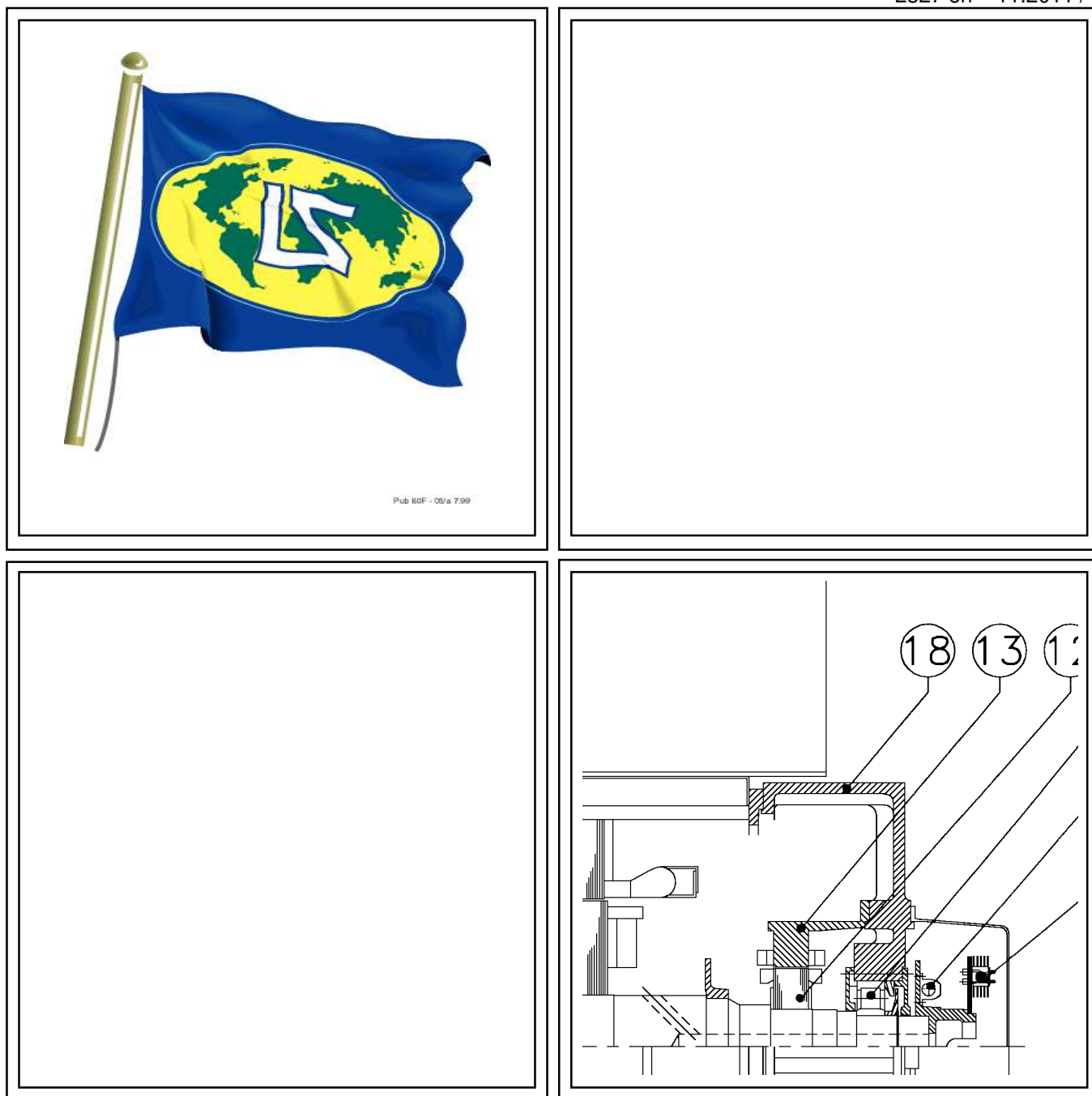




ALTERNATOR

Service & Operating Manual

ALTERNATORS

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1. GENERAL INFORMATION

1.1 INTRODUCTION

1.1.0 General points

This manual provides installation, operating and maintenance instructions for synchronous machines. It also describes the basic construction of these machines. This manual is general ; it applies to an entire group of synchronous generators. Additionally, in order to make information-finding easier, Section 1, "Characteristics and Performance", has been included, describing the machine completely (type of construction, type of bearing, protection index, and so forth...); this will enable you to determine exactly the chapters which apply to your machine.

This synchronous machine has been designed for a maximum length of service. To achieve this, it is necessary to pay special attention to the chapter concerning the periodic maintenance schedule for the machines.

1.1.1 Safety notes

The warnings "**DANGER, CAUTION, NOTE**" are used to draw the user's attention to different points:

DANGER :
THIS WARNING IS USED WHEN AN OPERATION, PROCEDURE, OR USE MAY CAUSE PERSONAL INJURY OR LOSS OF LIFE

CAUTION :
THIS WARNING IS USED WHEN AN OPERATION, PROCEDURE, OR USE MAY CAUSE DAMAGE TO OR DESTRUCTION OF EQUIPMENT

NOTE :
This warning is used when an operation, procedure, or delicate installation requires clarification.

1.1.2 Conditions of use

a) Generalities

A machine must only be installed, operated, by qualified and trained persons.

Any technical engineer operating, maintaining this machine must be allowed to practice in regard with local working laws (eg: to be certified to operate on high voltage devices...)

A machine can only be operated for the duty foreseen by its original tender.

The main data of this machine are summarized in "Section 1" of this manual

Any operating condition other than those specified by the original tender must receive a Leroy Somer agreement

Any modification of the machine structure must receive a Leroy Somer agreement

b) Vibratory analysis

It is the responsibility of the gen set manufacturer to ensure that the different assembled system will be vibratory compatible.(ISO 8528-9 and BS5000-3)

It is the responsibility of the gen set manufacturer to ensure that the shaft line torsional analysis has been done and accepted by the different parties (ISO 3046)

CAUTION :
EXCEEDING THE VIBRATORY LEVEL ALLOWED BY THE STANDARD ISO 8528-9 & BS5000-3 MAY CREATE HEAVY DAMAGES (BEARING DAMAGE, STRUCTURE CRACKS ...).
EXCEEDING THE TORSIONAL VIBRATORY LEVEL OF THE SHAFT LINE (ex: ABS, LLOYD ...) MAY CREATE HEAVY DAMAGES (CRANKSHAFT FAILURE , GENERATOR SHAFT FAILURE, ...)

Refer to chapter 2.1.3 for further information about the accepted vibration level of the standard ISO 8528-9 and BS5000-3

1.2 GENERAL DESCRIPTION

1.2.1 Generator

The synchronous generator is an alternating-current machine, without rings or brushes. The machine is cooled by the flow of air through the machine.

For a better comprehension, use the drawings of chapter 10.

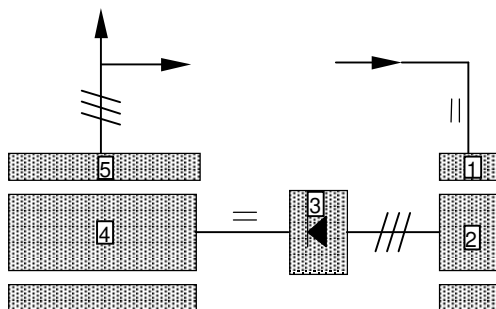
1.2.2 Excitation system

The excitation system is mounted on the side opposite the coupling.

The excitation system comprises two assemblies:

The excitation armature, generating a three-phase current, coupled with the three-phase rectifier bridge (comprised of six diodes) supplies the excitation current to the generator revolving field. The excitation armature and the rectifier bridge are mounted on the synchronous generator rotor shaft and are interconnected electrically with the revolving field of the machine.

The excitation field winding (stator) is supplied by the control (in direct current)



- 1- Excitation field winding
- 2- Excitation armature
- 3- Rotating diode bridge
- 4- Revolving field
- 5- Machine stator

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2. DESCRIPTION OF SUB-ASSEMBLIES

2.1 STATOR

2.1.1 Electric machine armature

a) Mechanical description

The machine stator comprises low-loss steel laminations, assembled under pressure. The steel laminations are blocked axially by a welded ring. The stator coils are inserted and blocked in the slots, then impregnated with varnish, and polymerised to ensure maximum resistance to mould, excellent dielectric rigidity and perfect mechanical linking.

2.1.2 Excitation field winding

The excitation field winding comprises a solid element and a winding.

The excitation is flanged on the rear end shield of the machine.

The winding is made of enamelled copper wires.

2.1.3 Stator protection

a) Heating resistor

The heating element avoids internal condensation during the shutdown periods. It is connected to the main terminal box strip. The heating resistor is switched on as soon as the machine is shut down. It is located at the back end of the machine.

The electrical characteristics are provided in Section 1 "Technical Characteristics".

b) Stator winding temperature sensor

The temperature sensors are located in the active part of the stack. They are located in the zone assumed to be the hottest part of the machine. The sensors are connected to a terminal box.

Depending on the temperature rise of the machine, the temperature of the sensors should not exceed a maximum of :

TEMP. RISE class	ALARM		TRIP	
	< 5000	> 5000	< 5000	> 5000
Power (KVA)				
B	130 °C	125 °C	135 °C	130 °C
F	155 °C	150 °C	160 °C	155 °C
H	175 °C	170 °C	180 °C	175 °C

To improve the machine protection the alarm set point may be reduced following effective site information:

Alarm temperature (*) = Highest recorded temp + 10°K

Trip temperature (*) = Alarm temperature + 5 °K

(*) do not pass over the values of the previous chart.

(*)Highest recorded temp: Temperature measured at the site in the worst temperature condition at the stator temperature sensor

E.g. : a class B machine reached 110°C during a factory heat run test. Set the alarm temperature to 120°C instead of 130°C as indicated in the previous chart. Set the emergency shutdown to 115°C instead of 135°C as indicated in the previous chart.

c) Stator air sensor

As an option an RTD or thermostat can measure the stator air inlet temperature (cold air)

Stator air inlet temperature; Alarm points and shutdown:

- alarm Nominal air inlet stator + 5 K
- shutdown 80°C

Stator air outlet temperature; Alarm points and shutdown:

- alarm Nominal air inlet stator + 35K
- shutdown Nominal air inlet stator + 40K

NOTE :

For an open drip proof machine the nominal air temperature entering the stator corresponds to the ambient temperature

Inhibit the stator air sensor safety "alarm" for few seconds during the machine start up;

NOTE:

For a water cooled machine (CACW) the nominal air entering the stator may be approximated as following:
Tair entering stator = Twater entering cooler + 15°K

d) Stator vibration sensor

This chapter concerns the setting of seismic probes. For setting of proximity probes refer to the rotor

The vibration level of the machines is directly linked to the duty and to the site characteristics.

We propose the following adjustment:

Vibration Alarm (*) = Site Highest Vibration level + 50%

Vibration Trip = Vibration Alarm + 50%

(*) do not pass over the values of the following chart

The machines are engineered to be able to withstand the vibration level specified by the standard ISO8528-9 and BS5000-3

Maximum levels for : reciprocating Internal combustion engines

Nominal speed (rpm)	kVA	Generator vibration level (nominal conditions)	
		Overall (mm/s rms) (2–1000 Hz)	Any harmonics
1300 à 2199	> 250	< 20	< 0.5 mm ; pp (5 – 8 Hz)
721 à 1299	≥ 250	< 20	
	> 1250	< 18	< 9 mm/s ; rm (8 – 200 Hz)
≤ 720	> 1250	< 15	
		< 10 (*)	

(*) generator on concrete base

Maximum levels for : Turbines

Turbines (hydraulic ; gaz ; steam)	Max advised : 4.5 (overall ; mm/s rms)
---------------------------------------	---

2.2 ROTOR

2.2.1 Revolving field-coil

The revolving field coil comprises a stack of steel laminations, stamped and cut to reproduce the indentation of the projecting poles.

The steel lamination stack-up is terminated at each end with high-conductivity electrical plates.

To enable parallel operation between machines, and in order to ensure stability, high electrical conductivity bars are inserted in holes crossing the poles from one side to the other. These bars are welded with the stack end laminations in order to obtain a complete cage winding (or LEBLANC dampening cage).

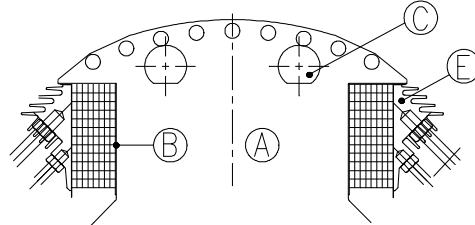
The winding (B) is placed around the pole (A) and is impregnated with epoxy resin (class F machine insulation) or with varnish (class H machine insulation).

The winding is made of insulated flattened copper with high electrical conductivity.

The aluminium plates (E) are pressed against the winding, acting as a heat dissipator and ensure excellent clamping of these coils.

Support bars (C) on each pole protect the end windings against the centrifugal force.

The revolving field-coil is heated and shrunk onto the shaft.



2.2.2 Excitation armature

The excitation armature is constructed by stacking magnetic steel laminations. These steel laminations are held in place by rivets.

The excitation coil is keyed and heat-shrunk onto the shaft.

The windings are enamelled copper wires, class "F" insulation (or "H", depending on the customer's request or size of the machine).

2.2.3 Fan (machines: IC 0 A1)

The synchronous machine is characterized by a self-ventilation system. A centrifugal fan is mounted between the revolving field coil and the front bearing.

