UTE TSK TÉCNICAS REUNIDAS ASHUGANJ NORTH	**Ashuganj Power Station Company Ltd. (APSCL)**	

ASHUGANJ COMBINED CYCLE POWER PLANT PROJECT (NORTH)

UTS PROJECT NO. 7485	**UNIT: CIRCULATING WATER PUMPS**
PURCHASE ORDER NUMBER (P.O.R) 074850505 / F557	**EQUIPMENT : PAC**

REVIEW RESPONSE BY PURCHASER:

Purchaser review and comments do not indicate either responsibility or liability for accuracy and completeness of this document or alter any contractual terms and conditions:

☐ REJECTED	☐ Reviewed With Comments	☒ Review. Without Comments
☐ COMMENTS AS NOTED	☐ REVIEWED AS BUILT	☐ FOR INFORMATION

DATE: 10/06/15

DOCUMENT VENDOR IDENTIFICATION: FLOWSERVE

DOCUMENT TITLE: Installation, maintenance and operation manual

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INDEX

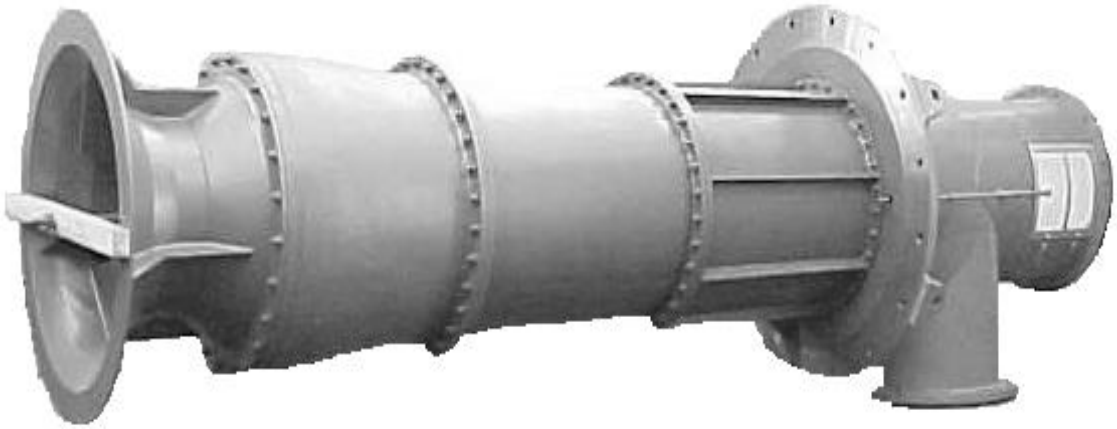
FLOWSERVE

USER INSTRUCTIONS

VCT Pumps
Type: 57 APM

Customer: TSK-INELECTRA
End user: ASHUGANJ POWER STATION COMPANY LTD.
Project: ASHUGANJ COMBINED CYCLE POWER PLANT (NORTH)

Installation
Operation
Maintenance



⚠ *These instructions should be read prior to installing, operating, using and maintaining this equipment.*

Experience In Motion

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1 INTRODUCTION AND SAFETY

1.1 General

These instructions must always be kept close to the product's operating location or directly with the product.

Flowserve products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilizing sophisticated quality techniques, and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

These instructions must be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety noted in the instructions, have been met.

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable the Directives and any additional Approvals cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals.

To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Flowserve to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organizations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorized Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by the Flowserve warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.

The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.

If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that the user seeks the written agreement of Flowserve before start up.

1.6 Safety

1.6.1 Summary of safety markings

These User Instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

DANGER This symbol indicates electrical safety instructions where non-compliance will involve a high risk to personal safety or the loss of life.

This symbol indicates safety instructions where non-compliance would affect personal safety and could result in loss of life.

This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.

CAUTION This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.

This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

This symbol is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure the cloth is damp. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

Note: This sign is not a safety symbol but indicates an important instruction in the assembly process.

1.6.2 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Always coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

1.6.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment. For products used in potentially explosive atmospheres section 1.6.4 also applies.

This manual contains instructions for installation, operation, and maintenance and servicing of your Flowserve Centrifugal Pump. It has been designed to provide safe and reliable service. It is both a pressure vessel, and a rotating machine; therefore, the operators must exercise good judgment and proper safety practices to avoid damage to the equipment and surroundings, and prevent personal injury.

It is recommended that your Safety Department establish a safety program based upon a thorough analysis of industrial hazards. Before installing, operating, or performing maintenance on the pump and associated components described in this manual the safety program must be reviewed by maintenance and operating personnel prior to installing, operating or performing any maintenance on the pump and its components.

It is important that due consideration be given to those hazards which arise from the presence of electrical power, high-pressure, high-temperature liquids, hot oil, toxic liquids or gases, and/or flammable liquids or gases. Proper installation and care of protective guards, shutdown devices, and over-pressure protection equipment shall also be considered an essential part of any safety program.

DANGER Also essential are special precautionary measures to prevent the possibility of applying power to the equipment at any time when maintenance work is in progress. The prevention of rotation due to reverse flow must not be overlooked.

In general, all personnel should be guided by all of the basic rules of safety associated with the equipment and the process.

CAUTION PREVENT EXCESSIVE EXTERNAL PIPE LOAD

Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.

CAUTION ENSURE CORRECT LUBRICATION
(See Section 5, *Commissioning, startup, operation and shutdown*.)

CAUTION START THE PUMP WITH DISCHARGE VALVE PART OPENED (Unless otherwise instructed at a specific point in the user instructions.)
This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See Section 5, *Commissioning start-up, operation and shutdown*.)

CAUTION NEVER RUN THE PUMP DRY

CAUTION INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING AND DURING START UP
Starting up or running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the seal.

CAUTION DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES
Operating at a flow rate higher than normal or at a flow rate with no back pressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/ vibration.

CAUTION UNDER NO CIRCUMSTANCES IS THE PUMP TO BE OPERATED WITH ANY SAFETY DEVICES RENDERED INOPERATIVE

DANGER NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER

HAZARDOUS LIQUIDS
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate sitting of the pump, limiting personnel access and by operator training. Wear protective clothing in the presence of caustic, corrosive, volatile, flammable, or hot liquids. If the liquid is flammable and/or explosive, strict safety procedures must be applied. Do not allow sparking, flames, or hot surfaces in vicinity of the equipment. ***Gland packing must not be used when pumping hazardous liquids.***

DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP
The appropriate safety precautions should be taken where the pumped liquids are hazardous.

FLUORO-ELASTOMERS (When fitted.)
When a pump has experienced temperatures over 250 ºC (482 ºF), partial decomposition of fluoro-elastomers (eg Viton) will occur. In this condition these are extremely dangerous and skin contact must be avoided.

HANDLING COMPONENTS
Many precision parts have sharp corners and the wearing of appropriate safety gloves and equipment is required when handling these components. To lift heavy pieces above 25 kg (55 lb.) use a crane appropriate for the mass. Consult current local regulations.

GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL
The unit must not be operated unless the guard(s) is bolted in place. Failure to observe this could result in injury to operating personnel.

THERMAL SHOCK
Rapid changes in the temperature of the liquid within the pump can cause thermal shock, which can result in damage or breakage of components and should be avoided.

NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.

HOT (and cold) PARTS
If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 68 °C (175 °F) or below 5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

1.6.4 Products used in potentially explosive atmospheres
This section only applies to products used in potentially explosive atmospheres.

Ⓔx Measures are required to:

- Avoid excess temperature
- Prevent build up of explosive mixtures
- Prevent the generation of sparks
- Prevent leakages
- Maintain the pump to avoid hazard

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. Both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC.

1.6.4.1 Scope of compliance

Ⓔx Use equipment only in the zone for which it is appropriate. Always check that the driver, variable speed coupling (if included), drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the coupling, driver and any additional equipment, with the necessary CE Certificate/ Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating affects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.

Ⓔx **II 2 GD c 135 ºC (T4)**

Equipment Group
I = Mining
II = Non-mining

Category
2 or M2 = High level protection
3 = normal level of protection

Gas and/or Dust
G = Gas; D= Dust

c = Constructional safety
(in accordance with prEn13463-5)

Maximum surface temperature (Temperature Class)
(See Section 1.6.4.3.)

1.6.4.3 Avoiding excessive surface temperatures

Ⓔx ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate.

The surface temperature on the pump is influenced by the temperature of the liquid handled. The maximum permissible liquid temperature depends on the temperature class and must not exceed the values in the table that follows.

Temperature class to prEN 13463-1	Maximum surface temperature permitted
T6	85 °C (185 °F)
T5	100 °C (212 °F)
T4	135 °C (275 °F)
T3	200 °C (392 °F)
T2	300 °C (572 °F)
T1	450 °C (842 °F)

The responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

If an explosive atmosphere exists during the installation, do not attempt to check the direction of rotation by starting the pump unfilled. Even a short run time may give a high temperature resulting from contact between rotating and stationary components.

Where there is any risk of the pump being run against a closed valve generating high liquid and casing external surface temperatures it is recommended that users fit an external surface temperature protection device.

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitor or a power monitor and make routine vibration monitoring checks.

In dirty or dusty environments, regular checks must be made and dirt removed from areas around close clearances, bearing housings and motors.

1.6.4.4 Preventing the build up of explosive mixtures

ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition the fitting of an appropriate dry run protection device is recommended (eg liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapour or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking and anti-static for Category 2.

To avoid the potential hazard from random induced current generating a spark, the earth contact on the baseplate must be used.

Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth; ensure cloth is damp.

The coupling must be selected to comply with 94/9/EC and correct alignment must be maintained.

1.6.4.6 Preventing leakage

The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance.

Avoid entrapment of liquid in the pump and associated piping due to closing of suction and discharge valves, which could cause dangerous excessive pressures to occur if there is heat input to the liquid. This can occur if the pump is stationary or running.

Bursting of liquid containing parts due to freezing must be avoided by draining or protecting the pump and ancillary systems.

Where there is the potential hazard of a loss of a seal barrier fluid or external flush, the fluid must be monitored.

If leakage of liquid to atmosphere can result in a hazard, the installation of a liquid detection device is recommended.

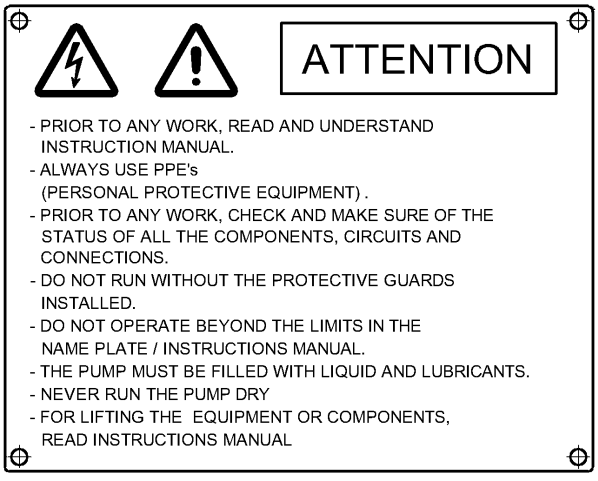
1.6.4.7 Maintenance to avoid the hazard

CORRECT MAINTENANCE IS REQUIRED TO AVOID POTENTIAL HAZARDS WHICH GIVE A RISK OF EXPLOSION

The responsibility for compliance with maintenance instructions is with the plant operator.

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting

1.7 Safety Labels Summary



1.8 Noise Level

When pump noise level exceeds 85 dB_A attention must be given to prevailing Health and Safety Legislation, to limit the exposure of plant operating personnel to the noise. The usual approach is to control exposure time to the noise or to enclose the machine to reduce emitted sound. You may have

already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined then machines above a certain power level will exceed 85 dB_A. In such situations consideration must be given to the fitting of an acoustic enclosure to meet local regulations.

Pump noise level is dependent on a number of factors - the type of motor, the operating capacity, pipework design and acoustic characteristics of the building.
Please refer to noise level details in section 8.3 (pump datasheets) for further details about expected noise level.

1.9 Specific machine performance

When the contract requirement specifies performance parameters to be incorporated into User Instructions, these are included in Section 10.1. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

1.10 CE Declaration

FLOWSERVE

CE

Flowserve Spain S.L, Avda. Fuentemar 26-28
Pol. Ind. -28823 COSLADA (Madrid)
Tel:++34 91 660 46 00, Fax: ++ 34 91 660 46 50

DECLARATION OF CONFORMITY

Section 1.0 MACHINE DESCRIPTION

Serial No	
Equipment/Item	
Purchase Order	
Model / Type	
Size	
CE Ex	
ATEX Compliant Ancillary Equipment	
Hydro. Pressure	
Material	
Date DD/MM/YY	
Liquid Temperature	
Flow	
Head	
Speed Min-1 / RPM	
Motor kW	
Hz	
Volts	
Amps	
Connection	
Language of User/ Final Destination	

Section 2.0 APPLICABLE DIRECTIVES / REGULATIONS

- **Machinery Directive, 98/37/EC Annex IIA up to Dec 28th 2009, 2006/42/EC Annex IIA from Dec 29th 2009**
- **EMC Directive 2004/108/EC**
- **Low Voltage Directive 2006/95/EC (73/23/EEC text identical). Only applicable to products with electrical devices with voltage input 50-1000 VAC and not applicable to hazardous areas to 94/9/EC (ATEX).**
- **Explosive Atmospheres Directive 94/9/EC (ATEX). Only applicable when the Ex marking appears in section 1.0 Equipment without the Ex marking must not be used in potentially explosive atmospheres.**

Section 3.0 APPLICABLE STANDARDS / SPECIFICATIONS

- **EN809:1998**

Section 4.0 DECLARATION

We, **Flowserve Spain, S.L**, at the above address, declare that under our sole responsibility for the supply of the machinery defined in **SECTION 1.0** above, the said machinery complies with all the applicable Directives and Regulations set out in **SECTION 2.0** above and with all the essential health and safety requirements applying to it when installed, operated and maintained in accordance with the applicable User Instruction manual(s).

Signed: A Person - Manager of a Department
(Authorised / Responsible Person)

Signed: A Person - Manager of a Department
(Authorised / Responsible Person)

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery and shipping documents for its completeness and that there has been no damage in transportation.

Any shortage and or damage must be reported immediately to Flowserve and received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

Check any crates, boxes and wrappings for any accessories or spare parts which may be packed separately with the equipment or attached to side walls of the box or equipment.

Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

The condition of the skid and covering is indicative as to the way the shipment was handled. Broken skids, torn coverings, bent hold-down bolting, broken straps, etc., indicate rough handling.

Inspect pump discharge nozzle cover. The protective covers on the pump nozzle should be in place and undamaged. If cover or seal for the cover are damaged or loose, they are to be removed and the interior areas visually inspected for accumulation of foreign materials or water. Install or replace cover and fasten securely.

Inspect the preservative coating on the various parts. If necessary, renew the preservative in areas where rubbed off or scraped to restore the parts to the as-found condition.
Inspect all painted surfaces. If necessary, touch up the areas where paint has been chipped or scraped. Paint and preservatives used are those specified in the contract and/or of Flowserve standard(s).

Driver transport blocking, screens, conduit boxes and other attached instrumentation boxes should be visually inspected for damage.

The shipping papers should be checked to determine satisfactory arrival of special tools, loose parts and/or spares (when provided), which are usually preserved and packaged in a separate box attached to the skid.

2.2 Handling

Boxes, crates, pallets or cartons may be unloaded using forklift vehicles or with slings attached to an overhead lifting device dependent on their size and construction.

Note: People responsible for pump or pump unit handling on site, in addition to these instructions, may refer to ISO 15513:2000, ISO 23813:2007 and ISO 23853:2004 for the necessary skills, training and qualification of people dealing with handling devices.

2.3 Lifting

FULLY TRAINED PERSONNEL MUST PERFORM ANY LIFTING. LIFTING MUST BE PERFORMED IN COMPLIANCE WITH LOCAL REGULATION.

IMPROPER LIFTING CAN RESULT IN INJURY TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT.

CAUTION

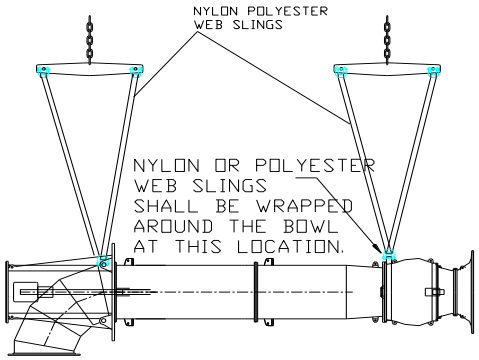
BE SURE THE LIFTING SLINGS AND/OR CHAINS ARE POSITIONED TO TAKE EQUAL STRAIN SO THAT TWISTING OR SUDDEN MOVEMENT WILL NOT OCCUR. CONTROL LINES AROUND THE PUMP OR DRIVER ARE RECOMMENDED TO PREVENT THE UNIT FROM SWINGING OR FLIPPING OVER.

MAKE SURE THAT ANY EQUIPMENT USED TO LIFT THE PUMP OR ANY OF ITS COMPONENTS IS CAPABLE OF SUPPORTING THE TOTAL WEIGHT ENCOUNTERED (SEE GENERAL ARRANGEMENT DRAWING FOR WEIGHTS) LIFTING APPARATUS MUST BE USED FOR ANY ITEM WEIGHT IN EXCESS OF 25 kg.

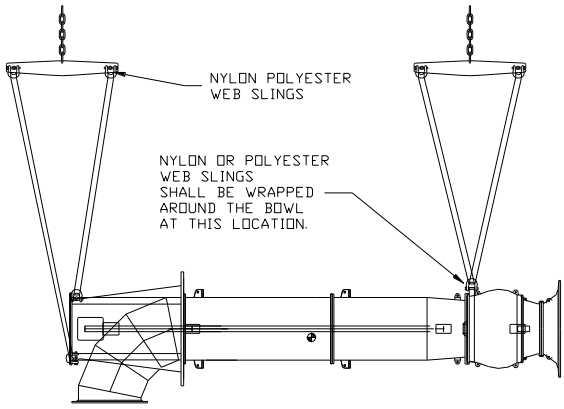
To avoid distortion, the pump unit should be lifted as shown. All lifting should be done using the lifting points that have been provided. (See the outline drawing for location, size configuration and for total equipment weight.)

Arrange any slings, chains or cables so that the weight is distributed uniformly. Use spread bars when necessary to avoid undue pressure on light sheet metal parts.

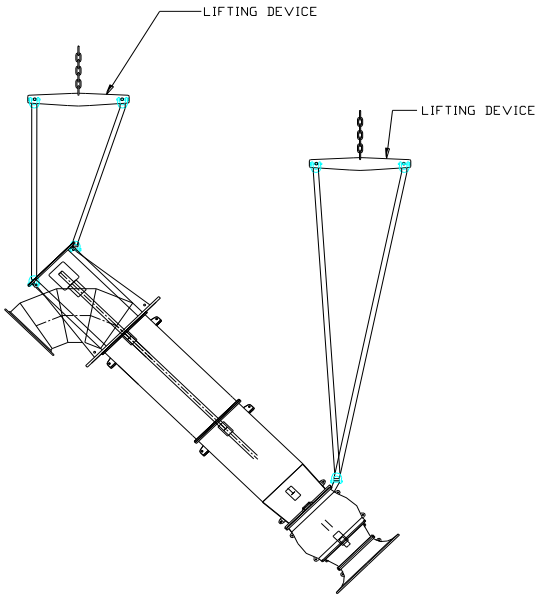
If lifting lugs are provided on discharge head baseplate lift it as shown.

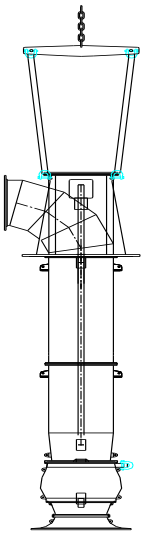


If lifting lugs are provided in the top of discharge head , lift it as follow.



For installing pump handle the pump as follow:





⚠ Fully trained personnel must carry out lifting, in accordance with local regulations. The driver and pump weights are recorded on their respective General Arrangement Drawing.

2.4 Storage

⚠ CAUTION If it is necessary to store the pump any length of time before installation, find a location where it will be protected. The nozzle and piping connection covers provided with the pump should be left in place during storage.

⚠ CAUTION The pump driver should not be stored in a damp atmosphere without special protection. Refer to driver instruction manual for storage instructions.

2.4.1 Rust preventive

Various parts of pump are coated with a thin-film of polar-type rust preventive. This can be removed by flushing with petroleum solvents. External machined surfaces are protected with durable, drying-type rust preventive. This can be removed with kerosene or other solvent.

External non-machined surfaces are painted (if not made of stainless steel). Parts ordered separately are protected with a thin-film of polar-type rust preventive. This can be removed with petroleum solvents.

2.4.2 Extended storage requirements for vertical pumps

2.4.2.1 General

During extended periods of storage prior to installation and from the time of installation until commercial operation, precautions must be taken to protect the pump from deterioration. The various parts of the pump are protected prior to shipment by applying varying grades of preservative and paint. However, during shipment and handling, the preservatives are subjected to conditions that can cause their removal. Also, during extended periods of time, the preservatives may deteriorate. The following procedures should be followed to prevent deterioration of the pump during the extended storage period. These procedures may also be supplemented by the experience of the persons performing the tasks.

It should be noted, that unless otherwise agreed to, full responsibility and costs associated with the storage and inspection of this equipment rests with the customer.

CAUTION If pump is equipped with a mechanical seal and is stored or has not been run for 1 year or more, the mechanical seal must be removed before start-up and faces re-lapped to guard against the possibility of seal leakage. When reinstalling the seal, new circular joint rings and gaskets must be used.

CAUTION If pump is equipped with a mechanical seal, the seal should be coated with preservative, boxed and stored in a warm dry place.

CAUTION Depending upon the length of time the equipment was stored and the class/type of storage provided, Flowserve may require a partial or complete dismantling of the equipment.

2.4.2.2 Storage area

When selecting a storage area, the following should be taken into consideration:

- deterioration of the equipment will be proportionate to the class/type of storage provided
- expenses involved in restoring the equipment at time of operation will be proportionate to the class/type of storage provided

CAUTION If at all possible, the pump and its component parts should be stored indoors where they will be protected from the elements. If it is not possible, precautions must be taken to protect them from the elements. Regardless of whether storage is inside or outside, the storage area should be vibration-free.

CAUTION All packages marked for inside storage must be stored indoors.

CAUTION The pump and its components when stored outdoors should be protected from dirt, dust, rain, snow or other unfavourable conditions by coverings of heavy gauge plastic sheets, canvas, waterproof burlap or other suitable coverings.

CAUTION All equipment must be placed upon skids or blocks to prevent contact with the ground and surface contaminants. Equipment must be adequately supported to prevent distortion and bending.

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CLASS OF STORAGE

Class A (Preferred)	Class B
Indoors on concrete with cribbing - temperature / humidity control	Indoors on concrete with cribbing - no temperature humidity control

Class C	Class D
Out doors on concrete with cribbing and tarpaulin under roof	Out doors on ground with cribbing and tarpaulin under roof

Class E	Class F
Out doors on concrete with cribbing and tarpaulin - no roof	Out doors on ground with cribbing and tarpaulin - no roof

2.4.2.3 Storage preferred (dry)

2.4.2.3.1 Customer Inspection and Maintenance

The stored equipment is to be placed on a periodic schedule by the customer.

The responsibility for setting up an inspection and maintenance schedule rests with the customer and will be dependent upon the class/type of storage provided and the storage conditions. It would be expected that initially inspection would occur weekly, then, depending upon the inspection reports being favourable or unfavourable, inspection would

continue weekly, monthly, or quarterly, as may be determined. Inspection reports must be kept on file.

Each inspection should consist of a general surface inspection:

a) Pump supports are firmly in place.

b) Pump covers over openings are firmly in place.

c) Pump covering, plastic or tarps, is firmly in place. Any holes or tears must be repaired to prevent entrance of dirt or water.

d) Pump covers are periodically removed from openings and interior accessible areas inspected. If moisture has accumulated or surface rusting occurred, dry out and clean or re-coat with preservative.

e) Loosen suction casing/discharge casing drain plugs or flanges to allow seepage of any accumulated moisture.

f) If rusting occurs on exterior surfaces, clean and repaint or re-coat with preservative.

g) Periodically remove bearing covers and inspect for accumulation of moisture, rust and foreign material. As required, clean bearings and bearing housings and re-preserve. Install bearing cover and secure it to assure maximum protection. Bearings removed for storage should be coated with preservative wrapped in oil/wax paper and stored in a warm dry area.

h) Check individually wrapped parts for signs of deterioration. If necessary, renew preservative and wrapping.

2.4.2.3.2 Six Months Prior To Installation
Six months prior to the scheduled installation date, a Flowserve representative is to be employed to conduct an inspection. All costs involved during inspection, dismantling, restoration, replacement of parts, and re-assembly will be the responsibility of the customer. All necessary labor, tools, and cranes will be supplied by the customer. This inspection will include (not necessarily in its entirety) but not be limited to, the following:

a) An inspection of all periodic inspection records as kept on file by the customer, and all inspection reports that have been compiled during the storage period.

b) An inspection of the storage area to determine the "as stored" condition of the equipment prior to any protection covers being removed.

c) An inspection of the equipment with protection covers and flange covers removed.

d) Depending upon the length of time the equipment was stored, the class/type of storage provided, (i.e.: indoor, heated, unheated, ground floor, concrete floor; outdoors, under roof, no roof, waterproof covering, on concrete, on ground) and as a result of the inspection of a, b and c above the Flowserve representative may require a partial or complete dismantling of the equipment.

e) Dismantling may necessitate restoration of painted or preserved surfaces, and/or replacement of gaskets, circular ring joints, packing and/or mechanical seal and bearings.

Upon completion of the inspection, the Flowserve representative shall submit a report to the customer, and to the Manager of Customer Service (Flowserve), stating in detail the results of the inspection.

2.4.2.3.3 One Month Prior To Installation
One month prior to installation of the equipment, a Flowserve representative is to be employed to conduct a final inspection. This final inspection will be made to assure that the requirements of the six month inspection report were satisfactorily completed and that the equipment is ready for installation.

Upon completion of this inspection, the Flowserve representative shall submit a final report to the customer, and to the Manager of Customer Service (Flowserve) advising the results of the final inspection.
All the costs involved in conducting the final inspection will be to the account of the customer.

2.4.2.4 Storage non-preferred (wet)
It is not recommended that the rotor be subjected to extended periods of submergence or wetting prior to start-up. However, it is recognized that in some cases, a long period of time may lapse from installation until commercial operation.

If the pump must be stored after being installed and wetted, the following inspection and maintenance procedures should be performed:

a. If it is possible, the pump pit should be dewatered. Otherwise, the pump should be dismantled for proper storage
b. The exterior below mounting portions of the pump should be washed down with high pressure potable water
c. Every effort should be made to wash down the internal portions of the pump with high pressure potable water
d. The discharge head bent connection of the pump should be opened up to the atmosphere to

allow the greatest amount of air exchange to take place within the pump

e. The pumps should be flushed every two weeks for a period of 15 minutes during which time the pump and motor rotor should be turned manually for several rotations. This can be accomplished by using a strap wrench on the pump-motor coupling.

CAUTION STAGNANT WATER CONDITIONS MAY IMPACT SEVERELY IN THE PUMP AND PROMOTE CORROSION DAMAGE. EVERY ATTEMPT MUST BE DONE IN ORDER TO AVOID THIS CONDITION

2.4.3 Storage requirements for drivers
Generally storage must be indoors and dry. See the specific manufacturer's storage requirement.

2.4.4 Storage requirements for lube system
See the specific manufacturer's storage requirement.

2.4.5 Storage requirements for other equipments
See the specific manufacturer's storage requirement.

2.5 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and in accordance with local regulations. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current local regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.

Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current local regulations at all times.

3. PUMP DESCRIPTION

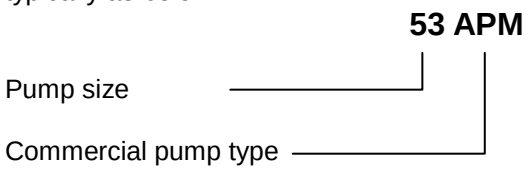
3.1 Configurations

The VCT type pump is a single stage, vertical mixed flow type pump, specifically designed for condenser cooling water service, flood control or where large capacities at relatively low heads are required and installation requirements are best suited to a vertical wet pit pump.

These pumps are vertically mounted wet pit type. They are designed to meet customer's specified material and construction requirements. Non-pull-out and pull-out pumping elements are available to fit customer's installation requirements. Open shaft or enclosed shaft with inner column construction is available.

3.2 Name nomenclature

The pump size will be engraved on the nameplate typically as below:



Identify the actual pump size and serial number from the pump nameplate. Check that this agrees with the applicable certification provided.

3.3 Design of major parts

Flowserve Pump design incorporates hydraulic and mechanical improvements resulting from years of experience in building this class of equipment.

3.3.1 Casing (1)
The casing can be cast or fabricated to meet customer material or construction specifications. When cast it is a one piece precision casting with heavy walls and vanes. Special foundry procedures involving hot shake out and stress relieving prevent subsurface cavities and eliminate shrinkage cracks. When fabricated conservative design stresses are used to insure extended life. The qualified welders flow specific quality control procedures.
All dimensions are checked to insure consistency in hydraulic performance.

3.3.2 Impeller (3)
The impellers are an open design and can be cast or fabricated to meet customer material or construction specifications. Open impeller and shroud offer improved efficiency and easily renewable clearances. Cast impellers are special low yield one piece casting formed in precision molds to assure subsurface quality and proper vane location, shape and finish. Fabricated impellers are designed with conservative design stresses.
Each impeller is checked to confirm required tolerances and vane profile is checked with templates. Dynamic balancing of the finish machined impeller insures low vibration levels.
Impeller surfaces are 100% visually inspected for surface defects and repaired by qualified welders. The impellers are locked in position by split rings which are bolted to the impeller hub on the inlet side.

3.3.3 Impeller Shroud
The impeller shroud is a one piece fabrication, bolted to the casing and bell on a non-pull-out design and bolted to the inner casing on the pull-out design. On a pull-out design the shroud is removed with the pumping element. Special consideration is given to fabrication procedures to remove locked-in stresses and provide the necessary finish to permit uniform running clearances with the impeller for extended high efficiency performance.

3.3.4 Suction bell (15)
The suction bell is a heavy wall one piece casting or fabrication with optimum shape and finish for efficient velocity increase and vortex suppression. The suction bell has straightening vanes to minimize flow disturbances at the impeller eye and to assure high design point efficiency.

3.3.5 Discharge Head (361)
The discharge head can be cast or fabricated to meet customer material or construction specifications. On a pull-out pump the discharge head involves two pieces. The discharge elbow and the discharge head liner, integral with the pull-out cover, efficiently change the direction of the flow from the column to the discharge nozzle. On a non-pull-out pump the discharge head is a one piece casting or fabrication, and turning vanes or long radius elbow is employed to accomplish the change of flow direction.
On all models the discharge head is conservatively designed to accept the continuous reaction force resulting from an unrestrained expansion joint.

3.3.6 Outer Column (423)
The outer column is fabricated or cast to meet customer material or construction specifications. The outer column flanges feature precision rabbet fits to insure proper alignment of each pump section. Where necessary, support feet for blocking are provided at proper locations to simplify assembly and disassembly.

3.3.7 Shafting (10)
The shaft is precision machined for trueness and balance to minimize shaft vibration and maximize bearing life. Shaft sections are held together with keyed sleeve couplings employing a split lock collar. Torque is transmitted by the keys and axial thrust by the lock collar. To facilitate assembly/disassembly, no threaded parts are used in critical areas.

3.3.8 Bearings (138)
The bearings are cutless rubber with metal backing and will be lubricated prior to and during operation. Two bearings are installed in the casing, one adjacent to the impeller, and one at the top of the casing to carry the radial impeller loading.
Column bearings and spiders are provided as necessary to maintain a stiff rotor construction. To support the shaft in the discharge head a bearing is located adjacent to the stuffing box extension.

3.3.9 Stuffing box (264)
The stuffing box is a one piece casting and is packed due to the service and pressures. Prior to start up and during operation, injection is supplied to the stuffing box and bearings. Alternative, fabricated construction may be offered.

3.3.11 Safety devices
The pump unit has been equipped with safety guards at each coupling for preventing mechanical hazards. At mechanical seals and flexible joint areas, also guards preventing fluid ejections are supplied. All the guards mentioned above are in accordance with EN ISO 13857, EN 349, EN 953 and EN 60529 Standards.
Other safety and control devices may be supplied upon request. Please refer to ancillary instruction manuals provided for further details.

3.4 Performance and operating limits

This product has been selected to meet the specifications of your purchase order see Section 1.5.

4. INSTALLATION

Please read all notes on General Arrangement drawing, especially those related to installation.
It's recommended to arrange an inspection to check that equipment remains in adequate conditions. Section 2.1 recommendations may be set as guidelines for this inspection

4.1 Location

When selecting pump location, allow adequate space for access, ventilation, operation, maintenance and inspection of the unit. Head room must be an important consideration for maintenance of the unit; lifts will have to be made in order to remove the pump fully assembled or by components

Note: IT IS THE RESPONSIBILITY OF THE INSTALLER TO ENSURE THAT THE DRIVER (SHIPPED SEPARATELY) IS ASSEMBLED TO THE PUMP AND ALIGNED AS DETAILED IN THIS SECTION OF THE MANUAL

4.2 Foundation

CAUTION Poor location and use of inadequate standards for the preparation of the foundation adversely affect pump life. A good foundation is particularly important since it can be a primary factor in preventing vibration, a major cause of wear and failure of the pump.

Note: The design of foundations is not the responsibility of Flowserve Corp. It is therefore recommended that the customer consult a competent specialist skilled in the field of foundations, to insure proper design and installation of the foundation.

Note: There are many methods of installing pump units to their foundations. The correct method depends on the size of the pump unit, its location and noise vibration limitations. Non-compliance with the provision of correct foundation and installation may lead to failure of the pump and, as such, would be outside the terms of the warranty. Ensure the following are met.

The foundation must be sufficiently rigid to absorb vibration and to form a permanent, rigid support for the pump. The mass of the foundation is considered to be an infinate mass in order that there will not be a resonant conection between it and the pump/motor assembly.

The combined resonant frequency of the pump, motor, foundation and discharge piping has been calculated to be sufficiently removed from the rotational speed so that no vibration amplification will occur; this analytical model has been based on the following:

a) A rigid foundation support system that has a stiffness of at least 3.72 X 10^5 kg/m. It has been assumed that the pump foundaton provides no lateral deflection to the combined assembly.

b) An assumed discharge piping stiffness has been used to simulate the effect of the discharge piping.

Non-compliance with the requirements fo a correct foundation and istallation may lead to failure of the the pump placing it outside the terms of the warranty.

4.2.1 Anchor bolts

During the (concrete) foundation pouring process soleplate anchor bolts must be positioned and installed. These must be sized to properly secure the pump soleplate and hold the pump / motor assembly rigid during all modes of operation. See figure 1 for typical anchor bolt arrangement.

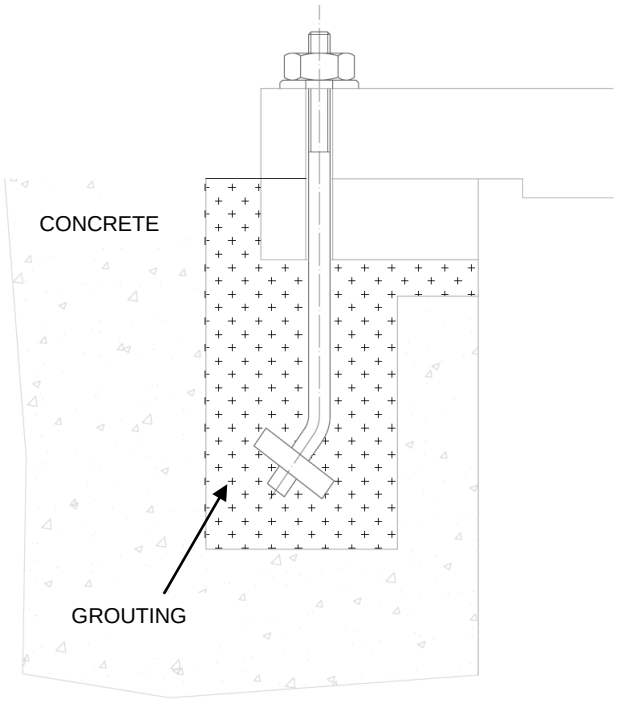


FIGURE 1

Note: REFER TO TORQUE TABLE FOR RECOMMENDED ANCHOR BOLT TORQUE

4.3 Soleplate installation

Anchoring details are shown in the general arrangement drawing.
Soleplate drills for anchor bolts have a clearance to allow levelling and alignment during installation.
Be sure threaded length of stud is large enough for soleplate and nut.
Following steps must be taken into account for soleplate installation:

a. Make ready packing pieces or metallic blocks (35 mm approx. thickness) between the anchor bolts, directly supported over concrete.

b. Make a preliminary levelling over these blocks, shimming if necessary. Set to concrete with grouting and clean top surface. In case that levelling bolts are available, they will be used for this purpose.

c. Install soleplate (471) supporting them over the levelling blocks. Level the soleplate by means of level bolts or metallic packing pieces.

d. Having installed the soleplate (471) into position on foundation, use a machinist's level to ascertain that the mounting surface of the soleplates is properly levelled (0,25 mm/meter off-level is required. See figure 2.

Note: Prior to pour grouting, be sure the concrete surface is rough enough and it is dust or sand free

e. When soleplate (471) is correctly levelled, spout grouting slowly, being sure to fill all framing surfaces. Vibrators to be used if necessary.

Note: Grouting shall be of the non shrinkable type.

f. Be sure grouting is dry, check the level stands and tight the anchor bolts nuts. Discharge head (361) is fixed to pump soleplate by means of these anchor bolts

4.4 Grouting

Note: Prior to pour grouting, be sure the concrete surface is rough enough and it is dust or sand free

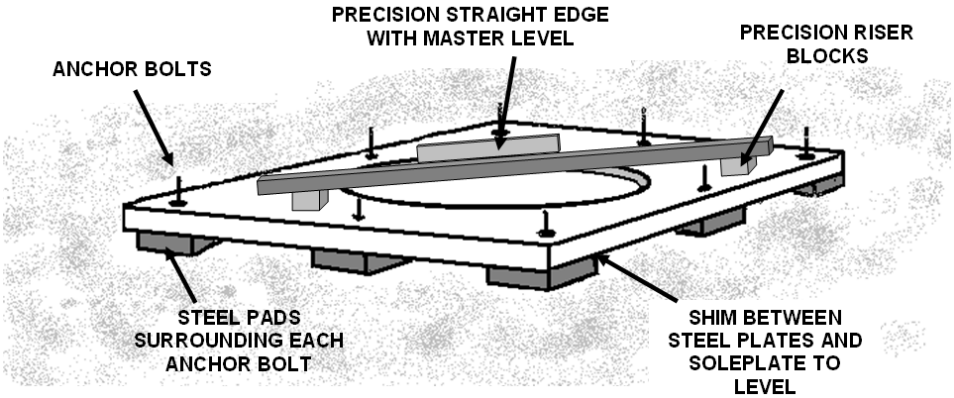
When soleplate (471) are correctly levelled, spout grouting slowly, being sure to fill all framing surfaces. Vibrators to be used if necessary.

Note: Grouting shall be of the non shrinkable type.

