control
ISO	International Organization for Standardization
LA...	Pressure flow power control
RE	Rexroth document in the English language
VDI 2230	Directive for the systematic calculation of high duty bolted joints and joints with one cylindrical bolt from the VDI (Verein Deutscher Ingenieure - Association of German Engineers)

2 General safety instructions

The axial piston unit has been manufactured according to the generally accepted rules of current technology. There is, however, still a danger of personal injury or damage to equipment if the following general safety instructions and the warnings before the steps contained in these instructions are not complied with.

- Read these instructions completely and thoroughly before working with the axial piston unit.
- Keep these instructions in a location where they are accessible to all users at all times.
- Always include the operating instructions when you pass the axial piston unit on to third parties.

2.1 Intended use

Axial piston units are components in terms of the EU machine directive 98/37/EC (sub units). Axial piston units are not ready-to-use machines for the purpose of the EU machine directive. The product/component is exclusively intended for being integrated in a machine or system or for being assembled with other components to form a machine or system. The product may only be commissioned after it has been installed in the machine/system for which it is intended.

The axial piston variable pump generates, controls and regulates a hydraulic-fluid flow. It is approved for use as a hydraulic pump in hydrostatic drives in open circuits.

- Observe the technical data, operating conditions and performance limits as specified in the data sheet and order confirmation.

The axial piston unit is not designed for private use.

Intended use includes having read and understood these instructions, especially chapter "2 General safety instructions".

2.2 Improper use

The axial piston unit may not be used in explosive environments.

In addition, any use of the axial piston unit other than described in chapter "2.1 Intended use" is considered to be improper.

2.3 Personnel qualifications

Assembly, commissioning and operation, disassembly, maintenance and repair require basic mechanical, hydraulic and electrical knowledge, as well as knowledge of the appropriate technical terms. For transporting and handling the product, additional knowledge is necessary with regard to working with a lifting device and the corresponding attachment equipment. In order to ensure operating safety, these activities may therefore only be carried out by qualified personnel or an instructed person under the direction and supervision of qualified personnel.

General safety instructions

Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant conditions pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area.

2.4 Safety instructions in this document

In this manual, there are safety instructions before the steps whenever there is a danger of personal injury or damage to equipment. The measures described to avoid these hazards must be observed.

Safety instructions are set out as follows:

SIGNAL WORD!	Type of danger!
	Consequences ► Precautions

- **Safety sign:** (warning triangle): draws attention to the danger
- **Signal word:** identifies the degree of the danger
- **Type of danger:** identifies the type or source of the danger
- **Consequences:** describes what could occur if the safety instructions are not complied with
- **Precautions:** states how the danger can be avoided.

The signal words have the following meaning:

Signal word!	Application
DANGER! 	Indicates an imminently hazardous situation which, if not avoided, will certainly result in death or serious injury.
WARNING! 	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION! 	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or damage to equipment.
	If this information is disregarded, the operating procedure may be impaired.

2.5 Adhere to the following instructions

General instructions

- Observe the regulations for accident prevention and environmental protection for the country where the product is used and at the workplace.
- Only use Rexroth axial piston units in good technical order and condition.
 - Inspect the product for obvious defects.
- Do not modify or retrofit the axial piston unit.
- Only use the product within the performance range provided in the technical data.

General safety instructions

- Persons who assemble, commission, operate, disassemble or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- The warranty only applies to the delivered configuration.
- The warranty is rendered void if the product is incorrectly assembled, commissioned or operated, as well as if not used as intended and/or handled improperly.
- Do not expose the product to any mechanical loads under any circumstances. Never use the product as a handle or step. Do not place/lay any objects on it.
- The noise emission of axial piston units depends on speed, operating pressure and installation conditions. The sound pressure level may rise above 70 dBA during normal operating conditions. This can cause hearing damage.
 - Always wear hearing protection while working in the vicinity of the operating axial piston unit.
- The axial piston unit heats up considerably during operation. The solenoids of the axial piston unit get so hot during operation that you may burn yourself:
 - Allow the axial piston unit to cool down sufficiently before touching it.
 - Wear heat-resistant protective clothing, e.g. gloves.

During transport

- Make certain that the lifting gear has adequate lifting capacity. The weight can be found in chapter "5 Transport and storage".

During assembly

- Before assembling, make sure that all fluids have been completely removed from the axial piston unit to prevent mixing with the hydraulic fluid used in the system.
- Make sure the relevant system component is not under pressure or voltage before assembling the product or when connecting and disconnecting plugs. Protect the system against being switched on.
- Lay cables and lines so that they cannot be damaged and no one can trip over them.
- Before commissioning, make sure that all hydraulic connections are tight and that all the connection seals and plugs are installed correctly to ensure that they are leakproof and fluids and contaminants are prevented from penetrating the product.
- When assembling, provide for absolute cleanliness in order to prevent contaminants, such as welding beads or metal cuttings, from getting into the hydraulic lines and causing product wear or malfunctions.

During commissioning

- Ensure that all electrical and hydraulic connections and ports are occupied or plugged. Only commission a completely installed product.

During cleaning

- Plug all openings with the appropriate protective equipment in order to prevent detergents from penetrating the system.
- Never use solvents or aggressive detergents. Use only water and, if necessary, a mild detergent to clean the axial piston unit.
- Do not point the high-pressure cleaner at sensitive components, e.g. shaft seal ring, electrical connections and electrical components.

**During maintenance
and repair**

- Perform the prescribed maintenance work at the intervals specified in the operating instructions (see chapter "9.3 Maintenance").
- Make sure that no lines, connections or components are disconnected as long as the system is under pressure. Protect the system against being switched on.

Disposal

- Dispose of the product and the hydraulic fluid in accordance with the currently applicable national regulations in your country.

2.6 Operator's obligations

The operator of the axial piston unit from Rexroth must provide personnel training on a regular basis regarding the following subjects:

- Observation and use of the operating instructions and the legal regulations
- Intended use and operation of the axial piston unit
- Observation of the instructions from the factory security offices and of the work instructions from the operator



Rexroth offers training support for special fields.

You can find an overview of the training contents on the Internet at:

<http://www.boschrexroth.de/didactic>.

3 Delivery contents

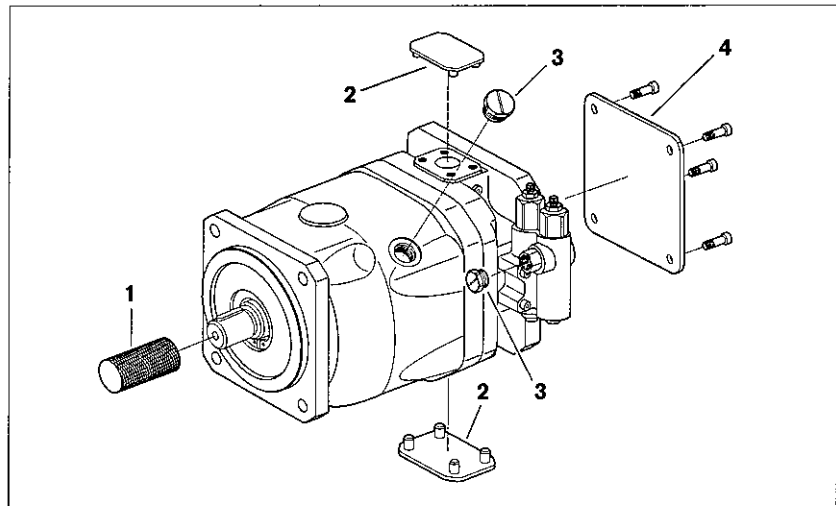


Fig. 1: Axial piston unit

Included in the delivery contents are:

- 1 Axial piston unit

The following parts are also assembled on delivery:

- Plastic transport protection for drive shaft end (1).
- Plastic protective cover (2)
- Plastic plugs / locking screws (3).
- Flange cover and fixing screws for versions with through drive (4)



On version with universal through drive plugged and pressure-proof.

4 Product description

4.1 Performance description

The axial piston variable pump generates, controls and regulates a hydraulic-fluid flow. The A10VSO has been designed for stationary applications.

Refer to the data sheet and order confirmation for the technical data, operating conditions and operating limits of the axial piston unit.

4.2 Device description

The A10VSO axial piston variable pump is an axial piston variable pump with swashplate design for hydrostatic drives in open circuits. Flow is proportional to drive speed and displacement. The flow can be freely varied by adjusting the swashplate setting (13).

Open circuit

With an open circuit, the hydraulic fluid flows from the tank to the variable pump and is transported from there to the consumer via a directional valve. From the consumer, the hydraulic fluid flows back to the tank via the directional valve.

4.2.1 Assembly of the axial piston unit

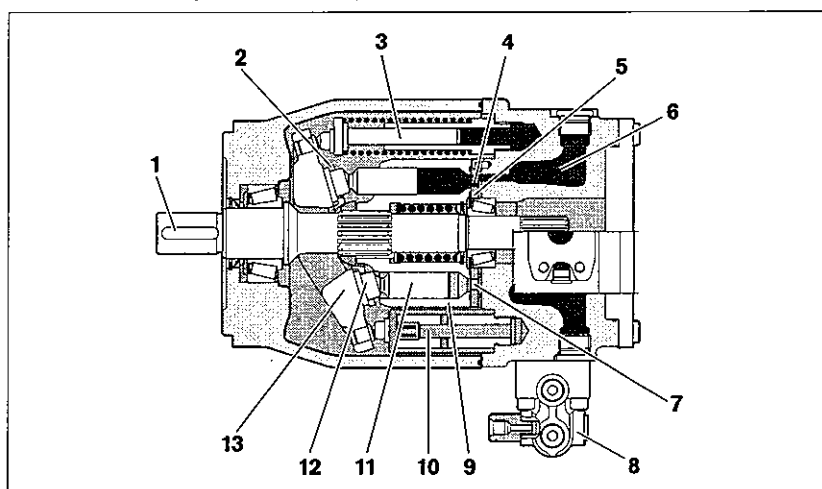


Fig. 2: Assembly of the A10VSO series 32

- | | | |
|-------------------|-------------------------------------|------------------|
| 1 Drive shaft | 6 Pre-compression volume (optional) | 10 Stroke piston |
| 2 Retaining plate | 7 Suction side | 11 Piston |
| 3 Opposing piston | 8 Control valve | 12 Slipper pad |
| 4 Pressure side | 9 Cylinder | 13 Swashplate |
| 5 Control plate | | |

For axial piston units with swashplate design, the pistons (11) are arranged axially with respect to the drive shaft (1). They are guided in the rotating cylinder (9) and support themselves with the slipper pads (12) on the non-rotating swashplate (13). The drive shaft (1) and cylinder (9) are connected to one another by means of gearing.

Product description**4.2.2 Functional description**

Pump Torque is applied to the drive shaft (1) by an engine. The cylinder (9) turns with the drive shaft, turning with it the pistons (11). On each rotation, the pistons perform a stroke movement which is defined by the pitch of the swashplate (13). The slipper pads (12) are held on and guided along the glide surface of the swashplate by the retaining plate (2). During a rotation, each piston moves over the bottom and top dead centers back to its initial position. During this action, the fluid volume defined by the piston surface and the stroke is fed in or removed through the two control slits in the control plate (5). On the low-pressure side, fluid flows into the enlarging piston chamber. At the same time, on the pressure side the fluid is pushed out of the cylinder chamber into the hydraulic system by the pistons.

Optional: On the version with pre-compression volume (6), the piston chamber is brought to a higher pressure before the piston (11) reaches the pressure side (4). This considerably reduces pressure pulsation within the hydraulic system.

Control The swivel angle of the swashplate (13) is infinitely variable. By changing the swivel angle, the piston stroke and, therefore, the displacement change. The swivel angle is controlled hydraulically via the stroke piston (10). The swashplate is mounted for easy motion in swivel bearings and it is kept in balance by the opposing piston (3). Increasing the swivel angle increases the displacement; reducing the angle results in a corresponding reduction in displacement.

The swivel angle can never be swiveled completely to zero because a minimum amount of hydraulic fluid is necessary for

- cooling the pistons,
- supplying the control,
- compensating for case drain fluid and
- lubricating all moving parts.

4.2.3 Control devices

DG – Twin-point adjustment, directly controlled

The variable pump is set to minimum swivel angle by activating an external switching pressure at port X.

This supplies control fluid directly to the stroke piston, whereby a minimum pressure $p_{St} \geq 50$ bar is required.

The variable pump can only be activated between $V_{g \max}$ and $V_{g \min}$.

Please note that the necessary switching pressure at port X is directly dependent on the level of the operating pressure p_B at port B.

Switching pressure p_{St} in $X = 0$ bar $\triangleq V_{g \max}$

Switching pressure p_{St} in $X \geq 50$ bar $\triangleq V_{g \min}$

The maximum permissible switching pressure is $p_{St} = 280$ bar.

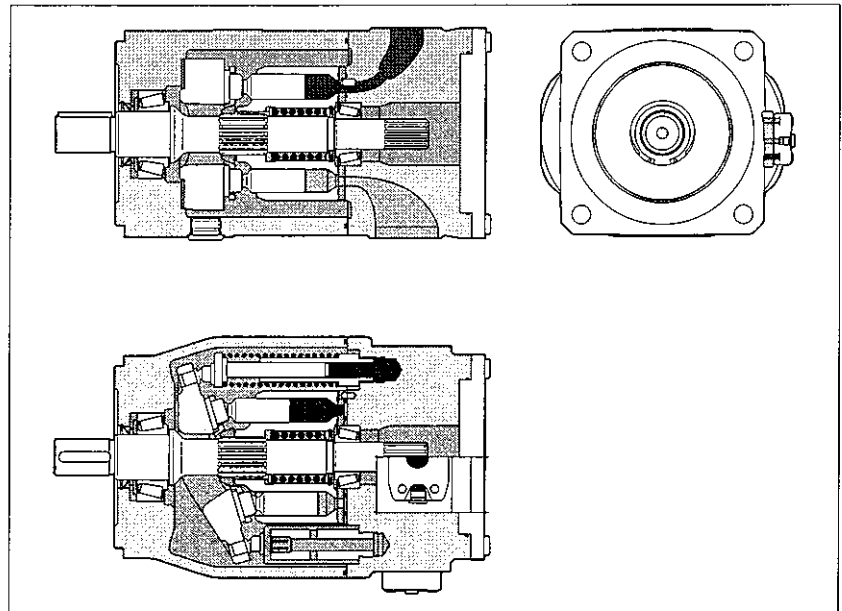


Fig. 3: Cutaway view of A10VSO with twin-point adjustment, directly controlled

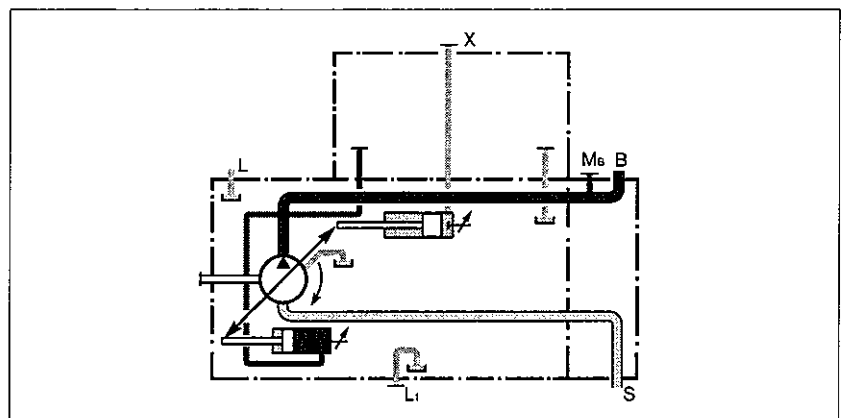


Fig. 4: Hydraulic circuit diagram of A10VSO with two-point adjustment, directly controlled

	High pressure		Case drain pressure
	Suction pressure		Control pressure

- | | | | |
|---|------------------|---|---------------------|
| | High pressure | | Case drain pressure |
|  | Suction pressure |  | Control pressure |

**DRG – Pressure controller,
remotely controlled**

The DRG control valve overrides the function of the DR controller.

A pressure-relief valve, which is not part of the delivery contents of the DRG control, can be connected to port X as a remote control.

The differential pressure at the control valve is set as standard to 20 bar.

The control fluid flow at port X is approx. 1.5 l/min.

We recommend the following as a separate pressure-relief valve:

- DBDH 6 (hydraulic) according to RE 25402, or
- DBETR-SO381 with orifice $\varnothing 0.8$ in P (electric) as per RE 29166.

The maximum line length must not exceed 2 m.

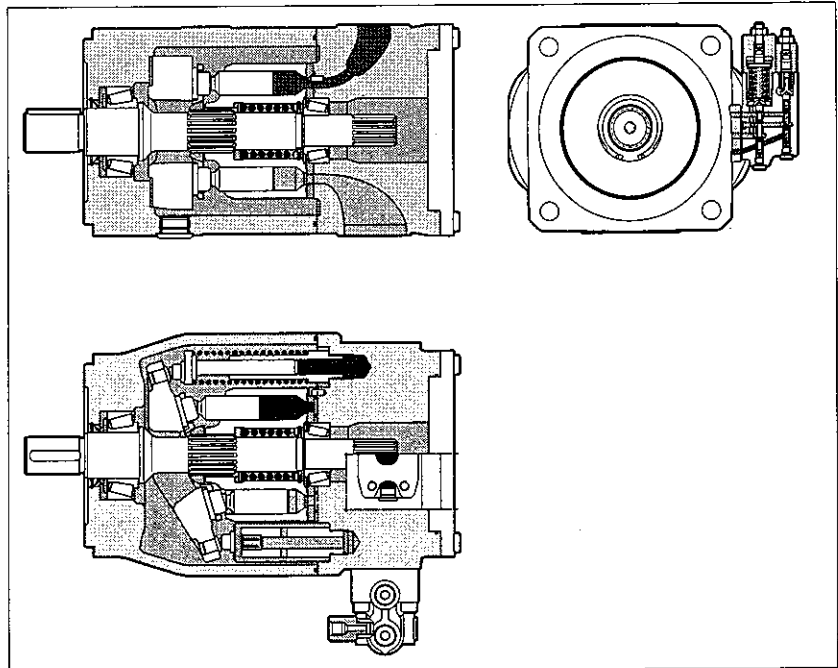


Fig. 7: Cutaway view of A10VSO with pressure controller, remote controlled

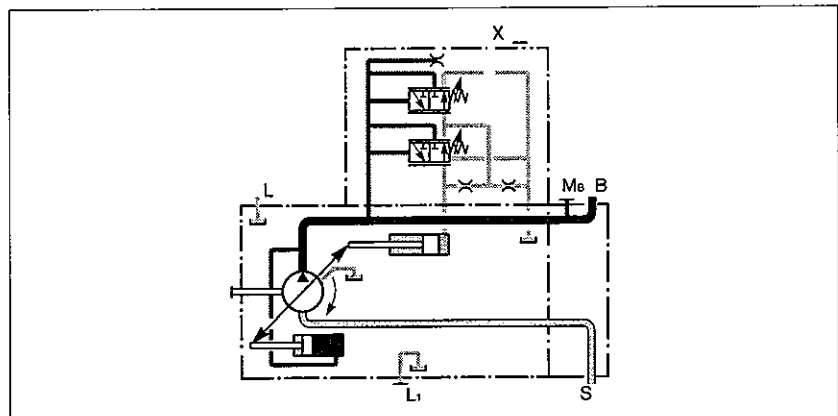
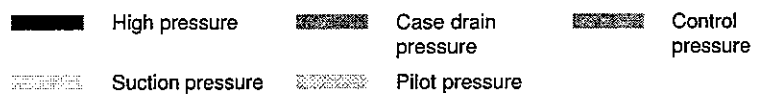


Fig. 8: Hydraulic circuit diagram of A10VSO with pressure controller, remote controlled



Product description

DRF/DRS – Pressure-flow controller

In addition to the pressure controller function, the flow (delivery) from the pump can be set using the differential pressure at the consumer (e.g. an orifice). The pump only supplies only the amount of hydraulic fluid actually required by the consumer.

The pressure controller is overriding.

The DRS1 version has no connection from X to the tank.

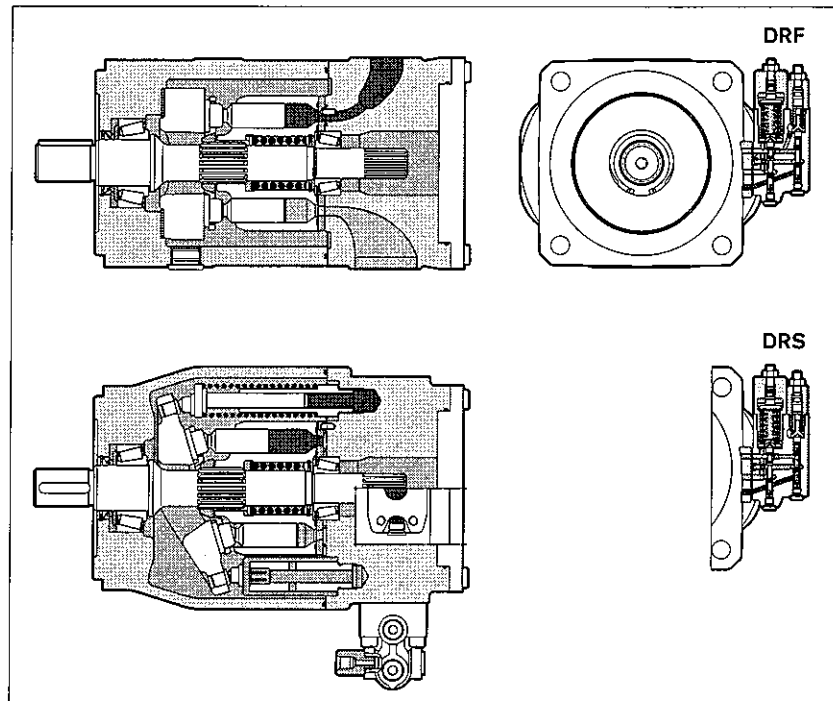


Fig. 9: Cutaway view of A10VSO with pressure flow control

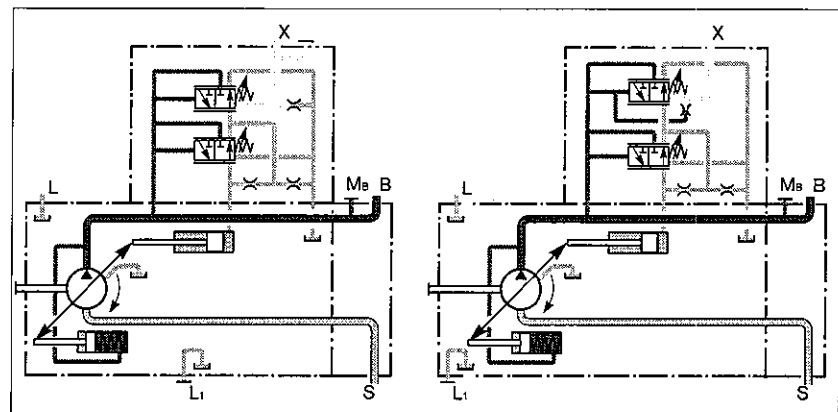
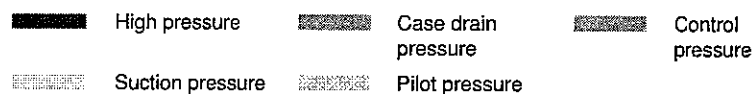


Fig. 10: Hydraulic circuit diagram for A10VSO with pressure flow control, DRF left-hand illustration, DRS right-hand illustration



ED – Pressure controller with remote-controlled pressure cut-off; electric

The control valve is set to a certain pressure by means of a pre-specified solenoid current. The inversely proportional current-pressure characteristic (I-p characteristic) shows that the pressure changes in proportion to the specified solenoid current.

For further information, see data sheet RE 92707.

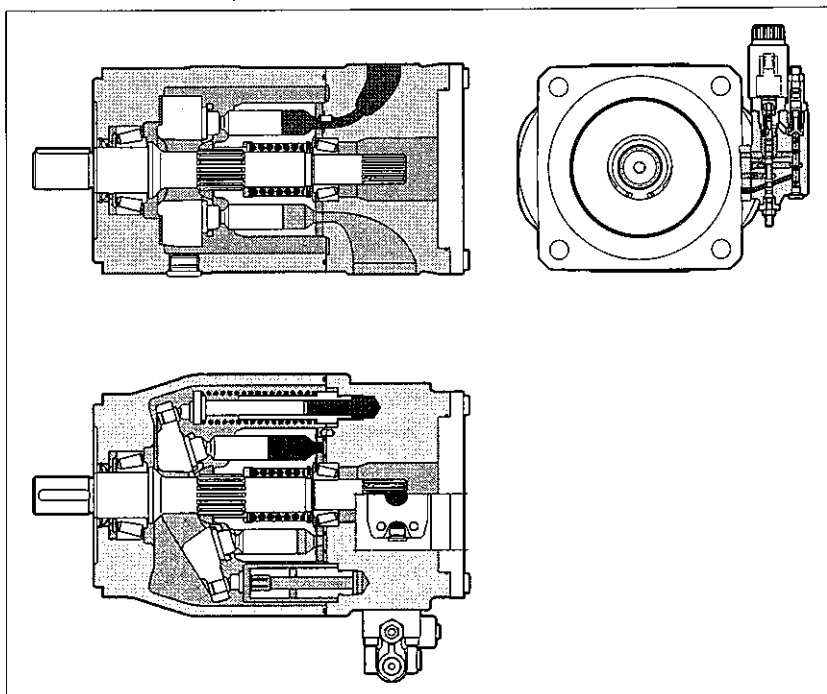


Fig. 11: Cutaway view of A10VSO with ED pressure controller

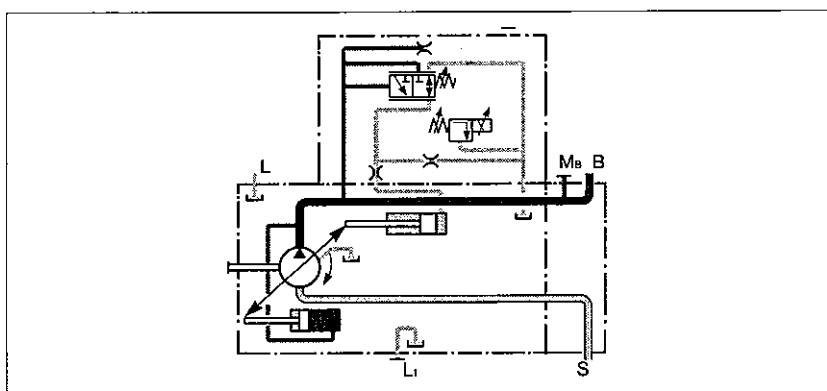
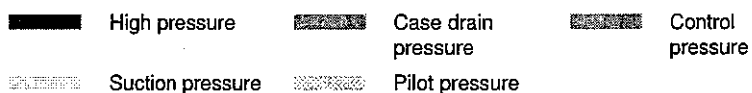


Fig. 12: Hydraulic circuit diagram of A10VSO with ED pressure controller



Product description

LA... – Power control

In order to achieve a constant drive torque, the swivel angle and thus the flow of the axial piston variable pump are varied with changing operating pressure such that the product of flow and pressure remains constant.

Power control is available in conjunction with

- pressure cut-off (LA.D),
- remote-controlled pressure cut-off (LA.DG), or
- flow control (LA.S)

(see descriptions below).

Pressure and pressure-flow control are provided underneath the power characteristic.

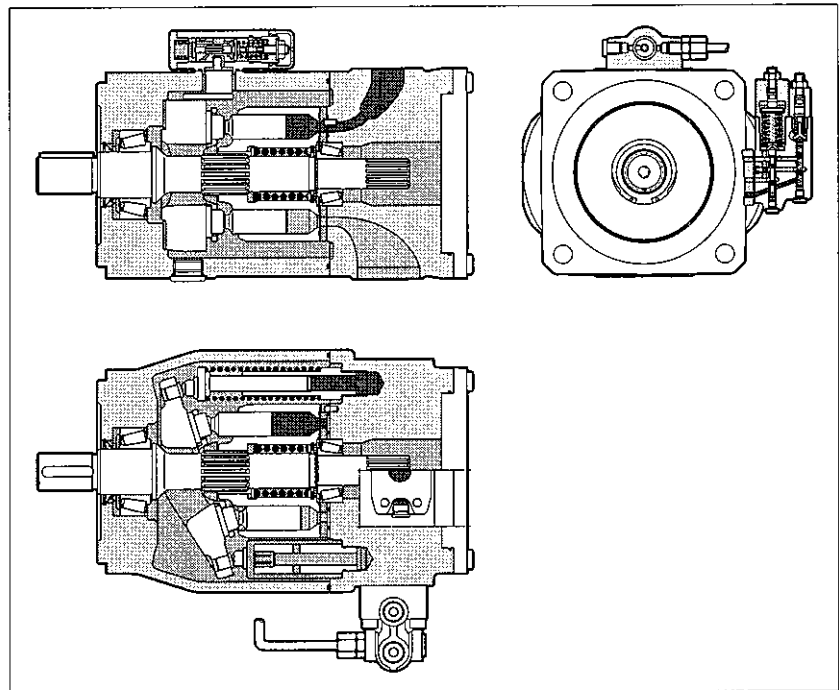
LA.D – Power control with pressure cut-off

Fig. 13: Cutaway view of A10VSO with LA.D power control

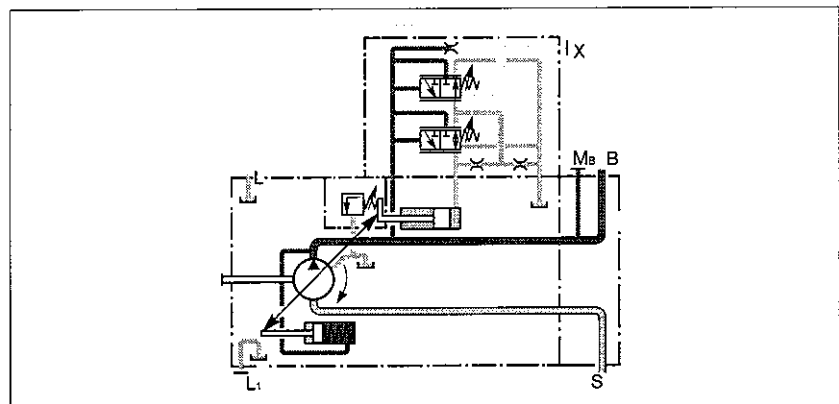


Fig. 14: Hydraulic circuit diagram of A10VSO with LA.D power control

	High pressure		Case drain pressure		Control pressure
	Suction pressure		Pilot pressure		

**LA.DG – Power control with
remote-controlled pressure cut-off**

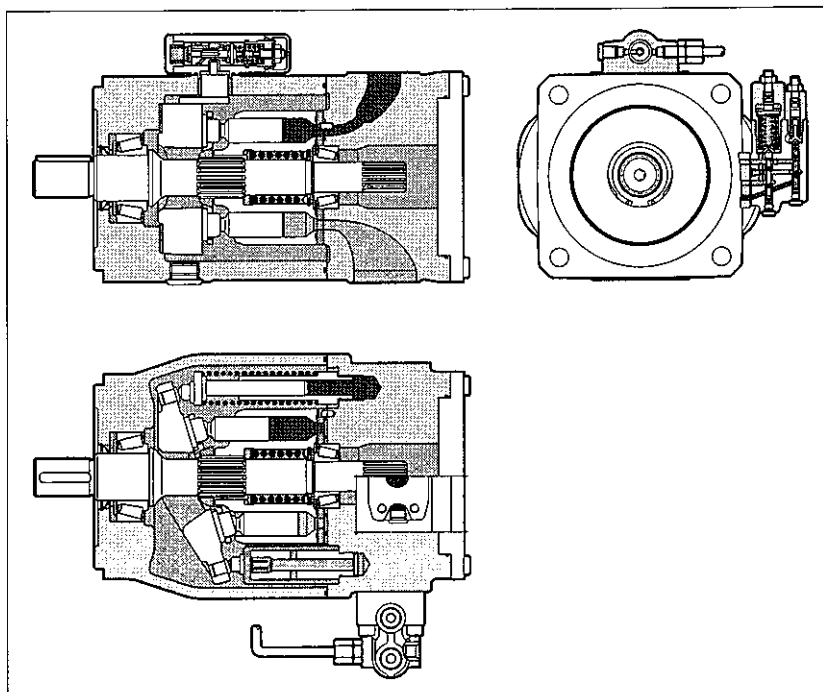


Fig. 15: Cutaway view of A10VSO with LA.DG power control

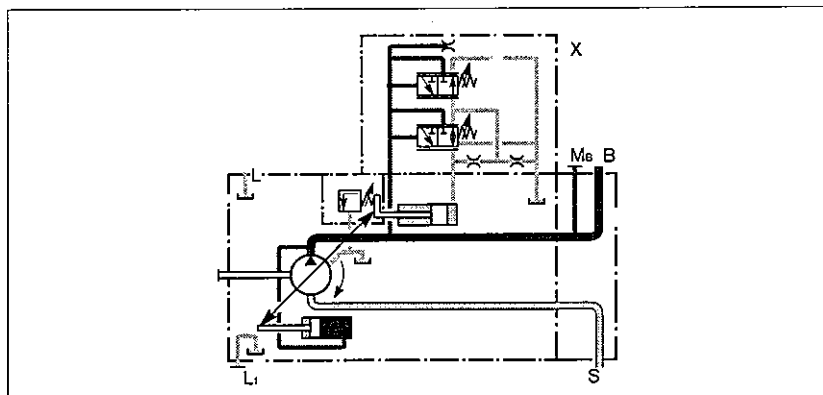
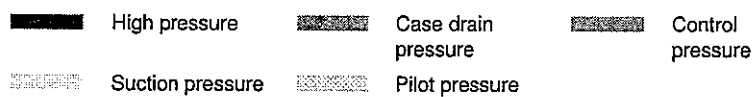


Fig. 16: Hydraulic circuit diagram of A10VSO with LA.DG power control



Product description

LA.DS – Power control with flow control

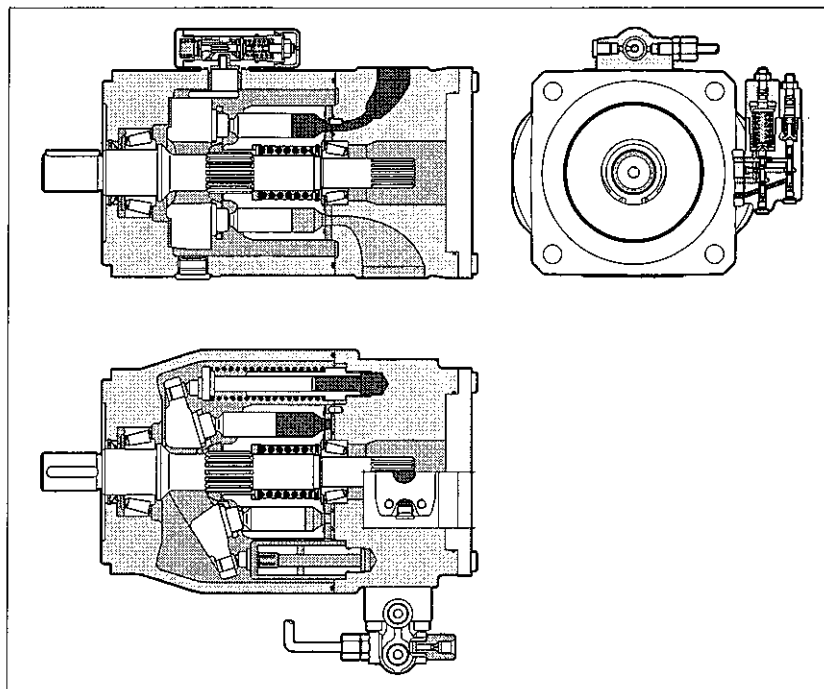


Fig. 17: Cutaway view of A10VSO with LA.DS power control

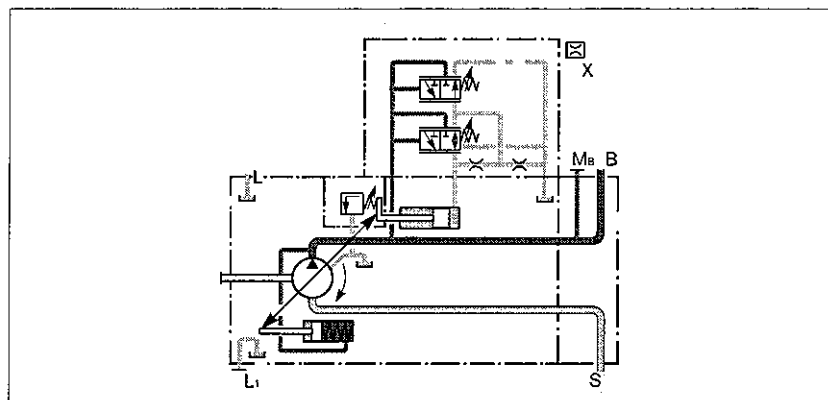
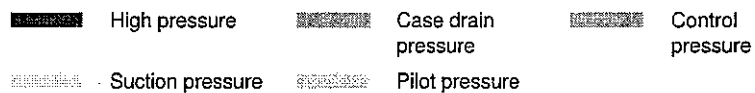


Fig. 18: Hydraulic circuit diagram of A10VSO with LA.DS power control



**LA.S – Power control with
separate flow control**

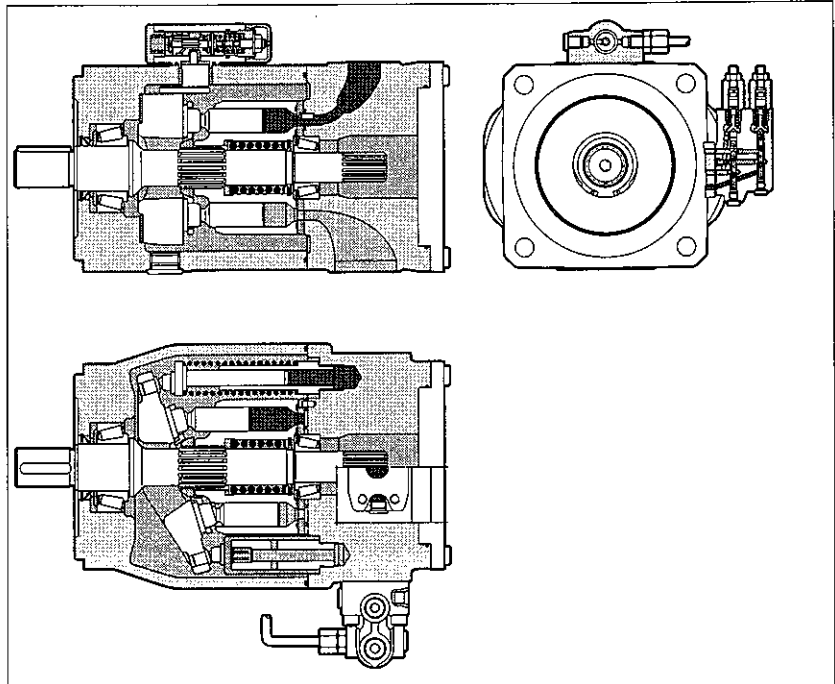


Fig. 19: Cutaway view of A10VSO with LA.S power control

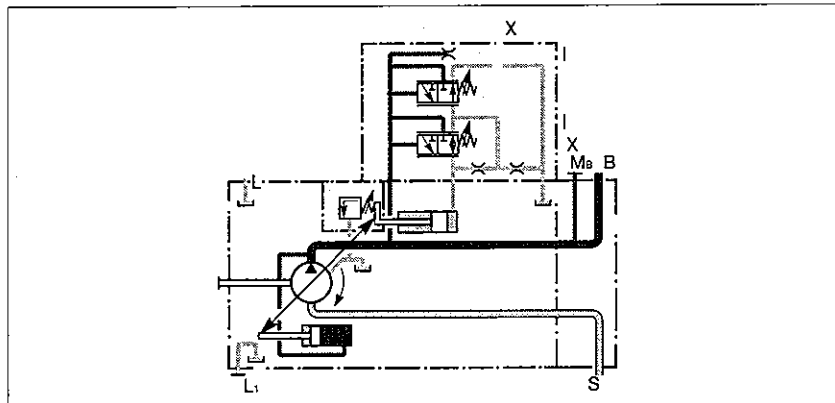
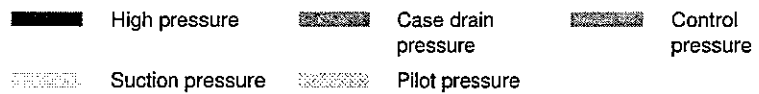


Fig. 20: Hydraulic circuit diagram of A10VSO with LA.S power control



Product description

4.3 Product identification

The axial piston unit can be identified with the name plate. The following example shows an A10VSO name plate:

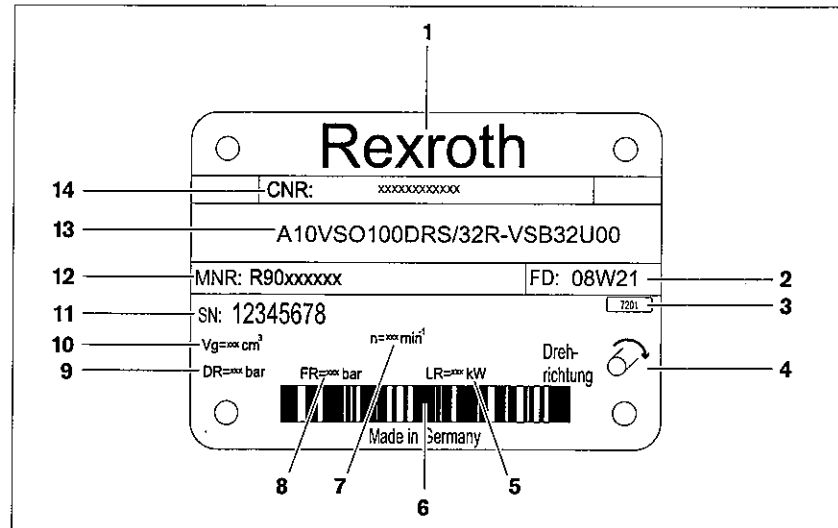


Fig. 21: name plate A10VSO

- | | |
|--|---|
| 1 Manufacturer | 9 Pressure controller setting (optional) |
| 2 Production date | 10 Displacement |
| 3 Internal plant designation | 11 Serial number |
| 4 Direction of rotation (looking at drive shaft) – here: clockwise | 12 Material number of the axial piston unit |
| 5 Power setting (optional) | 13 Ordering code |
| 6 Barcode | 14 Customer number |
| 7 Rotational speed | |
| 8 Flow setting (optional) | |

5 Transport and storage

5.1 Transporting the axial piston unit

CAUTION!