Air intake is at the rear of the machine and the exhaust on the drive end side.

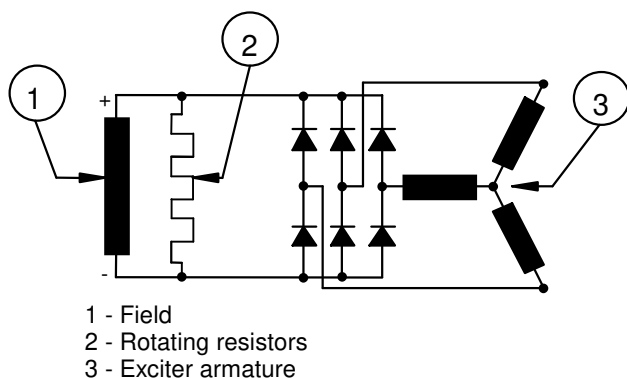
The fan consists of a hub, which is keyed and heat-shrunk onto the shaft. The flange is made of welded steel, attached to the hub with hexagonal head-cap screws. The ventilation effect is obtained through, inclined blades. The air is exhausted by centrifugation. The air inlet and outlet must remain free during operation.

2.2.4 Rotating diode bridge

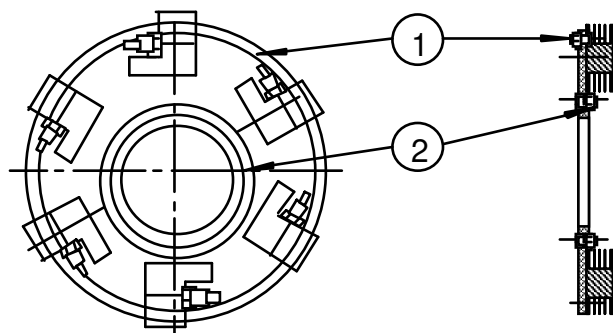
a) General points

The rectifier bridge, comprising six diodes, is placed at the rear of the machine. The rotating bridge is made of glass fibre with a printed circuit to connect the diodes together. This bridge is supplied with alternating current by the excitation armature and supplies direct current to the revolving field-coil. The diodes are protected against over voltage by rotating resistors, or by varistors. These resistors (or varistors) are mounted in parallel with the revolving field-coil.

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The inner and outer rings are connected to the revolving field-coil



1 - Outer ring
2 - Inner ring

The diode fastening screws must be tightened to the correct torque.

b) Tightening torque for the rotating diode fastening screws

CAUTION :
THE ROTATING DIODE FASTENING SCREWS MUST BE TIGHTENED USING A TORQUE WRENCH CALIBRATED TO THE RECOMMENDED TORQUE.

Diode	Tightening torque
SKR 100/..	1.5 m.daN
SKR 130/..	1.5 m.daN
SKN 240/..	3 m.daN

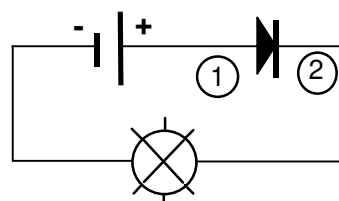
c) Rotating rectifier test

Carry out the test using a D.C. source as indicated below.

A diode in good condition should allow the current to flow **only** in the anode-to-cathode direction.

Disconnect the diodes before the test.

3 ... 48 volts



1 - Anode
2 - Cathode

Diode type	Positive	Negative
SKR	diode housing	diode wire
SKN	diode wire	diode housing

When reassembling ensure that the diodes are be tightened to the correct torque

2.2.5 Balancing

The entire rotor has been balanced according to ISO8221 standard in order to obtain a residual imbalance less than :
Gen set : Class G2.5
Turbine : Class G1

The balancing is carried out at two levels. The first is that of the fan. It is recommended, when the fan is refitted (after servicing) to respect the initial indexing.

The second is that of the shaft end. The shaft end is cold-stamped to indicate the type of balancing.

H : balancing with **Half-key carried out as standard**

F : balancing with Full key

N : balancing without key (None)

The coupling must be balanced to fit the generator rotor balancing.

2.2.6 Rotor vibration sensor

This chapter concerns the setting of proximity probes. For setting of seismic probes refer to the stator chapter

The vibration level of the machines is directly linked to the duty and to the site characteristics.

We propose the following adjustment:

Vibration Alarm (*) = 50% of the Bearing shell gap

Vibration Trip = 75% of the Bearing shell gap

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2.3 ANTI FRICTION-BEARINGS

2.3.0 Description of antifriction bearings

The bearings are installed at each end of the machine.
They can be replaced.

The bearings are protected from external dust by labyrinth seals.

The bearings must be lubricated regularly. The old grease is forced out at the lower part of the bearings by the force of the new grease being injected.

2.3.1 Start-up of antifriction bearings

The bearings are pre-lubricated in the factory, but before they are put into service, it is necessary to complete this lubrication.

CAUTION
UPON START-UP, GREASE THE MACHINE WHILE IT IS RUNNING SO AS TO FILL ALL THE FREE SPACES IN THE GREASING DEVICE

Record the temperature of the bearings during the initial operating hours. Poor lubrication can cause abnormal heating.

If the bearing hisses, lubricate it immediately. Some bearings may make a clattering noise if they do not operate at normal temperature. This may occur if the weather is very cold or when the machine is operating under abnormal temperature conditions (start-up phase, for example). The bearings will become quieter after having reached their normal operating temperature.

2.3.2 Storage of machine with anti friction bearings

This chapter must be taken in consideration if a machine is stopped more than 6 months.

Grease the bearings , machine stopped , inject two time the grease volume used for a standard maintenance.

Every 6 months turn the the machine shaft line of few turns. Then inject a standard grease volume

2.3.3 Maintenance of antifriction bearings

a) General points

Antifriction bearings or ball bearings do not require special maintenance.

They must be lubricated regularly with the same type of grease as used in the factory. For information concerning the lubrication quantity and interval, refer to Section 1 : "Characteristics and Performance".

CAUTION :
LUBRICATION MUST BE CARRIED OUT AT LEAST EVERY 6 MONTHS

CAUTION :
IT MUST BE DANGEROUS TO MIX GREASES WHICH HAVE DIFFERENT SOAP BASE. IT IS NECESSARY TO GET THE GREASE SUPPLIER APPROVAL OR TO CLEAN THE BEARING BEFORE TO PROCEED

NOTE:

After a regreasing the bearing temperature may increase of 10 to 20°C

This temporary temperature increase may stay few tens of hours

NOTE:

For re greasing period lower than 2000 hours we recommend to install a continuous greasing system to limit the maintenance operators visit
These type of system must be disable during machine stop
The grease contained in these systems must not be stored over a period of 1 year

b) Lubricant

Recommended lubricant:

SKF LGWA2

SHELL GADUS S3 V220C (lithium complex base).

SHELL RETINAX LX2 (lithium complex base).

CASTROL LMX NLGI2

TOTAL Multis complex EP2

Recommendation for a grease choice ::

Mineral oil or PAO (SHC)

Base (soap) grade NLGI 2

Lithium complex base

Base oil viscosity at 40°C: 100 to 200 mm2/s

Dye penetration test (DIN 51817) : 2% minimum

Use of grease which do not fit to the recomendated figure (substitution grease) :

Mineral oil or PAO (SHC)

Base (soap) grade NLGI 2 or NLGI 3

Lithium base

Base oil viscosity at 40°C: 100 to 200 mm2/s

Dye penetration test (DIN 51817) : 2% minimum

CAUTION :
THE USE OF A SUBSTITUTION GREASE CONDUCE TO REDUCE THE RE GREASING PERIOD OF 30%

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NOTE:

Lithium and complex lithium soap can be mixed
 Lithium complex and calcium lithium soap can be mixed
 In case of change of grease brand it is recommended to proceed to a massive greasing to waste the previous grease.

c) Cleaning bearings

This note is applicable when the type of grease is changed.

Dismantle the machine in order to get to the bearing

Remove the old grease with a palette knife.

Clean the lubricator and the grease removal tube.

For greater cleaning efficiency, use a brush with solvent.

NOTE:

The most widely-used solvent is gasoline : white spirit is acceptable.

In any cases national environmental and sanitary regulation must be fulfilled.

DANGER:

THE PROHIBITED SOLVENTS ARE:

CHLORINATED SOLVENT

(TRICHOLORETHYLENE, TRICHLOROETHANE) WHICH BECOMES ACID

FUEL-OIL (EVAPORATES TOO SLOWLY)

GASOLINE CONTAINING LEAD

BENZINE (TOXIC)

Blow compressed air onto the bearings to evaporate the excess solvent.

Fill the bearing with the new grease.

Re-assemble the cage and the parts, which have been dismantled, filling them with grease.

Use a grease pump to complete the bearing lubrication (while machine running)

2.3.4 Servicing the antifriction bearings**a) General points****CAUTION:**

CLEANLINESS IS IMPERATIVE

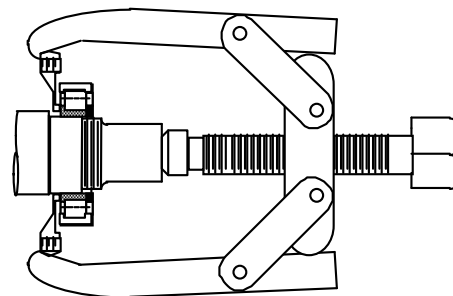
b) Removing the bearings

The inner bearing race is mounted, shrunk onto the shaft.

The outer bearing race is free, or slightly tightened, on the hub (depending on the type of bearing). To remove the bearing from the shaft, it is necessary to use a dedicated hub-puller to avoid damaging the surface of the shaft.

NOTE:

Heat the bearing during the pulling operation makes the operation easier and prevent the shaft from scratch.

**c) Bearing re-assembly**

A bearing can be refitted if it is known to be in perfect condition. As far as possible we recommend to use a new bearing.

Before refitting a bearing, carefully clean the surface of the bearing and the other parts of the bearing.

Measure the shaft diameter to check it is within the recommended tolerances.

To install the bearing on the shaft, it is necessary to heat the bearing. The heat source may be an oven or a space heater (the use of oil baths is strongly discouraged). The use of an induction bearing heater is recommended.

CAUTION:

NEVER HEAT A BEARING TO MORE THAN 125°C (257°F)

Push the bearing up to the shaft shoulder, and check after cooling that the inner ring is still in contact with the shoulder. Lubricate using the recommended grease.

2.3.5 Antifriction bearing protection devices

As an option, the bearing may be protected from overheating by RTD or PTC sensors (customer's choice)..

For special use in warm surroundings where the temperature of the bearings exceeds the authorised limit (for a bearing known to be in good condition), contact us.

Bearing; Alarm points and shutdown:

- alarm 90°C (194°F)
- shutdown 95°C (203°F)

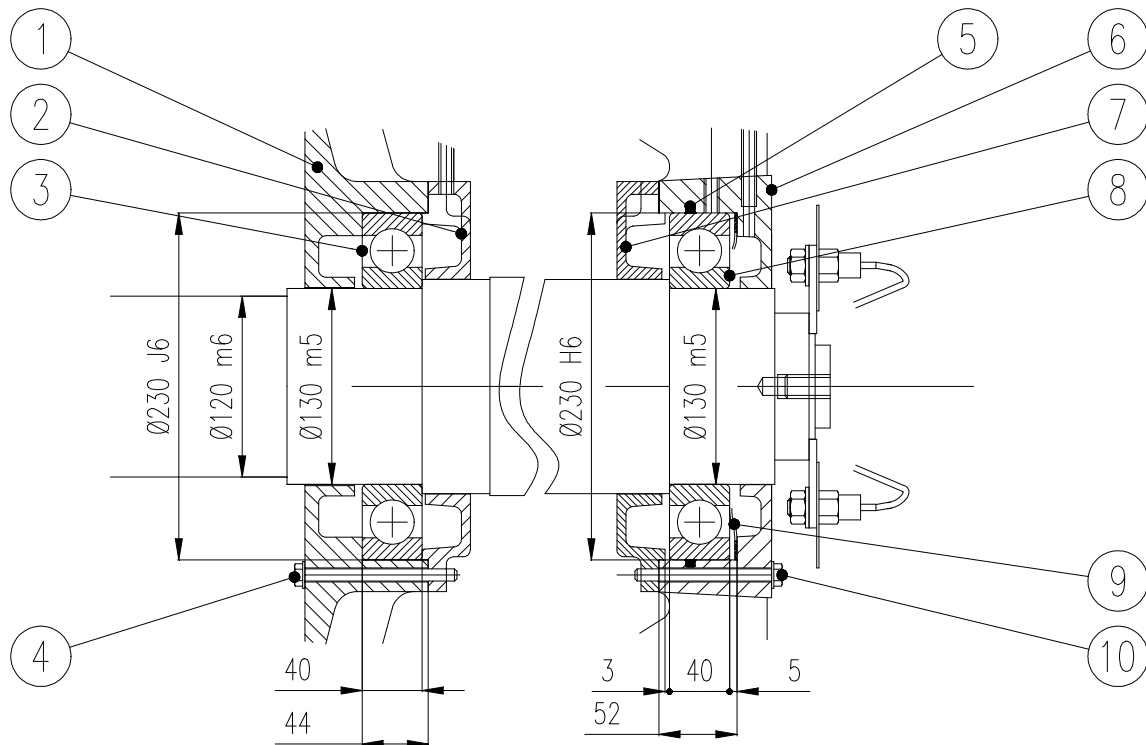
To improve the machine protection the alarm set point may be reduced following site effective information:

Alarm temperature (*) = Highest recorded temp + 15°K
 (*) do not pass over the values of the previous chart.