Be sure grouting is dry, check the level stands and tight the anchor bolts nuts. Discharge head (361) is fixed to pump soleplate by means of these anchor bolts.

Note: FLOWSERVE ENDORSES USING EPOXY TYPE GROUTS AS WELL AS A GOOD QUALITY NON-SHRINK PRODUCT SUCH AS UNISORB V-1 AND FIVE STAR

⚠ CAUTION FLOWSERVE DOES NOT ENDORSE USING ORDINARY CEMENT, SAND AND WATER MIXTURES FOR GROUT. THESE TEND TO SHRINK AS THE WATER EVAPORATES LEAVING THE UNDERSIDE OF THE SOLEPLATE INSUFFICIENTLY SUPPORTED. IT IS RECOMMENDED THAT GROUTING BE PERFORMED BY A QUALIFIED GROUT CONTRACTOR AND THAT THE GROUT MANUFACTURER BE CONSULTED FOR ANY QUESTION OR CONCERNS



SOLE PLATE MUST BE LEVEL TO WITHIN 0.25mm/m AND FLAT WITHIN 0.012mm FROM THE OUTSIDE TOWARD THE CENTER AT ANY PLACE MEASURED

4.5 Alignment

Note: Prior to align pump and motor set it's recommended to perform axial rotor setting when the pump is equipped with integral thrust bearing.

4.5.1 Thermal expansion

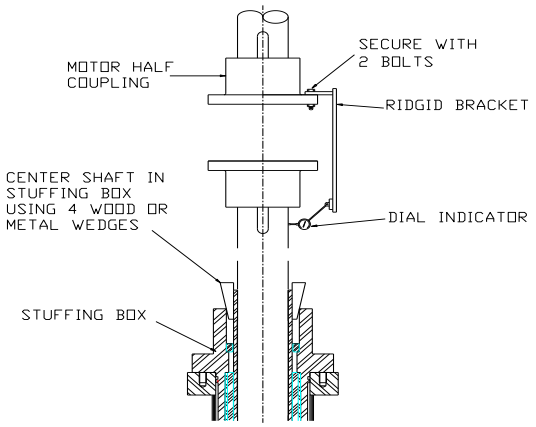
CAUTION The pump and motor will normally have to be aligned at ambient temperature and thermal expansion occurs after running at operating temperature. After eight hours of operation shut down and check the alignment immediately.

4.5.2 Alignment method

DANGER Ensure pump and driver are isolated electrically and the half couplings are disconnected.

CAUTION The alignment MUST be checked to ensure successful operation using dial indicators as follow:

a) Before mounting the motor check rotation (see point 5.3).
b) Support driver vertically, shaft facing down and thoroughly clean the shaft and mounting faces.
c) Install motor half coupling with its key and split ring on motor shaft, pull it down to seat firmly against the split ring.
d) Install pump half coupling and adjusting nut.
e) Using a dial indicator mounted to the driver half coupling, rotate driver shaft to take readings from the pump shaft, and move the driver as necessary to align driver and pump shaft within 0.002" (0.03 mm) total indicator run out and tighten driver mounting fasteners.(see Rotor setting point 5.3)
f) Refer to driver manufacturer's manual for driver operating instructions and lubrication. (See point 10.2)



4.6 Piping

CAUTION Protective covers are fitted to the discharge flange, pipe connections and suction head, to prevent foreign bodies entering during transportation and installation. Ensure that these covers and shipping brace are removed from the pump before connecting any pipes.

CAUTION Never use the pump as a support for piping.

Maximum forces and moments allowed on the pump flanges vary with the pump size and type (see general arrangement drawing for specific values). To minimize these forces and moments that may, if excessive, cause misalignment, vibration and the possible failure of the pump, the following points should be strictly followed:

- Prevent excessive external pipe load, design piping system to minimize pump nozzle loads.
- Permit no excessive strain on the pump discharge flange
- Never draw piping into place by applying force to pump flange connections
- Provide expansion joints with tie rods of suitable strength (sized for 1 ½ times shut off pressure).
- Discharge valve should be located at least one pipe diameter from face of pump discharge flange.
- Special considerations and provisions must be made to avoid the chance of water-hammer during pump operation and start up pump.

CAUTION Ensure piping is flushed before use.

4.7 Final shaft alignment check

After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free.

Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping, see point 4.5.2

4.8 Electrical connections

DANGER Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.

Ex It is important to be aware of the potentially explosive areas where compliance is an additional requirement for making electrical connections.

DANGER The motor must be wired up in accordance with the motor manufacturer's instructions in this user instruction manual, including any temperature, earth leakage, current and other protective devices as appropriate. The identification nameplate should be checked to ensure the power supply is appropriate.

A device to provide emergency stopping must be fitted.
The controller/starter electrical details will also be supplied within the controller/starter when applied.

CAUTION See section 5.3, *Direction of rotation* before connecting the motor to the electrical supply.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

CAUTION ***These operations must be carried out by fully qualified personnel.***

5.1 Pre-commissioning procedure

5.1.1 Lubrication

Determine the mode of lubrication of the pump-motor set and supply it.

5.2 Motor lubricants

See Motor's manual and motor outline in attachment in these User Instructions for motor **lubrication** details before any start up or test.

5.3 Direction of rotation

CAUTION Ensure the pump motor is given the same rotation as the pump direction arrow marked on the pump nameplate and Outline Drawing.

Some vertical motors are required to have non reverse couplings (non reverse device), to avoid pump-motor back spinning do to water column flow back during shutdown.
However the device is designed to support the forces developed by the pump, when the water is flowing back, which is increase gradually, the device is not expected to support the motor torque, which is suddenly applied as a shock a would damage the pins or ratchet plate teeth; Base on this, the motor must never be started against the ratchet pins, to avoid pins or ratchet plate damage and as in consequence, catastrophic failure to the top parts of the motor.
If the phase sequence of the incoming motor power cables is not positively known and the motor is to be "bumped" for rotation check, the ratchet pins must be removed from the pin carrier, to avoid the expected damage to the non reverse device.
The pins removal is under customer or motor installer responsibility.
Whenever the dismantling of couplings is necessary, the use of witness marks will assure a balanced condition when assembly is complete.

CAUTION If maintenance work has been carried out to the site's electricity supply, the direction of rotation should be re-checked as above in case the supply phasing has been altered.

It is recommended that records be kept pf the steady state uncoupled vibration and bearing temperatures to use for comparison with coupled and loaded conditions, and to provide a data base for judging the motor's performance in the future. These records should be permanently retained for reference.

5.4 Guarding

Guarding is supplied fitted to the pump set. If this has been removed or disturbed ensure that all the protective guards around the pump coupling and exposed parts of the shaft are securely fixed.

5.5 Rotor Setting

CAUTION Before pump start up, it is required adjust the impeller setting and avoid rubbing between impeller and impeller liner which can damage severely the pump, Rotor setting is specified on pump nameplate and pump outline drawing.
Follow next procedure in order to adjust the rotor setting:

a) Fit motor half coupling on motor shaft.

b) Fit split ring on motor shaft and move motor half coupling until it covers the split ring.

c) Fit pump half coupling on the pump top shaft.

d) Fit adjusting nut on the pump top shaft.

e) Adjust separation between adjusting nut and motor half coupling at rotor setting specified on nameplate; Use feeler gages.

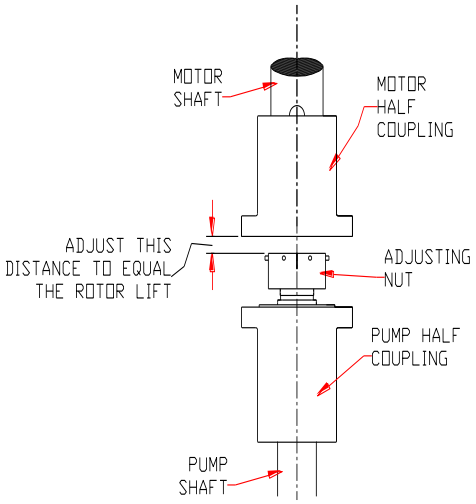
f) Turn motor half coupling so bolt holes will line up with the bolt holes in the pump half coupling

g) Insert two of the coupling bolts and tighten progressively until secure, thereby closing the gap above the adjusting nut and raising rotor to running position.

h) Insert the remaining bolts and tighten them securely.

i) Check for free rotation of driver and pump shaft. (See coupling detail in section 8)

j) If mechanical seal is supplied, the set screws of drive collar must be tighten in this moment.



5.6 Starting the pump

CAUTION

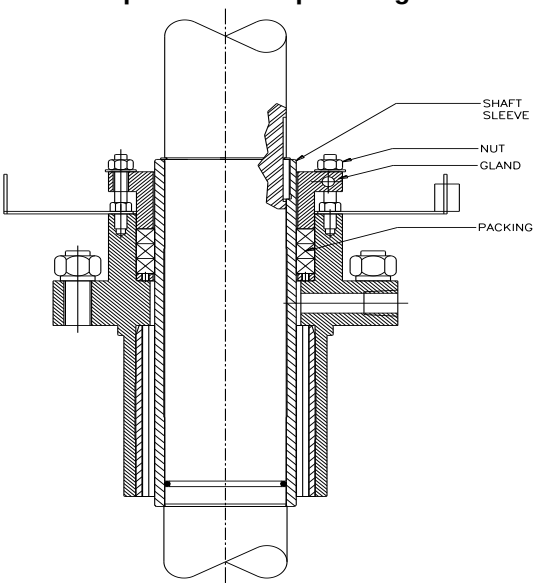
a) CLOSE the outlet valve, two –speed motor operator with valve opening and slow closing. Generally 15/45 second timing works satisfactorily for most pump systems. 15 second to open , 45 second to close totally the valve. A single speed valve motor, most economical, at 60 second should be satisfactory.
b) PRE-OPEN pump valve to 30 degrees with motor interlocked to start and stop position. The system can be primed or unprimed. If unprimed, system downstream should be fully opened and vented while hold valve to 30 degrees until system is stabilized, motor reaches rated speed and / or discharge piping is completely full.
c) On Fully Prime System using a 15/45 second valve operator. Start pump and valve simultaneously.
d) Check outlet pressure.
e) Check outlet capacity.
f) Check vibration at rated capacity. Note that vibration at different capacity than rated capacity could be bigger.
g) Check motor current.

5.7 Running the pump

5.7.1 Pumps fitted with packed gland

If the pump has a packed gland there must be some leakage from the gland. Gland nuts should initially be finger-tight only. Leakage should take place soon after the stuffing box is pressurised.

5.7.1 Pumps fitted with packed gland



If the pump has a packed gland there must be some leakage from the gland. Gland nuts should initially be finger-tight only. Leakage should take place soon after the stuffing box is pressurised.

The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland to avoid excess temperature. If no leakage takes place the packing will begin to overheat. If overheating takes place the pump should be stopped and allowed to cool before being re-started. When the pump is re-started, check to ensure leakage is taking place at the packed gland.

The pump should be run for 30 minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally a minimum of 120 drops per minute is required. Bedding in of the packing may take another 30 minutes.

Care must be taken when adjusting the gland on an operating pump. Safety gloves are essential. Loose clothing must not be worn to avoid being caught up by the pump shaft. Shaft guards must be replaced after the gland adjustment is complete.

CAUTION Never run gland packing dry or too tighten, even for a short time.

5.7.2 Pumps fitted with mechanical seal

Mechanical seals will be adjusted to pump shaft tighten collar set screws and moving set pieces after rotor setting was done according point 5.5; Any slight initial leakage will stop when the seal is run in.

Before pumping dirty liquids it is advisable, if possible, to run in the pump mechanical seal using clean liquid to safeguard the seal face.

CAUTION External flush or quench should be started before the pump is run and allowed to flow for a period after the pump has stopped.

CAUTION Never run a mechanical seal dry, even for a short time.(See mech. seal IOM manual)

5.7.3 Normal vibration levels, alarm and trip

CAUTION Alarm and trip values are given in attachment in these User Instructions. Measuring vibration at regular intervals will then show any deterioration in pump or system operating conditions.

5.8 Stopping and shutdown

a) CAUTION Close the outlet valve until 30 degrees.
b) Stop the pump motor.
c) Continue closing the outlet valve.

5.9 Emergency shutdown

In the event of power failure, water from system will flow in reverse through the pump while the pump discharge valve must be slowly closing. The pump and motor are designed so that no damage will occur from turning at speeds until 150% of rated speed which will be generated by the operating head in the pipe discharge system.

6 MAINTENANCE

6.1 General

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.8.

On completion of work all guards and safety devices must be re-installed and made operative again.

Before restarting the machine, the relevant instructions listed in section 5, *Commissioning, start up, operation and shut down* must be observed.

Oil and grease leaks may make the ground slippery. Machine maintenance must always begin and finish by cleaning the ground and the exterior of the machine.

If platforms, stairs and guard rails are required for maintenance, they must be placed for easy access to areas where maintenance and inspection are to be carried out. The positioning of these accessories must not limit access or hinder the lifting of the part to be serviced.

When air or compressed inert gas is used in the maintenance process, the operator and anyone in the vicinity must be careful and have the appropriate protection.

Do not spray air or compressed inert gas on skin.

Do not direct an air or gas jet towards other people.

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words: ***"Machine under repair: do not start"***.

With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words: ***"Machine under repair: do not connect".***

Never clean equipment with inflammable solvents or carbon tetrachloride. Protect yourself against toxic fumes when using cleaning agents.

6.2 Maintenance schedule

It is recommended that a maintenance plan and schedule is adopted, in line with these User Instructions, to include the following:

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
b) Gland packings must be adjusted correctly to give visible leakage and concentric alignment of the gland follower to prevent excessive temperature of the packing or follower.
c) Check for any leaks from gaskets and packings. The correct functioning of the shaft seal must be checked regularly.
d) Check that the duty condition (capacity, head, voltaje, current, etc.) is in the design operating range for the pump and record them.
e) Check vibration to confirm satisfactory operation.
f) Check dirt and dust is removed from areas around pump and motor.
g) Check coupling alignment and re-align if necessary.

Our specialist service personnel can help with preventative maintenance records and provide condition monitoring for vibration to identify the onset of potential problems.

If any problem are found the following sequence of actions should take place:

a) Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.
b) Ensure equipment complies with the recommendations in this manual.
c) Contact Flowserve if the problem persists.

6.2.1 Routine inspection (daily/weekly)

CAUTION The following checks should be made and the appropriate action taken to remedy any deviations:

a) Check operating behaviour. Ensure vibration is normal.
b) Check that there are no abnormal fluid or lubricant leaks (static and dynamic gasket or packing) and that any sealant systems (if fitted) are full and operating normally.
c) Check that shaft seal leaks are within acceptable limits.
d) Check the level and condition of motor lubricant. Check running hours since last recharge or complete lubricant change.
e) Check any auxiliary supplies (if fitted) are functioning correctly.

Refer to the manuals of any associated equipment for routine checks needed.

6.2.2 Periodic inspection (six monthly)

a) CAUTION Check foundation bolts for security of attachment and corrosion.
b) Check pump running records for hourly usage to determine if there is some operating change.
c) The coupling should be checked for correct alignment (If necessary).

Refer to the manuals of any associated equipment for periodic checks needed.

6.2.3 Re-lubrication

Stuffing box and radial bearings are lubricated by internal water source. Thrust bearing is oil lubricated.

Refer to the motor manual and any associated equipment for periodic checks needed.

6.3 Spare parts

6.3.1 Ordering of spares

Flowserve keeps records of all pumps that have been supplied. When ordering spares the following information should be quoted:

1) Pump serial number
2) Pump size
3) Part name – taken from sectional drawing in section 8, Parts list and drawings.
4) Part number – taken from sectional drawing in section 8, Parts list and drawings.
5) Number of parts required

The pump size and serial number are shown on the pump nameplate.
If over size or under size parts are required (like wear rings) a sketch is required with indication of diameter dimension required.
To ensure continued satisfactory operation, replacement parts to the original design specification should be obtained from Flowserve.

Any change to the original design specification (modification or use of a non-standard part) will invalidate the pump's safety certification. For Flowserve contact see section 10 at the end of these user instructions.

6.3.2 Storage of spares

Spares should be stored in a clean dry area away from vibration. Inspection and re-treatment of metallic surfaces (if necessary) with preservative is recommended at 6 monthly intervals.

6.4 Tools required

No special tool is required to maintain these pumps.

6.5 Fastener torques

6.5.1 Flange mating

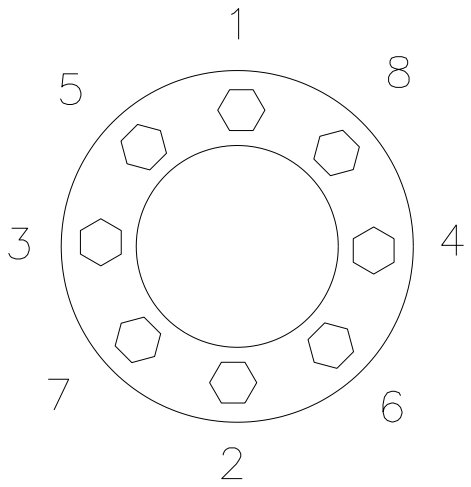
Surfaces shall be thoroughly cleaned. Assemble joint and hand tighten all fasteners to insure uniform metal-to-metal contact of the mating surfaces.

6.5.2 Using the proper size torque wrench

(Work in ¼ to ¾ of wrench scale). Pre-torque fasteners with an even steady pull to approximately 1/3 of the torque value in the sequence specified below. Repeat sequence increasing torque to approximately 2/3 of the specified value.
Finally repeat sequence for the specified torque.

6.5.3 Start with any bolt

Identify as (1) and location designated as 0°, bolt (2) will be at 180°, bolt (3) at 270° , and bolt (4) at 90°, Using counter-clockwise rotation, tighten bolt (5), (see figure below , where number of bolts are only as example) and continue rotation until all bolts have been tightened.



Tightening sequence

Note: Refer to "Torques Values" section 6.10, when assembling the pump.

6.6 Renewal of clearances

As wear takes place between the impeller and casing ring the overall efficiency of the pump set will decrease. To maintain optimum efficiency it is recommended that rings are replaced and the impeller renovated when the radial clearance detailed in attachment to this User Instructions is 1.5 bigger than new clearance.

6.7 Disassembly

Refer to section 1.6, *Safety*, before dismantling the pump. All numbers in parenthesis ( ) correspond to the part numbers on the sectional drawing.

CAUTION Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available.
Refer to sectional drawing in section 8, Parts list and drawings, for part numbers and identification.

6.7.1 Maintenance

6.7.1.1 Dismantling procedure

Your pump is a precision machine. Take precaution to avoid damage or even slight burrs to the shaft bearings areas, as well as any other machined surface when dismantling your pump.

CAUTION **Before attempting any inspection or repair on the pump, the motor controls must be in the "OFF" position, locked and tagged to prevent injury to personnel service on the pump.**

CAUTION .- **Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in personal injury to operating personnel.**

Numbers shown thus (10) are part numbers and refer to the Parts List included on the Sectional Assembly Drawing.

Follow these steps:

Take care on following points:

- Number of eyebolts used to lifting each pump subsets.
- Setting of "I" beams to support pump subset.

1. Break and tag motor circuit breaker. **Disconnect the motor leads**.
2. Remove instrumentations wires.
3. Disconnect any auxiliary piping that will interfere with dismantling. Drain oil inside thrust bearing housing (24).
4. Remove coupling guards from "windows" in discharge head (361) and/or motor support (172).
5. Disconnect the motor-pump coupling.

Note: **Make sure the coupling bolting is removed from the driver half coupling.**

6. For the equipment complete dismantling, follow the procedure in Chapter 4 in backwards.
7. Unfasten motor hold down bolting. Rig motor according to motor manufacture instructions manual. Lift it and rest carefully on blocking on the floor. Motor foundation frame has to be removed to enable dismantling of pump.
8. Dismantle pump side coupling half (185).
9. If mechanical seal (429) is supplied, loose set screws from the drive collar (in this way, the shaft and seal sleeve will have free movement).
10. Unfasten bolting joining adjusting nut (2006) to thrust sleeve. With the help of a M20 eye bolt threaded to the discharge head shaft (10D) end and a crane, pull and lift shaft (10D) and turn adjusting nut (2006) counter clockwise until it is raised more than 4 mm. Then lower carefully pump shaft (10D) to its lowest position. Now impeller (3) is resting on its shroud in the suction bell (15).
11. Loose adjusting nut (2006) completely and carefully slide it off along discharge head shaft (10D) taking care not to damage the threaded portion of it.
12. Unfasten thrust bearing housing hold down bolting to discharge head (361). With the help of some eye-bolts threaded to thrust bearing housing cover, lift it and carefully slide it off along discharge head shaft (10D) and rest it on the floor.
13. With the top shaft (10D) rigged to a crane with the help of a M24 eye bolt threaded on it unfasten the upper side rigid coupling bolts, and remove the upper coupling half (33A) Now the top shaft (10D) can be removed from the rest of the assembly . Unfasten the lower side rigid coupling bolts and remove the spacer (439) the lower coupling half (33).
14. Unfasten the studs holding the mechanical seal (429) to the stuffing box (264) and remove the mechanical seal. (see seal manufacturer instruction for disassembly)
15. Unfasten bolting joining stuffing box (264) to discharge head (361) and remove stuffing box. Discard gaskets.
16. Unfasten bolting joining discharge head (361) mounting plate to foundation plate (471).
17. Rig slings to the lifting lugs on discharge head (361) mounting plate and lift pump carefully until supporting legs on outer column (423) are out of the pit.
18. Position the two auxiliary I-beams horizontally on pit opening and lower the pump assembly until the upper outer column (423) supporting legs are resting on the two I-beams.

19. Rig the discharge head (361) to a crane, unfasten the bolts between upper outer column (423) and discharge head, lift the discharge head and leave it blocked on the floor.
20. Rig upper intermediate shaft (10C) to a crane with the help of a M24 eye-bolt threaded on exposed end of shaft.
21. Unfasten the three setscrews M8 holding the intermediate coupling sleeve and slide it back on upper intermediate shaft (10C) until the two keyways on shafts are cleared. Secure it to the upper intermediate shaft with its setscrews.
22. Remove the two keys (12C/D) split ring-shaft coupling (252). Now upper intermediate shaft (10C) can be withdrawn from the rest of the pump assembly.
23. Rig remaining pump assembly, remove the two auxiliary I-beams, lift it until supporting legs on pump outer lower column (423) are cleared, position again the two auxiliary I-beams. Lower the pump assembly until the two supporting legs on lower column (423) rest on the two auxiliary beams.
24. Unfasten bolting joining upper and lower columns (423) and lift upper column out of the assembly taking care not to damage the upper intermediate shaft (10B), column bearing (138C) or journal sleeve (135B). Position upper column blocking on floor.
25. Rig upper intermediate shaft (10B) to a crane with the help of a M24 eye-bolt threaded on exposed end of shaft.
26. Unfasten the three setscrews M8 holding the intermediate coupling sleeve and slide it back on upper intermediate shaft (10B) until the two keyways on shafts are cleared. Secure it to the upper shaft with its setscrews.
27. Remove the two keys (12C/D) split ring-shaft coupling (252). Now upper intermediate shaft (10B) can be withdrawn from the rest of the pump assembly.
28. Rig remaining pump assembly, remove the two auxiliary I-beams, lift it until supporting legs on pump lower column (423) are cleared, position again the two auxiliary I-beams. Lower the pump assembly until the two supporting legs on the pump casing (1) rest on the two auxiliary beams.
29. Unfasten bolting joining lower column (423) and pump casing (1) and lift lower column out of the assembly taking care not to damage the lower intermediate shaft (10B), column bearing (138C) or journal sleeve (135B). Position upper column blocking on floor.
30. Rig lower intermediate shaft (10B) to a crane with the help of a M24 eye-bolt threaded on exposed end of shaft.
31. Unfasten the three setscrews M8 holding the intermediate coupling sleeve and slide it back on lower intermediate shaft (10B) until the two keyways on shafts are cleared. Secure it to the upper shaft with its setscrews.
32. Remove the two keys (12C/D) split ring-shaft coupling (252). Now lower intermediate shaft (10B) can be withdrawn from the rest of the pump assembly.
33. Rig remaining pump assembly from the pump casing (1) lifting lugs or exposed flange holes, remove the two auxiliary beams, lift it.
34. Remove bolting joining pump casing (1) to suction head (15). Rig pump casing (1) and carefully slide it off taking care not to damage lower shaft (10A), bearings (138A) or journal sleeves (135A). Position on blocking on floor.
35. With the help of a M20 eye-bolt threaded in the exposed end of lower shaft (10A), lift pump rotor and with the help of a secondary crane or pulley maneuver until it gets horizontal. Then rest it on the floor on blocking supporting properly lower shaft (10A) end to avoid distortion.
36. Unfasten impeller split ring (312) bolting, remove it and carefully slide impeller from lower shaft (10A). Remove impeller key (11) from shaft.

6.8 Examination of parts

⚠ CAUTION Used parts must be inspected before assembly to ensure the pump will subsequently run properly. It is recommended to replace all gaskets, “O” rings, bearings and wear rings during overhaul.
In particular, fault diagnosis is essential to enhance pump and plant reliability.

1. Wire brush and clean all pump parts. Inspect parts for wearing, corrosion, and erosion. Inspect the impeller (3) and casing (1) for cracks.

6.8.1 Shafts (10A/B/C)

Indicate each section of shaft on rollers or V-blocks for runout.

a) Indicate each section of shaft on “V” blocks or rollers for total indicated runout (TIR). The shaft shall be supported by two “V” blocks (rollers) near the ends of the shaft at the bearing and/or coupling areas of approximately the same diameter. The TIR of the rollers (“V blocks) shall not exceed .0005 inches per foot (0.04 mm/m), with a maximum variation of 0.005 inches (0.13 mm). The shaft journals or journal sleeves must be round to within .001 inch (0.03 mm) at the support areas on the “V” blocks or rollers.

b) Total indicator readings should be taken at every bearing and coupling area and/or every 12 inches (305 mm) between long bearing spans. Record distances from end of shaft to each TIR measurement. TIR measurements are to be taken every 90 degrees around the shaft.

c) Maximum allowable TIR is .001 inch X total length of shaft in feet. Shafts that exceed the limit can be straightened by either cold straightening or heat straightening. Refer to Flowserve FSG for heat straightening procedure.

6.8.2 Journal sleeves (135A/B)

Inspect journal sleeves. If journal sleeves are worn, they can be removed from the shaft. Install new journal sleeve onto shaft and locate sleeve on its key. Install new setscrews and apply "Loctite" (Screw Lock Grade) to the threads.
Stake the setscrew threads.

Note: If the used holes for the journal sleeve setscrews cannot be located when installing the sleeves (135A/B/C) on the pump shafts (10A/B/C), the new holes will have to be drilled to spot the shaft to ensure securing of the journal sleeves (135A/B/C) in their proper location with setscrews.

6.8.3 Radial Bearings (138A/B/C)

a) Removal: remove setscrews from bearings (if supplied). Bearing can be removed by pressing it out of its respective fit.

b) Assembly: chill rubber bearing and fit into place or press bronze bearing into its fit. If graphite bearings are supplied, they can be installed using a constant hydraulic press in dry, but it is recommended that bushings be dipped in water solvent or kerosene for easier installation. Chilling carbon bearings using nitrogen or refrigerator is a good option too.

⚠ CAUTION *When installing the "cutless rubber bearing" do not chill to less that 0°F (-18ºC).The rubber portion of the bearing will detach from its respective metal backing.*

Install new setscrews (if supplied) in bearings and apply "loctite" (screw lock grade) to the threads.

6.8.4 Mechanical seal (429)

Check possible damage in shaft. Verify circulating piping is not choked. Clean stuffing box inside surface.

See mechanical seal manual.

6.8.5 Gaskets and O'rings

Renew gaskets, "O" rings during reassembly prodedure.

6.8.6 Wear rings (4/6)

Removal:

- For removing wear ring cut them down taking care not to damage impeller (3) hub or casing (1) hub.

Assembly:

a) Impeller rings (6) (when fitted) should be slipped onto the impeller and pressed down to the shoulder. (Do NOT use a steel hammer to knock them into position).

b) Drill and tap 3 holes approximately 120° apart into the diametral mating faces of the ring and impeller and insert set screws. (The existing tapped holes from the removed impeller ring cannot be re-used).

c) Casing wear rings must be fitted onto casing (Do NOT use a steel hammer to knock them into position) and locate set screws approximately 120° apart (The existing tapped holes from the removed set screws cannot be re-used).

d) Check the running clearance between impeller and casing ring. It must be inside following values: 0.8 and 0.7mm.

6.8.7 Bearing housing (24)

The thrust bearing assembly consists of a ball bearing and a taper roller bearing. This combination has been studied in order to stand the hydraulic up and down thrust as well as the complete rotor weight. It is oil bath lubricated and water cooled from external water.
Oil to be used is a good mineral grade ISO VG 68 with VI (viscosity index). Change interval is 3000 h.
Oil level must be periodically checked. Refill if necessary to keep oil level between acceptable limits

6.8.8 Coupling (185)

See Manufacturer Instructions included separately in the following sections of this manual.

6.8.9 Motor

See Manufacturer Instructions included separately in the following sections of this manual.

6.9 Assembly

To assemble the pump consult the sectional drawing GIS-04-42-PAC-md-flc-035-002-2, see section 0 *Typical Cross Section and Parts list drawings*.

6.9.1 Pump reassembly

Re-assembly and re-install the complete pumping arrangement following the dismantling procedure (see Section 6.7.) in backward sequence and instructions through Section 6.9

Use loctite ref. 243 or equivalent to fix studs and nuts.

Use loctite 515 or equivalent in the contact surface between shroud casing and column flanges, suction bell and casing flanges and impeller shroud and casing flanges.

6.9.2 Coupling reassembly

See Manufacturer Instructions included separately in the following sections of this manual.

6.9.3 Motor reassembly

See Manufacturer Instructions included separately in the following sections of this manual.

6.10 List of tightening torques

PARTS	Size	Material	TORQUE (Nm)
SUCTION BELL (15) TO CASING (1)	M33	ASTM A193 Gr. B8	530
CASING (1) TO LOWER COLUMN (423)	M33	ASTM A193 Gr. B8	530
LOWER COLUMN (423) TO UPPER COLUMN (423)	M33	ASTM A193 Gr. B8	530
UPPER COLUMN (423) TO DISCHARGE HEAD (361)	M33	ASTM A193 Gr. B8	530
MOTOR SUPPORT TO DISCHARGE HEAD (361)	M39	ASTM A307 Gr. B	975
MOTOR SUPPORT TO CUSTOMER BEAMS			
IMPELLER (3) TO IMPELLER SPLIT RING (312)	M27	ASTM A193 Gr. B8	290
STUFFING BOX EXTENSION (264) TO DISCHARGE HEAD (361)	M24	ASTM A193 Gr. B8	195
MECHANICAL SEAL (429) TO STUFFING BOX EXTENSION (264)	M24	ASTM A193 Gr. B8	195
MOTOR TO MOTOR SUPPORT (172)	M39	ASTM A307 Gr. B	975

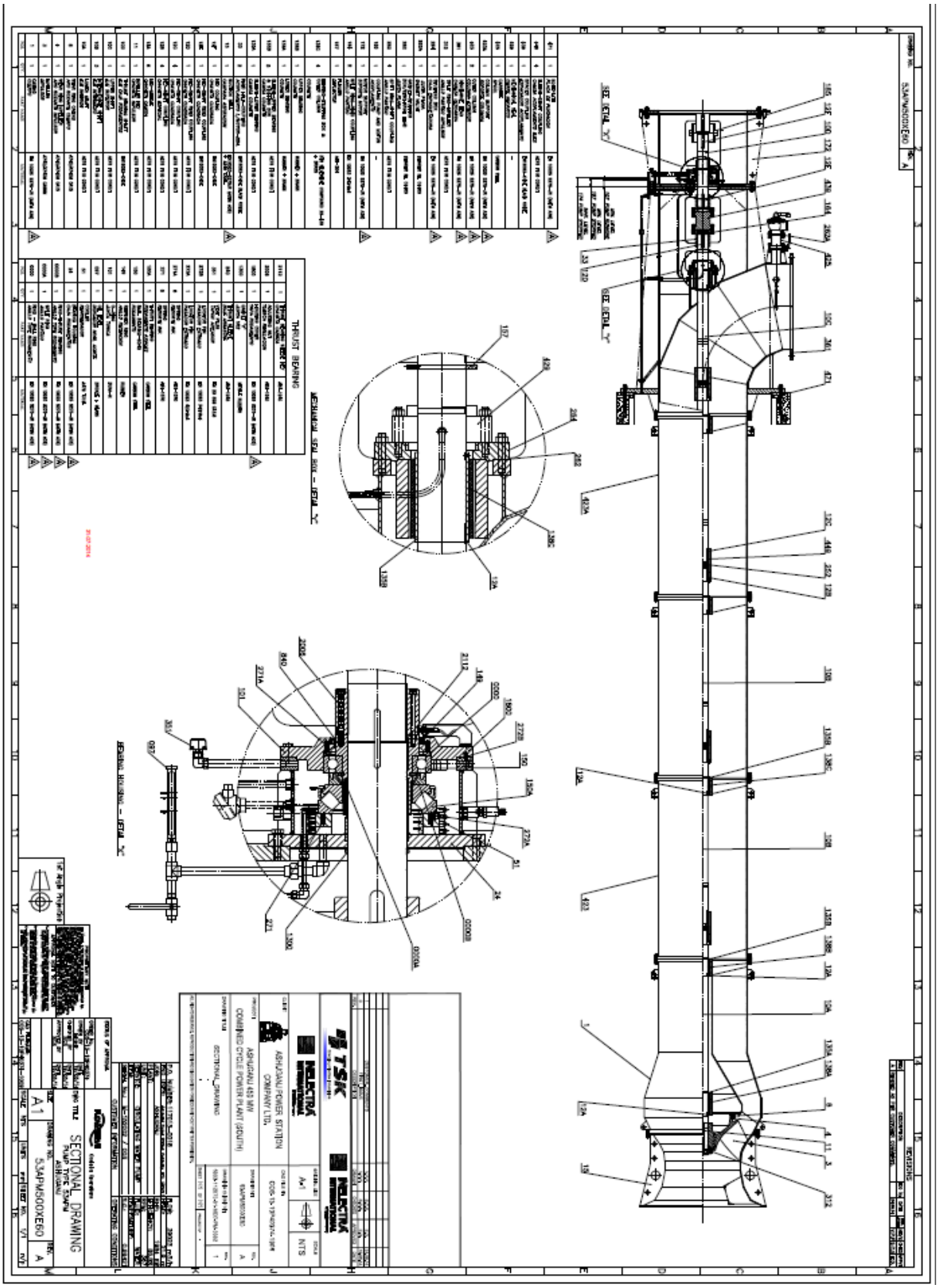
Refer to driver manufacturer’s instruction manual for trouble shooting of driver.

7. FAULTS; CAUSES AND REMEDIES

Trouble	Cause	Remedy
Insufficient Capacity	Speed too low	Check power supply to motor for correct voltage.
	Wrong rotation	Reconnect motor leads
	Foreign material in impeller, casing, diffusion vanes, and/or discharge head nozzle	Dismantle pump and remove any foreign material
	Mechanical defects: Impeller damaged. Sheared impeller key.	Dismantle pump and check
	Insufficient supply of water to be pumped	Determine proper level of water in sump and proper pump submergence.
Pump vibrates	Loose mounting or coupling bolts. Broken or worn pieces	Tighten bolts Inspect and replace them
	Coupling misalignment	Check alignment and correct
	Cavitation	Determine proper level of water in sump and proper pump submergence
	Foreign material in impeller causing unbalance.	Dismantle pump and remove foreign material.
	Mechanical defects: Shaft bent. Bearing worn.	Dismantle pump and replace part or parts causing vibration
Pump overloads driver	Speed too high	Check power supply for correct frequency
	Pump bearings seize or rotating element binds	Check rotor setting. Dismantle pump and replace parts causing rubbing, seizures or binding.
Pump stops abruptly	Pump binding at running fits	Dismantle pump and correct
Stuffing box overheats	Stuffing box packed too tight	Repack stuffing box with new packing per “Stuffing Box Packing” instructions.
	Insufficient leakage in packing	Loosen gland nuts and retighten finger tight or until proper leakage is obtained
Excessive Gland Leakage	Packing not seated	Gland not evenly tightened. Loosen nuts and tighten evenly. (see “Stuffing Box Packing” instructions)
	Worn Packing	Replace packing
Pump is noisy	Cavitation	Determine proper level of water in sump and proper pump submergence
	Loose parts	Tighten or replace defective parts
	Noise in driver	Check driver IOM manual

8-PARTS LIST AND DRAWINGS

Typical Cross Section and Parts List



9. CERTIFICATION

Certificates, determined from the contract requirements will be provided separately.

10. OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instruction manuals

Supplementary instruction determined from the contract requirements for inclusion into User Instructions such as for a driver, instrumentation, controller, sub-driver, seals, sealant system, mounting component etc. are included under this User instructions.

10.2 Change notes

If any changes, agreed with Flowserve Pump Division, are made to the product after its supply, a record of the details should be maintained with these User Instructions.

10.3 Additional sources of information

Reference 1:
NPSH for Rotordynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.

Reference 2:
Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

Reference 3:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 4:
ANSI/HI 1.1-1.5
Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

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Fax Service : (34) 91 669 43 54
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Your local Flowserve representative:

To find your local Flowserve representative please use the Sales Support Locator System found at www.flowserve.com

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FLOWSERVE

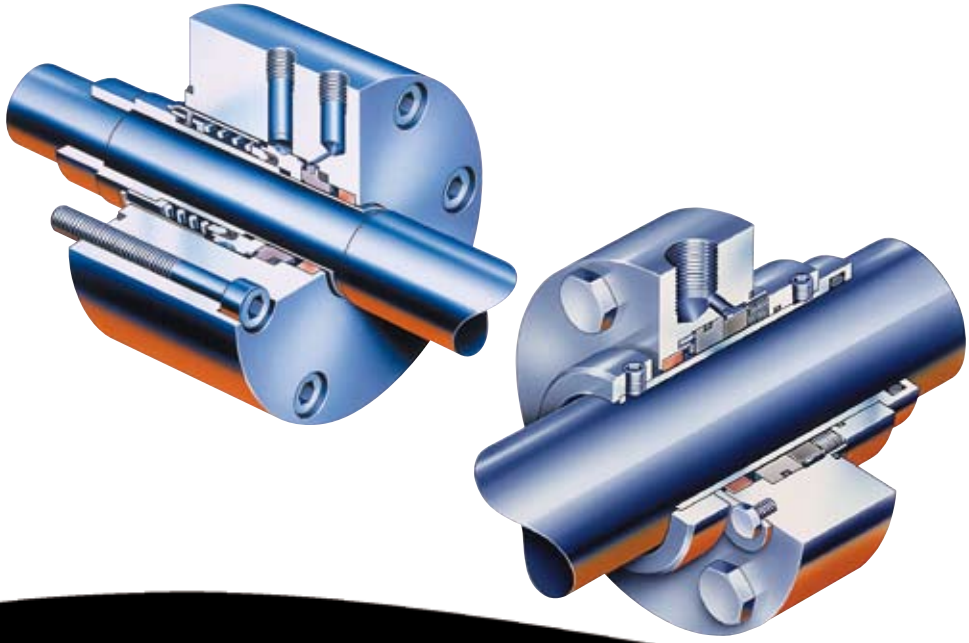
USER INSTRUCTIONS
-Original Instruction-

General Installation and Maintenance Instructions for Machinery Components

These installation instructions can be used for the following seal types:

Pusher seals: Allpac 4 series, Allpac N series, Centipac 1 series, CRO, D series, DHT series, Europac 306, Europac 6 series, FRO, GSD, GSL, HD series, HSC, HSH, LD, P series, Q series, RO, Simpac 3 series, SRO, U series, UHT series.