Risk of damage!

Hitting or impulsive forces on the drive shaft can damage the axial piston unit.

- Do not hit the coupling or drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft.
- Details on the permissible axial and radial forces can be found in the data sheet.

Axial piston units can be transported with a forklift truck or with a lifting device.

- Make certain that the forklift truck or lifting device has adequate lifting capacity.

Dimensions and weights

Table 3: Dimensions and weights

Size		71	100	140
Weight	kg	47	69	73
Width	mm	The dimensions vary with the unit type. Values valid for the axial piston unit can be found in the installation drawing (please request if needed).		
Height	mm			
Depth	mm			

5.1.1 Transporting with lifting device

For transporting, the axial piston unit can be connected to a lifting device via a ring screw or a lifting strap.

Transport with ring screw

The drive shaft can be used to transport the axial piston unit as long as only outward axial forces occur. Thus, you can suspend the axial piston unit from the drive shaft.

- To do this, screw a ring screw completely into the thread on the drive shaft. The threaded size is stated in the installation drawing.
- Make sure that each ring screw can bear the total weight of the axial piston unit plus approx. 20 %.

You can hoist the axial piston unit as shown in Fig. 22 with the ring screw screwed into the drive shaft without any risk of damage.

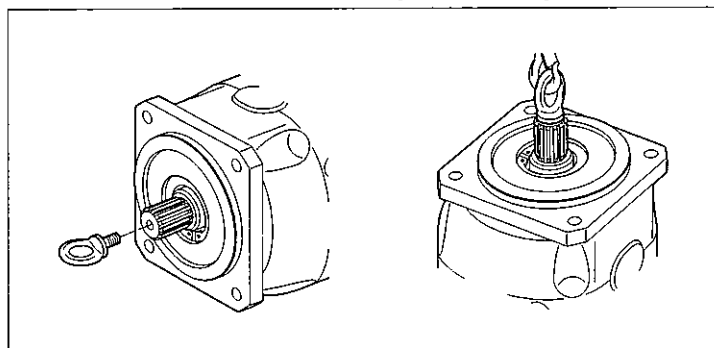


Fig. 22: Fixing the ring screw

Transport and storage

Transport with lifting strap

- Place the lifting strap around the axial piston unit in such a way that it passes over neither the attachment parts (e.g. valves) nor such that the axial piston unit is hung from attachment parts (see Fig. 23).

WARNING!**Risk of injury!**

During transport with a lifting device, the axial piston unit can fall out of the lifting strap and cause injuries.

- Hold the axial piston unit with your hands to prevent it from falling out of the lifting strap.
- Use the widest possible lifting strap.

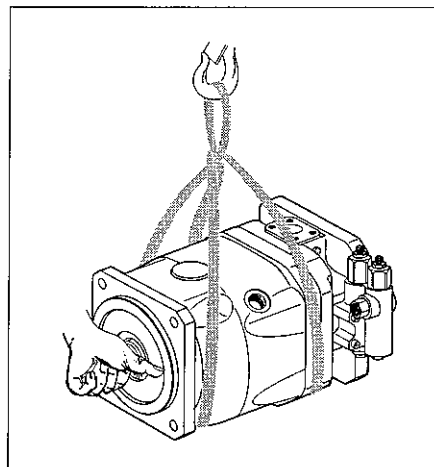


Fig. 23: Transport with lifting strap

5.2 Storing the axial piston unit

Requirement

- The storage areas must be free from corrosive materials and gasses.
- The storage areas must be dry.
- The ideal temperature for storage lies between +5 °C and +20 °C.
- Avoid intense lights.
- Do not stack axial piston units and store them shock-proof.
- For other storage conditions, see Table 4.

- Check the axial piston unit monthly to ensure proper storage.

After delivery

The axial piston unit is provided ex-works with a corrosion protection packaging (corrosion protection film).

Listed in the following table are the maximum permissible storage times for an originally packed axial piston unit.

Table 4: Storage time with factory corrosion protection

Storage conditions	Standard corrosion protection	Long-term corrosion protection
Closed, dry room, uniform temperature between +5 °C and +20 °C. Undamaged and closed corrosion protection film.	Maximum 12 months	Maximum 24 months



The warranty is rendered void if the requirements and storage conditions are not adhered to or after expiration of the maximum storage time (see Table 4).

Procedure after expiration of the maximum storage time:

1. Check the entire axial piston unit for damage and corrosion prior to installation.
2. Check the axial piston unit for proper function and leaks during a test run.
3. If the storage time exceeds 24 months, the shaft seal ring must be replaced.



After expiration of the maximum storage time, we recommend that you have the axial piston unit inspected by your responsible Rexroth Service partner.

In the event of questions regarding repair and spare parts, contact your responsible Rexroth Service partner or the service department of the manufacture's plant for the axial piston unit, see chapter "9.5 Spare parts" for further information.

After disassembly

If a dismounted axial piston unit is to be stored, it must be conserved against corrosion for the duration of the storage.



The following instructions only refer to axial piston units which are operated with a mineral-oil based hydraulic fluid. Other hydraulic fluids require conservation methods that are specifically designed for them. In such a case, consult with Rexroth Service (see chapter "9.5 Spare parts" for address).

Rexroth recommends the following procedure:

1. Clean the axial piston unit, see chapter "9.1 Cleaning and care" for further information.
2. Completely empty the axial piston unit.
3. For storage time up to 12 months: Moisten the inside of the axial piston unit with mineral oil and fill with approx. 100 ml mineral oil.
For storage time up to 24 months: Fill the axial piston unit with corrosion protection VCI 329 (20 ml).
Fill via case drain port "L" or "L₁",
see chapter "6.4 Assembling the axial piston unit", Fig. 30.
4. Seal all ports airproof.
5. Moisten the unpainted surfaces of the axial piston unit with mineral oil.
6. Package the axial piston unit airproof together with desiccant in corrosion protection film.
7. Store the axial piston unit so that it is protected against jolts.
See "Requirement" in this chapter for further conditions.

6 Assembly

Prior to assembly, the following documents must be available:

- Installation drawing for the axial piston unit (available from Rexroth)
- Hydraulic circuit diagram for the axial piston unit (in the installation drawing)
- Hydraulic circuit diagram for the system (available from the system manufacturer)
- Order confirmation (contains the preset data of the axial piston unit)
- Data sheet for the axial piston unit (contains the technical data)

6.1 Unpacking

The axial piston unit is delivered in a corrosion protection film made of polyethylene material.

- Dispose of the packaging according to the national regulations of your country.

CAUTION!**Risk of parts falling out!**

If the packaging is not opened correctly, parts may fall out and damage the parts or even result in injury.

- Place the packaging on a flat and solid surface.
 - Only open the packaging from the top.
-

6.2 Installation conditions

- The installation location and position of the axial piston unit essentially determine the procedures during installation and commissioning (such as when filling the axial piston unit).
 - Note that you can expect certain installation positions to affect the control device. Because of gravity, dead weight and case pressure, minor characteristic displacements and actuating time changes may occur.
- Adhere to all limits specified in the data sheet regarding temperature, viscosity, cleanliness of the hydraulic fluid.
 - Make certain that the case of the axial piston unit is filled with hydraulic fluid during commissioning and operation. This is also to be observed following relatively long standstill periods as the axial piston unit may empty via the hydraulic lines.
 - The case drain fluid in the case interior must be directed to the tank via the highest case drain port. Use the line size which is appropriate for the port.
 - A check valve in the case drain line is only permissible on a case-by-case basis upon request.
 - To achieve favorable noise values, decouple all connecting lines from all vibration-capable components (e.g. tank) using elastic elements.
 - Make certain that the suction line, case drain line, and return line flow into the tank below the minimum fluid level in all operational states.

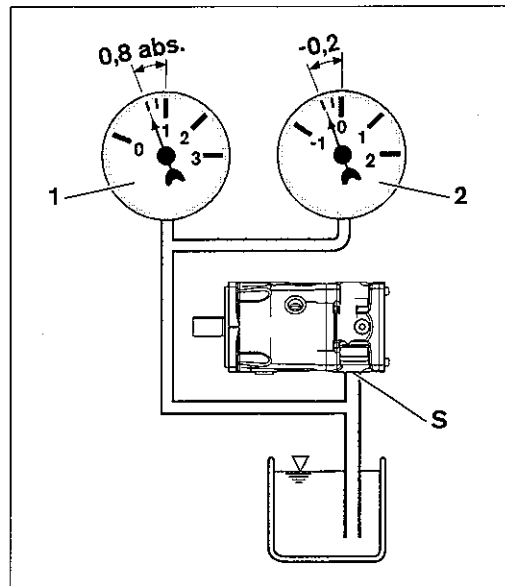


Fig. 24: Suction pressure

- 1 Absolute pressure gauge
- 2 Standard pressure gauge

- Make certain that a minimum suction pressure of 0.8 bar absolute is present at port "S" during operation and on cold starts in all installation positions and installation locations for the axial piston pump, see Fig. 24. See data sheet for additional values.
- Absolute cleanliness is required. The axial piston unit must be installed in a clean condition. Contamination of the hydraulic fluid can have a considerable impact on the service life of the axial piston unit.
- Do not use any cotton waste or linty cloths for cleaning.
- Use suitable liquid detergents to remove lubricants and other difficult-to-remove contamination. Detergents must not penetrate the hydraulic system.

CAUTION!**Risk of damage by air inclusions!**

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
- During commissioning and during operation, the suction line must be filled with hydraulic fluid.

CAUTION!**Risk of damage by hydraulic fluid loss!**

With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.

- For this reason, check the hydraulic fluid level in the case interior regularly, recommissioning as necessary.

6.3 Installation position

The following installation positions are permissible. The shown piping layout illustrates the basic layout.

6.3.1 Below-tank installation (standard)

Below-tank installation is when the axial piston unit is installed outside of the tank below the minimum hydraulic fluid level.



Recommended installation positions: 1 and 3.

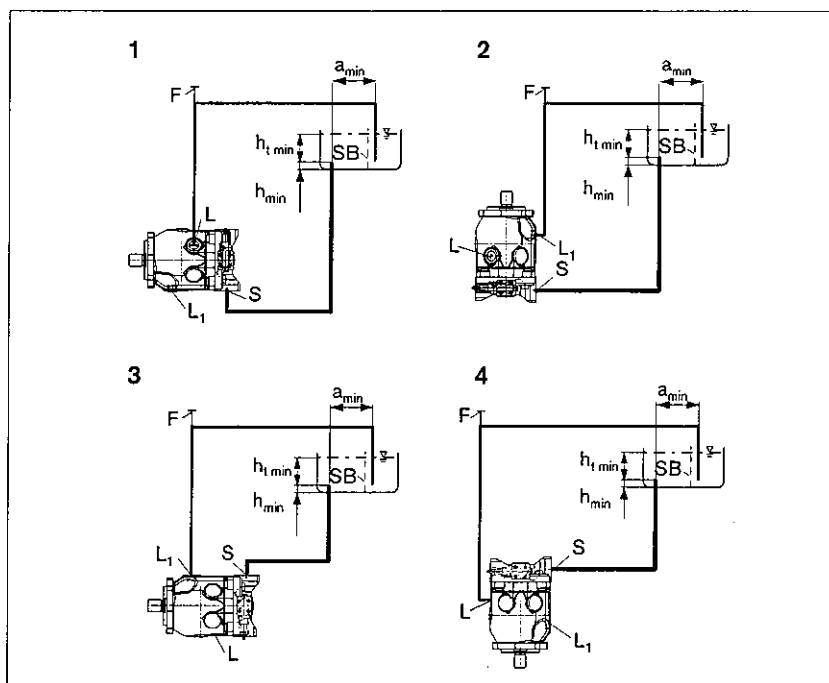


Fig. 25: Below-tank installation with installation positions 1–4

L/L₁	Highest case drain port L or L ₁	h_{t min}	Minimum permissible immersion depth (200 mm)
F	Air bleed and filling port	h_{min}	Minimum permissible spacing from suction port to tank base (100 mm)
S	Suction port	a_{min}	Minimum spacing between suction line and return line (200 mm)
SB	Baffle (baffle plate)		

Table 5: Below-tank installation

Installation position	Air bleeding	Filling
1 (drive shaft, horizontal)	L	S + L (F)
2 (drive shaft, vertical)	L ₁	S + L ₁ (F)
3 (drive shaft, horizontal)	L ₁	S + L ₁ (F)
4 (drive shaft, vertical)	L	S + L (F)

6.3.2 Tank installation

Tank installation is when the axial piston unit is installed in the tank below the minimum hydraulic fluid level. The axial piston unit is completely below the hydraulic fluid.

If the minimum fluid level is equal to or below the upper edge of the pump, see chapter "6.3.3 Above-tank installation".

CAUTION!



Risk of damage during tank installation!

To prevent damages to the axial piston unit, all plastic parts (e.g. protective caps, covers) must be removed prior to installation in the tank.

- Remove all plastic parts before installing the axial piston unit in the tank. Make certain that no pieces of these parts remain in the tank.
- Axial piston units with electrical component must not be installed below the hydraulic fluid level.



Our advice is to fill the axial piston unit before fitting the piping and filling the tank with hydraulic fluid.



Our advice is to fit a suction pipe to the suction port "S" and to fit a pipe to case drain port "L" or "L₁". In such cases, the other case drain port must be plugged.

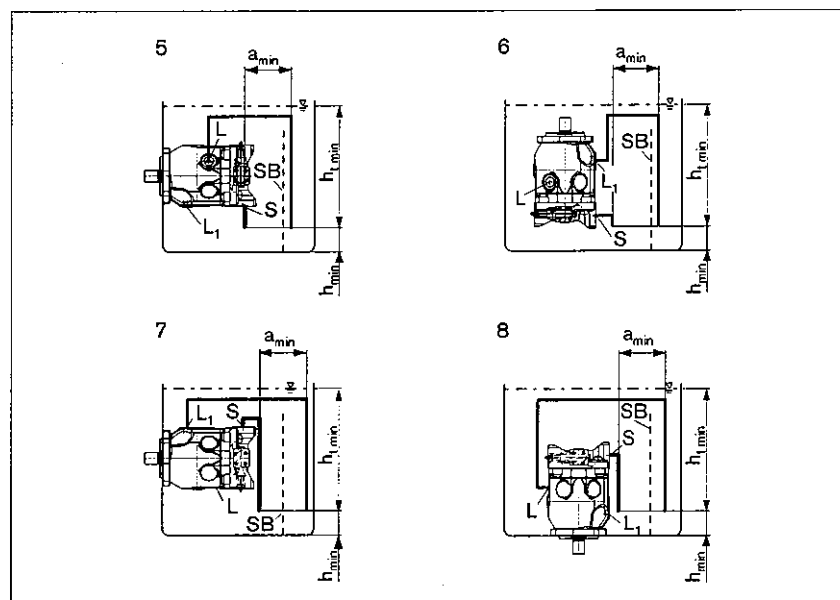


Fig. 26: Tank installation with installation positions 5–8

L	Highest case drain port L or L ₁	h_{min}	Minimum permissible spacing from suction port to tank base (100 mm)
S	Suction port	a_{min}	Minimum spacing between suction line and return line (200 mm)
h_{t min}	Minimum permissible immersion depth (200 mm)		

Assembly

Table 6: Tank installation

Installation position	Air bleeding	Filling
5 (drive shaft, horizontal)	via the highest open port L	automatically via the open port L, by position below hydraulic fluid level
6 (drive shaft, vertical)	via the highest open port L ₁	automatically via the open port L ₁ , by position below hydraulic fluid level
7 (drive shaft, horizontal)	via the highest open port L ₁	automatically via the open port L ₁ , by position below hydraulic fluid level
8 (drive shaft, vertical)	via the highest open port L	automatically via the open port L, by position below hydraulic fluid level

6.3.3 Above-tank installation

Above-tank installation is when the axial piston unit is installed above the minimum fluid level of the tank.

CAUTION!**Risk of damage to the product!**

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
- Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.
- Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation.



Observe the maximum permissible suction height $h_{S \max} = 800 \text{ mm}$.

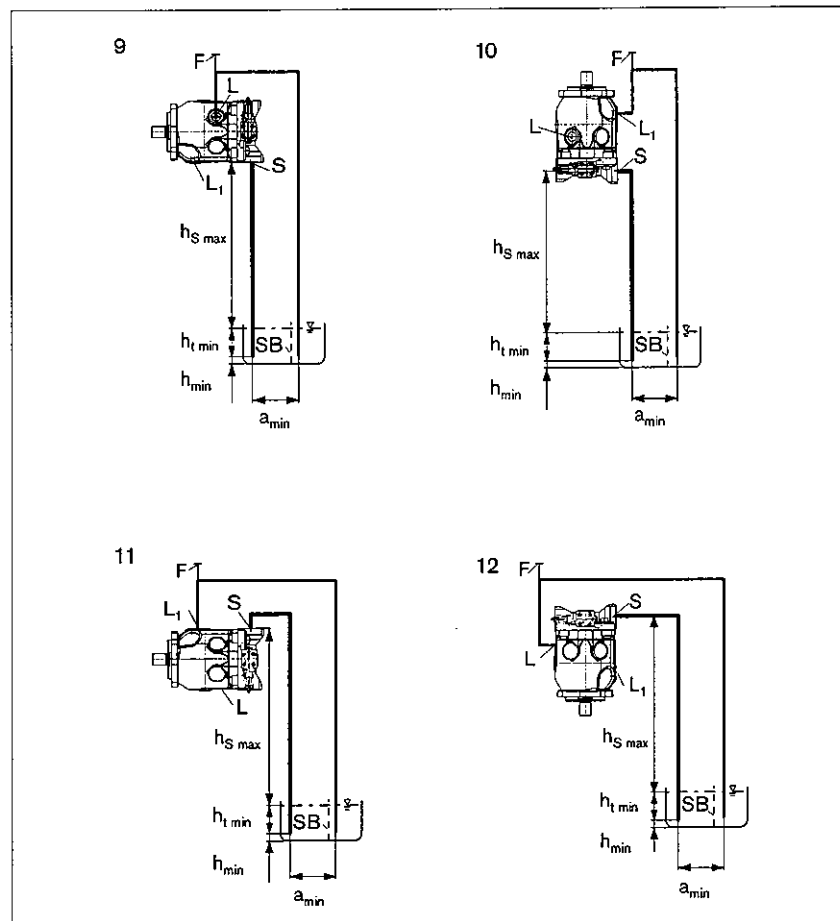


Fig. 27: Above-tank installation with installation positions 9–12

L	Highest case drain port L or L ₁	h_{S max}	Maximum permissible suction height
F	Air bleed and filling port	h_{t min}	Minimum permissible immersion depth (200 mm)
S	Suction port	h_{min}	Minimum permissible spacing from suction port to tank base (100 mm)
SB	Baffle (baffle plate)	a_{min}	Minimum spacing between suction line and return line (200 mm)

Table 7: Above-tank installation

Installation position	Air bleeding	Filling
9 (drive shaft, horizontal)	F	L (F)
10 (drive shaft, vertical)	F	L ₁ (F)
11 (drive shaft, horizontal)	F	L ₁ (F)
12 (drive shaft, vertical)	F	L (F)

6.4 Assembling the axial piston unit

DANGER!



Systems which are in operation pose a risk of injury!

Working on operating systems poses a danger to life and limb. The work steps described in this chapter must only be performed on systems which are at a standstill. Before beginning work:

- Ensure that the engine cannot be switched on.
- Ensure that all power-transmitting components and connections (electric, pneumatic, hydraulic) are switched off according to the manufacturer's instructions and are secured against being switched on again. If possible, remove the main fuse for the system.
- Ensure that the system is completely hydraulically relieved and depressurized. Please follow the system manufacturer's instructions.
- Only qualified personnel (see chapter "2.3 Personnel qualifications") are authorized to assemble the axial piston unit.

6.4.1 Preparation

1. Check the delivery contents for completeness and transport damages.
2. Compare the material number and designation (ordering code) with the details in the order confirmation.



If the material number for the axial piston unit does not correspond to the one in the order confirmation, contact Rexroth Service for clarification, see chapter "9.5 Spare parts" for address.

3. Before assembling, completely empty the axial piston unit to prevent mixing with the hydraulic fluid used in the system.
4. Check the direction of rotation of the axial piston unit (on the name plate) and make sure that this corresponds to the direction of rotation of the engine.

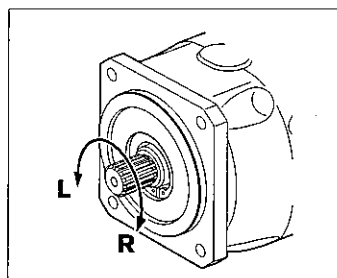


Fig. 28: Direction of rotation

- L Counter-clockwise
R Clockwise



The direction of rotation as specified on the name plate determines the direction of rotation of the axial piston unit as viewed on the drive shaft. For information on the direction of rotation of the engine, please refer to the engine manufacturer's operating instructions.

6.4.2 Dimensions

The installation drawing contains the dimensions for all ports on the axial piston unit. Also observe the instructions provided by the manufacturers of the other components when selecting the required tools.

6.4.3 General instructions

During assembly (and disassembly) of the axial piston unit, observe the following general instructions and handling instructions:

- After a short operating time, toothed belts lose a major portion of their pre-tension and thus cause speed variations and torsional vibrations. Torsional vibrations may cause leakages on the shaft seal ring or increased rotary angle accelerations of the rotary group of the driven axial piston unit. Particularly at risk are diesel drives with a small number of cylinders and low flywheel mass.
- V-belt drives without automatic clamber are also critical with regard to speed variations and torsional vibrations. These can also lead to leakages on the shaft seal ring.
An automatic clamber can lessen the speed variations and vibrations and thus avoid consequential damage.
- When driving an axial piston unit with the aid of a cardan shaft, vibrations may occur which may result in leakages on the shaft seal ring of the axial piston unit depending on the temperature and frequency.
 - ▶ When driving with toothed belts or v-belts, always use an automatic clamber.
 - ▶ Fix the axial piston unit so that the expected forces and torques can be transferred without any danger.
 - ▶ The permissible axial and radial loading of the drive shaft, the permissible torsional vibration, the optimum direction of load force, as well as the limit speeds can be found in the data sheet.
 - ▶ Observe the permissible radial forces on the drive shaft when driving with radial loading (belt drives). If necessary, the belt disc must be separately mounted.

WARNING!**Risk of damage!**

Hitting or impulsive forces on the drive shaft can damage the axial piston unit.

- ▶ Do not hit the coupling or drive shaft of the axial piston unit.
- ▶ Do not set/place the axial piston unit on the drive shaft.
- ▶ Details on the permissible axial and radial forces can be found in the data sheet.

How to assemble the axial piston unit depends on the connecting elements to the drive side. The following descriptions explain the installation of the axial piston unit:

- with a coupling
- on a gearbox

Assembly

6.4.4 Installation with coupling

How to assemble the axial piston unit with a coupling is described in detail in the following:

1. Assemble the specified coupling half onto the drive shaft of the axial piston unit according to the instructions of the coupling manufacturer.



The drive shaft end of the axial piston unit is provided with a threaded bore. Use this threaded bore to pull the coupling element onto the drive shaft. Refer to the installation drawing for the dimensions of the threaded bore.

2. Make sure that the installation location is clean and free from dirt and contaminants.
3. Clamp the coupling hub onto the drive shaft or ensure permanent lubrication of the drive shaft. This prevents the formation of frictional corrosion and the associated wear.
4. Transport the axial piston unit to the installation location.
5. Assemble the coupling onto the drive according to the instructions of the coupling manufacturer.



The axial piston unit must not be tightened down until the coupling has been correctly assembled.

6. Fix the axial piston unit at the installation location.
7. If necessary, details on the required tools and tightening torques for the fixing screws are available from the machine or system manufacturer.
 - For bell housing installation, check the coupling axial play through the bell window according to the manufacturer's instructions.
 - For flange installation, align the support for the axial piston unit with the drive.
8. When using flexible couplings, check that the drive is free of resonance after completing the installation.

6.4.5 Installation on a gearbox

How to assemble the axial piston unit on a gearbox is described in detail in the following:

After installing on a gearbox, the axial piston unit is covered and is difficult to access:

- Therefore, before installing, make sure that the centering diameter centers the axial piston unit (observe tolerances) and that no impermissible axial or radial forces act on the drive shaft of the axial piston unit (installation length).
- Protect the spline of the drive shaft from frictional corrosion by providing permanent lubrication.

6.4.6 Completing assembly

1. Remove any mounted transport screws.
2. Remove the transport protection.
The axial piston unit was delivered with protective covers and plastic plugs or locking screws. These must be removed before connecting. Use appropriate tools.
3. Make certain that the sealing and functional surfaces are not damaged.



Ports which are intended for connecting lines are provided with plastic plugs or locking screws which serve as transport protection. If no connection is made, these ports must be plugged with a suitable metal locking screw since the plastic plugs are not pressure-proof.

CAUTION!



Risk of damage to persons and property!

Operating the axial piston unit with plastic plugs can result in injuries or damage to the axial piston unit.

- Before commissioning, remove all plastic plugs and replace them with suitable, pressure-proof, metal locking screws.

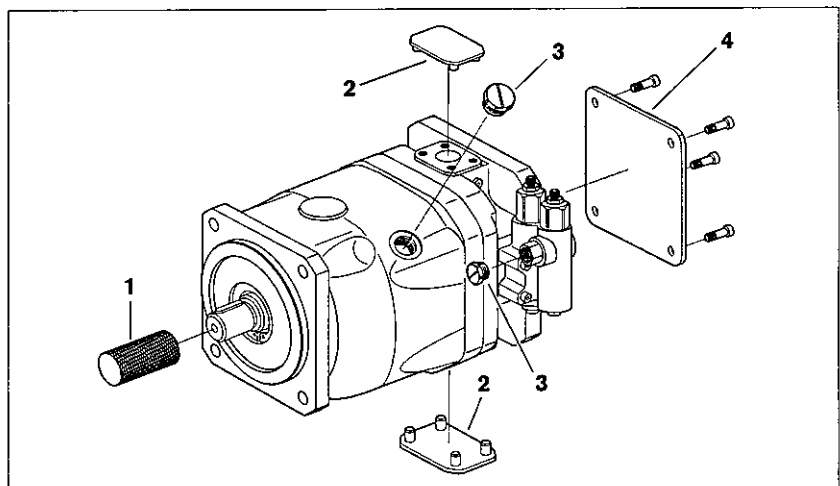


Fig. 29: Removing transport protection

- | | |
|--|--|
| 1 Plastic transport protection for shaft end | 4 Flange cover and fixing screws for versions with through drive |
| 2 Plastic protective cover | |
| 3 Plastic plugs / locking screws | |



On version with universal through drive plugged and pressure-proof.



The adjusting screws are protected against unauthorized resetting by means of protective caps. Removal of the protective caps will void the warranty. If you need to modify the setting, please contact your responsible Rexroth Service (address as to chapter "9.5 Spare parts").

4. For versions with through drive, assemble the auxiliary pump according to the pump manufacturer's instructions.

Assembly

6.4.7 Hydraulically connecting the axial piston unit

The machine or system manufacturer is responsible for dimensioning the lines. The axial piston unit must be connected to the rest of the hydraulic system in accordance with the hydraulic circuit diagram of the machine or system manufacturer.

CAUTION!**Damage to the axial piston unit!**

When installing hydraulic lines and hoses under mechanical stress, they are exposed to additional mechanical forces during operation which reduce the service life of the axial piston unit and the entire machine or system.

- ▶ Assemble hydraulic lines and hoses without mechanical stress.

CAUTION!**Risk of damage!**

Generally, a minimum permissible suction pressure at port "S" is specified for axial piston pumps in all installation positions. If the pressure at port "S" drops below the specified values, damage may occur which may lead to destruction of the axial piston pump.

- ▶ Make certain that the necessary suction pressure is achieved.
This is influenced by:
 - appropriate piping of the suction cross-section
 - appropriate pipe diameters
 - appropriate position of the tank
 - appropriate viscosity of the hydraulic fluid
 - filter cartridge in the suction line (regularly check the level of soiling of the filter cartridge)



Only connect hydraulic lines to the service and function ports.

CAUTION!**Wear and malfunctions!**

The cleanliness of the hydraulic fluid has a considerable impact on the cleanliness and service life of the hydraulic system. Any contamination of the hydraulic fluid leads to wear and malfunctions. In particular, contaminants, such as welding beads or metal cuttings in the hydraulic lines, may damage the axial piston unit.

- ▶ Absolute cleanliness is required.
- ▶ The axial piston unit must be installed in a clean condition.
- ▶ Make sure that all ports, hydraulic lines and add-on units (e.g. measuring devices) are clean.
- ▶ Make sure that no contaminants penetrate when sealing the ports.
- ▶ Make sure that no detergents enter the hydraulic system.
- ▶ Do not use any cotton waste or linty cloths for cleaning.
- ▶ Do not use hemp as sealant under any circumstances.

Notes on routing the lines

Observe the following notes when routing the suction, pressure and case drain lines.

- Make certain that the suction line (pipe or hose) is as short and straight as possible.
- The line cross section of the suction line is to be measured so that the minimum permissible pressure at the suction port is not dropped below and the maximum permissible pressure is not exceeded.
- Observe the air tightness of the junctions and the pressure resistance of the hose, also with respect to the external air pressure.
- With the pressure lines, make certain that the pipes, hoses and connecting elements are approved for the operating pressure range.
- Always route the case drain lines so that the housing is constantly filled with hydraulic fluid and to ensure that no air gets through the shaft seal ring even during extended standstill periods. The case internal pressure must not exceed the limit values listed for the axial piston unit in the data sheet under any operating conditions. The case drain line in the tank must end up below the minimum fluid level under all conditions (see chapter "6.3 Installation position").



The ports and fixing threads are designed for the peak pressure specified in the data sheet. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified operating conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

Procedure

To connect the axial piston unit to the hydraulic system:

1. Remove the locking screws at the ports at which the connections are to be made according to the hydraulic circuit diagram.
2. Use only clean hydraulic lines.
3. Connect the lines according to the hydraulic circuit diagram.
Either pipes or hoses must be connected to all ports according to the installation drawing and machine or system circuit diagram or the ports plugged using suitable locking screws.



The installation drawing contains the dimensions for all connections and ports on the axial piston unit. Also observe the instructions provided by the manufacturers of the other hydraulic components when selecting the required tools.

4. Make sure that the cap nuts on the fittings and flanges are tightened correctly (observe the manufacturer's tightening torque!). Mark all checked fittings using e.g. a permanent marker pen.
5. Make sure that the pipes and hose lines and every combination of connecting piece, coupling or connecting point with hoses or pipes have been inspected by a technically qualified person for safe working condition.

Assembly

Port overview

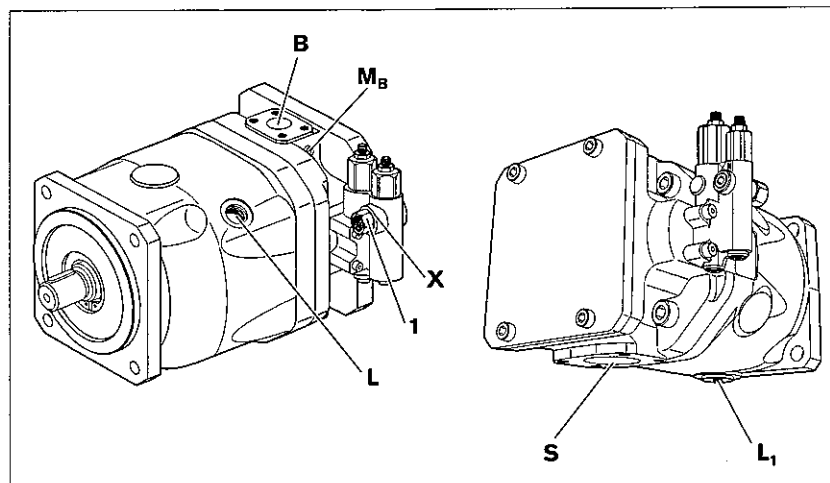


Fig. 30: Overview of ports on A10VSO series 32, left-hand view – counter-clockwise rotation, right-hand view – clockwise rotation

Table 8: Ports A10VSO series 32

Designation	Port for	Standard	Peak pressure [bar] ¹⁾	State
B	Service line Fixing thread	SAE J518 ²⁾ DIN 13	350	O
S	Suction Fixing thread	SAE J518 ²⁾ DIN 13	5	O
L	Case drain fluid	DIN 3852	2	O ³⁾
L₁	Case drain fluid	DIN 3852	2	X ³⁾
X	Pilot pressure with adapter ⁴⁾	ISO 11926 DIN 3852	350	O
X	Pilot pressure at DG control	DIN 3852	350	X
M_B	B pressure measurement	DIN 3852	350	X

¹⁾Short term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and armatures.

²⁾Only dimensions according to SAE J518

³⁾Depending on the installation position, "L" or "L₁" must be connected (see chapter "6.3 Installation position")

⁴⁾The adapter must be secured with a tightening torque of 20 Nm when connecting the line

O = Must be connected (plugged with plastic plugs on delivery)

X = Plugged (in normal operation)

Connect line to pilot pressure port with adapter

Comply with the following instructions on the version with adapter.

- When connecting and tightening the connection line to the pilot pressure port "X", the adapter (1) must be secured with a tightening torque of 20 Nm (WAF 19). The maximum permissible tightening torque of 45 Nm in the threaded hole of the adapter (M14 x 1.5) must not be exceeded.

If the adapter (1) is unscrewed from the pilot pressure port "X" and then screwed back in again, it must be tightened with a tightening torque of 23±2.5 Nm.



Tightening torques The following tightening torques apply:

- Threaded hole of the axial piston unit:
The maximum permissible tightening torque M_{Gmax} are maximum values of the threaded holes and must not be exceeded. For values, refer to the following table.
- Armatures:
Observe the manufacturer's instruction regarding the tightening torques of the used armatures.
- Fixing screws:
For fixing screws according to DIN 13/ISO 68, we recommend checking the tightening torque in individual cases as per VDI 2230.
- Locking screws:
For the metallic locking screws supplied with the axial piston unit, the required tightening torques of locking screws M_V apply. For values, refer to the following table.

Table 9: Tightening torques of the threaded holes and locking screws

Threaded port sizes		Maximum permissible tightening torque of the threaded holes M_{Gmax}	Required tightening torque of the locking screws M_V	WAF hexagon socket for the locking screws
G1/4	DIN 3852	70 Nm	30 Nm	6 mm
M22 x 1.5	DIN 3852	210 Nm	80 Nm	10 mm
M33 x 2	DIN 3852	540 Nm	225 Nm	17 mm
7/16-20 UNF-2B	ISO 11926	40 Nm	15 Nm	3/16 in

Assembly

Risk of mix-ups with threaded connections

The axial piston units are used in application areas with metric as well as with Imperial systems of units.

Both the system of units as well as the size of threaded hole and threaded plug (e.g. locking screw) must match.

Due to the lack of options for visually detecting differences, there is a risk of mix-ups.

WARNING!**Risk of damage to persons and property!**

If a threaded plug which is of a different measurement system and size with respect to the threaded hole is pressurized, the threaded plug may loosen itself or even be ejected from the hole in a projectile-like manner. This can result in serious injury and damage to equipment. Hydraulic fluid can be discharged from this leakage point.

- Use the drawings (installation drawing/data sheet) to determine the required threaded plug for each fitting.
- Make certain that there are no mix-ups when assembling armatures, fixing screws and locking screws.
- For all threaded holes, use a threaded plug from the same system of units and of the correct size.

6.4.8 Electrical connection of axial piston unit

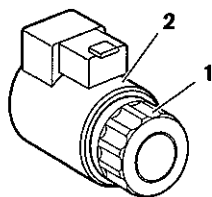
The machine or system manufacturer is responsible for the layout of the electric control.

For electrically controlled axial piston units, the electric control must be connected according to the circuit diagram of the system manufacturer.

CAUTION!**Short circuit in event of penetrating hydraulic fluid!**

Fluid can penetrate the product and cause a short circuit.

- Do not install electrically controlled axial piston units in a tank below the tank fluid level (tank installation).

Changing plug position

If necessary, you may vary the position of the plug by turning the body of the solenoid.

To do this, proceed as follows:

1. Unscrew the solenoid fixing nut (1). To do this, turn the fixing nut (1) on full turn counterclockwise.
2. Turn the body of the solenoid (2) to the desired position.
3. Tighten the fixing nut again. Fixing nut tightening torque: 5+1 Nm.

Further details and technical data, e.g. for the matching mating connector can be taken from data sheet RE 92707.

7 Commissioning

WARNING!**Danger while working in the danger zone of a machine or system!**

It is not permissible to work in the danger zone of a machine or system.

- The machine or system must only be operated if safe working is ensured.
- Pay attention to and rectify potential danger sources before commissioning the machine or system.
- Nobody may stand in the danger zone of the machine or system.
- The emergency stop button for the machine or system must be within the operator's reach.
- Always follow the instructions of the machine or system manufacturer during commissioning.

CAUTION!**Risk of damage to persons and property!**

Commissioning of the axial piston unit requires basic mechanical and hydraulic knowledge.

- Only qualified personnel (see chapter "2.3 Personnel qualifications") are authorized to commission the axial piston unit.

WARNING!**Risk of toxication and injury!**

Contact with hydraulic fluids may damage your health (e.g. eye injuries, skin damage, toxication upon inhalation).

- Always check the lines for wear and damage before each commissioning.
- While performing these checks, wear safety gloves, safety glasses and suitable working clothes.
- If hydraulic fluid should, nevertheless, come into contact with your eyes or penetrate your skin, consult a doctor immediately.
- When working with hydraulic fluids, strictly observe the safety instructions provided by the hydraulic fluid manufacturer.

WARNING!**Fire hazard!**

Hydraulic fluid is easily flammable.

- Keep open flames and ignition sources from the axial piston unit.

CAUTION!**Missing seals and connections lead to noncompliance with the protection class!**

Fluids and contaminants may penetrate and damage the product.

- Prior to assembly, make sure that all seals and connectors are tight.

Commissioning

7.1 First commissioning

CAUTION!**Risk of damage to the product!**

Any contamination of the hydraulic fluid leads to wear and malfunctions. In particular, contaminants, such as welding beads or metal cuttings in the hydraulic lines, may damage the axial piston unit.

- Ensure utmost cleanliness during commissioning.
- Make sure that no contaminants penetrate when sealing the gauge ports.

CAUTION!**Risk of damage to the product!**

If you commission the axial piston unit without or with insufficient hydraulic fluid, the axial piston unit is damaged immediately or even destroyed.

- When commissioning or recommissioning a machine or system, make sure that the case interior and the suction and service lines of the axial piston unit are filled with hydraulic fluid and remain filled during operation.



When commissioning the axial piston unit, observe the basic safety instructions and intended use provided in chapter "2 General safety instructions".

7.1.1 Filling the axial piston unit

You will require an approved hydraulic fluid:

The machine or system manufacturer can provide you with precise details on the hydraulic fluid. Details on minimum requirements for mineral-oil based hydraulic fluids, environmentally acceptable hydraulic fluids or HF hydraulic fluids for the axial piston unit are available in the Rexroth publications RE 90220, RE 90221 and RE 90223, respectively.

To ensure the functional reliability of the axial piston unit, cleanliness level 20/18/15 according to at least ISO 4406 is necessary for the hydraulic fluid. For permissible temperatures, see the data sheet.

CAUTION!**Risk of damage to the product!**

An air pocket in the area near the bearings will damage the axial piston unit.

- Make certain that the case is completely filled with hydraulic fluid during commissioning and during operation with the "drive shaft upwards" installation position.
- Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-tank installation, the case interior may drain via the case drain line after longer standstill periods (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated when the pump is restarted.
- Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation.



The axial piston unit should be filled with a filling unit (10 μ m filter grade). The axial piston unit must not be operated while it is being filled.

CAUTION!**Danger of environmental contamination!**

The discharge or spillage of hydraulic fluid while filling the axial piston unit can lead to environmental pollution and contamination of the groundwater.

- ▶ When filling and changing the hydraulic fluid, always place a catch pan under the axial piston unit.
- ▶ Observe the information in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.

1. Fill and air bleed the axial piston unit via the appropriate ports, see chapter "6.3 Installation position". The hydraulic lines of the system must also be filled.
2. Test the direction of rotation of the engine. To do this, rotate the engine briefly at the lowest rotational speed (inching). Make sure that direction of rotation of the axial piston unit matches the details on the name plate, see also chapter "4.4 Product identification", Fig. 21: Name plate.
3. Operate the axial piston pump at a lower speed (starter speed for internal combustion engines or inching operation for electric motors) until the pump system is completely filled and bled. To inspect, drain the hydraulic fluid at the case drain port and wait until it drains without bubbles.
4. Make certain that all ports are either connected to pipes or plugged according to the general circuit diagram.

7.1.2 Testing the hydraulic fluid supply

The axial piston unit must always have a sufficient supply of hydraulic fluid. For this reason, the supply of hydraulic fluid must be ensured at the start of the commissioning process.

When you test the hydraulic fluid supply, constantly monitor the noise development and check the hydraulic fluid level in the tank. If the axial piston unit becomes louder (cavitation) or the case drain fluid is discharged with bubbles, this is an indication that the axial piston unit is not being sufficiently supplied with hydraulic fluid.

Notes on troubleshooting can be found in chapter "14 Troubleshooting".