E.g. : At site the common bearing temperature is 60°C . Set the alarm temperature to 75°C instead of 90°C as indicated in the previous chart

2.3.9 Anti friction bearing installation drawing

Machine type A50

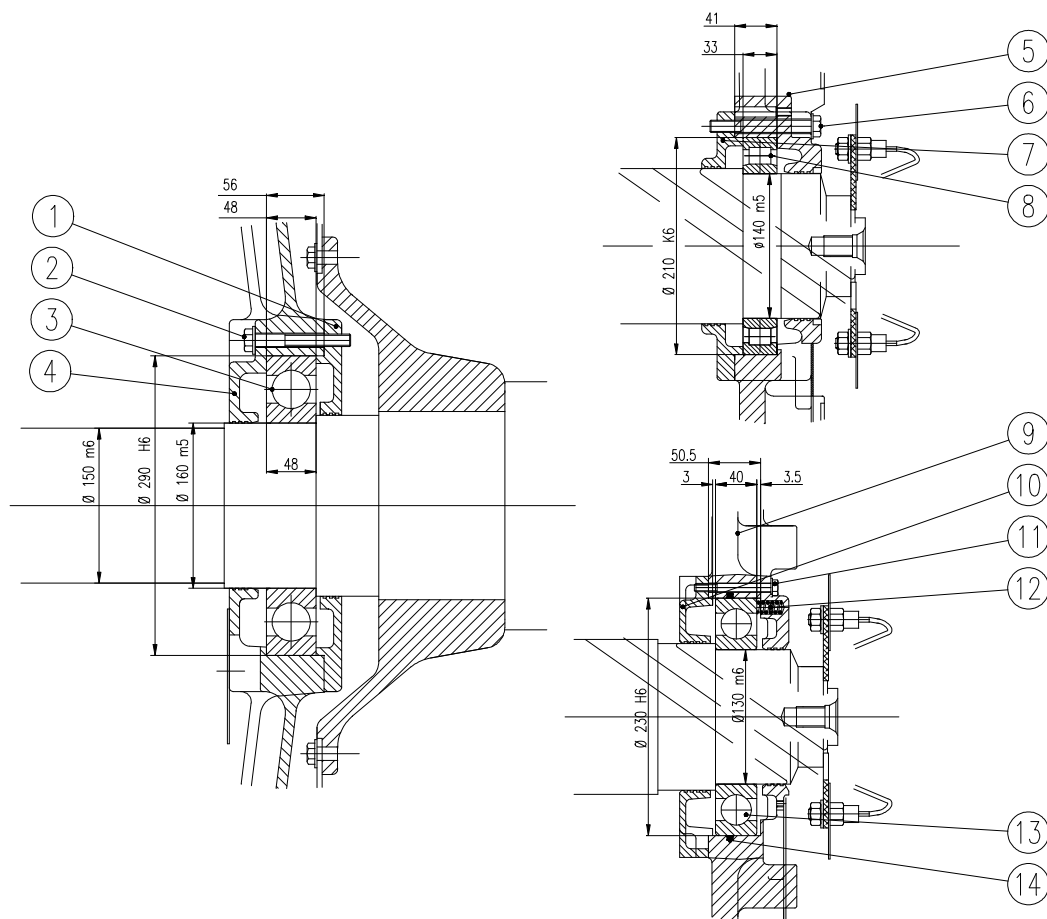


Drive end		Non drive end	
1	End shield	5	O-Ring
2	End cover	6	Non drive end shield
3	Ball bearing 6226 C3	7	End cover
4	End cover fixing screw	8	Ball bearing 6226 C3
		9	Bearing pre load washer
		10	End cover fixing screw

ALTERNATORS

2.3.9 Anti friction bearing installation drawing (following)

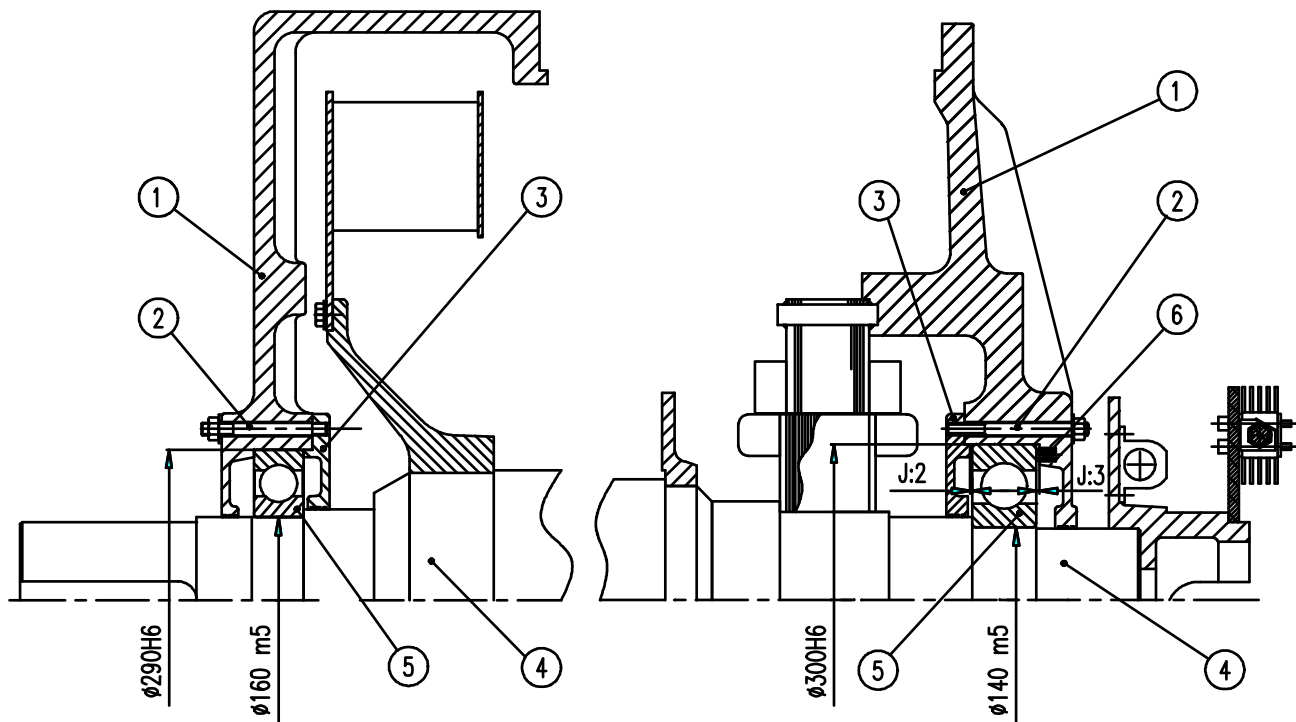
Machine type A52.2; Two bearings



Bearing assembly "Power plant"			
Drive end		Non Drive end	
1	End cover	5	End shield
2	End cover fixing screw	6	End cover fixing screw
3	Ball bearing 6232 MC3	7	End cover
4	End shield	8	Roller bearing NU 1028 MC3
Bearing assembly " Marine "			
Drive end		Non Drive end	
1	same as à "power plant"	9	End shield
2		10	End cover
3		11	End cover fixing screw
4		12	Bearing pre load spring
		13	Ball bearing 6226 C3
		14	O-Ring

2.3.9 Anti friction bearing installation drawing (following)

Machines A53 and A54 :



Drive end side (2 bearing machine)

- 1 – End shield
- 2 – M12 stud
- 3 – End cover
- 4 - Shaft
- 5 – Ball bearing 6232 MC3

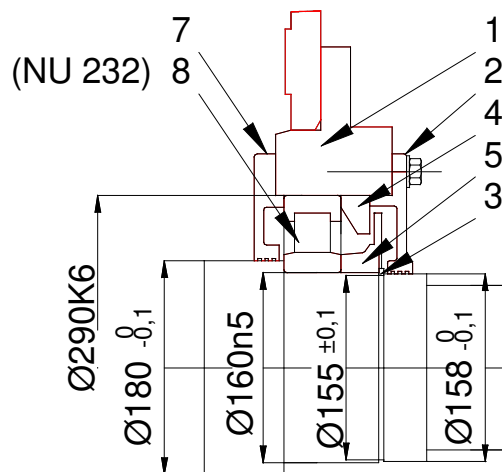
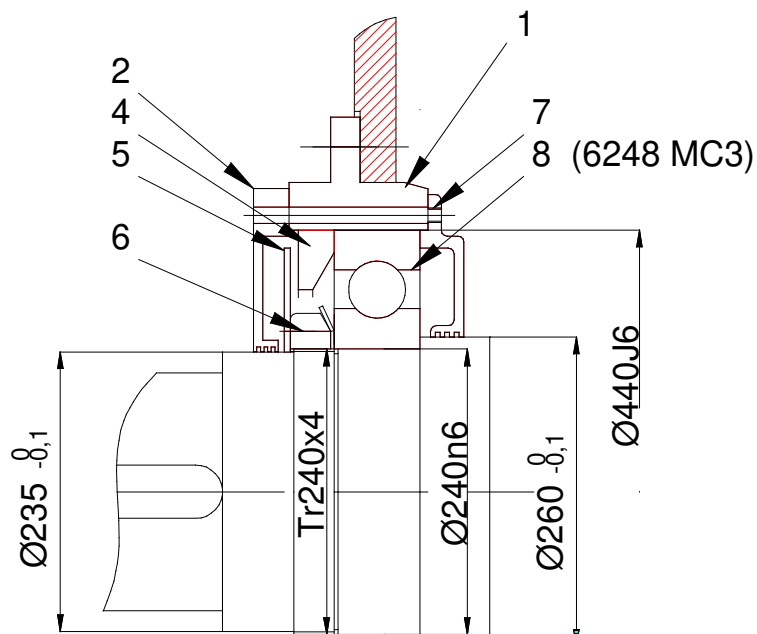
Non drive end side

- 1 – End shield
- 2 – M12 stud
- 3 – End cover
- 4 – Shaft
- 5 – Ball bearing 6328 MC3
- 6 – Spring

ALTERNATORS

2.3.9 Anti friction bearing installation drawing (following)

Machine type A56 ; Power plant (6 poles and more)



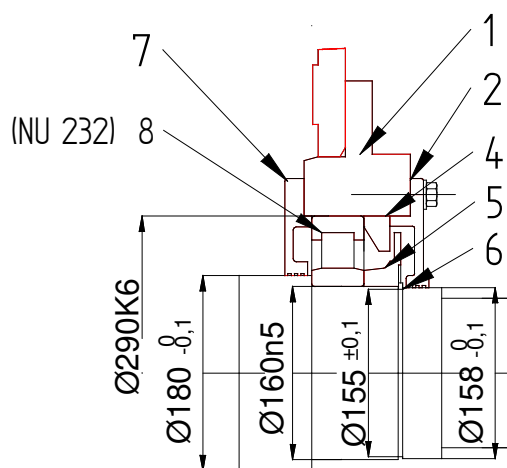
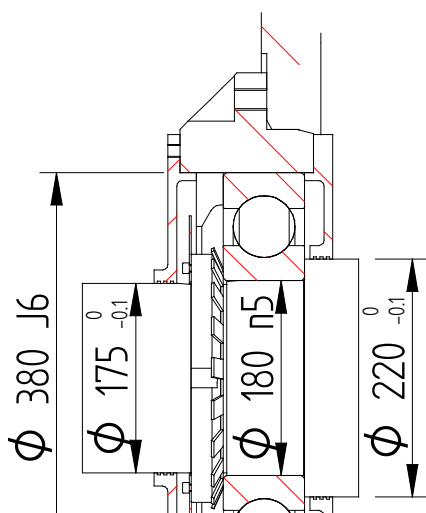
1 – Bearing carrier
2 - Outside bearing cover

3 – Snap ring
4 - Fixed deflector

5 - Rotating deflector
6 - Nut

7 - Inside bearing cover
8 – Anti friction bearing

Machine type A56 ; Power plant (4 poles only)



1 – Bearing carrier
2 - Outside bearing cover

3 – Snap ring
4 - Fixed deflector

5 - Rotating deflector
6 - Nut

7 - Inside bearing cover
8 – Anti friction bearing

2.4 SLEEVE BEARINGS

Note : For vertical machines refer to the attached specific bearing notice.

Refer to the attached cut view in "chapter 10" for an easier understanding

2.4.0 Description of horizontal Sleeve bearings

a) Physical description

Rotation of the machine rotor is guided by Sleeve bearings.

The bearing housing is constructed in two ribbed parts providing considerable heat extraction potential.

The sleeve bearing comprises two half-shells with an external spherical shape. This allows self-alignment. The guiding surfaces of the sleeve bearing are covered with tin-based anti-friction metal.

The spherical seat of the housing of the electrically insulated bearings is covered with an insulating coating. The positioning pin of the sleeve bearing in the housing is also insulated with an insulating bush.

The lubrication ring, mounted free on the shaft, is made of brass. In order to simplify dismantling, the ring is cut in two parts, assembled using screws.

A guide for the lubrication ring (synthetic materials) is attached to the upper bearing half-shell (for marine applications only).

The floating labyrinth seals are cut in two parts, held together by an expandable ring. These seals are inserted in a support. A seal-positioning pin rests in the support to block it during rotation.

The upper part of the housing is closed by means of a glass plug allowing observation of the rotation of the lubrication ring. A threaded metal plug allows the bearing to be filled with oil.