Bellows seals: BRC series, BX series, BXH series, BXLS series, BXRH, CBR series, CBS, GSDH, PBR, PBS, X series.



Experience In Motion

1. Drawing, Brief Description, Explosion Protection, Functional Requirements

! This mechanical seal is designed to provide reliable performance under a wide range of operating conditions. The information and specifications presented in this product brochure are believed to be accurate, but are supplied for information purposes only and should not be considered certified or as a guarantee of satisfactory results by reliance thereon. Nothing contained herein is to be construed as a warranty or guarantee, express or implied, with respect to the product.
Although Flowserve Corporation can provide general application guidelines, it cannot provide specific information for all possible applications.
The purchaser/user must therefore assume the ultimate responsibility for the proper selection, installation, operation and maintenance of Flowserve products. Because Flowserve Corporation is continually improving and upgrading its product design, the specifications, dimensions and information contained herein are subject to change without notice.

1.1 Assembly Drawing

The assembly drawing is included in the shipping box with the mechanical seal.

1.2 Brief Description

A mechanical seal is a device designed to seal a rotating shaft against a stationary housing, e.g. a pump shaft against a pump casing. The stationary components will consist of a seal ring and (depending on the design) a springloaded element. The spring-loaded element can be a spring or a bellows. The seal ring is sealed against the housing with a secondary gasket, e.g. an O-ring. The rotating components will consist of a seal ring and (depending on the design) a spring-loaded element.
The spring-loaded element can be a spring or a bellows. The seal ring is sealed against the shaft with a secondary gasket, e.g. an O-ring.

A mechanical seal can be supplied as a pre-assembled cartridge or in separate components. Assembly is done in accordance with the assembly drawing. A mechanical seal will run in the pumped product or external source fluid. Liquid seals must always have a film of liquid present between the seal faces. Gas seals must always have a film of gas present between the seal faces. The sealing surfaces are separated from each other by a fluid film (liquid or gas) during shaft rotation and in principle run without contact and thus minimal wear under these conditions.

1.3 Explosion Protection

The mechanical seal is regarded as a machine element. Machine elements do not need to comply with Directive 94/9/EC (ATEX 95 product guide) as these are regarded as an integral part of a larger piece of machinery (pump, agitator). This has been confirmed by both the EC ATEX standing committee as well as the European Sealing Association (ESA). Reference is made to following web-sites:

EC ATEX standing committee: http://ec.europa.eu/enterprise/atex/rotating.htm

ESA position statement: http://www.europeansealing.com/statements.html

For applications which require information on expected surface temperatures of the mechanical seal faces, Flowserve document “ATEX 137 information declaration” is available upon request. This document allows users to determine typical surface temperatures based upon seal design, operating conditions and face materials and may be used by the users to comply with ATEX 1999/92/EC (ATEX 137).

1.4 Functional requirements

The proper functioning of a mechanical seal is only achieved once the following conditions have been met:

- The sealing surfaces are lapped within specification.
- Perpendicularity and concentricity between the shaft and the seal chamber face and bore respectively
- Freedom of movement of the spring loaded components in axial direction
- Axial and radial shaft movements within Flowserve or OEM tolerances whichever is the tightest.
- The seal is used under the conditions for which it was selected.
- The equipment in which the seal(s) is (are) installed is operated within normal parameters (no cavitation, excess vibration etc.)
- Prevention of sedimentation on shaft or sleeve surfaces caused by for instance crystallisation or polymerisation
- Permanent liquid or gas film between the sealing surfaces, depending on seal type.

Failure to meet these requirements will result in excessive leakage and / or shortened seal life and may result in high component and surface temperatures (see the directive 94/9/EC, 1999/92/EC and EN 13463-5).

2. Safety

DANGER:

This means that personal danger or major material damage can occur when no attention is paid to this.

! ATTENTION:

This means that important information is pointed out that may also be overlooked by skilled personnel. The information can be important to avoid personal injury or material damage.

Please read these instructions carefully. Installation in accordance with the following instructions will contribute to long and trouble free running of the mechanical seal. For related mechanical seal auxiliary equipment (reservoirs, coolers, etc.), separate instructions will be provided.

The ultimate user must ensure that personnel assigned to handle, install and run the mechanical seal and related equipment is well acquainted with the design and operating requirements of such equipment.

! For this personnel it may be required to wear protective clothing as per the plant's safety regulations.

Damage to any of the seal components and in particular the faces may cause (excessive) leakage in liquid or gas form. The degree of hazard depends on the sealed product and may have an effect on people and / or the environment. Components coming into contact with leakage must be corrosion resistant or suitably protected. Normal seal leakage should not result in the formation of an explosive mixture. Plant regulations concerning work safety, accident prevention and pollution must be strictly adhered to.

This mechanical seal has been designed and built to seal rotating equipment. Damages resulting from use in other applications are the responsibility of the user.

Failure, recovery or fluctuation in power supply to the machine and/or supply system may not expose persons or environment to dangerous situations or harm the functionality of the mechanical seal.

Guards that are provided by the equipment manufacturer have to be in accordance with plant regulations, but should not create additional danger. These guards have to ensure proper access to the working area required for maintenance to the mechanical seal.

The electricity supply of the equipment must be in accordance with directive 2006/95/EC. When machinery is powered by a source of energy other than electricity this may not cause dangerous situations for persons and environment.

3. General

All illustrations and details in these installation and maintenance instructions are subject to changes that are necessary to improve product performance without prior notice.

The copyright of these instructions is the property of Flowserve. These instructions are intended for Maintenance, Operating and Supervisory personnel and contain regulations and drawings of a technical character that may not, in full or in part, be copied, distributed, or used without authorisation for competitive purposes, or given to others.

! It should be understood that Flowserve does not accept any liability for instances of damage and/or malfunctioning incurred through non-adherence to these installation instructions.

4. Transport, Storage

The mechanical seal and related equipment must be transported and stored in the unopened, original shipping box. The warehouse in which the mechanical seals and related equipment are stored must be dry and free of dust.
Avoid exposing equipment to large temperature fluctuations and radiation.

Parts or complete mechanical seals that have been dropped or otherwise have been subjected to heavy impacts during transport must not be installed.
An inspection by Flowserve or its appointed representative is strongly advised.

After a storage period of 3 years the mechanical seal must be inspected for its “as new” properties. This applies in particular to the seal faces and secondary sealing elements. An inspection by Flowserve becomes necessary.

! If the equipment is to be preserved with the mechanical seal(s) installed, the preserving medium must not impair the function of the mechanical seal by e.g. fouling of the seal faces and/or attack the secondary seals.

! The mechanical seal can in principle be transported with suitable means like lifting accessories.

5. Equipment Check

! 5.1 Follow plant safety regulations prior to equipment disassembly:

- 5.1.1 Wear designated personal safety equipment
- 5.1.2 Isolate equipment and relieve any pressure in the system
- 5.1.3 Lock out equipment driver and valves
- 5.1.4 Consult plant Material Safety Data Sheet (MSDS) files for hazardous material regulations

5.2 Disassemble equipment in accordance with the equipment manufacturer’s instructions to allow access to seal installation area.

5.3 Remove existing sealing arrangement (mechanical seal or otherwise). Clean seal chamber and shaft thoroughly.

! 5.4 Verify the shaft dimensions as shown on the seal assembly drawing. Inspect surfaces under gaskets to ensure they are free from pits or scratches. Break all sharp corners on shaft steps, threads, reliefs, shoulders, key ways, etc. over which gasket(s) must pass and/or seal against.

! 5.5 Verify the seal chamber bore or OD pilot fit as shown on the seal assembly drawing.

! 5.6 Check seal assembly drawings for any modifications (reworks) to be made to the equipment for mechanical seal installation and act accordingly.

! 5.7 The equipment must be earthed to prevent sparks due to static electricity discharge.

! Shaft runout should not exceed 0,05 mm (.002") TIR (Total Indicator Reading) at any point along the shaft for ball or roller type bearings. For sleeve type bearings, refer to manufacturer instructions. If the equipment is not completely dismantled, verify runout near seal location.

The above values apply to shaft speeds in the range from 1000 to 3600 RPM. For values above and below, consult your Flowserve representative.

See figure 1.

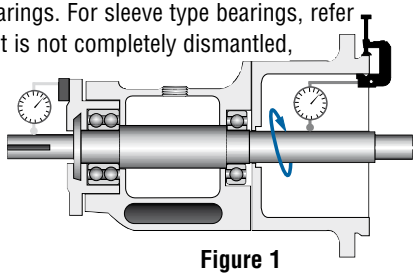


Figure 1

! Shaft endplay should not exceed 0,25 mm (.010") TIR, regardless of thrust bearing type.

See figure 2.

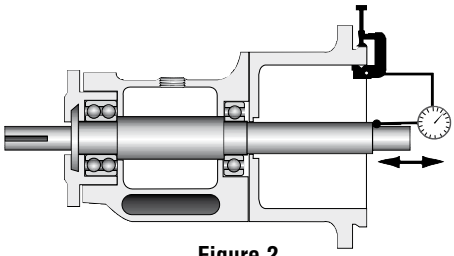


Figure 2

! Radial shaft movement should be checked against the equipment manufacturer's specifications. Generally 0,05 - 0,10 mm (.002" -.004") will be applicable for ball or roller type bearings. For sleeve or journal type bearings, values will generally be in the order of 0,10 - 0,15 mm (.004" - .006").

See figure 3.

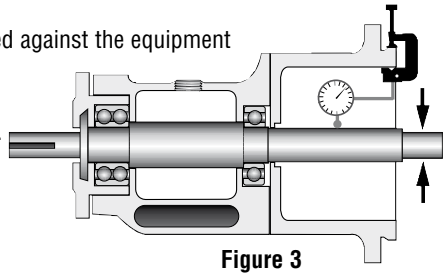


Figure 3

! Seal chamber squareness to the shaft centreline should be within 0,015 mm per 25 mm seal chamber bore (.0005" per 1" seal chamber bore).
Note: make sure that shaft endplay does not affect the reading.
Verify the smoothness of the seal chamber face for a good gasket joint.

See figure 4.

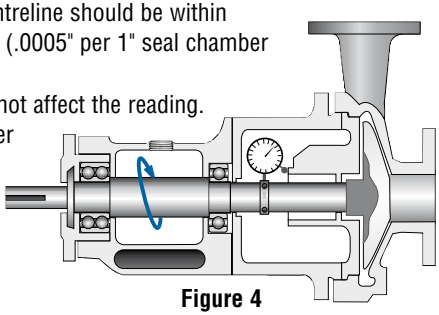


Figure 4

! Concentricity of the shaft to the seal chamber bore should be within 0,025 mm per 25 mm shaft diameter (.001" per 1" shaft diameter) to a maximum of 0,125 mm (.005") TIR.

See figure 5.

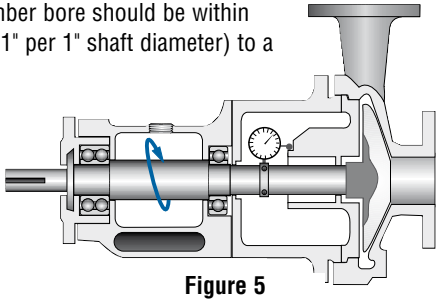


Figure 5

6. Mechanical Seal Installation

Verify that the mechanical seal is in accordance with the order documents, to ensure that the correct seal is being installed.

Take care that seal cartridge or components of the seal are handled and carried safely during installation of mechanical seal and that the ergonomic principles are followed. In order to prevent personal injuries the operator should also wear protective clothing as per the plant's safety regulations.

Correct seal setting is important for running a mechanical seal successfully.

! Incorrect seal setting can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

Cartridge seals unitize the complete seal assembly on a sleeve such that the entire seal is installed simultaneously. Component seals are assembled sequentially on the equipment and require careful measurements to properly locate and lock the rotating components relative to the stationary components. When measuring the setting or securing cartridge seals, always make sure the shaft is in the same position as when the equipment is operating (e.g. including the effects of thermal growth or contraction of the shaft relative to the casing).

To ease installation, gaskets may be lightly lubricated. Lubricant must be compatible with both handled product and gasket material. Generally, silicon grease is suitable but this should be verified before applying.

! Caution: avoid over compressing a bellows. This could result in reduced spring force and length.

Some mechanical seals are sensitive to direction of rotation. Verify that the direction of rotation of the shaft corresponds to that of the mechanical seal before installation.

Precautions must be taken for parts of the mechanical seal that will be used as support to step on during assembly operations. These parts must be protected against slipping, stumbling or falling (for example by using a strut).

6.1 Installation of Cartridge Type Seal with Setting Plates

See figure 6.

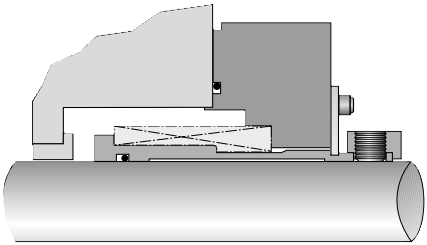


Figure 6

6.1.1 Check assembly drawing, bill of material and seal assembly prior to installation.

6.1.2 Install the seal onto the shaft and locate the gland against the face of the seal chamber.

6.1.3 Orient the ports on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.1.4 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

Do not tighten drive arrangement screws.

6.1.5 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.1.6 Ensure the setting plates are correctly located and engaged.

! Incorrect position of the setting plates can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.1.7 Tighten drive arrangement screws to the torque values shown on the seal assembly drawing.

Inaccurate tightening of these screws can lead to unsafe situation as mechanical seal may move out of the seal chamber when pressure is applied.

6.1.8 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.1.9 Disengage setting plates from the sleeve and secure tightly in disengaged position.

! Ensure that plates cannot fall back onto the sleeve as to prevent risk of contact between rotating and static parts.

6.1.10 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.1.11 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.2 Installation of a Cartridge Type Seal with Centring Tabs.

See figure 7

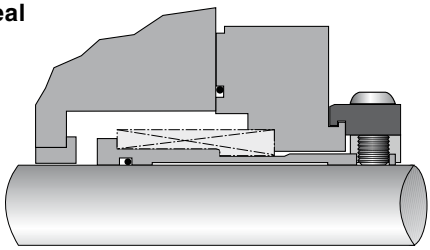


Figure 7

6.2.1 Check assembly drawing, bill of material and seal assembly prior to installation.

6.2.2 Install the seal onto the shaft and locate the gland against the face of the seal chamber.

6.2.3 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.2.4 Install gland bolts/nuts, but do not tighten. The gland must be free to move radially.

6.2.5 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.2.6 Ensure the centring tabs are correctly located and engaged.

! Incorrect position of the setting plates can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.2.7 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.2.8 Tighten drive arrangement screws to the torque values shown on the seal assembly drawing.

Inaccurate tightening of these screws can lead to unsafe situation as mechanical seal may move out of the seal chamber when pressure is applied.

6.2.9 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.2.10 Remove centring tabs and store them in a known place.

6.2.11 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.2.12 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.3 Installation of a Component Type Seal

See figure 8.

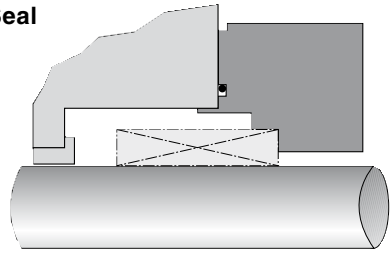


Figure 8

6.3.1 Check assembly drawing, bill of material and seal components prior to installation. Ensure seal faces and joints are free of scratches, contamination and other damage. Prior to installation, wipe lapped surfaces clean with a lint free cloth and quick drying solvent. Lubrication of seal faces is not recommended unless specified on the seal assembly drawing.

6.3.2 Assemble seal chamber and shaft (including thrust bearings, if applicable) and verify/ scribe the seal setting distance as shown on the assembly drawing. Other setting aids such as spacer rings may be indicated on the assembly drawing.

! Please note that incorrect seal setting can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.3.3 When applicable, pre-assemble the rotating and stationary components or sub-components of the seal in accordance with the assembly drawing.

6.3.4 Assemble the seal components sequentially onto the equipment, fastening the rotating components. Locate the gland(s) against the face of the seal chamber.

6.3.5 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing.

6.3.6 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.3.7 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.3.8 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.3.9 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.3.10 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.4 Installation of Seals with Hooked Sleeves (overhung pumps)

See figure 9.

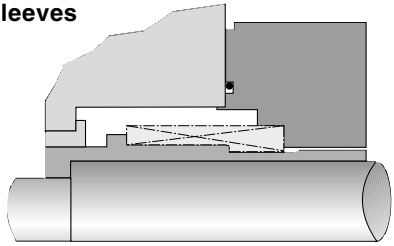


Figure 9

6.4.1 Check assembly drawing, bill of material and seal components prior to installation. Ensure seal faces and joints are free of scratches, contamination and other damage.

Prior to installation, wipe lapped surfaces clean with a lint free cloth and quick drying solvent. Lubrication of seal faces is not recommended unless specified on the seal assembly drawing.

6.4.2 Assemble seal chamber and shaft (including thrust bearings, if applicable) and verify the distance from the seal chamber face to the end of the shaft as shown on the assembly drawing.

! If this distance is not in accordance with dimension on assembly drawing the setting of the mechanical seal will be incorrect and this can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.4.3 When applicable, pre-assemble the rotating and stationary components or sub-components of the seal in accordance with the assembly drawing.

6.4.4 Assemble the seal components sequentially onto the equipment. Locate the gland(s) against the face of the seal chamber. If applicable, install drive keys as indicated on the seal and/or pump assembly drawing.

6.4.5 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.4.6 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.4.7 After the impeller nut is properly torqued, check that the sleeve is completely seated

6.4.8 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.4.9 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.4.10 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.4.11 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

Parts of the mechanical seal that are moving during operation of the machine (for example drive collar) have to be protected against contact with guards that are in accordance with specifications of manufacturer from the machine.

7. Piping Instructions

Piping instructions are detailed on the mechanical seal assembly drawing.

These instructions must be followed precisely to ensure correct seal operation. Ensure that piping is connected to the correct pipe ports to prevent unsafe situations.
For auxiliary systems: carefully read the maintenance instructions provided with the system.

The connections on the mechanical seal are properly marked.

Minimize restrictions, especially in closed loop piping arrangements.
Unless otherwise specified, the minimum internal diameter for pipe, tubing and connecting hardware should be 12,7 mm (.500”).

Total pipe length and number of bends should be kept to a minimum.
Use smooth, large radius bends; do not use elbows, tees, etc. Orifices should be installed as far away from the seal gland as possible. An exception to this rule should be made for orifices fitted to drain piping. To avoid clogging of the orifice it is advisable to install it in the seal gland so that the generated heat will serve to keep the leaked product fluid.

For “loop type” systems (API-plan 23, 52 and 53 A, B, C)

Pipe runs should be sloped continuously up or down to allow adequate circulation, proper venting and draining. Make sure that the loop, including seal gland, does not include vapor traps. Unless otherwise specified, reservoirs and coolers must be mounted 40 to 60 cm (15” to 24”) above the seal inlet or outlet connection, whichever is the highest, to promote thermosyphoning in standby condition.

Seals equipped with excess leakage detection

Excess leakage detection, often used with single or non-pressurized dual seals, is commonly achieved by monitoring liquid level or pressure increases. With such an arrangement, the drain line for normal leakage must slope downward continuously to the point of exit (e.g. sump). Refer to the seal assembly drawing for additional piping requirements including the proper location of the restriction orifice and instrumentation.

8. Performance Testing of Pumps

Pump manufacturers will often perform pump performance tests on water with the mechanical seal installed. If the pump product used during field operation is not equal to water, seal

designs and face materials require special precautions to prevent damage to the seals during these tests. For example, on seals with two hard faces, the seals may be provided with faces in alternate materials more suitable for the pump test medium. These faces are to be replaced with faces in the selected materials at the conclusion of the testing. A mechanical seal equipped with a hard face comination can be safely operated on water provided the pressure does not exceed 5 bar and the speed does not exceed 10 m/s.

When high temperature seals with graphoil gaskets are tested on water during a pump performance test, the seals must be carefully dried after the test to prevent vaporization of water absorbed by the gaskets when the pump is brought to its (high) operating temperature.

Contact your Flowserve representative for additional information.

9. Functional Recommendations

! 9.1 The pressure and temperature in the seal chamber or of the barrier fluid must not exceed the recommended maximum seal limits. The shaft speed must also not exceed the seal's limits.

! 9.2 For seals using external cooling and/or an external flush, apply cooling and / or flush prior to seal start-up. Avoid inadvertent operation of valves located in the cooling system that might result in shutting off the cooling flow.

9.3 Single and dual non-pressurized (tandem) seals require adequate vapor pressure margin in the seal chamber to prevent flashing of the product at the seal faces.

9.4 Dual non-pressurized (tandem) seals require the buffer fluid pressure to be maintained at a value lower than the seal chamber pressure. Buffer fluid pressure is usually equal to atmospheric or vapor recovery system pressure, unless otherwise specified.

9.5 Dual pressurized (double) seals require the barrier fluid pressure to be maintained at least 2 bar (30 psi) above the seal chamber pressure, unless otherwise specified. It is imperative to pressurize the barrier prior to pressurizing the equipment. Likewise, do not de-pressurize the barrier system until the equipment has been fully isolated, depressurized and vented.

9.6 Flowserve can supply information on barrier fluid temperature and flow requirements based on product type, seal size, product temperature, barrier fluid characteristics and shaft speed. The buffer/barrier fluid must contain little or no additives for anti-wear/oxidation. Automotive antifreeze should never be used. Ensure that the barrier fluid is clean and compatible with the product.

9.7 This seal is designed to resist corrosion by the product(s) listed on the assembly drawing. Do not expose the seal materials to products other than those shown on the assembly drawing. The seal assembly drawing lists the materials of construction. Consult your Flowserve representative when in doubt or when using the seal for another application than for which it was selected.

9.8 Liquid seal requirements: Do not start the equipment dry. Open valves to flood equipment with product. Vent all air and/or product vapor from the equipment casing and the seal chamber before start up. Vent casing and tubing of heat exchange (if applicable). Process fluid must flood and pressurize the seal chamber at all times for single seal and non-pressurized dual seals. Barrier fluid must flood dual seals at all times during equipment operation.
Gas seal requirements: Do not apply liquids to gas seal designs. Non-pressurized dual seals with the outboard seal designed to work in gas must be connected only to a gas purge, if applicable.

9.9 When required, dry steam should be applied to the quench connection.
Use a needle valve (or other flow restriction) to provide 0.1 bar (1 to 1.5 psi) steam to the quench connection on the seal gland.

Take care to apply steam pressure gradually to prevent an unsafe situation due to an excessive flow of hot steam being blown into the operator's working area.

This should result in wisps of steam exiting the seal gland area. Ensure that all condensate is drained from the supply line and open the steam quench slowly before the pump is preheated to prevent thermal shock.

9.10 Start up equipment in accordance with normal maintenance procedures unless specifically requested otherwise by Flowserve.
If the equipment is not operating properly (e.g. seals and / or bearings running hot, cavitation, heavy vibration, etc.), shut down the equipment, investigate and remove the cause.

The temperature of the external of the mechanical seal depends from the operating temperature of the product and/or barrier fluid.
Proper precautions need to be taken to prevent contact with hot parts

Points 9.1 to 9.10 must be taken into account during the first start up as well as during restarts after machine was stopped.

10. Shut Down, Disassembly

The equipment can be shut down at any time. Before the mechanical seal can be removed the equipment must be de-pressurized and drained.

! Operator must persuade himself before starting disassembling of mechanical seal that the external of the equipment is cool enough to be handled without risk.

Barrier pressure (if applicable) must be relieved after the equipment has been de-pressurized.

Dismantling of the mechanical seal is only allowed after machine has been stopped.

Product may be released during removal of the mechanical seal. Safety measures and protective clothing may be required as per the plant's safety regulations.

Further disassembly of the mechanical seal must be done according to the supplier's specifications.

11. System Check

Checking of the system, limits itself to monitoring pressure, temperature, leakage and consumption of barrier (buffer) fluid, when applicable.

Maintenance to the mechanical seal is only allowed after machine has been stopped.

The required area for operating the machine or doing maintenance to the mechanical seal must be easy accessible.

12. Spare Parts, Repairs

Repairs will be necessary when the seal reaches the end of its normal life expectancy or when it has been running outside of its design capabilities.

This product is a precision sealing device. The design and dimensional tolerances are critical to seal performance. Only parts supplied by Flowserve should be used to repair this seal. These are available from the numerous Flowserve stocking locations.

To order replacement parts, refer to the part code, order number or B / M number, which can be found on the assembly drawing. It is recommended to keep a spare seal on stock to reduce equipment downtime.

All liabilities and warranties to Flowserve for damage incurred through the use of non-original replacement parts and accessories will be rendered null and void.

Please note that special manufacturing and delivery specifications exist for all parts of our products manufactured or produced by ourselves and the replacement parts are always offered in accordance with the latest technology and with the most current regulations and laws.

Flowserve seals can normally be reconditioned. When repair is necessary, the seal should be carefully removed from the equipment (reinstall the centring tabs or setting plates if applicable).

! Decontaminate the seal assembly and return it to a Flowserve authorized repair facility with an order marked "Repair or Replace". A signed certificate of decontamination must be attached.

A Material Safety Data Sheet (MSDS) must be enclosed for any product that came in contact with the seal. The seal assembly will be inspected and, if repairable, a quotation will be made for restoring it to its original condition. Upon acceptance of the quotation, the parts will be rebuilt, tested, and returned to sender.

FLOWSERVE®

TO REORDER REFER TO
B/M # _____
Order #_____

FIS144eng REV 12/2009 Printed in Europe

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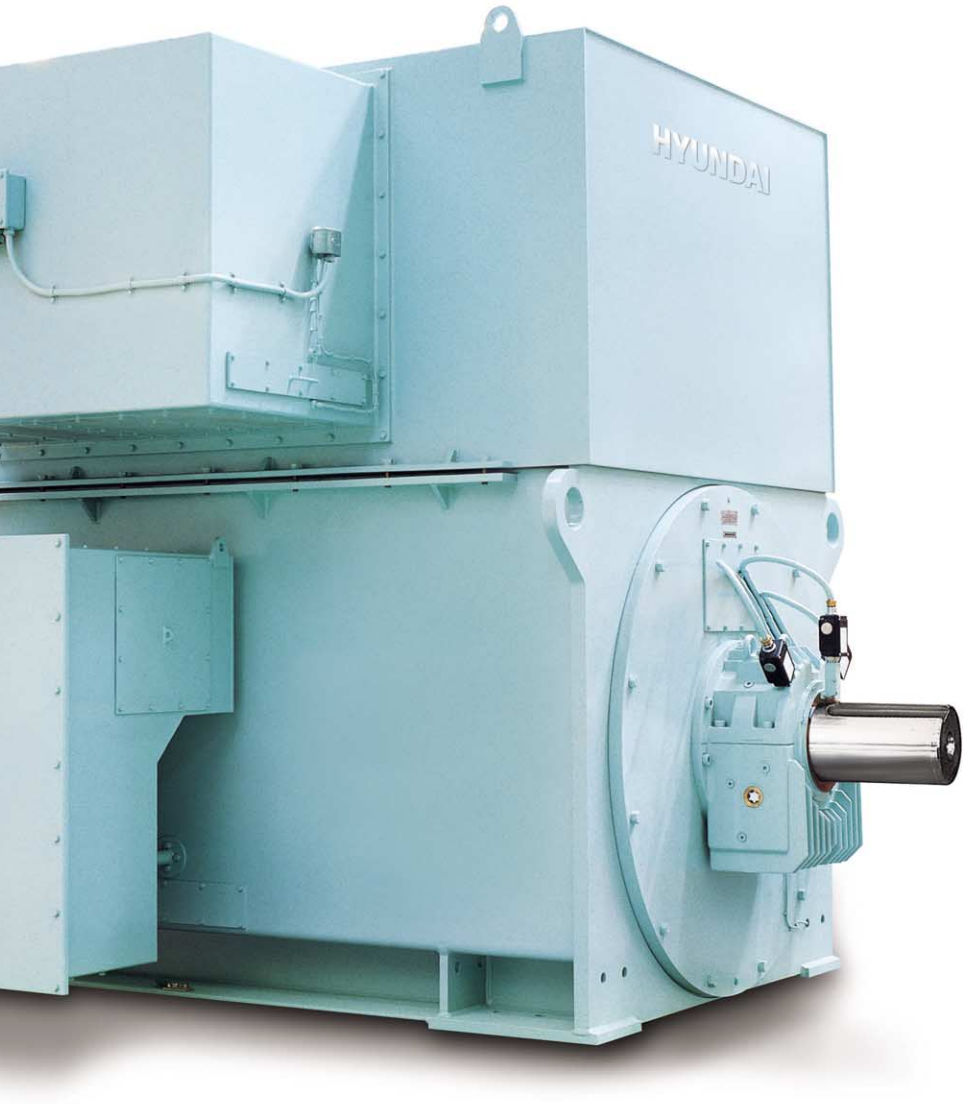
Building a better future
Global Leader

Instructions for

Three-phase Induction Motor

Common Items | Instruction Manual



Notice

- The information contained in this book is intended to assist operating personnel by providing information on the general characteristics of the purchased equipment.
- It does not relieve the user of the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Safety Procedures

This equipment contains hazardous voltages. Death, serious personal injury or property damage can result if safety instructions are not followed.

The successful and safe operation of motors is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure or loss of the motor as well as damage to other property.

Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices and maintenance procedures contained herein. Only qualified personnel should be involved in inspection, maintenance and repair procedures and all plant safety procedures must be observed.

Qualified Person: For the purpose of this manual and product labels, a Qualified Person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he or she:

a. is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
b. is trained in the proper care and use of protective equipment, such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
c. is trained in rendering first aid.

DANGER	For the purpose of this manual and product labels, Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING	For the purpose of this manual and product label, Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION	For the purpose of this manual and product label, Caution indicates a potentially hazardous situation which, if not avoided, may result in property damage or minor or moderate injury. It is also used to alert against unsafe practices.

Motors should be installed and grounded per local and national codes.
Do not operate this equipment in excess of the values given on the nameplate or contrary to the instructions contained in this manual. The equipment (or a prototype) has been factory tested and found satisfactory for the conditions on which it was sold. Operation in excess of these conditions can cause stresses and strains beyond design limitations. **Failure to heed this warning may result in equipment damage and possible personal injury.**

DANGER 	**Hazardous Voltage.** Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

NOTE: Many squirrel cage induction machines are driven by various types of prime movers as induction generators. This instruction manual applies to both motors and induction generators. However, for reasons of clarification, the machine will be referred to as a "motor."

Contents

01 Foreword

This instruction manual describes and provides instructions for installation, operation and maintenance of induction motors.

These instructions do not support to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently, the matter should be referred to the nearest HYUNDAI HEAVY INDUSTRIES business office.

NOTE

For service shop requirements, refer to

ROTATING MACHINERY MANUFACTURE DEPT.
ELECTRO & ELECTRIC SYSTEMS DIVISION
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Address: 1000, Bangeojinsunhwan-doro
Dong-gu, Ulsan, Korea
Telephone: 82-52-202-6671, 6672
Fax: 82-52-202-6996

02 Receiving, Handling and Storage

2.1 Receiving

Each shipment should be carefully examined upon arrival. If the packing is damaged, unpacking should be made immediately to check whether or not the motor and its fitting are in good condition, and any damage to contents should be photographed and reported to the carrier and to the nearest HYUNDAI HEAVY INDUSTRIES business office.

All large motors are equipped with a locking device, which protects the bearing from damage due to the movement of the rotor in transit. Do not remove this device until transport is complete and coupling is ready to be fitted.

⚠ WARNING

Heavy Equipment
Improper lifting can cause death, severe injury, or damage. Check eyebolts, lifting lug and eyenuts before lifting. Use proper slings and spreaders.

2.2 Handling

To ensure proper handling after unpacking, the motors require the chain hoist, wire ropes and other handling equipment. When hoisting the motor, wire ropes should be attached to the lifting holes on the side of the motor frame, and should be put in hard rubber, thick cloth, etc. between the external covers for protective purposes. Then the motor is slowly and carefully raised and moved to the intended position.

⚠ CAUTION

When unpacking and handling the motor, attention should be given to the following points:
- Anticorrosive agent which is applied to the coupling shaft ends should be removed right before starting the motor. The coupling or shaft ends should be checked to ascertain whether or not they are in abnormal condition.

2.3 Storage

If the motors are not put into service at the time of delivery, they should be stored according to the following conditions.

⚠ WARNING	**Top Heavy.** Can cause severe injury or property damage. When lifting motor, 1. Lift only at designated locations. 2. Use spreader for lifting. 3. Apply tension gradually to cables. 4. Do not jerk or attempt to move unit suddenly. 5. Do not use cover lugs when lifting.

Outdoor Storage is Not Recommended.

Variations in temperature and humidity can cause condensation, resulting in corrosion of metal parts and possibly in insulation failure. Therefore, the following cover the minimum acceptable storage arrangements in an unheated but protected environment:
It is preferable to use a heated facility, which would simplify meeting these conditions.
When outdoor storage cannot be avoided, contact HYUNDAI HEAVY INDUSTRIES for specific instructions on minimizing damage, giving full particulars of the circumstance.

Storage Facility Requirements

⚠ CAUTION	**Damp Location.** Can cause property damage if equipment is operated intermittently. Use space heaters to prevent dampness. Grease machine fits when unit is reassembled to prevent corrosion.

The storage facility must provide protection from contact with rain, hail, snow, blowing sand or dirt, accumulations of groundwater, corrosive fumes and infestation by vermin or insects.
There should be no continuous or severe intermittent floor vibration. Power for the space heaters and illumination should be available. There should be fire detection and a fire-fighting plan. The motors must not be stored where it is liable to be accidentally damaged or exposed to weld spatter, exhaust fumes or dirt and stones kicked up by passing vehicles.

If necessary, use guards or separating walls to provide adequate protection. Avoid storage in an atmosphere containing corrosive gases, particularly chlorine, sulfur dioxide and nitrous oxides.

Protecting the Cooling-water System

When the motors are delivered, the cooling water system is not filled with cooling water.

- When you place the motor in storage after use, drain the cooling water systems and purge them with air so that they are completely empty.
- The detail instructions are as follows and the caution name plates are installed on the motor

1) Air-to-Water Coolers

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please drain the cooling water completely to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F).

2) Water Cooled Type Ball or Roller Bearings

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please drain the cooling water completely to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F)

3) Water Cooled Type Thrust and Guide Pad Bearings

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please make the cooling water flow continuously to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F)

⚠ CAUTION	**Frost Damage to the Cooling Circuit.** The cooling circuit can be damaged if the cooling water freezes. If the ambient temperature falls below 0°C during operation, add anti-freeze to the cooling water.

Temperature Control.

DANGER

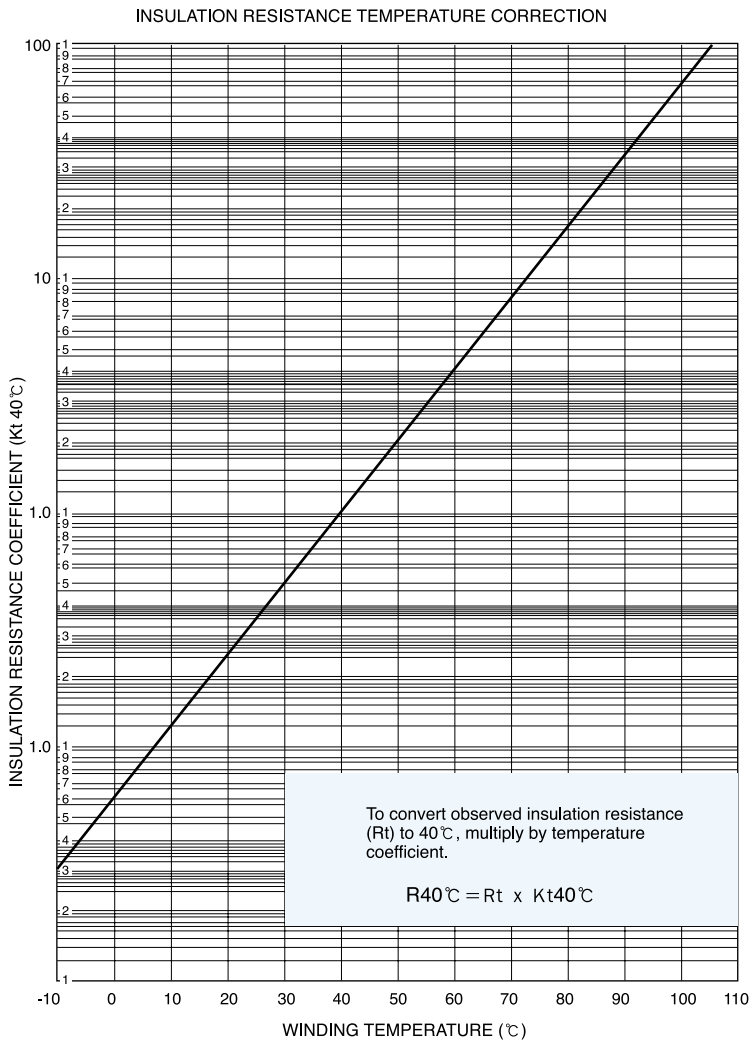
Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

Whenever the motor temperature is equal to and below ambient temperature, water vapor can condense on and within it, promoting rapid deterioration.
Prevent this by energizing the space heaters to keep the motor temperature above ambient temperature by at least 3°C However, during periods of extreme cold or rapid temperature drops, the space heaters may not be adequate to maintain this differential and supplementary heating may be required.

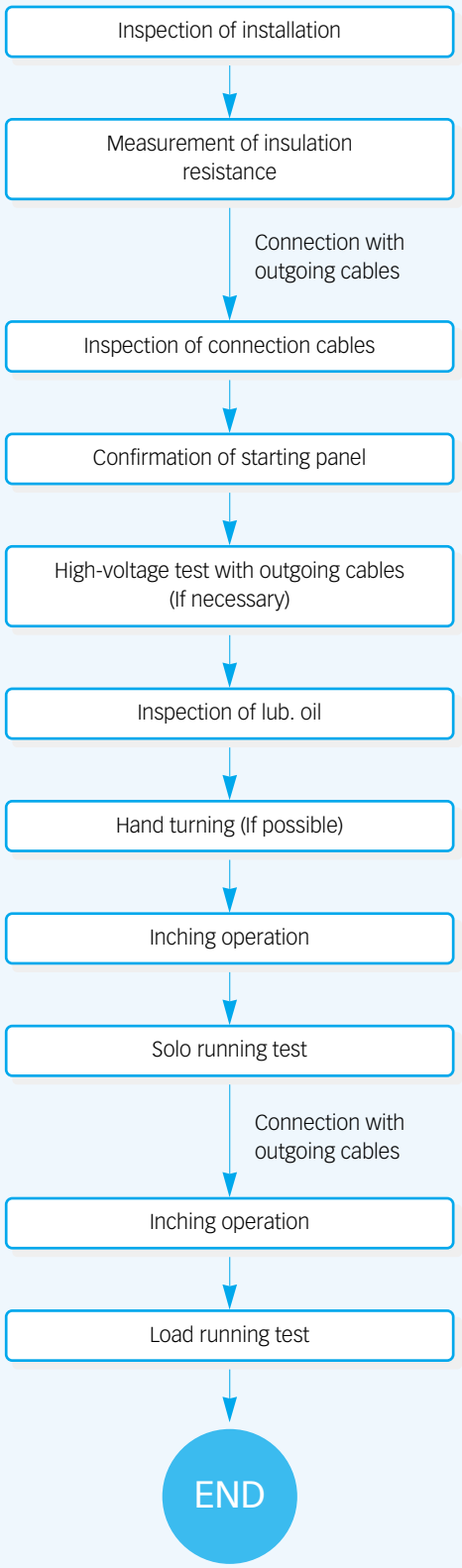
CAUTION

If the motor is boxed or covered in any way when the space heaters are energized, there should be thermostatic control and sufficient surveillance to detect an over-temperature condition quickly. Ensure that temporary packaging does not contact the space heaters.
When windings of motor are uninjured and their insulation resistance to ground is well above the minimum of rated voltage (kV) plus 1 megohm when corrected to 40°C according to IEEE 43 or as below in Fig. 1, low temperature is not a problem.
However, if the resistance drops, the windings can be permanently damaged by freezing. Therefore, the motor temperature should be kept above freezing point.