To test the hydraulic fluid supply:

1. Allow the engine to run at the slowest speed. The axial piston unit must be operated without load. Pay attention to leakage and noise.
2. Check the axial piston unit's case drain line during the test. The case drain fluid should not contain any bubbles.
3. Check the suction pressure at port "S" of the axial piston pump. Refer to data sheets RE 92714 and RE 92711 for the permissible value.
4. Check the case drain pressure at connected port "L" or "L₁". Refer to data sheet RE 92714 for the permissible value.

Commissioning

7.1.3 Performing functional test

WARNING!**Risk of injury in case of incorrectly connected machine or system!**

Any change of the connections will lead to malfunctions (e.g. lift instead of lower) and thus represents a corresponding danger to persons and equipment.

- When connecting hydraulic components, observe the specified piping according to the hydraulic circuit diagram of the machine or system manufacturer.

Once you have tested the hydraulic fluid supply, you must perform a functional test on the machine or system. The functional test should be performed according to the instructions of the machine or system manufacturer.

The axial piston unit is checked for functional capability before delivery according to the technical data. During commissioning, it must be ensured that the axial piston unit was installed in accordance with the design of the machine or system.

7.1.4 Performing flushing cycle

In order to remove foreign bodies from the system, Rexroth recommends a flushing cycle for the entire system.



During the flushing cycle, the axial piston unit must be operated without load. The flushing cycle can be performed, e.g. by using an additional flushing unit. Follow the instructions of the flushing unit's manufacturer for the exact procedure during the flushing cycle.

7.2 Recommissioning after standstill

Depending on the installation conditions and ambient conditions, changes may occur in the system which make recommissioning necessary.

Among others, the following criteria may make recommissioning necessary:

- Air in the hydraulic system
- Water in the hydraulic system
- Old hydraulic fluid
- Other contamination

- Before recommissioning, proceed as described in chapter "7.1 First commissioning".

7.3 Running-in phase

The bearings and sliding surfaces are subject to a running-in phase. The increased friction at the start of the running-in phase results in increased heat development which decreases with increasing operating hours. The volumetric and mechanical-hydraulic efficiency increases as well through the conclusion of the running-in phase of approx. 10 operating hours.

CAUTION!**Risk of damage by insufficient viscosity!**

The increased temperature of the hydraulic fluid during the running-in phase can cause the viscosity to drop to impermissible levels.

- Monitor the operating temperature during the running-in phase.
 - Reduce the loading (pressure, rpm) of the axial piston unit if impermissible operating temperatures and/or viscosities occur.
-

8 Operation

The product is a component which requires no settings or changes during operation. For this reason, this chapter of the manual does not contain any information on adjustment options. Only use the product within the performance range provided in the technical data. The machine or system manufacturer is responsible for the proper project planning of the hydraulic system and its control.

9 Maintenance and repair

9.1 Cleaning and care

CAUTION!

Damage to the surface caused by solvents and aggressive detergents!

Aggressive detergents may damage the seals on the axial piston unit and cause them to age faster.

- Never use solvents or aggressive detergents.

CAUTION!

Damage to the hydraulic system and the seals!

A high-pressure cleaner's water pressure could damage the electronics and the seals of the axial piston unit.

- Do not point the high-pressure cleaner at sensitive components, e.g. shaft seal ring, electrical connections and electrical components.

For cleaning and care of the axial piston unit, observe the following:

- Plug all openings with suitable protective caps/devices.
- Check whether all seals and plugs of the plug connections are securely seated to ensure that no moisture can penetrate into the axial piston unit during cleaning.
- Use only water and, if necessary, a mild detergent to clean the axial piston unit.
- Remove coarse dirt from the outside of the machine and keep sensitive and important components, such as solenoids, valves and displays, clean.

9.2 Inspection

In order to enable long and reliable operation of the axial piston unit, Rexroth recommends testing the hydraulic system and axial piston unit on a regular basis and to document the following operating conditions:

Table 10: Inspection schedule

Task to be carried out		Interval
Hydraulic system	Check level of hydraulic fluid in the tank.	daily
	Check operating temperature (comparable load state).	weekly
	Check quality of the hydraulic fluid.	yearly or every 2000 h (which ever occurs first)
Axial piston unit	Check axial piston unit for leakage. Early detection of hydraulic fluid loss can help identify and rectify faults on the machine or system. For this reason, Rexroth recommends that the axial piston unit and system always be kept in a clean condition.	daily
	Check axial piston unit for noise development.	daily
	Check fixing elements for tight seating. All fixing elements have to be checked when the system is switched off, depressurized and cooled down.	monthly

9.3 Maintenance

The axial piston unit is low maintenance when used as intended.

The service life of the axial piston unit is heavily dependent on the quality of the hydraulic fluid. For this reason, we recommend changing the hydraulic fluid at least once per year or every 2000 operating hours (whichever occurs first) or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use.

The service life of the axial piston unit is limited by the service life of the built-in bearings. The service life can be requested from the responsible Rexroth Service partner, see "9.5 Spare parts" for address. Based on these details, a maintenance period is to be determined by the system manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system.

9.4 Repair

Rexroth offers a comprehensive range of services for the repair of Rexroth axial piston units.

Repairs of the axial piston unit may only be performed by authorized, skilled and instructed staff.

- Only use genuine spare parts from Rexroth for repairing the Rexroth axial piston units.

Tested and pre-assembled original Rexroth assembly groups allow for successful repair requiring only little time.

9.5 Spare parts

CAUTION!**Damage to persons and property due to faulty spare parts!**

Spare parts that do not meet the technical requirements specified by Rexroth may cause damage to persons or property.

- Use only original spare parts from Rexroth.

The list of spare parts for axial piston units are order specific. When ordering spare parts, please quote the material and serial number of the axial piston unit as well as the material numbers of the spare parts.

Please address all questions regarding spare parts to your responsible Rexroth Service partner or the service department of the manufacture's plant for the axial piston unit.

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For the addresses of foreign subsidiaries, please refer to
www.boschrexroth.com/addresses

10 Decommissioning

The axial piston unit is a component that does not require decommissioning. For this reason, this chapter of the manual does not contain any information. For details about how to disassemble or replace your axial piston unit, please refer to chapter "11 Disassembly and replacement".

11 Disassembly and replacement

11.1 Required tools

Disassembly can be performed with standard tools. No special tools are necessary.

11.2 Preparing for disassembly

WARNING!**Risk of injuries due to disassembling under pressure and voltage!**

If you do not switch off the pressure and power supply before disassembling the product, you may get injured or the device or system components may be damaged.

- Make sure that the relevant system components are not under pressure or voltage.

-
1. Decommission the entire system as described in the overall manual for the machine or system.
 2. Relieve the hydraulic system according to the instructions of the machine or system manufacturer.

11.3 Disassembling the axial piston unit

Proceed as follows to disassemble the axial piston unit:

1. Make sure that the hydraulic system is depressurized.
2. Check whether the axial piston unit has cooled down far enough so that it can be disassembled without danger.
3. Place a catch pan under the axial piston unit to collect any hydraulic fluid that may escape.

CAUTION!**Danger of environmental contamination!**

The discharge or spillage of hydraulic fluid while filling the axial piston unit can lead to environmental pollution and contamination of the groundwater.

- When filling and changing the hydraulic fluid, always place a catch pan under the axial piston unit.
 - Observe the information in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.
-

Disassembly and replacement

4. Loosen the lines and collect the escaping hydraulic fluid in the collector.
5. Remove the axial piston unit. Use an appropriate lifting device.
6. Completely empty the axial piston unit.
7. Plug all openings.

11.4 Preparing the components for storage or further use

- Proceed as described in section "5.2 Storing the axial piston unit".

12 Disposal

Observe the following points when disposing of the axial piston unit:

1. Completely empty the axial piston unit.
2. Dispose of the hydraulic fluid according to the national regulations of your country.
3. Disassemble the axial piston unit into its individual parts and properly recycle these parts.
4. Separate parts by:
 - Cast parts
 - Steel
 - Nonferrous metal
 - Electronic waste
 - Plastic
 - Seals.

12.1 Environmental protection

Careless disposal of the axial piston unit, the hydraulic fluid and the packaging material could lead to pollution of the environment.

- Therefore, dispose of the axial piston unit, the hydraulic fluid and the packaging material in accordance with the currently applicable regulations in your country.
- Dispose of hydraulic fluid residues according to the applicable safety data sheets for these hydraulic fluids.

13 Extension and conversion

Do not convert the axial piston unit. This also includes a modification of the adjusting screws.



The warranty from Rexroth only applies to the delivered configuration. In case of extensions or conversions, the warranty will become void.



Adjusting screws are protected against unauthorized resetting by means of protective caps. Removal of the protective caps will void the warranty. If you need to modify the setting, please contact your responsible Rexroth Service (address as to chapter "9.5 Spare parts").

14 Troubleshooting

The following table may assist you in troubleshooting. The table makes no claim for completeness.

In practical use, problems which are not listed here may also occur.

14.1 How to proceed for troubleshooting

- Always act systematically and targeted, even under pressure of time. Random and imprudent disassembly and readjustment of settings might result in the inability to ascertain the original error cause.
- First obtain a general overview of how your product works in conjunction with the entire system.
- Try to determine whether the product worked properly in conjunction with the entire system before the troubles occurred.
- Try to determine any changes of the entire system in which the product is integrated.
 - Were there any changes to the product's operating conditions or operating range?
 - Were there any changes (conversions) or repairs on the complete system (machine / system, electrics, control) or on the product? If yes, which?
 - Was the product or machine used as intended?
 - How did the malfunction appear?
- Try to get a clear idea of the error cause. Directly ask the (machine) operator.
- If you cannot rectify the error, contact one of the contact addresses which can be found under:
www.boschrexroth.com/addresses.

14.2 Malfunction table

Table 11: Malfunction table for variable pumps

Fault	Possible cause	Remedy
Unusual noises	Drive speed too high.	Machine or system manufacturer.
	Wrong direction of rotation.	Ensure correct direction of rotation.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Improper fixing of the axial piston unit.	Check fixing of the axial piston unit according to the specifications of the machine or system manufacturer. Observe tightening torques.
	Improper fixing of the attachment parts, e.g. coupling and hydraulic lines.	Fix attachment parts according to the information provided by the coupling or armature manufacturer.
	Pressure-relief valve of the axial piston unit (pressure cut-off).	Air bleed axial piston unit Check viscosity of the hydraulic fluid Contact Rexroth Service.
No or insufficient flow	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Faulty mechanical drive (e.g. defective coupling).	Machine or system manufacturer.
	Drive speed too low.	Machine or system manufacturer.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Hydraulic fluid not in optimum viscosity range.	Use suitable hydraulic fluid (machine or system manufacturer).
	External control of the control device defective.	Check external control (machine or system manufacturer).
	Insufficient pilot pressure.	Check pilot pressure, contact Rexroth Service.
	Malfunction of the control device or controller of the axial piston unit.	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.

Troubleshooting

Table 11: Malfunction table for variable pumps

Fault	Possible cause	Remedy
No or insufficient pressure	Faulty mechanical drive (e.g. defective coupling).	Machine or system manufacturer.
	Drive power too low.	Machine or system manufacturer.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid.
		Remove contaminants from the suction line.
	Hydraulic fluid not in optimum viscosity range.	Use suitable hydraulic fluid (machine or system manufacturer).
	External control of the control device defective.	Check external control (machine or system manufacturer).
	Insufficient pilot pressure.	Check pilot pressure, contact Rexroth Service.
	Malfunction of the control device or controller of the axial piston unit.	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
	Mechanical damage to the axial piston unit.	Exchange axial piston unit, contact Rexroth Service.
Pressure/flow fluctuations	Output unit defective (e.g. hydraulic motor or cylinder).	Machine or system manufacturer.
	Axial piston unit not or insufficiently air bled.	Completely air bleed axial piston unit.
	Insufficient suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, contaminants in the suction line.	Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid).
		Completely air bleed axial piston unit, fill suction line with hydraulic fluid. Remove contaminants from the suction line.
Hydraulic fluid temperature too high	Excessive inlet temperature at the axial piston unit.	Machine or system manufacturer: inspect system, e.g. malfunction of the cooler, insufficient hydraulic fluid in the tank.
	Malfunction of the pressure control valves (e.g. high-pressure relief valve, pressure cut-off, pressure controller).	Contact Rexroth Service.
	Wear of axial piston unit.	Exchange axial piston unit, contact Rexroth Service.

15 Technical data

The technical data of your axial piston unit can be found in data sheet RE 92714.

In addition, data sheet RE 92707 also applied for the control device "ED – Pressure controller with remote controlled pressure cut-off; electric".

The data sheets can be found on the internet under

www.boschrexroth.com/ics

The preset technical data of your axial piston unit can be found in the order confirmation.

16 Appendix

16.1 Address directory

For the addresses of foreign subsidiaries, please refer to

www.boschrexroth.com/addresses

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KONGSBERG

Kongsberg K-Chief 500 Engine Monitoring

Operator Manual

Bearing Wear Condition Monitoring
Water In Oil
Bearing Temperature

344527/B

May 2011 © Kongsberg Maritime AS

Document history

Document number: 344527		
Rev. A	February 2010	First Edition
Rev. B	May 2011	Readjust updated Installation distance control added Rapid Wear Alarm function test

The reader

This operator manual is intended as a reference manual for the system operator. This manual is based on the assumption that the system operator is familiar with something or other.

Note

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Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.

Kongsberg Maritime disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Comments

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism.

e-mail: km.documentation@kongsberg.com

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Glossary

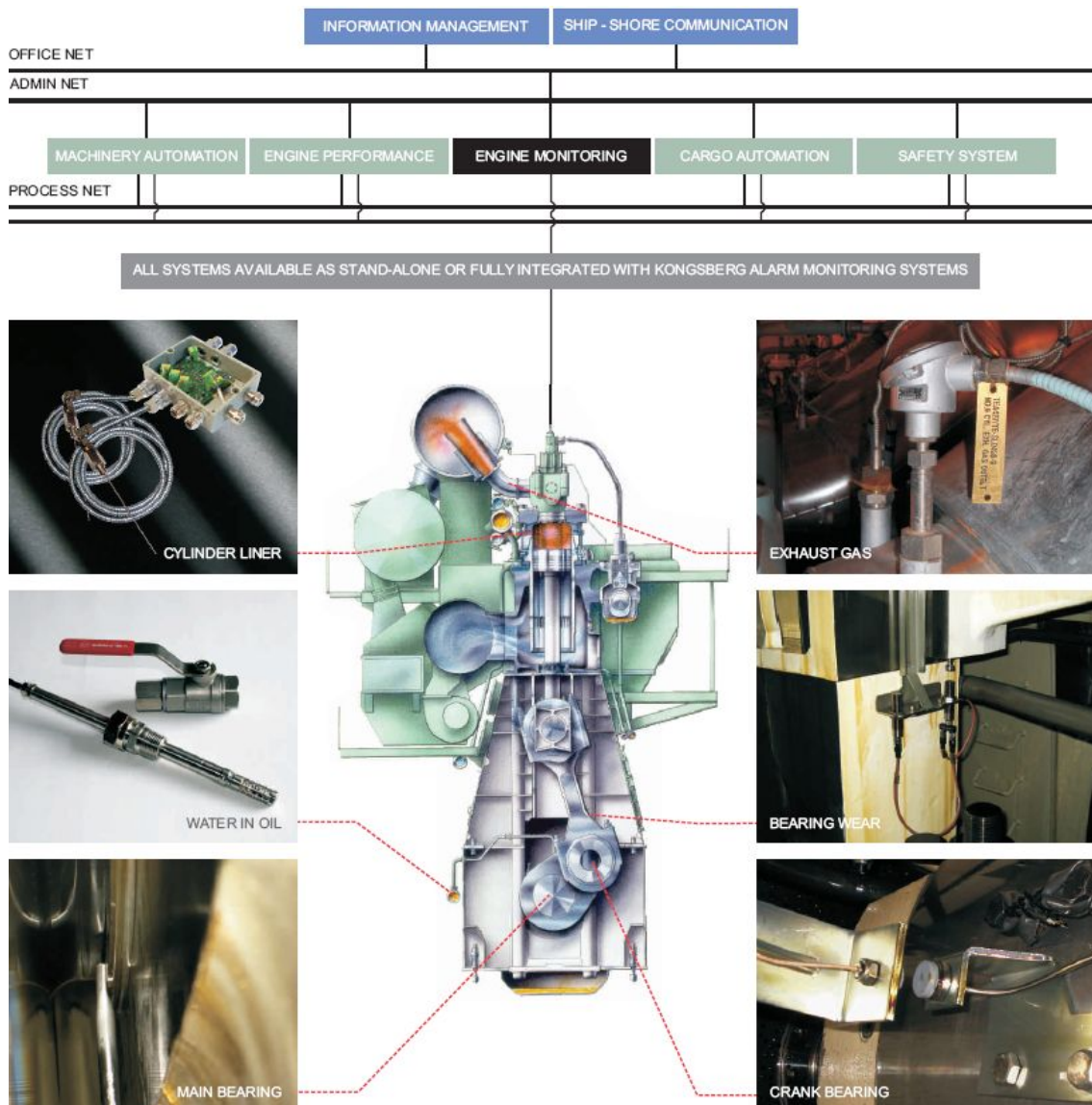
aw	Water activity
BW	Bearing Wear
BWM	Bearing Wear Monitoring
BWCM	Bearing Wear Condition Monitoring
CAN	Controller Area Network
Cis	CAN interface server
CT	Configuration tool
DPU	Distributed Processing Unit
EM	Engine Monitoring
GB200	SENTRY wireless temperature sensor
GN-14	Converter
IDC	Installation distance control
LM	Learning Mode
OS	Operator Station
PS-11	Bearing Wear sensor
WIOM	Water In Oil Monitoring

1 SYSTEM DESCRIPTION

1.1 System functions, Alarm and Monitoring System

1.1.1 Engine monitoring

Kongsberg K-Chief 500 Engine Monitoring Systems consist of bearing monitoring components covering Bearing Wear, Water in Oil, temperature of all bearings and additional measuring points like: cylinder liner, exhaust gas temperature and torque measurement. Software and system components are common within AutoChief C20, allowing integration and joined support. Data transfer via CAN bus is the base for easy communication with other Kongsberg K-Chief 500 applications.



Bearing Monitoring

The Kongsberg K-Chief 500 Bearing Monitoring Systems consist of the Bearing Wear Condition Monitoring, SENTRY Wireless Temperature Monitoring and PT100 Main Bearing Temperature Sensors. In combination these solutions give the optimal monitoring of crosshead, crank and main bearing wear/temperature on 2-stroke engines.

In a modern large bore two-stroke diesel engine, the reliability, particularly for critical components are vital. All major engine manufacturers continually work to maintain and improve reliability of existing and future machines in spite of i.e. higher power output demands. In this picture bearing monitoring is important. The reason for this is firstly that constant monitoring of operating conditions and performance increases the chance of detecting a developing problem at an early stage. Secondly, experience has showed

that some components fail most frequently shortly after an inspection, due to incorrect reassembly, foreign particles being introduced etc. Finally, servicing a part only when necessary reduces the owner's maintenance costs.

Both the Kongsberg K-Chief 500 Bearing Wear Monitoring and the Kongsberg K-Chief 500 Bearing Temperature Solutions have the function of predicting a bearing damage before it becomes critical. The systems will provide the crew with an early warning if any of the crank train bearings (crosshead, crank and main bearings) has an unexpected bearing problem during service. By providing advanced warning of impending problems, the consequential damage to crankshafts and connecting rods may be avoided. In addition the following advantages might be obtained by installing Kongsberg K-Chief 500 Bearing Monitoring Solutions;

- Extended time between “open up” intervals of bearings
- Reduction of insurance costs

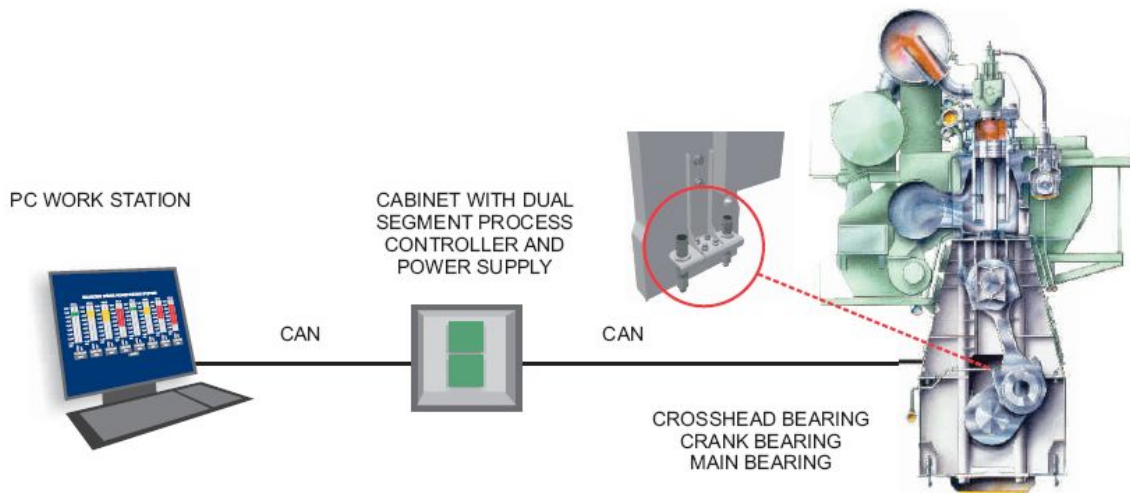
The above benefits will call for individual discussions with the relevant Classification Society / Insurance Company.

Bearing Wear Condition Monitoring

The Bearing Wear Condition Monitoring system predicts bearing wear in large two-stroke diesel engines, before it becomes critical. The system will provide an early warning if any of the three crank-train bearings (crosshead, crank and main bearing) experience unexpected wear during ship operation.

The PS-11 Bearing Wear sensor is based on the eddy current principle and is used for measurements against electrically conductive, ferromagnetic materials. The measurements take place every time the crosshead passes Bottom Dead Centre (BDC). Engine speed is measured continuously to compensate for engine loads and rpm.

The Kongsberg K-Chief 500 BWM system complies with MAN specifications on all points. This includes **Alarm/Event log**, **Short term log** and **Long term log** and data storage over more than 5 years for condition based maintenance and avoiding open up inspection. These functions are also available for other Kongsberg K-Chief 500 applications that easily can be connected to the BWCM computer.



SENTRY; Wireless temperature monitoring

SENTRY is designed to monitor the temperature of crank pin- and crosshead bearings in diesel engines. These bearings can experience rapid temperature changes during damage development. The sensors are designed to give immediate response to the monitoring system.

The measurement system is based on radar technology with passive sensors without need of an external power source. A low energy and high frequency radar pulse is transmitted to the SENTRY Wireless Sensor via the SENTRY Stationary Antenna. When the sensor passes the antenna, the radar pulse is picked up and reflected back to the SENTRY Signal Processing Unit. The shape and characteristics of the reflected pulse determine the temperature of the sensor, i.e. the bearing temperature. The processing unit software calculates the temperature and transmits this to the engine control and monitoring system.

The installation of the stationary antenna related to the sensor is flexible and non-critical.

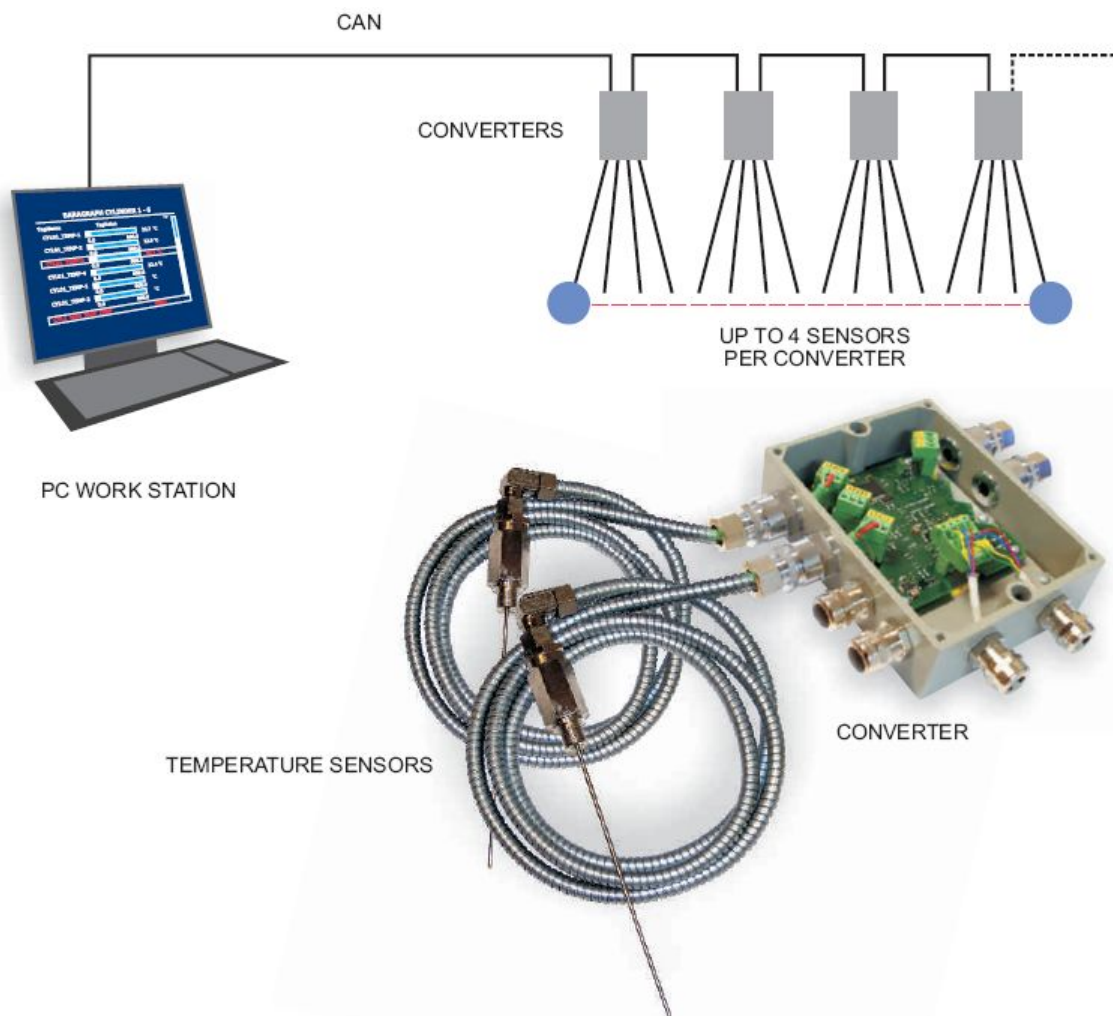


Main Bearing temperature

Custom designed main bearing temperature sensors can be fitted into any type of 2-stroke diesel engines. The sensors are mounted on the main bearing girder with the tip of the sensor in direct contact with the bearing shell. The sensor measures the combined temperatures of the bearing shell and of the lubrication oil that flows from the bearing.

Cylinder Liner Temperature

The Cylinder Liner Monitoring system measures temperatures in the upper part of the cylinder liner 5-6 mm from the inner surface, thus monitoring the piston running performance in operation. Increased friction between the piston rings and the cylinder liner creates an elevated temperature level, leading to abnormal wear and eventually to piston breakage.



Scuffing monitoring and alarm

The added Kongsberg K-Chief 500 software and system components provide detection of cylinder liner scuffing. Scuffing occurs at sub-alarm level temperatures and is recognized by fluctuation temperature readings. When scuffing is detected, an alarm is given for the related cylinder.

Scuffing control

When scuffing is detected an alarm is given for the related cylinder. An output is then given to the cylinder lubrication system that will increase the amount of cylinder lubrication oil to normalize the condition of the given liner. This function is only available in combination with the MAN Diesel Alpha lubricator.

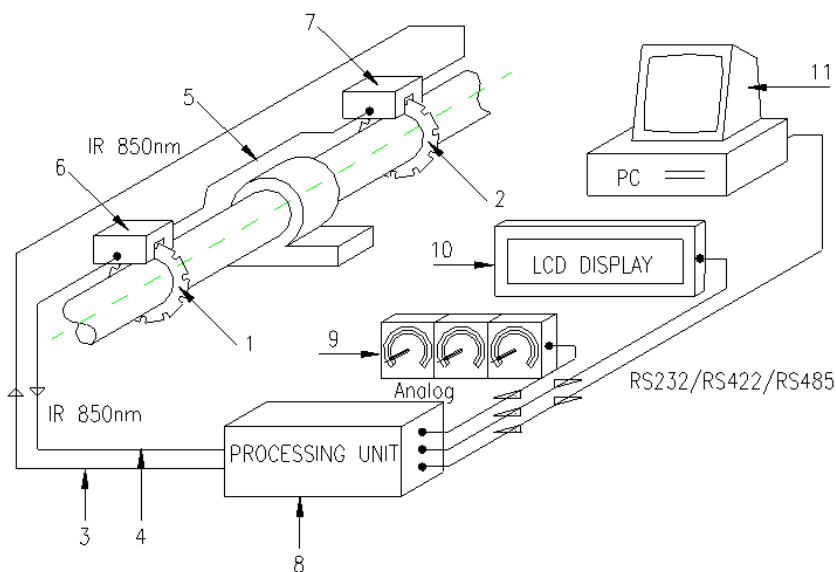
Water in oil detection

The quality of the lubrication oil is critical. Only a small content of water reduces the oils ability to lubricate the bearings. When the water content is high enough for the water to segregate from the oil a rapid corrosive process of the bearings will occur. The life time of a Tin/Aluminium bearing may be reduced to only a few hours. This measuring point has become standard on all new MAN Diesel engines.

MetaPower torque monitoring

The intention of MetaPower system is to enable the ship owner to optimize the operation parameters of the ship, i.e. to maintain or increase the speed with less consumption of fuel. This is carried out by measuring exact power transferred to the propeller(s) during the trimming procedure.

MetaPower is based on a patented LASER technology. The principle is as follows:



An IR beam is transmitted from the processing unit (8) through optical fibre (3). In the optical forks (6) and (7) placed in a distance of around 1 m from each other, the light will be pulse modulated by the coding wheels (1) and (2). The modulation will depend on the shaft speed and torque. The signal is received in the processing unit, processed and displayed as rpm, torque and power on system level.

The processing unit may via serial communication, analogue or digital outputs be connected to the automation system.

2 UNIT DESCRIPTIONS

2.1 Sensor Applications

2.1.1 BW Sensor, PS-11

The BW Sensor PS-11 is designed to communicate with external equipment on CANopen, and to communicate with DPU on local CAN segment.

Main features

- Unique long term measuring accuracy
- Internal temperature compensation
- Internal engine speed measurement and compensation
- Self checking.
- CANopen Communication

Figure 1 BW Sensor, PS-11



2.1.2 Signal converter, GN-14

The GN-14 signal converter is designed to communicate with external equipment on CAN, and to communicate with DPU on local CAN.

Main features

- 4 input channels selectable:
 - Pt100
 - Pt1000

- NiCr-NiAl
- Passiv 4 — 20 mA
- Self checking.
- Built-in temperature sensor for compensation of thermo couple inputs
- CANopen Communication

Figure 2 Signal converter, GN-14



2.1.3 SENTRY, GB200

The SENTRY, GB200 wireless temperature sensor is designed to communicate with external equipment on CANopen and 4–20 mA.

Main features

- Self checking.
- CANopen Communication

Figure 3 SENTRY, GB200



2.1.4 WIO sensor, MMT330

The WIO sensor is designed to communicate with external equipment on local CAN and 4–20 mA.

Main features

- Continuous on-line measurements.
- Values and alarm limits can be verified with salt solutions and no reference oils are needed
- CANopen Communication

Figure 4 WIO sensor, MMT330



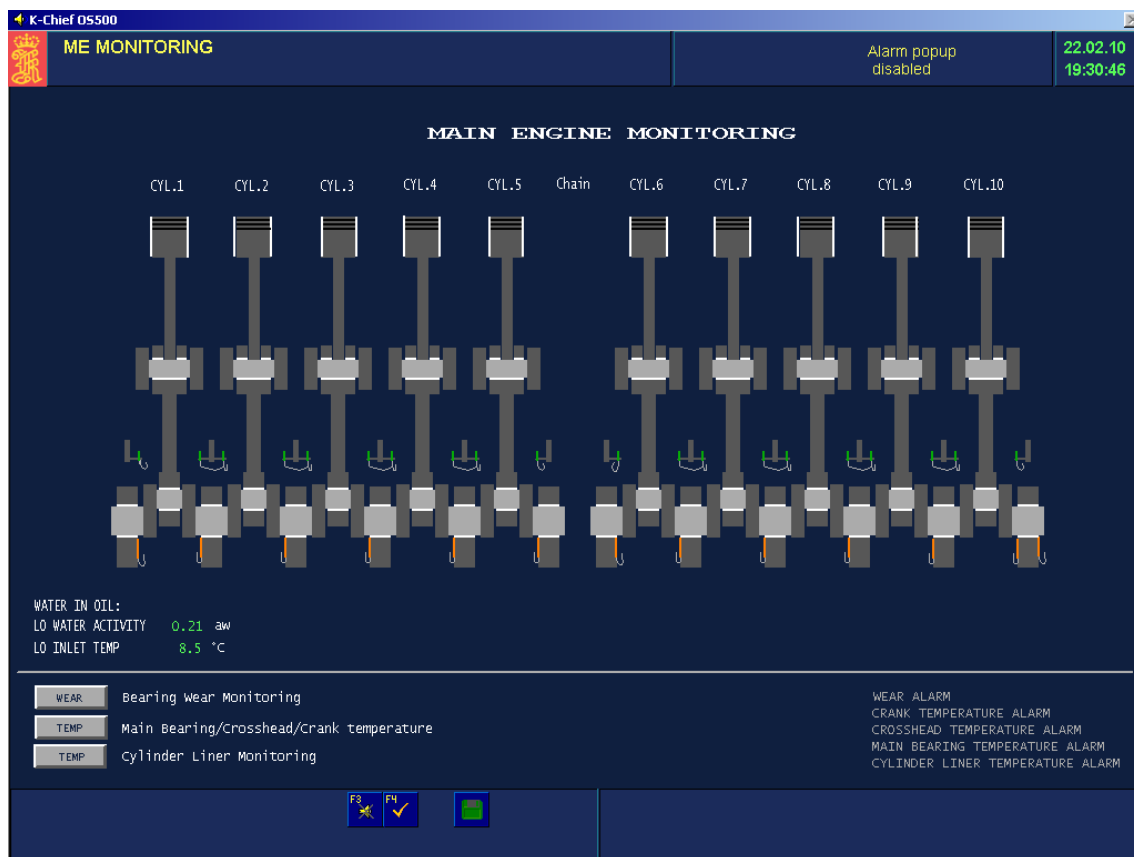
3 OPERATIONAL PROCEDURES, ALARM AND MONITORING SYSTEM

3.1 Engine monitoring overview mimic

The Main engine monitoring overview mimic gives you full access to all subsystems in your configuration. It provides easy access to alarm view and easy detection of the position where the alarm occurs.

The navigator button **Monitoring** will open the overview mimic. This mimic has links to detailed information mimics of Bearing Wear Monitoring and bearing temperature measuring points. To give the user a better overview of installed equipment and a fast overview of the condition; there is a cross-section drawing of the engine showing where the sensor/measuring points are. Status of these points is shown with colours.

Figure 5 Engine monitoring overview mimic



Colour indication

Cylinder liner:

- White →OK
- Red →Alarm

Bearing shell:

- White →OK
- Red →Alarm

Sensor:

- Green →OK
- Red →Alarm

Functions

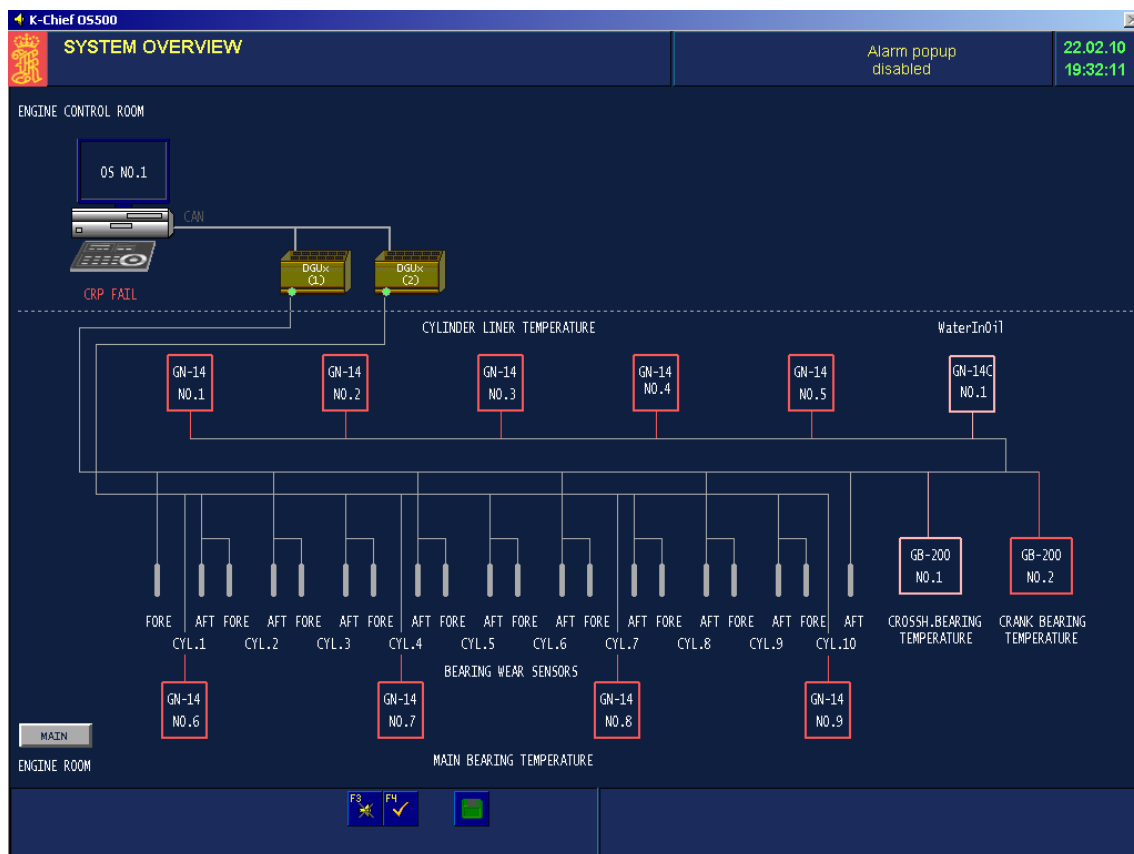
Buttons: →Opens detail mimic

3.2 Engine Monitoring System mimic

System overview mimic

This mimic indicates which part of the system that has a failure alarm. If any bearing wear sensor fails, this will be displayed by the mimics. The **System overview** mimic shows the topology and display, as well where sensors are connected.

Figure 6 System overview mimic



Colour indication

- **Green** → OK
- **Red** → Alarm
- **Orange** → Not updated or invalid values

3.3 Bearing Wear Condition Monitoring

3.3.1 Slow Wear

Bearing Wear Monitoring Slow Wear mimic

When the operator selects **Slow WEAR** through the **Engine overview** mimic, the navigator will open the Bearing Wear Slow Wear monitoring mimic. This mimic contains detailed information regarding slow wear, as follows:

Figure 7 Bearing wear monitoring Slow Wear mimic



BWCM values

SENSOR: BWM sensor value

DEV.: BWM sensor deviation value in text and bar graph

DEV. CYL: BWM cylinder deviation value

PREW.: BWM Prewarning value

Colour indication values

Text:

- **Green** →OK
- **Red** →Alarm
- **Blue** →Alarm state, inhibited

- **Orange** → Not updated or invalid values

Bar graph:

- **Yellow** → OK
- **Red** → Alarm

Running status

Engine running direction	BWCM running status	Action
Engine running Ahead	BWCM running	Engine protected by alarms
Engine running Astern	BWCM stopped	BWCM stopped because engine running astern
Engine stopped	BWCM stopped	
Engine running direction unknown	BWCM stopped	BWCM stopped because engine running direction is unknown, see chapter on page

Mode status

Different modes are used to handle alarm states under commissioning, 3 modes are used.

Mode	State	Action
Uncompensated	Before 3 point learning is done	All alarms for BW values are inhibit
	Before 500 hour learning without 3 point learning done	
Learning Mode	500 hour learning started and 3 point learning done	High alarm limits
Normal	500 hour learning is done	Normal alarm limits

Functions



button opens → **Engine monitoring overview mimic**

Alarm limits

To avoid unnecessary/false bearing wear alarms, the bearing wear monitoring system is build up with dynamics alarm limits. Dependent upon system conditions, the alarm system will change alarm limits accordingly.

Sensor value Tagname: CYLxx_BWS-y				
State	LL	L	H	HH

Normal	- 0.7	- 0.5	0.5	0.7
High	- 0.9	- 0.8	0.8	0.9
Sensor Deviation value Tagname: CYLxx_DEV-y				
State	LL	L	H	HH
Normal	- 0.5	- 0.4	0.4	0.5
High	- 0.7	- 0.5	0.5	0.7
Cylinder Deviation value Tagname: SNSxx_y_DEV				
State	LL	L	H	HH
Normal		- 0.3	0.3	
High		- 0.4	0.4	
Prewarning value Tagname: SNSxx_y_PREW				
	LL	L	H	HH
	-0.5	-0.25	0.25	0.5
Engine speed curve deviation value Tagname: CYLxx_yCURVE				
		- 0.2	0.2	

xx = cylinder number

y = cylinder position, 1 = Fore and 2 = Aft

Sensor Configuration tool communication error with sensor Tagname: SENSOR_CONF TAG description: SENSOR CONFIG. COM. ERROR Note _____ <i>See Engine Monitoring Log for event description from Sensor Configuration SW</i>		
Value: xxyy	xx = node id	yy = cylinder position, 10 = Fore and 20 = Aft
BWM compensation data ready for download: Tagname: LM READY TAG description: BWM COMP_DATA READY-DOWNL		
H Alarm: Engine speed compensation data ready		

Note _____

TAG name can vary for multiple engine setup

How to use Bearing Wear monitoring parameters

	State	Action
BWM sensor value	Alarm	Gauge bearings for this cylinder at next opportunity
BWM sensor deviation value	Alarm	Gauge bearings for this cylinder at next opportunity
BWM cylinder deviation value	Alarm	Gauge bearings for this cylinder at next opportunity
BWM Prewarning value	Alarm	Keep a closer look at the BWCM system
BWM RPM curve deviation	Alarm	Indicating possible bearing wear under 500 hour learning; gauge bearings for this cylinder at next opportunity

3.3.2 Rapid Wear

Purposes is to detect wear that occurs in a short time frame, by using a floating baseline to measure deviation against (transient value) this is achieved with low dynamic alarm limits that increase regarding to change in RPM. The Rapid wear values are absolute values and will cover both growth and wear of the bearings.