The lower housing may be equipped with an oil-level sight indicator, a thermometer and a temperature sensor.

b) Operating description of Self-lubricating bearing

Upon stopping, the shaft rests on the lower bearing; there is metal-to-metal contact.

During the start-up phase, the shaft rubs against the anti-friction metal of the bearing. Oil lubrication is used.

After having reached its transition speed, the shaft creates its oil film. At this point there is no further contact between the shaft and bearing.

CAUTION:
PROLONGED OPERATION AT EXTREMELY SLOW ROTATION SPEEDS (SEVERAL rpm) WITHOUT LUBRICATION COULD SERIOUSLY DAMAGE THE SERVICE LIFE OF THE BEARING.

c) Operating description of Oil circulation bearing

Proceed as for the self-lubricated bearings.

For special duty of high speed machine or high loaded bearing it might be necessary to have an oil circulation system (external device which ensure the cooling and the circulation of the oil)

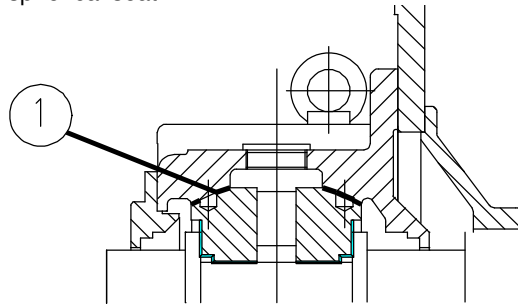
The oil warmed by the bearing losses is externally cooled and is returned directly to the shell. To obtain efficient cooling the oil flow must be correct (refer to section 1).

2.4.1 Electrical insulation of Sleeve bearings

a) Illustration diagram of the insulating film

Following the used technology shaft circulating current may occurs. When necessary, ACEO insulates the Non Drive End bearing to avoid shaft-circulating current.

An insulating film is applied to the bearing housing spherical seat.



1 – Electrical insulation

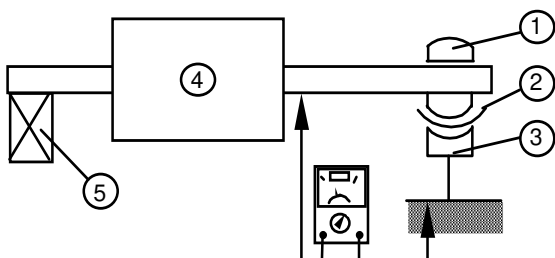
CAUTION:
WHEN INSULATED BEARING IS USED THE ACCESSORIES IN CONTACT WITH THE SHELL MUST BE ELECTRICALLY INSULATED (TEMPERATURE SENSOR ...)

ALTERNATORS

b) Insulation check

Single bearing machine:

Maintain the rotor at the drive end side to insulate it from the earth (disconnect the coupling if not done). Measure the insulating resistance between the shaft and the ground. The insulation should be better than 0.1 MΩ. measured under 500 V DC



- 1 - Bearing shell
- 2- Insulating film
- 3 - Bearing housing
- 4 - Rotor
- 5 - Insulating wedging

Double bearing machine:

Maintain the rotor at the drive end side to insulate it from the earth (disconnects the coupling; Dismount the drive end bearing if not done). Measure the insulating resistance between the shaft and the ground. The insulation should be better than 0.1 MΩ. measured under 500 V DC

Installed shell accessories (e.g: RTD) must fit 0.1 MΩ. measured under 500 V DC

2.4.2 Storage of Sleeve bearings machine

a) General points

CAUTION:

FOR MINERAL OIL WE RECOMMEND THE USE OF TECTYL PRODUCTS FROM "VALVOLINE GmbH" SUCH AS TYPE "511 M"
FOR SYNTHETIC OIL WE RECOMMEND THE USE OF "JELT 003400" SPRAY FROM "ITW SPRAYTEC"

NOTE :

It is possible to start the machine up without removing the recommended protection agent.

b) Short term storage

When a sleeve bearing machine has to be stopped for more than one month and less than one year:

Do not drain the bearing

Pour the recommended protecting agent through the oil filling hole of the bearing (around 50 cc). Turn the shaft several times in order to spread the product evenly throughout the bearing.

c) Long term storage

When a sleeve bearing machine has to be stopped for more than one year:

Drain the bearing. Place a "Silicagel" gag inside the bearing oil sump (it is necessary to open the bearing housing to proceed)

Place an adhesive strip along the parting lines of the housing.

Pour the recommended protecting agent through the oil filling hole of the bearing (around 50 cc). Turn the shaft several times in order to spread the product evenly throughout the bearing.

CAUTION:

A VISIT OF THE BEARING (research of corrosion marks) MUST BE DONE AT LEAST ONCE PER YEAR

CAUTION:

BEFORE START UP IT WILL BE NECESSARY TO REMOVE THE "SILICAGEL" BAG AND TAPES

2.4.3 Oil circulation installation

Refer to chapter 2.6

2.4.4 Start-up of Sleeve bearings

a) General check before start up

To identify your bearing characteristics refer to section 1

This verification must be carried out upon the first start-up, during periodic inspection of the bearing, or as soon as any part of the bearing alignment is changed (coupling ...).

After a long shutdown period, proceed following the used storage procedure (refer to chapter 2.4.2)

Check that the shaft has not corroded (onto journal surface; thrust faces and seals surfaces)

Fill the bearing oil cavities with oil.

CAUTION:

THE BEARINGS ARE DELIVERED WITHOUT OIL

Clean the external parts of the bearing. Dust and dirt impede the radiation of the heat

Check if the temperature monitoring equipment works.

b) Self-lubricating bearings start up data

To identify your bearing characteristics refer to section 1

Fill the bearing with the recommended oil. The oil must be new, absolutely free of any traces of dust or water.

The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass

maximum oil level: 2/3 the top of the oil sight glass

NOTE: It is recommended to filter the oil before filling the bearing.

CAUTION:

**NOT ENOUGH LUBRICANT LEADS TO TEMPERATURE RISES AND THUS TO DAMAGE TO THE BEARING.
TOO MUCH LUBRICANT LEADS TO LEAKAGES.**

Retighten the split line and flange screws (12) by using the following torque values:

Bearing Size	14	18	22	28
Torque [Nm] (lightly oiled)	170	330	570	1150

Check the firm position of the top sight glass (5).

Check the firm position of the oil sight glass (23).

If a temperature sensor or thermometer is used check they are correctly fixed.

Retighten all screw plugs in the connection holes (4), (22), (24) (27) by using the necessary torque values:

Plugs threads	G 3/8	G 1/2	G 3/4	G 1
Torque [Nm]	30	40	60	110

Plugs threads	G 1 1/4	G 1 1/2	G 2	G 2 1/2
Torque [Nm]	160	230	320	500

Check the operation of the temperature monitoring equipment.

During the start-up period, check the temperature of the bearings. The temperature should stay below 95°C and then drop down to the temperature normally recommended (refer to the technical characteristics for Sleeve bearings in Section 1.)

In case of oil oozing retighten the bearing fixing screws and the plugs to the recommended torque.

c) Water cooled bearing (type EFW..) start up data

To identify your bearing characteristics refer to section 1

Proceed as for the self-lubricated bearings and check the water flow of the cooler. (refer to the data contained in section 1)

Water has to be filtered as per chapter 2.7.5

d) Oil circulation bearing with non accurate oil flow (+0% ; -40%)

To identify your bearing characteristics refer to section 1

This chapter typically applies for standard bearings (as for bearing types E..Z.K ; E..Z.Q).

The oil circulating bearings (without Leroy Somer lubricating system) are delivered with:

- a breather
- an oil inlet flow regulating system.

The "oil flow regulating system" consists of :
an adjustable pressure reducing valve "A"
a diaphragm.

NOTE: The breather can be removed if it is proved that the bearing casing is in depressure regarding the atmosphere. Fit a plug in place of the breather

The oil flow adjustment does not request high accuracy. Do not feed the bearing with an oil flow higher than this one indicated in section 1.

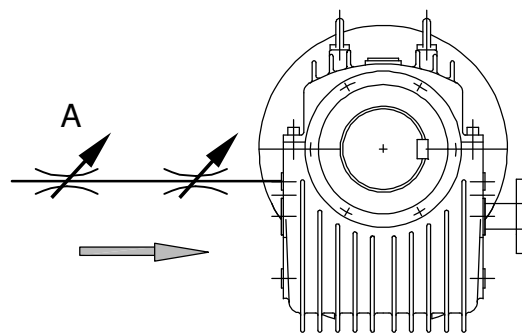
Ensure that the complete oil supply and return lines have been rinsed as instructed in the chapter.2.4.3

Ensure that the installation instructions have been followed (refer to chapter.2.4.3) such as filtering unit, return line properly inclined etc.

Proceed as for the self-lubricated bearings and then start the oil supply system (pump etc.).

To adjust the oil flow as recommended in section 1: Machine stopped, adjust the pressure reducing valve "A" to get the bearing oil level at the middle of the glass. And then run the generator

Machine running and oil at the operating temperature the oil sight glass level should be within 1/3 and 1/2 of the glass. If necessary readjust the pressure reducing valve "A"



During generator operation the oil level in the bearing must comply with the indications in Chapter 2.4.5.

ALTERNATORS

e) Oil circulation bearing with accurate oil flow (+5% ; -10%)

To identify your bearing characteristics refer to section 1

This chapter typically applies for bearings engineered for heavy thrust (tilting pads as for bearing types E..Z.A).

CAUTION:

THE OIL FLOW MUST BE CAREFULLY ADJUSTED TO THE REQUESTED VALUE

The oil circulating bearings are delivered with:
a breather
an oil inlet flow regulating system.

The "oil inlet regulating system" consists of :
an adjustable pressure reducing valve "A"
a diaphragm.

NOTE: The breather can be removed if it is proved that the bearing casing is in depressure regarding the atmosphere

Ensure that the complete oil supply and return lines have been rinsed as instructed in the chapter.2.4.3

Ensure that the installation instructions have been followed (refer to chapter.2.4.3) such as filtering unit, return line properly inclined etc.

Proceed as for the self-lubricated bearings and then start the oil supply system (pump etc.). The oil flow must be strictly adjusted within the requested value using a flow meter. Run the generator.

Machine running and oil at the operating temperature the oil sight glass level should be within 1/3 and 2/3 of the glass. If the level reach the top of the oil sight glass investigate for the oil return line design.

f) Inspection of Sleeve bearings at the end of start-up

Supervise the bearing during the trial run (5-10 operating hours).

Pay special attention to:

- oil level
- bearing temperature
- sliding noises of the shaft seals
- tightness of the sump plugs
- tightness of the bearing accessories
- occurrence of vibrations.

CAUTION :

IF THE BEARING TEMPERATURE EXCEEDS THE CALCULATED VALUE OF 15 K STOP THE MACHINE IMMEDIATELY. INSPECT THE BEARING AND DETERMINE THE CAUSES.

In case of oil oozing retighten the bearing fixing screws and plugs to the recommended torque

2.4.5 Maintenance of Sleeve bearings

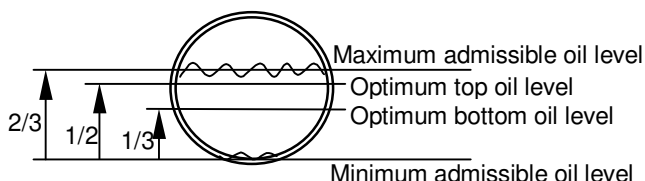
a) Verification of oil-level

Check the oil level at regular intervals.

The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass

maximum oil level: 2/3 the top of the oil sight glass



b) Temperature verification

Check the bearing temperature and record it. A bearing temperature, which suddenly varies without any obvious reason (change of ambient temperature etc.), indicates abnormal operation. It is then necessary to inspect the bearing.

c) Oil draining

NOTE:

Risk of pollution! Please observe the instructions for the use of the lubricating oil. The manufacturer can provide information on waste oil disposal

It is recommended to drain the oil at intervals of
8000 hours of operation in dirty environment (eg : gen set application)
16000 hours of operation in clean environment (eg : hydro power plant)

A yearly inspection of the oil sump is recommended. Have a special attention to water contamination.

It is possible to decide the oil change only after making an analysis and not at fixed period. In such practice the oil analysis report must fulfill pollution recommendation of chapter "2.4.10-e":

Shut down the installation and secured it against unintended operation.

Take all necessary measures to collect all of the lubricating oil.

Release the lubricating oil while it is still warm. Impurities and residues will thus be removed.

Unscrew the oil drain plug (27). Release the lubricating oil and collect it.

NOTE:

If the lubricating oil contains unusual residues or is visibly changed, eliminate the causes. If necessary, carry out an inspection.

Tighten the oil drain plug (27) using the following torque values:

Bearing size	14	18	22	28
Torque [Nm]	30	40	60	60

Remove the screw plugs from the oil filler hole (4).

NOTE:

Make sure that no impurities get into the bearing.

Use a lubricant with the viscosity indicated on the bearing type plate. Fill the lubricant through the oil filler hole (4) up to the middle point of the oil sight glass (23).

The oil level limits are as follows:

minimum oil level: bottom of the oil sight glass

maximum oil level: 2/3 the top of the oil sight glass

NOTE:

Insufficient lubricant leads to temperature rises and thus to damage to the bearing.

Too much lubricant leads to leakage. In the case of bearings lubricated by a loose oil ring, too much lubricant could break the oil ring, thus leading to damage to the bearing.

Tighten the screw plug into the oil filler hole (4) using the following torque values:

Bearing size	14	18	22	28
Torque [Nm]	30	40	60	60

d) Pressure measurement of a Sleeve bearing housing

The external environment of the electric machine may cause pressurizing or depressurizing of the Sleeve bearing and lead to oil leakage.