➡ Fig. 1 Insulation Resistance Temperature Correction



Generally, inspection and text of motors are performed as in the following chart for initial start-up on site.



3.1 Installation

General

Ensure that the motor enclosure is suitable for its environment, that the ambient temperature is less than specifications for operating the motor at all times and that all bearings are lubricated before operating the motor.

Foundation

Motors should be mounted on solid and rigid foundations to ensure proper vibration and free operation. The desirable foundation and anchor bolt design will

– accommodate at least the maximum static and dynamic foundation loads indicated on the motor outline dimension drawings.
– have sufficient rigidity to maintain acceptable alignment after the application of load.
– be free of natural frequencies, which are likely to be excited during normal operation (this could result in vibration problems on the motor).

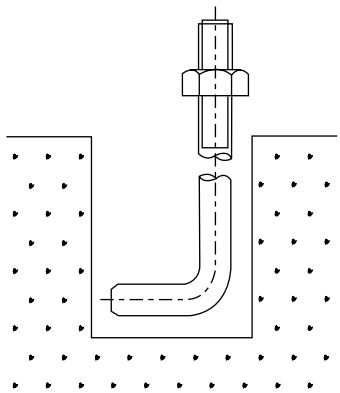
In some cases where precision is required, a study of these factors should be conducted to determine the natural frequencies of the motor support.

NOTE: If normal vibration or noise will be objectionable (as in office buildings), it may be advisable to use vibration dampeners between the machine or driven/drive unit and the foundation.

Foundation Bolt

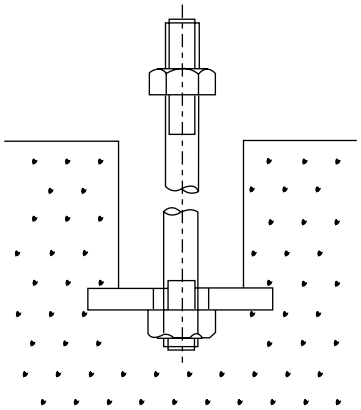
There are some different methods of installing the foundation bolt as shown in Fig. 2. The methods depend on the capacity and construction of the motor.

Fig. 2 Type of Foundation Bolt



< J-Type >

Fig. 2 Type of Foundation Bolt



< Plate-Type >

Mounting

After removing the package from the skid of the motor, remove the polyethylene shroud. Remove the motor from the skidding. The motors should be mounted on a flat surface and packed about with shims (shim allowance is generally 2-3 mm thick).
The shims should support the maximum length of each motor foot. It is preferable to use corrosion-resistant shims such as brass or stainless steel; otherwise "shim swell" due to corrosion resistance may be detrimental to good alignment. Care should be taken not to distort the frame during "bolting down".

⚠ CAUTION

A basic rule is to not have more than 5 shims in a shim pack under any one machine foot. Thick shim packs consisting of many thin shims will cause a soft foot and cause vibration or twisted frame (machine foot out of plane).

NOTE: Experience has shown that any base-mounted assemblies of motor and driven units temporarily aligned at the factory, no matter how rugged or deep, may twist during shipment. Therefore, alignment must be checked after mounting.

Remove the Locking Device of Large Motors

All large motors are equipped with a device for preventing the shaft from movement in order to protect the rolling face of bearing from damages due to vibration in transit.

This locking device is fitted on the drive side or on the non-drive side. Before connecting a motor to a machine, the fitting bolts should be loosened, and the fitting device should be taken off.

⚠ CAUTION

The rotor is locked by a rotor locking device for the purpose of protection during transportation. These are normally locked on the drive end shaft, but sometimes locked on the non-drive end shaft. The locking device shall be taken off by simply loosening the screw bolt. As the locking device is generally painted in yellow-brown, it can be easily visible.

Bolt Tightening Torque

The following table provides the general guidance of Max. bolt tightening torque, especially mounting bolt tightening situation. The values are maximum for each case, thus care should be taken not to exceed the values.

Material / Thread Size	Tightening Torque(kgf • m)	
	SS400 (For anchor bolt)	S45C (Strength grade: 8.8)
M6 X 1	0.4	1.1
M8 X 1.25	0.8	2.1
M10 X 1.5	1.6	4.3
M12 X 1.75	2.8	7.5
M14 X 2	4.6	12.1
M16 X 2	6.7	18
M20 X 2.5	13.3	35
M22 X 2.5	18.3	49
M24 X 3	22.4	60
M30 X 3.5	46.9	124
M36 X 4	80.5	215
M42 X 4.5	128	343
M48 X 5	194	518
M56 X 5.5	310	822
M64 X 6	463	1233
M72 X 6	667	1776
M80 X 6	922	2454
M90 X 6	1325	3540
M100 X 6	1855	4929

⚠ CAUTION

For the maximum tightening torque for main power cable connection bolt, please refer to '7.4 Operation, 3) Tightening Torque', page 24.

3.2 Inspection of Installation

After installation, check for looseness of bolts and nuts on the terminal boxes, cooler boxes and so on. Then, the foundation and centering of the motors should be checked. These items are normally checked and reviewed on the erection records.

Checklist for inspection of installation

1. Outside view of machine
   - No rusted portions.
   - No damaged portions/parts.
   - Confirmation of caution, nameplate.

↓

2. Removal of rotor locking device
   (If necessary)

↓

3. Check for no looseness
   - End covers.
   - Terminal boxes.
   - Cooler boxes.

↓

4. Check around foundation
   - Motor levelling.
   - Tightness of foundation bolts.

↓

5. Inspection of accessories
   - Thermometers
     (indication checks at amb. temp.).
   - Temperature detectors
     (indication checks at amb. temp.).

↓

6. Confirmation of centering

3.3 Measurement of Insulation Resistance and Polarization Index

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

The insulation resistance of stator, rotor and auxiliaries shall be measured before the initial start-up of the machine or after a long period of standstill. The insulation resistance testing is available method for determining the extent of moisture absorption and dirtiness of the insulation. The insulation resistance of new machines with dry windings is very high. If the machine has been subjected to incorrect transportation and bad storage environment such as high humidity, salty and dirty, the insulation resistance can be extremely low. Based on the result of insulation measurement, correct cleaning and drying action shall be determined and conducted.

3.3.1 Procedures for insulation resistance test

The insulation resistance is measured by using an insulation resistance meter (Megger). Guidelines for test voltage are presented in the following table.

Winding rated voltage (V)*	Insulation resistance test direct voltage (V)
< 1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001- 12000	2500 - 5000
> 12000	5000 - 10000

* - Rated line-to-line voltage for three-phase AC machines, that is the rated voltage of machines.
- The test voltage guidelines were quoted from IEEE 43-2000.

The test voltage is applied between the winding and the frame for 1 minute. The test is usually performed to the whole windings as a group. In case that the test is conducted to each phase winding, the frame and other windings not under test shall be earthed. Before the insulation resistance test is conducted, the following actions shall be taken.

– Verify that all power supply cables are disconnected.
– The winding temperature is measured.
– All resistance temperature detectors are earthed.
– All other external equipment such as surge capacitors, lightening arrestors, current transformers and etc are disconnected and earthed.

3.3.2 Correction to temperature of insulation resistance

The insulation resistance value varies inversely, on an exponential base, with the winding temperature. In order to be able to compare measured insulation resistance values, it is recommended that all insulation test values be corrected to a common base temperature of 40°C.
The correction is made by using the following equation :

$$R_C = K_T R_T , \quad K_T = (0.5)^{(40-T)/10}$$

Where:

R_C is insulation resistance (in MΩ) corrected to 40°C

K_T is insulation resistance temperature coefficient at temperature T°C

R_T is measured insulation resistance (in MΩ) at temperature T°C

Example:

R_T = 3000 MΩ at 35°C

$K_T = (0.5)^{(40-35)/10} = (0.5)^{5/10} = (0.5)^{1/2} = 0.707$

R_C = 0.707 x 3000 MΩ = 2121 MΩ

3.3.3 Polarization Index (PI)

The measured insulation resistance will usually rapidly increase when the voltage is first applied, and then gradually approach a relatively constant value as time elapses. The insulation resistance of a dry winding in good condition may approach a constant value of insulation resistance in 4 min or less. If the winding is wet or dirty, a low steady value will usually be reached 1 min or 2 min after the test voltage is applied.
The polarization index is normally defined as the ratio of the 10 min resistance value (IR_{10}) to the 1 min resistance value (IR_1). The polarization index test is less dependent on the temperature than the insulation resistance. So, it is not necessary to make a temperature correction to the PI. If the 1 min insulation resistance is above 5000 MΩ, the polarization index is not an indication of the insulation condition and is therefore not recommended as an assessment tool.

3.3.4 Recommended minimum values for insulation resistance and polarization index

The actual winding insulation resistance to be used for comparison with IR_{1min} is the observed insulation resistance, corrected to 40°C, obtained by applying a constant direct voltage to the entire winding for 1 min. Generally, the insulation resistance value for dry windings exceeds the minimum values significantly. It is impossible to give definite values, because resistance is affected by the machine type, humidity, temperature, aging, operation period and etc. Therefore, the following values can only be considered as guidelines.

• Recommended value for Insulation Resistance (IR)

New stator windings	Used stator windings	Wound rotor windings
IR_{1min} > 1000 MΩ	IR_{1min} > 100 MΩ	IR_{1min} > 5 MΩ

※ If the measuring conditions are extremely warm and humid, IR_{1min} value of stator windings above 100 MΩ may be accepted.

• Recommended value for Polarization Index (PI)
The minimum PI value for class F insulated windings is more than 2.

3.3.5 Suitability for operation

Recommended minimum values of the IR or PI may be used to estimate the suitability of the winding for operation. If the IR or PI is low because of dirt or excessive moisture, it may be improved to an acceptable value by cleaning and drying. It may be possible to operate machines with PI and IR values lower than the recommended minimum values; however, it is not recommended. In all cases where the test values fall below the recommended minimum values, investigations should be undertaken to determine the cause to such low readings.

3.3.6 Insulation resistance measurement for auxiliaries

To ensure correct operation of the machines protections and other auxiliaries, their condition can be determined by an insulation resistance test. The test voltage for the space heater shall be 500 VDC and for other auxiliaries 100 VDC. The recommended minimum value of the space heater is over than 1MΩ. The insulation resistance measurement for temperature sensors is not recommended.

3.4 Inspection of Lubrication Oil

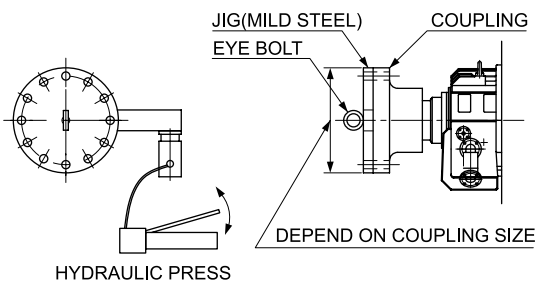
Before the initial running test, inspection of lubrication oil is very important, that is, confirmation of no oil leakage and proper oil level.
Refer to bearing maintenance manual.

⚠ CAUTION	Before starting the machine, fill the bearing chamber to the center of the oil gauge. Always fill through the pipe or plug at the side of the motor. Do not overfill, as the oil may then escape along the shaft and enter the unit. Avoid adding oil while unit is running.

3.5 Manual Rotation

If possible, rotate the rotor manually to ensure that it is free to move without rubbing or scraping and to lubricate the bearing surfaces. A minimum of 10 revolutions is recommended. If start of turning is very difficult by hand. The JIG for starting as per the below sketch is requested depend on actual coupling size. Couple the JIG with coupling and push or pull the handle using hydraulic jacking or chain block. Once Shaft is moving, turn is using pipe to eye bolt. It is easy to turn continuously once the shaft is moving.

➡ Manual Rotation



3.6 Connection to Power and Grounding

Examine the nameplate data to know the correct power supply. Also check heater power where applicable. Check all connections to ensure that they have not come loose during transport. Make certain that the correct cable size has been selected and connected to phase rotation as shown in motor terminal box. The motor and control wiring, overload protection and grounding should be done in accordance with the National Electrical Code and local requirements.
In case of the wound rotor, check to see that brushes are "free" in the holder and the pressure of the brushes is applied correctly. Ensure that the slip ring surface is clean and free from contamination. Avoid "fingerprint" marks on ring surface. To maintain the proper degree of protection, make sure all gaskets and cover plates are properly fixed and sealed. Any unused entry holes should be plugged.

⚠ WARNING	- Ensure that the motor starter (supplied by others) is open. - Make the connections as in the required rotation. - Drill the cable entry plate (at bottom of box) to suit your power cable and its fitting. - Connect the station ground to one of the ground pads provided on the stator frame.

3.7 Solo Run Test

⚠ CAUTION	**Do not exceed number of HYUNDAI-specified hot and cold starts per hour.** Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool.

Before coupling with the load machine, the motor is normally run through a solo running test.
At the initial start, the motor is inching operated for approx. 1-2 sec.
At that time, inspection of rotation, abnormal noises, and lubrication conditions are checked during the idling. If these items have any problems, the supplied power shall be taken off, checked and reported in detail.

The motor is then restarted. The motor is run during 1-2 hrs. and vibration amplitude on the bearing housing and bearing temperature are measured and recorded.

⚠ WARNING	**Do not operate equipment beyond design limitations.** Can cause personal injury or damage to equipment. Operate in accordance with instructions in the manual and nameplate ratings.

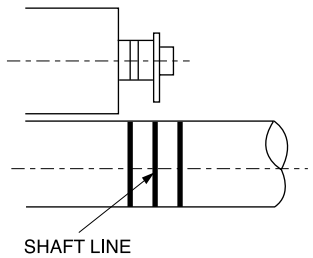
3.8 Alignment

The correct alignment of machinery is very important for reducing the stress and vibration of the shaft and the wear of the bearing and coupling. In case a coupling maker gives those instructions, it is recommended that the instructions be followed.

Flexible Coupling

The flexible coupling set forth herein means the one driven through the rubber brush or the leather brush including the gear coupling. In aligning the motor equipped with the sleeve bearing, attention is to be paid to the endplay of the motor bearing and to the position of the coupling. The center of the motor bearing endplay is indicated by the endplay indicator.
The bearing endplay can be equally divided by setting the endplay indicator to the standard line of the shaft as shown in Fig. 3.

Fig. 3 Endplay Indicator



CAUTION

In case the coupling is used, it may be considered that the rotor can be easily moved in the axial direction. In fact, however, it hardly slides in the axial direction at the coupling as the torque grows greater. When by some reason the rotor has undergone some axial movement, and the coupling does not provide enough slip to allow the rotor to return to the magnetic center of the motor, it will continue to operate with the bearing end in contact with the shoulder of the journal.

Rigid Coupling

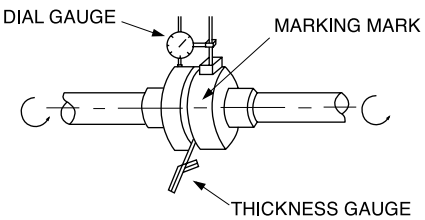
In case of the sleeve bearing, when both flanges are connected to each other, the endplay indicator is referred to install the flexible coupling in order to determine the position of the motor.

Alignment

NOTE: The foot plane is of concern for each unit of rotating equipment. Check driven equipment if necessary.

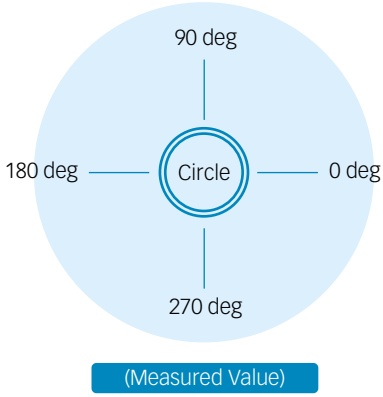
Alignment is made to bring the shaft centers of the motor and machine combined with it into the same line; the parallel and eccentricity are measured through the coupling. Generally a thickness gauge or a taper gauge is used in measuring the parallel, and in measuring the eccentricity, a dial gauge is to be fitted to the coupling on one side; the both shafts are to be turned by 0 deg, 90 deg, 180 deg and 270 deg; and the dial gauge reading is to be taken at the four points as shown in Fig. 4. The alignment accuracy is to be generally 0.025 mm or less (both plate and circle).

Fig. 4 Procedure for Alignment

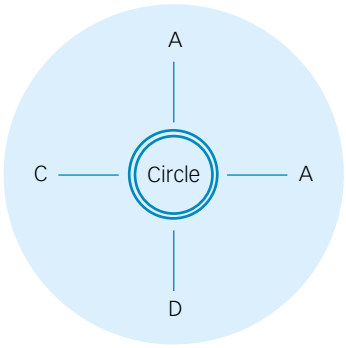


Measurement of Eccentricity

The both shafts are to be simultaneously turned; the values shall be obtained from the measurement made at four points by means of a dial gauge and are to be recorded; and the corrected value is to be obtained in the following manners.



(Measured Value)

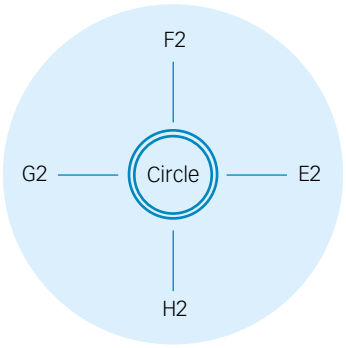


(Measured Value)

$$\text{Corrected value of left and right} = \frac{A - C}{2}$$

$$\text{Corrected value of left and right} = \frac{A - C}{2}$$

(Corrected Value)



(Measured Value)

$$\text{Corrected value of left and right} = \frac{(F1 + F2) - (H1 + H2)}{2}$$

$$\text{Corrected value of left and right} = \frac{(E1 + E2) - (G1 + G2)}{2}$$

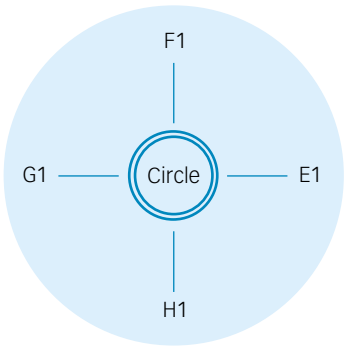
(Corrected Value)

CAUTION

The difference between the total of the measured values at the left and right points (A-C) and the total of the measured values at the top and bottom points (B- D) should not exceed 0.03 mm. The improper fitting of the dial gauge and the erection of the fitting arm, if any, may cause greater difference.

Measurement of Parallelism

The values at the four points of E1, F1, G1 and H1 are to be corrected after measurement made by means of a thickness gauge at the position where both shafts were connected to each other at the time of eccentricity measurement; and measurements are to be made again at the points of E2, F2, G2 and H2 after turning both shafts.



(Measured Value)

Belt Connection

If it is intended that the motor will be directly coupled through a flexible coupling to a machine, no check for the minimum sprocket diameter will be necessary. However, if a chain, gear, V-belt, or flat belt drive is used on the output shaft a check should be made.

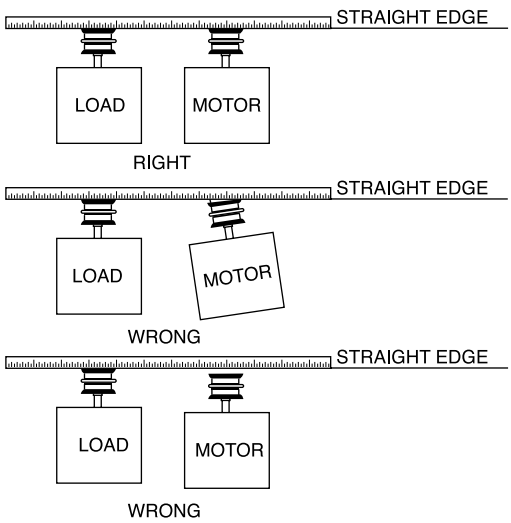
Direction of Belt Tension

In the case of the motor with roller bearing, belt tension may be applied in the horizontal or the vertical direction. In case of the motor with the sleeve bearing, the belt tension should be applied in the horizontal direction only.

Alignment of Belted Drives

Aligning a belted drive is much simpler than aligning a direct coupling drive. To check alignment, place a straight edge across the faces of the drive and driven sheaves. If properly aligned, the straight edge will contact both sheave faces squarely.

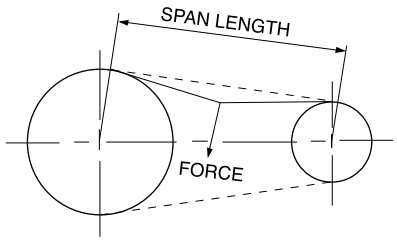
Fig. 5 Alignment of Belt Drive



Belt Tension

The V-belt is to be stretched in the following way. There is calculated deflection force to be applied perpendicular to the belt at the center of the belt span as shown in Fig. 6.

Fig. 6 Belt Tension

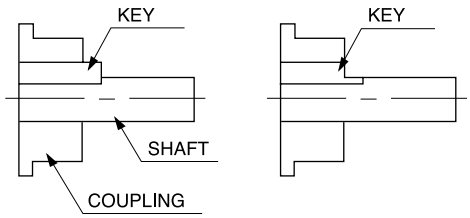


The drive is properly tensioned when the deflection of the belt caused by the deflection force is equal to 1.6 mm for span length of 100 mm. If the deflection force is higher than normal values, this will result in reduced belt life, reduced bearing life and could cause shaft failure.

Coupling Balance

The coupling should be dynamically balanced to G2.5 or better. The motor is dynamically balanced with a half key fitted; therefore, the proposed coupling should be balanced accordingly, and the correct key profile fitted.

Fig. 7 Coupling Balance



Incorrect key profile Correct key profile

Frame Distortion Check

In addition to ensure the proper alignment of the coupling, care should be taken to ensure that the motor frame is not distorted during alignment.

To confirm that distortion has not occurred, we recommend the following procedure be adopted:

1) Align the motor within tolerances as required by section “alignment.”
2) Apply a dial gauge between the motor frame adjacent to one mounting foot and the foundation and set indicator to zero.
3) Loosen hold down bolt and record movement of dial gauge measurement.
4) Re-torque hold down bolt.
5) Repeat steps 1-4 for all hold down bolts, one at a time.

3.9 Test Run of Motor

⚠ CAUTION	Carry out the initial operation in accordance with contractual agreements. The initial operation may only be carried out by trained personnel who have been assigned to do this by the person responsible for the plant.

After coupling with the load machine, the motor is inching operated at first.
When both motor and load machine show no abnormality, the motor is restarted with a minimum load. At that time, the current, supplied voltage is checked and recorded.
While the motor is running continuously, the motor vibrations on the bearing housing are controlled by Fig. 8.

⚠ CAUTION	**Do not exceed number of HYUNDAI-specified hot and cold starts per hour.** Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool.

The following maintenance and inspection schedules cover the necessary steps for inspection of the motors. Since the conditions under which the motors are required to operate may differ considerably, the maintenance and inspection schedules can only be recommended for the intervals at which at least first inspection should be carried out if operating conditions are normal. On the basis of the experience gained with the plant, the inspection intervals should therefore be selected to meet such conditions as contamination, frequency of start-ups, load, etc.

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
A: Daily Inspection B: First Inspection, no later than 6 months. C: Following Inspection, no later than two (2) years (when required, dismantle the machine).				
○			Check the machine for irregular noise and excessive vibration (Fig. 8).	
○			Where possible, measure and record the bearing temperature.	
			Relubricate the grease lub. Bearing oil-lub bearing: Change the oil. Clean and inspect the bearings. For the intervals of maintenance work, see the lubrication instruction plate on the machine.	
	○	○	Check the shaft sealing rubber ring for deterioration.	
○			Where possible, measure the bearing temperature, oil pressure and flow rate.	Sleeve (white metal) bearing
○			Check that the oil-rings are operating correctly.	
○			Check the oil flow, oil level and any oil leaks.	
	○	○	Check the contamination of lub. oil and change the lub. oil.	
	○	○	Carry out the following oil changes with normal amb. temp. Self oil lub.: 5000-8000 operating hours Forced feed oil lub.: 15,000-20,000 operating hours	
		○	Check the axial play.	
	○	○	Check the shaft sealing for deterioration.	
		○	Inspect the bearing surface.	
	○	○	Clean and inspect the bearing insulation and insulation of the pipe.	
	○	○	Check the system, connections and piping for leaks.	Forced feed oil lub. system
	○	○	Check the oil level.	
	○	○	Clean and inspect the oil filters and oil coolers.	
	○	○	Check to see that the enclosure is not clogging (blocking) the machine ventilation.	Enclosure
	○	○	Check the gaskets for deterioration.	
	○	○	Check the enclosure for any deformities or damage.	
	○	○	Check the noise-suppression material for damage.	

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
	○	○	Check and clean the external cooling air paths.	Enclosure
		○	Drain the drain plug, when provided.	
	○	○	Replace and clean the air filter, when provided.	
	○	○	Check the clearances to rotating parts.	
	○	○	Check the enclosure for corrosion.	
		○	Check earthing (grounding) terminals.	
	○	○	Check the enclosure including external cabling conduit connection for ingress of water or dust.	Junction (terminal) box, terminals
		○	With loose leads: Check to see that the cable connections are properly insulated.	
		○	Check connection for good contact.	
		○	Check terminal insulators for damage.	
○			Measure and record the winding temperature detectors, when provided.	Stator winding
	○	○	Check and record the insulation resistance of windings.	
	○	○	Clean the windings, as far as possible.	
		○	For totally enclosed machines, clean the winding if required.	
		○	For the wound rotor machine with continuous sliding brushes and open enclosure machine, clean the entire winding and cooling air paths, including the core packs-air duct.	
		○	Check the slot wedge for tight fit.	
		○	Check condition of winding insulation, including end connections.	
		○	Check winding and bracing for tightness.	
	○	○	Clean the winding, as far as possible.	Squirrel-cage rotor
		○	For totally enclosed machine, clean entire winding if required.	
		○	For the open enclosed machine: Clean entire winding and cooling air paths including the core packs-air duct.	
		○	Check cage bars and end rings for fractures and loosely soldered connection.	
		○	Check cage for axial displacement.	
		○	Check end rings and support rings and the associated locking elements for tight fit.	
	○	○	Check and record the insulation resistance of windings.	Wound rotor winding
	○	○	Clean the winding, as far as possible.	
		○	For totally enclosed machines, clean the winding if required.	

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
		○	For the machine with continuous sliding brushes or open enclosure machines, clean entire winding and cooling air paths including the core packs-air duct.	Enclosure
		○	Check the slot wedge for tight fits.	
	○	○	Check the winding-end for deposits of oil and carbon dust.	
		○	Check the banding for tightness, and check for any loosely soldered joints.	
		○	Check bracings and wedges of winding end and ring circuits for tightness.	
		○	Check leads of stator winding, slip ring leads of wound rotor machine and their locking elements for tightness.	Water air cooler (heat exchanger)
○			Vent the cooler while in operation.	
○			Where possible, measure and record the water temperature. (Caution that cooling pipes are not damaged by freezing when the operation is stopped).	
	○	○	Check the cooler, connection and piping for leaks.	
	○	○	Check and clean the cooler.	
	○	○	Inspect the corrosion protection (when provided).	
○			Compare brush noise, sparking and contact marking with conditions found in previous inspection.	Slip ring, brushes
	○	○	Check to see that the brushes can move freely in the brush holders.	
	○	○	Check the pigtail (connection) leads for discoloration and damage.	
	○	○	Take out and clean the air filter.	
A or at least within 1 month			Check the brush length and replace as necessary.	Slip ring, brushes (cont'd)
			Inspect contact surfaces; they should be bright, free from rubbing or threading and have a uniform skin.	
1 week			Remove deposits of carbon dust from the slip ring chamber, slip ring and brush holders.	
3 or 6 months			Check the holder for damage.	
			Check the tightness of slip ring, including separators and fixing studs.	
	○	○	For arm type brush holder, check brushes for screw tightness.	
○			Avoid continuously sliding the brushes.	Brush lifting mechanism
○			Avoid continuously rotating the thrust roller.	
	○	○	Check to see that the mechanism, including the sliding surface of the shaft to the short-circuit ring, is free form dust.	
	○	○	Check the abnormality of thrust roller and limit switch.	
	○	○	Check the sliding surface of short-circuit ring for corrosion.	
		○	Check setting of short-circuit ring to shaft.	
	○	○	For arm type brush holders, check brushes for screw tightness.	
	○	○	Re-lub. the reduction gear assembly.	
	○	○	Check the manually operated gear unit for damage.	

04 Inspection and Maintenance Schedule

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
○			Axial rotor placement should be kept by indication of the shaft on its magnetic center.	Shaft and coupling
	○	○	Check and adjust the belt tension.	
	○	○	Check the external and internal fan for damage or corrosion.	
		○	Check rotor alignment.	
		○	Check the balancing weight for tightness.	
		○	Check all coupling bolts and locking elements for tightness.	
		○	Check the oil leakage of gear coupling.	
		○	Check the shaft keys for tightness.	
		○	Check the monitoring instruments and contact device for proper function.	Monitoring instruments
	○	○	Check the brush length and replace as necessary.	Ground brush
		○	Check the holder for damage.	

➡ Fig. 8 Values of Vibration

Speed, rpm	Rotational Frequency, Hz	Velocity, in/s (mm/s) peak
3600	60	0.15(3.8)
1800	30	0.15(3.8)
1200	20	0.15(3.8)
900	15	0.12(3.0)
720	12	0.09(2.3)
600	10	0.08(2.0)

05 Maintenance of Windings

5.1 General

It is important to keep the machines in good condition by performing periodical maintenance to prevent the insulation from being damaged by moisture, dirt and other foreign matter.

If the machines have been operated under high humidity conditions, not been used for a long time, or been subjected to sudden changes in ambient temperature, the insulation may have absorbed considerable moisture, causing deterioration of the insulation.

Other causes of insulation breakdown include operation of the machines at an overcurrent exceeding the rated current, use under an ambient temperature exceeding the specified values as may be possible with a heated air blower which directly radiates heat over the machines, and overheated windings resulting from dust accumulating on the core packs and coil ends. All of the above items impair insulation and reduce the life of the machine.

5.2 Cleaning of Coils

The method selected will depend on the type of machines, type of insulation, kind of dirt, and other conditions and circumstances.

Cleaning by Wiping with Cloth

Wiping cloths can be used for cleaning when the machine

is small, the surfaces to be cleaned accessible, and the dirt to be removed dry.
Waste should not be used, as lint will adhere to the insulation and increase the collection of dirt, moisture, and oil. This is particularly objectionable on high-voltage insulation, as it tends to cause concentration of Corona.

Cleaning by Means of Compressed Air

Compressed air, used to blow out dirt with a jet of air, is usually effective especially where dirt has collected in places that cannot be reached with a wiping cloth.
Cleaning can be done more quickly with compressed air than with wiping cloth especially on the large machines. If blowing with compressed air results in simply transferring dirt from one place to another on the machine, little is accomplished.

There are a number of precautions to be observed when using compressed air: Air being blown should be dry, especially if blowing against insulation. Moisture condenses and accumulates in air lines and hoses.
Care should be taken to assure this has been completely dried out before using the compressed air on insulation.
Compressed air should never be more than 3~4 kg/cm^2 pressure. Higher pressures can damage insulation and force dirt under loosened tape.
Care should be taken not to blow loosened dirt into inner recesses where it will be difficult to remove and where it might obstruct ventilating ducts.

⚠ WARNING	Wear goggles when blowing dirt out with compressed air and be careful not to direct the air jet toward others. Failure to heed this warning can result in injury to the eyes.

Cleaning by Means of Solvents

Solvents are usually required to remove grease and oil dirt. A lint-free cloth wet with solvent may be dipped in the fluid.
Petroleum distillates are the only solvents recommended for cleaning electrical apparatuses. These solvents, classed as Safety-Type Solvents, have a flash point of above 37.8 deg and are available from most oil companies and other supply sources under various trade names:
- Mineral spirits, cleaner's naphtha, and similar products with a flash point above 37.8 deg.
- Gasoline, naphtha, and similar grades must not be used for cleaning. They are highly volatile and present a great fire hazard.

⚠ WARNING	Avoid prolonged or repeated contact with petroleum distillates or breathing their vapors. These solvents can cause severe skin irritation, are toxic, and are readily absorbed into the system. Failure to heed this warning can cause severe personal injury or death. Do not use carbon tetrachloride or mixtures containing carbon tetrachloride for cleaning purposes. Carbon tetrachloride and its fumes are highly toxic. Failure to heed this warning can result in serious illness or death. Avoid excessive contact with cleaning solvents and breathing their vapors. Some solvents are extremely toxic and readily absorbed into the system.

5.3 Use of Space Heaters

When the motor is operating, its interior is not humid and in a dry condition. But it absorbs humidity at rest.
In order to prevent absorption of humidity, the space heater installed inside the frame should be immediately energized after the motor comes to a stop, and the temperature inside of the motor should be controlled 3 to 5 deg higher than the ambient temperature.
If there is no space heater, a 100-150-W incandescent lamp may be used.

⚠ CAUTION	Connect this heating system according to its output and reference voltage. Arrange the control so that the heating system - switches on after the electrical machine switches off. - switches off before the electrical machine switches on.

5.4 Drying Insulation

Should the insulation resistance for the winding have poor insulation resistance due to the ingress of moisture, then the windings must be dried to improve the insulation resistance to the minimum specified value before the application of insulation resistance. The preferred method of drying windings is the external heat method. The alternative is the internal heat method.

1) The External Heat Method.

* Temperature-controlled oven
The best method is to dismantle the motor (including

bearings) and place the motor in a temperature-controlled oven at between 110°C max. for 8-10 hours depending on oven efficiency to remove moisture.

* The alternative external heat method is to remove end shields and covers, connect the anti-condensation heaters, and fit additional "black heat" resistance in and around the motor.

A temperature controller should control additional resistance heaters with a probe adjacent to the winding at the top of the motor. The temperature should be set for 100°C to 120°C. The drying process will take approximately 10-16 hours once the correct temperature is achieved.

< Key Points to Remember >

1) Heaters must be the "black heat" types otherwise the insulation might be burnt.
2) The motor may need to be covered by some thermal insulation to retain the heat.
3) A vent opening should be placed in the tip of the thermal insulation tent for the evaporated moisture to escape.
4) Sufficient space should be allowed between the heaters and any winding insulation so as not to generate local excess heating of the winding insulation.

2) The Internal Heat Method

With this method, the heat is applied by passing current through the windings to generate heat. Extreme caution should be exercised using this method so that you do not damage the internal insulation before the windings are up to optimal temperature.

⚠ WARNING	This method should only be used if all winding resistance is greater than 1 megohm.

< Key Points to Remember >

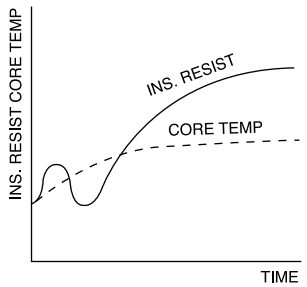
1) Remove brushes and short the ring together with a copper link in case of a slip ring motor (wound rotor).
2) Connect an AC supply voltage to the stator windings. The applied voltage should be approximately 12%. In this case the stator nominal voltage is 3,300 V and since 415 V AC represents 415/3,300 x 100 = 12.5%, this will be a convenient supply voltage. In case the current is taken from the supply, it would be typically 70% of the full load rated current.
3) The power supply should be controlled with a temperature controller operating from the internally connected RTDs supplied by the motor manufacturer.
4) The shaft should be locked to prevent rotation.
5) Set the temperature controller to 110°C maximum.
6) Drying will take approx. 8-12 hours once the windings have reached 100°C. The windings should take 6-8 hours to heat up to 110°C.

Determination of Dried Insulation

During the drying process the insulation resistance should be checked with a 500-V (low-voltage machine) or 1,000-V (only high-voltage machine) DC low-energy source meter (e.g. megger) and then recorded after 1 minute.
This process should be repeated every hour until the results show the winding is dry.

Once the winding is completely dry, the insulation resistance will stabilize. After the windings cool down, the insulation value should increase.

Fig. 9 Change in Insulation Resistance



Notes on Drying Insulation

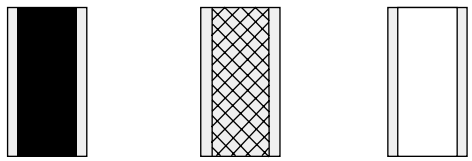
1) A temperature-controlled oven should be used if the windings have been completely immersed in water.
2) Should the windings contain contamination, the windings should be properly cleaned before attempting to dry windings. Contact your factory representative for further advice.
3) All processes for drying insulation should be performed under the supervision of qualified personnel. Failure to observe proper procedures may result in permanent damage to the insulation or winding system. For further advice contact your factory representative.

6.1 Slip Rings

Good Conditions

The slip ring must run true to the center of rotation. The maximum permissible TIR (Total Indicator Runout) must be no greater than 0.2 mm. If the TIR is greater than this, the slip rings must be machined true. The surface of the slip rings must be a smooth finish. The slip ring will normally show a running band under the brush contact area. This can be from light straw in colour to dark brown (almost black). The most normal colour is "light brown". The surface should be consistent in colour around the periphery and across the brush track. Sparking should not be evident during operation and the rings should be dry with no signs of contamination.

Fig. 10 Examples of Good Condition



The Brush Running Band is a film on the ring basically consisting of copper oxide and carbon. This film occurs naturally during normal operating and it is essential for good brush and ring condition. Do not try to remove it. The film is easily maintained by ensuring the area is free from contamination and the machine is properly loaded.

Poor Conditions

Poor ring conditions can be caused by several conditions. The common causes of poor ring conditions are:

1) ***Brush loading is not optimum correction***:
See Section "Optimizing Brush Wear".

2) ***Contamination***:
Such as oil, salt air, H_2S or silicone vapours (even from Silastic) may destroy the film built up on the rings.
Correction: The contamination should be removed and a new set of brushes fitted and bedded in. It is preferred that slip rings be cleaned with a dry lint-free cloth. If required, some "non-residue/noncorrosive" electrical cleaning solvent could be used.