BWCM — Rapid Wear values

Single Sensor: Absolute value of the transient value for the corresponding cylinder position

Cylinder Sum: Absolute Sum of the Fore and Aft transient values

Main Bearing Sum: Absolute Sum of the Aft and Fore transient values from two neighbor cylinders

Note

For the first main bearing, last main bearing and main bearing against the chain drive there are no Main Bearing Sum because there are no neighbor cylinder for these main bearings

Colour indication values

Text:

- **Green** →OK
- **Red** →Alarm
- **Blue** →Alarm state, inhibited
- **Orange** →Not updated or invalid values

Bar graph:

- **Yellow** →OK
- **Red** →Alarm

Running status

Engine running direction	BWCM running status	Action
Engine running Ahead	BWCM running	Engine protected by alarms
Engine running Astern	BWCM stopped	BWCM stopped because engine running astern
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Mode	State	Action
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	Before 500 hour learning without 3 point learning done	
Learning Mode	500 hour learning started and 3 point learning done	High alarm limits
Normal	500 hour learning is done	Normal alarm limits

Functions



button opens → Engine monitoring overview mimic

Alarm limits

To avoid unnecessary/false bearing wear alarms, the bearing wear monitoring system is build up with dynamics alarm limits. Dependent upon engine speed changes, the alarm system will increase alarm limits accordingly.

Single Sensor value			
TAG name	TAG description	Basic value	Max value
SS_ALIM	SINGLE SENSOR ALARM LIMIT	0.25	0.375
Cylinder Sum value			
TAG name	TAG description	Basic value	Max value
CS_ALIM	CYLINDER SUM ALARM LIMIT	0.18	0.27
Main Bearing Sum value			
TAG name	TAG description	Basic value	Max value
MB_ALIM	MAIN BEARING ALARM LIMIT	0.25	0.375

Note _____

The alarm limit for all Rapid Wear values is shown on these three TAGs and are not updated in TAG details

How to use Bearing Wear monitoring parameters

	State	Action
Single Sensor value	Alarm/Slowdown	Gauge bearings for this cylinder

Cylinder Sum value	Alarm/Slowdown	Gauge bearings for this cylinder
Main Bearing value	Alarm/Slowdown	Gauge bearings for this cylinder

3.4 WIOM

```
WATER IN OIL :  
LO WATER ACTIVITY  0.00  AW  
LO INLET TEMP      0.0  °C
```

LO Water activity [aw]: Saturation point with water

LO Inlet temp [°C]: Lube Oil temperature

Note _____

Water activity indicates directly whether there is a risk of free water formation. The measurement is also independent of oil type and age.

Alarm limits

LO Water activity	
H	0.50 aw
HH	0.90 aw
LO Inlet temp	
H	50 °C
HH	60 °C

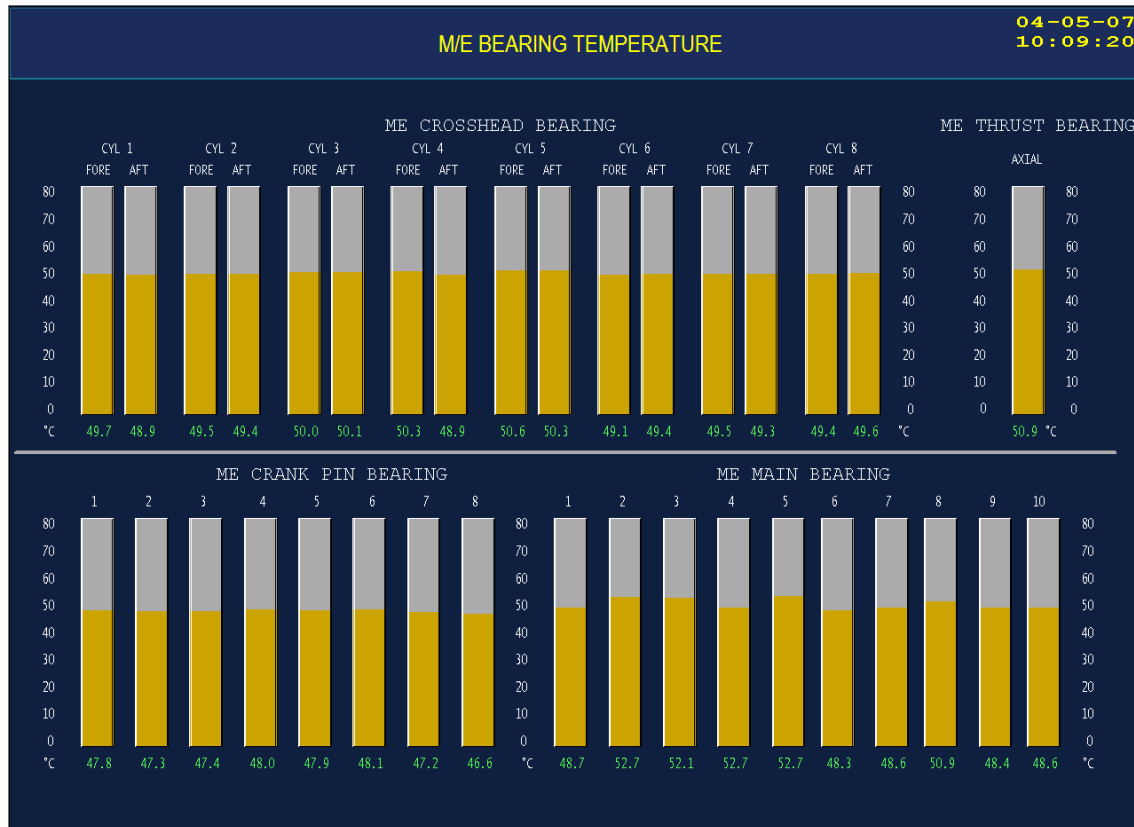
Note _____

Lube oil inlet temperature limits are engine specific and may vary

Water activity indicates the amount in the scale of 0 — 1 aw. In this scale, 0 aw is an indication of completely water free oil and 1 aw an indication of oil fully saturated with water. Water is present in free form.

The most important feature which distinguishes the measurement of water activity (aw) from traditional measurement of absolute water content (in ppm) is that the saturation point remains stable regardless of the oil type or the aging of oil, additives used etc. As water activity exceeds 0.9 aw in any system, there is a risk for segregation (especially if the temperature decreases). The water activity is used for alarming at the point of >0.9 aw that the risk for free water in the system is obvious. the most important advantages of this system are the fact that water activity is immune to the aging of oil and to additives.

3.5 Crank Train Bearing temperature



Colour indication values

Text:

- Green →OK
- Red →Alarm
- Orange →Not updated or invalid values

Bar graph:

- Yellow →OK
- Red →Alarm

3.6 Engine monitoring log

3.6.1 BWCM Long trend log

The main purpose of the long term log is documentation to classification societies that no wear has occurred. This log will give a good overview if there exists a slow progressing wear that can be repaired before it becomes critical.

The following TAGs is logged per cylinder:

- Engine running hour
- Sensor value FORE
- Sensor value AFT
- Sensor deviation FORE
- Sensor deviation AFT
- Cylinder value

On each BWM TAG these values are logged for each 6 hour period

- Maximum value
- Minimum value
- Average value

Data will be stored in:

c:\ros\pdslog\BWlog\LongTermData

Each cylinder will have its own file:

Engine1 Cylxx-yyyy.csv

xx = number of the cylinder

yyyy = year

Note

A new log file will be started each year.

The first line is the heading. Each tag name shows up 3 times. First the average value, then minimum value and maximum value:

```
Sample time;Engine running hours;1CYL04_BWS-1 avg;1CYL04_BWS-1 min;1CYL04_BWS-1 max;.
31.08.2009 03:29;1721;0.01;-0.23;0;.....
```

The values are separated by semicolons, which makes it easy to open the file in Microsoft Excel:

Table 1 Imported in Excel

Sample time	Engine running hours	1CYL04_BWS-1 avg	1CYL04_BWS-1 min	1CYL04_BWS-1 max
31.08.2009 03:29	1721	0.01	-0.23	0.05
31.08.2009 09:29	1724	0.01	-0.23	0.05
31.08.2009 15:29	1728	0.01	-0.23	0.05
31.08.2009 21:29	1731	0.01	-0.23	0.05

3.6.2 BWCM Short trend log

When a bearing wear alarm occurs (on sensor deviation, cylinder deviation or sensor value), **Short trend log** will be stored. Values for all tags related to the bearing wear system will be stored. Data is preserved for 23 hours before the alarm and 1 hour after the alarm. This will be stored on

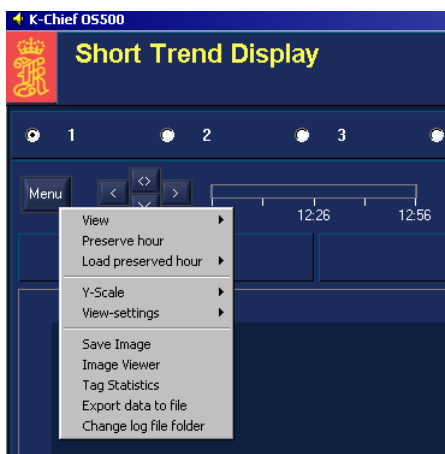
c:\ros\Pdslog\BWlog\Preserved

and saved in separate folders. The name of the folder is given by the date and time when the alarm occurs.

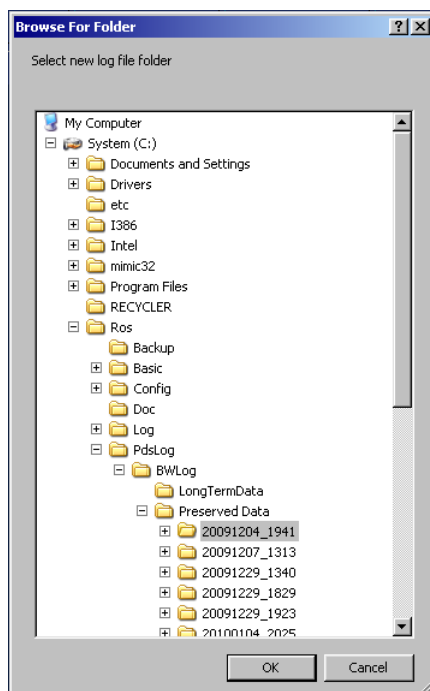
It is possible to trend a preserved alarm folder. All details regarding the use of short trend displays are described in **How to make your own short trend display** in the **K-Chief 500** manual on page .

To select preserved BWCM data folder

- 1 Go to **Config displays** → **Short Trend Display**
- 2 Click → **Menu**
- 3 Click → **Change log file folder**



- 4 Select the preserved data folder with the date where the alarm has occurred and click **OK**



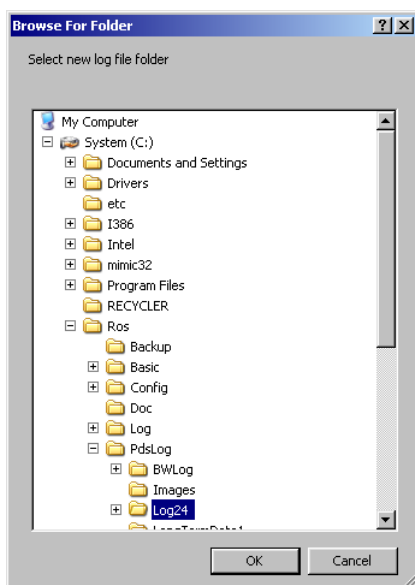
- 5 Select TAGs to be viewed as described in on page

To set standard 24 hour log folder

- 1 Click →Menu
- 2 Click →Change log file folder



- 3 Select the preserved data folder with the date where the alarm has occurred and click **OK**

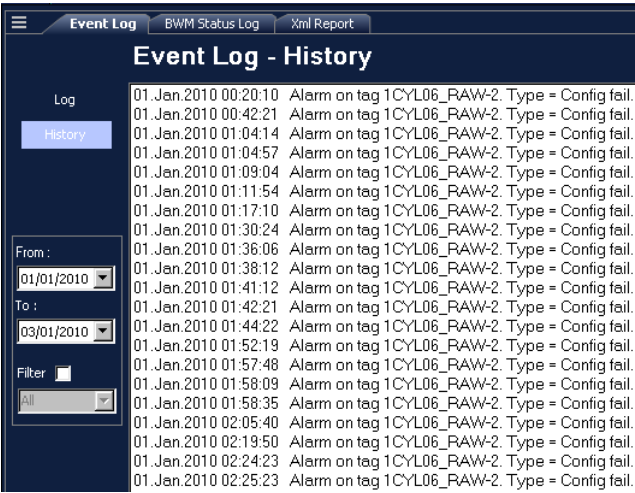


3.6.3 Event log

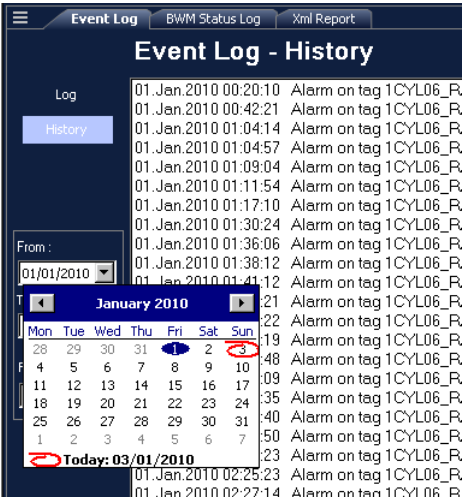


Event log lists all events and alarms on the **Engine Monitoring System**; mandatory for **BWCM**

History

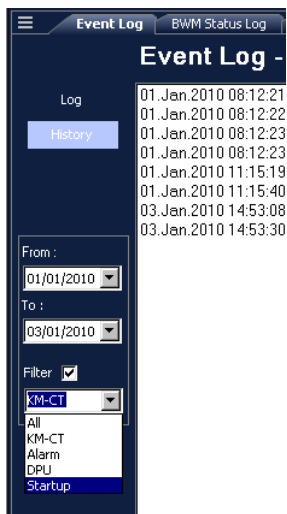


Show all events and alarms stored in file



How to set time frame

- 1 Click **From**
- 2 Select date
- 3 Click **To**
- 4 Select date
- 5 Click **History** to reload



How to set filter

- 1 Check off **Filter** box
- 2 Click drop down box
- 3 Select parameter
 - All
 - KM-CT (Sensor Configuration)
 - Alarm
 - DPU
 - Startup
- 4 Click **History** to reload

3.6.4 BWCM status log

K-Chief 05500

Engine Monitoring Log

03.01.10
15:01:05

Event Log

BWCM Status Log

Xml Report

Status log - Engine 1

Engine 1

Engine 2

	Normal	PreWarning	Alarm	Unknown
Cylinder 1	04. January 2010 19:44:00 N			
Cylinder 2	04. January 2010 19:44:00 N			
Cylinder 3	04. January 2010 19:44:00 N			
Cylinder 4	04. January 2010 19:44:00 N			
Cylinder 5	04. January 2010 19:44:00 N			
Cylinder 6	04. January 2010 19:44:00 N			
Cylinder 7	04. January 2010 19:44:00 N			
Cylinder 8	04. January 2010 19:44:00 N			
Cylinder 9	04. January 2010 19:44:00 N			
Cylinder 10	04. January 2010 19:44:00 N			

Normal

When cylinder started in normal operation

Alarm

Time of last alarm on cylinder

PreWarning

Time of last prewarning on cylinder

Unknown

Both sensors in the cylinder readjusted, initial reference point lost

F8

P4

Gives a overview of there has been a event or alarm on the cylinder with date and time when the status has been set.

3.6.5 Report

How to generate report

- 1 In Select time set time period or time frame

Set time period

- a Check box for period selection
- b Click dropdown
- c Select period

Set time frame

Select time Sel

☐ All ☒

From ☐

☒ 18/01/2010 ☐

To ☐

18/01/2010 ☐

January 2010

Mon	Tue	Wed	Thu	Fri	Sat	Sun
28	29	30	31	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

Status

Writing to file c
Data export co

Today: 18/01/2010

- a Check box for date selection
 - b Click **From**
 - c Select date
 - d Click **To**
 - e Select date
- 2 In **Select data** select data types:
 - **Classification Report:** Pre-selected set of data for documentation to the class
 - **Log:** Data from the alarm/event log
 - **Status log:** Status log for the engine
 - **Trend data:** Long trend data
 - 3 If there is a multi engine setup select engine in **Select engine**
 - 4 Click **Generate Report**

File location

Data will be stored in:

c:\ros\pdslog\BWlog\Xml Reports

Each report file is named:

Shipname_hullno_serialno_date_time.xml

3.7 Sensor Configuration

3.7.1 Main Window

Parameter	Value
Ship name	KM lade
IMO no.	1
Builder	KM
Hull no.	14
Ship type	Container
Engine type	10K98MC
Engine serial number	34
Class register no.	2
Component	ME
Engine licensor	MAN Diesel
Engine maker	KM lade
Bearing Wear Monitoring	
Number of cylinders	10
Engine bore size	80-108
Maximum engine speed	105
Minimum engine speed	19
Load enabled	☐
DPU channel with load source	0
Node id load source	40
Input channel load source	1
GN-14	
Number of GN-14 on channel 0	6
Number of GN-14 on channel 1	4
GB200	
Number of GB200 on channel 0	2

☰ Opens the **Main menu**

Set Access **EM Engine1** The different types of windows are available on TAB

▼ All open windows are available on a drop down list

✕ Closes the active window when pushed

3.7.2 Messages

Time	Sender	Message
2/4/2010 9:39:42 AM	Engine Running Hour	Error in reading 'engine running hours' in under sensor failure area for cylinder 2. This cylinder will be excluded from Readjust.
2/2/2010 5:26:20 PM	LearningMedia timer failed	System.ArgumentOutOfRangeException: Index was out of range. Must be non-negative and less than the size of the collection. Parameter name: index at System.ThrowHelper.ThrowArgumentOutOfRangeException(ExceptionArgument argument, ExceptionResource resource) at System.ThrowHelper.ThrowArgumentOutOfRangeException()

The message window will open at the underpart of the **Main window**, error messages will be available in this window

To open messages window

1 Click **Main menu** ☰

- 2 Click →  **Show Messages**

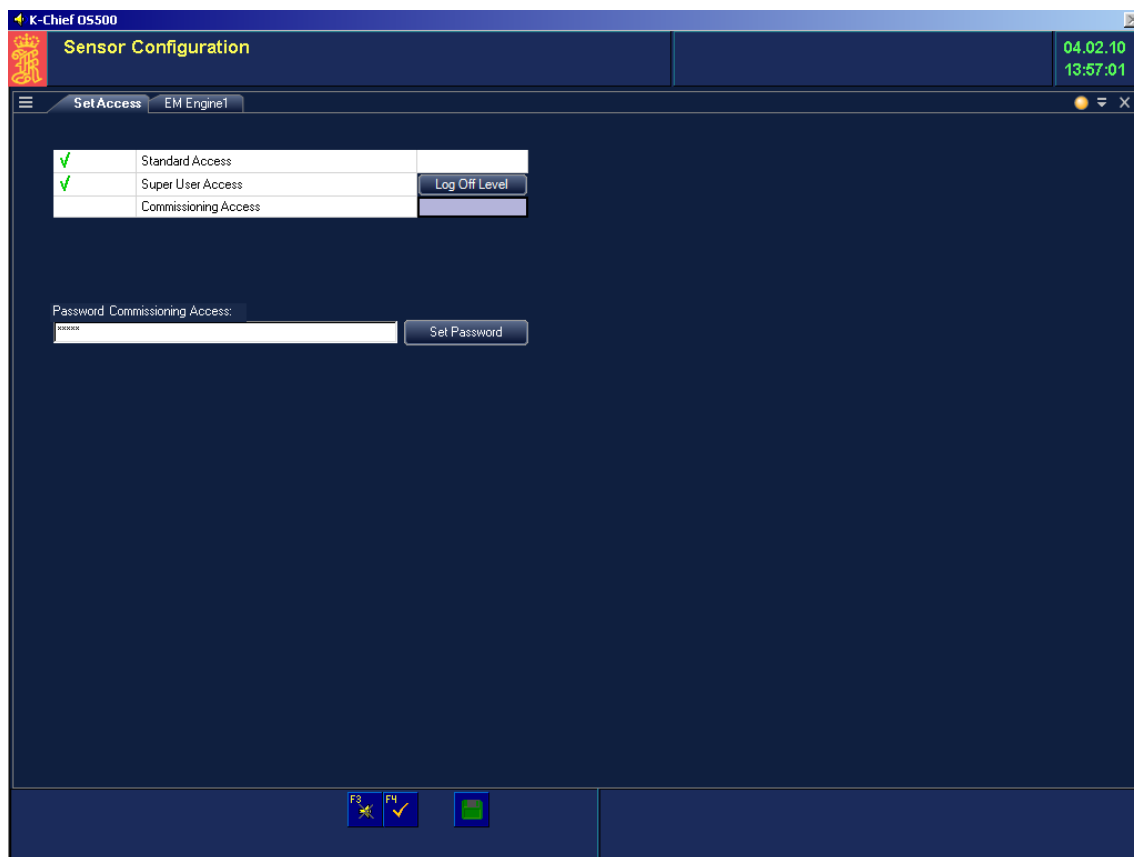
To clear messages

- 1 Click **Main menu** 
- 2 Click → **Clear Messages**

To close messages window

- 1 Click **Main menu** 
- 2 Click →  **Hide Messages**

3.7.3 Set Access



Standard Access

Indicator: 

View

Super User

Indicator: 

Basic functions

Password: Project specific and K-Chief commissioning password

Commissioning Access

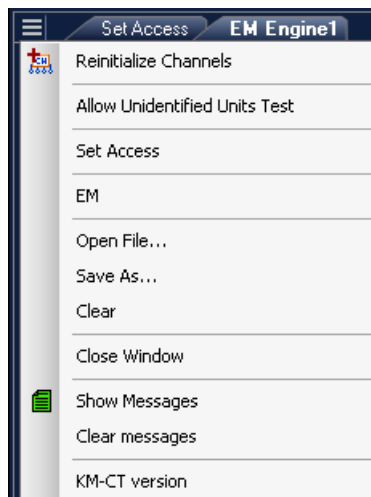
Indicator: 

Advanced functions and parameter changes

Password: K-Chief commissioning password

3.7.3.1 Open Set Access

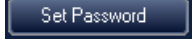
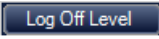
- 1 Click  to open **Main Menu**
- 2 Select →**Set Access** to open **Set Access** window



3.7.3.2 Change access level

- 1 Write the password in the text field



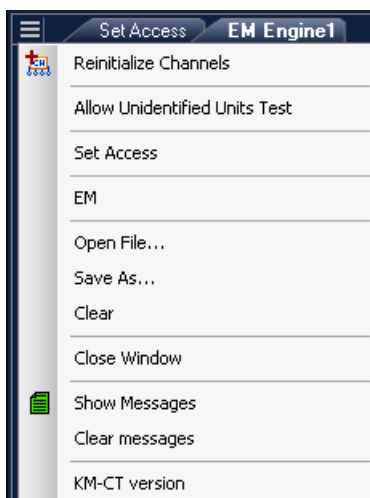
- 2 Click 
- 3 To log off an access level click 

WARNING

There is no time out on this access so after the work is finished; log off to standard level

3.7.4 Auto start with K-Chief 500

- 1 Start **K-Chief**
- 2 Go to **Service** →**Sensor Configuration**
- 3 Click →**EM** in **Main Menu**



4 Open **Set Access** in **Main menu** and set access to →**Commissioning Access**

5 Go to **Engine Setup** →**Advanced functions**

Advanced functions		
Storage hard disk		C:\
Auto Start Configuration	☒	
Number of engines		2
Engine 1 - Channel no. 0 DPU Node id		20
Engine 1 - Channel no. 1 DPU Node id		21
Engine 2 - Channel no. 2 DPU Node id		23
Engine 2 - Channel no. 3 DPU Node id		24

6 **Auto Start:** Checked box for on

7 **Number of engines:** Write number of engines, 1 or 2

8 **Engine 1 — Channel no. 0 DPU Node id:** Write node id on DPU with local segment A on engine 1

9 **Engine 1 — Channel no. 1 DPU Node id:** Write node id on DPU with local segment B on engine 1

10 **Engine 2— Channel no. 2 DPU Node id:** Write node id on DPU with local segment A on engine 2

11 **Engine 2— Channel no. 3 DPU Node id:** Write node id on DPU with local segment B on engine 2

12 Go to **Engine Setup** →**System Setup** and fill in Ship name, Builder, Hull no and engine serial number.

Important

If two engine setup is selected it's important that each setup has different serial number to split system data

System Setup	
Ship name	
IMO no.	
Builder	
Hull no.	
Ship type	Chemical tanker
Engine type	
Engine serial number	
Class register no	
Component	
Engine licenser	
Engine maker	

13 Click 

14 Restart K-Chief

Note

*If the **SensorCTStartup.xml** file exists in **Database** folder with correct setup before start of **K-Chief** there is no need for restart, use **Notepad** to modify file.*

3.7.5 Engine monitoring — system setup

Information in **Engine Monitoring Setup** is used to setup **Sensor Setup** and **Commissioning**. This information will also be included in the BWCM report for the classification society to avoid open up inspection of the bearing.



3.7.5.1 System Setup

Fill in information on these points in **Engine setup** → **System setup** window.

System Setup	
Ship name	
IMO no.	
Builder	
Hull no.	
Ship type	Chemical tanker
Engine type	
Engine serial number	
Class register no	
Component	
Engine licenser	
Engine maker	

Ship name: Write Ship name

IMO no: Write

Builder: Write

Hull no: Write

Ship type: Click and select one of the types in the drop down list.

- Bulk
- Chemical tanker
- Container
- LNG
- LPG
- Reefer
- Tanker
- Vehicle Carrier
- Custom

Engine type: Write

Engine serial number: Write

Class register no: Write

Component: Write

Engine licenser: Write

Engine maker: Write

Important _____

Use different serial numbers on each engine in a two engine setup

3.7.5.2 Bearing Wear Condition Monitoring

Bearing Wear Monitoring	
Number of cylinders	1
Engine bore size	60-70
Maximum engine speed	
Minimum engine speed	
Load enabled	☐
DPU channel with load source	0
Node id load source	40
Input channel load source	1

Number of cylinders: Write number 0 - 16 (0 = no BWM) or double click in field and select from drop down list

Engine bore size: Double click in field and select size range from list.

- 80 – 108
- 60 – 70
- Up to 50

Maximum engine speed: Write maximum RPM

Minimum engine speed: Write minimum RPM

Engine load

If engine is running a CP propeller or a generator the system has to be setup with a load input:

Load enabled: Check to activate the load functionality

DPU channel with load source: Double click in the field and select the channel with the DPU where the GN-14 signal converter with the load signal is connected

Node id load source: Double click in field and select the node id or write the node id of the GN-14 signal converter that has the engine load input

Input channel load source: Double click in field and select the input channel on the GN-14 signal converter where the engine load is connected

3.7.5.3 GN-14

GN14		
	Number of GN14 on channel1	6
	Number of GN14 on channel2	4

Double click in the field and select or write the number of GN-14 signal converter on each channel

3.7.5.4 GB200

GB200		
	Number of GB200 on channel1	2
	Number of GB200 on channel2	0

Double click in the field and select or write the number of SENTRY GB200 units on each channel

3.7.5.5 Advanced functions

Advanced functions		
Storage hard disk		C:\
Auto Start Configuration	☒	
Number of engines		2
Engine 1 - Channel no. 0 DPU Node id		20
Engine 1 - Channel no. 1 DPU Node id		21
Engine 2 - Channel no. 2 DPU Node id		23
Engine 2 - Channel no. 3 DPU Node id		24

Storage hard disk: Default C:\

Auto Start: Enables auto start of configuration

- Checked box for **On**
- Unchecked box for **Off**

Number of engines: Write number of engines, 1 or 2

Engine 1 — Channel no. 0 DPU Node id: Write node id on DPU with local segment A on engine 1

Engine 1 — Channel no. 1 DPU Node id: Write node id on DPU with local segment B on engine 1

Engine 2— Channel no. 2 DPU Node id: Write node id on DPU with local segment A on engine 2

Engine 2— Channel no. 3 DPU Node id: Write node id on DPU with local segment B on engine 2

3.7.5.6 Save Setup

Saves the setup to file with name generated from information in Engine Setup.

Click 

File name containing

- Ship name
- Bulider
- Hull number
- Engine serial number
- Date
- Time

ex. KM Lade_KM_99_22_20091117_0948.xps

File is saved to a folder with name generated from information in Engine Setup.

Folder name containing

- Ship name
- Bulider
- Hull number
- Engine serial number

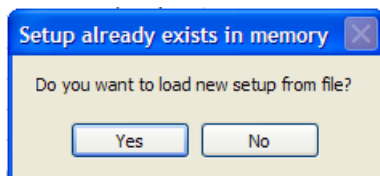
ex. KM Lade_KM_99_22

Folder location: C:\Ros\Config\KM-ConfigTool sensor

3.7.5.7 Load setup

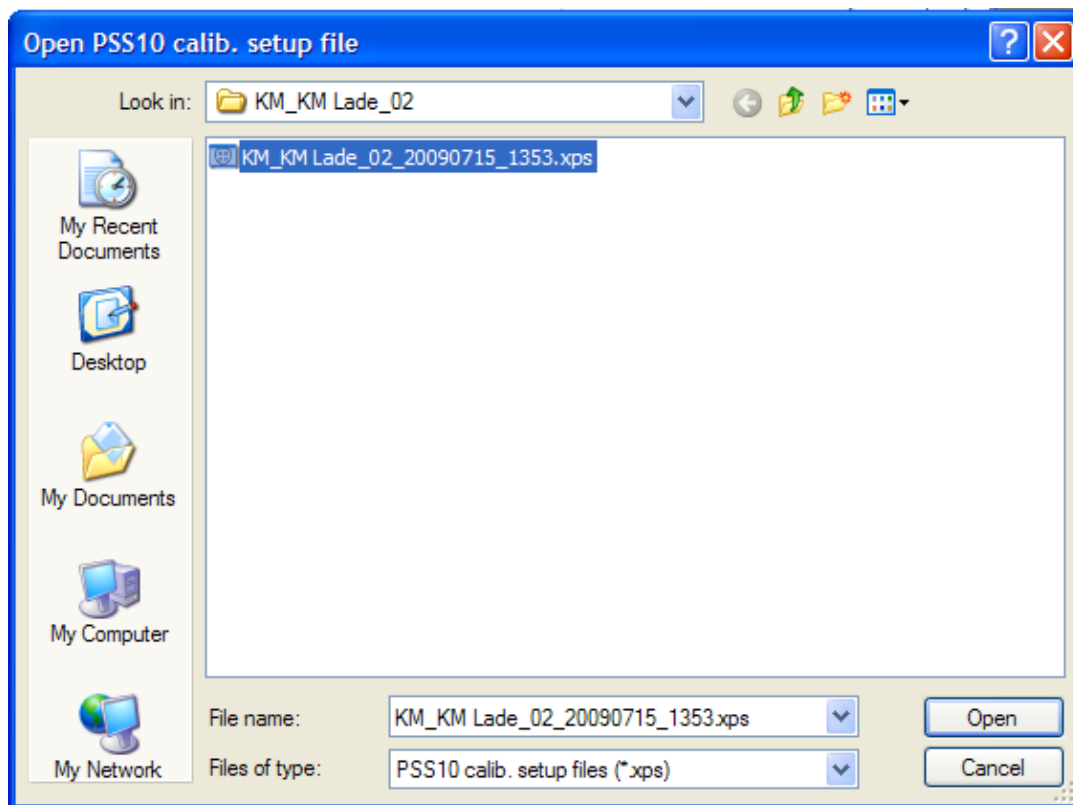
Opens saved setups

- 1 Click 
- 2 Warning window will pop up



- Yes: Go to next window
- No: Cancel operation

3



- Select the folder where the setup file is located
- Select setup file
- Click “Open” to open file or click “Cancel” to end operation

4 Click 

3.7.5.8 System setup procedure

- 1 Setup communication
- 2 Fill in → **System setup**
- 3 Fill in → **Bearing Wear Monitoring**
- 4 If setup with variable load click 
- 5 Fill in load signal information
- 6 Fill in → **GN-14**
- 7 Fill in → **GB200**
- 8 Click 



Load Setup and **Save Setup** has same function as in **Engine Setup**.

3.7.6.1 Unconnected sensors

Used to search for sensors based on serial number to drag and drop on a fixed setup, see sections →**BWM**, →**GN-14** and →**GB200**.

Filter settings

Filter setting are used for sorting different sensor types and setting the serial number range for the search.

The 'Filter settings' dialog box contains the following fields:

Product Code	PSS11__
Min Serial number	1
Max Serial number	999999999999

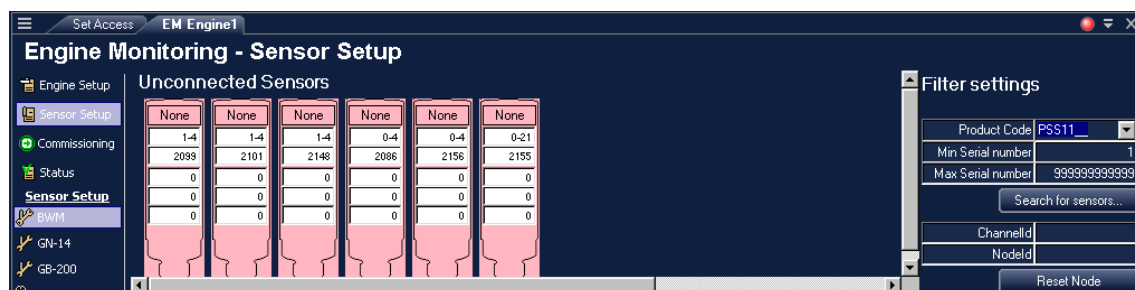
Below the fields is a button labeled 'Search for sensors...'.

- 1 Select sensor type

Device name	Product code
PS-10	PSS10__
PS-11	PSS11__
GN-14/C	GN-14
GB200	GB200__

- 2 Select serial number range with minimum and maximum serial number if specific serial numbers is wanted

- 3 Click



Sensors of the specified product code that are not assign to a setup will show up under unconnected sensors; drag and drop the sensor with the correct serial number to the correct place in the setup for →**BWM**, →**GN-14** or →**GB200**.

Note

A sensor needs to be removed from the setup to show up again in the “Unconnected sensors” list

3.7.6.2 Reset node

Restarts the unit

ChannelId	
NodeId	
Reset Node	

- 1 Write **Channel Id** and **Node Id**
- 2 Click 

3.7.6.3 BWM

	Fore	Alt	Fore	Alt	Fore	Alt	Fore	Alt	Fore	Alt
Node ID:	0-20	1-20	1-21	0-21	0-22	1-22	1-23	0-23	0-24	1-24
Serial nr.:	2086	0	2101	2155	2156	2148	2157	2191	2207	2166
RPM:	20.60	0	23.80	21.20	21.60	22.90	23.10	20.90	20.90	23.90
Wear:	0.0070	0	0.0090	-0.0200	0.0060	0.0270	0.0330	0.0010	0.0020	0.0340
Temp. [°C]:	31.00	0	29.80	31.60	31.10	29.90	29.90	31.00	31.10	29.50
	Cyl. 1		Cyl. 2		Cyl. 3		Cyl. 4		Cyl. 5	
	Fore	Alt	Fore	Alt	Fore	Alt	Fore	Alt	Fore	Alt
Node ID:	1-25	0-25	0-26	1-26	1-27	0-27	0-28	1-28	1-29	0-29
Serial nr.:	2172	2181	2109	2134	1707	1556	1709	1708	2127	1713
RPM:	23.80	21.90	20.90	33.70	24.50	21.60	23.20	25.80	23.70	22.30
Wear:	-0.0110	-0.0100	0.0070	0.0350	0.0150	-0.0110	-0.0070	-0.0170	0.0160	0.0120
Temp. [°C]:	29.50	31.00	30.00	30.10	27.90	29.30	30.20	27.60	29.60	29.80
	Cyl. 6		Cyl. 7		Cyl. 8		Cyl. 9		Cyl. 10	

Research nodes Load Setup Save Setup

Node id: Channel for this cylinder position — Address of unit

Serial Number: Serial number of unit connected to this position

RPM: Engine speed measured by sensor

Bearing Wear value: Compensated Bearing Wear sensor value

Sensor temperature: Ambient sensor temperature

Status:

- **Turquoise** → **Not Initialized:** No unit has been connected to this position
- **White** → **Connected:** Unit is connected to this position
- **Orange** → **Missing:** Unit not on-line

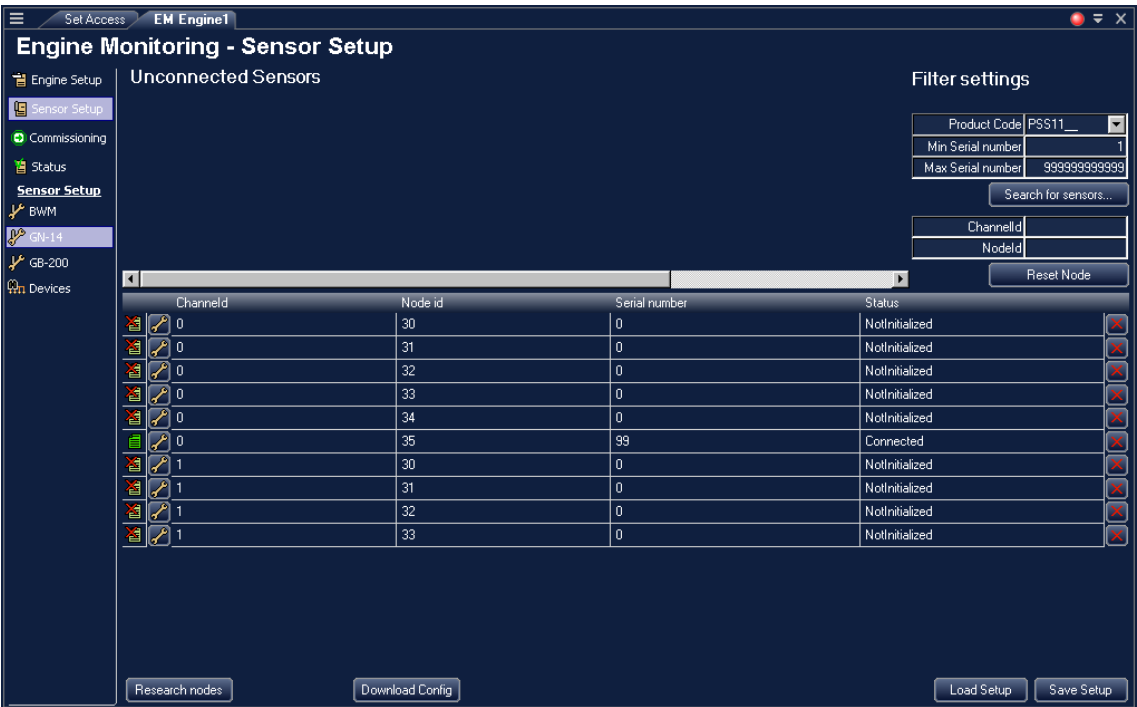
3.7.6.3.1 Setup Bearing Wear sensor

- 1 Go to **Sensor setup** → **BWM**
- 2 Select **Product code** → **PSS11** in **Filter settings**
- 3 Click 
- 4 Drag the sensors with the regard to serial number from **Unconnected Sensors** to the cylinder and position where it's installed
- 5 Click **Save**

Note _____
Unit can only be dropped to the channel where it's installed

Note _____
*For replacement or reinstall of sensor see **Readjust** chapter*

3.7.6.4 GN-14



Channel id: Correspond to which CANopen line the unit is connected.

Note _____
The unit can only be dropped to the channel where it's installed

Node id: Address of unit

Serial Number: Serial number of unit connected to this position

Status: Connection status of the unit

- →**Not Initialized:** No unit has been connected to this position
- →**Connected:** Unit is connected to this position
- →**Missing:** Unit not on-line

Functions

 Configuration exist on file



No configuration available



Opens configuration window



Removes sensor from setup

GN-14 signal converter setup

The screenshot shows the BWGN14Setup window. It has a title bar 'BWGN14Setup' and a menu bar. The main area is titled 'GN14 Setup'. It contains the following fields and a table:

- ChannelId: 0
- NodeId: 35
- Number of channels: 2
- A table with 4 columns: Channel, Description, ChType, and Value.

Channel	Description	ChType	Value
1		Current	10.2
2		Current	25
3		Thermocouple	0
4		Thermocouple	0

At the bottom, there are five buttons: Upload, Download, Open, Save, and Save As...

Channel id: Correspond to which CAN line the unit is connected on.

Node id: Address of the unit.

Number of channels: Double click in the field and from drop down list select the number of input channels used on the unit

Channel: Input channel on the unit

Description: Write a description of each input

Ch type: Double click in the field and select type of input from the drop down list. In the drop down list the channel types are listed with **Channel code**. They will turn to text when selected

Channel type	Channel code
Thermo coupling	61442
PT100 2 wire	61470
PT100 3 wire	61726
PT100 4 wire	61982
Resistor	120
Current (4–20 mA passive)	61573

Value: Shows value of the channel



Uploads settings from unit



Downloads settings to the unit and saves the settings to file.