Example: The oil return line (of a circulation bearing) opening directly into a diesel motor lower sump and allowing the housing back-pressure to return to the bearing.

Example: A vacuum generated by a coupling located too close the Sleeve bearing and acting as a fan.

The relative depression (or pressure) during operation must remain less than 5 mm of water column. The relative pressure is the pressure difference existing between the bearing oil sump and the bearing outside (measured close to the seals).

P_e : external pressure close to the seal

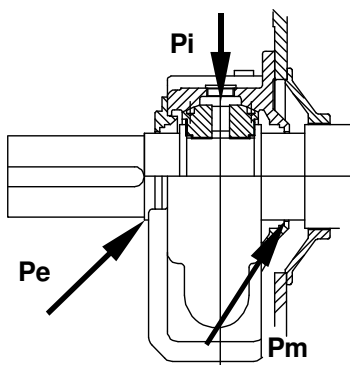
P_i : bearing oil sump pressure

P_m : machine expansion chamber (gain access as indicated by the arrow)

$$\Delta (P_e - P_i) < 50\text{Pa}$$

$$\Delta (P_m - P_i) < 50\text{Pa}$$

Note: 50Pa=5mmWC



Field pressure measure :

Using a transparent tube as water column manometer.

Connect a flexible transparent tube to the upper part of the bearing. Connect a pressure tap corresponding to the flexible tube used.

Install the pressure tap in place of the filling plug located on the top of the bearing housing.

Partially fill the pipe with water.

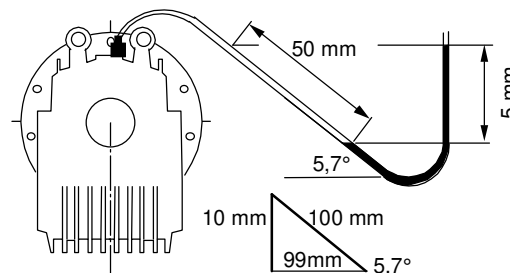
NOTE:

Be careful not to cause water to enter the bearing

Measure the pressure (or depression) in millimeters of water column.

NOTE:

Given the low pressures measured, to make the reading easier it is advised to incline the water column manometer by 5.7° (diagram below). A reading amplification of "10" is thus obtained.



e) Oil for sleeve bearing

We do not have any special recommendation regarding any mineral oil manufacturer.

The used oil must comply with the requested viscosity (refer to Section 1).

For frequent cold starting (lower than -15°C) without oil sump heater please contact us. A new oil viscosity may be advised.

Use a non-foaming mineral oil, without additives. If an oil containing additives has to be used, make sure that the supplier confirms the chemical compatibility of the oil and the lead anti-friction properties.

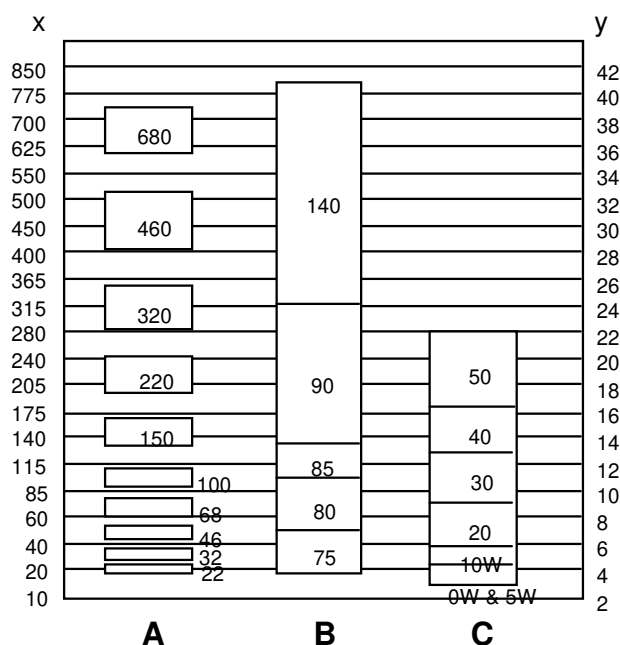
CAUTION:

SYNTHETIC OILS MAY BE USED ONLY IF USED LUBRICANT ARE ISSUED FROM THE FOLLOWING LIST

Since the synthetic lubricants are not standardized, no guarantee can be given regarding their chemical and mechanical behavior. Some synthetic lubricant may become acid and destroys bearing parts (white metal, oil ring, sight indicator..) in a short time

If synthetic oil has to be used; during the first 2000 hours of use the lubricant should be checked at short intervals.

Viscosity data (for information) :



x - CST at 40°C
y - CST at 100°C
A - ISO (VG)
B - SAE J306c Transmissions
C - SAE J300d motors

Few examples of mineral oil:

	viscosity ISO	viscosity (cSt ; 40°C)	Type
ARAL	VG 32 VG 46 VG 68	32 46 68	Vitam GF 32 Degol CL46 Degol CL 68
BP	VG 32 VG 46 VG 68	31,5 46 68	Energol CS 32 Energol CS 46 Energol CS 68
CHEVRON	VG 32 VG 46 VG 68	30,1 43,8 61,9	Mechanism LPS 32 Mechanism LPS 46 Mechanism LPS 68
ESSO	VG 32 VG 46 VG 68	30 43 64	TERESSO 32 TERESSO 46 TERESSO 68
MOBIL	VG 32 VG 46 VG 68	30 43 64	D.T.E. Oil Light D.T.E. Oil Medium D.T.E. Oil Heavy Medium
SHELL	VG 32 VG 46 VG 68	32 46 68	Tellus Oil 32 Tellus Oil 46 Tellus Oil 68

The only synthetic lubricant allowed are those one issued from the following list

	viscosité (cSt ; 40°C)	Type
KLUBER	32 44 62 81	Summit SH 32 Summit SH 46 Summit SH 68 Summit SH 100
MOBIL	31 65	SHC 624 SHC 626
SHELL	32 48 68	Madrella Oil AS 32 Madrella Oil AS 46 Madrella Oil AS 68

f) Oil sump capacity (liters)

Bearing EFxxx	14	18	22	28
Volume (l)	8	13	21	34

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ALTERNATORS		

g) Sealing Compound

Mineral oil.

On split surfaces it is possible to use following compounds (never dry):

Loctite 128068

"Hylomar M ; Marton-Domsel"

"Universal-Dichtmasse 200 PU ; Reinze-Dichtungs-gmbh"

On split surfaces only (do not use on floating labyrinth seals) it is possible to use following compounds :

Terostat-9140 ; Teroson

Blue silicone RTV n°6 ; Loctite

Blue RTV 6B ; Permatex

Hi-Temp RTV FAG 26B ; Permatex

NOTE:

We do not recommend the use of sealing compound onto the floating labyrinth seals.

However for certain leakage type , the use of "Curyl T" may help to solve the encountered issue.

CAUTION

COMPOUND WITH SILICONE BASE CAN POLLUTE THE SYNTHETIC OIL BATH. THE USE OF SILICONE BASE COMPOUND CAN BE DONE ONLY AFTER CHECKING COMPATIBILITY WITH OIL MANUFACTURER.

2.4.6 Dismantling

a) Tools and equipment

The following tools and equipment are necessary:

- Allan key set
- Wrenching key set
- Open-jaw spanner set
- Feeler gauges (up 0.05mm)
- Caliper gauge
- Emery paper, Sleeve scraper
- Lifting equipment
- Permanent sealing compound (refer to chapter 2.4.5)
- Clean cloth
- Oil with the viscosity indicated (see bearing type plate)
- Detergents
- Liquid screw locking compound (e.g. LOCTITE 242)
- Liquid sealing compound and Teflon tape.

DANGER

BEFORE TRANSPORTING OR LIFTING CHECK IF THE EYE BOLTS ARE TIGHT! INSECURE EYE BOLTS COULD RESULT IN THE BEARING BECOMING LOOSE. BEFORE MOVING THE BEARING BY THE EYE BOLTS MAKE SURE THAT THE SPLIT LINE SCREWS ARE TIGHTENED, OTHERWISE THE BOTTOM HALF OF THE BEARING COULD BECOME DETACHED. MAKE SURE THAT THE EYE BOLTS ARE NOT EXPOSED TO BENDING STRESS, OTHERWISE THE BOLTS COULD BREAK.

Follow exactly the instructions for the use of the lifting equipment.

NOTE:

Make sure that the work place is clean. Contamination and damage to the bearing, especially of the running surfaces, have a negative influence on the operating quality and could lead to premature damage.

Shut down the installation and ensure that any unintended operation is prevented.

Interrupt the cooling water supply (EFW.. bearing only).

Remove all thermo sensors from the connection holes.

Take all necessary measures to collect the lubricating oil.

Unscrew the oil drain plug (27) and collect the lubricating oil (refer to chapter 2.4.5.c)

b) Lifting equipment

The following steps are to be observed before using the lifting equipment:

To transport the complete bearing unit

Check if the split line screws are tight (12):

Check if the eye bolts are tight (6).

Connect the lifting equipment to the eye bolts (6).

ALTERNATORS

To transport the top half of the housing

Check if the eye bolts are tight (6).

Connect the lifting equipment to the eye bolts (6).

To transport the bottom half of the housing

Screw 2 eye bolts (6) with suitable threads tight into the tap holes (17) marked with a cross.

Bearing size	14	18	22	28
Tap hole	M 16	M 20	M 24	M 30

Connect the lifting equipment to the eye bolts (6).

To transport the Bearing shells

Screw 2 eye bolts or screw hooks with suitable threads tight into the tap holes (9):

Bearing size	14	18	22	28
Tap hole	M 8	M 12	M 12	M 16

Connect the lifting equipment to the screw hooks.

c) Dismantling of the shaft seal type 10 (outboard side)

Loosen all screws (55) and turn them off.

Remove simultaneously in axial direction both top half (48) and bottom half (51) of the seal carrier from the housing.

Shift the top half of the seal (53) a little (about 20 mm). Tilt it over carefully until the hook spring (49) unbends.

DANGER:

DURING DISMANTLING OF THE FLOATING LABYRINTH SEAL HOLD TIGHT THE HOOK SPRING (38). THIS IS UNDER TENSION AND COULD SPRING BACK AND LEAD TO INJURY.

Open the hook spring (49) and remove the bottom half of the seal (52) from the shaft.

d) Dismantling of the shaft seal type 20 (outboard side)

Untight all seals fixing screw (49) and remove them.

Simultaneously remove in axial direction both top and bottom (48), (52) halves of the rigid labyrinth seal.

- Remove the split line screws (50).
- Separate the top half of the rigid labyrinth seal (59) from the bottom half (63).

e) Dismantling of the top half of the housing

Remove the flange screws (8).

Remove the split line screws (12).

Lift the top part of the housing (1) until the top part of the housing can be moved in axial line over the bearing shell, without touching it.

f) Removal of the top half of the shell

Unscrew the split line screws (19) and lift the top half of the shell (11).

CAUTION:

DO NOT DAMAGE THE THRUST AND RADIAL RUNNING SURFACES.

g) Dismantling of the loose oil ring

Open both split lines of the loose oil ring (44) by untightening and removing the screws (47). Separate both halves of the loose oil ring (44) carefully without using any tools or other devices.

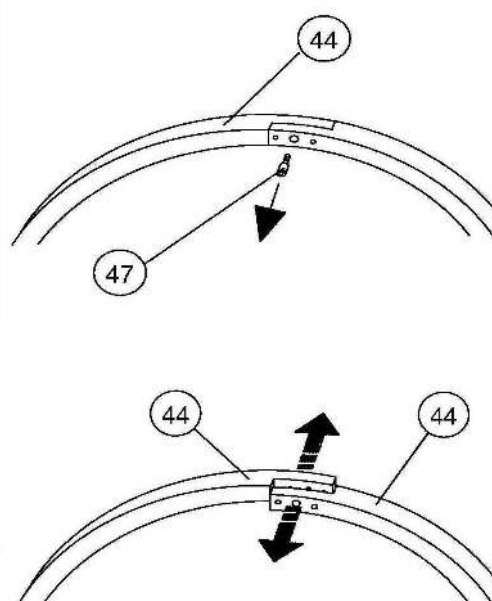


Illustration 1 : Opening of the loose oil ring

To check the geometry of the loose oil ring put it together as follows:

Press the positioning pin (45) into the holes (46).

Adjust both halves of the loose oil ring till the split lines match each other.

Tighten the screws (47).

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ALTERNATORS		

h) Dismantling the machine side shaft seal

Shift the top half of the seal (53) a little (about 20 mm). Tilt it over carefully until the hook spring (49) unbends.

DANGER:

DURING DISMANTLING OF THE FLOATING LABYRINTH SEAL HOLD TIGHT THE HOOK SPRING (38). THIS IS UNDER TENSION AND COULD SPRING BACK AND LEAD TO INJURY.

Open the hook spring (49) and turn the bottom half of the seal (52) in the opposite direction to the anti-rotation pin out of the integrated seal groove of the bottom half of the housing.

i) Removal of the bottom half of the shell

CAUTION:

MAKE SURE THAT ALL BEARINGS MOUNTED ON A SHAFT LINE ARE OPENED. LOOSEN THE SPLIT LINE SCREWS OF THE HOUSINGS.

CAUTION:

THE LIFTING EQUIPMENT SHOULD NOT COME IN TOUCH WITH THE SEAL AND RUNNING SURFACES OF THE SHAFT.