> **WARNING**
> Electrical solvent, if inhaled or absorbed through the skin, can be dangerous to your health. Please refer to the manufacturer safety information for proper advice

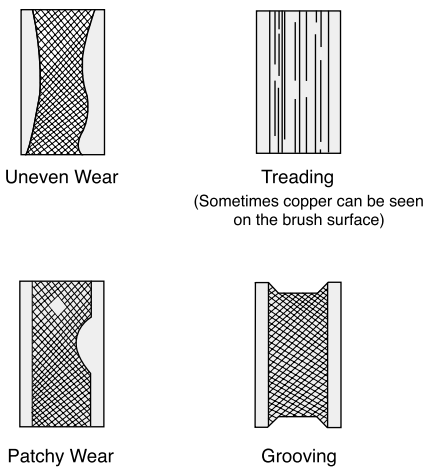
3) ***Corrosion of Brush Rings***
This condition may occur if the motor has been at standstill for a long time (e.g. after extended storage).
Correction: This should be removed by using a fine "grinding stone" stone available from most service shops or brush suppliers. Rotate the motor either with a small pony motor or run the motor on no load and uncoupled with the slip rings short-circuited after accelerating to full speed (do not start without rotor resistance starter).

> **WARNING**
> Although no voltage is present across the rings during this operation you should
> - ensure the rings cannot open circuit, otherwise high voltages could be present.
> - follow electrical safety rules.
> This procedure should only be performed by qualified and experienced personnel.

4) ***Threading***
If threading occurs, brush optimization should be corrected first.
(1) Light threading can be corrected the same way as "corrosion".
(2) Heavy threading should be corrected by machining the slip rings.

5) ***Out of Round Rings***
This must be corrected by machining the slip rings.

Fig. 11 Examples of Poor Conditions



Machining Slip Rings

Method 1 - Preferred:
Dismantle the motor and remove bearings. Place the rotor in a lathe, centre bearing journals true and machine slip rings.

Method 2 - Alternative:

The rings are removed from the shaft with a puller which can be attached to the hub of the slip ring assembly. Access to the rings can be gained by removing the drive end endshield and carefully disconnecting the rotor leads. After the rings have been removed they can be machined in a lathe.

Method 3 - Alternative:

Some motor repair shops offer on-site machining. This is not a preferred method, but may be required for emergency repair. If on-site machining is performed, the following precautions should be adhered to

- replace brushes after machining operation is complete.
- all ring scrap to be removed from slip ring enclosure.
- this operation should only be performed by experienced personnel.

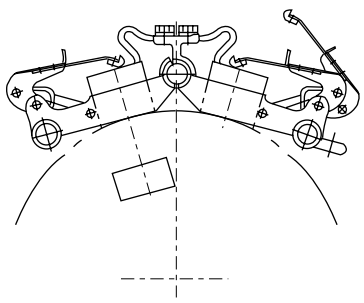
After machining, the rings should be kept clean and free from fingerprints until ring film has developed during operation.

6.2 Brushes and Brush Holders

General

The brushes must make good contact with the slip ring surface. To ensure this, they must move freely within the brush holder and pressure lever must apply the correct pressure. The brush holder assembly is fixed. To replace brushes, unclip the pressure level and undo the "pigtail" from the holder assembly.

Fig. 12 Brush Holder Assembly



If satisfactory brush life has been obtained, replace the brushes with the same grade as the original. Always make sure brushes are bedded in after replacement.

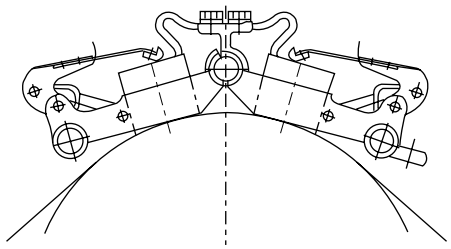
It may be possible that brushes wear out quickly. A common cause for this is a light load or brushes not making proper contact with the rings. In this case consult Section "Brush Optimization" or your carbon brush supplier. If brush holders need replacing, the brush assembly may be removed by taking off the drive end endshield. The brushes are to be changed when they have worked down to about 1/3 of their original length. The wear is not the same for all brushes. It is important to keep the brush housing clean and grease from excess carbon dust. Clean out housing periodically, using vacuum cleaner and clean, dry compressed air (max. 4 bars) where possible.

⚠ WARNING	Cleaning while operating is not recommended, except in case of experienced operators. High velocity compressed air can lift brushes or short pigtails together.

Bedding Brushes

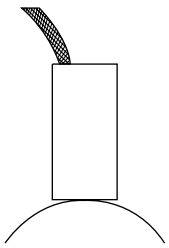
When new brushes are fitted they should be bedded in. If the slip rings wear, the diameter can vary, so the diameters of the brush face and the diameter of the rings may not be exactly the same. So, in all cases, brushes should be bedded in.

Fig. 13 "Bedding" Brushes In



Some abrasive sandpaper should be placed around the slip ring and the brush fitted in the holder with the tensator in place. The abrasive is drawn back and forth until all of the brush is in contact with the ring.

Fig. 14 Example of Poor Surface Profile



The brush surface contact area must not be less than 80% of the surface of each individual brush.
During the initial run, if possible, it is desirable to apply some bedding chalk to the rings before entering under the brush surface, this will promote the final bedding in of the brush.

NOTE: Bedding chalk is usually available from most service shops or carbon brush suppliers.

7.1 General

Transport, Storage

Always keep the cover and the cable entries tightly closed.

7.2 Description

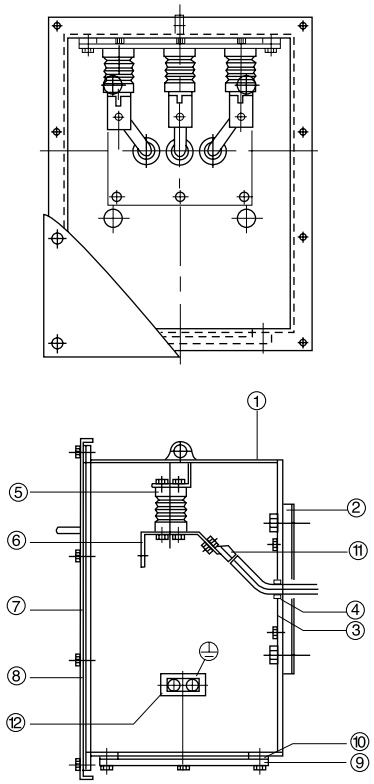
1) Application

In the terminal box, the connection is made between the stator winding and the supply cable from the system. The terminal box is mounted on the machine frame at an easily accessible location.

2) Construction

A typical construction is shown in Fig. 15

➡ Fig. 15 Construction of Terminal Box
(Example, delivered design may deviate in details)



① Terminal box body	⑦ Packing
② Packing	⑧ Terminal box cover
③ Cable holder	⑨ Gland plate
④ Cable grommet	⑩ Packing
⑤ Insulator	⑪ Terminal lug
⑥ Connector	⑫ Earthing terminal

3) Degrees of Protection

The terminal boxes comply at least with degree of protection IP55 as per IEC 34-5.

4) Connection Part for Main Terminals

The connection part is suitable for connection with cable lug depending on the equipment complement.

7.3 Installation

1) Termination

General

Ensure that the power supply agrees with the rating plate data. The supply cables should be matched to the rated current and plant-specific conditions (e.g. ambient temperature, method of cable installation, etc.). Connect the supply-cable conductors.

⚠ CAUTION	Connection cables and cable ends must not exert any bending or torsion forces on the connection bolts!

Connection by Means of Cable Lugs

The size of cable lugs must be matched to the size of the supply cable. Use appropriate units with sufficient current-carrying capacity.

Direction of Rotation

When the power supply phase conductors L1, L2, L3 are connected to terminals U, V, W respectively, the motor will rotate in a correct direction. If the connections to any two terminals are reversed, i.e. if lines L1, L2, L3 are connected to terminals V, U, W (or U, W, V or W, V, U) respectively, the motor will rotate in a reverse direction.

Installing and Entering the Cable

The following steps are recommended for split entry:

- Cut the sealing insert so that its opening is some millimeters smaller than the cable diameter.
- Introduce the cable into the cable gland. In the case of a very small cable diameter, the cable diameter should be increased by applying insulation tape at the securing point to ensure concentric positioning of the cable in the sealing insert.
- Provisionally attach the terminal box cover in order to check whether perfect sealing is achieved both at the flange surfaces and at the entry point with sufficient prestressing. If this is not the case enlarge the sealing insert cut out or adjust the cable diameter by means of insulation tape. The securing bolts should then be tightened alternately in steps.
- Unused entry openings always must be closed off by suitable plugs.

These must

- be of permissible resistant material,
- conform to degree of protection IP55,

- be tightened so that they can be removed only by means of a tool.

Earth Connection

An earth terminal for connecting the cable earth conductor is provided in the terminal box.

The minimum connection cross-section of earth connections should be selected according to IEC 34-1 with reference to live conductors.
Make sure in any case of installation and maintenance work that the equipotential bonding is maintained.

Final Checks

Before closing the terminal box, check the following:
- Conductor connections and, if applicable, the circuit connections have been made correctly.
- Interior of the terminal box is clean and free from remainders of cable material.
- All terminal screws and the appropriate cable entry parts are firmly tightened.
- Clearance in air of ≥8 mm at 500 V, ≥10 mm at 660 V, ≥14 mm at 1 kV, ≥60 mm at 6 kV, ≥100 mm at 10 kV are maintained. Remove any projecting wire ends!
- Connection leads are not subject to strain and the insulation cannot be damaged.
- Unused entry openings are closed off by suitable plugs.
- All seals and sealing surfaces are in perfect condition. If sealing of the joints is effected by metal-to-metal joints only, the surfaces should be cleaned and thinly regreased.
- Entry glands fulfill all requirements concerning degree of protection, conditions of installation, permissible lead diameter.

7.4 Operation

Safety Advice

Covers to prevent accidental contact with live or rotating parts and those required for proper air guidance and thus effective cooling should not be opened during operation.
During maintenance or inspection work in the immediate vicinity of the terminal box or of the rotating machine suitable measures should be taken to protect personnel against hot gases escaping under short-circuit conditions.

⚠ CAUTION	Only switch off the electrical machine during the main running period in an emergency, in order to protect the switchgear and electrical machine.

7.5 Maintenance

⚠ DANGER 	High-voltage power source must be disconnected before working on equipment. Failure to disconnect power source could Result in injury or death. Terminal box only to be opened by skilled personnel.

1) Safety Advice

Before any work is started on the machines, particularly before covers are removed from live parts, make sure that the machine/plant has been correctly disconnected from the power supply.
Please adhere to the general “5 safety rules”
- Isolate the equipment from the power supply,
- Provide a safeguard to prevent unintentional reclosing,
- Verify safe isolation from the supply,
- Earth and short-circuit,
- Provide barriers or covers for adjacent live parts.

2) Tightness, High-current Loading

The terminal boxes should be inspected regularly to ensure that they are tight, that the insulation is undamaged and that the connections are firmly attached.
If the terminal box is subject to extremely high current loading it is recommended that the insulators, connecting parts and cable connectors be checked.
If any dust or moisture has penetrated the terminal box, clean and dry out the terminal box. The seals and sealing surfaces should also be checked and the cause of faulty sealing should be remedied.

3) Tightening Torque

Max. tightening torque for current-carrying bolted joints is given in below table.

Screw Strength class	Tightening Torque (Nm)	
	Steel (8.8)	Brass
M5	-	2.9
M6	10.8	4.9
M8	20.7	9.8
M10	42.4	19.7
M12	73.9	34.5
M16	177.4	82.8

※ The tolerance of tightening torques is±10%

NOTE: Replace the cover and tighten up the screws (taking safety elements into consideration).

8.1 General

Transport, storage

Always keep the cover and the cable entries tightly closed.

8.2 Description

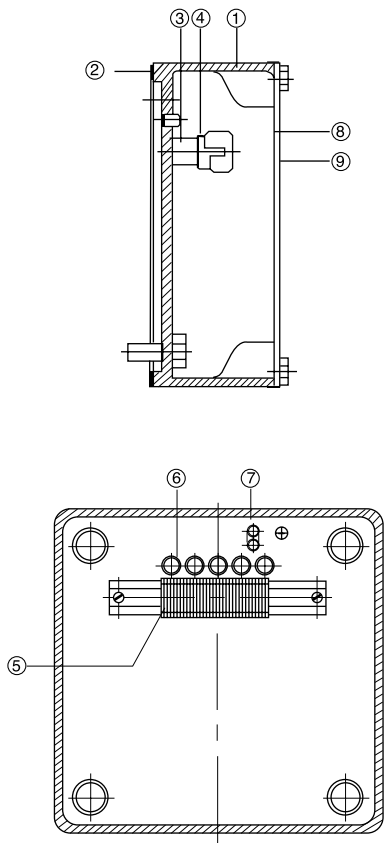
1) Application

The terminal boxes are employed for connection of auxiliary circuits.
If specially ordered for anti-condensation heater, an auxiliary terminal box for anti-condensation heater may be supplied.

2) Construction

The typical construction is shown in Fig. 16.

➡ Fig. 16 Construction of Terminal Box
(Example, delivered design may deviate in details)



① Terminal box body
② Packing
③ Support ring
④ Rail
⑤ Terminal block.
⑥ Cable grommet
⑦ Earthing terminal
⑧ Packing
⑨ Terminal box cover

3) Degrees of Protection

The terminal boxes comply at least with degree of protection IP55 as per IEC 34-5.

8.3 Installation

1) Termination

When making the connections of auxiliary circuits note wiring diagram for auxiliary circuits documented in the approval specification.
The cross-section of a supply cable should be selected on the basis of the rated current and plant-specific conditions.
The connection terminals for auxiliary circuits are suitable for conductor cross-sections of at least 2.5mm².
The ends of the conductors should be stripped in such a way that the remaining insulation reaches almost up to the terminal.

2) Installing and Entering the Cable

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

In addition to the information given for cable selection and preparation, the following specific notes apply, depending on the type of entry fitting used :
To maintain the degree of protection IP all screwed-in glands must be firmly tightened and sealed by suitable measure, e.g. by means of an adhesive or by fitting sealing ring. The same measures are required when fitting screwed-in plugs.

The center rings of screw glands included in the scope of supply are always screwed in place, fixed in position and sealed in accordance with degree of protection IP55 by use of LOCTITE. These glands also are fitted with blind washers for transport protection.

For adapting the cable diameter to the gland conditions it may be necessary to apply a layer of insulation tape to the leads to enlarge its overall diameter or to cut out some rings of the sealing insert.
With extreme lead diameter it may be necessary to replace the glands by those of appropriate dimensions.
Entry plates of terminal boxes may be supplied undrilled in order to allow selection of cable entry screw glands, whose design, number and size are suitable for the cables employed.

08 Terminal Box for Auxiliary Circuits

The entry elements should be selected so that
- they are suitable for the cable diameter,
- they conform to the degree of protection,
- they are suitable for the installation conditions.

The supply leads-particularly the protective conductor-should be laid loosely in the terminal box with an extra length to protect the cable insulation against splitting. Unused entry openings always must be closed off by suitable plugs.

These must
- be of permissible resistant material,
- conform to degree of protection IP55,
- be tightened so that they can be removed only by means of a tool.

3) Earth Connection

An earth terminal for connecting the cable earth conductor is provided in the terminal box.

09 Anti-condensation Heating with Heating Tube

9.1 Description

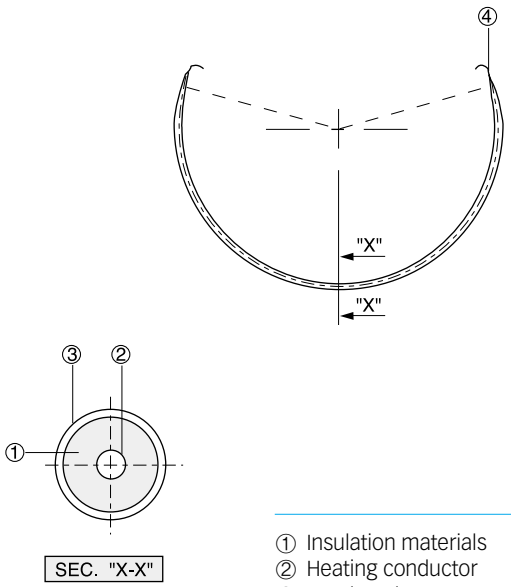
1) Application

Anti-condensation heaters fitted in electrical machines warm the air inside the stationary machine to a temperature above that of the surroundings, thus effectively preventing moisture condensation.

2) Construction

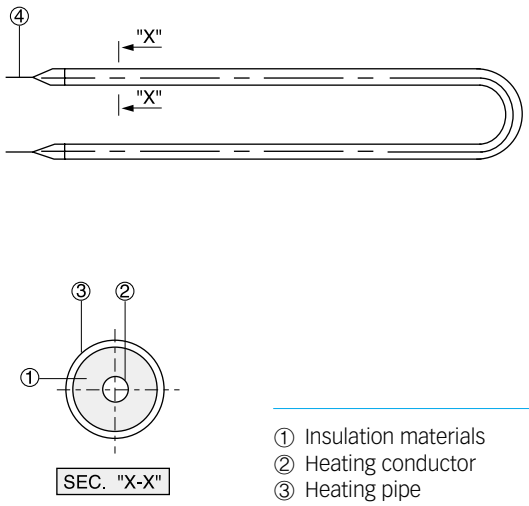
The typical constructions are shown in Fig. 17, 18 and 19.

➡ Fig. 17 O Type Anti-condensation Heater
(Example, delivered design may deviate in details)



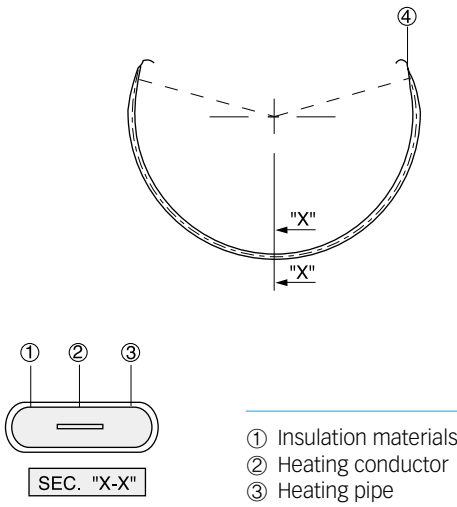
① Insulation materials
② Heating conductor
③ Heating pipe
④ Lead cable

➡ Fig. 18 U Type Anti-condensation Heater
(Example, delivered design may deviate in details)



① Insulation materials
② Heating conductor
③ Heating pipe
④ Lead cable

Fig. 19 Strip Type Anti-condensation Heater for Explosion-proof Machines with "increased safety" (Example, delivered design may deviate in details)



The heating tube has a heating conductor which is embedded in insulating material and arranged inside a corrosion-resistant metal tube. The tube ends are sealed to prevent the ingress of moisture.

3) Installation

The anti-condensation heater consists of one or more tubular heating elements connected together. These heating tubes are combined to form units and are installed in the stator frame. The arrangement constitutes the so-called "stabilized design", i.e. the heating temperature stabilizes itself at the rated voltage thanks to the optimum balance of heater rating and heat dissipation. Special temperature monitoring devices are therefore not necessary. This applies to explosion-proof versions as well.

9.2 Installation

1) Connecting the Supply Cable

The heater connections are brought to terminals which are located in a separate terminal box and may be made without cable lugs.
Connection must be made in accordance with wiring diagram documented in the approval specification.
Examine the data plate to see that the voltage and the power of the heating agree with the main supply. The supply connection of the heaters must be interlocked with the main breaker of the machine to ensure that the heaters are switched off when the machine is running and switched on once the machine has come to a standstill.

Through appropriate series connection of the heating tubes, even the temperature of explosion
– proof machines can be limited such that these machines meet the requirements of "stabilized design" and do not require any additional temperature monitoring measures. For this reason, no changes may be made in the original heating-tube connection!

2) Insulation Testing

The heater may only be put into operation if the specified minimum insulation value of 0.5 Mega-ohm is obtained from measurement of the insulation resistance with the heater connected.
For the period after commissioning of machines equipped for anti-condensation heating, it is assumed that either the machine itself is in operation or the anti-condensation heater is heating the stationary machine.

9.3 Maintenance

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

1) Safety Advice

The anti-condensation heater is switched on when the machine has come to a standstill. Therefore, it must be switched off before any protecting cover is opened for maintenance work.

2) Cleaning

With respect to maintenance, occasional cleaning performed during routine maintenance of the machine and the replacement of any damaged parts is sufficient.

3) Repairs

Should replacement of the heating tubes become necessary use the same type of heaters. Install the new tubes securely and lock the fixing elements.
The heating tube units in explosion-proof machines may only be replaced as a whole and must be purchased as whole preformed units to suit the particular application.
If repairs and modifications to models covered by the certificate for these machines are not performed in a HYUNDAI workshop, an acceptance inspection by an authorized engineer is necessary. If modifications not covered by the certificate are made, the machine must be newly certified.

10.1 Flange-type Sleeve Bearings (Ring Lubrication System)

1) Mounting

The flange-type sleeve bearings of electrical machines are of the split type. They are ring-lubricated and are subject to the following instructions supplementing and modifying the operating instructions of the machine:
Corresponding to the operating conditions the sleeve bearings of new machines have a favorable bearing clearance which should not be changed. Also scraping (spot grinding) is not allowed as it could worsen the antifriction qualities.
It is possible to remove the upper part of the bearing housing for maintenance without removing the coupling. And using the crane or chain block is good method in dismantling.
Before the machines are aligned and commissioned, the bearings should be filled with lubricating oil, because the machines are delivered without oil in the bearings (Oil type is indicated on the nameplate for bearing).

2) Oil Change

⚠ CAUTION	**Maintain Proper Oil Level.** May cause damage to equipment due to improper lubrication. Follow lubricating instructions carefully. Avoid adding oil while unit is running.

Check the bearing temperature regularly. The governing factor is not the temperature rise itself, but the temperature variations over a period of time. If abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.
The lubrication oil indicated on the data plate is used for starting up the machines at an ambient temperature of above +5°C At lower temperatures (to about -20°C), it is sufficient to preheat the oil. If the ambient temperature is below -20°C another type of oil according to the special conditions is used. Do not mix oils of different grades.
Recommended oil changing intervals are about one operating year in the case of intermittent and continuous duty. When cleaning, first flush the bearings with kerosene and then with oil. Pour in the kerosene and oil through the top sightglass hole. Leave the drain open until all the kerosene has been removed and clean oil runs out. Now plug the drain and fill the bearing with oil up to the centre of the lateral inspection glass.
When the machine has run up to speed, check the oil ring through the top inspection glass to see that it rotates correctly, and check the bearing temperature, Should the bearing temperature not drop to the normal value after the oil change, it recommended that the surfaces of the bearing shells be inspected.
If the bearings are fitted with thermometers for checking the bearing temperature, fill the thermometer well in the upper bearing shell for thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.

3) Dismantling, Assembling

When dismantling the machine the lower part of the bearing housing need not be unscrewed from the end shield, When opening the bearing housing, determine, if on which side of the machine the adjusting shims.(upper and lower parts)are installed. These shims must be installed at the same place when assembling the machine. Exceptions are possible if the stator core was changed. Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in peripheral direction. The oil ring can be withdrawn by holding it at an inclined position to the shaft.
If only slight damage has occurred to the bearing surface, it may be re-conditioned by scraping as long as the cylindrical shape of the bore is maintained, so that a good oil film can form. The lining must be renewed if more serious damage is found. The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care

The replacement bearing shells are delivered by the works with a finished inner diameter. Only if the bearing shells were delivered unfinished, the inner diameter is 1mm smaller than the finished diameter. Oil rings which have become bent through careless handling will not turn evenly. Straighten or replace such rings. Replace any damaged sealing rings.

Fig. 20 Oil Pockets and Oil Grooves

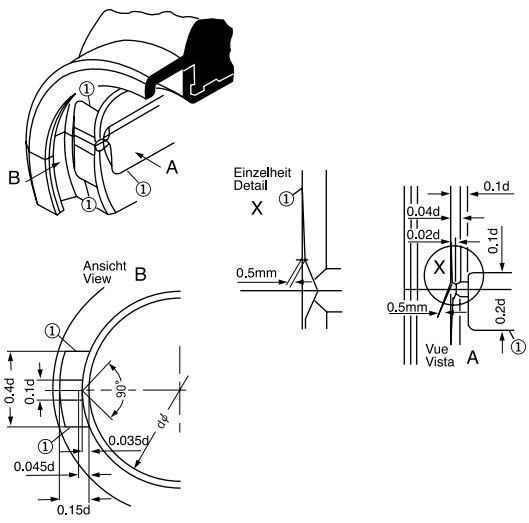
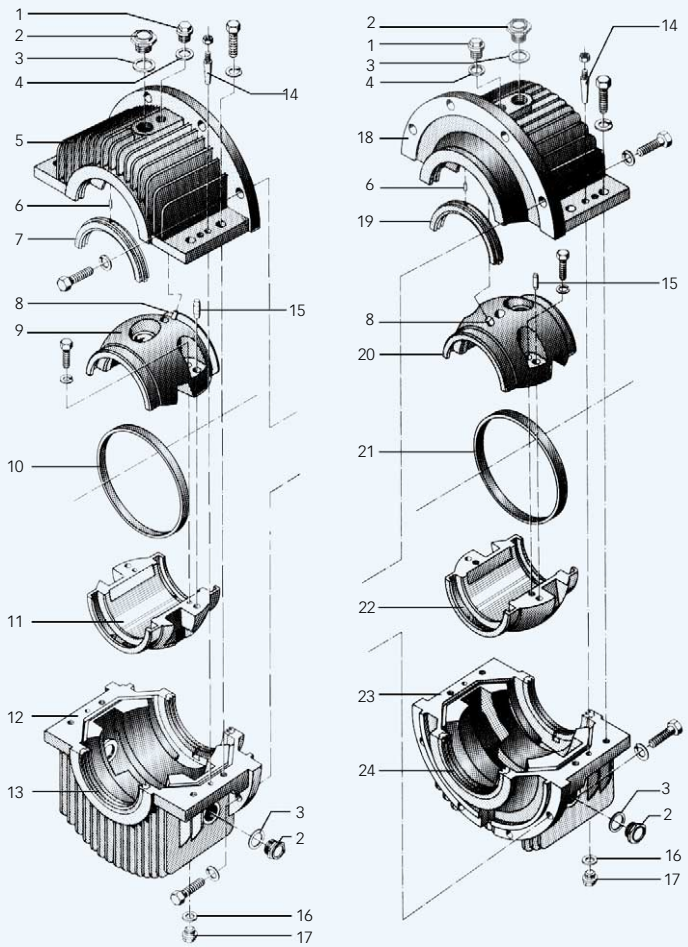
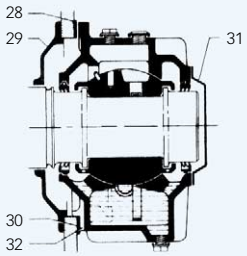
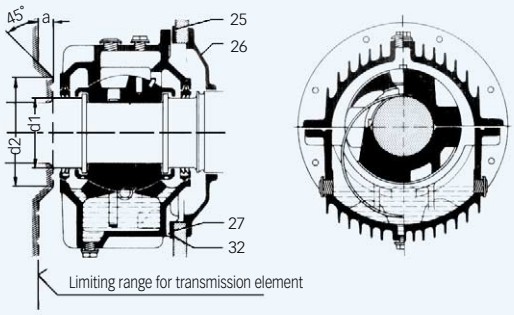


Fig. 21 Ring-lubricated Flange-type Sleeve Bearings (Example, delivered design may deviate in details)







1. Screw plug(thermometer mounting)
2. Inspection glass
3. Sealing ring for 2
4. Sealing ring for 1
5. Bearing housing, upper part drive end
6. Cylindrical pin
7. Sealing ring, upper half, drive end
8. Guide pin to prevent twisting
9. Upper bearing shell, drive end
10. Oil ring, drive end
11. Lower bearing shell, drive end
12. Bearing ring, lower half, drive end
13. Sealing ring, lower half, drive end
14. Taper pin
15. Guide pin to fix bolted parts
16. Sealing ring for 17
17. Drain plug
18. Bearing housing, upper part, non-drive end
19. Sealing ring, upper half, non-drive end
20. Upper bearing shell, non-drive end
21. Oil ring, non-drive end
22. Lower bearing shell, non-drive end
23. Bearing housing, lower part, non-drive end
24. Sealing ring, lower half non-drive end
25. Upper adjusting shim, drive end
26. Sealing cover drive end
27. Lower adjusting shim, drive end
28. Upper adjusting shim, non-drive end
29. Sealing cover, non-drive end
30. Lower adjusting shim, non-drive end
31. Protective cap
32. Pressure compensation opening

10.2 Flange-type Sleeve Bearings (Forced Lubrication System)

1) Mounting

These flange bearings of electrical machines are of the split type. They are lubricated and oil rings and are provided for additional forced lubrication. They are subject to the following instructions supplementing and modifying the operation instructions of the machine: Corresponding to the operating conditions the sleeve bearings of new machines have a favorable bearing clearance which should not be allowed to worsen the antifriction qualities.
It is possible to remove the upper part of the bearing housing for maintenance without removing the coupling. And using the crane or chain block is a good method in dismantling.
Before the machines are aligned, the bearings should be filled with lubricating oil (oil type is indicated on the nameplate for bearing), because the machines are delivered without oil in the bearings.
Check the oil piping to the bearings, oil pump, oil tank, and cooler before commissioning the machines. No reducers must be fitted in the piping. Install a regulating orifice on the oil supply line to protect the bearing from flooding. If the oil pump fails, the lubrication maintained by the oil ring is effective for about 15 to 30 minutes, provided the oil contained in the bearing does not drain away. As the oil is discharged to the atmospheric pressure, the discharge-end of oil piping shall be positioned at the lower level about over 500mm than the level of oil suface. And the diameter of piping shall be sufficient enough so as not to be clogged during the oil discharging to raise the level of the oil in the bearing. Oil discharge tubes must terminate flush with the inside surface of the bearing housing to prevent the oil rings from rubbing against the tubes.
Fill the oil tank with lubricating oil indicated on the data plate. This oil is used for starting up the machine at an ambient temperature of above +5°C At lower temperatures preheat the oil. It is recommended to use a control system adjusted in such a manner to have an oil temperature of 15 to 20°C in the tank and to have a preheated oil flow through the cold bearings for 5 to 10 minutes before starting up the machine. Do not mix oils of different grades.
The necessary pressure of the oil entering the bearings and the oil flow rates are indicated on the data plate. Adjust to these values when starting up the machine for the first time and correct them when the bearing has attained its normal running temperature. The oil in the bearing housing must not rise above the center of the lateral inspection glass.
If the bearings are fitted with thermometers for checking the bearing temperature, Install the thermometer in the upper bearing shell for the thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.
In the case of insulated bearings, make sure that the insulation is not bridged by the tubes; interrupt the electrical conductivity of the tubes near the bearings, e.g. by installing oil-resistant fittings of plastic material or hoses of rubber or plastic material.
Switch on the oil pump before starting up the machine. The use of a pump driven from the shaft of the main machine is permitted only in special cases, i. e. when the acceleration and coasting times are short.

2) Oil Change

⚠ CAUTION	**Maintain Proper Oil Level.** May cause damage to equipment due to improper lubrication. Follow lubricating instructions carefully. Avoid adding oil while unit is running.

Check the bearing temperature regularly. The governing factor is not the temperature rise itself, but the temperature variations over a period of time, if abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.
Recommended oil changing intervals are about 20,000 operating hours. After the machine has come to a standstill and the old oil is drained out of the bearings and oil tank operate the oil pump with kerosene for a short time and then use oil to clean the bearings, the oil pump, the oil tank, the cooler and the pipe lines. Pour in the kerosene and then the oil through the filling opening of the oil tank. Leave the drains open from time to time until all the kerosene has been removed and clean oil runs out of the bearings and the oil tank. Then, plug the drains and fill the tank with oil. Should the bearing temperature not return to the normal value after the oil change, it is recommended that the surfaces of the bearing shells be inspected.

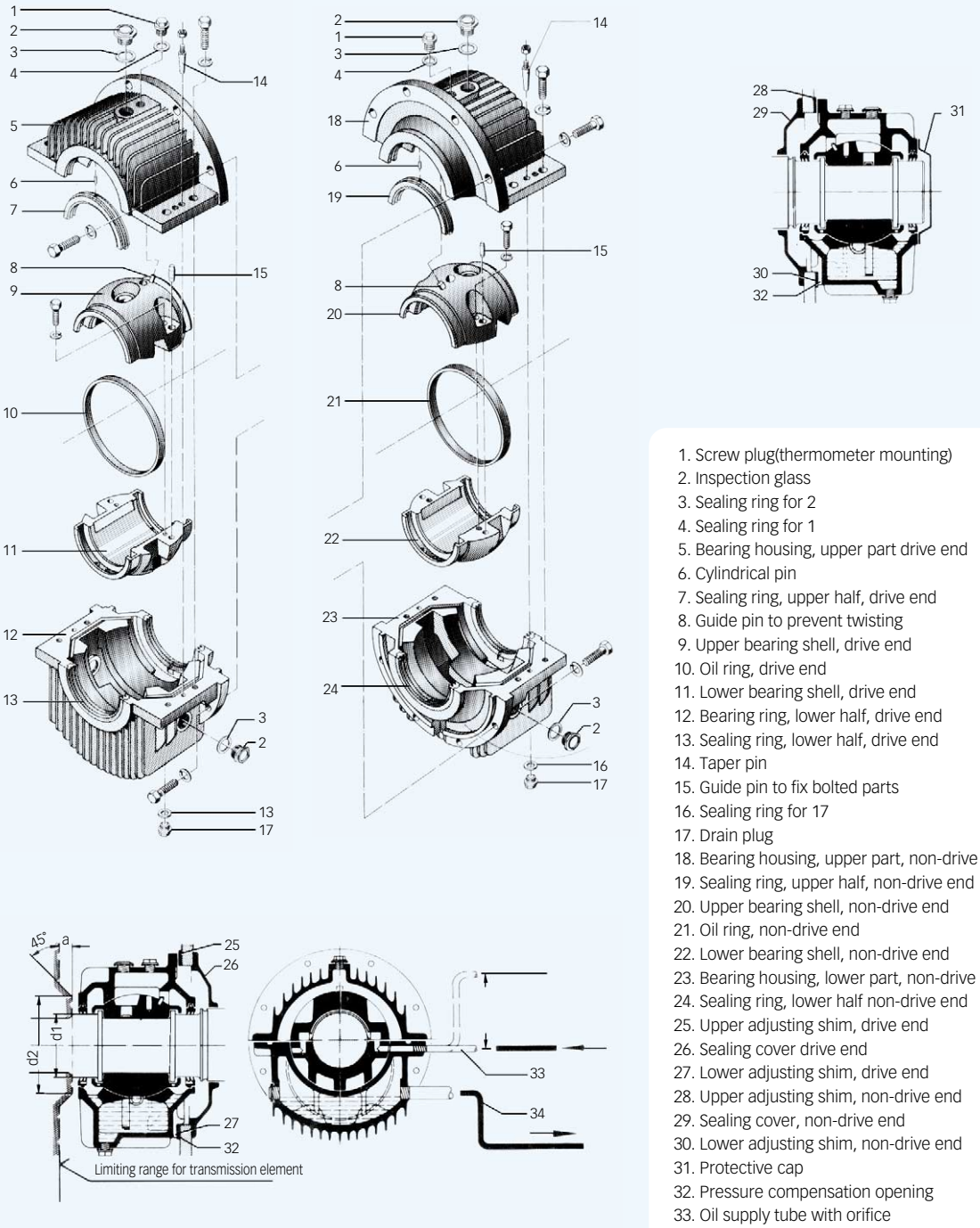
3) Dismantling, Assembling

When dismantling the machine the lower part of the bearing housing need not be unscrewed from the end shield. When opening the bearing housing, determine on which side of the machine the adjusting shims (upper and lower parts) are installed. These shims must be installed at the same place when assembling the machine. Exceptions are possible, if the stator core was changed.
Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in peripheral direction. The oil ring can be withdrawn by holding it at an inclined position to the shaft.

If only slight damage has occurred to the bearing surface, it may be re-conditioned by scraping as long as the cylindrical shape of the bore is maintained, so that a good oil film can form.
The lining must be renewed if more serious damage is found. The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care.

The replacement bearing shells are delivered by the works with a finished inner diameter. Only the bearing shells were delivered unfinished, the inner diameter is 1mm smaller than the finished diameter. Oil rings that have become bent through careless handling will not turn evenly. Straighten or replace such rings. Replace any damaged sealing rings.

Fig. 22 Flange-type Sleeve Bearing for Forced-oil Lubrication (Example, delivered design may deviate in details)



1. Screw plug(thermometer mounting)
2. Inspection glass
3. Sealing ring for 2
4. Sealing ring for 1
5. Bearing housing, upper part drive end
6. Cylindrical pin
7. Sealing ring, upper half, drive end
8. Guide pin to prevent twisting
9. Upper bearing shell, drive end
10. Oil ring, drive end
11. Lower bearing shell, drive end
12. Bearing ring, lower half, drive end
13. Sealing ring, lower half, drive end
14. Taper pin
15. Guide pin to fix bolted parts
16. Sealing ring for 17
17. Drain plug
18. Bearing housing, upper part, non-drive end
19. Sealing ring, upper half, non-drive end
20. Upper bearing shell, non-drive end
21. Oil ring, non-drive end
22. Lower bearing shell, non-drive end
23. Bearing housing, lower part, non-drive end
24. Sealing ring, lower half non-drive end
25. Upper adjusting shim, drive end
26. Sealing cover drive end
27. Lower adjusting shim, drive end
28. Upper adjusting shim, non-drive end
29. Sealing cover, non-drive end
30. Lower adjusting shim, non-drive end
31. Protective cap
32. Pressure compensation opening
33. Oil supply tube with orifice
34. Oil discharge tube with sight glass

10.3 Rolling-contact Bearings

1) Mounting

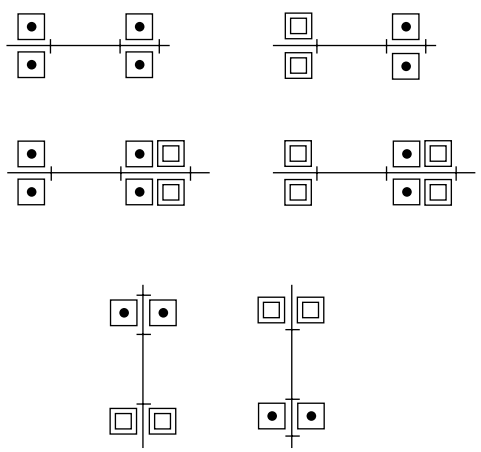
Electrical machines fitted with rolling-contact bearings mentioned above are subject to the following instructions supplementing and modifying the operating instructions of the machine:

The locating bearings are deep-groove ball bearings for horizontally mounted machines. These bearings may also be in pairs with cylindrical roller bearings in the case of bearings is not guide radially and is prevented from rotating by compression springs.

The locating bearings for vertically mounted machines are angular-contact ball bearings of type range 72 or 73 (angular-contact ball bearings with increased axial fixation see supplementary operating instructions).

The floating bearings are deep-groove ball bearings or cylindrical roller bearings. In case of deep-groove ball bearings as floating bearings, the axial play is compensated by means of compression springs.

➡ Fig. 23 Examples for Bearing Combination



Deep-groove ball bearing

Cylindrical roller bearing

Angular contact ball bearing

2) Regreasing

NOTE: A common mistake is over-lubrication of bearings. When grease is added without removing the drain plug, the excess grease must go somewhere and usually it is forced into and through the inner bearing cap and is then thrown into the windings. Excess grease in the bearing can cause bearings to run hot and could lead to bearing failure.

Initial lubrication of the bearings is normally carried out in the works with grease satisfying the conditions of running test at a test temperature of 120°C to DIN 51 806. If a different type of grease is required, this is indicated on the data plate, provided that the particular operating conditions were given in the order.