-  Opens saved settings
-  Save settings to file
-  Save settings to new file

3.7.6.4.1 Setup new GN-14 signal converter

- 1 Go to **Sensor setup** →GN-14
- 2 Select **Product code** →GN-14 in **Filter settings**
- 3 Click 
- 4 Choose unit by serial number in **Unconnected Sensors** and drag and drop them to the position where it's installed
- 5 Click **Save**
- 6 If there is a pre-installed setup file  for all units click  when all sensors have **Status** →**Connected**; if not setup file  go to next step
- 7 To make setup file click  when all units has status **connected** in **Status** field; repeat procedure for each unit.
 - a Set number of channels
 - b Set type of input
 - c Add description if required
 - d Click 

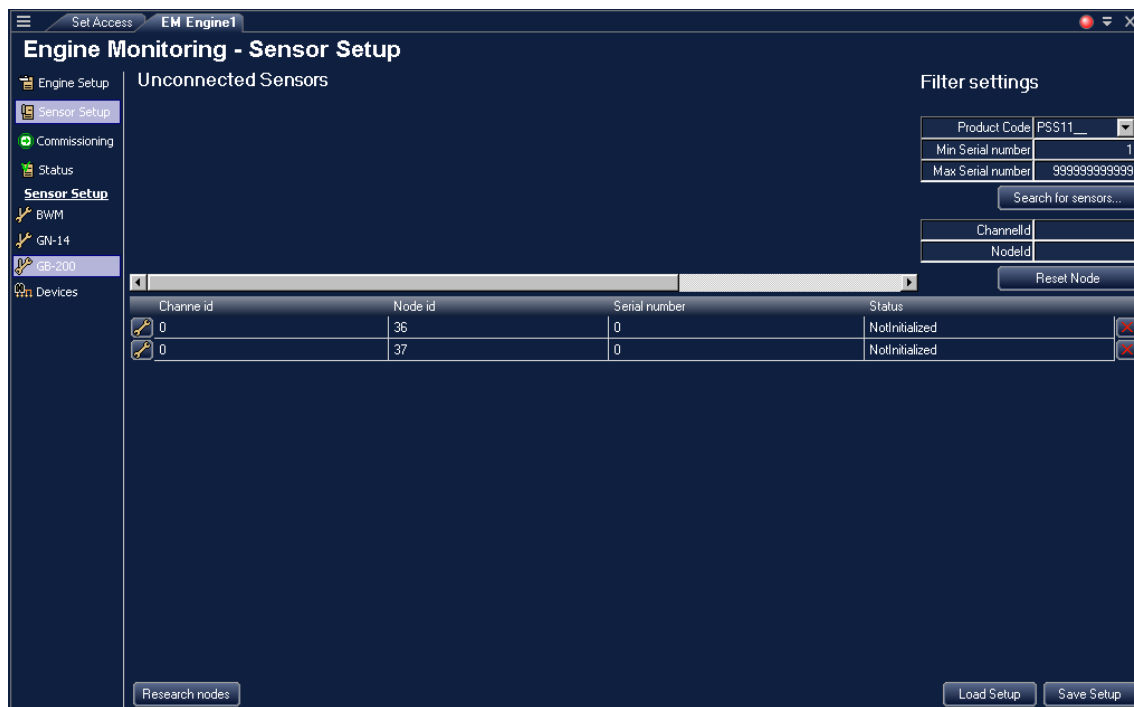
3.7.6.4.2 Replace GN-14 signal converter

- 1 Go to **Sensor setup** →GN-14
- 2 Select **Product code** →GN-14 in **Filter settings**
- 3 Click 
- 4 Remove old unit by clicking 
- 5 Choose unit by serial number in **Unconnected Sensors** and drag and drop them to the spot for unit that was replaced
- 6 When all units have **Status** →**Connected** click 

Note

*If the configuration don't exist  set up a configuration with the procedure described in **Setup new GN-14***

3.7.6.5 GB200



Channel id: Channel correspond to which CAN line the unit is connected

Note

The unit can only be dropped to the channel where it's installed

Node id: Address of unit

Serial Number: Serial number of unit connected to this position

Status: Status of the unit

- →**Not Initialized:** No unit has been connected to this position
- →**Connected:** Unit is connected to this position
- →**Missing:** Unit not on-line

Functions

 opens commission window

 Removes sensor from setup

3.7.6.5.1 Setup SENTRY GB200

- 1 Go to **Sensor setup** →**GB200**
- 2 Select **Product code** →**GB200__** in **Filter settings**
- 3 Click 

- 4 Choose unit by serial number in **Unconnected Sensors** and drag and drop them to the position where it's installed
- 5 Click Save
- 6 Click  to open commissioning window

Note

See SENTRY GB200 manual for commissioning procedure

3.7.6.6 Devices

Devices are showing status of the channels and will list all units connected to these channels



Input channels

Channel: Channels that are available

Status:

- → **Cis not started**
- → **Not found**
- → **Found**
- → **Operational** System ready for search of units

Note

When running together with K-Chief 500 units will be mapped automatically

Units

Channel id: The address where the units are connected

Node id: The address of the unit

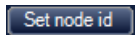
Name: Device name on the unit

Serial number: A number that is separating units of the same type

Functions



opens the configuration window



Sets the node id written in **Node id** box



Used to scan for units based on node id



Searches for units based on serial number

3.7.7 BWCM Service

3.7.7.1 Service

Service is used to download and upload engine speed compensation data for the BW sensors

Fixed pitch propeller (FPP)

Engine Monitoring - Commissioning

Compensation Table

Node id	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28
Channel id	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
Select	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RPM [0]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wear [0]	-0.20	-0.07	-0.02	-0.03	-0.02	-0.06	-0.06	-0.07	0.00	-0.04	-0.04	0.00	-0.01	-0.02	-0.01	0.00	0.02
RPM [1]	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
Wear [1]	-0.20	-0.07	-0.02	-0.03	-0.02	-0.06	-0.06	-0.07	0.00	-0.04	-0.04	0.00	-0.01	-0.02	-0.01	0.00	0.02
RPM [2]	20.69	20.26	20.10	20.60	20.36	20.49	20.58	20.70	20.37	20.41	20.47	20.45	20.63	20.47	20.83	20.30	20.25
Wear [2]	-0.19	-0.09	-0.01	-0.02	-0.02	-0.06	-0.05	-0.08	-0.01	-0.03	-0.04	0.00	-0.01	-0.02	-0.01	-0.01	0.01
RPM [3]	21.50	21.33	21.23	21.74	21.90	21.90	21.71	21.90	21.51	21.61	21.20	21.10	21.84	21.77	21.90	21.13	21.40
Wear [3]	-0.20	-0.05	-0.02	-0.02	-0.01	-0.07	-0.07	-0.08	0.01	-0.03	-0.01	0.00	-0.02	-0.05	-0.02	0.00	0.02
RPM [4]	22.19	22.50	22.66	22.80	22.50	22.20	22.83	22.48	22.68	22.85	22.43	22.37	22.90	22.90	22.18	22.34	22.67
Wear [4]	-0.20	-0.05	-0.03	-0.03	-0.02	-0.07	-0.05	-0.08	0.01	-0.01	-0.06	0.03	-0.03	-0.04	-0.01	0.01	0.01
RPM [5]	23.69	23.74	23.95	23.30	23.19	23.42	23.50	23.70	24.00	24.00	23.68	23.58	23.26	23.10	23.53	23.54	23.78
Wear [5]	-0.21	-0.06	-0.05	-0.01	-0.02	-0.06	-0.06	-0.07	-0.01	-0.01	-0.05	0.01	-0.02	-0.04	0.01	0.02	0.01
RPM [6]	24.70	24.80	25.00	24.43	24.50	24.57	24.27	24.51	25.00	24.20	25.00	24.50	24.30	24.20	24.65	24.63	24.96
Wear [6]	-0.20	-0.05	-0.05	-0.03	-0.01	-0.06	-0.04	-0.08	-0.01	-0.04	-0.04	0.01	-0.01	-0.04	-0.01	0.01	0.02
RPM [7]	25.90	25.50	25.30	25.95	25.64	25.70	25.50	25.50	25.10	25.64	25.50	25.53	25.38	25.40	25.86	26.00	25.50
Wear [7]	-0.22	-0.09	-0.02	-0.02	-0.03	-0.06	-0.06	-0.09	-0.01	-0.03	-0.04	-0.01	-0.02	0.00	-0.02	0.01	0.01
RPM [8]	26.10	26.30	26.23	26.50	26.80	26.20	26.50	26.49	26.69	27.00	26.56	26.75	26.44	27.00	26.90	26.10	26.37
Wear [8]	-0.20	-0.07	-0.04	-0.03	-0.02	-0.07	-0.08	-0.09	0.04	-0.02	-0.04	-0.04	-0.02	-0.01	-0.02	0.01	0.01
RPM [9]	27.27	27.34	27.50	27.45	28.00	27.25	27.58	27.64	27.47	27.20	27.50	27.40	27.74	27.50	27.10	27.20	27.63
Wear [9]	-0.20	-0.07	-0.02	-0.04	0.00	-0.07	-0.07	-0.08	0.03	-0.01	-0.04	-0.03	-0.01	-0.03	-0.04	0.00	0.00

Open File... Save File... Download... Upload... Points 100

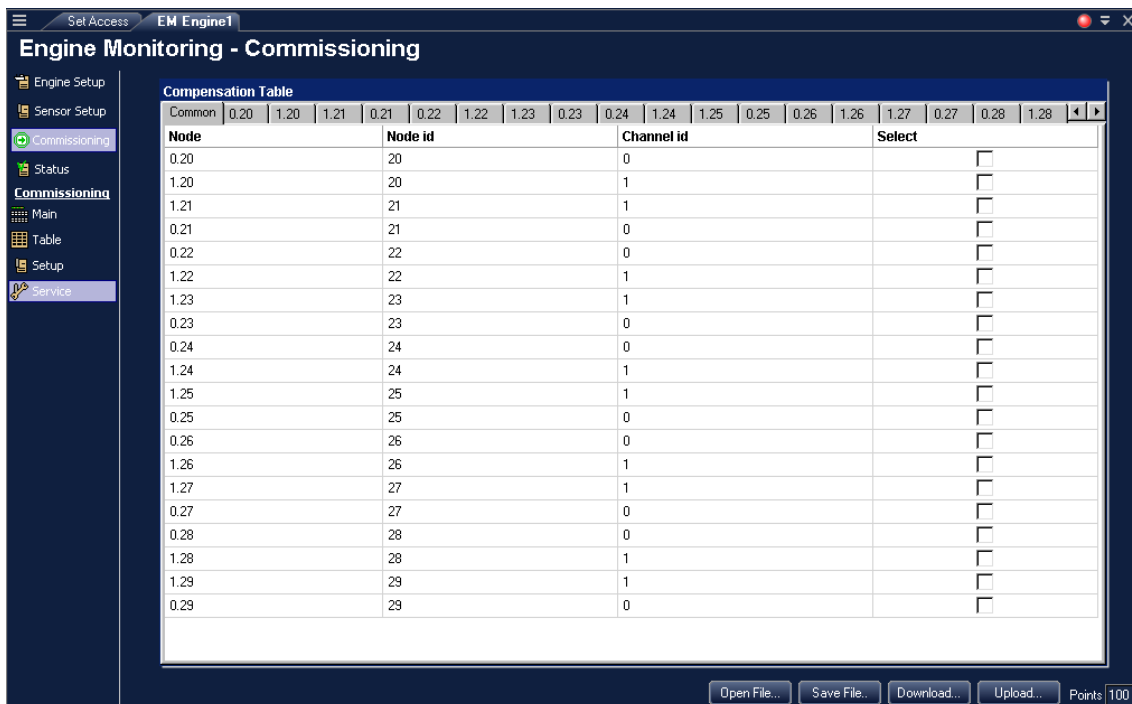
Controlled pitch propeller (CPP)

Engine Monitoring - Commissioning

Compensation Table

Common	0.20	1.20	1.21	0.21	0.22	1.22	1.23	0.23	0.24	1.24	1.25	0.25	0.26	1.26	1.27	0.27	0.28	1.28
Table	Min																	
RPM [0]	0.00																	
Load [0]	5.46																	
Wear [0]	-0.01																	
RPM [1]	20.88																	
Load [1]	5.46																	
Wear [1]	-0.01																	
RPM [2]	24.13																	
Load [2]	5.32																	
Wear [2]	-0.01																	
RPM [3]	27.75																	
Load [3]	5.30																	
Wear [3]	0.01																	
RPM [4]	32.02																	
Load [4]	5.29																	
Wear [4]	-0.02																	
RPM [5]	36.74																	
Load [5]	5.20																	
Wear [5]	0.01																	
RPM [6]	40.96																	
Load [6]	5.20																	
Wear [6]	0.02																	
RPM [7]	44.61																	
Load [7]	5.20																	

Open File... Save File... Download... Upload... Points 100



How to open saved compensation file

- 1 Click
- 2 Select file
- 3 Click

How to save data in table

- 1 Click
- 2 Write file name
- 3 Click

How to down-load compensation data to sensor

- 1 Open compensation file
- 2 Select the sensors by checking the **Select box** on top of column for FPP and on common page for CPP
- 3 Click

Note

Only data for the selected sensor will be downloaded; check Cis to see when the system is finished with downloading data.

How to up-load data from sensors

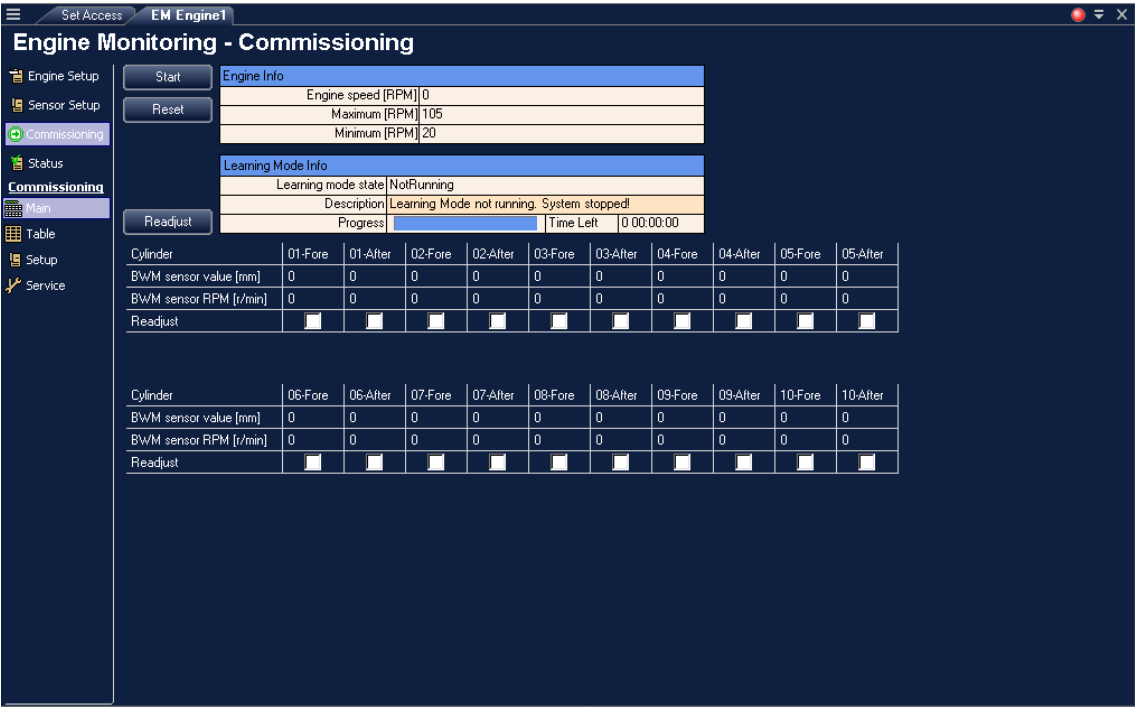
- 1 Write in number of points to up-load in

- 2 Click  to start up-load to table

Note

Data from all connected sensors will be up-loaded

3.7.7.2 Readjust



The readjust function is used to adjust and download engine speed compensation data to the replaced sensors and to sensors that have been removed and reinstalled after a bearing inspection. This is divided into two procedures **Short readjust** and **Long readjust**; the system selects automatically which type to run.

Note

This procedure can only be used after the commissioning are finished , see the Commissioning Manual for procedure when doing Main Bearing inspection after Sea trial

Readjust: Check the box on the cylinder position for the sensor that shall be readjusted

-  Starts the readjust procedure
-  Stops and resets the readjust procedure
-  Opens readjust table

Short

Used when a sensor has been reinstalled after a bearing inspection or if the sensor is changed without the engine running with sensor failure.

The procedure will run for 50 hours.

Note _____

Set the BW Sensor value in offscan with value 0 to avoid alarms during this period

Long

Used when a sensor has been replaced and the engine running during the time of sensor failure

The procedure will run for 500.

Note _____

Set the BW Sensor value in offscan with value 0 to avoid alarms under this period

Reinstalled sensor

- 1 Check **Readjust** for sensor to be adjusted
- 2 Click **Start**

Sensor replacement

- 1 Setup sensor in **Sensor setup** → **BWM**
 - a Select **Product code** → **PSS11** in **Filter settings**
 - b Click 
 - c Drag the sensors with the regard to serial number from **Unconnected Sensors** to the cylinder and position where it's installed
 - d Click **Save**
- 2 Check **Readjust** for sensor to be adjusted
- 3 Click **Start**

Readjust Table

Readjust Table										
Set Access EM Engine1										
Ch.	Sensor	Readjust	Cylinder	Type	Time	Before	After	During	Offset	
0	20	False	1	None	00:00:00	0	0	0	0	0
1	20	False								0
1	21	False	2	None	00:00:00	0	0	0	0	0
0	21	False								0
0	22	False	3	None	00:00:00	0	0	0	0	0
1	22	False								0
1	23	True	4	Short	00:09:50.5000000	0	0	0	0	0
0	23	False								0
0	24	False	5	None	00:00:00	0	0	0	0	0
1	24	False								0
1	25	False	6	None	00:00:00	0	0	0	0	0
0	25	False								0

Update

Gives an overview of the readjust procedure

Update

 Updates the table with the latest information

Event log

All steps in the readjust is documented in the event log for the BWCM system

Example of Long readjust event:

Engine Monitoring Log

Event Log | BWM Status Log | Report

Event log - History

Log

History

From : 1/ 1/2010

To : 2/24/2010

Filter ☒

KM-CT

- 24.Feb.2010 15:54:38 KM-CT: BW Setup saved from Learning Mode Setup
- 24.Feb.2010 15:54:47 KM-CT: BW Readjust started
- 24.Feb.2010 15:54:47 KM-CT: BW Readjust started for node 0:26.1
- 24.Feb.2010 15:54:47 KM-CT: BW RPM Comp. Download node 0:26.1
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure start: 2/16/2010 11:06:43 AM
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure end: 2/18/2010 11:06:43 AM
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure slope: 4.52777777777778E-05
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure timespan: 48
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure offset: -0.00144666666666667
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time before sensor failure B1 (BasePoint): -0.00362
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time under sensor failure start: 2/18/2010 11:06:43 AM
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time under sensor failure end: 2/20/2010 11:07:11 AM
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time under sensor failure slope: -1.76767676767677E-05
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time under sensor failure timespan: 42
- 24.Feb.2010 15:54:48 KM-CT: BW Readjust node 0:26.1 Time under sensor failure offset: -0.000742424242424241
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust node 0:26.1 Time after sensor failure start: 2/20/2010 11:07:11 AM
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust node 0:26.1 Time after sensor failure end: 2/23/2010 11:07:11 AM
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust node 0:26.1 Time after sensor failure slope: -0.00100699300699301
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust node 0:26.1 Time after sensor failure timespan: 66
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust node 0:26.1 Time after sensor failure offset: -0.0664615384615385
- 24.Feb.2010 15:54:49 KM-CT: BW Readjust nodes 0:26.1 TotalOffset: -0.0686506293706294
- 24.Feb.2010 15:54:50 KM-CT: BW Readjust nodes 0:26.1, Offset Downloaded to sensor: -0.0686506293706294
- 24.Feb.2010 15:54:50 KM-CT: BW Readjust completed for node 0:26.1

3.7.8 BWCM Commissioning

3.7.8.1 Description

The commissioning procedure for BWCM starts with the inspection of a completely installed and connected system and includes a number of steps and operations ending with a system that is ready for learning mode. The final step of the commissioning is to start the learning mode and to instruct the chief engineer how to interact with the system during this period after which the system will be fully operational.

The purpose of the learning mode is to tune the system so that final and lower alarm limits can be taken into use. The two steps of learning mode are:

- 1 3 Point Learning mode:** Compensation data are gathered during 3 x 10 min. periods at 3 different RPM levels. This gives a rough RPM compensation that after which the rough alarm limits are activated.

Note

For best result on the 3 point compensation the vessel has to sail straight ahead (rudder angle of $\pm 5^\circ$) when measuring the 3 points and hold the specified RPM level to the speed is stable, then keep it stable for 10 minutes to log the Bearing Wear value at each step.

- 2 **500 Hour Learning mode:** Compensation data are gathered during 500 hours. This gives a high definition RPM compensation after which the lower alarm limits are activated.

3.7.8.2 Main

K-Chief 05500
Sensor Configuration
 04.02.10 14:55:52

Set Access: EM Engine1

Engine Monitoring - Commissioning

Engine Setup [Start] [Reset] [Force]

Engine Info

Engine speed [RPM]	97
Maximum [RPM]	105
Minimum [RPM]	19

Three Point Comp. Target

Min RPM-50%	36 rpm ±2
50-80%	70 rpm ±2
80-100%	96 rpm ±2

Learning Mode Info

Learning mode state	NotRunning
Description	Learning Mode not running. System stopped!
Progress	0 00:00:00
Time Left	0 00:00:00

Three point Comp.

Min RPM-50%	Not Logged
50-80%	Not Logged
80-100%	Not Logged

Cylinder	01-Fore	01-After	02-Fore	02-After	03-Fore	03-After	04-Fore	04-After	05-Fore	05-After
B/W sensor value [mm]	-0.196	-0.105	-0.024	-0.024	-0.019	-0.087	-0.02	-0.043	0.03	-0.079
B/W sensor RPM [r/min]	97	100	99.7	98	97.8	99.7	99	98.1	94.5	99.7
In learning mode	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒

Cylinder	06-Fore	06-After	07-Fore	07-After	08-Fore	08-After	09-Fore	09-After	10-Fore	10-After
B/W sensor value [mm]	0.006	0.025	0.009	-0.02	0.022	0.01	0.019	0.048	0.005	-0.02
B/W sensor RPM [r/min]	98.7	98.7	98	69.2	99.7	99.3	98.9	99.1	99.1	98.7
In learning mode	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒

Engine info

Engine speed (RPM): Engine speed measured by BW sensors

Maximum (RPM): Maximum engine speed

Minimum (RPM): Minimum engine speed

Learning Mode Info

Learning mode state: Description of state

Description: Description of procedure

Progress: Time remaining in bar graph for active procedure

Time left: Time remaining for active procedure

Table

Cylinder: Position of sensor

BWM sensor value: Uncompensated sensor value

BWM sensor RPM: RPM value measured by sensor

In Learning mode: Check sensor to be in the learning mode procedure

BWM Load: Engine load value shown when **Load** is selected in **System setup** → **Bearing Wear Monitoring**

Cylinder	01-Fore	01-After	02-Fore	02-After
BWM sensor value [mm]	-0.205	-0.04	-0.068	-0.025
BWM sensor RPM [r/min]	20.9	21.3	20.6	20.2
BWM Load [%]	18	18	18	18
In learning mode	☒	☒	☒	☒

Three Point Comp. Target Shows engine speed target

- Orange colour is the active area

Three Point Comp. Target	
Min RPM-50%	80 rpm ±2
50-80%	86 rpm ±2
80-100%	90 rpm ±2

Three Point Comp. Show status of compensation point

- **Not** This point is remaining
- **OK** Point in this engine speed area is finished
- Orange colour is the active area

Three point Comp.	
Min RPM-50%	Not
50-80%	Not
80-100%	Not

Start Starts the commissioning procedure

Pause The **Start** button turns to **Pause** button after the commissioning procedure has started and can set the **3 Point Learning** or **500 Hour Learning** in pause.

Reset Resets the commissioning

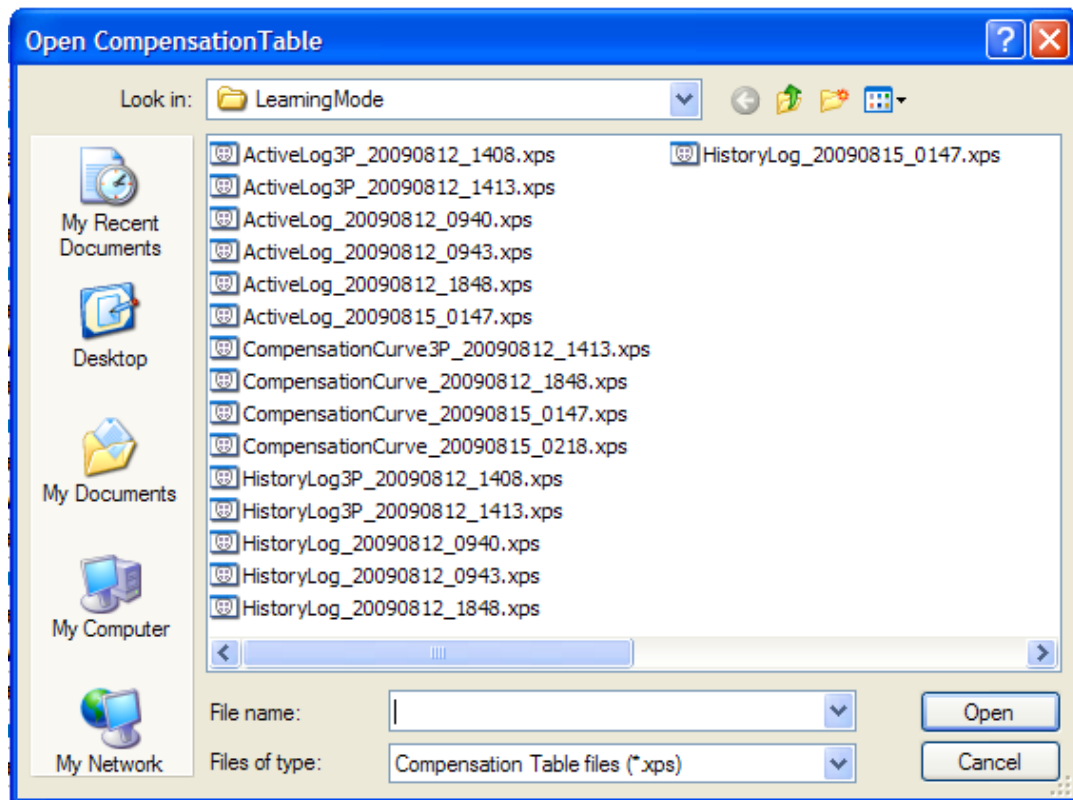
Force Used to initiate one of the 3 points learning point if it's difficult to reach the target RPM

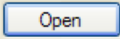
Commissioning procedure

- 1 Do System setup
- 2 Do Sensor setup
- 3 Go to **Commissioning** → **Main** click **Start**
- 4 Hold the engine on the 3 engine speed levels selected for the **3 Point Learning**
- 5 **500 Hour Learning** will start automatically when 3rd point of **3 Point Learning** is finished.

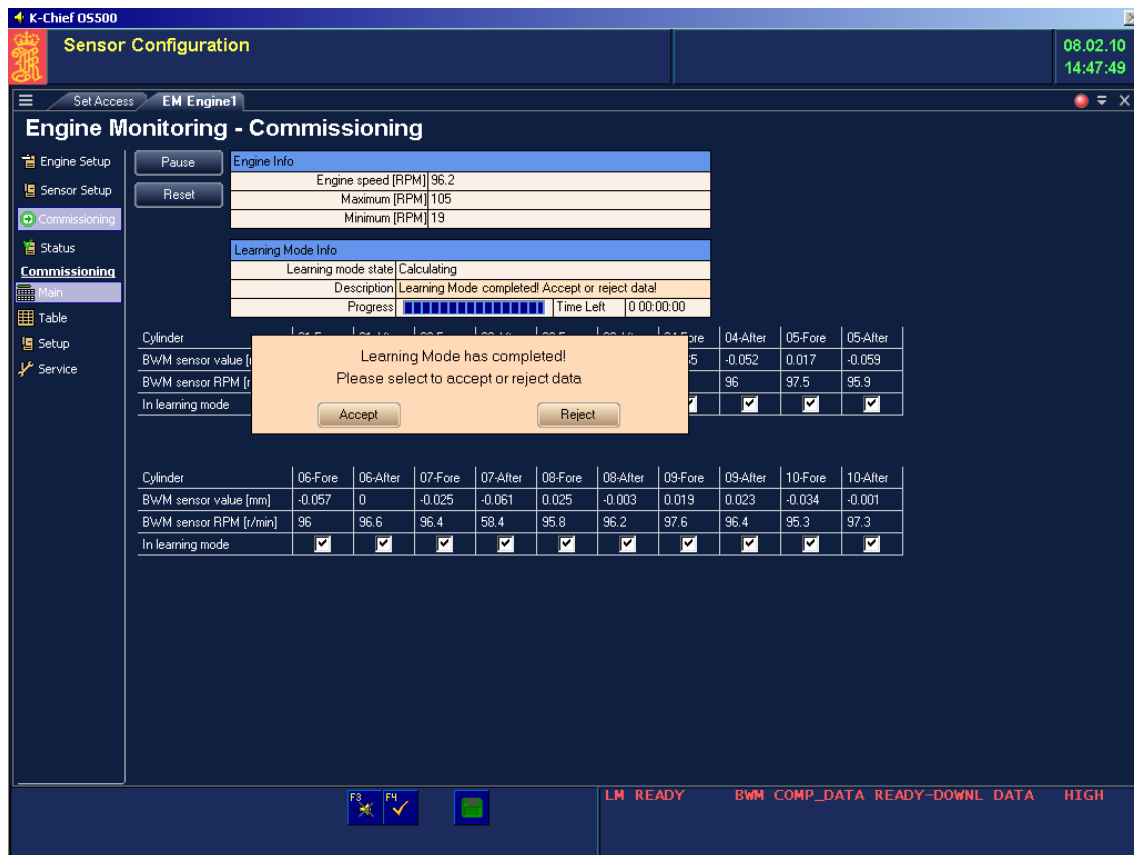
Restart a Reset commissioning

- 1 Go to **Commissioning** → **Table**
- 2 Click 
- 3 Select active log file to be restarted



- 4 Click 
- 5 Go to **Commissioning** → **Main**
- 6 Click 

BWCM Learning Mode Completed



LM-Ready TAG will give alarm when **500 Hour Learning** is finished and the compensation is ready to be downloaded.

- **Accept** Starts the download of compensation values to the sensors
- **Reject** Cancels the download of compensation values to the sensors

How to start download

- 1 Go to **Config Displays** → **Sensor Configuration** → **Commissioning** → **Main**
- 2 Click **Accept** in popup to start download to the sensors

Note

Compensation data are saved to disk automatically when the learning mode is finished. If compensation data needs to be reloaded use **Commissioning** → **Service** to open this file and reload sensor with engine speed compensation data

Variable load

Engine Monitoring - Commissioning

Compensation Table

Load groups	-1%-1%	1%-5%	5%-10%	10%-15%	15%-20%	20%-25%	25%-30%	30%-35%	35%-40%	40%-45%	45%-50%	50%-55%
RPM [0]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Load [15]	0.00	0.00	6.41	11.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wear [15]	0.00	0.00	-0.02	-0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Count [15]	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total time [15]	00:00:00	00:00:00	00:00:15	00:00:04	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00
RPM [16]	0.00	0.00	82.22	81.10	0.00	82.24	0.00	0.00	84.20	0.00	84.20	0.00
Load [16]	0.00	0.00	6.40	11.20	0.00	23.02	0.00	0.00	39.20	0.00	48.30	0.00
Wear [16]	0.00	0.00	-0.01	-0.04	0.00	-0.01	0.00	0.00	-0.02	0.00	-0.02	0.00
Count [16]	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00
Total time [16]	00:00:00	00:00:00	00:00:00	00:00:02	00:00:00	00:00:12	00:00:00	00:00:00	00:00:01	00:00:00	00:00:04	00:00:00
RPM [17]	0.00	0.00	86.36	0.00	87.90	0.00	87.90	0.00	86.80	0.00	85.50	85.50
Load [17]	0.00	0.00	6.40	0.00	17.20	0.00	28.60	0.00	0.00	41.30	48.10	51.00
Wear [17]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.03
Count [17]	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00
Total time [17]	00:00:00	00:00:00	00:00:00	00:00:00	00:00:01	00:00:00	00:00:01	00:00:00	00:00:00	00:00:06	00:00:01	00:00:04
RPM [18]	0.00	0.00	90.50	0.00	88.50	0.00	0.00	89.80	0.00	89.94	0.00	0.00
Load [18]	0.00	0.00	6.40	0.00	16.58	0.00	0.00	33.50	0.00	42.50	0.00	0.00
Wear [18]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Count [18]	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00
Total time [18]	00:00:00	00:00:00	00:00:00	00:00:00	00:00:08	00:00:00	00:00:00	00:00:03	00:00:00	00:00:09	00:00:00	00:00:00
RPM [19]	0.00	0.00	94.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Data are divided on TAB's for each sensor; load is divided up in to sub ranges where as 3 levels (minimum value, value that has most counts between minimum and maximum value and maximum value) will be selected for the final compensation table.

The points that are selected for the 3 levels are colour indicated and the indication is from the time **Load Table** button table has been pushed.

Blue: Minimum value

Green: Value that has most counts between minimum and maximum value

Red: Maximum value

[17]: Element number

RPM: Engine speed for the compensation point

Wear: Compensation value in [mm]

Count: Number of measurements that are averaged in RPM and Wear

Total time: Logging time for values

Load: Engine load

Note _____

Compensation values in points with zero count are calculated from the nearest points with count

Updating data in table during commissioning

1 Click 

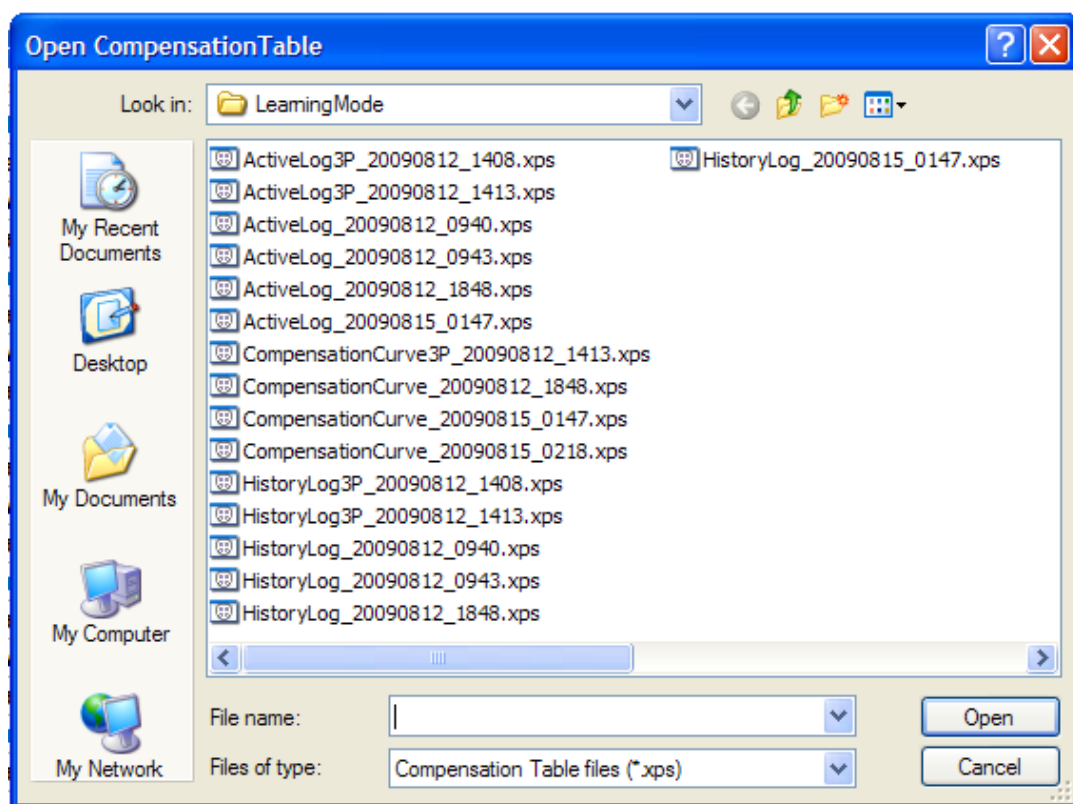
- 2 Table will reload with latest data from active log

Loading data from a saved file.

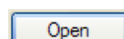
Note

Used when restarting a 500 Hour Learning after a Reset

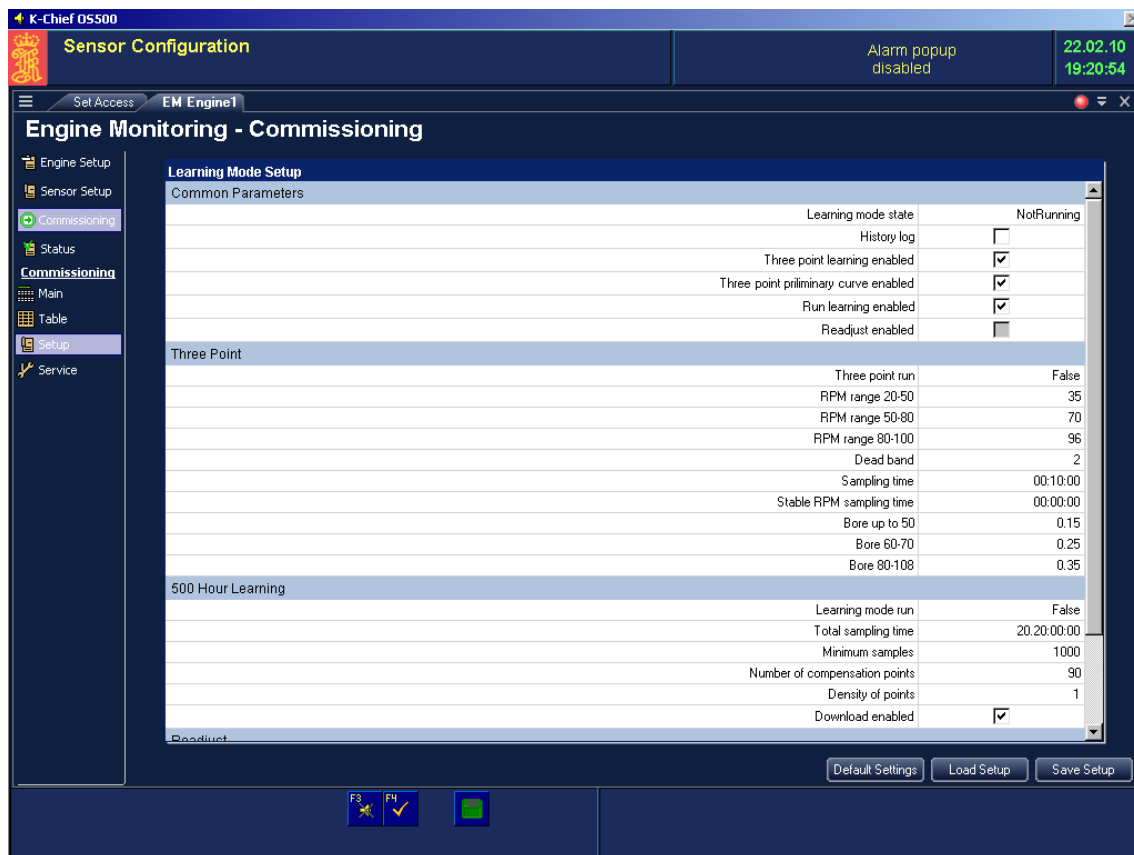
- 1 Click 
- 2 Select active log file
ActiveLog_date_time.xps



- 3 Click



3.7.8.4 Setup



Common Parameters

History log: Check to enable, logs all vales for compensation points to file

Three point learning enabled: Check to enable, 3 point rough compensation

Three point preliminary curve enabled: Check to enable, 3 point rough compensation curve made from first compensation point measured a preset slope

Run learning enabled: Check to enable, 500 hour compensation

Readjust enabled: Check to enable, to activate readjust function

Three Point

Three point run:

- →False Procedure has not been run
- →True Procedure has been run

RPM range 20–50%: RPM level for this RPM range

RPM range 50–80%: RPM level for this RPM range

RPM range 80–100%: RPM level for this RPM range

Dead band: Set tolerance for the RPM level

Sampling time: Sampling time for each RPM level

Bore up to 50: Slope for preliminary 3 point curve at this bore size

Bore 60–70: Slope for preliminary 3 point curve at this bore size

Bore 80–108: Slope for preliminary 3 point curve at this bore size

500 Hour Learning

Learning mode run:

- →**False** Procedure has not been run
- →**True** Procedure has been run

Total sampling time: Sampling time for total period, d.tt:mm:ss

Minimum samples: Minimum numbers of samples before compensation point is set to part 2/2

Number of compensation points: Number of points in compensation curve

Note _____

*Density of points is master. Set to blank if **Number of compensation points** are to be used instead.*

Density of points: Density of points in compensation curve

Download enabled: Check to enable, download of **500 Hour Learning** engine speed compensation data

Readjust

Set zero delay: Time before zero point is set for **Short readjust**

Readjust time: Sampling time for **Short readjust**

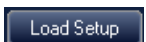
Time before sensor failure: Data collection time before sensor break for **Long readjust**

Time after sensor failure: Sampling time after sensor break for **Long readjust**

Buttons

 Default Settings

Sets the default parameters

 Load Setup

 Save Setup

Load Setup and **Save Setup** has same function as in **Engine Setup**.

4 MAINTENANCE

4.1 Sensor Communication error

If the Operator Station gives a communication error for one of the sensor applications, the unit in question must be checked.