Lift the shaft up to the point where shaft and bottom half of the shell (13) do not touch each other any more. Protect the shaft against unintended movement.

Turn the bottom half of the shell (13) out of the bottom half of the housing (21) and remove it from the shaft.

j) Dismantling of the machine seal

Usually it is not necessary to dismantle the machine seal (10) if maintenance works are carried out.

If due to certain reasons the split machine seal must be dismantled please observe that this operation can be carried out only from the inner part of the machine. Loosen the split line screws of the machine seal and remove the flange screws (7).

Non-split machine seals can be dismantled only after dismantling the machine shield or the shaft completely.

In the case the machine seal is equipped with a hamp packing, some visible changes can be noticed, such as : tallow excess, black color of the seal due to temperature development. Even in such cases it is not necessary to renew the hamp packing. Color changes will appear with a new hamp packing too, until the seal clearance adjusts during operation.

2.4.7 Cleaning and checking

a) Cleaning

CAUTION:

USE ONLY NON-AGGRESSIVE DETERGENTS SUCH AS FOR INSTANCE

- VALVOLINE 150
- ALKALINE CLEANING COMPOUNDS (PH-VALUE 6 TO 9, SHORT REACTION TIME).

DANGER:

PLEASE OBSERVE THE INSTRUCTIONS FOR THE USE OF THE DETERGENTS.

CAUTION:

NEVER USE CLEANING WOOL OR CLOTH. RESIDUES OF SUCH MATERIALS LEFT IN THE BEARING COULD LEAD TO EXCESSIVE TEMPERATURES.

Clean the following parts thoroughly :

- top half of the housing (1)
- bottom half of the housing (21)
- top half of the shell (11)
- bottom half of the shell (13)
- sealing surfaces of the top half (48) and bottom half (51) of the seal carrier or of the rigid labyrinth seal
- loose oil ring (44).

Water cooler cleaning (bearing type EFW.. only)

Check the condition of the oil cooler (26).

In case the oil cooler (26) is encrusted with oil sludge:

Dismantle the oil cooler. Remove the encrustation by using for instance a wire brush.

Install the oil cooler (26) into the bearing.

ALTERNATORS

b) Wear checking

Carry out a visual check of the wear condition of all bearing parts. The following graph provides information on the parts that must be replaced in case of wear. The right evaluation of the wear condition, especially of the running surfaces of the bearing shell, implies a lot of experience. If in doubt, replace the worn part with new ones.

Part	Wear condition	Maintenance proceedings
Shell	Scoring	Bearing temperature before inspection: · not increased no new shells · increased new shells
	White metal lining damaged	New shell
	Bow wave ridges	New shells
Shaft seal	Baffles broken or damaged	New shaft seal
Loose oil ring	Geometrical form (roundness, flatness) visibly changed	New loose oil ring

c) Insulation checking (only for insulated bearing)

Check the insulating layer of the spherical seating (14) of the top half (1) and bottom half (21) of the housing. In case of damage contact Leroy Somer; département ACEO factory.

2.4.8 Assembly of the Bearing

CAUTION:

REMOVE ALL IMPURITIES OR OTHER OBJECTS SUCH AS SCREWS, NUTS, ETC. FROM INSIDE THE BEARING. IF LEFT INSIDE THEY COULD LEAD TO DAMAGE OF THE BEARING. COVER UP THE OPENED BEARING DURING BREAKS.

CAUTION:

CARRY OUT ALL ASSEMBLY OPERATIONS WITHOUT MAKING USE OF FORCE.

CAUTION:

USE A LIQUID SCREW LOCKING COMPOUND (E.G. LOCTITE 242) FOR ALL HOUSING, SPLIT LINE AND FLANGE SCREWS.

a) Fitting in the bottom half of the shell

Apply some lubricant on the spherical seating (14) in the bottom half of the housing (21) and on the running surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).

Place the bottom half of the shell (13) on the running surface of the shaft. Turn the bottom half of the shell (13) into the bottom half of the housing (21) with the split line surfaces of both halves in true alignment.

In case the bottom half of the shell does not turn in easily, check the position of the shaft and the alignment of the bearing housing

CAUTION:

(ONLY FOR BEARINGS EF..K)

THESE OPERATIONS SHOULD BE CARRIED OUT MOST CAREFULLY. THE THRUST PARTS OF THE BOTTOM SHELL SHOULD NOT BE DAMAGED.

Lower down the shaft till it sits on the bottom half of the shell (13).

b) Assembly of the shaft seal machine-side

The machine-side shaft seal is standard-wise a floating labyrinth seal. The integrated seal groove is in the top and bottom halves of the housing.

DANGER:

DURING ASSEMBLY HOLD THE HOOK SPRING ENDS SECURELY TO AVOID THEM SUDDENLY RELEASING AND CAUSING POSSIBLE INJURY!

Check the movement of the floating labyrinth seal on the shaft in the seal area outside the housing:

Put the hook spring (49) around the shaft and hook both ends into each other.

Put both halves of the seal (52), (53) in their place on the shaft.

Put the hook spring (49) into the spring groove (50).

Turn the floating labyrinth seal on the shaft.

ALTERNATORS

CAUTION:

THE FLOATING LABYRINTH SEAL SHOULD TURN EASILY ON THE SHAFT. A JAMMED SEAL COULD LEAD TO OVERHEATING DURING OPERATION AND EVEN TO SHAFT WEAR.

If the floating labyrinth seal jams, dismantle it from the shaft. Remove the worn parts of the seal carefully, by using emery paper or a Sleeve scraper.

Dismantle the floating labyrinth seal.

NOTE:

We do not recommend the use of sealing compound onto the floating labyrinth seals. However for certain leakage type , the use of "Curyl T" may help to solve the encountered issue.

Apply sealing compound on the guide surfaces of the integrated seal groove in the bottom half of the housing.

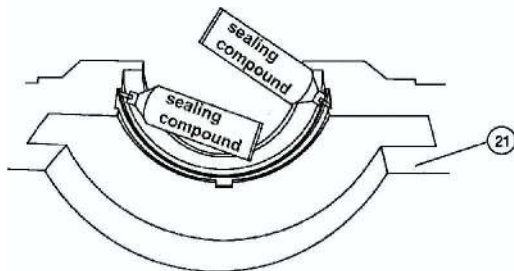


Illustration 2: Coating of sealing compound on the integrated seal groove

Apply a uniform layer of sealing compound on the seal surfaces and on the split line surfaces of both halves of the seal (52), (53).

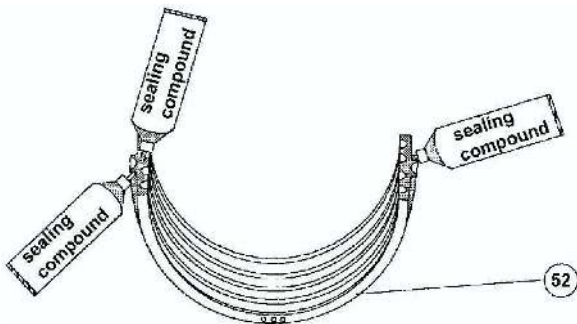


Illustration 3 : Coating of sealing compound on the floating labyrinth seal

Place the bottom half of the seal (52) with the labyrinths onto the shaft.

The oil return holes at the bearing side must be opened.

Turn the seal in the opposite direction to the anti-rotation pin into the groove of the housing until the split lines of the bottom half of the housing and the bottom half of the seal match each other.

Remove the rest of the sealing compound.

Push the spring hook into the integrated seal groove between the bottom half of the housing and the seal until both ends jut out from the split line.

Place the top half of the seal with the cam facing the inside of the bearing on the bottom half of the seal.

Stretch the hook spring until both ends can be hooked.

c) Installation of the loose oil ring

Open both split lines of the loose oil ring (44) by untightening and removing the screws (47). Separate both halves of the loose oil ring (44) carefully without using any tools or other devices.

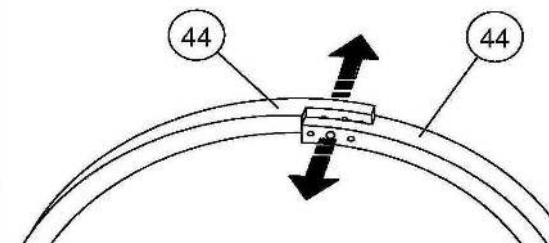
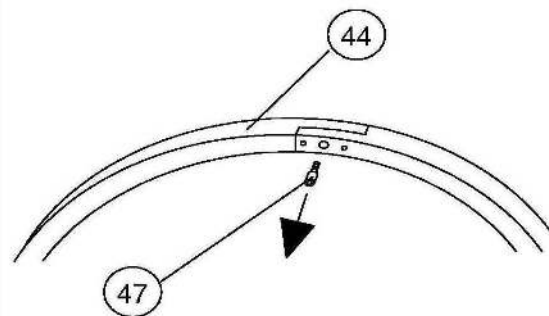


Illustration 4 : Opening of the loose oil ring

Place both halves of the loose oil ring into the shell groove (13) encircling the shaft. Press the positioning pin (45) of each split line into the corresponding hole (46).

ALTERNATORS

Adjust both halves of the loose oil ring until the split lines match each other.

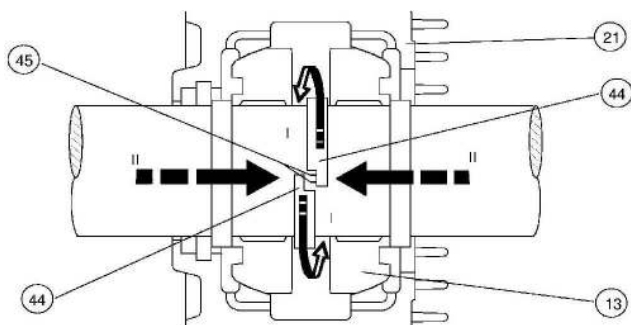


Illustration 5 : Installation of the loose oil ring

Tighten the screws (47) by using the following torque values:

Bearing size	14	18	22	28
Torque [Nm]	1,4	2,7	2,7	2,7

d) Fitting in the top half of the shell

Apply some lubricant on the running surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).

Check if the engraved numbers (15) on the bottom and top halves of the shell correspond.

Place the top half of the shell (11) on the shaft; both engraved numbers (15) should be on the same side.

CAUTION :

AN INCORRECTLY PLACED SHELL COULD JAM THE SHAFT THUS LEADING TO THE DAMAGE OF BOTH SHAFT AND BEARING.

CAUTION : (FOR BEARINGS TYPE EF..K ONLY)

PLACE THE TOP HALF OF THE SHELL CAREFULLY ON THE SHAFT. THE THRUST PARTS OF THE TOP HALF OF THE SHELL SHOULD NOT BE DAMAGED.

Tighten up the split line screws (19) by using the following torque values:

Bearing size	14	18	22	28
Torque [Nm]	20	69	69	170

Check the split line of the bearing shell by using a feeler gauge. The split line gap should be less than 0.05 mm. If the split line is greater than this, dismantle both top and bottom (11), (13) halves of the shell.

Check the mobility of the loose oil ring (44).

Marine bearing only:

A guide bush in the top half of the shell secures the function of the loose oil ring.

Check the mobility of the loose oil ring (44) in the guide bush.

e) Closing of the bearing

Check the true alignment of the shell (11), (13) and bottom half (21) of the housing.

The positioning pin (3) in the top half of the housing fits in the corresponding positioning pin hole (2). The bearing shell is thus placed into its right position.

Check if the engraved numbers (20) on the top and bottom halves of the housing correspond.

Clean the split line surfaces of the top and bottom halves (1), (21) of the housing.

Apply sealing compound over the whole surface of the split line of the bottom half (21) of the housing.

Place the top half of the housing carefully into the machine shield, without touching the seals or the bearing shell.

Lower the top half of the housing (1) vertically on the bottom half of the housing (21). Lower the top half of the housing (1) until the split line of the housing is not visible any more.

Gently hit the bottom half of the housing (21) with a nylon hammer, thus ensuring the alignment of the spherical seating.

Insert the split line screws (12). Tighten them hand-tight.

Insert the flange screws (8). Tighten them using the following torque values:

Bearing size	14	18	22	28
Torque [Nm]	170	330	570	1150

Tighten the split line screws (12) of the housing crosswise using the same torque values

f) Assembly of the type 10 Outboard Side Seals

DANGER:

DURING ASSEMBLY HOLD THE HOOK SPRING ENDS (49) SECURELY TO AVOID THEM SUDDENLY RELEASING AND CAUSING POSSIBLE INJURY!

Check the movement of the floating labyrinth seal on the shaft in the seal area outside the housing.

Place the hook spring (49) around the shaft and hook both ends into each other.

Locate both halves of the seal (52), (53) in their place on the shaft.

Locate the hook spring (49) in the spring groove (50).

Turn the floating labyrinth seal on the shaft.

CAUTION:

THE FLOATING LABYRINTH SEAL SHOULD TURN EASILY ON THE SHAFT. A JAMMED SEAL COULD LEAD TO OVERHEATING DURING OPERATION AND EVEN TO SHAFT WEAR.

If the floating labyrinth seal jams, dismantle it from the shaft. Remove the worn parts of the seal carefully, by using emery paper or a Sleeve scraper.

Dismantle the floating labyrinth seal.

NOTE:

We do not recommend the use of sealing compound onto the floating labyrinth seals.

However for certain leakage type, the use of "Curyl T" may help to solve the encountered issue.

Apply a uniform layer of sealing compound on the seal surfaces and on the split line surfaces of both halves of the seal (52), (53).