Keep the new grease meticulously clean. Greases having a different soap base should not be mixed since this would reduce the grease quality.

For regreasing, clean the lubricating nipple and press in the grease quantity indicated on the data plate, using a grease gun. The shaft should rotate during regreasing; hence, the machines need not be stopped. After regreasing, the bearing temperature will rise by a few degrees and will drop to the normal value when the grease has reached its normal service viscosity and the excess grease has been forced out of the bearing.

It is recommended that the lubricating instructions be strictly followed. Special cases may require lubrication to special instructions, e.g. where there is an extreme coolant temperature or aggressive vapours. The old grease from several regreasing operations gathers in the space inside the outer bearings caps. Remove the old grease when overhauling the machines.

The model of bearing is favorably chosen as for direction and size of load (type of construction, forces acting on the shaft) and therefore it should not be changed.

The permissible values of axial and radial forces may be taken from the list of machine.

The machines should operate in only one type of construction as shown on the rating plate, because another type of construction required perhaps further measures in addition to a modification of the model of bearing. Always in this case an inquiry is necessary.

3) Lubrication

In case the machines are stored at warehouse or storage area for longer than 6 months, the existing lubricant shall be poured out and be replaced with new one.

The regrease interval for grease is 3 months, and the replacement interval for oil is 6 months. In case of 2 pole motor, refer to the lubrication name plate.

4) Dismantling, Assembling

⚠ CAUTION	**May cause bearing damage(brinelling) if outer race of bearing is struck.** BECAREFUL When replacing bearing. Avoid subjecting bearing to impact.

For working on the locating bearing in the vertical position of the machine, support or discharge the rotor.

It is recommended that new roller bearings be installed as follows: Heat the ball bearings or the inner ring of the roller bearings in oil or air to a temperature of approx. 80°C and slip them onto the shaft. Heavy blows may damage the bearings and must be avoided.
When installing single angular-contact ball bearings, make sure that the broad shoulder of the inner ring (and the narrow shoulder of the outer ring) in operating position points upwards, i.e. in a direction opposite to that of the axial thrust.
When assembling the machines, avoid damage to the sealing rings. Rubber sealing rings (V-rings) should be carefully fitted over the shaft as shown Fig. 28. New felt sealing rings should be so dimensioned that the shaft can run easily while proper sealing is still effected. Before fitting new rings, soak them thoroughly in highly viscous oil (normal lubricating oil N68 to DIN 51 501) having a temperature of approx. 80°C.

5) Locating Faults

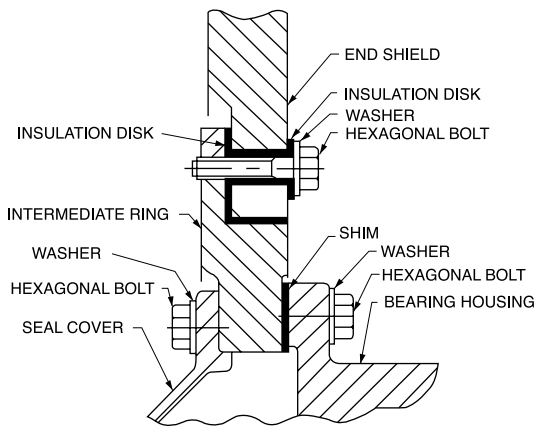
The troubleshooting table helps to trace and remove the causes of faults. It is partly difficult to be found the damages of bearings. In case of doubt, it is recommended to renew the bearings.

10.4 Insulation to Prevent Shaft Current (High-voltage and Large Machines)

NOTE: Not all machines are equipped with insulated bearings.

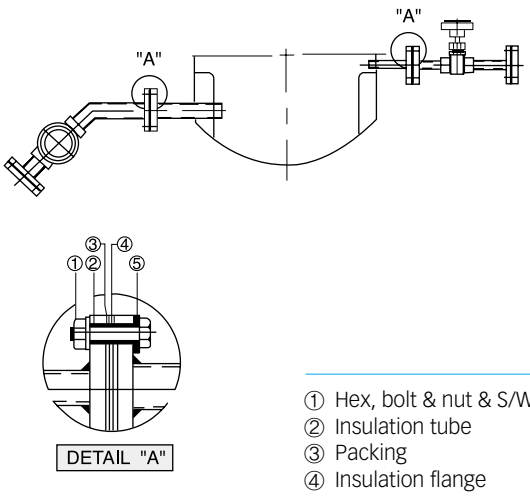
To prevent the risk of bearing damages due to the circulating shaft current, which is induced by shaft voltage, the insulation disk is provided at the end shield as shown in Fig. 24.

Fig. 24 Bearing Insulation



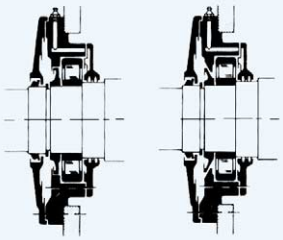
With motors having single shaft extension, the bearing at non-drive end is insulated. In case of motors with double shaft extension, both bearings are insulated. When the motors with the double shaft are coupled with the driven load, one of the couplings must be insulated to prevent the damage of other shaft connected equipments.

Fig. 25 Bearing Cooling Pipe System for Forced-oil Lubrication

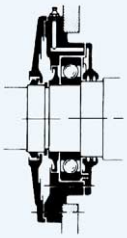


Care should be taken to prevent shorting out this insulation. All lines (lubrication oil pipes, V.T.D., vibration sensors, etc) fitted at the workshop are insulated from the end shield, but it is necessary to ascertain whether or not the insulation is required for all lines which are connected at the time of the motor installation at the site.
The bearing cooling pipe for forced-oil lubrication is insulated as shown in Fig. 25. The shaft voltage (peak to peak) is usually high frequency voltage of 1 volt or les and rarely several volts. When a shaft current by this voltage flows, the shaft and journal part are tarnished and in the worst case sparking can make minute black spots on shaft and journal parts. There is a possibility that the oil film will be locally broken by electrical spark.
When disassembling or assembling, be sure to measure the insulation resistance. Measure the insulation resistance between the shaft and the earth using no more than 100 VDC. The insulation resistance is acceptable if the resistance value is more than 10 kΩ.

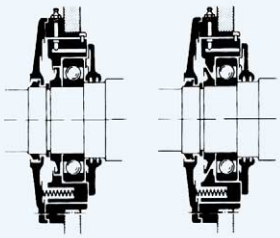
Fig. 26 Floating Bearings (Example, delivered design may deviate in details)



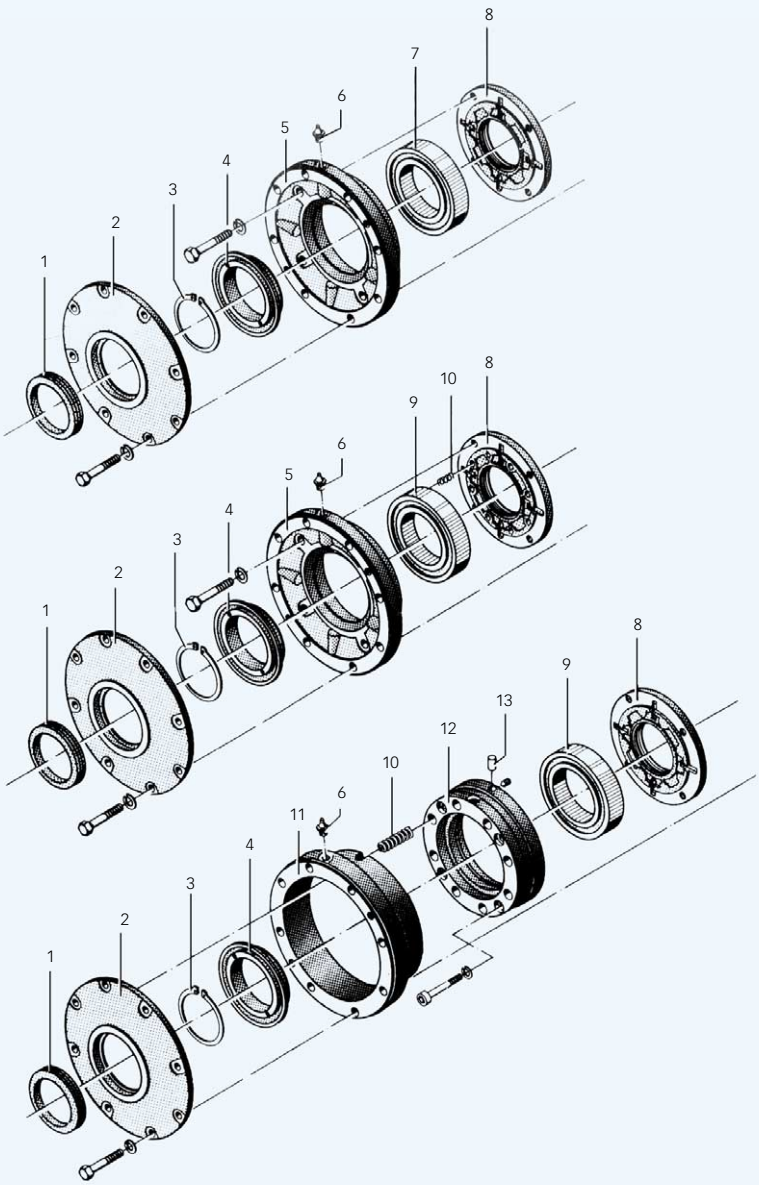
Cylindrical roller bearing



Deep-groove ball bearing
with compensation of axial play



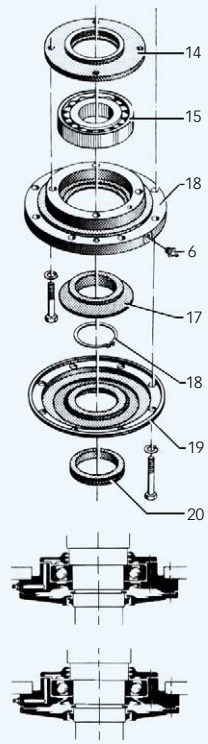
Deep-groove ball bearing with compensation of axial play, with bearing housing bush and intermediate ring



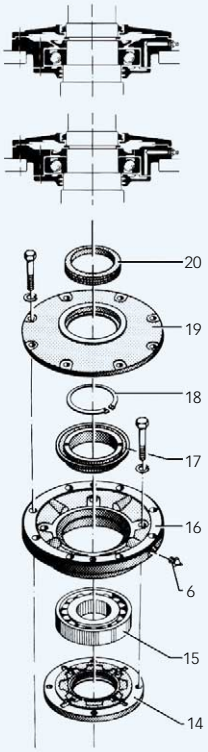
1. V-ring [1]
2. Outer bearing cap [1]
3. Circlip [1]
4. Grease slinger [1]
5. Bearing housing [1]
6. Lubricating nipple
7. Cylindrical roller bearing [1]
8. Inner bearing cap with felt sealing rings [1]
9. Deep groove ball bearing (floating-bearing)
10. Compression spring [1]
11. Bearing housing ring
12. Bearing housing bush
13. Cylindrical pin

[1] Floating bearing side

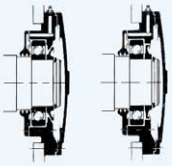
Fig. 27 Locating Bearings (Example, delivered design may deviate in details)



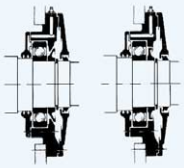
Angular-contact ball bearing placed below



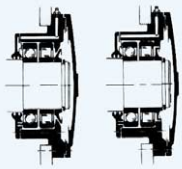
Angular-contact ball bearing placed above



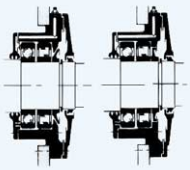
Single bearing, shaft does not pass through the outer bearing cap



Single bearing, shaft passes through the outer bearing cap



Duplex bearing, shaft does not pass through the outer bearing cap



Duplex bearing, shaft passes through the outer bearing cap

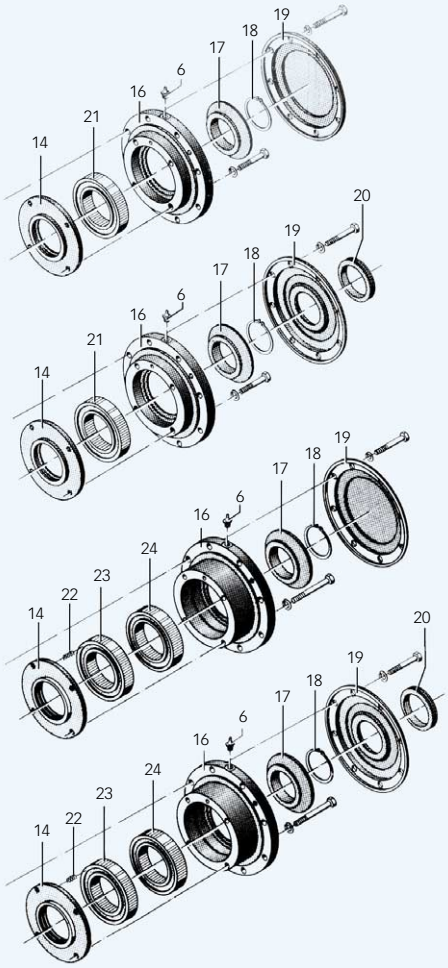
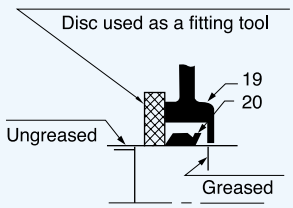
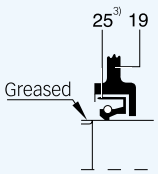


Fig. 28 Fitting Instructions for V-ring and Oil Seal for Shaft



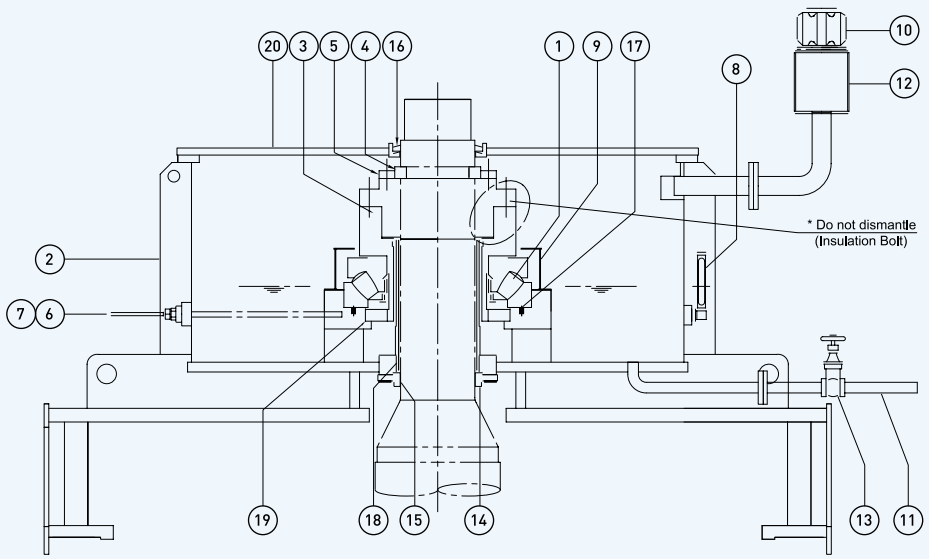


Single bearing, shaft does not pass through the outer bearing cap.

14. Inner bearing cap with felt sealing rings [2]
15. Angular-contact ball bearing
16. Bearing slinger [2]
17. Grease slinger [2]
18. Circlip [2]
19. Outer bearing cap [2]
20. V-ring [2]
21. Deep-groove ball bearing(Locating bearing) or angular-contact ball bearing
22. Compression spring [2]
23. Deep-groove ball bearing [2]
24. Cylindrical roller bearing [2]
25. Oil seal for shaft [1][2][3]

[1] Floating bearing side
[2] Locating bearing side
[3] Special operating conditions only

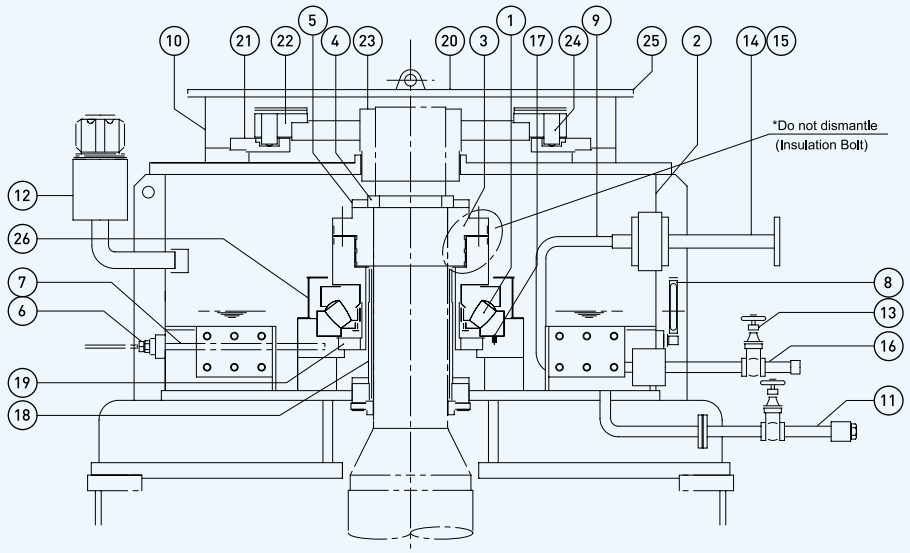
Fig. 29 Replacement Procedure for Upper Bearing(Upper Bearing Assembly Drawing)



NO.	Description	NO.	Description	NO.	Description
1	Bearing	8	Oil Level Gauge	15	Bearing Inner Cap Packing
2	Upper Bearing Support	9	Oil Cover	16	V-ring
3	Bearing Runner	10	Air Breather	17	Spring
4	Ring Key	11	Oil Drain Pipe	18	Guide Pipe
5	Ring	12	Oil Cup	19	Guide Bushing
6	Bearing Temp. sensor	13	Globe Valve	20	Top Cover
7	Thermo well	14	Bearing Inner Cap0		

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle V-ring (Item No. 16 shown on above drawing).
3. Dismantle Top Cover (Item No. 20 shown on above drawing).
4. Fully drain out bearing oil.
5. Dismantle coupling cover to install hydraulic jack.
6. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
7. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
8. Jacking up to lift 0.5 mm.
9. Dismantle ring (Item No. 5).
10. Dismantle ring key (Item No. 4). If ring key cannot be dismantled, jacking up 0.5 mm additionally and try to dismantle again.
11. Set special JIG using crane and install stud bolts and nuts between top of bearing runner (Item No. 3) and JIG.
12. Install hydraulic jack between JIG and shaft top.
13. Jacking up JIG and dismantle bearing runner.
14. Dismantle bearing from bearing runner after heating by gas torch.
15. Dismantle racer & pressure spring (Item No. 17).
16. Dismantle guide bushing (Item No. 19) and cleaning inside of bearing support.
17. Assemble new bearing to bearing runner after heating by electric heater. If heater is not available, oil heating is acceptable.
18. Start reassembly in accordance with reverse sequence of above.
19. After completion of assemble, try hand turning to confirm condition.

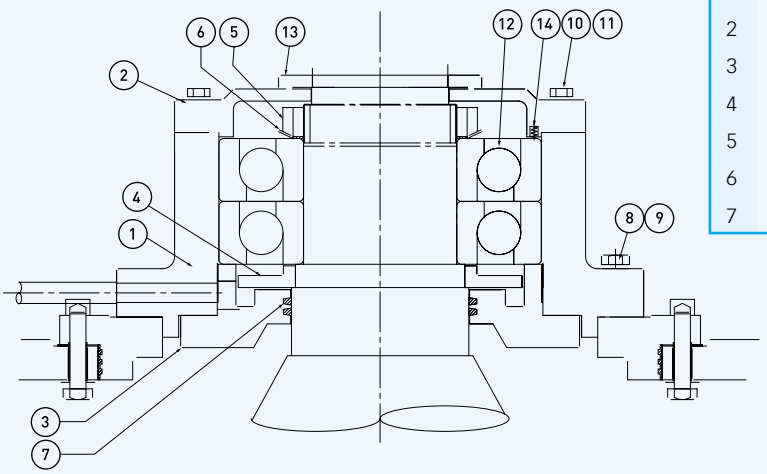
Fig. 30 Replacement Procedure for Upper Bearing(Upper Bearing Assembly Drawing)



NO.	Description	NO.	Description	NO.	DESCRIPTION
1	Bearing	10	Ratchet Housing	19	Guide Bushing
2	Upper Bearing Support	11	Oil Drain Pipe	20	Support Cover
3	Bearing Runner	12	Oil Cup	21	Non-Reverse Ratchet
4	Ring Key	13	Globe Valve	22	Pin Housing
5	Ring	14	Water Inlet Pipe	23	Ratchet Runner
6	Bearing Temp. sensor	15	Water Outlet Pipe	24	Ratchet Pin
7	Thermo well	16	Water Drain Pipe	25	Ratchet Pin Cover
8	Oil Level Gauge	17	Spring	26	Oil Cover
9	Heat Exchanger	18	Guide Pipe		

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle Ratchet housing cover (Item No. 20 shown on above drawing).
3. Dismantle Pin housing, ratchet wheel (Item No.22 and 21)
4. Dismantle Ratchet Runner (Item No.23) and Ratchet housing(Item No.10)
5. Fully drain out bearing oil.
6. Dismantle coupling cover to install hydraulic jack.
7. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
8. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
9. Jacking up to lift 0.5 mm.
10. Dismantle ring (Item No. 5).
11. Dismantle ring key (Item No. 4). If ring key cannot be dismantled, jacking up 0.5 mm additionally and try to dismantle again.
12. Set special JIG using crane and install stud bolts and nuts between top of bearing runner (Item No. 3) and JIG.
13. Install hydraulic jack between JIG and shaft top.
14. Jacking up JIG and dismantle bearing runner.
15. Dismantle bearing from bearing runner after heating by gas torch.
16. Dismantle racer & pressure spring (Item No. 17).
17. Dismantle guide bushing (Item No. 19) and cleaning inside of bearing support.
18. Assemble new bearing to bearing runner after heating by electric heater. If heater is not available, oil heating is acceptable.
19. Start reassembly in accordance with reverse sequence of above.
20. After completion of assemble, try hand turning to confirm condition.

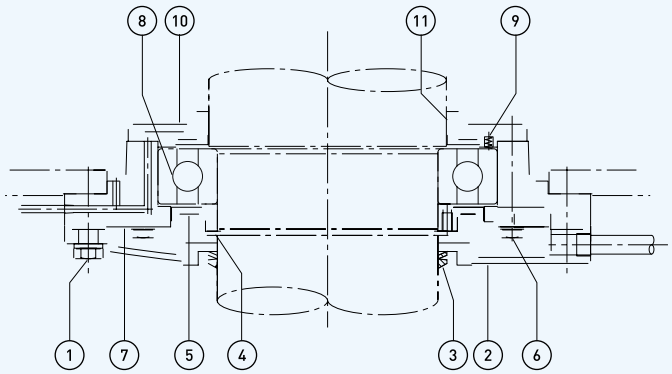
Fig. 31 Replacement Procedure for Upper Bearing(Upper Side Bearing Assembly Drawing)



NO.	Description	NO.	Description
1	Bearing Housing	8	Hex Bolt
2	Outer Bearing Cap	9	Spring Washer
3	Inner Bearing Cap	10	Hex Bolt
4	Slinger	11	Spring Washer
5	Lock Nut	12	Ball Bearing
6	Lock Washer	13	Sealing Disk
7	Inner Cap Packing	14	Compression Spring

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle Grease pipes and Sealing disk (Item No. 13 shown on above drawing).
3. Dismantle Outer bearing cap (Item No. 02).
4. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
5. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
6. Jacking up to lift 0.5 mm.
7. Dismantle Lock Nut and Washer (Item No.05 and 06)
8. Dismantle Bearing Housing (Item No.01).
9. Heating the bearing(Item No. 12) by gas torch.
10. Dismantle bearing from shaft. Be careful of shaft damage.
11. Dismantle grease slinger after heating by gas torch (Item No.04).
12. Dismantle Inner bearing cap (Item No.03).
13. Cleaning all items
14. Assemble new bearing to shaft after heating by electric heater. If heater is not available, oil heating is acceptable.
15. Start reassembly in accordance with reverse sequence of above.
16. After completion of assemble, try hand turning to confirm condition.

Fig. 32 Replacement Procedure for Lower Bearing(Bottom Side Bearing Assembly Drawing)



1. Dismantle Outer bearing cap and seal ring (Item No. 02 and 03 shown on above drawing).
2. Dismantle Circlip (Item No.04).
3. Dismantle grease slinger after heating by gas torch (Item No.05).
4. Dismantle Bearing Housing (Item No.07).
5. Heating the bearing (Item No. 08) by gas torch..
6. Dismantle bearing from shaft. Be careful of shaft damage.
7. Dismantle Inner bearing cap and Compression spring (Item No.09 and 10).
8. Cleaning all items
9. Assemble new bearing to shaft after heating by electric heater. If heater is not available, oil heating is acceptable.
10. Start reassembly in accordance with reverse sequence of above.
11. After completion of assemble, try hand turning to confirm condition.

11.1 Air Filter

Air Filter Cleaning Period

The cleaning period depends on the site conditions and can change. The cleaning of the filter is required if the record of the stator winding temperature (using the stator winding sensors) indicates an abnormal increase in temperature.

Air Filter Cleaning Procedure

The filter element (flat or cylindrical) is immersed in a tank of cold or warm water (temperature less than 50°C). Use water with detergent added.
Shake the filter gently to ensure that the water flows through the filter in both directions.
When the filter is clean, rinse it with clear water.
Drain the filter properly (there must be no formation of droplets).
Refit the filter on the machine.

> ⚠ CAUTION
> Do not clean the filter using compressed air. This procedure would reduce filter efficiency.

11.2 Cooler

1) General Points

The purpose of the cooler is to remove machine heat losses (mechanical, ohmic, etc). The exchanger is located on the top of the machine.

Normal Operation

The air is pulsed by a fan fixed to the machine shaft.

Description of Air-Water Double Tube Exchanger

The double-tube technique keeps the cooling circuit from being affected by possible water leakage. The double tube provides a high safety level. In case of leakage, the water goes from the inside of the internal tube to the coaxial space between the two tubes. The water is drained axially to a leakage chamber where it may activate a sensor. An exchanger comprises a fin-tube block containing :
- a steel frame
- a fin-tube block expanded mechanically to the tubes.

The tube bundle is roll-expanded in the end plates. The water distribution in the tubes is provided by two removable water boxes. A water box is equipped with collars for fitting the inlet and outlet lines. Neoprene seals ensure the water box and the end plate joints.

2) Cleaning

The frequency of cleaning operations depends essentially on the purity of the water used. We recommend a minimum of one inspection per year. The life of zinc block for anticorrosion is about a year. Therefore, replace it with a new one every year.
Cut off the water supply by isolating the inlet and outlet lines and drain the water. Disconnect the leak sensor (option with double-tube cooler) and make sure that there are no leaks. Remove the water boxes on each side of the machine. Rinse and brush each water box.

> **NOTE:** Do not use a hard wire brush, as this will remove the protective tar-epoxy layer formed on the surface of the water boxes. Clean each tube with a metal scraper. Rinse in soft water. Keep the leakage chamber dry (double-tube water-cooler only).

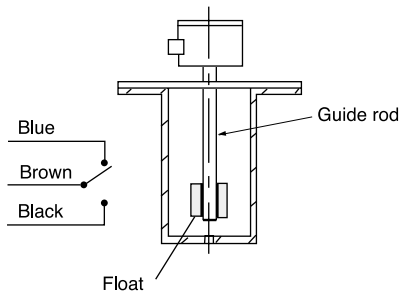
3) Stop the Machine

Leak detection for a double-tube exchanger. If a leak is detected, cut off the power supply of the water in/outlet lines and change to emergency operations, it is necessary to ascertain and repair it. Remove the two water boxes, apply a slight positive pressure in the leakage chamber and thus between the two tubes (only concerns double-tube coolers). If a tube is damaged, plug it at both ends. Use a tapered plug. The plug should preferably be made of saltwater-resistant aluminum bronze or of a synthetic material.

4) Leak Detection (Float System)

A magnet float activates a switch located in the float-guiding rod.

Fig. 33 Leakage Detector



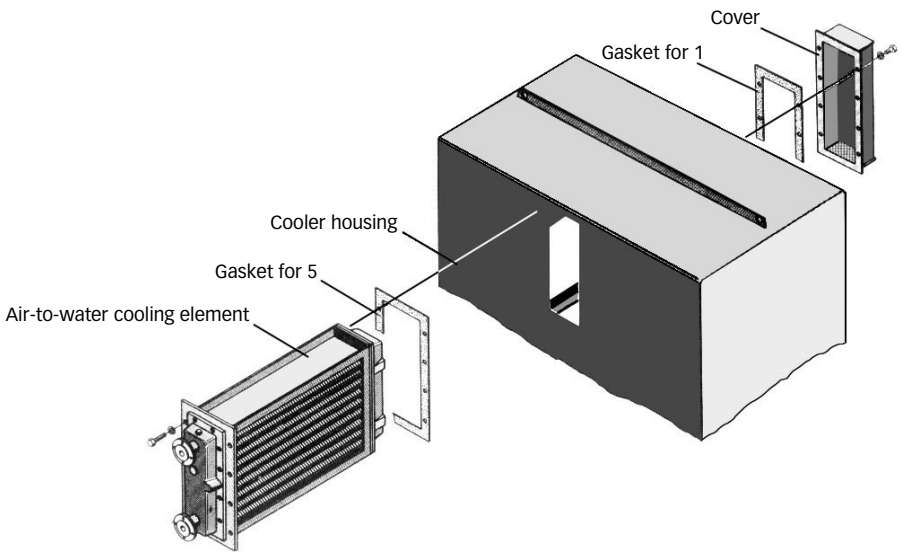
5) Cooler Removal

The cooler unit is slid into its housing. It is possible to remove the cooler from the housing without removing the water boxes. The cooler is fastened to the housing via a series of screws on the housing. Remove the supply and return pipes. Provide two supports to hold the cooler when it comes out of its housing. Remove the cooler using slings that can be attached to the connecting flanges.

6) Cooler Reassembly

Carry out the operations of the "Cooler Removal" in the reverse order. Be careful to push the cooler completely into its housing before tightening the fastening screws of the cooler to the casing.

Fig. 34 Cooler Removal



General

It is our recommendation that all electric motors are fitted with motor protection. The preferred type of motor protection should provide the following protection features:

1) Current limit by a programmable thermal limit curve with thermal modeling based on winding temperature.
2) If RTD is installed for winding temperature detector, winding temperature detection by RTDs should have separated alarm and trip set points.
3) Ambient temperature RTD located in the motor ambient air stream.
4) If a bearing temperature indicator is installed, alarm and trip set points should be separated.
5) Calculation of motor thermal capacity available.
6) Ground fault detection.
7) Current unbalance detection.
8) Capacity for the protection system to learn motor cooling times.

A motor protection system with these features should reward you with better reliability and will allow you to optimize the motor to its maximum performance.

Protection Setting Recommended

Guide values for adjustment of tripping temperature.

Description	Temperature Rise 'B'			Temperature Rise 'F'		
	Permissible Max. Temperature	Alarm	Trip	Permissible Max. Temperature	Alarm	Trip
Winding Temperature	Max. 130 °C	130 °C	135 °C	Max. 155 °C	155 °C	160 °C
Bearing Temperature (Anti-friction*)	Max. 100 °C	100 °C	105 °C	Max. 100 °C	100 °C	105 °C
Bearing Temperature (Sleeve)	Max. 95 °C	95 °C	100 °C	Max. 95 °C	95 °C	100 °C
Current unbalance	Max. 10%	6% (10-sec delay)	10% (Inst.)	Max. 10%	6% (10-sec delay)	10% (Inst.)

- T means operation temperature including ambient temperature.
- Max. permissible temp. rise includes ambient temperature.

* When a suitable heatproof lubricant is used or a greasing interval is changed, the limit of temperature rise shall be determined by agreement between manufacturer and purchaser.

Induction Motor Troubleshooting

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

Abnormality		Probable Cause	Remedy
Motor fails to start	Power source & line	1. Drop in line voltage	A check is to be made with a voltmeter.
		2. Great drop in voltage due to inadequate line capacity and impedance drop	a. A check is to be made on voltage at motor terminal before and at time of starting. b. Similar change in voltage is to be checked at motor terminal.
		3. Cut line or unbalanced	Defective parts are to be repaired.
	Starter	4. Erroneous wire connection	To be repaired
		5. Cut line or unbalanced voltage	To be reconditioned
		6. Drop in line voltage	Compensator tap connection is to be raised.
		7. Cut line or unbalance in starting resistor	Resistance is to be measured; repairs are to be made.
	Motor	8. Cutting of stator coil or of rotor coil	Resistance and current are to be measured, and repairs are to be made.
		9. Erroneous connection of stator coil	To be reconditioned
		10. Defect of rotor	a. Squirrel cage motor, rotor conductor is to be checked for disconnection. b. Wound motor, a check is to be made for line cutting and unbalance. c. Repairs or renewal is to be made.
		11. Stator core is in contact with rotor.	a. A check is to be made by turning by hand.
		12. Defective bearing	b. Bearing is to be disassembled and examined.
		13. Insufficient starting torque	a. Squirrel cage motor, motor is to be replaced with the one having larger capacity and of the wound type. b. Wound motor, tap for starting resistor is to be replaced.
	Load	14	Load is to be reduced.
Length of time required for acceleration after starting		1. Inadequately low voltage.	A check is to be made on voltage drop of power source and line.
		2. Defective rotor.	a. Squirrel cage rotor, rotor bar and end ring are to be checked for contact. b, Wound motor, a check is to be made on coil for unbalance and on brush for imperfect contact.
		3. Overload or inadequate torque	Load is to be checked, if load is normal, motor capacity is to be changed.