	Check	Corrective actions
Alarm on all units on segment	Power	
	Fuse	Check cables and connections before fuse is turned on
	Cables	Replace cable
	Terminations	There shall be 120 ohm resistor at each end of main line
Alarm on specific unit	Cable connected to unit	Replace cable
	Cable OK	Replace unit

Note _____

Before replacing units try to repower unit to restart it.

4.2 Sensor Failure codes

Each sensor has a failure tag, and failure will be displayed as a value. This value is a code depending of type of fails sensor is reporting.

The following table describes the failure codes:

Value	Tag Details - failure description	Criteria	Unit	Action
0	Normal			
101	Channel 1 Sensor Break		GN-14	Check sensor connected to X1

Value	Tag Details - failure description	Criteria	Unit	Action
102	Channel 1 Sensor P Overload	Value over upper limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X1 if OK replace converter
103	Channel 1 Sensor N Overload	Value below lower limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X1 if OK replace converter
201	Channel 2 Sensor Break		GN-14	Check sensor connected to X2
202	Channel 2 Sensor P Overload	Value over upper limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X2 if OK replace converter
203	Channel 2 Sensor N Overload	Value below lower limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X2 if OK replace converter
301	Channel 3 Sensor Break		GN-14	Check sensor connected to X3
302	Channel 3 Sensor P Overload	Value over upper limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X3 if OK replace converter
303	Channel 3 Sensor N Overload	Value below lower limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X3 if OK replace converter
401	Channel4 Sensor Break		GN-14	check sensor connected to X4
402	Channel 4 Sensor P Overload	Value over upper limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X4 if OK replace converter
403	Channel 4 Sensor N Overload	Value below lower limit	BW Sensor	Replace sensor
			GN-14	Check sensor connected to X4 if OK replace converter
501	Device Sensor Break		GN-14	
502	Device Sensor P Overload	102. 202. 302 or 402 code activated		
503	Device Sensor N Overload	103. 203. 303 or 403 code activated		

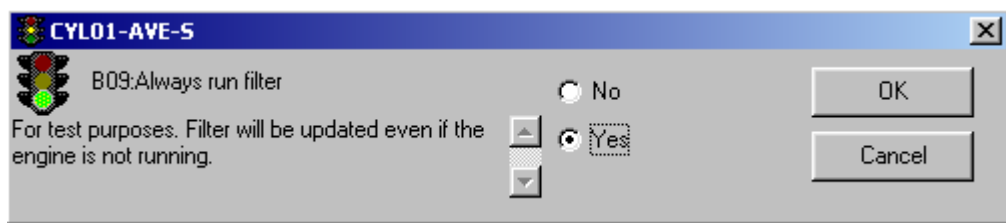
507	Checksum Error in NVRAM			
508	Checksum Error in PROGRAM		All	Reload application SW

4.3 Alarm function test

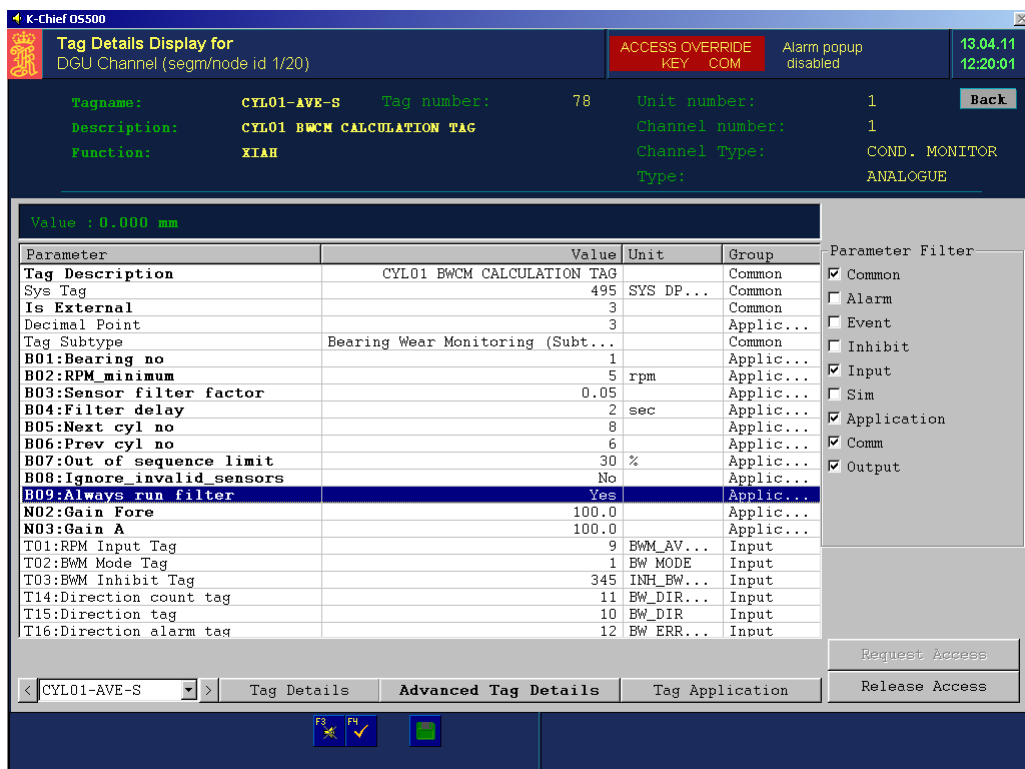
BWCM

Set system in alarm function test mode

- 1 Press **Home** button and click **Bearing Wear TAG** group in the **Navigator**
- 2 Double click on the **CYL01-AVE-S** TAG
- 3 Click **Advanced TAG Details** and adjust **B9:Always run filter** parameter
 - a Double click on **B9:Always run filter** and select **Yes**



- b Click **OK**



- 4 Click **Back** to **Bearing Wear TAG** group and double click on **CYL01_BWC-1**

- 5 Click on **Tag Details** → **Offscan Enable** → **Offscan Value** set value to 0.45 and click **OK**

Parameter	Value	Unit	Group
Auto log	Off		
Noon log	Off		
Event log	Off		
Alarm Relay HL	0		
Alarm Relay HLL	0		
Alarm On-delay 1	10	sec	
Alarm Off-delay 1			
Alarm On-delay 2			
Alarm Off-delay 2			
Tag Subtype			
Counts High			
Counts Low			
Raw data			
Alarm Limit Lo-Lo		mm	
Alarm Limit Lo		mm	

- 6 Go to Slow Wear mimic
- Press **Home** button and click → **Bearing Wear or Engine Monitoring** → **Slow Wear Monitoring**
 - Wait for value on cylinder 1 to increase and release **High alarm** that will be Horn and Ligth
- 7 Repeat step 4 and 5, set **Offscan Value** to 0.55
- 8 Go to Slow Wear mimic and wait for value on cylinder 1 to increase and release **High High alarm** that will be Horn, Ligth and Slow Down

Reset system

- Press **Home** button and click → **List Views** → **Offscan Tags**
 - Double click on **CYL01_BWC-1**
 - Click on **Tag Details** → **Offscan Disable**
- Press **Home** button and click **Bearing Wear** TAG group, double click on the **CYL01-AVE-S** TAG and select **Advanced TAG Details** and adjust **B9:Always run filter** parameter
 - Double click on **B9:Always run filter** and select **No**

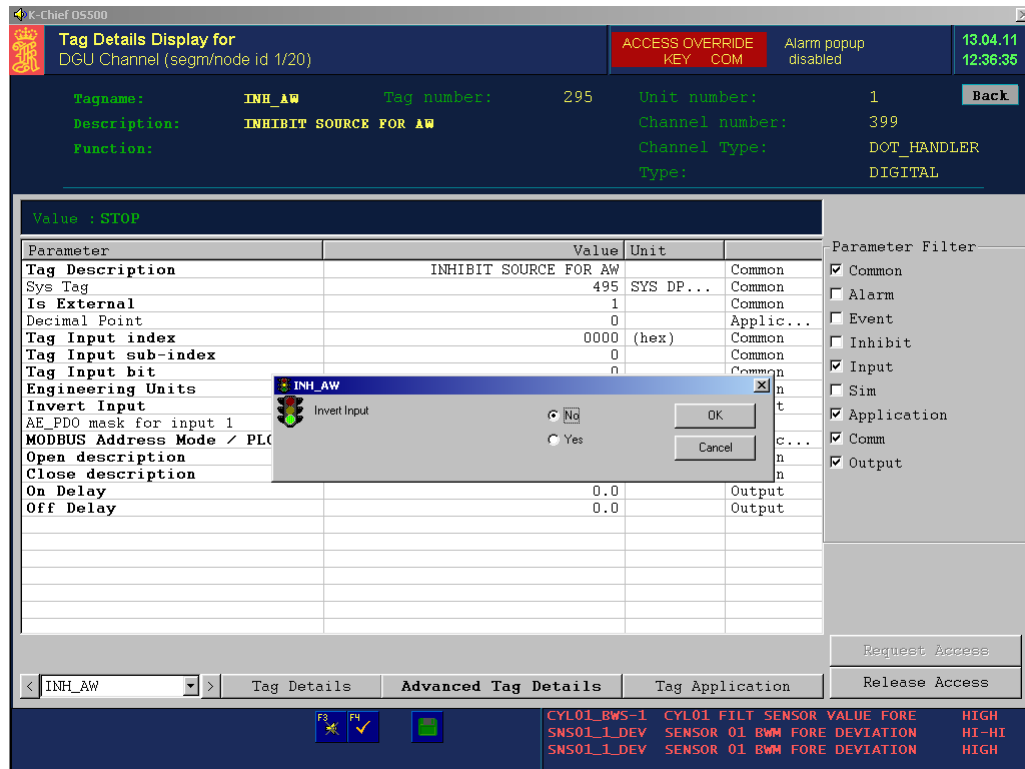
- Click **OK**

WIOM

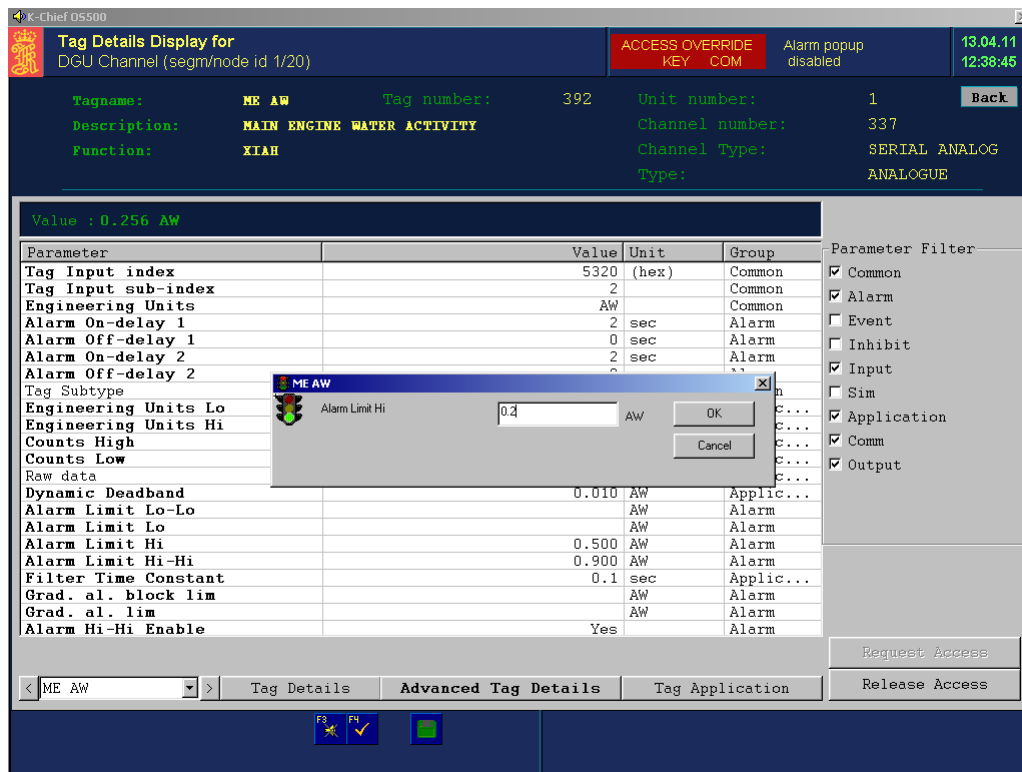
Alarm function test

- Press **Home** button and click **Inhibit Points** TAG group in the **Navigator**

- 2 Double click on the INH_AW TAG
- 3 Click **Advanced TAG Details** and adjust **Invert Input** parameter
 - a Double click **Invert Input**
 - b Select **Yes** and click **OK**



- 4 Press **Home** button and click **Bearing Wear TAG** group in the **Navigator**
- 5 Double click on the **ME AW** TAG
- 6 Click **Advanced TAG Details** and adjust **Alarm Limit Hi** parameter
 - a Double click on **Alarm Limit Hi**
 - b Set limit to below **aw** value and click **OK**



- 7 Go to **Engine Monitoring** mimic
 - a Press **Home** button and click → **Bearing Wear or Engine Monitoring** mimic group → **Engine Monitoring** mimic
 - b Wait for **WIO aw** value to increase and release **Hi alarm** that will be Horn and Lighth
- 8 Repeat step 4 — 6 and set **Alarm Limit Hi — Hi** to a value between **Alarm Limit Hi** and **aw** value
- 9 Go to **Engine Monitoring** mimic
 - a Press **Home** button and click → **Bearing Wear or Engine Monitoring** mimic group → **Engine Monitoring** mimic
 - b Wait for **WIO aw** value to increase and release **Hi — Hi alarm** that will be Horn and Lighth

Reset system

- 1 Press **Home** button and click **Inhibit Points** TAG group in the **Navigator**
- 2 Double click on the **INH_AW** TAG
- 3 Click **Advanced TAG Details** and adjust **Invert Input** parameter
 - a Double click **Invert Input**
 - b Select **No** and click **OK**
- 4 Press **Home** button and click **Bearing Wear** TAG group in the **Navigator**
- 5 Double click on the **ME AW** TAG
- 6 Click **Advanced TAG Details** and adjust **Alarm Limit Hi** parameter

- a** Double click on **Alarm Limit Hi**
- b** Set limit to 0.5 value and click **OK**
- c** Double click on **Alarm Limit Hi — Hi**
- d** Set limit to 0.9 value and click **OK**

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KONGSBERG

MMT330 Water in Oil Sensor

Alarm settings

Before the sensor is in operation the system has to be updated to include the new sensor. See manual for automation system.

Recommended settings are as follows:

Temperature: 4 to 20 mA equals 0 to 100 °C

Alarm limit: User specified

Water Activity a_w 4 to 20 mA equals 0 to 1.00 a_w

High alarm: 0.5 a_w

High-high alarm: 0.9 a_w

1 CALIBRATION, MAINTENANCE AND TEST

This chapter provides information needed in basic maintenance of the product.

1.1 Calibration

Normally the sensor shall not be calibrated or adjusted.

1.2 Periodic maintenance

Under normal use the sensor itself do not need maintenance. To secure stable operation over time, it is recommended to reinstall the sensor and check/clean the probe filter once a year.

1.2.1 Cleaning

Clean the sensor enclosure by use of a soft, lint-free cloth moistened with mild detergent.

Clean the sensor before storing the MMT330 probe and before calibration. For cleaning the probe you need instrument air and heptane (C_7H_{16}) liquid. Use instrument air for drying to prevent oxidation of the oil on the sensor. The oxidation of the oil on the sensor can cause extended response time or drifting.

- 1 Blow the probe with instrument air (with filter attached) to remove any remains of the oil.
- 2 Immerse the probe into heptane liquid and rinse out the oil (for 1 minute maximum).
- 3 Dry the probe by use of instrument air. In case you are going to calibrate the probe, remove the filter and dry the sensor with instrument air. Check that the sensor is clean.

1.3 Replacing / removing a sensor tip

1.3.1 Procedure

- 1 If a ball valve is installed, shutting down the process is only required if the process pressure is higher than 10 bars. If the pressure is lower there is no need to shut down the process.
- 2 If a ball valve is not installed, shut down the process.

- 3 Measure the length of the probe from top of probe to the top of the clasp nut (*Figure 10*).
- 4 Loosen the torque between the fitting screw and the clasp nut.
- 5 Pull the probe out until it reach the sliding limit.
- 6 For ball valve, close the ball valve.
- 7 Remove/replace/reinstall the sensor.
- 8 Slide the clasp nut of the probe toward the filter, as far as possible.
- 9 Insert the probe and tighten the clasp nut to the fitting body by hand.
- 10 For ball valve installation, open the ball valve.
- 11 For installation without ball valve, the process may be started again.
- 12 Push the probe through the ball valve assembly into the process. The depth should be according to measurement made in *Point 3* of this procedure.
- 13 Mark the fitting screw and the clasp nut.
- 14 Tighten the clasp nut with a fork spanner further 50 to 60 ° (ca. 1/6 turn). If you have a suitable torque spanner, tighten the nut to maximum 45 ±5 Nm. See *Chapter 2.8, Figure 10*.

1.4 Replacing the probe filter

- 1 Remove the filter from the probe.
- 2 Install a new filter on the probe. When using the stainless steel filter (for oil and fuel cell), take care to tighten the filter properly (recommended force 130 Nm).

New filters may be ordered from KONGSBERG.

1.5 Test

1.5.1 Test of sensor alarm

To verify that the sensor is able to give alarm if the the procedure is as follows:

1. Connect the sensor is to the system via the 4-20 mA outputs. Set the alarm limit in the system. (aw = 0.5)
2. Disconnect the sensor tip from the oil tube.
3. Put the sensor tip into a can of clean water.
4. Wait until alarm is given on the system (may take up to 3 minutes)
5. Put the sensor tip back in place.

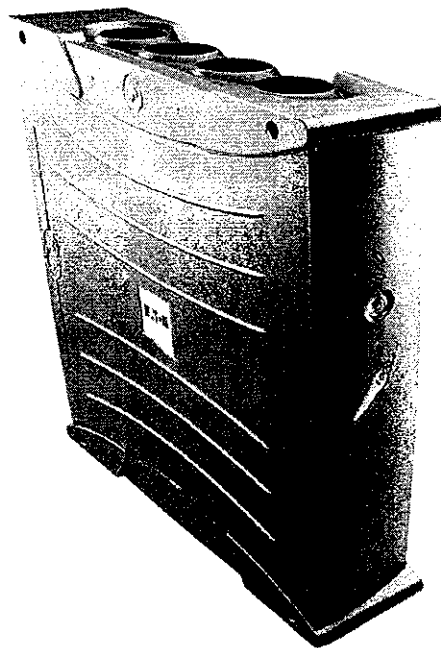
Note! After the sensor tip has been exposed to water, it may take several minutes before the sensor output signal is back to normal reading, up to 5 minutes in oil, 30 minutes or more if the sensor is left in free air.

1.5.2 Test of system alarm

To verify that the system is giving alarm on a certain input signal, the following procedyre has to be followed:

1. Check the alarm limits set on WIO in the system.
Standard: **H alarm = aw 0,50, HH alarm = aw 0,9**
2. Disconnect the sensor from the input board of the system.
3. Connect an active 4-20 mA test generator to the input (for Kongsberg RAI 16 + to terminal 0x2 and, – to 0x4).
4. **To test H alarm set the generator to 13mA (for aw = 0,5 H alarm = 12 mA)**
5. **To test HH alarm set the generator to 19mA (for aw = 0.9 HH alarm = 18.4 mA)**
6. Disconnect the test generator.
7. Reconnect the water in oil sensor.
8. Verify that the sensor reading is back to a normal value.

www.eaton.com



Pulsar Series

Ellipse
375/600/750/
1000/1500/XL

Installation and user manual

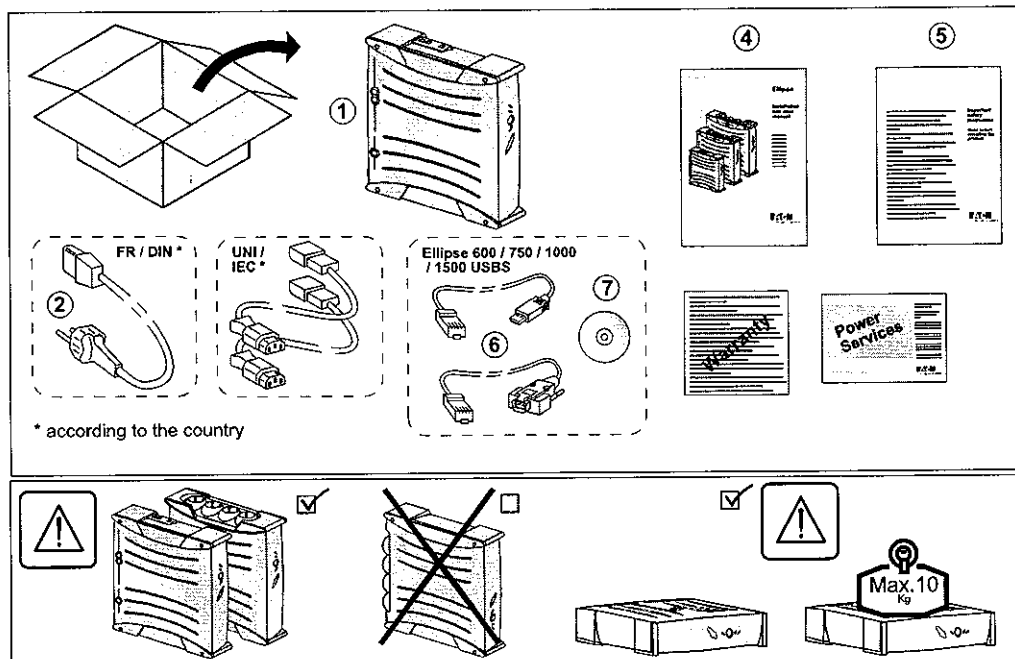
English - Français
Deutsch - Italiano
Español - Nederlands
Português - Ελληνικά
Polski - Český
Slovenčina - Slovensko
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Caution!

► Before installing the **Ellipse**, read the booklet (4) containing the safety instructions to be respected. Then follow the instructions given in this manual (5).

► Avant l'installation de **Ellipse**, lire le livret (4) qui présente les consignes de sécurité à respecter. Suivre ensuite les instructions du présent manuel (5).

► Vor Installation des **Ellipse** die im Heft (4) genannten Sicherheitsvorschriften lesen. Anschließend die Anweisungen im vorliegenden Handbuch (5) befolgen.

► Prima dell'installazione del **Ellipse**, leggere attentamente le istruzioni di sicurezza riportate sul libretto (4). In seguito, attenersi alle istruzioni riportate sul presente manuale (5).

► Antes de la instalación del **Ellipse**, lea el manual (4) que presenta las instrucciones de seguridad a cumplir. A continuación, siga las instrucciones del este manual (5).

► Lees voordat u het **Ellipse** gaat installeren eerst de veiligheidsinstructies in boekje (4). Volg daarna de instructies van deze handleiding (5).

► Antes da instalação do **Ellipse**, ler o caderno (4) onde constam as instruções de segurança a respeitar. Depois, seguir as instruções do presente manual (5).

► Πριν την εγκατάσταση του **Ellipse**, διαβάστε το φυλλάδιο (4) με τις συμβουλές ασφαλείας που πρέπει να τηρείτε. Στη συνέχεια, ακολουθήστε τις οδηγίες χρήσης αυτού του φυλλαδίου (5).

► Przed zainstalowaniem **Ellipse**, należy przeczytać instrukcję (4), która zawiera niezbędne zalecenia bezpieczeństwa. Następnie należy zapoznać się z zaleceniami zawartymi w niniejszej instrukcji (5).

► Před instalací zdroje **Ellipse** si prostudujte příručku (4), kde najdete bezpečnostní předpisy, které je třeba dodržovat. Dále postupujte podle pokynů uvedených v příručce (5).

► Pred inštaláciou výpusky si prečítajte knižku (4), v ktorej sú uvedené bezpečnostné príkazy, ktoré je potrebné dodržať. Potom postupujte podľa pokynov tejto príručky (5).

► Preden instalirate **Ellipse**, preberite knjižico (4), v kateri so varnostna navodila, ki jih je treba upoštevati. Nato sledite navodilom tega priročnika (5).

► Az **Ellipse** telepítése előtt olvassa el a (4)-es könyvet, mely a betartandó biztonsági előírásokat tartalmazza. Ezután kövesse a jelen (5)-ös kézikönyv utasításait.

Ellipse'in tésisatını yapmadan önce, uyulacak güvenlik talimatlarını gösteren (4) sayılı kitapçığı okuyunuz. Daha sonra işbu (5) sayılı el kitabındaki talimatlara uyunuz.

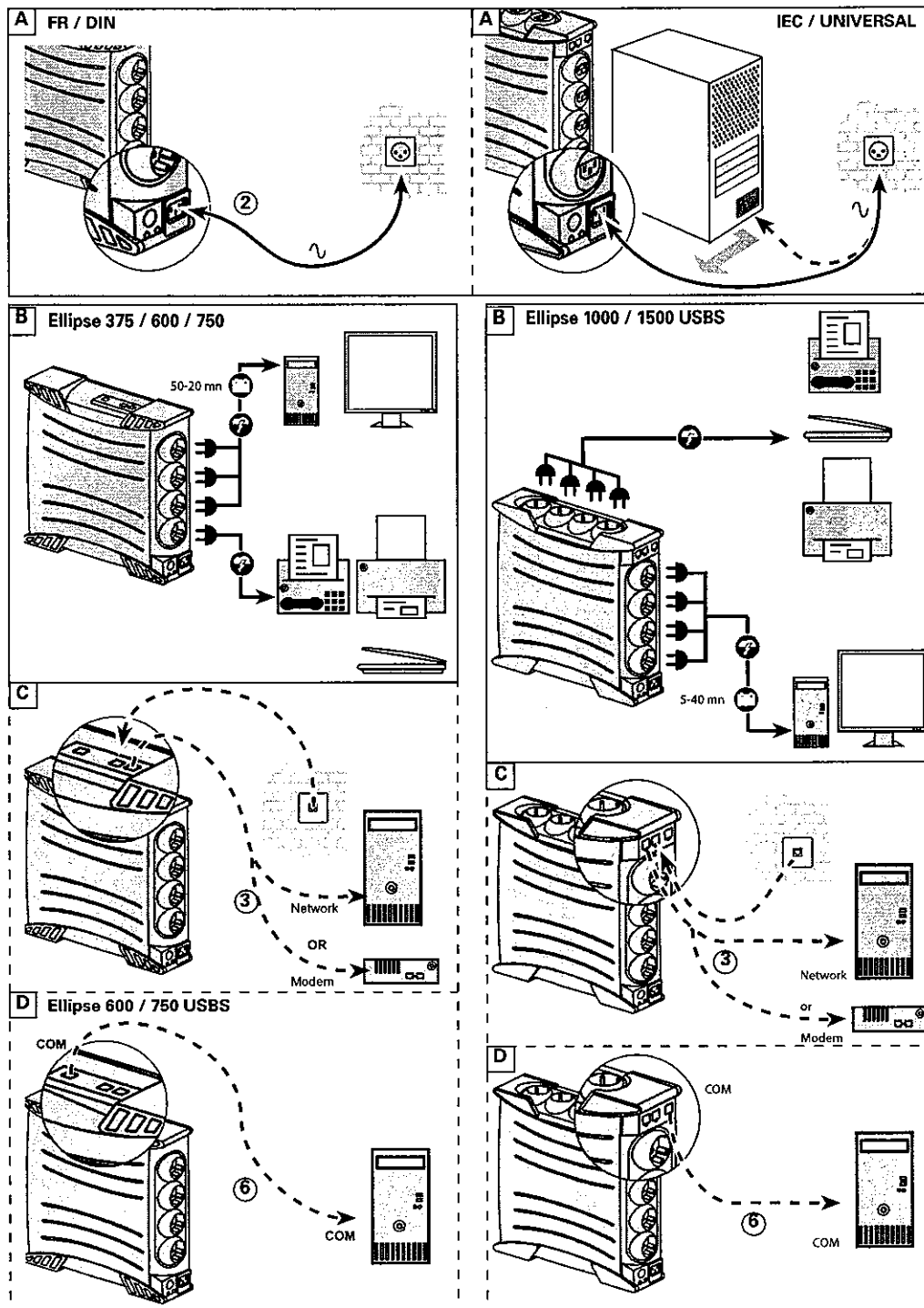
► Перед установкой **Источника Бесперебойного Питания (АВР)** прочитайте инструкцию (4) с правилами по технике безопасности, которые необходимо соблюдать. Затем следуйте указаниям настоящего руководства (5).

安装**Ellipse**之前，请阅读手册(4)，该手册介绍须遵守的安全指令。然后按照本手册(5)的指示操作。

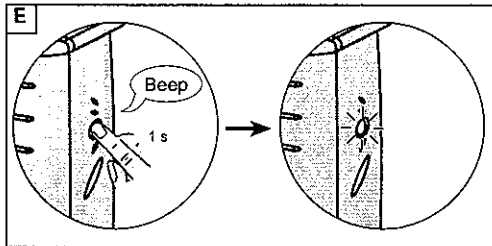
تحذير!

قبل تركيب جهاز **Ellipse** يجب الرجوع للكتاب (4) الذي يشتمل على إرشادات الأمان التي يجب التقيد بها، ثم اتباع التعليمات الموجودة في هذا النليل (5).

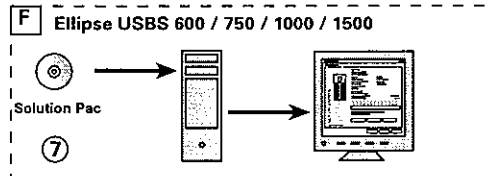
Quick start



Quick start



Product representations not legally binding.



CAUTION

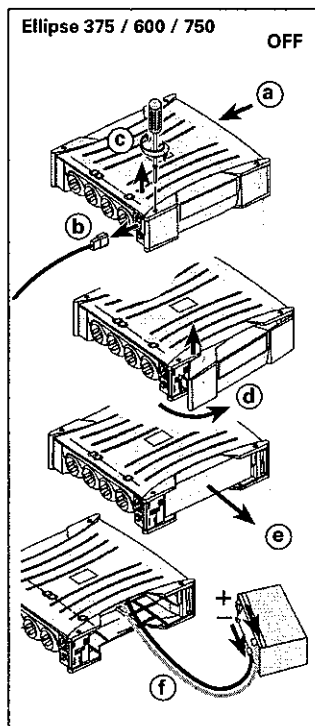


Ellipse ASR UNI

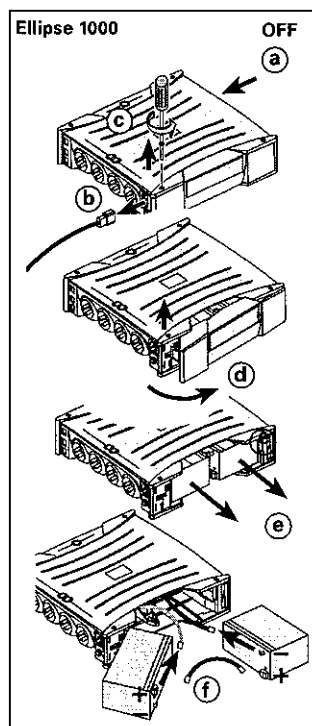
Do not use with French or Schuko plug.

- (FR) Ne pas utiliser avec les prises Françaises ou Schuko.
- (DE) Nicht mit Französischem oder Schuko Stecker betreiben.
- (IT) Non usare con prese Francesi o Schuko.
- (ES) No usar con tomas Francesas o Schuko.
- (PT) Não utilizar com tomadas do tipo Francês ou Schuko.

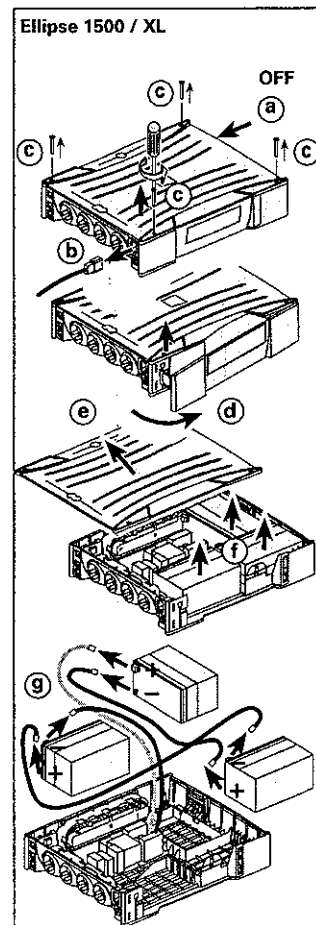
Battery change



Warning: take care not to inverse the polarity + (red) and - (black) when connecting the batteries as this will destroy the device.



Attention : lors du raccordement des batteries, une inversion des polarités + (rouge) et - (noir) provoque la destruction de l'appareil.



3400774700 AG

Technical characteristics

Ellipse:	375	600	750	1000	1500	XL
► UPS power	375 VA / 225 W	600 VA / 360 W	750 VA / 450 W	1000 VA / 600 W	1500 VA / 900 W	420 VA / 250 W
► Nominal input voltage	184 V - 264 V, adjustable to 161 V - 284 V					
► Input frequency	50/60 Hz (46 - 70 Hz working range)					
► Voltage/frequency of battery backup outlets ⑨ in battery mode	220 V / 230 V / 240 V ± 7% (50/60 Hz ± 1 Hz) with pseudosinusoidal wave					
► Total output current for all outlets	10 A max					
► Output current of battery backup outlets ⑨	1.6 A max	2.6 A max	3.5 A max	4.4 A max	6.5 A max	1.8 A max
► Leakage current	0.06 mA					
► Input protection	10 A resettable circuit breaker					
► Transfer time	5 ms typical					
► Telephone surge protection	Tel, ISDN, ADSL, Ethernet					N/A
► Sealed lead-acid battery	12 V, 7 Ah	12 V, 9 Ah	2x12V, 7Ah	3x12V, 7Ah		
► Automatic battery test	Once a week					
► Average battery life	4 years typical, depending on number of discharge cycles and temperature					
► Operating temperature	0 to 35°C					
► Storage temperature	-25°C to +55°C					
► Operating relative humidity	0 to 85%					
► Operating elevation	0 to 3000 m					
► Safety standards	IEC 60950-1, IEC 62040-1-1, CE certified					
► Electromagnetic compatibility standards	IEC 62040-2, C1*					
► Warranty	2 years					
► Dimensions (mm)	264 x 81 x 268			305x81x313	316x81x388	
► Weight (Kg)	4.2			8	12	

(*) **Warning:** Ellipse 1500 FR/DIN/UNI and Ellipse XL are class C2-UPS product. In a domestic environment, these products may cause radio interference, in which case, the user may be required to take additional measures.

Performances tested according to IEC 61643-1 (class 3) standard for 8/20 μ s surge wave

AC input source protection, Ellipse:	375	600	750	1000	1500	XL
▶ Uoc (common mode / differential mode)	6kV/2kV	6kV/2kV	6kV/2kV	6kV/1.8kV	6kV/2.6kV	6kV/2.6kV
▶ Up (common mode / differential mode)	2kV/1.2kV	2kV/1.2kV	2kV/1.2kV	1.6kV/1.2kV	1.7kV/1.1kV	1.7kV/1.1kV
▶ In	2.5 kA					
▶ Imax	8 kA					
Dielectric isolation						
▶ AC Ground	2500 Vac, 50 Hz					
▶ AC / TEL	3000 Vac, 50 Hz					
▶ AC + Ground / Screw	4000 Vac, 50 Hz					
▶ Tel / Ground	1000 Vac, 50 Hz					
Temporary overvoltage (TOV)						
▶ Uc	250 Vac					
▶ Ut	400 Vac					
▶ TOV	1450 Vac					
Load-side surge withstand capability						
▶ Uoc	6.6 kV					
▶ Up	1.5 kV					
▶ In	2.5 kA					
Energy dissipation	525 Joules					

Operating conditions

► This product is an Uninterruptible Power Supply (UPS) for computers and their peripherals, television sets, stereo systems and video recorders... It must not be used to supply other electrical equipment (lighting, heating, household appliances, etc.).

► UPS can be installed in horizontal, vertical position, or placed in Rack 2U (optional kit).

UPS connections

► Connect the UPS (1) to the AC-power system via a wall outlet with an earth connector, using the supplied cord (2) for a UPS with FR/DIN sockets or with the supply cord of your computer for a UPS with IEC/UNIVERSAL sockets (see figure A).

► Plug critical equipment (computer, monitor, modem, etc.) into the outlets (9) providing battery backup power and surge protection (see figure B), taking care not to exceed the rated current indicated in amperes.

► Other devices (printer, scanner, fax, etc.) can be connect to the filtered outlets (8) that provide surge protection (see figure B). The filtered outlets are not backed up by battery power in the event of a power outage.

Optional Internet modem / Network connection:

A modem or Ethernet data line can be protected against surges by connecting it via the UPS. Connect the existing device cable between the wall outlet and the UPS, and use a similar cable between the UPS and the device, as indicated in figure C (cable (3) not supplied).

Optional COM connection:

The UPS devices with communication (COM) sockets can be connected to the computer using the special USB or serial cable (6) supplied.

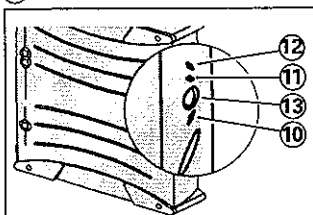
The software available on the CD-ROM (7) (or downloadable from the www.eaton.com site) can be configured to monitor the UPS and the supply of power to the computer (see figures D and F).

► Follow the indicated procedure.

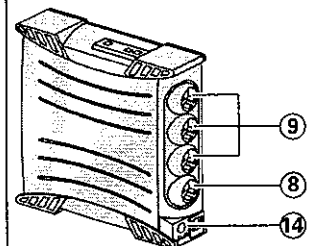
► At the same time, register for the warranty on the www.eaton.com site (see figure G).

Operation

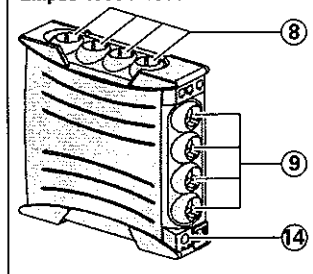
- (8): Filtered outlets.
- (9): Battery backup outlets.
- (10): LED ON indicate that surge protection is active on all outlets.
- (11): LED ON indicate a UPS fault.
- (12): LED ON indicate an overload on the battery backup outlets.
- (13): ON/OFF button for the battery backup outlets.
- (14): Protection circuit breaker.



Ellipse 375 / 600 / 750



Ellipse 1000 / 1500 / XL



► **Battery charge:** The UPS charges the battery as soon as it is connected to the AC outlet, whether button (13) is pressed or not. When used for the first time, the battery will only provide its maximum autonomy after it has been charged for 8 hours. It is recommended that the UPS be permanently connected to the AC power supply to ensure the best possible autonomy.

► **Switching-on the UPS:** press button (13) for about 1 second.

Filtered outlets (8) without battery backup:

Equipment connected to these outlets is supplied as soon as the AC cord (2) is plugged in. They are not affected by button (13).

Battery backup outlets (9):

Equipment connected to these outlets is supplied as soon as button (13) turns green (see figure E). These outlets can be turned on even if the UPS is not connected to AC power (button (13) flashes).

► **AC-power disturbance:** If AC power is disturbed or fails, the UPS continues to operate on battery power. Button (13) flashes green. In normal mode, the audio alarm beeps every ten seconds, then every three seconds when the end of battery backup time is near. In silent mode (see the section on settings), the audio alarm simply beeps once when the UPS transfers to battery power.

► If the power outage lasts longer than the battery backup time, the UPS shuts down and automatically restarts when power is restored. Following a complete discharge, a few hours are required to recharge the battery back to full backup time.

► To save battery power, it is possible to press button (13) to cut the supply of power to the devices connected to the battery backup outlets.

► **Lightning protection:** All outlets, whether backed up or simply filtered, include surge protection, whatever the position of button (13).

► **Shutdown of the battery backup outlets (9):** Press button (13) for more than two seconds.

Battery disposal and safety

► **Caution.** Battery service life is reduced by 50% for every ten degrees above 25°C.

► **The battery elements must be replaced exclusively by qualified personnel (risk of electrocution),** with new elements approved by EATON to ensure correct operation of the UPS.

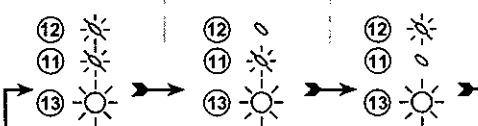
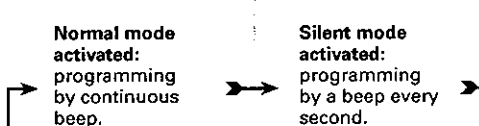
► The battery must be disposed of in accordance with applicable regulations. To remove the battery elements, shut down the UPS (button (13) OFF), remove the power cord and proceed as indicated in page 4 "Battery change".

► **Warning: take care not to inverse the polarity + (red) and - (black) when connecting the batteries as this will destroy the device.**

Troubleshooting (For further information, visit the www.eaton.com site or contact after-sales support.)

Problem	Diagnostic	Solution
1 The battery backup outlets (9) are not supplied with power.	Button (13) is not lighted on.	Press button (13) and check that it turns green.
2 The connected devices are not supplied when AC power fails.	The devices are not connected to the battery backup outlets (9).	Connect the devices to the battery backup outlets (9).
3 AC power is available, but the UPS operates on battery power.	Circuit breaker (14), located under the UPS, has been tripped by an overload on the UPS output.	Disconnect excess equipment and reset the circuit breaker (14) by pressing the corresponding button.
4 The filtered outlets (8) are not supplied.	The wall outlet is not supplied. Circuit breaker (14), located under the UPS, has been tripped by an overload on the UPS output.	Supply power to the wall outlet. Disconnect excess equipment and reset the circuit breaker (14) by pressing the corresponding button.
5 Green button (13) flashes frequently and audio alarm beeps.	The UPS frequently operates on battery power because the AC power source is of poor quality.	Have the electrical installation checked by a professional or use another wall outlet.
6 Red LED (12) is on and the audio alarm beeps every 30 seconds.	The UPS battery backup outlets (9) are overloaded.	Disconnect excess equipment connected to the battery backup outlets (9).
7 Red LED (11) is on and the audio alarm beeps every 30 seconds.	A fault has occurred on the UPS. The battery backup outlets (9) are no longer supplied.	Call after-sales support.
8 Green LED (10) is off and the filtered outlets (8) are supplied.	Surge protection is no longer provided.	Call after-sales support.
9 The telephone line is disturbed or modem access is not possible.	Surge protection on the telephone line is no longer provided.	Disconnect the telephone line from the wall outlet. Call after-sales support.
10 Red LED (11) flashes.	The battery has reached the end of its service life.	Have the battery replaced.