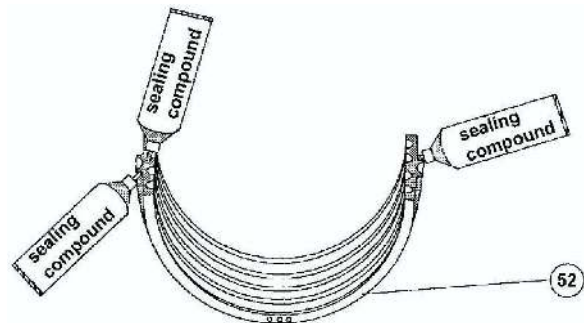


Illustration 6 : Application of sealing compound on the floating labyrinth seal

Press the bottom half of the seal (52) against the shaft. Place the top half of the seal (53) on the shaft and align both halves of the seal to each other.

Place the hook spring (49) into the spring groove (50) and stretch until both ends can be hooked.

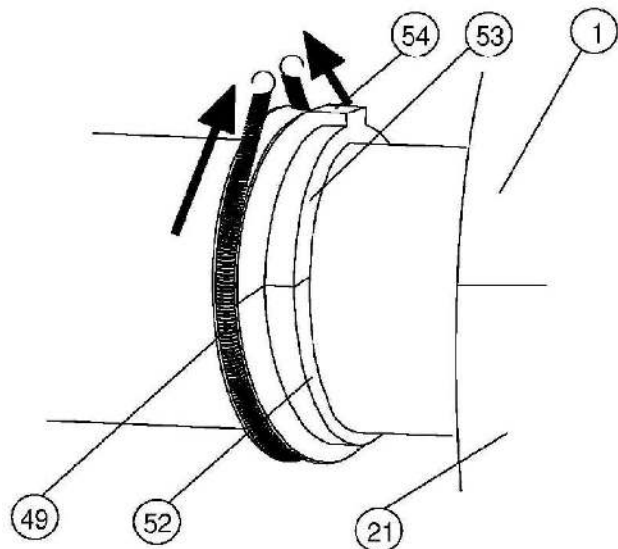


Illustration 7 : Assembly of the floating labyrinth seal

Align the split line of the floating labyrinth seal and the split line of the seal carrier.

Check that both engraved numbers (56) and (58) on top and bottom halves of the seal carrier (48), (51) correspond.

Clean the following:

the seal surfaces of the top (48) and bottom (51) half of the seal parts: carrier (the groove of the floating labyrinth seal, the flange surfaces)

the split line surfaces of the top (48) and bottom (51) half of the carrier

the flange surfaces of the housing.

ALTERNATORS

Apply a uniform layer of sealing compound on:
the lateral surfaces of the groove at the top (48) and
bottom (51) half of the seal carrier
the flange surfaces of the top (48) and bottom (51) half of
the seal carrier
the split line surfaces of the bottom half of the seal carrier
(51).

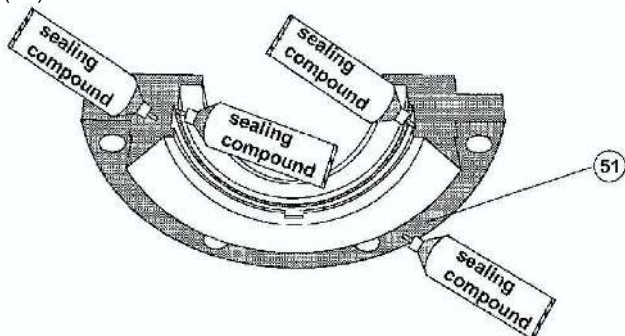


Illustration 8 : Application of sealing compound on the seal carrier

Place the top half of the seal carrier (48) on the top half of
the seal (53). Press the bottom half (51) of the seal carrier
against it. Push the shaft seal completely into the housing.

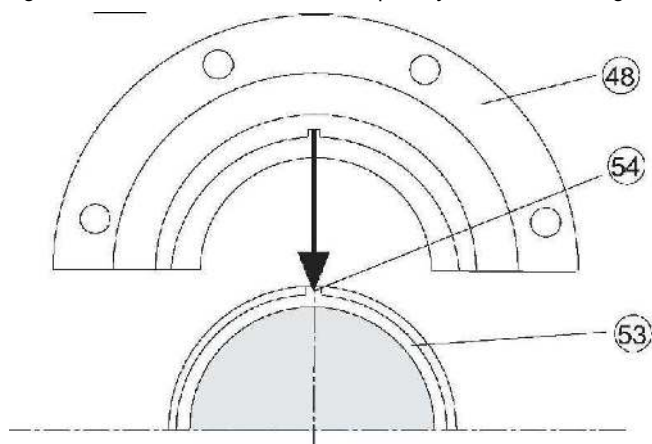


Illustration 9 : Assembly of the seal carrier

Align the split lines of the seal carrier and the housing.

Tighten up the screws (55) by using the torque values:

Bearing size	14	18	22	28
Torque [Nm]	8	20	20	20

g) Assembly of the type 20 Outboard Side Seals

Check if the engraved numbers on the bottom half (63) and top half (59) of the rigid labyrinth seal correspond.

Clean the flange surfaces of
the top half and bottom half (63) of the rigid labyrinth seal
the split line surfaces of the top half and bottom half (63) of
the rigid labyrinth seal
the flange surfaces of the housing.

Apply a uniform layer of sealing compound on the following
parts:

the flange surfaces of the top (59) and bottom half (63) of
the rigid labyrinth seal
the split lines of the bottom half (63) of the rigid labyrinth
seal.

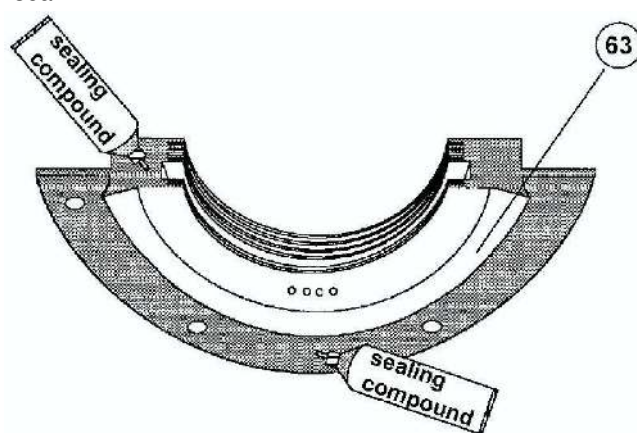


Illustration 10: Application of sealing compound on the rigid labyrinth seal

Place the top half (59) of the rigid labyrinth seal on the shaft and press slightly the bottom half (63) of the rigid labyrinth seal from below against it. Lightly push the rigid labyrinth seal completely into the housing.

Tighten the split line screws (61).

Place in parallel alignment the split line of the rigid labyrinth seal and the split line of the housing.

CAUTION:
PRESS THE RIGID LABYRINTH SEAL FROM BELOW AGAINST THE SHAFT

Adjust the rigid labyrinth seal in such a way that the clearance "f" between the shaft and the rigid labyrinth seal at both split lines has the same figure.

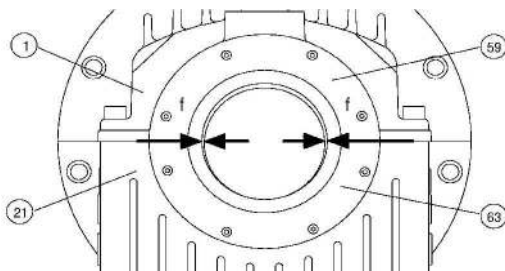


Illustration 11: Alignment of the rigid labyrinth seal

Tighten the screws (60) by using the following torque values:

Bearing size	14	18	22	28
Torque [N.m]	8	20	20	20

h) Assembly of the RD-thrust pads ; bearing type E...A

Clean both top and bottom halves of the shroud ring and all RD-thrust pads..

Check if the parts show any visible damage.

Carry out the assembly of both thrust parts of the top (6) and bottom (27) half of the shell according to the following instructions:

An RD-thrust pad on both sides of the top half of the shell has a bore for the insertion of a thermo sensor (thrust part temperature measurement).

To mount the RD-thrust pad into the correct position proceed as follows:

- Find the position of the location hole (38) on the top half of the shroud ring (39). Insert the RD-thrust pad (42) with the anti-rotation pin (43) into the corresponding thrust pad location hole (37).

Insert all other RD-thrust pads (42) into the corresponding thrust pad holes (37) of the top and bottom half of the shell (6),(27).

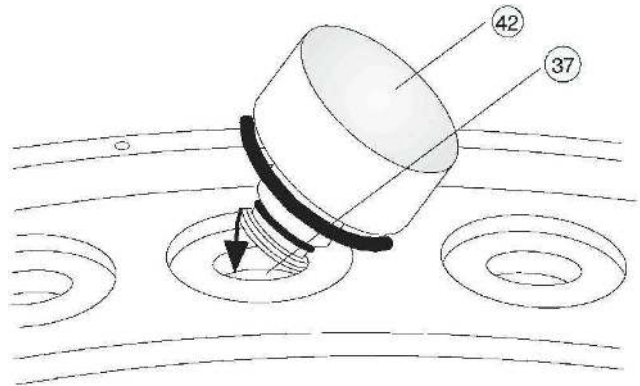


Illustration 1: Assembly of the RD-thrust pads

Place the top half of the shroud ring (39) into the top half of the shell (6) by inserting the anti-rotation pin (43) into the location hole (38). Match the split line of the top half of the shell (6) with the split line of the top half of the shroud ring (39) in true alignment.

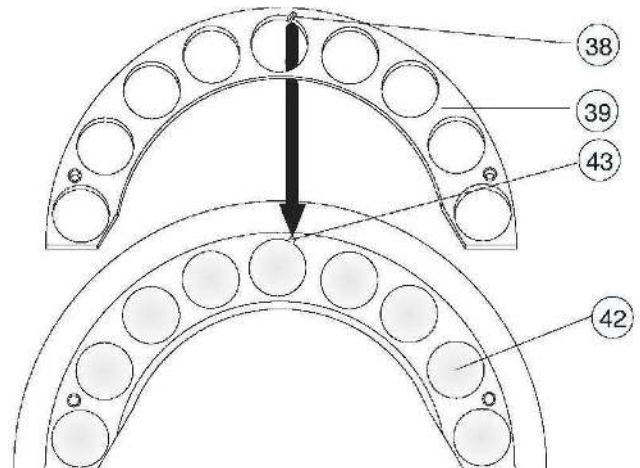


Illustration 2: Assembly of the shroud ring

Tighten the screws (40) by using the following torque values:

Bearing size	14	18	22	28
Tap hole	M5	M6	M8	M10
Torque [N.m]	2,7	8	20	40

Place the bottom half of the shroud ring (41) into the bottom half of the shell (27). Match the corresponding split lines in true alignment. Tighten the screws (40) with the same torque value as valid for the top half of the shell (6).

Check the mobility of all RD-thrust pads (42). If the RD-thrust pads jam, realign the top (39) and bottom half (41) of the shroud ring.

CAUTION
INSUFFICIENT MOBILITY OF THE RD-THRUST PADS WILL CAUSE DAMAGE OF THE BEARING.

Both top and bottom halves of the shells are prepared for assembly.

ALTERNATORS

2.4.9 Oil-leakage trouble-shooting

A bearing loss more than 4 drops of oil per day can be considered as a leakage

Below this quantity this phenomenon is named oozing and is inherent to sleeve bearing technology. An oil oozing need a periodic cleaning done by the end user without necessary corrective action

Oil leakage can occur in the Sleeve bearings if certain measures are not taken.

a) Self-lubricating bearing

- Is the oil level correct? (see chapter 2.4.5.a)

- Is the Sleeve bearing in decompression? (see chapter 2.4.5.d). If the depression level is abnormal, add a protective screen.

- Is the leakage occurring around the parting line? Clean the parting lines carefully with a solvent. Apply a sealing compound (refer to chapter 2.4.5) upon reassembly (see chapter 2.4.6)

b) Oil circulation bearing

- All information and instructions concerning the "self-lubricating bearings" apply.

- Is the bearing oil flow correct (for data refer to section 1)? To adjust the oil flow refer to chapter 2.4.4

-Is the Sleeve bearing under pressure?

To measure refer to chapter 2.4.5 . This pressure most certainly comes from the oil-return circuit. Check the oil-return circuit (refer to chapter 2.4.3). The back-pressure can often be eliminated by inserting a siphon-effect on the oil-return line (then make sure that the circuit modification does not disturb the oil-return flow).

2.4.10 Sleeve bearing protection devices

a) Sight-level glass

A sight-level gauge is placed on each bearing housing (on the left or the right). The level control method is described in chapter 2.4.5 a

b) Oil thermometer (optional)

The thermometer gives the oil sump temperature.

The recorded oil sump temperature must stay below 85°C in normal condition.

c) Thermostat or sensor (optional)

The recorded oil sump temperature must stay below 85°C in normal condition.

The shell temperature must stay below 90°C in normal condition.

Shell metal ; Alarm points and shutdown:

- alarm 95°C (203°F)
- shutdown 100°C (212°F)

Oil sump ; Alarm points and shutdown:

- alarm 85°C (185°F)
- shutdown 90°C (194°F)

To improve the bearing protection the temperature set points can be reduced following the effective site condition

Alarm temperature (*) = Highest recorded temp + 5°K

Trip temperature (*) = Alarm temperature + 5 °K

(*)Highest recorded temp: Temperature measured at the site in the worst temperature

Eg: A bearing reach 80°C in the worst site condition

Adjust the alarm set point to 85°C instead of 95°C as previously recommended.