Abnormality	Probable Cause	Remedy
Rotation in reversal direction	Phase reversal	Two phases of U.V.W.(or R.S.T.) at starter or motor terminal are to be changed.
Motor body overheated	1. Overload	Load is to be reduced (to rated current)
	2. Overcurrent due to voltage drop	a. A check is to be made with a voltmeter power source. Voltage is to be raised. b. Load is to be reduced.
	3. Excessive iron loss due to overvoltage.	A check is to be made with a voltmeter power source. Voltage is to be reduced.
	4. Cut line or imperfect contact in one phase	To be reconditioned
	5. Short-circuiting and grounding of coil	Resistance and current are to be checked and reconditioned.
	6. Contact between stator and rotor	Judgment can be made according to noise; bent shaft, bearing, etc., are to be corrected.
	7. Inadequate ventilation due to dust.	Cleaning is to be carried out.
Vibration	1. Unbalance of rotor a. Bending of shaft b. Loose joint c. Residual unbalance d. Critical speed of shafting e. Dust attached to rotor f. Imperfect connection between coupling and shaft	 To be repaired To be tightened by bolts securely To be readjusted To be cleaned To be reconditioned
	2. Improper magnetic center	To be reconditioned
	3. Defective bearing	Refer to the “Bearing” section
	4. Coupling deflection	To be reconditioned
	5. Abnormal contact between shaft and stationary part, such as end cover, etc.	a. To be checked by turning manually b. To be disassembled for detecting defects
	6. Unsatisfactory contact of brush	Brush is to be checked for contact.
	7. Improper alignment	To be reconditioned
	8. Sinking of foundation	To be reconditioned
	9. Transmission of vibration from combined machine	Insulation for vibration
	10. Unequal pitch of claw coupling	Reconditioning of pitch
	11. Improper bush of flexible coupling	Reconditioning of pitch

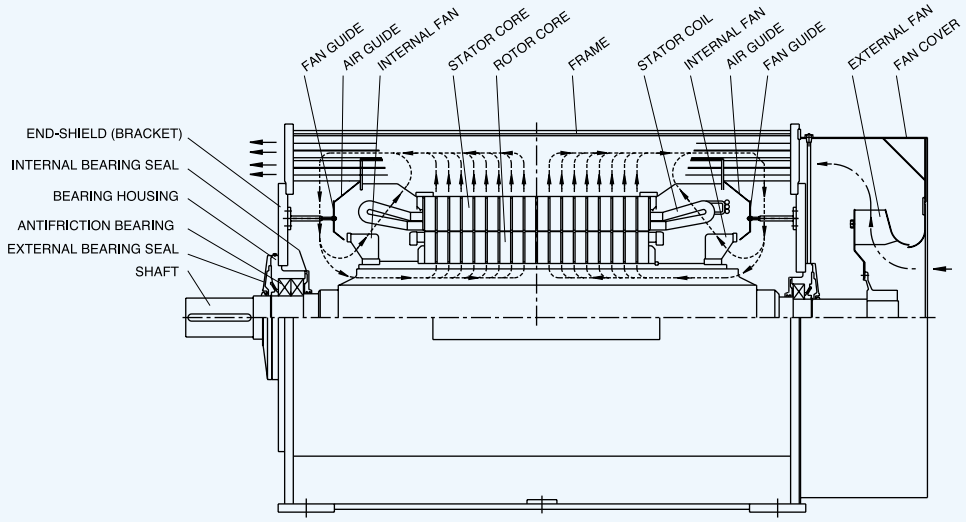
Abnormality	Probable Cause	Remedy
Noise	1. Disagreement of air gap	Causes are to be detected; repairs are to be made.
	2. Single-phase operation	Causes of single-phase operation such as line cutting and imperfect contact are to be detected; repairs are to be made.
	3. Short-circuits of layer and phase of stator coil and rotor coil	To be reconditioned
	4. Abnormal contact between shaft and stationary part such as end cover	1. A check is to be made by turning manually. 2. To be disassembled for inspection
	5. Unsatisfactory foundation and installation	Readjustment of installation
	6. Loose bolts for foundation	Foundation bolts are to be tightened.
	7. Gap between foundation and base	Reconditioning of installation
	8. Resonance with foundation	Readjustment of foundation
	9. Crackings at brazed joint rotor bar and end ring	To be disassembled and defective parts are to be repaired.
Unbalance of phase current	1. Voltage unbalance	Power source and lines are to be checked and balanced.
	2. Single-phase operation	Line cutting and improper contact are to be reconditioned.
	3. Secondary circuit	1. Rotor shaft coil resistance is to be measured and reconditioned. 2. Contact of brush or short-circuit ring is to be checked. 3. A check is to be made on endring contact of a squirrel cage motor.
Flaking (a) Flaking of rolling elements	1. Excess of tightening allowance	1. Care should be taken on shaft at time of assembling and on bearing box at time of matching.
	2. Erroneous selection of clearance	2. Clearance is to be reinspected.
	3. Minus operating clearance	3. Care should be taken at time of assembly.
	4. Thermal expansion	4. Examination of working condition
(b) Local flaking of a race	1. Inclusion of dust and other foreign substances or rust, bruises	
(c) Flaking all over a race (d) Flaking on component parts opposite to a race	1. Shaft or bearing box is distorted elliptically.	Machining accuracy and tightening of bearing box are to be checked.
	2. Improper tightening	
	3. Inaccuracy due to improper matching	
	4. Deterioration with time	

Abnormality	Probable Cause	Remedy
(e) Flaking all over around track center (f) Flaking across a race	Abnormal thrust load	Design of bearing system is to be checked.
	1. Shaft bending	
	2. Oblique fitting of outer and inner rings	
(g) Flaking similar to pitting on a race	1. Vibration during stoppage	Examination of working condition
	2. Rust	
Seizing (a) Race ring and rolling discolored and turned soft (b) Damage	1. Inadequate clearance	Proper clearance is to be provided.
	2. Inadequate lubrication	Oil amount of lubricant is to be checked.
	3. Improper overload of lubricant	Reconsideration of working condition and handling
Breakage (total or partial) (a) Fracture (b) Cutting	1. Advancement of flaking caused by shock and below. 2. Great tightening allowance & large round corner of fitted part	Careful handling Examination of tightening Examination of machining accuracy of shaft & bearing housing
Breakage of retainer (a) Fracture (b) Nonuniform abrasion (c) Wear of pocket section (d) Biting-off	1. Moment load 2. Rotation at shift speed 3. Inadequate lubrication 4. Inclusion of foreign substances	Careful handling and reconsideration of working condition Examination of oil supply and lubricant
Rust (a) Rust formed all over surface (b) Rust on local place (c) Contact erosion on joint surface	1. Unsatisfactory condition of storage 2. Left alone 3. Inadequate cleaning 4. Rust-preventive reagent 1. Unsatisfactory packing 2. Sweet 1. Inadequate allowance of tightening 2. Change in load	Inspection of storage room Careful handling Examination of rust-preventive reagent Reexamination of machining of shaft & bearing housing Reexamination of working condition
Wear (a) Abnormal wear of race and rolling element (b) Abnormal wear of retainer	1. Inclusion of foreign substances 2. Occurrences of wear Inadequate lubrication	Examination of lubrication and oil supply
Electrode (a) Crater-shaped depression and corrugated scars	Passage of current	Examination of design of bearing system

Abnormality	Probable Cause	Remedy
Dent and scratch (a) Indentation (on a race, etc.) (b) Aventurine hardening (c) Dents given during handling (d) Scratches during assembly	Dust and foreign substances pressed between race and body Careless handling (dropping, etc.)	Examination of handling and assembling conditions Careful handling Careful assembling
Smearing biting-off on a race and rolling element	1. Inadequate lubrication 2. Skewing of rolling element 3. Selection of lubricant	Examination of lubricant and lubricating condition
Creep wear of outer and inner surface, sliking and discoloring	1. Inadequate tightening allowance 2. Inadequate tightening of sleeve	1. Examination of tightening 2. Examination of machining accuracy of shaft and bearing box 3. Examination of design

14.1 HLA7 Horizontal-type Motor Construction

Fig. 1 HLA7 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HLA7 Type induction motor with antifriction bearing

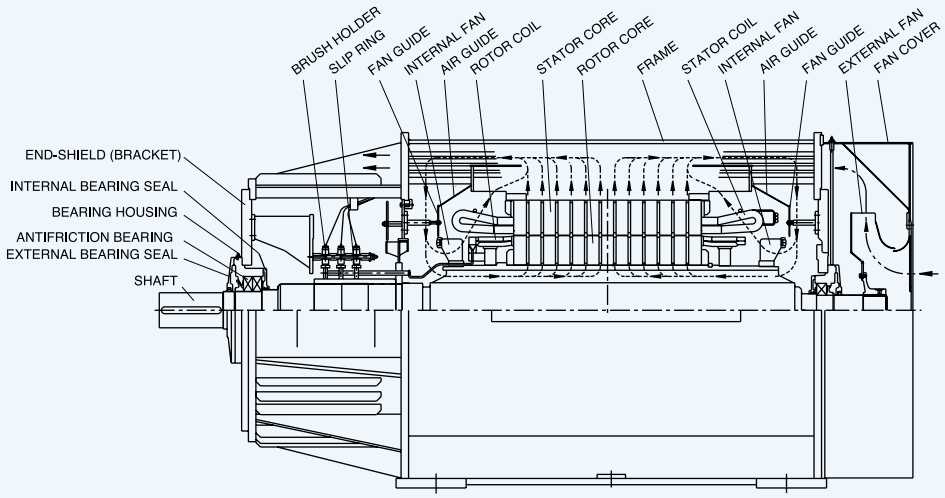
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the end shield (bracket) with fan guide	
11.	Remove the air guide	
12.	Remove the rotor from the stator	

14.2 HLS7 Horizontal-type Motor Construction

Fig. 2 HLS7 Horizontal-type Motor Construction (WOUND ROTOR)



*Disassembly and reassembly of HLS7 Type induction motor with antifriction bearing

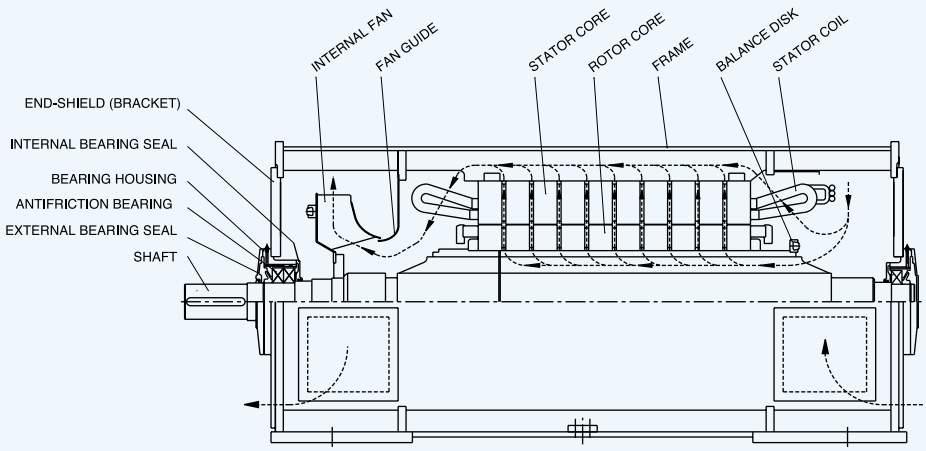
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, secondary t/box cable, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the end-shield with brush holder	
11.	Remove the end-shield with fan guide	
12.	Remove the air guide	
13.	Remove the rotor from the stator	

14.3 HRA3 Horizontal-type Motor Construction

Fig. 3 HRA3 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRA3 Type induction motor with antifriction bearing

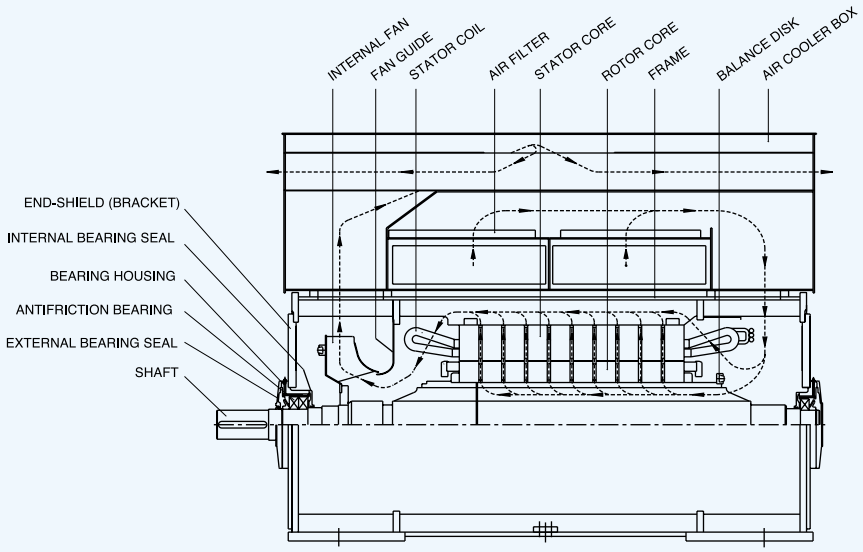
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	

14.4 HRP3(4P~) Horizontal-type Motor Construction

Fig. 4 HRP3 (500 Fr.-2P & More Than 4P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

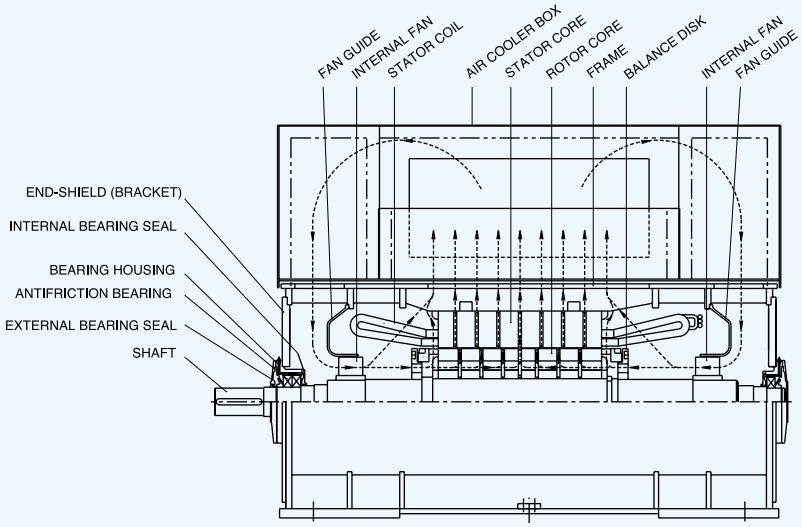
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	
13.	Dismantle the air cooler box, if necessary	

14.5 HRP3(2P) Horizontal-type Motor Construction

Fig. 5 HRP3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

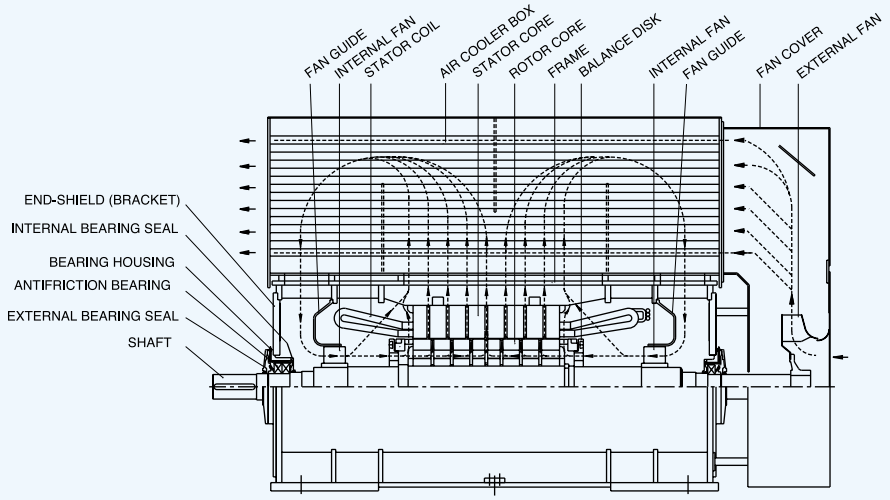
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing housing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the fan guide	
11.	Remove the rotor from the stator	
12.	Dismantle the air cooler box, if necessary	

14.6 HRQ3 Horizontal-type Motor Construction

Fig. 6 HRQ3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

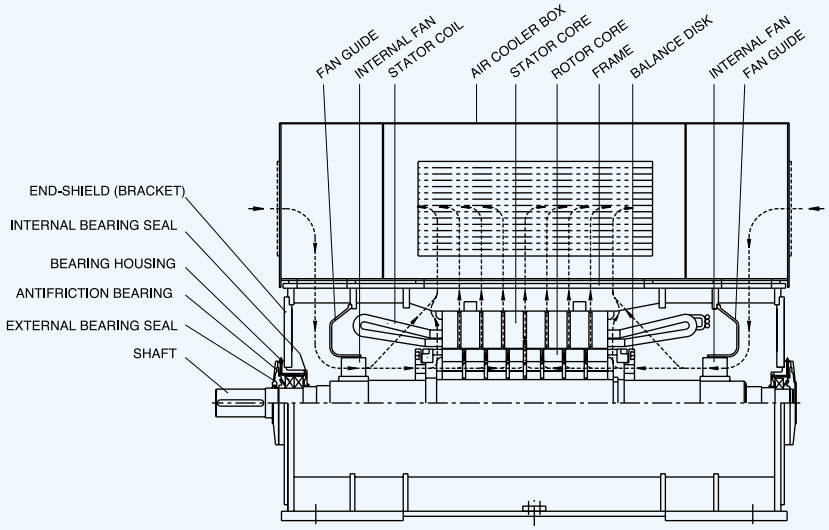
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the intermal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.7 HRP3(2P) Horizontal-type Motor Construction

Fig. 7 HRP3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

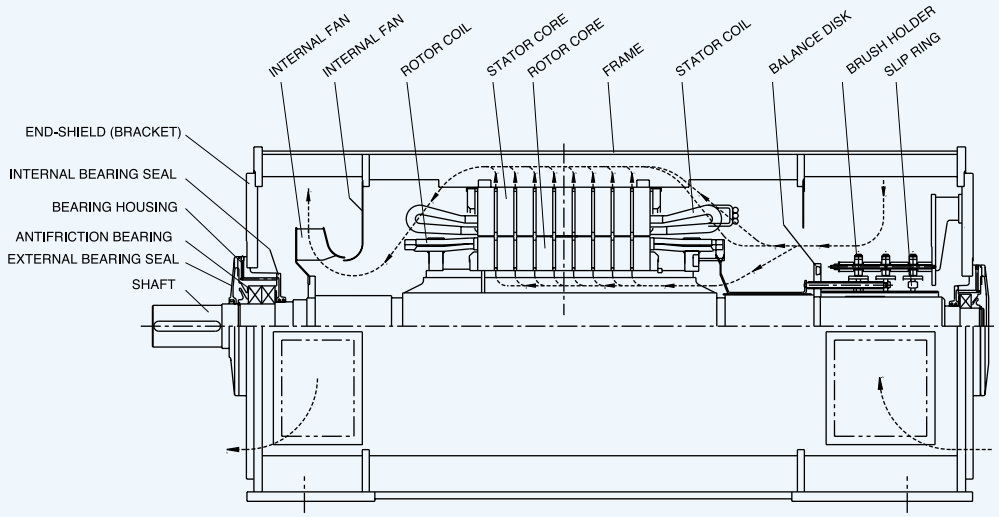
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the fan guide	
11.	Remove the rotor from the stator	
12.	Dismantle the air cooler box, if necessary	

14.8 HRS7 Horizontal-type Motor Construction

Fig. 8 HRS7 Horizontal-type Motor Construction (WOUND ROTOR)



*Disassembly and reassembly of HRS7 Type induction motor with antifriction bearing

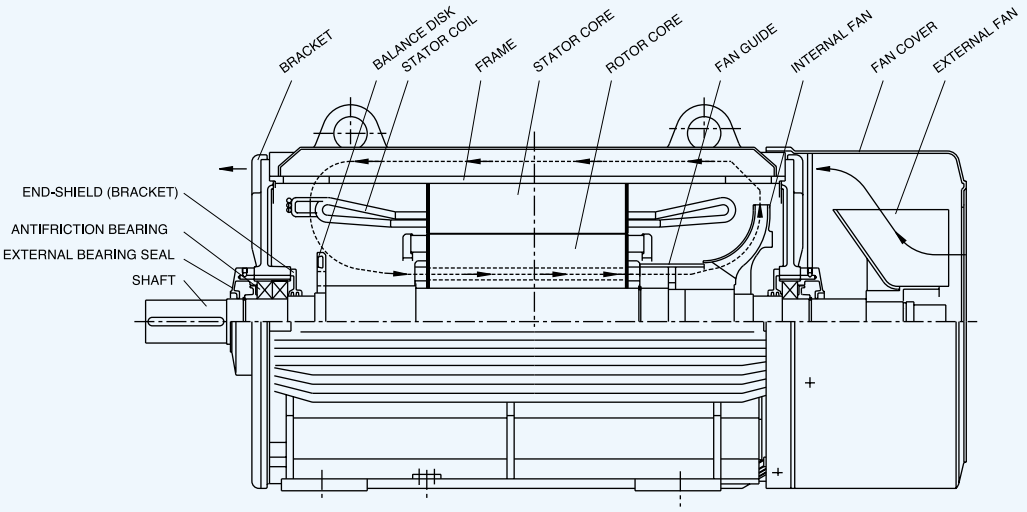
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, secondary t/box cable, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the end-shield with brush holder	
9.	Remove the end-shield with fan guide	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	

14.9 HLE5 Horizontal-type Motor Construction

Fig. 9 HLE5 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HLE5 Type induction motor with antifriction bearing

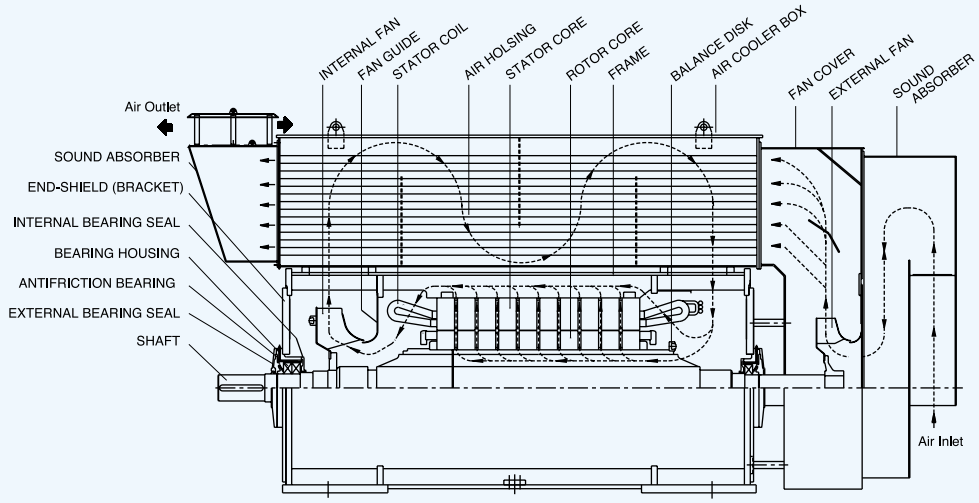
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bracket	
9.	Remove the antifriction bearing	
10.	Remove the internal bearing seal	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the rotor from the stator	

14.10 HRQ3 Horizontal-type Motor Construction

Fig. 10 HRQ3 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

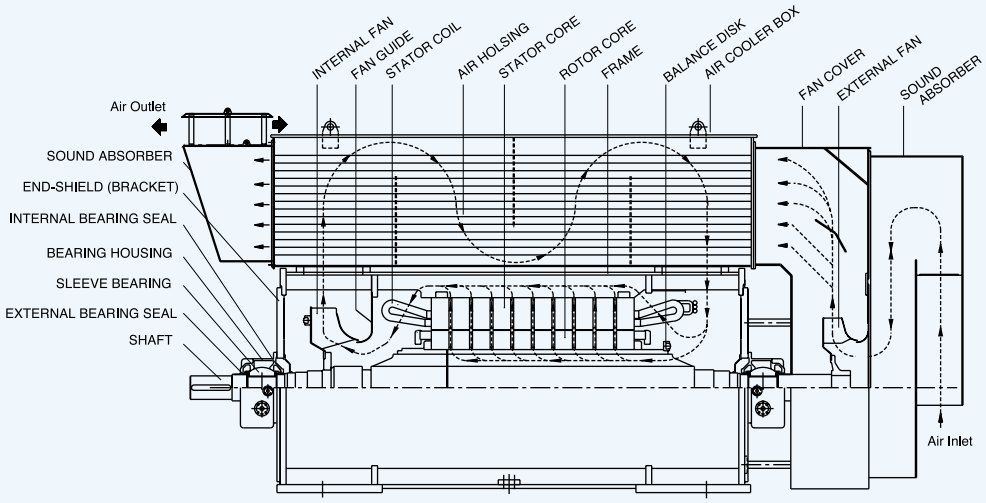
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the intermal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.11 HRQ3 (Sleeve Bearing) Horizontal-type Motor Construction

Fig. 11 HRQ3 (Sleeve Bearing) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

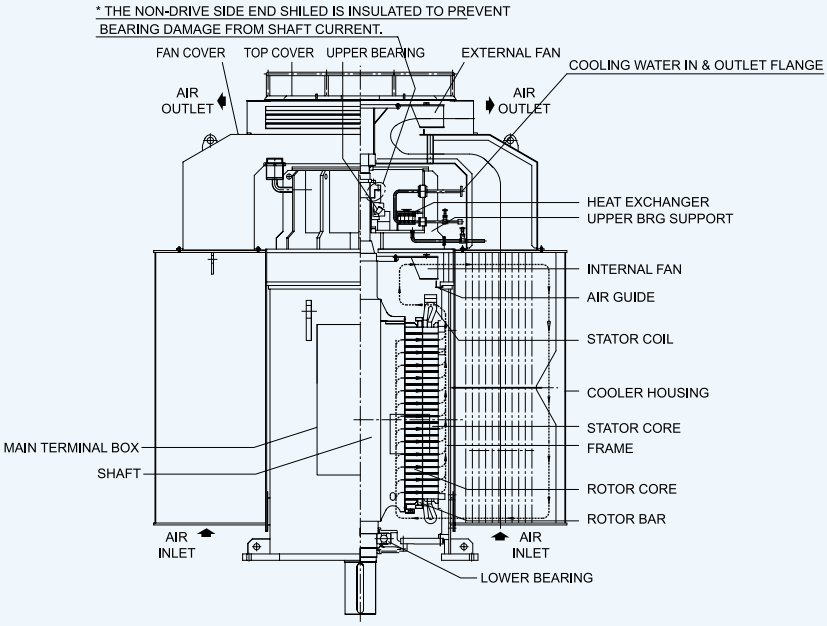
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the intermal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.12 HRQ3 Vertical-type Motor Construction

Fig. 12 HRQ3 Vertical-type Motor Construction



*Disassembly and reassembly procedure for Vertical Motor

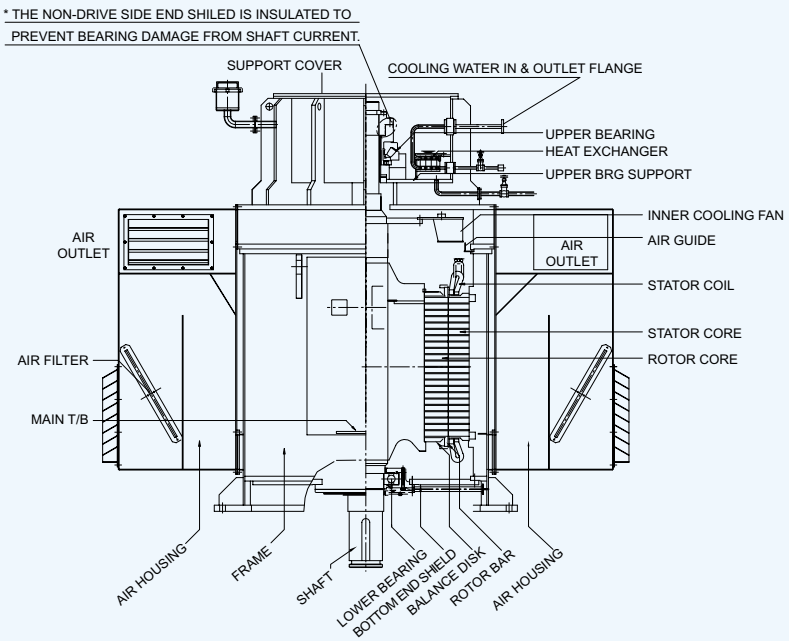
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing disassembly steps.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perform an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	* A distance equal to the rotor's length may be required at both end's of the motor drive end and Non drive end
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc)	
5.	Remove the top cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove fan cover	
8.	Remove the cooler housing	
9.	Remove the bottom bearing. Refer to bottom bearing disassembly procedure.	
10.	Remove the bottom end shield	
11.	Remove the upper bearing support cover	
12.	Remove the Upper bearing. Refer to upper bearing disassembly procedure.	* Before disassemble the upper bearing, install the hydraulic jack at the bottom surface of shaft.
13.	Remove the upper bearing support	
14.	Remove the rotor from stator (From DE side to N-DE side	
15.	Remove the inner cooling fan from rotor, if necessary	

14.13 HRP3 Vertical-type Motor Construction

Fig. 13 HRP3 Vertical-type Motor Construction



*Disassembly and reassembly procedure for Vertical Motor

Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing disassembly steps.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perform an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	* A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the the air housing	
6.	Remove the bottom bearing. Refer to bottom bearing disassembly procedure.	
7.	Remove the bottom end shield.	
8.	Remove the upper bearing support cover	
9.	Remove the upper bearing. Refer to upper bearing disassembly procedure.	* Before disassemble the upper bearing, install the hydraulic jack at the bottom surface of shaft.
10.	Remove the upper bearing support	
11.	Remove the rotor from stator(From DE side to N-DE side	
12.	Remove the inner cooling fan from rotor if necessary	* Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.

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All steel disc coupling

JAURE®

Lamidisc®

Installation, alignment and maintenance instructions.

Installation of hubs . Machinery alignment. Installation of disc packs and spacer.

1.- Installation of the hubs on the machine shafts.

a) Straight shafts with keyway.
Jaure supplies Lamidisc hubs machined machined with **H7** (ISO-286) tolerances. Jaure recommends that the shaft should be machined for an interference fit, using tolerance **s6** (ISO-286).

Whenever the shafts are already machined with a different tolerance from s6, Jaure will customize the hub bores. The following tolerances are recommended by Jaure.

Shaft tolerance	Hub tolerance
h6	**T7**
k6	**R7**
m6	**P7**
n6	**N7**
p6	**M7**

b) Clamping devices.
When clamping devices, such as tapered bushings, are used, Jaure recommends that the shafts should be machined with **g6** tolerances, for a standard Lamidisc bore.

For other type of connections, please consult our Technical Department.

2.- Machinery Alignment.

As long as the machines are aligned within the specifications from this catalog, the Lamidisc couplings will operate for a long time. However, it should be understood that the useful life of any disc pack coupling is directly influenced by the operating misalignment: the better the alignment, the longer the coupling life.

Although the Lamidisc couplings can operate satisfactorily at the misalignment listed in the catalog, both the coupling life and machine bearing wear can be greatly improved if the machines are aligned better than the maximum that the coupling can accomodate. Jaure recommends that the installation misalignment should not exceed 20 % of the catalog values. Therefore, the following formulas show Jaure´s recommendations for maximum misalignment.

Three types of machine misalignment (offset, angular, and axial) should be checked. Jaure has the following recommendations:

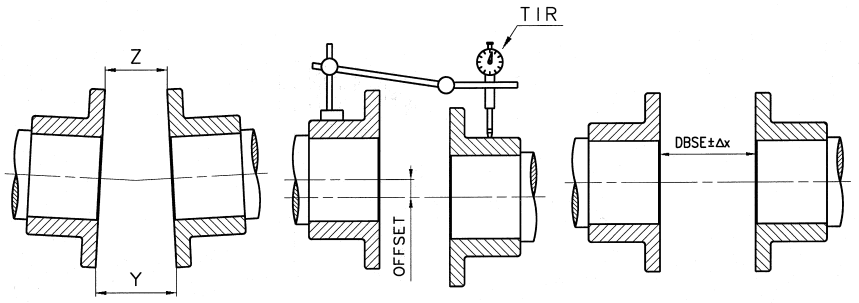
• The maximum offset misalignment that the Lamidisc coupling can accomodate is a function of the distance between the disc packs. For the configurations SX this distance is practically the same as the distance between the shaft ends. This statement is not valid for other configurations, such as CC, DO, CX, DX.

If shafts have an offset misalignment with minimum angular misalignment, the following maximum values for the offset are applicable for installation.

Lamidisc® with 6 bolts — TIR = (disc pack to disc pack distance) / 150
Lamidisc® with 8 bolts — TIR = (disc pack to disc pack distance) / 300
Lamidisc® with 10 bolts — TIR = (disc pack to disc pack distance) / 350
(NOTE : TIR is the Total Indicator Reading, which is twice the shaft offset)
Ex.: For size 380-6, SX type: TIR < DBSE/150.

• The maximum angular misalignment at each disc pack during installation is listed in the tables. This angular misalignment can be verified by measuring the flange-to-flange distance (see figure below) and substracting the smallest reading from the largest reading (Y-Z). The maximum value of (Y-Z) depends on the flange diameter, therefore on the coupling size. Based on the data from the tables, the following maximum values for (Y-Z) are recommended:

Lamidisc with 6 bolts — (Y-Z) = Coupling size / 300
Lamidisc with 8 bolts — (Y-Z) = Coupling size / 600
Lamidisc with 10 bolts — (Y-Z) = Coupling size / 750



Example: For Lamidisc size 380-6 (maximum angular misalignment of 1º). (Y-Z) should not exceed 380/300 = 1.27 mm. during installation.

• The axial displacement allowable between shafts during installation (Δx), should not exceed 20% of the allowable displacement given in the catalog (Δka) (See table 1). This displacement is a function of the coupling size and the number of bolts utilized. The larger the size the larger axial displacement.
The axial displacement creates large stresses in the discs. For a long life it is recommended that the discs are as close as possible to being flat. Therefore, the movements of the shafts as caused by thermal expansion should be carefully considered. For instance, if the distance between shaft ends changes by 5 mm (the shafts are coming closer to each others) from cold to hot machines, the distance between shaft ends with cold machines should be intentionally be made larger by 5 mm when the coupling is installed.

Table 1. Allowable installation axial displacement (20% of catalog valves, Δx=0.2Δka).
This value can be added or subtracted from the nominal DBSE. Values for 2 disc packs.

	(±) Δx installation (mm.)
6 Bolts	**OD/250**
8 Bolts	**OD/375**
10 Bolts	**OD/500**

Coupling OD in (mm.)
Example: Size 228-6:±Δka = 228/250 = ±0.9 mm, for 2 disc packs during installation.

3.- Installation of disc packs and spacer.
The installation of the coupling components depends of the type Lamidisc coupling: the only tool needed are regular wrenches or sockets, and a torque wrench. **Tightening the bolts of a coupling to specification is very important.**

a) Standard configuration. SX and SXR types.
The only bolts to be installed and tightened are the ones that attach the disc packs to the hubs and spacer. Place the spacer and install the bolts with their heads at the flange and not at the disc pack. The nuts shall be turned with the torque wrench, while the heads of the bolts are held stationary.

Table 2. Bolt tightening torque values.
In case an specific exists, refer to the values mentioned in it if they differ from the values below.
Values for Disc bolt tightening torque:

Size	Disc bolt non-lubricated tightening torque (Nm)	Size	Disc bolt non-lubricated tightening torque (Nm)	Size	Disc bolt non-lubricated tightening torque (Nm)
110	30	302	600	540	4100
132	30	325	600	570	5100
158	60	345	780	605	6200
185	100	380	1100	635	7900
202	150	410	1500	675	9900
228	230	440	2000	700	12200
255	450	475	2600	730	12200
278	450	505	3300	760	14800

NOTE: For lubricated threads reduce the given values by 20%.
For stainless-steel bolts refer to our technical Dep.

Values for dry tightening torque in Nm for flange connecting bolts.
Types DO-6 and DO-8.

Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)
110-6	35	302-6	780	278-8	108	475-8	660
132-6	35	325-6	780	302-8	108	505-8	660
158-6	69	345-6	580	325-8	325	540-8	760
185-6	120	380-6	780	345-8	325	570-8	760
202-6	190	410-6	1000	380-8	325	605-8	760
228-6	295	440-6	1500	410-8	565		
255-6	580	475-6	2000				
278-6	580	505-6	2000				

NOTE: For lubricated threads reduce the given values by 20%.
For stainless-steel bolts refer to our technical Dep.

Values for spacer (type CX) and flange (type DX) bolt non lubricated tigthening torque in Nm.

Size	CX and DX types	Size	CX and DX types
132-6/10	8	302-8/40	230
158-6/15	20	325-8/45	230
185-6/20	68	345-8/50	325
202-6/25	108	380-8/55	325
255-6/30	108	410-8/60	325
278-8/35	230	540-8/70	565

Table 3. l_1, l_2 and s catalog valves for CC, CCR types.

Size	l_1 - l_2	s	Size	l_1 - l_2	s
110	50	8.4	302	135	24.4
132	60	8.4	325	145	26
158	70	11.2	345	155	28.2
185	80	14.0	380	170	32
202	90	15.5	410	185	33.2
228	100	17.5	440	195	36.4
255	115	20.5	475	210	38.2
278	125	21.2	505	230	42

b) Close coupled configuration. CC and CCR types.
The CC coupling type was created for use with machines that have the shafts too close for the use of the standard SX coupling. The outside diameter of the hubs was reduced to be inserted in the inside of the hole of the disc pack.
To install the hubs on their shafts, the shafts must be spaced apart at least the length of one hub (see dimension l_1 and l_2 in table 3). To install the coupling, the disc packs can be first attached with their bolts to the spacer, and then slid over one of the hubs, and attached to it. Next, the machines must be brought in position so that the second disc pack can be attached to its hub.
The machine alignment can now be performed. Because the spacer covers the shaft ends, the axial spacing must be checked by measuring the flange to flange distance (dimension "S" in the table 3). The offset and angular misalignments can be checked as previously described.
The bolts that attach the disc packs to the hubs and spacer must be tighten to specification, using a torque wrench at the nuts, while the bolts heads are held stationary.

c) Drop-out configuratio . DO type. *(See table 4 in page 4).*
The drop-out configuration allows the installation and removal of the coupling assembly , without the need to remove the hubs from their shafts. The coupling is received from Jaure fully assembled, with the bolts tightened to specifications. If, however, there is a need to disassemble the coupling assembly in case the disc packs need to be replaced) the nuts should be tightened to Jaure's specification (valves not shown in these instructions) using a torque wrench, while the bolt heads are held stationary.
The coupling assembly will not fit between the hubs, as long as the shaft-to-shaft distance was correctly set. The coupling ends should be brought together, by compressing the disc packs using the flange screws in the shipping holes, so that the assembly will fit between the male rabbets.
Once in position, the coupling will snap in place, and the bolts that attach the assembly to the shaft hubs must be tightened to Jaure specifications (see table 2) using a torque wrench. This operation must be carefully performed, as these bolts transmit the full coupling torque.
Machine alignment should be done before the coupling assembly is in place.
To remove the coupling assembly first remove all the bolts that retain it to the shaft hubs. Then compress the assembly by introducing the existing flange bolts in the shipping holes, and press the coupling assembly away from the male rabbets.

d) Reduced moment coupling with spacer according to AGMA 516, CX type.
The reduced moment configuration is used whenever the shaft stresses require that the center of gravity of the coupling is very close to the machine bearings. This configuration also allows either machine to be removed by dropping the spacer, without the need to disturb the disc-pack assemblies.
The installation of this coupling requires the following steps:
- Install the hubs on their shafts.
- Measure and adjust the shaft to shaft (DBSE) distance.
- Align the machine shafts as previously described.
- Attach one disc pack and a short sleeve at each hub, by tightening the nuts to specifications, while holding the bolt heads stationary.
- Place the spacer between the two sleeves. It should fit without interference, or without a gap remaining between the flanges. Correct the machine spacing if necessary, as any axial displacement can adversely affect coupling´s long term performance.
- Insert the flange bolts and tighten the nuts to specifications using a torque wrench and adaptor, while holding the bolt heads stationary.
- Recheck the alignment, and correct if necessary.

e) Drop-out coupling with floating assembly, flanges according to AGMA 516, DX type.
The drop-out configuration allows the installation and removal of the coupling assembly, without the need to remove the hubs from their shafts. The coupling is received from Jaure fully assembled, with the bolts tightened to specifications. If, however, there is a need to disassemble the coupling assembly (in case the disc packs need to be replaced) the nuts should be tightened to specification using a torque wrench, while the bolt heads are held stationary.
The coupling assembly will fit between the hubs, as long as the shaft-to-shaft distance was correctly set. Once in position, the nuts that attach the assembly to the shaft hubs must be tightened to specifications using a torque wrench and adaptor, while the bolt heads are held stationary. This operation must be carefully performed, as these bolts transmit the full coupling torque.
Machine alignment should be done before the coupling assembly is in place.

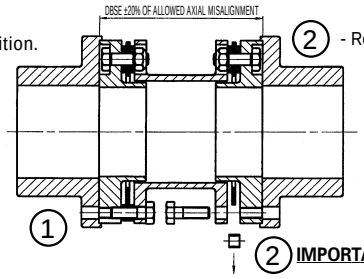
Coupling Lamidisc®

Table 4, DO type.

DO Type with STANDAR HUB

Mounting and dismounting instructions.

Mounting



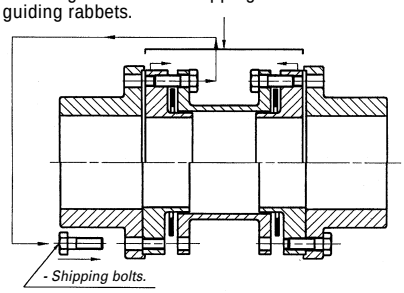
(1) - Shipping position.

(2) - Remove the flange bolts.

(1)

(2) **IMPORTANT:** Remove shipping bushings for instalation. (when supply, only big couplings).

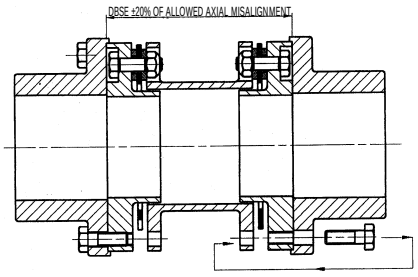
(3) - Introduce the flange bolts in the shipping holes in order to compress the central element and save the guiding rabbets.



(4) - Bolt up with the recomended tightening torque.

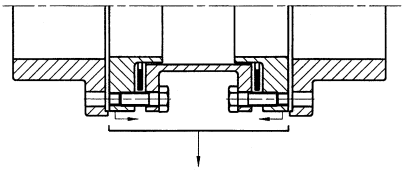
(5) - Work position.

Dismounting



(1) - Work position.

(2) - Remove flange bolts.



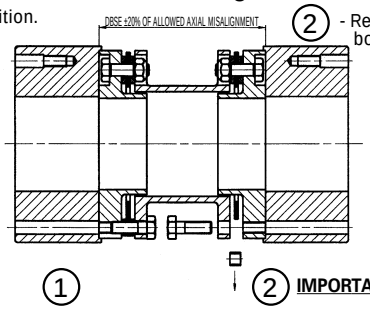
(3) - Introduce the flange bolts in the shipping holes in order to compress the central element.

DO Type with JUMBO HUB

Mounting and dismounting instructions.

Mounting

(1) - Shipping position.



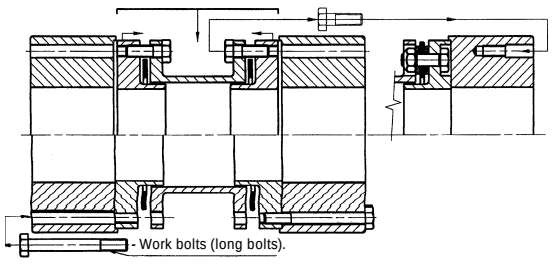
(2) - Remove the long and short flange bolts.

(1)

(2) **IMPORTANT:** Remove shipping bushings for instalation. (when supply, only big couplings).

(3) - Introduce the shipping-dismounting bolts (short bolts) in the shipping holes in order to compress the central element and save the guiding rabbets.

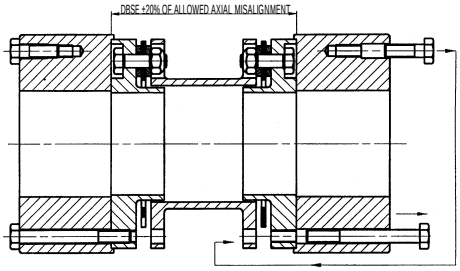
- After remove shipping bolts and store in screw bores of the hubs.