Advanced customizing of your UPS:

Sensitivity to variations of the AC power supply	Audio alarm					
Only to be used if frequent switching to the UPS battery due to large variations in the AC supply voltage. Accessing the programming mode: with the device switched off, press button 13 for 6 s and release it once LEDs 11 12 13 have come on. Display of the 3 possible voltage ranges according to the status of LEDs 11 and 12: <table> <tr> <td> Normal mode (factory configuration): AC supply between 184V and 264V </td><td> Low range mode: AC supply between 161V and 264V </td><td> Low and high range mode: AC supply between 161V and 284V </td></tr> </table>  Change from one mode to another by successively pressing button 13 while the sound is audible. Memorizing the mode: 10 s after the last press of the button.	Normal mode (factory configuration): AC supply between 184V and 264V	Low range mode: AC supply between 161V and 264V	Low and high range mode: AC supply between 161V and 284V	Possibility of deactivating the audio alarm when the UPS is operating on the battery. Accessing the programming mode: with the device switched off, press button 13 for 11 s and release it when the audio alarm sounds. Display of the 2 possible audio alarm modes: <table> <tr> <td> Normal mode (factory configuration): the UPS emits a beep every 10 s when operating on its battery. </td><td> Silent mode: the UPS emits a single beep when switching to battery operation and then remains silent. </td></tr> </table>  Change from one mode to another by successively pressing button 13 while the sound is audible. Memorizing the mode: 5 s after the last press of the button.	Normal mode (factory configuration): the UPS emits a beep every 10 s when operating on its battery.	Silent mode: the UPS emits a single beep when switching to battery operation and then remains silent.
Normal mode (factory configuration): AC supply between 184V and 264V	Low range mode: AC supply between 161V and 264V	Low and high range mode: AC supply between 161V and 284V				
Normal mode (factory configuration): the UPS emits a beep every 10 s when operating on its battery.	Silent mode: the UPS emits a single beep when switching to battery operation and then remains silent.					

Installation and maintenance manual

Crankcase explosion relief valves of type HWG

Application: Oil mist-and gas explosions

Version: 2.0



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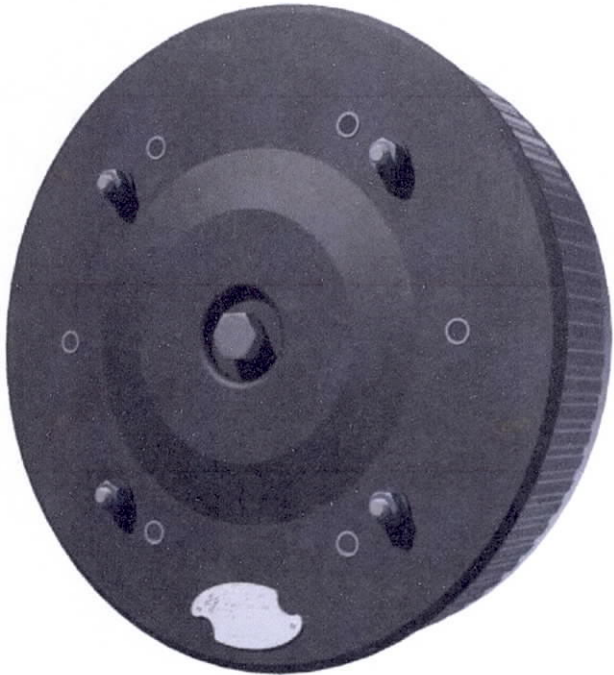
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1. INTRODUCTION.

This Operation and maintenance manual is mentioned of the following valves

	Crankcase Explosion Relief Valve	
	Large Group	HWG-735 HWG-645 HWG-565 HWG-480 HWG-420 HWG-345 HWG-320
	Small Group	HWG-266 HWG-224 HWG-204 HWG-173 HWG-162 HWG-122

Manufacturer:

Head Office:

348-30, Naengchon-ri, Oedong-eup, Gyeongju-si, Gyeongbuk, Korea.

Tel: 82-54-776-5174 Fax: 82-54-776-2769 E-Mail : hwimc@paran.com

Suwon Factory:

955, Advance Technology Complex, Gosaek-dong, Kweonseon-gu, Suwon-city, Korea.

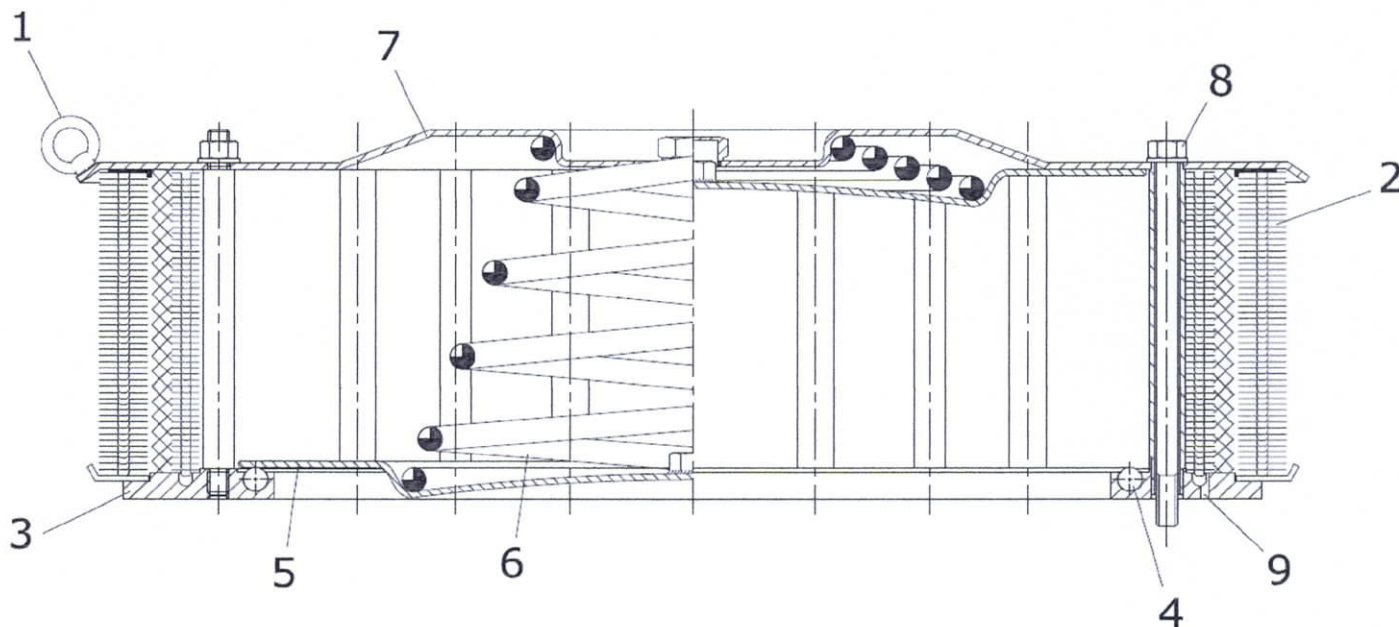
Tel: 82-31-298-6323 Fax: 82-31-291-6390



Used Symbols:

		IACS
Safety advice Risk of injury	Functional advice Concerning correct function	IACS M66 Rules Advices according IACS M66 Rules(Directive for application of Crankcase Explosion Relief Valves in ship engines)

2. Design of Explosion Relief Valve HWG.



Position	Description
1	Eye Bolt or Nut
2	Flame Arrester consisting of Inner Trap, Mesh and Out Trap
3	Seat
4	O-Ring
5	Disc
6	Spring
7	Cover
8	Mounting Bolts for assembly on the Crankcase(This bolts are included in delivery)
9	Drain Hole(Leak oil return)

3. Description of valve with details of function and design limits.

3.1 Design limits

The HYUNWOO SMT Crankcase Explosion Relief Valve type HWG covered in this manual is designed for protection of crankcase in ship engines and applicable up to following design limits:

Operation pressure	1 bar absolute (atmospheric condition in the crankcase)
Operating temperature	-20°C to +100°C
Maximum Kg	100 bar *m*s ⁻¹
Installation site	The standard execution is designed for indoor use. For outdoor application corrosion protection has to be observed.



Applications beyond the design limits are prohibited. HYUNWOO SMT warranty and liability becomes immediately invalid in case of improper application.

IACS

In principle Crankcase explosion relief valves work reliably in any installation position, for applications according to IACS M66 Rules only the vertical installation(as tested) of Crankcase explosion relief valves is permitted.



HYUNWOO SMT Crankcase Explosion Relief Valve type HWG are components for diesel and gas engines which necessarily require a connection to the engine to describe a functional machine.

3.2 Function and Operation

Crankcase explosion relief valves type HWG protect man and equipment in the event of on oil mist or gas explosion.

In the event of an explosion the explosion relief valve open immediately.

The valve is designed to relieve the excess pressure during an explosion, avoid flame escape and to close rapidly after an explosion.

The valve closes absolutely tight after explosion, thus preventing oxygen or dirt to get entrained into the chamber.

4. Installation Instructions.

4.1 General assembly instructions



All work done on the valve like mounting or dismounting has to be carried out by skilled personnel wearing suitable protective clothes using appropriate tools.



Sharp edges on the valve and the weight of the valve may lead to injury of personnel. Due to improper handling the valve might drop and hurt personnel



The valve has to be mounted on the outside surface of the crankcase or protected volume. Mounting the valve in wrong way inside of the protected volume leads to a non-fulfillment of its safety function

During fitting the valve to the machine the information stated in the assembly drawing has to be observed.



The required number of bolts has to be used, A suitable sealing has to be used to seal the seat of the valve to the crankcase or protected machine.

Additional to these instructions the assembly guidelines of the engine manufactures are valid.



It has to be observed that there is enough space for accessing the valves, to enable a visual check of the condition at any time.

The valve has a bore hole for leak oil return.

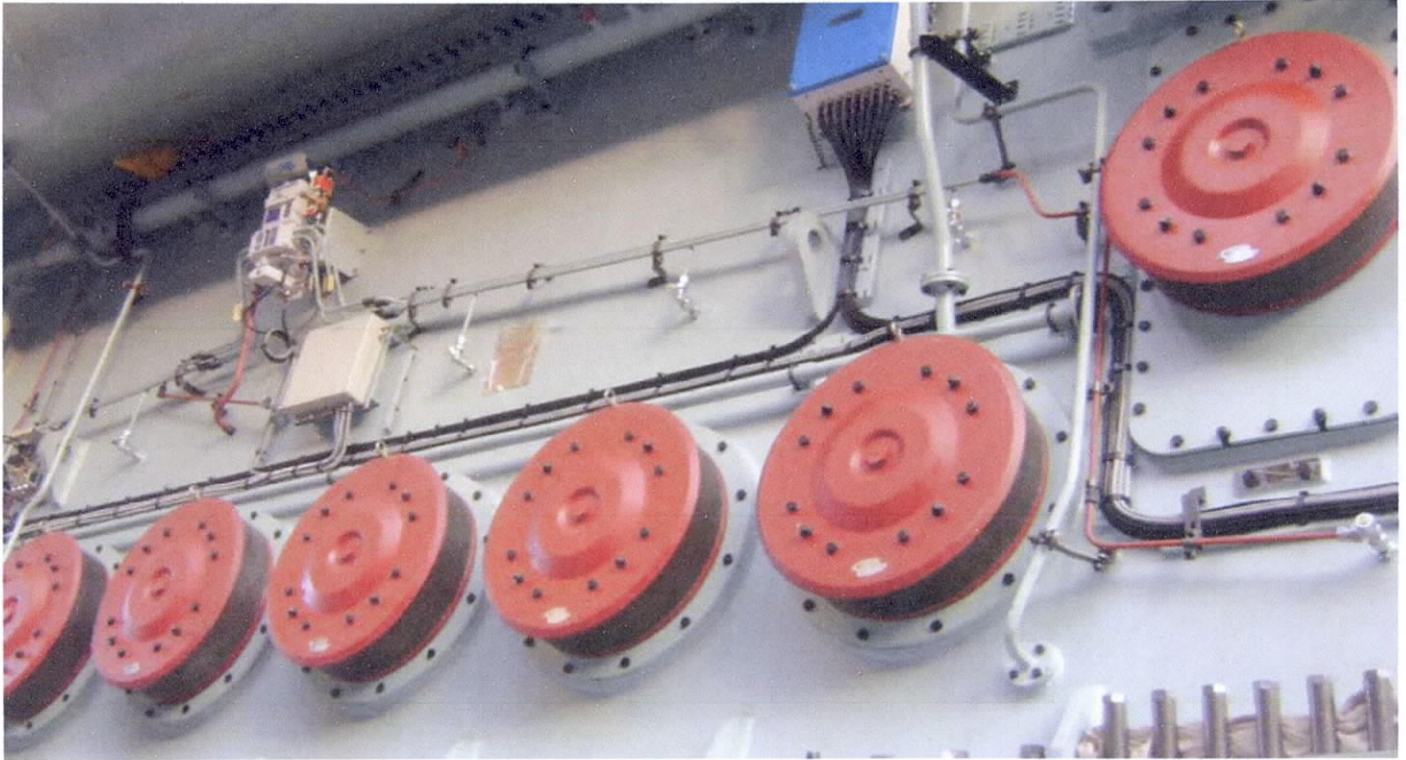
If required the leak oil return can be activated by setting a counter hole.



If the leak oil return has been activated design modifications are required to avoid oil mist-/ gas escape in counter direction (to the outside).

The explosion relief valve has to be mounted with the leak oil return hole in 6 o'clock position to maintain the backflow of the leaking oil.

The following picture shows the typical placement of explosion relief valves on a diesel engine.



5. Maintenance and in service instruction to include testing and renewal of any sealing arrangements.

5.1 Inspection

Following visible checks have to be done on explosion relief valves during routine machine inspection.

- Damage of the flame arrester or other components requires a replacement at the next scheduled maintenance shutdown.
- The appearance of oil leakage requires an exchange of the O-Ring at the next scheduled maintenance shutdown.

5.2 Maintenance intervals

The explosion relief valve is almost maintenance free; however, the following instructions have to be observed.

After an explosion in the crankcase the flame arrester has to be exchanged. In case of visible damage of any other component the complete valve has to be replaced during the next scheduled maintenance shutdown.

In course of the required maintenance intervals given by the engine-manufacturer the following two points have to be checked or if necessary carried out.

- In case that dirt is collected on the flame arrester, it has to be cleaned with compressed air or respectively with a non-corrosive and inflammable substance (degreaser) during standstill of the machine.



For proper operation the flame arrester has to be periodically kept clean.

- The O-Ring loses its sealing function through ageing or chemical attacks. In case of oil leakage the O-Ring has to be replaced during the next scheduled shutdown.



All instructions of engine manufacturers and all advices for secure operating and mounting of explosion relief valves given in the previous chapters are valid.



The lead seal of the flame arrester must not be removed.

Disassembling the flame arrester is forbidden. HYUNWOO SMT warranty and liability become invalid immediately in case of an opened lead seal.

5.3 Exchange and cleaning of flame arrester

Explosion relief valves of type HWG allow to exchange the complete flame arrester, for this work following tools are required

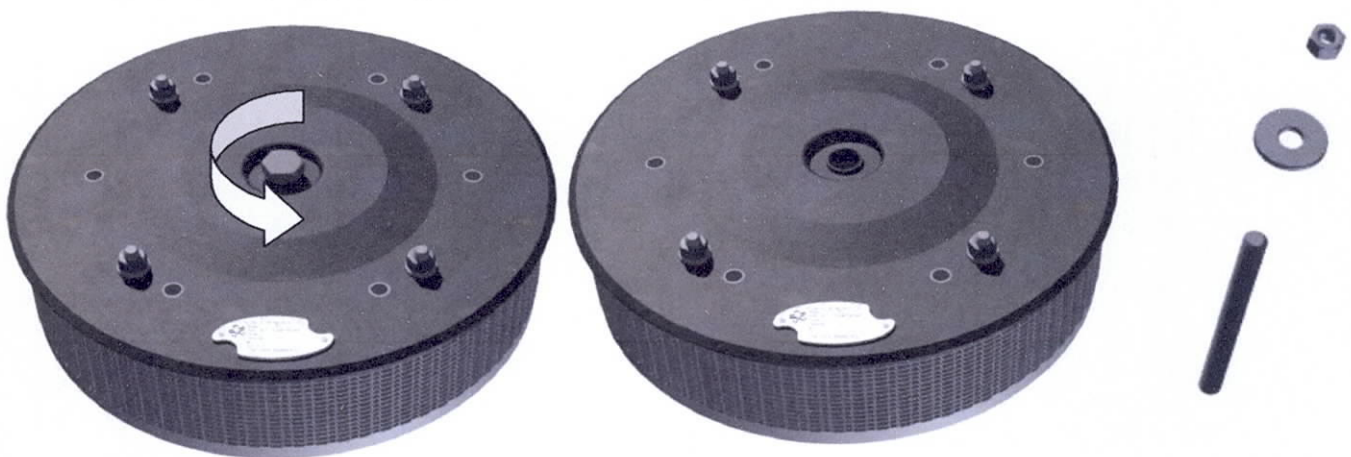
- 1 piece thread rod of DISC NUT standard
- 1 piece Washer and 1 piece Nut of equal standard with thread rod

The exchange of the flame arrester should be done by skilled personnel according to the assembly drawing of HYUNWOO SMT with following steps:

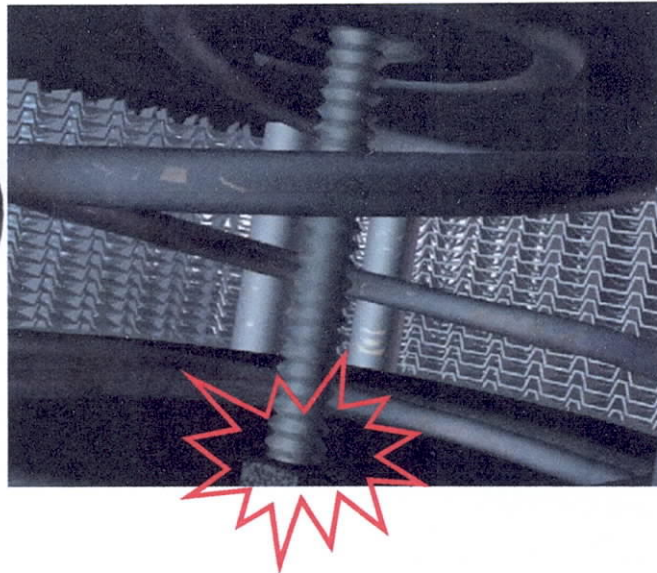
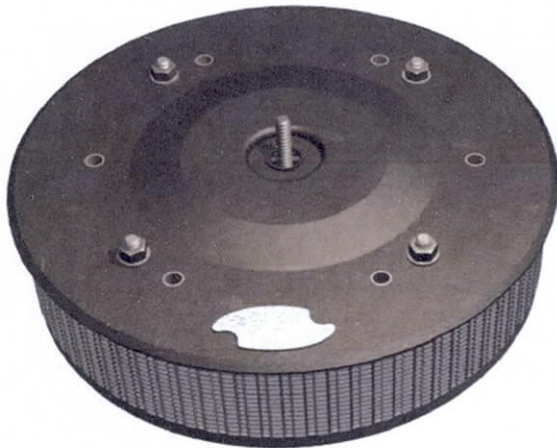
1. If necessary, dismantle the explosion relief valve from the crankcase.

Work is possible in the inside and the outside without dismantling the products.

2. Disassemble the plug (see fig.)



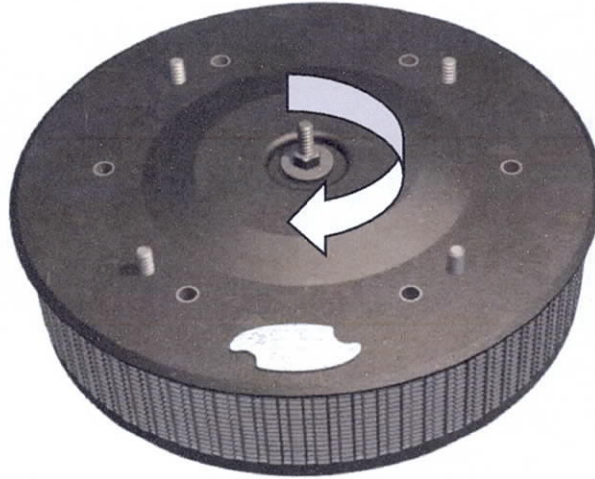
3. Insert a thread rod in Plug Hole, and completely put Nut into the Disc according to figure.
At this point , certainly confirm the cover position (Name Plate & Eye Nut's position confirmation)



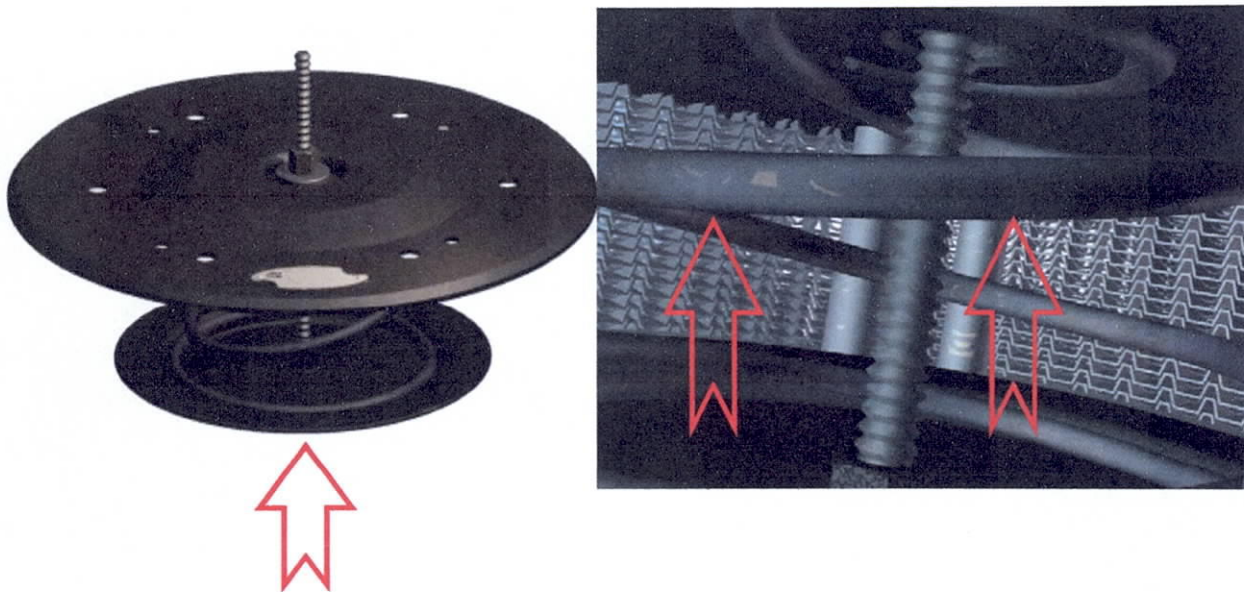
4. Put the Washer into the thread rod according to figure and then put the nut.



5. When the top cover close to the nut, grease a thread rod and a nut and then continuously tighten a nut with thread rod.



6. When continuously tightening a nut, Cover close to Disc like pictures.
As you do not look in the outsides, you shall confirm in the floor of a product.



7. Check the valve inside, clean up arrester Flame Arrester .
8. .If necessary exchange O-Ring. (See chapter 5.4)
9. Wipe cleanly Disc floor of the product which you dismantled.
10. Now dismantle a thread rod and tighten a Plug
11. Install the valve to the machine, recommend confirming Drain Hole of a product floor.

IACS

It is prohibited to disassemble the flame arrester. Disassembling expires the certification according IACS Rules M66. HYUNWOO SMT warranty and liability becomes invalid immediately in case of dismantling the flame arrester.

5.4 Exchange of O-Ring

The exchange of O-Rings should be done together with the cleaning of the flame arrester and has to be carried out by skilled personnel.

Demounting of the O-Ring follows the same procedure described in the prior chapter

(5.3 Exchange and cleaning of flame arrester). Following points have to be considered additionally:

- Remove valve plate
- Take out old O-Ring
- Clean O-Ring-insertion part
- Insert O-Ring, Apply glue on O-Ring surface.

5.5 Testing and renewal of any sealing arrangements

The pre and periodical inspection of O-ring is necessary to prevent malfunction of relief valve.

If the appearance of oil leakage, O-ring will not be worked properly.

In case that dirt is collected on O-ring, It has to be cleaned with a soft and clean cloth.

In case of visible damage of O-ring, It has to be replaced according to above chapter 5.4

After replacement of O-ring, the valve has to be checked by carrying out the visual inspection again.

6. Actions required after a crankcase explosion.

IACS

After an explosion the flame arrester has to be exchanged at the next scheduled maintenances shutdown.

In case of visible damage of other parts, the whole valve has to be replaced.

Furthermore the instructions of the engine manufacturer have to be observed.



For reasons of the remaining heat, the crankcase explosion relief valve must not be touched after an explosion? Danger of severe injury!



Work at the relief valve is not allowed if the equipment is under operation. Relief to the guidelines of the engine manufacturer.



In case of visible damage of the valve, either the Flame arrester unit or the valve has to be replaced.



The lead seal of the flame arrester must not be removed.

Disassembling the flame arrester is forbidden. HYUNWOO SMT warranty and liability become invalid immediately in case of an opened lead seal.



During all manipulation of the relief valve, i.e. handling, fitting to the machine, etc. suitable protective clothing and protective gloves have to be used



The flame arrestor must not be damaged or manipulated in any way.
Also damage of all other components has to be prevented.

7. Warranty.

HYUNWOO SMT offers warranty on material and execution for a period of 12 months after start of operation, however, not longer than 18 months after delivery.

8. Table of revisions.

IACS The operational manual is part of the documentation for the classification society to obtain the approvals according IACS Rules M66. HYUNWOO SMT has to report to the classification society if there are any changes.

Version	Date	Author	Comment
1.1	11 th . Oct. 2010	Lee Jae-Hwan	Type test Cert.
2.0	14 th . Oct. 2010	Lee Jae-Hwan	Contents.



Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 09.0064 - 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30, Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30, Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type ERV 735**

Sample number: **14967**

Certificate number: **none**

Test samples supplied on: **03th February 2009**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method: **none**

Present at the tests : **From: Member of Germanischer Lloyd Group: Mr. Swen Neddenien
MAN Diesel A/S , Mr. C.H. Andersen,
HYUNWOO SMT Co.,Ltd , Mr. Bang
Lloyd's Register EMEA , Mr. Vladimír Volánek**

Responsible person: Josef Krupica



Elaborated by: Josef Krupica

Date of issue: 03th February 2009

Number of pages : 4

Number of annexes: 4

Videorecord

Test results mentioned in this test report relate only to the items tested and not replace any other documents.
In any case the test report shall not be reproduced except in full without the written approval of the testing laboratory



Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 08.0687 - 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type HWG 420**

Sample number: **14769**

Certificate number: **none**

Test samples supplied on: **09th October 2008**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method: **none**

Present at the tests :

**From: Member of Germanischer Lloyd Group: Mr. Frank Lutz
MAN Diesel A/S , Mr. C.H. Andersen,
HYUNWOO SMT Co.,Ltd , Mr. Lee Won-Kon
Lloyd's Register EMEA , Mr. Vladimír Volánek
Hyundai Heavy Industries, Mr. K.S. Lee,**

Responsible person: Josef Krupica

Elaborated by: Josef Krupica

Date of issue: 23th October 2008



Number of pages : 4
Number of annexes: 10
Videorecord

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Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 09.0063- 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type HWG 320**

Sample number: **14698**

Certificate number: **none**

Test samples supplied on: **03th February 2009**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method:

Present at the tests :

From: **Member of Germanischer Lloyd Group: Mr. Swen Neddenien
MAN Diesel A/S , Mr. C.H. Andersen,
HYUNWOO SMT Co.,Ltd , Mr. Bang
Lloyd's Register EMEA , Mr. Vladimír Volánek**

Responsible person: Josef Krupica

Date of issue: 03th February 2009



Elaborated by: Josef Krupica

Number of pages : 4

Number of annexes: 4

Videorecord

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Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 08.0694- 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type HWG 266**

Sample number: **14641**

Certificate number: **none**

Test samples supplied on: **04th September 2008**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method: **none**

Present at the tests :

From: Member of Germanischer Lloyd Group: Mr. Nimrichter
MAN Diesel A/S , Mr. C.H. Andersen, Mr. E. Ohlsen
HYUNWOO SMT Co.,Ltd , Mr. Bang Yun - Oh
Lloyd's Register EMEA , Mr. Vladimír Volánek
Hyundai Heavy Industries, Mr. K.S. Lee

Responsible person: Josef Krupica



Elaborated by: Josef Krupica

Date of issue: 25th.September 2008

Number of pages 3

Number of annexes 5

Videorecord

Test results mentioned in this test report relate only to the items tested and not replace any other documents.
In any case the test report shall not be reproduced except in full without the written approval of the testing laboratory



Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 08.0695- 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30, Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30, Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type HWG 173**

Sample number: **14723**

Certificate number: **none**

Test samples supplied on: **23th September 2008**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method: **none**

Present at the test:

From: **Member of Germanischer Lloyd Group: Mr. Nimrichter
MAN Diesel A/S , Mr. C.H. Andersen, Mr. E. Ohlsen
HYUNWOO SMT Co.,Ltd , Mr. Bang Yun Oh
Lloyd's Register EMEA , Mr. Vladimír Volánek
Hyundai Heavy Industries, Mr. K.S. Lee,**

Responsible person: Josef Krupica

Elaborated by: Josef Krupica

Date of issue: **25th September 2008**



Number of pages : **5**

Number of annexes: **11**

Videorecord

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Physical - technical testing institute, Ostrava - Radvanice

National Authority No. 210, EU Notified body No 1026

Ostrava - Radvanice, tel: +420 595223111, fax: +420 596232672, email: ftzu@ftzu.cz

TEST REPORT No.: 08.0696 - 47

Test: **Explosion test of protective system**

Applicant: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Manufacturer: **HYUNWOO SMT Co.,Ltd., 348-30,Naengchon-ri Oeidong-eup
Kyungju-city, Kyungbuk, Korea**

Test samples: **Relieve Valve type HWG 122**

Sample number: **14724**

Certificate number: **none**

Test samples supplied on: **23^h September 2008**

Test samples were tested in accordance with: **Modified M66 Specification (Rev.January 2008)**

Deviation of the test method: **none**

Present at the tests :

From: **Member of Germanischer Lloyd Group: Mr. Nimrichter
MAN Diesel A/S , Mr. C.H. Andersen, Mr. E. Ohlsen
HYUNWOO SMT Co.,Ltd , Mr. Bang Yun - Oh
Lloyd's Register EMEA , Mr. Vladimír Volánek
Hyundai Heavy Industries, Mr. K.S. Lee**

Responsible person: Josef Krupica

Date of issue: 25th.September 2008



Elaborated by: Josef Krupica

Number of pages : 3

Number of annexes: 4

Videorecord

Test results mentioned in this test report relate only to the items tested and not replace any other documents.
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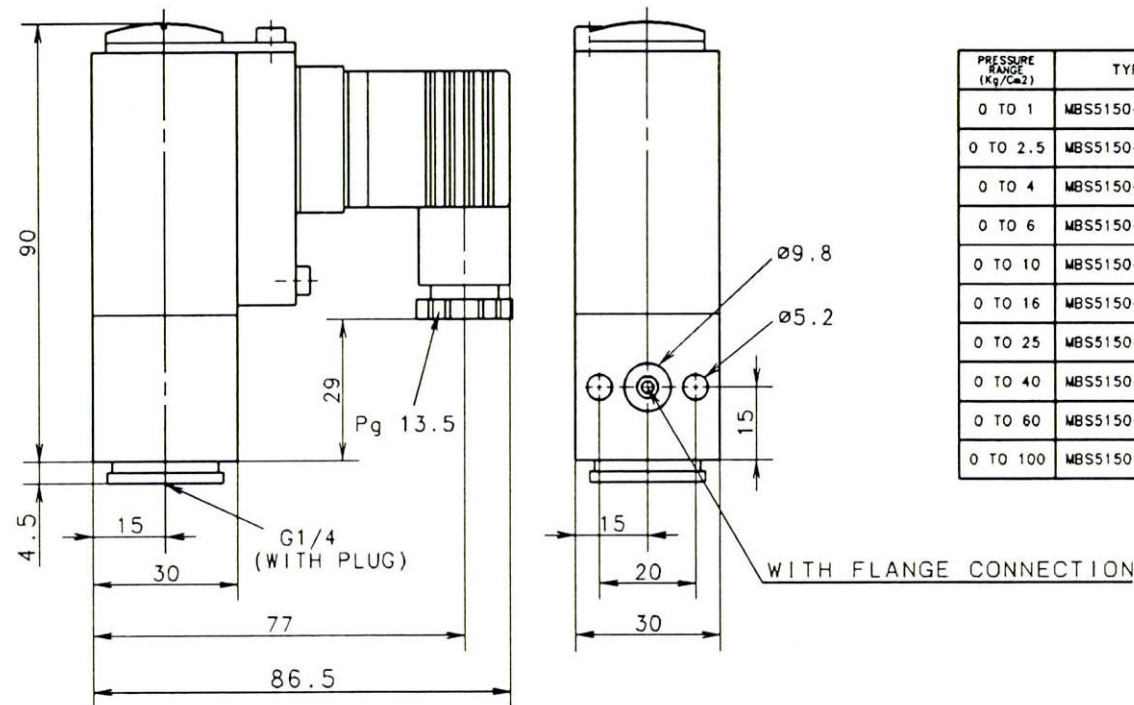
1. PARTS OF PNEUMATIC MANOEUVRING SYSTEM

List of Components

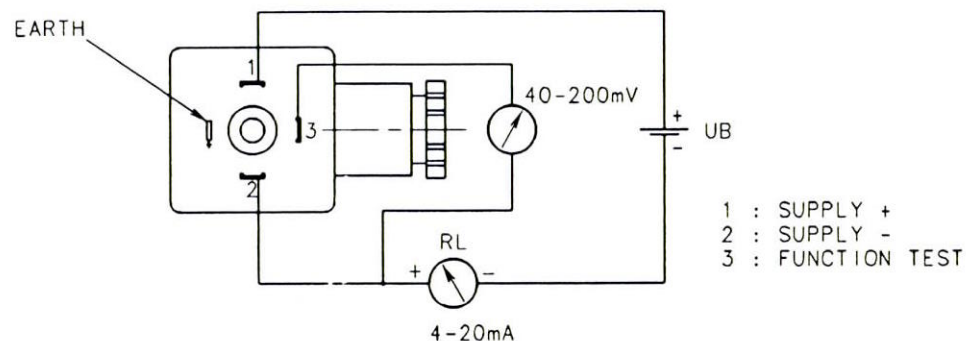


ENGINE TYPE : S90ME-C

Pos.	Description	Maker / Type	Drawing No.:	Page
1	BALL VALVE	HYUP SHIN METAL	A12-231256-3	1
2	PRESSURE SENSOR	DANFOSS	A13-172231-6	2
3	BALL VALVE	HYUP SHIN METAL	A12-231256-3	1
5	PRESSURE SENSOR	DANFOSS	A13-172231-6	2
6	PRESSURE GAUGE	HHI	A13-231359-3	3
12	5/2 WAY VALVE	REXROTH	A13-227470-1	10
21	DRAIN VALVE	REXROTH	A13-136129-4	5
22	DRAIN VALVE	REXROTH	A13-136129-4	5
23	NON-RETURN VALVE	REXROTH	A14-004468-0	9
26	5/2-WAY SOLENOID VALVE	MECMAN	A13-163304-0	14
68	5/2 WAY VALVE	REXROTH	A13-227470-1	10
74	AIR RECEIVER	HHI	A13-190821-6	4
75	AIR RECEIVER	HHI	A13-231437-3	17
92	3/2-WAY SOLENOID VALVE	REXROTH	A13-136031-0	8
93	3/2-WAY SOLENOID VALVE	REXROTH	A13-136031-0	8
94	3/2-WAY SOLENOID VALVE	REXROTH	A13-136031-0	8
113	SWITCH	HYUP SHIN METAL	A13-231396-0	15
115	5/2 WAY VALVE	REXROTH	A13-158710-2	7
116	SWITCH	SEE SEPARATE INSTRUCTION	-	-
118	SHUT OFF VALVE	HYUP SHIN METAL	A13-231397-1	12,13
119	SWITCH	HYUP SHIN METAL	A13-231396-0	15
121	SWITCH	HHI	A13-004451-7	11
122	PRESSURE SENSOR	DANFOSS	A13-172231-6	2
123	SWITCH	HHI	A13-004451-7	11
137	NON-RETURN VALVE	HHI	A14-138339-6	6
138	PRESSURE SENSOR	DANFOSS	A13-172231-6	2
139	PRESSURE GAUGE	HHI	A13-231359-3	3
150	REDUCTION UNIT	TMC	A12-231446-7	16



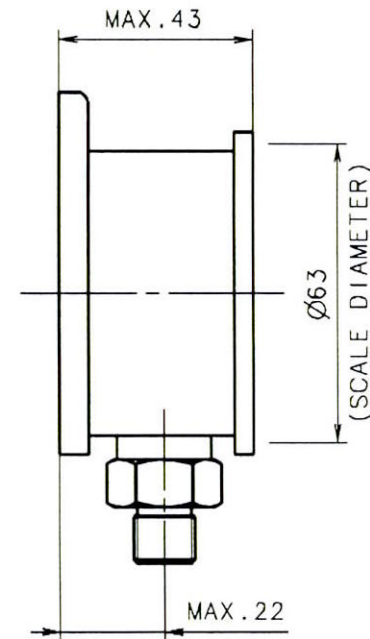
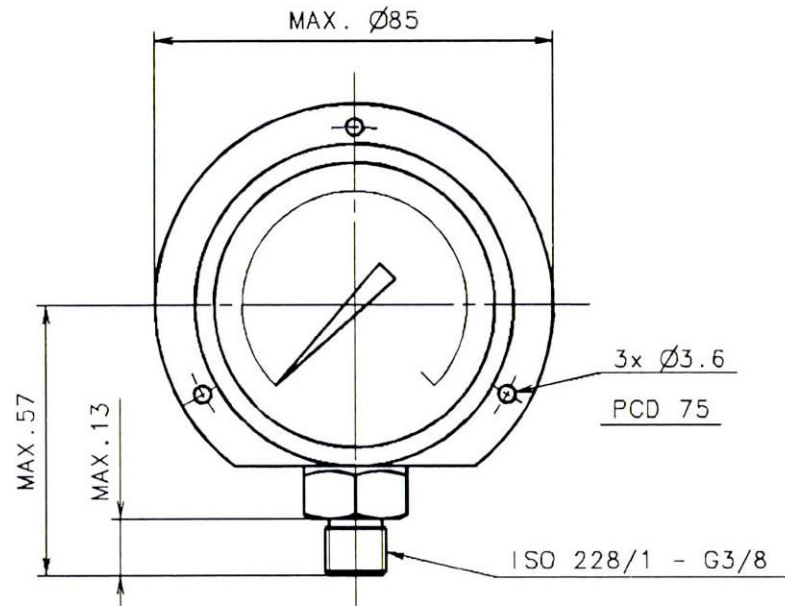
MAKER : DANFOSS



PRESSURE RANGE (Kg/Cm ²)	TYPE NO.	DESCRIPTION	INFORM NO.	PART NUMBER
0 TO 1	MBS5150-1011-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153100-1.2
0 TO 2.5	MBS5150-1411-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153101-3.2
0 TO 4	MBS5150-1611-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153102-5.2
0 TO 6	MBS5150-1811-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153103-7.2
0 TO 10	MBS5150-2011-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153104-9.2
0 TO 16	MBS5150-2211-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153105-0.2
0 TO 25	MBS5150-2411-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153106-2.2
0 TO 40	MBS5150-2611-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153107-4.2
0 TO 60	MBS5150-2811-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153108-6.2
0 TO 100	MBS5150-3011-20B04	VERSION WITH PULSE-SNUBBER	135963	A19-153109-8.2

POSITION NO. ON DIAGRAM ②,⑤,⑫,⑬

Supplement Drawing no.:			Projection:		Mass (kg):		Material / Blank:	
								
			Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
				*	*			6
				*	*			5
				*	*			4
				*	*			3
990518	BYJ	JCMBHS		*	*	TYPE NO. CAHNGED.		2
990222	BYJ	JCMBHS		*	*	CODE NO. CHANGED.		1
990119	BYJ	JCMBHS		*	*			0
Similar Drawing No.:					Replacement of Ident. No.:			
Scale:	Size:	Type:				Page No.:		
1:1	A3		DIESEL ENGINE			01 (01)		
Info. No.:		Description:				Ident. No.:		
696131		PRESSURE TRANSMITTER				A13-172231-6		



Green Marked : 5.5~7kg/cm²

- 126 Make or similar: 1115
- 455 Type: 63M10-1, D1 (Liquid filled)
- 151 Graduation: 0-10 kg/cm²
- To be calibrated at 55-65°C
- 619 Medium: Air

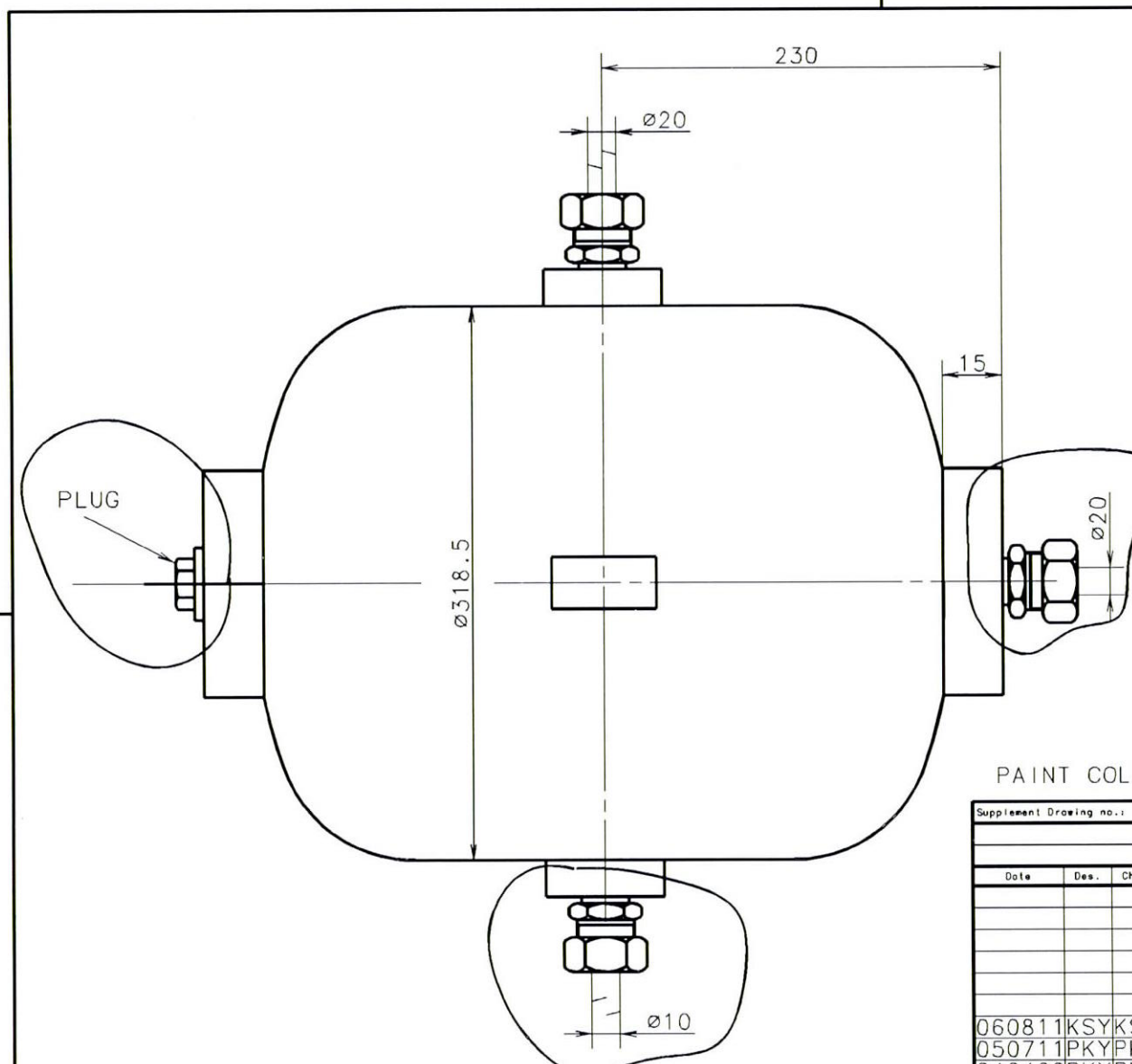
POSITION NO. ON DIAGRAM ⑥, ⑬

Supplement Drawing no.:				Projection:		Mass (kg):		Material / Blank:		
						0.30				
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
				1825504-9.3						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No
				*	*	Replaced by Ident. No.:				9
				*	*					8
				*	*					7
				*	*					6
				*	*					5
				*	*					4
				*	*					3
				*	*					2
				*	*					1
7 of 10	040426PKYPKYKJG			*	*					0

PAGE NO. 3

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Standard for surface roughness						Tolerances for dimensions without tolerance indication (ISO 2768-1989)						
The basic symbols and class numbers are in accordance with ISO 1302-1978.						This standard states the permissible deviations for dimensions without direct tolerances regulations or permissible deviations regulated by machining.						
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _{max} value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
Permissible deviations	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2						

Similar Drawing No.:			Replacement of Ident. No.:		
Scales			Page No.:		
1:1			01 (01)		
Size:			Type:		
A3			Description:		
Info. No.:			Ident. No.:		
681000			PRESSURE GAUGE DIAL TYPE		
			A13-231359-3		



POSITION NO. ON DIAGRAM ⑦④

MAX. WORKING PRESSURE : 9.9Kgf/cm²
 HYDRAULIC TEST : 15Kgf/cm²
 MEDIUM : AIR
 CAPACITY : 20 LITER

PAINT COLOR : 해당공사 PAINT COLOR 확인하여 도장하여 입고할것.