(4) - Bolt up the long bolts with the recomended tightening torque.

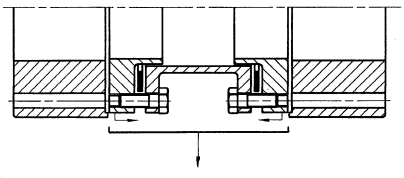
(5) - Work position.

Dismounting



(1) - Work position.

(2) - Remove flange bolts (long bolts) and shipping-dismounting bolts (short bolts).



(3) - Introduce the shipping-dismounting bolts (short bolts) in the shipping holes in order to compress the central element.

JAURE, S.A.

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OTZARRETA (Zarautz) - Mod.: JAU0117586 - Dep. Leg.: SS-30/2000

INDEX

0. TARGET AND SCOPE

This instruction is valid for all standard gear couplings according to the standard catalogue. This instruction substitutes the former 1610 and 1611 instructions.
In case the drawing of the coupling that you are working with; indicates a different instruction than IMO000678, then pay attention only to that instruction on the drawing.

☞ **A T T E N T I O N!**

Make sure that this is the latest version of instruction, by checking it at JAURE's website WWW.JAURE.COM.

1. PREPARATION PRIOR TO INSTALLATION

The gear couplings should be kept in a non corrosive atmosphere. Machined surfaces, especially bores, should always have an anticorrosive protection from bores. Adequate corrosive protection has to be provided if the coupling has to be kept in stock.

⚠ **C A U T I O N!**

If the coupling has to be in stock for more than 6 months it is advised to dismount the O-rings for the coupling and keep them in ozone free area.

☞ **A T T E N T I O N!**

When installing the hubs on the shafts, remove any anticorrosive protection from bores.

☞ **A T T E N T I O N!**

Gear couplings are potentially dangerous rotating parts. Always use proper guards to prevent accidents and comply with existing safety regulations.

☞ **A T T E N T I O N!**

Before installing the couplings and when handling them, always avoid any damage to the coupling and especially in the gear mesh.

2. INSTALLATION OF KEYED HUBS AND GREASING OF COUPLINGS

2.1 Ensure that all the parts are clean.

2.2 Apply a light coat of grease to the O-rings (6) and install them in the sleeves (2, 3 or 4, 5) grooves. It is necessary to apply some sealant at the keyway area so that the grease leakage is avoided during operation. We recommend to apply Rhodorseal 5661.

2.3 Apply the said grease on the sleeves (2, 3 or 4, 5) teeth. Place the sleeves on the shafts; avoid damage of the O-rings (6).

2.4 For sizes larger than MT Marine 260 or MT-275 place only the cover (7), once the O-rings (6) have been placed in the cover grooves.

2.5 Heat the hubs (1) to 110-130ºC prior to installing onto the shafts. Do not use an open flame burner. Protect the O-rings against temperature (max. O-ring temperature 80ºC)

2.6 Install hubs (1) on their respective shafts. Hub faces have to be flush shaft end. In case of doubt, please contact JAURE.

2.7 Install units to be connected in place and check the spacing "a" between hubs. See tables1 or approved drawing for correct hub spacing "a", according to coupling type. In case of doubt, please contact us.

2.8 Align the two shafts, check alignment using a dial indicator or laser alignment. Alignment precision depends on running speed. (See point 8).

2.9 Allow the hubs (1) to cool before installing the sleeves (2, 3 or 4, 5) over the hubs. Apply grease on coupling hub (1) teeth before installing the sleeves (2, 3 or 4, 5).

2.10 Bolt up the sleeves with the recommended tightening torque (see tables 1) (the use of Loctite 243 is highly recommended), after installing the sealing paper (sizes smaller than MT-275) or O-ring (10) (MT-280 and bigger sizes) in place. Using grease on the O-ring is recommended. Make sure that flange lubrication holes, after mounting, are 90° angle to each other as shown in fig. 1.

2.11 Remove both plugs (9) on the sleeve (2,3 or 4,5). As an approximate method proceed as follows: Turn the coupling so that the flange lubrication holes are in 1^{30}, 4^{30}, 7^{30}, 10^{30} watch position. Take away the 1^{30} and 7^{30} plugs (9) and pump grease into the 1^{30} holes, until grease leaks out from the lower 7^{30} (see fig. 1). During the process it is recommended to remove the 10^{30} plug to vent the interior. For grease quality and more accurate quantity see points 5 and 6. If running conditions are different than the ones given in tables 3 and 4, consult JAURE. For types MTD, MTGD, MTX, MTGX, MTCL, MTB, it is necessary to lubricate each half coupling separately. Introduce the oil plugs (9).

2.12 In order to periodically inspect the gear mesh, there should be enough space to withdraw the sleeves from the hub gear mesh, distance "s" on the catalogue, If this is not the case, it is advised to install a coupling with side covers as the MTN type.

2.13 For assembly balanced couplings respect the matching marks between components at installation.

For installation by cylindrical (IMO000917) or conical (IMO000918) hydraulic Extraction please consult Jaure

3. MAINTENANCE INTERVALS

Coupling should be disassembled and inspected (see point 4), and grease should be changed every 8000 working hours or maximum 2 years, whichever is earlier.

If the working temperature has been high (about more than 60ºC), then change the grease every 4000 hours or maximum 1 year, whichever is earlier.

If longer periods are needed, contact JAURE. Proceed as mentioned in point 2.11. Refill the coupling with grease. It is recommended to use oil (compatible with the used grease), for a correct cleaning of the grease.

4. DISASSEMBLY AND INSPECTION

- Before moving the sleeves, clean the hub surfaces near the O-rings (6) of dust or dirt.
- Remove bolts (11) and the O-ring (10).
- Inspect gearing and sealing.
- Maintain alignment.
- Use new grease. It is recommended to use Low viscosity oil to clean the coupling from old grease.

☞ **A T T E N T I O N !**

Take care, oil must be compatible with the grease that is inside the coupling. Once oil and grease are mixed inside the coupling, it will be easier to make that grease go out.

When the hub and the shaft are coupled by means of a keyway and the disassembly of the coupling hubs is required to be done, first the sleeve and the coupling cover will have to be removed. The hub can be removed from the shaft by heating the hub with a flare (80ºC approximately) and making use of the extraction holes.
A more detailed information of this process is given in IMO000060. Coupling to shafts using keyways B01-B04.

☞ **A T T E N T I O N !**

Try not to use the sleeves to remove the hubs. Make use of the extraction holes.

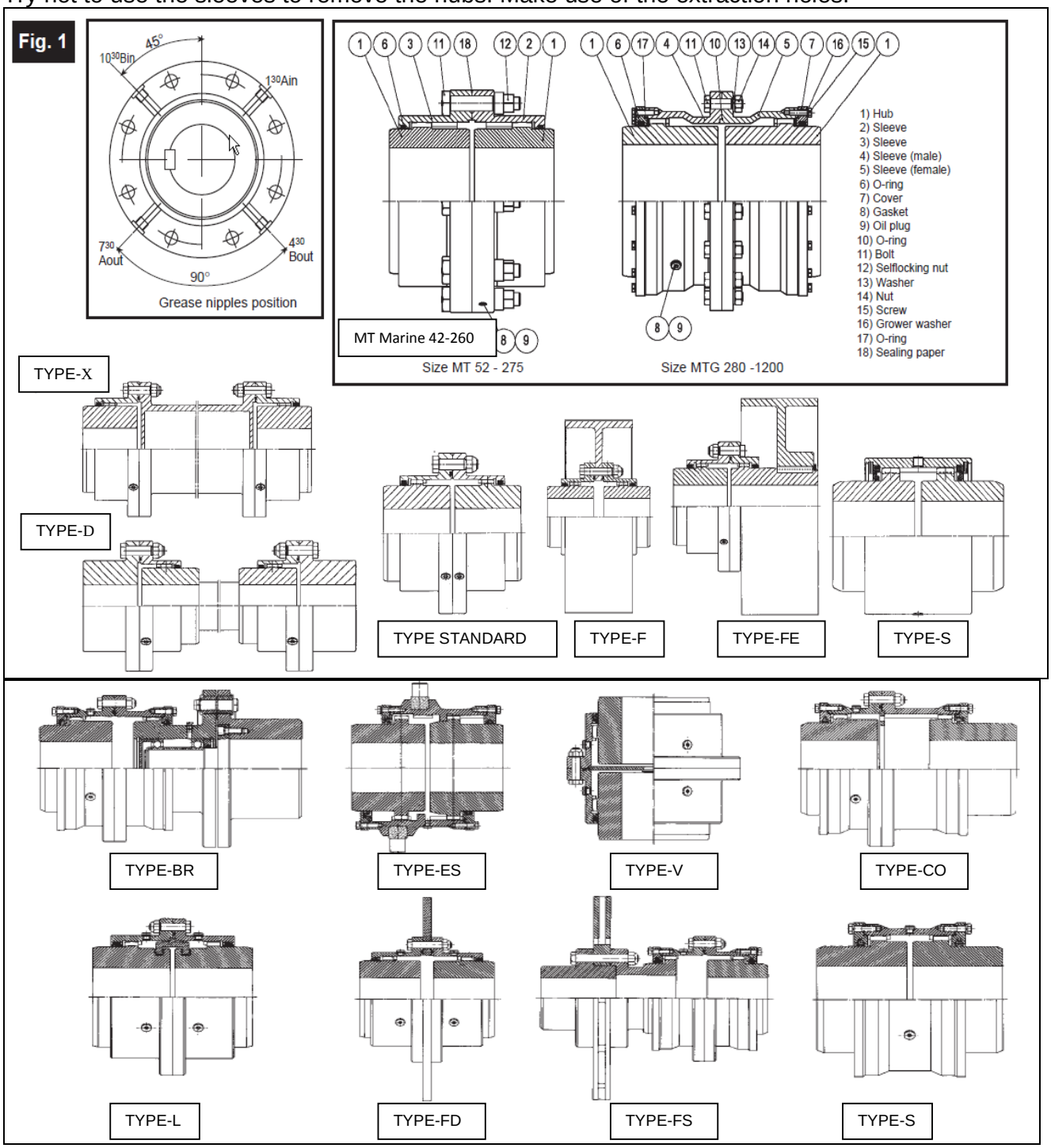

Fig.2: Types of couplings

CouplingsType MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG			
Size	**"a" (mm.)**	**Size**	**"a" (mm.)**
MT-42	6±1	**MTG-280**	16±3
MT-52	3±1	**MTG-310**	16±3
MT-55	6±1	**MTG-345**	16±3
MT-62	3±1	**MTG-370**	20±4
MT-70	6±2	**MTG-390**	20±4
MT-78	3±2	**MTG-420**	20±4
MT-90	8±2	**MTG-460**	20±4
MT-98	5±2	**MTG-500**	25±4
MT-100	8±2	**MTG-550**	25±4
MT-112	5±2	**MTG-590**	25±4
MT-125	8±2	**MTG-620**	30±6
MT-132	6±2	**MTG-650**	30±6
MT-145	10±2	**MTG-680**	30±6
MT-156	6±2	**MTG-730**	30±6
MT-165	10±3	**MTG-800**	30±6
MT-174	8±3	**MTG-900**	35±7
MT-185	10±3	**MTG-1000**	35±7
MT-190	8±3	**MTG-1100**	35±7
MT-205	12±3	**MTG-1200**	35±7
MT-210	8±3		
MT-230	12±3		
MT-233	8±3		
MT-260	12±3		
MT-275	10±3		

CouplingsType MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG				
Size	**Tightening torque (Nm)**	**Size**	**Tightening torque coupling screws (Nm) (See Fig. 2.1)**	**Tightening torque cap screw (Nm) (See Fig. 2.1)**
MT-42	6	**MTG-280**	375	73
MT-52	8	**MTG-310**	375	73
MT-55	15	**MTG-345**	660	73
MT-62	20	**MTG-370**	660	73
MT-70	52	**MTG-390**	760	178
MT-78	42	**MTG-420**	760	178
MT-90	82	**MTG-460**	760	178
MT-98	73	**MTG-500**	1.140	178
MT-100	82	**MTG-550**	1.140	328
MT-112	73	**MTG-590**	1.140	328
MT-125	174	**MTG-620**	1.800	328
MT-132	178	**MTG-650**	1.800	328
MT-145	174	**MTG-680**	1.800	328
MT-156	178	**MTG-730**	1.800	328
MT-165	174	**MTG-800**	1.800	328
MT-174	178	**MTG-900**	2.300	328
MT-185	247	**MTG-1000**	2.300	570
MT-190	245	**MTG-1100**	2.300	570
MT-205	247	**MTG-1200**	2.300	570
MT-210	245			
MT-230	247			
MT-233	245			
MT-260	428			
MT-275	470			

Table 1: Gap spacing "a" and flange bolt tightening torque for MT Marine, MT, MTG, MTCL, MTX, MTF, MTFE, MTS, MTV,MTCO,MTFD and MTFS

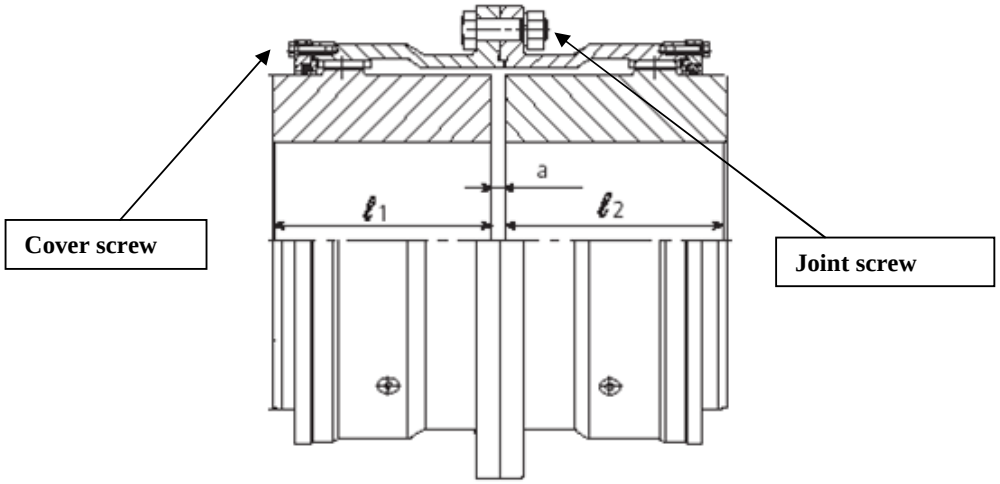

Fig.2.1: Different MTG coupling screws

MTN Type Couplings	
Size	**"a" (mm)**
MTN-42	6±1
MTN-55	6±1
MTN-70	6±2
MTN-90	8±2
MTN-100	8±2
MTN-125	8±2
MTN-145	10±2
MTN-165	10±3
MTN-185	10±3
MTN-205	12±3
MTN-230	12±3
MTN-260	12±3

MTN Type Couplings		
Size	**Tightening torque (Nm)**	**Tightening torque in covers (Nm)**
MTN-42	20	8
MTN-55	39	8
MTN-70	39	8
MTN-90	68	20
MTN-100	68	20
MTN-125	68	20
MTN-145	108	40
MTN-165	108	40
MTN-185	325	40
MTN-205	325	40
MTN-230	325	40
MTN-260	375	70

Table 1.1: Gap spacing "a" and flange bolt tightening torque for MTN.

☞ **A T T E N T I O N!**

If the bolts are oiled, these tightening torque values have to be 20% lower.

5. RECOMMENDED LUBRICANTS:

The lubricants shown at tables 2 are recommended based on JAURES's experience. In case the final user wants to use a different lubricant, please check the data given at the end of this point in this document.

MEDIUM SPEED, NORMAL or HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	KSG	-40 to +88
Castrol	Tribol 3020/1000-1	-30 to +120
Total Fina Elf	Ceran GEP-0	-25 to +180
Total	Ceran MS	-20 to + 180
Klüber	Klüberplex GE 11-461	-40 to +180
Esso-Exxon-Mobil	Mobilgrease XTC	-30 to +120
Esso-Exxon-Mobil	Mobilith SHC 460	-50 to +150
Molyduval	Molyduval coupling grease	-30 to +150
Shell	Gadus S3 HSCG	-10 to +120
Shell	Gadus S3 V770D1	-20 to +150
Verkol	Verkol 320-1 Grado 1	-15 to +150

Table 2.1

HIGH SPEED, NORMAL DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	KHP	-40 to +88
Klüber	Kluebersynth GE 14-151	-35 to +140
Shell	Gradus S2 HSCG	-30 to + 120
Esso-Exxon-Mobil	Mogilgrease XTC	-30 to +120

Table 2.2

SPEED LESS THAN 500 rpm, VERY HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	Waverly Torque Lube A	-18 to +100
Esso-Exxon-Mobil	Mobilith SHC 1000 Spec	-20 to +150
Klüber	Klüberlub BE 41-1501	-10 to +150
Castrol	Mollub Alloy 870	-10 to + 130

Table 2.3

LOW SPEED, NORMAL or HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Mobil	Mobilith SHC 007	-50 a +150
Klüber	Klueberplex 11-680	-10 to +130

Table 2.4

MEDIUM or HIGH SPEED, HEAVY or VERY HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	Syn-tech 3913G	-55 to +120
Mobil	Mobilith SHC 1500	-20 to +150
Mobil	Mobilux EP 111	-10 to +120
BP	BP Energrease SY 1501	-20 to + 180

Table 2.5

Duty level	Duty
Normal	When teeth material is standard (see catalogue)
Heavy	When teeth material is HD (see catalogue)
Very Heavy	When Teeth Material is hardened by any surface heat-treatment

Table 3: Clarification about levels of duty

Speed level	Peripherical Speed (*)
Low	< 2 m/sec
Medium	>2 m/sc and <60 m/sec
High	>60 m/sec

Table 4: Clarification about levels of speed

For calculating the pheriperical speed, use this formula

(*)
$$\frac{\prod \times D1 \times n}{60000} (m/s)$$

Where,

D1 (mm) = External diameter of the sleeve body at the MT catalogue (see catalogue)
n(rpm) = Maximum Operating speed

6. RECOMENDED GREASE QUANTITY

Couplings are supplied with protective grease but not with working grease. The teeth mesh has to be cleaned from any protective oil or grease prior to mounting.

Before mounting, approx. 50 to 70 % of total grease quantity shall be hand packed between hub and sleeve teeth and surrounding area. After mounting, the remaining (30 to 50%) of the grease shall be pumped into the flange lubrication holes.

At high temperature, low speed and reversing drive, more frequent lubrication is needed than the one recommended in these instructions.

For MTV case, fill of grease the upper side half coupling, and introduce the 50% of the indicated quantity at table 5 at lower side half coupling.

⚠ **C A U T I O N!**
Overfilling the coupling with grease may result in equipment damage.

☞ **A T T E N T I O N!**
In case of special couplings, the quantity of grease with which the coupling is to be lubricated will be indicated in the plan.

MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG Type Couplings			
Size	**[2] Qty. (kg)**	**Size**	**[2] Qty. (kg)**
MT-42	0.04	**MTG-280**	3
MT-52	0.03	**MTG-310**	3.6
MT-55	0.06	**MTG-345**	4.8
MT-62	0.06	**MTG-370**	5
MT-70	0.17	**MTG-390**	9
MT-78	0.09	**MTG-420**	9.8
MT-90	0.24	**MTG-460**	11.5
MT-98	0.12	**MTG-500**	11.5
MT-100	0.36	**MTG-550**	14.5
MT-112	0.3	**MTG-590**	23
MT-125	0.5	**MTG-620**	23
MT-132	0.4	**MTG-650**	30
MT-145	0.7	**MTG-680**	36
MT-156	0.6	**MTG-730**	38
MT-165	1.3	**MTG-800**	46
MT-174	0.8	**MTG-900**	57
MT-185	1.75	**MTG-1000**	75
MT-190	1.4	**MTG-1100**	115
MT-205	2.2	**MTG-1200**	125
MT-210	2.5		
MT-230	2.8		
MT-233	3		
MT-260	4.5		
MT-275	4.5		

MTN Type Couplings	
Size	**[2] Qty. (kg)**
MTN-42	0.07
MTN-55	0.1
MTN-70	0.12
MTN-90	0.22
MTN-100	0.3
MTN-125	0.4
MTN-145	0.6
MTN-165	1
MTN-185	1.1
MTN-205	1.6
MTN-230	2
MTN-260	1.3

Coupling type MTGX and MTGD			
Size	**[2] Qty. (kg)**	**Size**	**[2] Qty. (kg)**
MTGX-MTGD-190	1.4	**MTGX-MTGD-460**	10
MTGX-MTGD-210	2.5	**MTGX-MTGD-500**	14
MTGX-MTGD-233	3	**MTGX-MTGD-550**	16
MTGX-MTGD-275	4.5	**MTGX-MTGD-590**	19
MTGX-MTGD-280	3.5	**MTGX-MTGD-620**	24
MTGX-MTGD-310	4	**MTGX-MTGD-650**	28
MTGX-MTGD-345	5	**MTGX-MTGD-680**	36
MTGX-MTGD-370	6	**MTGX-MTGD-730**	40
MTGX-MTGD-390	8	**MTGX-MTGD-800**	50
MTGX-MTGD-420	9	**MTGX-MTGD-900**	70

Tables 5: Recommended grease quantity

2) Quantity per complete coupling for MT Marine, MT, MTG, MTG-HD, MTCL, MTS, MTFD, MTFS, MTF, MTFE, MTB, MTBX, MTN, MTNBR.

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For types MTX, MTGX, MTD, and MTGD add the specific quantity shown in the corresponding catalog sheet divided by 2 at each half. Ex. MTX-112: 0,15 kg at each half.

☞ **A T T E N T I O N!**

For types MTS, MTCO, vertical couplings and disengaging couplings consult JAURE.

☞ **A T T E N T I O N!**

For MTGX, MTGD sizes above 1000, please consult JAURE

7. TEETH WEAR CHECK

In order to be able to do a preventive maintenance on gear couplings, it is very recommendable to to check teeth wear level. There are different options. All of them are based on measuring the backlash (B) (tangencial clearance between gear teeth, see image), which must be lower than the values given at table 6. The two most practical methods to do this are:

- By marking both hub and sleeve. By this method, the Backlash is measured by marking the hub and sleeve at the same diameter as figure 3 shows. As the backlash is a tangential dimension, that value is almost the same as the one shown at figure 4, which is the real backlash. This method can be used in theory for all standard couplings that appear on the standard catalogue, but due to the low number of the maximum values, it is especially complex for the smallest sizes (approximately up to size MT 233 or MT Marine 230). Follow these steps:

    - Turn the hub until the sleeve and hub's teeth are in contact.
    - At that position, mark sleeve and hub (see Fig 3).
    - Turn now the hub to the other side until it is in contact with the sleeve again.
    - Measure the dimension B. Check if this value is higher than the maximum admissible Backlash value for that size.

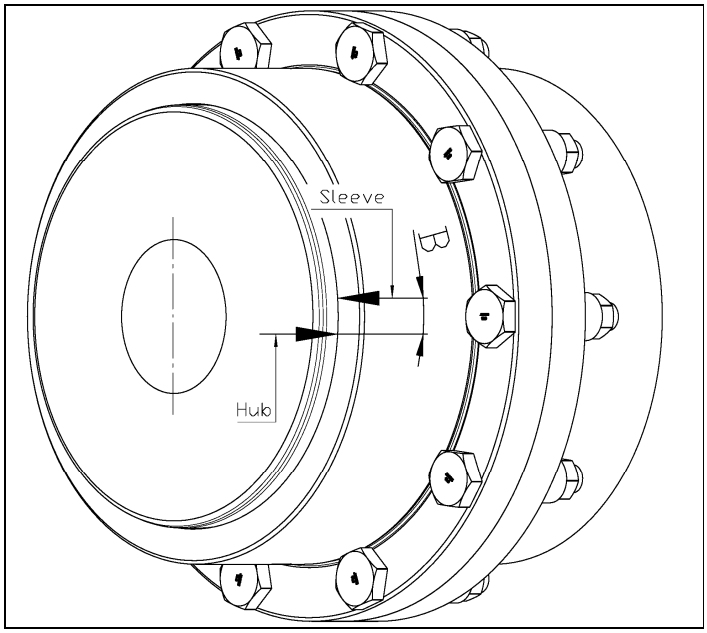

Fig 3: Backlash using marking method

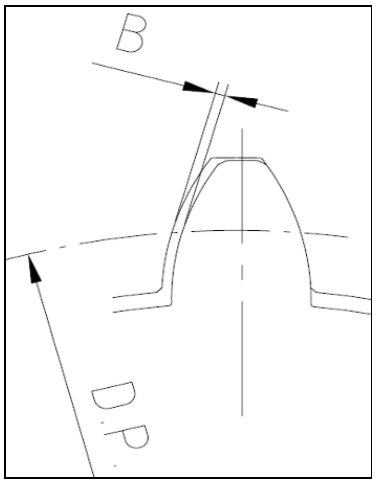

Fig 4: Backlash

- By using measuring gauges. This method is only valid when this fact has been previewed during design process. The reason is that it is necessary to make some holes for this (so, the customer must require this when he orders the coupling). This method is easier to practice, but correct size gauges must

be used (Jaure does not supply them). Also the target is to measure the B value.

- Turn the hub until the sleeve and hub's teeth are in contact.
- Insert the gauges through the hole in the way that it may be seen on figure 5. This must be done through the side that has no in contact between hub and sleeve.

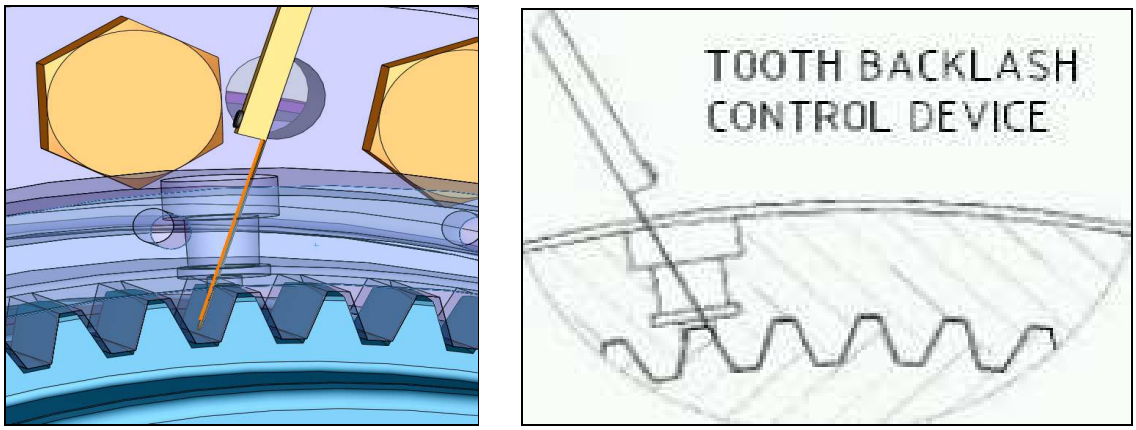

Fig 5: Two sights of gauge method for backlash measurement

☞ **A T T E N T I O N!**

Make sure that you have located the plug in place after measuring the backlash. In case this is not done, the grease will leak through that hole.

- **Other methods:** There are other two methods that can also be used, but they require more disassembly work.
  - By disassembling into two half couplings which are still mounted on their corresponding shafts. Gauges must be inserted through the teeth, but it must be made sure that they reach the middle of the total teeth length.
  - By measuring both teeth span for hub, and distance between pins for sleeve. Through these two dimensions, it is possible to calculate the corresponding backlash. This method is very used by coupling manufacturers, but it is more difficult for final users. The reason is that some experience on this is needed.

COUPLING	B* (admissible backlash, wear limit for gear teeth with standard or HD material) (mm)	COUPLING	B* (admissible backlash, wear limit for gear teeth with standard or HD material) (mm)
MT-42	0.8	**MTN-42**	1
MT-52	0.8	**MTN-55**	1
MT-55	0.8	**MTN-70**	1
MT-62	0.8	**MTN-90**	1.5
MT-70	1	**MTN-100**	1.5
MT-78	1	**MTN-125**	1.5
MT-90	1	**MTN-145**	2
MT-98	1	**MTN-165**	2
MT-100	1.3	**MTN-185**	2
MT-112	1.3	**MTN-205**	2.5
MT-125	1.3	**MTN-230**	2.5
MT-132	1.5	**MTN-260**	2.5
MT-145	1.5	**MTG-280**	3
MT-156	1.8	**MTG-310**	3
MT-165	1.8	**MTG-345**	3.5
MT-174	1.8	**MTG-370**	3.5
MT-185	2	**MTG-390**	4
MT-190	2	**MTG-420**	4.5
MT-205	2	**MTG-460**	4.5
MT-210	2	**MTG-500**	5
MT-230	2.5	**MTG-550**	5
MT-233	2.5	**MTG-590**	5.5
MT-260	2.5	**MTG-620**	5.5
MT-275	2.5		

Table 6: Admissible backlash (Only valid for couplings that have not the surface hardened by heat treatment)

8. ALIGNMENT PRECISION

In operation, each half coupling may work at maximum 0,5º misalignment, but the lower the working misalignment is, the longer the lifetime. So, in order to get to an optimized lifetime of the coupling, it is very important to align the coupling properly during assembly. The following must be followed when a JAURE gear coupling is assembled on site in standard conditions. Looking at figures 6 and 7, and tables 7, 8, 9, and following the next formula:

$$\left[\left(\frac{X}{DCD}\right)+\left(\frac{1}{2}x\frac{(Y-Z)}{D2}\right)\right]x\left(\frac{180}{PI}\right)\leq \text{MAMDA}^{o}$$

MAMDA= Maximum Accepted Misalignment During Assembly
PI= 3,1415
X= Offset (half of the TIR measurement)
During alignment, the following values must be respected:

MT, MT Marine, MTG and MTN	Speed (rpm)		
	0 – 500	500 - 1500	1500 – 4000
	MAMDAº	MAMDAº	MAMDAº
All sizes	0,1º	0,075º	0,05º

Table 7: Alignment precision

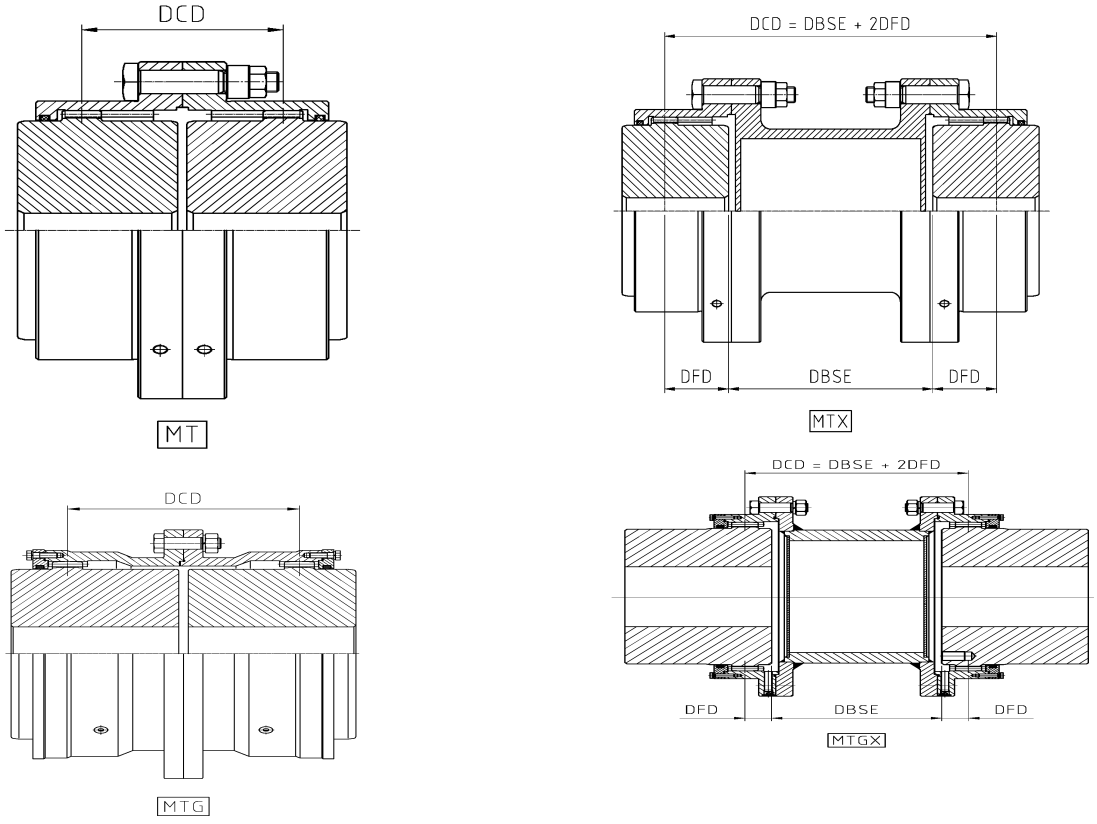

Fig. 6 : Representation of the DCD distances for MT, MTX, MTG and MTGX couplings

MT	DCD (mm)	MTX	DFD (mm)	MTG	DCD (mm)	MTGX	DFD (mm)
42	46	**46**	20	**280**	332	**280**	48
52	48	**52**	22,5	**310**	366	**310**	50
55	56	**55**	25	**345**	401	**345**	57,5
62	58	**62**	27,5	**370**	460	**370**	60
70	75	**70**	34,5	**390**	478	**390**	63
78	76	**78**	36,5	**420**	515	**420**	66,5
90	88	**90**	40	**460**	558	**460**	69
98	88	**98**	41,5	**500**	581	**500**	79
100	113	**100**	52,5	**550**	607	**550**	84
112	114	**112**	54,5	**590**	641	**590**	89
125	131	**125**	61,5	**620**	712	**620**	104
132	132	**132**	63	**650**	720	**650**	111
145	151	**145**	70,5	**680**	730	**680**	117
156	152	**156**	73	**730**	760	**730**	122
165	170	**165**	80	**800**	804	**800**	127
174	172	**174**	82	**900**	855	**900**	146,5
185	202	**185**	96	**1.000**	916	**1.000**	152,5
190	200	**190**	96	**1.100**	990	**1.100**	157,5
205	225	**205**	106,5	**1.200**	1090	**1.200**	162,5
210	227	**210**	109,5				
230	244	**230**	116				
233	248	**233**	120				
260	284	**260**	136				
275	292	**275**	141				

MT and MTX	D2 (mm)	MTG and MTGX	D2 (mm)
42	60	**280**	370
52	69	**310**	410
55	79	**345**	450
62	85	**370**	490
70	101	**390**	520
78	107	**420**	560
90	124	**460**	600
98	133	**500**	650
100	143	**550**	710
112	152	**590**	760
125	170	**620**	810
132	178	**650**	840
145	205	**680**	890
156	209	**730**	950
165	216	**800**	1050
174	234	**900**	1180
185	250	**1000**	1320
190	254	**1100**	1450
205	275	**1200**	1580
210	279		
230	300		
233	305		
260	340		
275	355		

Table 8: DCD, DFD and D2 distances for MT, MTX, MTG and MTGX couplings

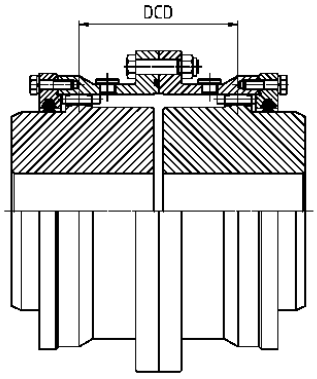

Fig 7: Representation of DCD distances for MTN couplings

DCD: distance between centre of the teething DCD = 2*DFD + DBSE

DFD: distance from the centre of the teething to the end of the hub

MTN	DCD (mm)	D2 (mm)
42	61	71
55	76	86
70	86	105
90	101	124
100	120	148
125	128	174
145	149	198
165	168	220
185	190	244
205	220	270
230	242	304
260	294	320

Table 9: DCD, DFD and D2 distances for MTN couplings.

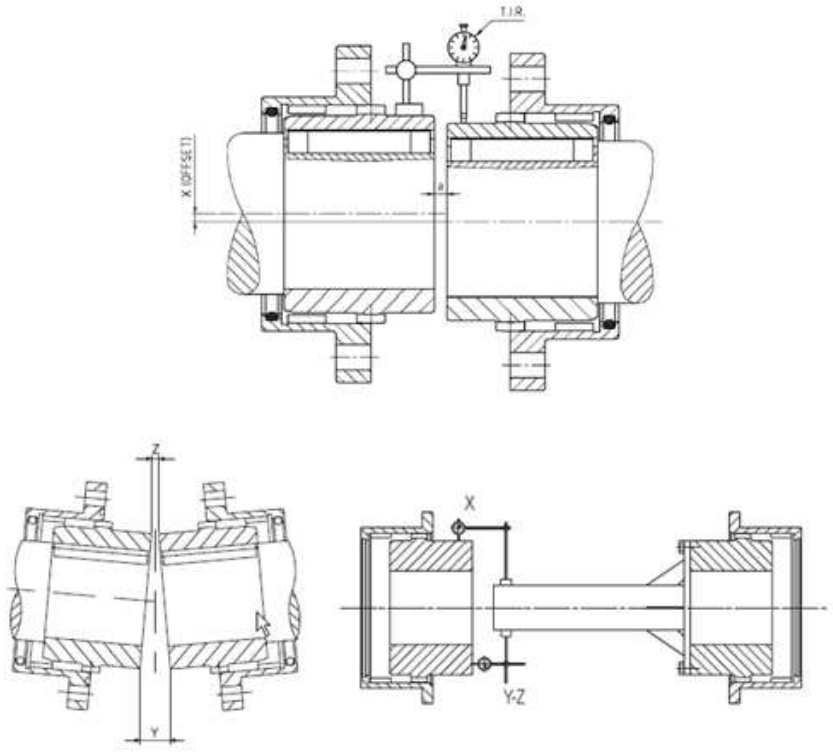

Fig.8: Alignment detail

☞ **A T T E N T I O N !**

A better alignment than the one given in this table will increase coupling life and reduce the reaction forces in shafts and bearings.

☞ **A T T E N T I O N!**

For Y-Z dimension, measure as close as possible to the D2 diameter as it can be seen at the right side of Fig. 7.

Nevertheless the minimum value (Y-Z) should not give an angular misalignment lower than 0.005º degrees in order to provide good teeth penetration between the Gears in the sleeve and hub

9. TRANSPORTATION AND STORAGE

The volume of the supply is indicated in the dispatch documentation. The condition of the goods supplied should be checked at the time of receipt. If there are any damages due to transportation or parts that are missing, these should be notified.

The coupling is packed differently depending on the transportation route and the size. Unless agreed upon otherwise in the contract, the packaging shall be the standard packaging of Jaure.

The pictograms affixed to the packaging should be kept in mind during handling.

☞ **A T T E N T I O N !**

Ensure the use of a suitable elevation device.

The coupling is supplied duly prepared with storage products and can be stored for 6 months in a dry, dust-free place, suitable for the same. If storage for a longer period is planned, we recommend that you must consult Jaure.

☞ **A T T E N T I O N !**

If the coupling is to be stored for more than 6 months, it is recommended that the housing rings are dismantled in the coupling and kept in an ozone-free area.

☞ **A T T E N T I O N !**

Humid stores (with humidity greater than 65%) are not suitable. It must be kept in mind that there should be no condensation.

CHANGE HISTORY

Rev.	Author	Date	Reviewed	Date	Approved	Date
05	XVL	14/09/2011	OGU	14/09/2011	IGM	14/09/2011
Rev.05: Changes made according to ANP000989						

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