Supplement Drawing no.:		Projection:	Mass (kg):	Material / Blank:			
		15					
Licensor's Ident. no.:		Dist.:	Licensor's Material / Blank:				
		A92					
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*	DWG. CORRECTED.	2
				*	*	UP TO DATE	1
				*	*	DIM. CORRECTED; 230	0
				*	*		
Similar Drawing No.:		Replacement of Ident. No.:					
Scale:	Size:	Type:	Page No.:	HYUNDAI HEAVY INDUSTRIES CO., LTD.			
NS.	A3	ME/ME-C	01 (01)				
Info. No.:	Description:		Ident. No.:				
345064	ASSY. OF AIR RECEIVER		A13-190821-6				

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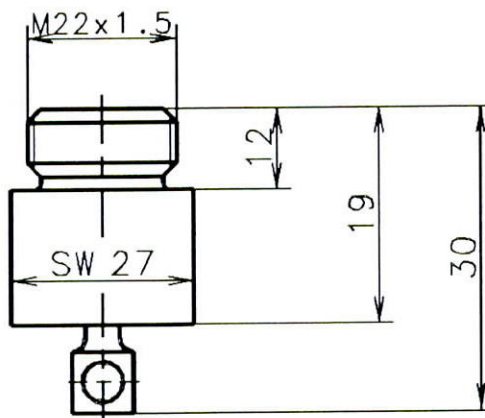
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Standard for surface roughness												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R _a max. value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768-1989)						
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.						
Dim. measurement	0.5	over 0.5	over 30	over 120	over 315	over 1000
Permissible deviations	up to 6	up to 30	up to 120	up to 315	up to 1000	up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

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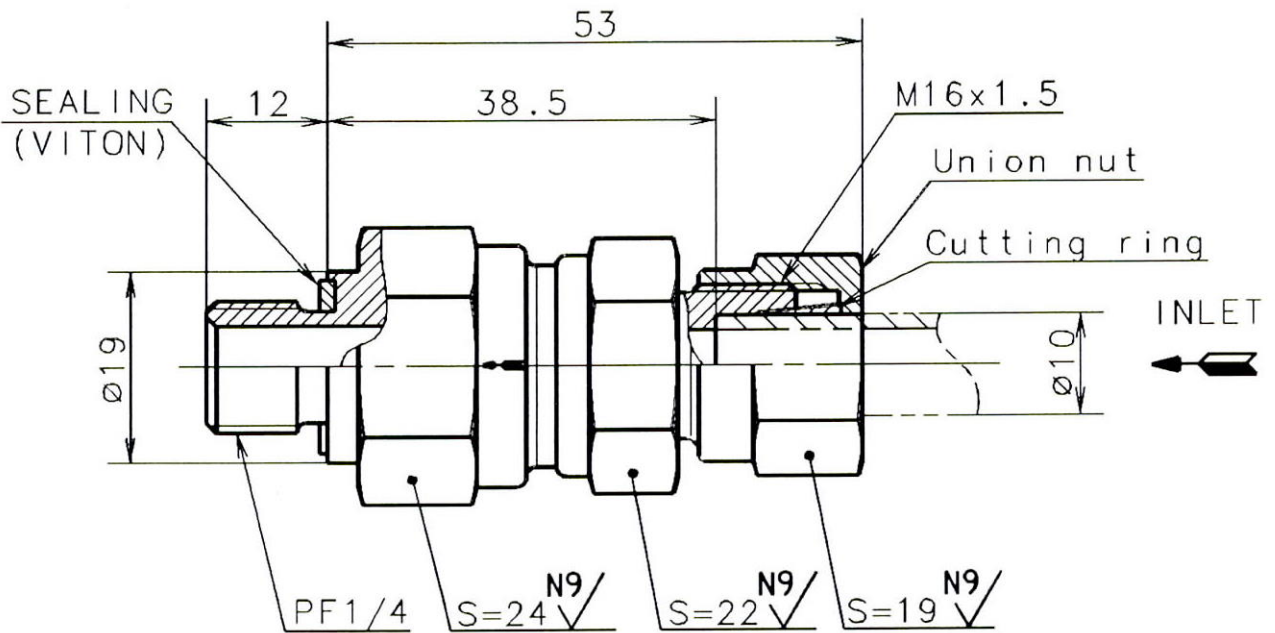
- 126 Make or similar: WESTINGHOUSE
- 455 Type: 934 300 001 0
- 002 Max. working pressure: 20 bar
- Max ambient temp. 70°C
- Medium: Air/water

POSITION NO. ON DIAGRAM ②①, ②②

Supplement Dwg no.:		Projection:		Mass (kg): 0.05		Material / Blank:	
		Licensor's Ident. no.: 428431-8.2		Dist.:		Licensor's Material / Blank:	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
				*	*		0
960423PKYBJSBHSZ4							
Similar Drawing No.:				Replacement of Ident. No.:			
Scale:	Size: A4	Type:		Page No.: 01 (01)			
Info. No.: 238171		Description: DRAIN VALVE				Ident. No.: A14-136129-4	

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Working pressure : 100 bar

POSITION NO. ON DIAGRAM ⑬

Opening pressure : 0.5 bar

Surface treatment : Cadmium plated

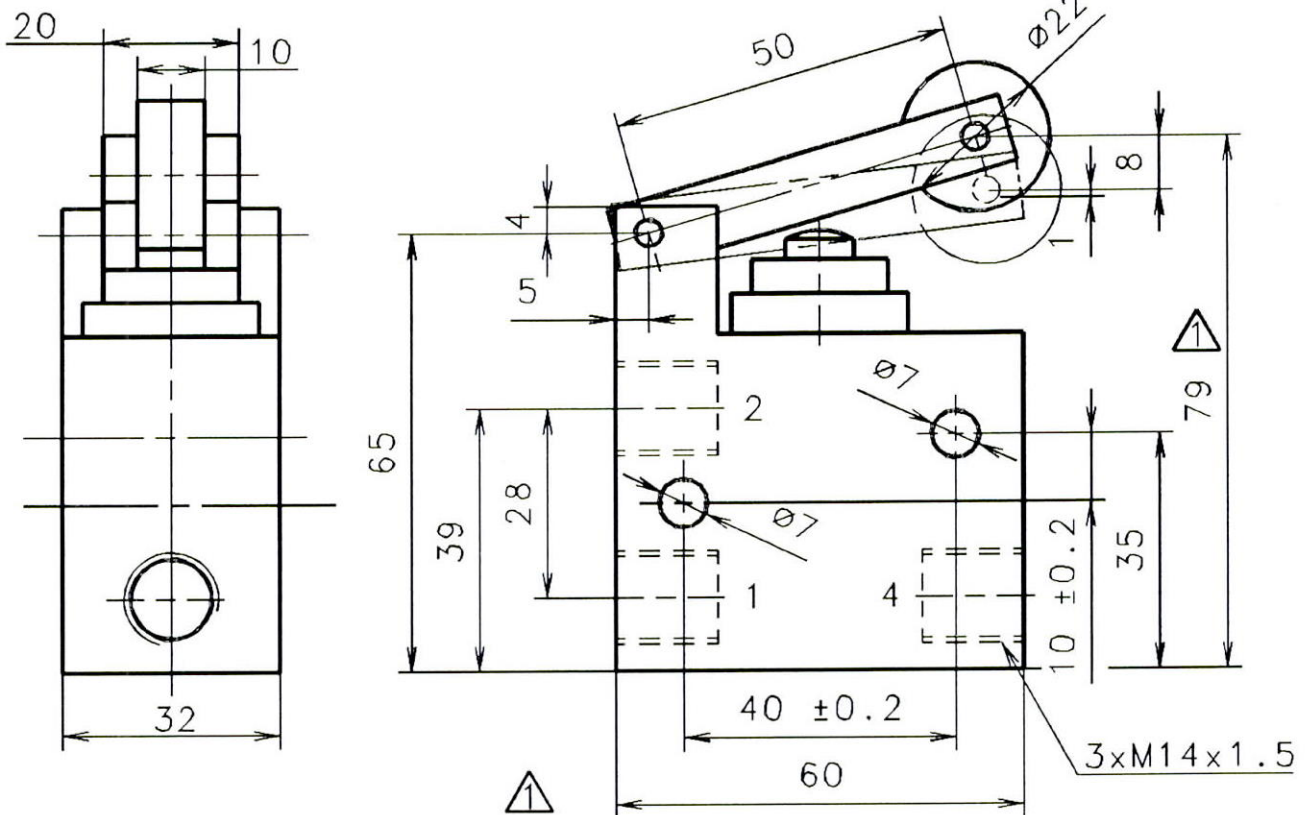
Execution : With sealing, union nut and cutting ring

Media : Fuel oil and lubricating oil

Standard for surface roughness (ISO 1302-1978)		Supplement Dwg no.:		Projection:		Mass (kg):		Material / Blank:	
Close No.	N1	N2	N3	N4	N5	N6	N7	N8	N9
Rmax (μm)	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3
Tolerances for dimensions without tolerance indication (ISO 2768-1989)									
Permissible deviation	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2			
Medium series									
Scale:	1.5:1		Size:	A4		Type:			
Info. No.:			Description:	NON-RETURN VALVE, MALE			Ident. No.:	A14-138339-6	
Similar Drawing No.:		951221CJC		COGYKSL		Replacement of Ident. No.:			
Page No.:		01 (01)		HYUNDAI		HEAVY INDUSTRIES CO., LTD.			

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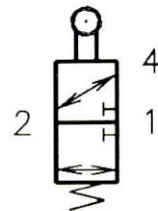
-126 Make or similar: 1125

-455 Type: 363 007 000 0

-002 Working pressure: max. 10 bar

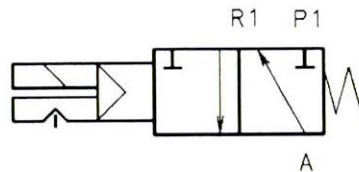
-454 Temperature: -20 - +70°C

-619 Medium: Air



POSITION NO. ON DIAGRAM ⑪⑤

Supplement Dwg no.:		Projection:		Mass (kg): 0.2		Material / Blank:	
		Licensor's Ident. no.: 477727-2.4		Dist.:		Licensor's Material / Blank:	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
000529KJMJJDYKBY				*	*	WESTINGHOUSE --> 1125.	1
980207JDYYGSSCR				*	*		0
Similar Drawing No.:				Replacement of Ident. No.:			
Scale: 1:1	Size: A4	Type:		Page No.: 01 (01)			
Info. No.: 677063		Description: 3/2 WAY VALVE				Ident. No.: A14-158710-2	



1 -455 Type: 372 352 222 0
Max. working pressure: 10 bar
Min. working pressure: 3 bar
Nominel diameter: ND 7
Temperature: -25°C to +80°C
Medium: air
Connection: M14x1,5
Voltage: 24V DC
Nominel current: 0.190 A
Protection: IP65

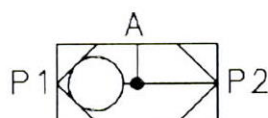
2 -455 Type: 894 101 610 2

Supplement Drawing No.:				Projection:		Mass (kg):		Material / Blank:		
						0.75				
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:		
				0557611-5.7						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No
				*	*	Replaced by Ident. No.:				9
				*	*					8
				*	*					7
				*	*					6
				*	*					5
				*	*					4
				*	*					3
				*	*					2
				*	*					1
				*	*					0
960517PKYR.ISRHS74										

HSEF-k210-012(R1)

현대중공업(주) 엔진사업본부

A3 (420mm x 297mm) 大3号

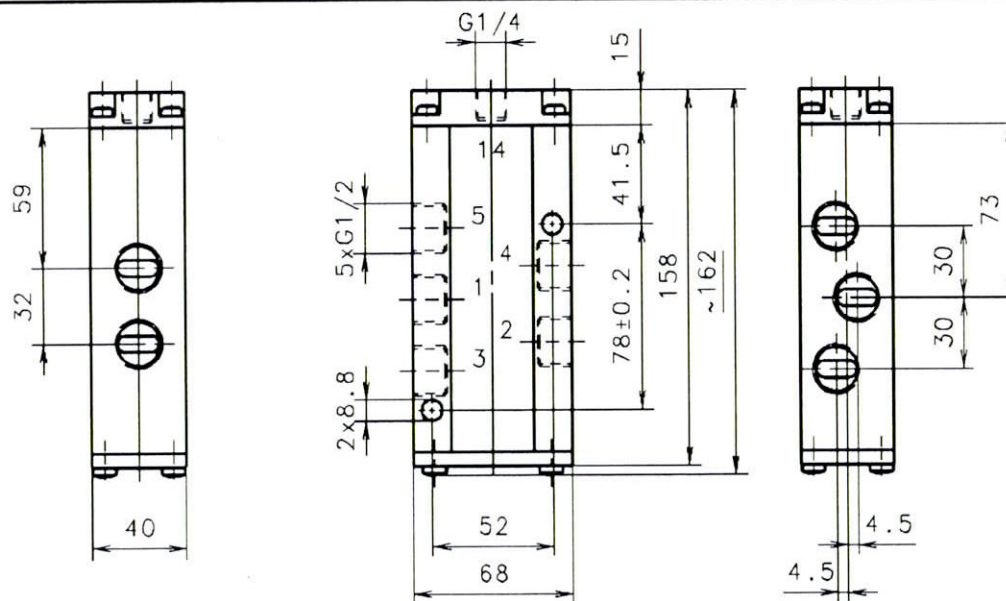


#125 Make: WESTINGHOUSE, 1125

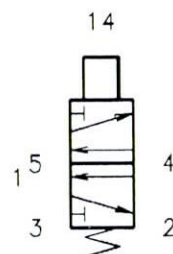
#455 Type: 534 017 000 0

#002 Working pressure: Max. 10 bar
Min. 0.3 bar
Max. ambient temp. -20 to +60°C
Medium: Air
Thread: M14x1.5 A

CAD Drawing - do not correct by hand



-125 Make: 1125
 -455 Type: 571 100 030 0
 -002 Working pressure: max. 10 bar
 min. 2 bar
 -454 Temperature: -25 - +70°C
 -619 Medium: Air
 Connection: ISO228/1



POSITION NO. ON DIAGRAM ⑫, ⑥⑧

Supplement Drawing no.:						Projection: 1.0		Mass (kg):		Material / Blank:	
Licensor's Ident. no.:						1210299-6.2		Dist.:		Licensor's Material / Blank:	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No
				*	*	Replaced by Ident. No.:					9
				*	*						8
				*	*						7
				*	*						6
				*	*						5
				*	*						4
				*	*						3
				*	*						2
				*	*						1
				*	*						0

020730KSYKSYEHJ

Similar Drawing No.:			Replacement of Ident. No.:		
Scales: 1:1		Size: A3		Type:	
Info. No.:		677806		Description:	
		5/2 WAY VALVE		Ident. No.:	
				A13-227470-1	

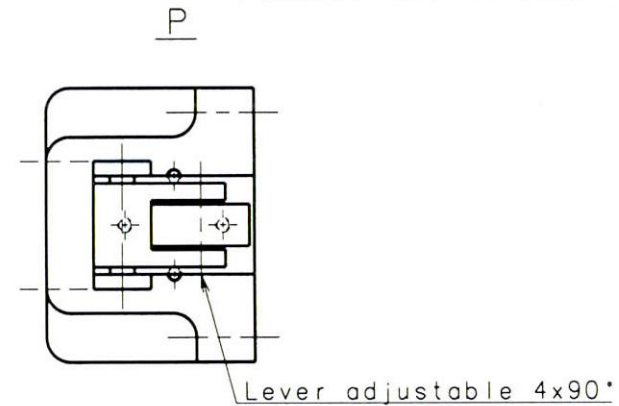
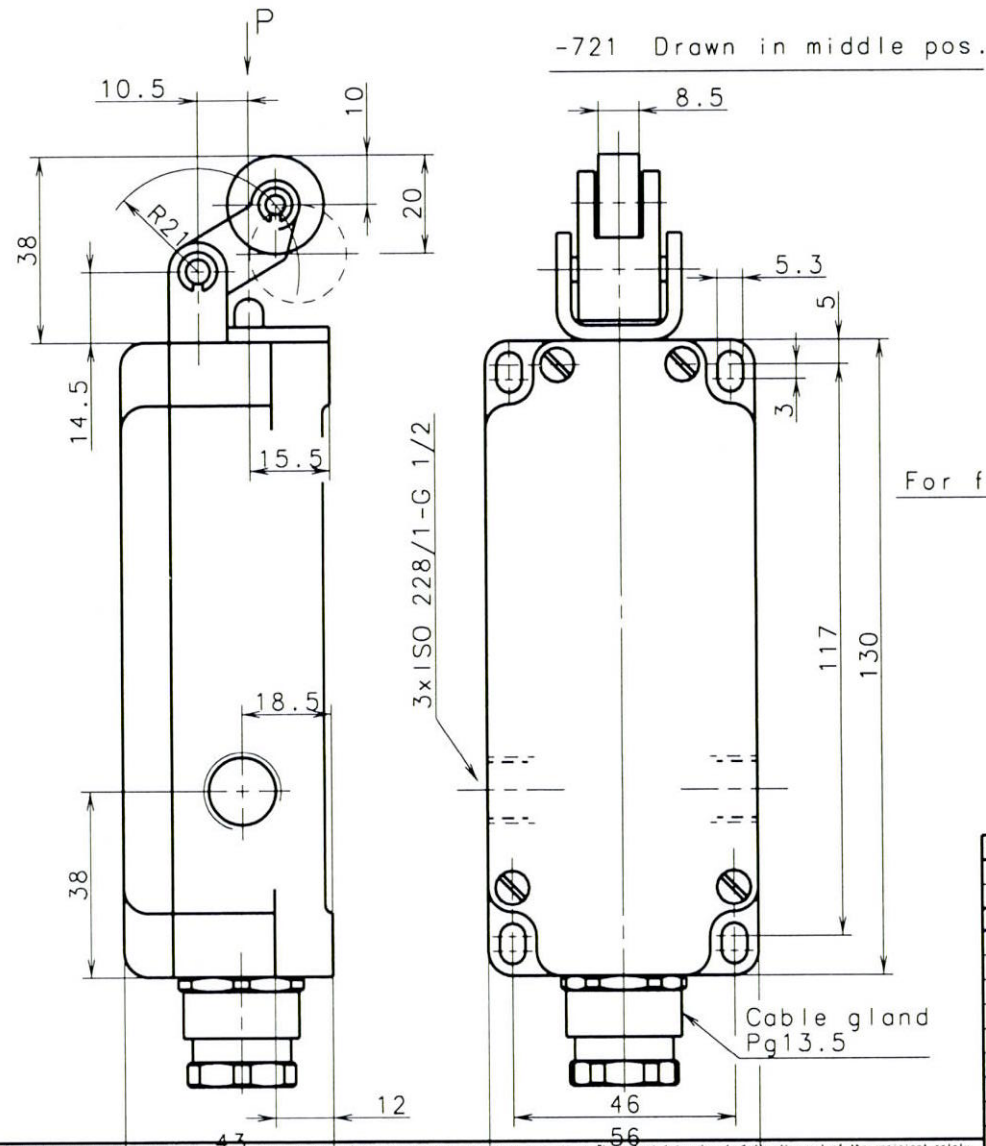
PAGE NO. 10

HSEF-k210-012(R1)

현대중공업(주) 엔진사업본부

A3(420mm×297mm) B4g8

POSITION NO. ON DIAGRAM ⑫①, ⑫③

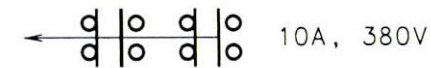


For fitting of lever direction: See arrangement drawing

-126 Make or similar: 1100

-455 Type : MK 017-22Y

TERMINALS



Supplement Drawing no.:				Projection:		Mass (kg):		Material / Blank:			
						0.44					
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blank:			
				0547439-8.4							
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No.	
				*	*	* Replaced by Ident. No.:				9	
				*	*					8	
				*	*					7	
				*	*					6	
				*	*					5	
				*	*					4	
				*	*					3	
				*	*					2	
961010YSB				SDCLSJ		* * CABLE GLANDS PG13.5 ADDED				1	
900829LGH				SDCKSW		* *				0	
Similar Drawing No.:					3-459195-2					Replacement of Ident. No.:	
Scale:		Size:		Type:		Page No.:					
1:1		A3		L/SMC		01 (01)					
Info. No.:		Description:				Ident. No.:					
698013		SWITCH 111-...VOLTS				A13-004551-7					

tarting air
istributor
s BLOCKED

The diagram shows the internal mechanism of the starting air distributor in its closed state. A horizontal piston rod extends from the left, connected to a large cylindrical piston. The piston is positioned against a vertical stop, preventing rotation. To the right of the piston, a lever arm is pivoted at its base. The lever's tip is engaged with a small pin or valve stem, which is currently closed. Further right, another horizontal rod passes through the assembly, featuring a hexagonal nut and a circular flange. This rod terminates in a rectangular handle labeled "PILOT-AIR INLET". Below the main body, a dashed outline indicates the "OPEN" position where the lever would rotate downwards.

CLOSED

PILOT-AIR INLET

OPEN

Starting air
distributor

POS
Supplie

[illegible]

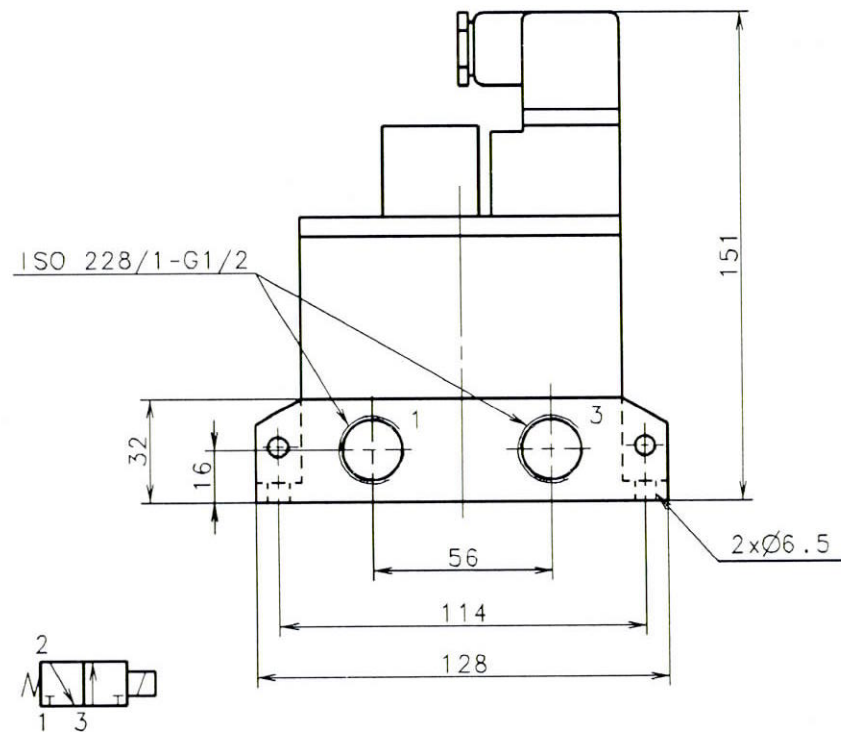
Supplement Drawing no.:				Projections:		Mass (kg):		Material / Blanks:		
						2.5				
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blanks:		
				3171987-1.0						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No
				*	*	Replaced by Ident. No.:				9
				*	*					8
				*	*					7
				*	*					6
				*	*					5
				*	*					4
				*	*					3
				*	*					2
				*	*					1
				*	*					0
040Z19PKYPKYKJG										

Supplement Drawing no.:				Projections:		Mass (kg):		Material / Blanks:		
						2.5				
				Licensor's Ident. no.:		Dist.:		Licensor's Material / Blanks:		
				3171987-1.0						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement				C.No
				*	*	Replaced by Ident. No.:				9
				*	*					8
				*	*					7
				*	*					6
				*	*					5
				*	*					4
				*	*					3
				*	*					2
				*	*					1
				*	*					0
040Z19PKYPKYKJG										

[illegible]

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A3(420mm×297mm) 世嘉3A



Temperature range: -20° – $+70^{\circ}\text{C}$

Supplement Drawing no.:					Projection:		Mass (kg):		Material / Blank:		
					1		1.145				
					Licensor's Ident. no.:			Dist.:		Licensor's Material / Blank:	
					1235947-9.1						
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement					C.No
				*	*	Replaced by Ident. No.:					9
				*	*						8
				*	*						7
				*	*						6
				*	*						5
				*	*						4
				*	*						3
				*	*						2
				*	*						1
				*	*						0
981013RGSGJGBHS											0

Similar Drawing No.:		Replacement of Ident. No.:	
Scale:	Size:	Type:	Page No.:
1:1.5	A3		01 (01)
Info. No.:		Description:	Ident. No.:
677051		3/2-Way Solenoid Valve	A13-163304-0

HSEF-k210-012(R1)

현대중공업(주) 엔진사업본부

A3(420mm×297mm) 用紙サイズ

SUPPLY PRESSURE	MAX.	30 bar
OUTLET PRESSURE	MIN.	1,0 bar
"	MAX	10,0 bar
"	ADJUSTED	7 bar
FLOW RATE		
SUPPLY PRESSURE	30bar	4000l/min
"	15bar	2100l/min
SAFETY VALVE		
RESPONSE PRESSURE		8,5 bar
FILTER, POROSITY		25 μ m
AMBIENT TEMPERATURE		MAX. 170°
ADMISSIBLE MEDIUM		COMPRESSED AIR

1	CUT OFF COCK	7	352 032 410 0
2	CHECK VALVE	6	534 098 140 0
2	PRESSURE GAUGE	5	353 019 010 0
2	SAFETY VALVE	4	134 607 003 0
2	PRESSURE REDUCING VALVE	3	535 021 541 0
2	AIR FILTER	2	J2SL10C
2	CUT OFF COCK	1	352 034 310 0
Q'TY	DESCRIPTION	POS	TYPE

Reducing unit will be delivered separately
and to be installed at hull side by shipyard

Supplement Drawing No.:						Projection:  36.00		Material / Blank:	
						LICKNADT'S IDENT. NO.:		Dist.: A92 LICKNADT'S MATERIAL / Blank:	
Date	Des.	Chk	Appd.	A-C	E	Change / Replacement			C.No
				1	1	Replaced by Ident. No.:			1
				1	1				2
				1	1				3
				1	1				4
				1	1				5
				1	1				6
				1	1				7
				1	1				8
				1	1				9
				1	1				10
041213	PKY	PKY	KJG	1	1				11

Similar Drawing No.:		Replacement of Ident. No.:	
Scale: 1 : 5	Size: A2	Type: ME / ME - C	Page No.: 01 (01) 

Info. No.:	Description:	Ident. No.:
245125	ASSY OF REDUCING VALVES	A12-231446-7

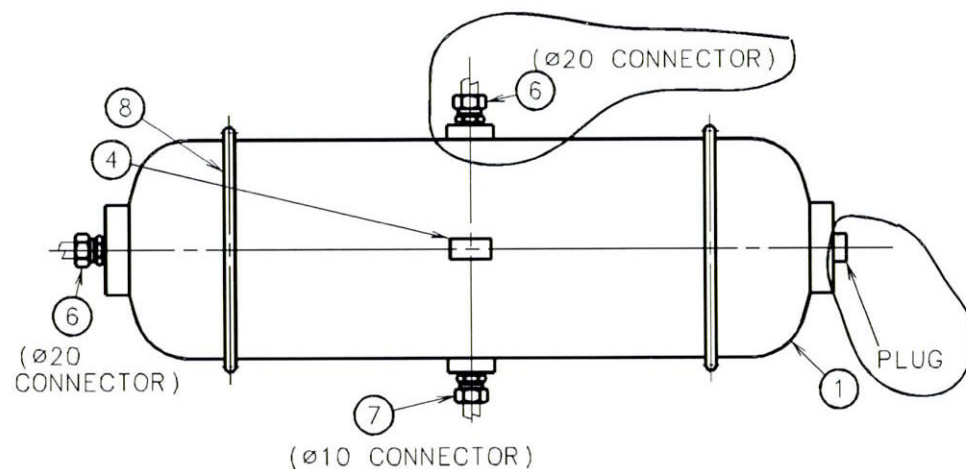
HSEF-k210-011(R1) 전(주)삼영(주) 연천사업본부 A2(394mm x 420mm) 800g

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Standard for surface roughness												
The basic symbols and class numbers are in accordance with ISO 1502-1978.												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_{max} value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication (ISO 2768- S)						
This standard states the permissible deviations for dimensions without di- rect tolerance indications as follows: components are received by suppliers						
Part	Non-measurable	0,8	over 8	over 30	over 120	over 215
	Permissible deviations	up to 8	up to 30	up to 120	up to 215	up to 1000
Medium series		±0,1	±0,2	±0,3	±0,5	±1

POSITION NO. ON DIAGRAM 150



MAX. WORKING PRESSURE : 9.9Kgf/cm²
 HYDRAULIC TEST : 15Kgf/cm²
 SCREW CONNECTION : PF1 1/2
 MEDIUM : AIR
 CAPACITY : 60 LITER

*ALL THE FITTINGS EXCEPT U-BOLT(2EA)/NUT(8EA)
 TO BE PROVIDED AS ASSEMBLED CONDITION.

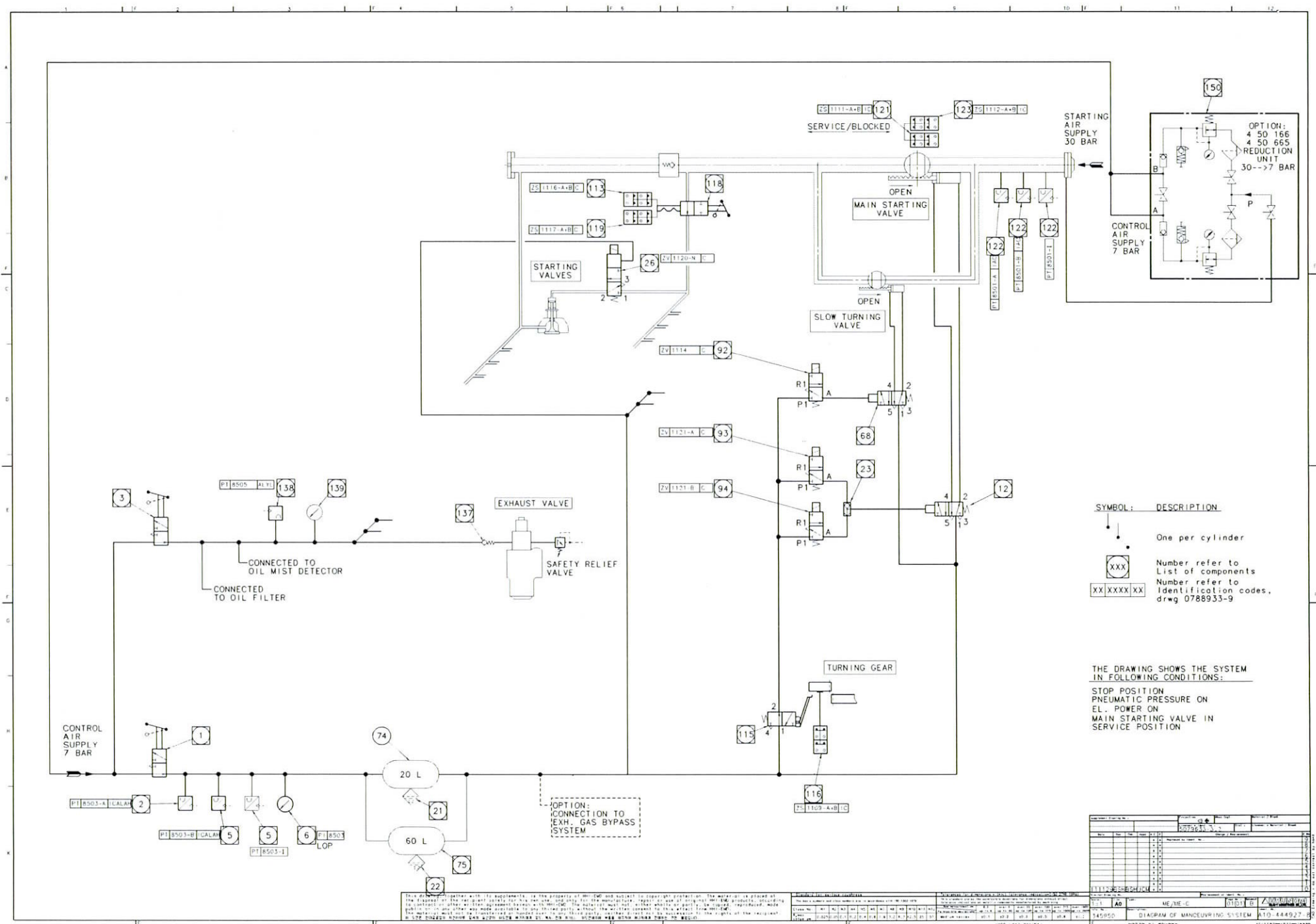
POSITION NO. ON DIAGRAM 75

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Standard for surface roughness													Tolerances for dimensions without tolerance indication(ISO 2768-1989)					
The basic symbols and class numbers are in accordance with ISO 1302-1978.													This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.					
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	Permissible deviations	0.5	over 0.5	over 30	over 120	over 315
R _a max. value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50	Medium series	±0.1	±0.2	±0.3	±0.5	±0.8

Supplement Drawing no.:		Projection:		Mass (kg): 54.00		Material / Blank:	
		Licensor's Ident. no.:		Dist.: A92		Licensor's Material / Blank:	
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
				*	*	DWG. CORRECTED.	0
060811KSYKSYKJG		041130PKYPKYKJG					
Similar Drawing No.:		Replacement of Ident. No.:					
Scale: 1:7	Size: A3	Type: K98ME, ME-C	Page No.: 01 (01)				
Info. No.: 245192		Description: ASSY. OF E/S AIR RECEIVER		Ident. No.: A13-231437-3			

2. DIAGRAM & UNITS OF PNEUMATIC MANOEUVRING SYSTEM



3. MAINTENANCE INSTRUCTIONS

Maintenance Instructions

Equipment	Kind of maintenance work.		Intervals							Lubricants
			day 1	week 1	month 1	years				
	Step	Description				1	2	4	8	
Cylinders	II							x		H1/B1 ;
Actuators	III								x	
Filters	I	Draining	x			x				H2
	I	Clean filter insert.								
	III	Replacement							x	
Lubricators	I	Check oil level	x							A1
Antifreezers	I	Fill up with antifreeze solution at temperatures below +5 °C.	x							G; H1/B5
	I	Empty completely, clean and fill up again.				x				
	II	Replace wick						x		
Check-and choke valves.	II							x		
	III	Replacement							x	
Air reservoir	I	Draining	x							
Drain Valves	II	Mech. operation	x							
	III	Replacement							x	
Safety valves	III	Replacement							x	
Change over valve	II							x		H1/B1
	III								x	
Cut-off cocks	III	Replacement						x		
Rotary connectors	II							x		H1/B1;B7
	III								x	
Control air valve.	II							x		H1/B1
	III								x	
Maneuvering valves.	II						x			H1/B1
	III							x		
Multiway valves for 10 bars	II							x		H1/B1
	III								x	
Multiway valves for 30 bars	II						x			H1/B1
	III							x		
Pressure governors	II							x		H1/B1
Hydraulic multiway valves.	III								x	

Maintenance Instructions

Chart of lubricants and detergents

mark	deterdent	Designation		application
		Wabco	General	
A1	oil		Viscosity ; up to 2 E/50 C the following types of oil may be used ; TEXACO Capella Oil AA SHELL Waxfree. Tellus 15 Diala D BP HLP-40 IS-O ARAL TT ESSO Spinesso 34 Mobil Oil Velocite No.6	for lubricators
B1	grease	WEST I	BECHEM-RHUS-GREASE LBO Fa. Carl Bechem GmbH, Hagen (Westf.) SHELL Alvania R2 ESSO Beacon 2 ARAL-Fett HL 2 TEXACO DEA Glissando Eo20 MOBIL OIL Mobilplex 47 Bp Energreuse LS 2	for rubber seals and valve housings in pneumatic devices,also for mineral oil resistent rubber seals in valves and cylinders.
B5	grease	WEST V	WACKER CHEMIE Silicon Paste P weich	for devices subject to extreme tempeatures
B7	grease	WEST VII	CALYPSOL H422 Fa.Deutsche Calypsol- Gesellschaft Düsseldorf. ESSO Beacon 2 TEXACO DEA Dealub MZ TEXACO Multifak 2 MOBIL OIL Mobilux 2	for roller bearings
C	alcohol	Wabcothy I	ethyl alcohol (ethanol, fuel alcohol)	for antifreezers
H1	Washing agents	—	gasoline for cleaning purpose	for metallic housings
H2	Washing agents	—	nitro-solvents	for sintered fillter cartridges.

available packing sizes of lubricant B=grease

designation	PC. No.	tube 0.2kg	box 0.5kg	pail 10.0kg	Volume
WEST I	830 502 010 4		x		
	830 502 011 4			x	
WEST V	830 502 015 4	x			
WEST VII	830 502 018 4	x			
Wabcothy I	830 702 087 4				11
Wabcothy I	830 702 088 4				51