Adjust the trip set point to 90°C instead of 100°C as previously recommended.

d) Pre lub pump (optional)

A pump takes up the oil from the bearing oil sump and pours it over the bearing shell.

This pump ensures bearing lubrication, increasing the greasing effect during operation at very low speed and start up period

Check the electrical connection of the pump motor to be sure of the rotation direction (the rotation direction is indicated on the pump).

The pump has to be run few seconds before the synchronous machine starting (pre lub effect) and stopped as soon as the main shaft line pass over 200 rpm

For application having a long stop period (time over 5 minutes; eg: Steam Turbine, hydro turbine) the pump has to be run as soon as the speed pass below 200 rpm

The pump has to be run continuously during barring period (eg: engine maintenance)

e) Oil filtering and pollution

Following indication are related to the maximum acceptable oil pollution level and to the oil filtering level (filter efficiency) which has to be installed to obtain a clean oil

Refer to Section 1 to get data about the used bearing

The viscosity change must remains within +/- 10% of a fresh oil lubricant

Acidity change must remains (TAN) +/- 0.5 mg KOH/g of a fresh oil lubricant

Humidity ratio must remains below 0.05 %

This paragraph applies to bearings designed for high axial thrust (tilting pads technology as used in bearings typeA).

Maximum acceptable pollution:

following ISO 4406 : 17/15/12

following NAS 1638 classe 7

Filtering level to ensure :

following ISO 16889 : $\beta_{10(c)} = 100$ (filtering 10 μ)

This paragraph applies to standard bearings with low axial thrust , self lub or oil circulation (as types E..Z.K ; E..Z.Q).

Maximum acceptable pollution:

following ISO 4406 : 18/16/13

following NAS 1638 class 9

Filtering level to ensure (oil circulation bearing):

following ISO 16889 : $\beta_{25(c)} = 100$ (filtering 25 μ)

2.6 OIL CIRCULATION LUBRICATING UNIT

2.6.0 General points

Oil circulating bearing are noticeable by the third digit of their code. Letters "Z" ; "X" ; "U" indicate the use of an oil circulating bearing

Example of oil circulating bearing :

EFZLK ; ERXLA

For engineering reason (need of cooling, need of lubrication) an external oil supply can be requested.

Following the machine engineering the lubricating oil can come from different sources :

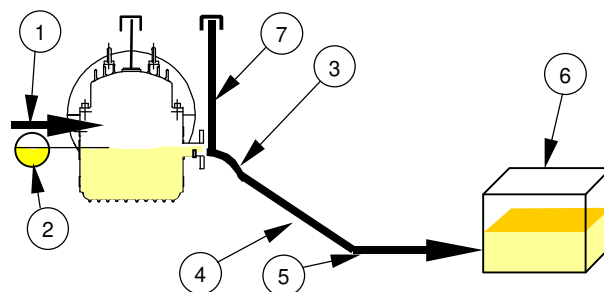
- Oil from the drive engine (System with gravity return)
- Oil lubricating unit (System with gravity return)
- Unit heater

2.6.1 Oil circulation by gravity return

a) General

This chapter applies for bearings, which need an oil circulation system

The operating condition (sequences of operation, maintenance ...) are given by a specific notice attached to the present one.



- 1 – Oil inlet
- 2 – Oil sight level indicator
- 3 – Exhaust elbow
- 4 – Immediate slope
- 5 – Following ducts
- 6 – Return oil sump
- 7 - Breather

Correct oil flow is obtained by regulating the pressure at the bearing inlet. (item 1)

ALTERNATORS

b) Supply line

To avoid excessive difficulties of cleaning, and to allow an easy ducting, it is necessary to use pipes requested for hydraulic duty

After installation of the oil lines, rinse the entire oil circuit in order to avoid dirt or impurities entering inside the bearing and its connections. Rinse with washing oil. It is important to remove the instrumentation (for example, pressure gauge, flow-meter ...) during the rinsing operation to avoid any pollution.

NOTE:

Never leave the Sleeve bearing on the rinsing circuit, as insoluble particles could enter the bearing and damage it.

The oil circulating bearings are equipped with an oil inlet pressure regulating system (item 1)

The delivered oil pressure has to be reduced by the bearing system before entering the bearing to get the correct oil flow, refer to chapter 2.4.4 for start up).

A filtering unit must be installed on the supply system. Refer to chapter 2.4.10.

c) gravity oil return

CAUTION:

REMEMBER THAT THE OIL EXHAUSTED FROM THE BEARING GOES BACK TO THE TANK ONLY BY GRAVITY EFFECT

CAUTION:

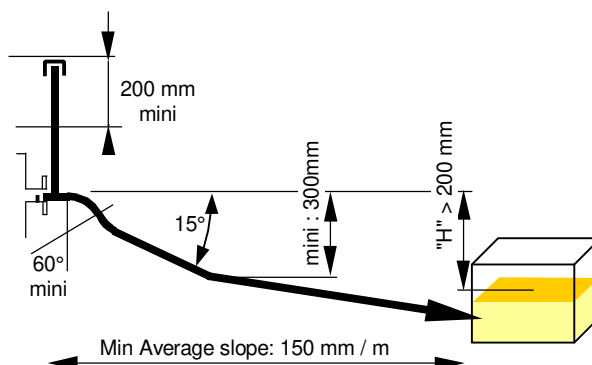
NOT TO FOLLOW THESE RULES MAY CAUSE HEAVY LEAKS BY BEARING SUMP OVERFLOW.

CAUTION:

ADVISES AND REQUEST DONE IN THIS CHAPTER DO NOT ALLOW THE INSTALLATOR TO COMPLETE BY ITS OWN CALCULATIONS NEEDED FOR A CORRECT OPERATION OF ITS SYSTEM.

Some bearing may have two exhaust. In this case the both exhaust lies must be connected

Because of the requested engineering rules the return ducts frequently have big size. Their manufacturing is frequently done by welding. It will be necessary to clean the welds and to rinse the oil lines before use.



Install a breather as close as possible of the bearing output. The breather should be to a minimum of 200 mm above the highest point of the bearing.

The breather line should be linked to the top side of the main oil line

It is imperative to quickly go down after the bearing output: Install an elbow (minimum 60°) immediately after the bearing exhaust.(item 3)

Pipe with a Minimum slope of 15°(so: a difference of 25 cm for 100cm long) minimum 300 mm high

The difference of level between return oil sump and bearing exhaust must be strictly higher than "H"=200 mm

The average slope of the return line must be strictly higher than 15 cm per meter of ground line. The average slope is based on the difference of level between bearing exhaust and return sump oil level.

The oil return line must not be exposed to counter current air flow (air which should go from the oil return sump and go toward the bearing).

Eg: a return line which should exhaust above the oil level inside an engine oil sump should receive a crankcase back pressure which should have a real negative effect.

NOTE : The requested oil flow is indicated in section 1

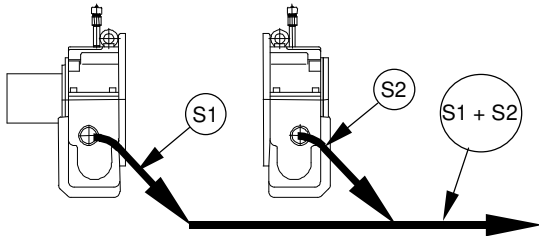
Oil return line size :

Flange	Thread	Ø inter (mm)	Oil flow ; max (l/min)	
			ISO VG 32 ISO VG46	ISO VG 68 ISO VG100
DIN DN32	G 1 1/4"	33	7,5	5,5
DIN DN40	G 1 1/2"	40	11	9
DIN DN50	G 2"	50	17	16
DIN DN65	G 2 1/2"	66	30	25
DIN DN80	G 3"	80	45	40

ALTERNATORS

Connection in "Y" shape:

It is acceptable to join the return lines of two bearings. In this case it is necessary to maintain a constant oil speed (Pipe section after = sum of the both pipes section)



2.6.2 Oil cooling unit Air/Oil exchanger

This system does not apply to high thrust capability bearings (bearings noticeable by the fifth digit of their code). Example : cannot be used for a bearing EFZLA

The "cooling unit" is a compact system totally fitted on the machine, close to the bearing

The oil is pumped from the bearing sump, passes through an Air to Oil cooler, and is then routed back to the bearing shell. A fan ensure the cooling of the unit using the ambient air

The oil circulates under low pressure

The oil flow is fixed at the factory without any possible adjustment.

The pump and the fan must run permanently as long as the synchronous machine will rotate

No specific maintenance is required (except vibration dampers)

CAUTION:

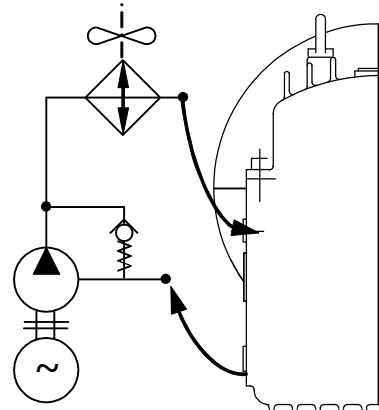
IN CASE THE SYSTEM INSTALLED WITH VIBRATION DAMPERS, THE DAMPERS MUST BE PERIODICALLY CHECKED AND CHANGED EACH FIVE YEARS.

In case of failure of the "cooling unit" the synchronous machine :

Remains able to operate safely during a certain time (few minutes)

The machine can be started without the cooling system

In such event, the bearing temperature will slowly increase permitting the bearing temperature sensors to detect overheating, trigger the alarm and protect the bearing by stopping the machine



ALTERNATORS

2.6.3 Oil cooling unit Water/Oil exchanger

This system does not apply to high thrust capability bearings (bearings noticeable by the fifth digit of their code). Example : cannot be used for a bearing EFZLA

The "cooling unit" is a compact system totally fitted on the machine, close to the bearing

The oil is pumped from the bearing sump, passes through an Water to Oil cooler, and is then routed back to the bearing shell. The water flow is ensured by the electrical machine

The oil circulates under low pressure

The oil flow is fixed at the factory without any possible adjustment.

The pump must run permanently as long as the synchronous machine will rotate. The Water flow must be ensured as far as the pump is operating.

No specific maintenance is required (except vibration dampers)

CAUTION:

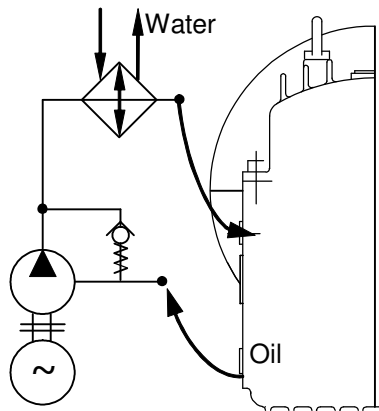
IN CASE THE SYSTEM INSTALLED WITH VIBRATION DAMPERS, THE DAMPERS MUST BE PERIODICALLY CHECKED AND CHANGED EACH FIVE YEARS.

In case of failure of the "cooling unit" the synchronous machine :

Remains able to operate safely during a certain time (few minutes)

The machine can be started without the cooling system
In such event, the bearing temperature will slowly increase permitting the bearing temperature sensors to detect overheating, trigger the alarm and protect the bearing by stopping the machine.

Water has to be filtered as per chapter 2.7.5



2.7 COOLER

2.7.0 Description of the cooler

a) 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 internal air goes through the exchanger, transferring the heat and then goes back to the machine.

CAUTION:

IN CASE THE HOUSING INSTALLED WITH VIBRATION DAMPERS, THE DAMPERS MUST BE PERIODICALLY CHECKED AND CHANGED EACH FIVE YEARS.

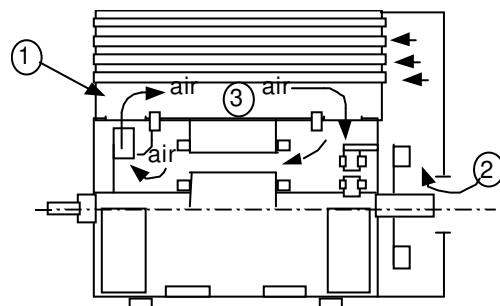
CAUTION:

THE COOLER MUST BE FULLY OPERATIONAL AS SOON AS THE MACHINE IS ROTATING (EVEN IF THE MACHINE IS RUN AT NO LOAD !)

b) Description of Air/Air coolers

The internal air flow is moved by a fan fixed on the machine shaft. The internal cooling air circulates through the machine and through the air-cooler in a closed circuit.

The External air circulation can be created through natural ventilation (machine class IC 6 A1 A1) or through separate ventilation (machine class IC 6 A1 A6).



1 - Air to Air cooler

2 - Ambient air

3 - Internal air

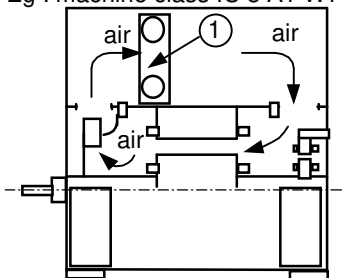
The air-cooler comprises a main housing containing the tubes and an end housing which act as an air guide

ALTERNATORS

c) Description Air/Water double tube exchanger

The internal air flow is moved by a fan fixed on the machine shaft. The internal cooling air circulates through the machine and through the air-cooler in a closed circuit. The internal air circulation can be created through natural ventilation (machine class IC 8 A1 W7) or through separate ventilation (machine class IC 8 A6 W7).

Eg : machine class IC 8 A1 W7



1 – Air to Water cooler

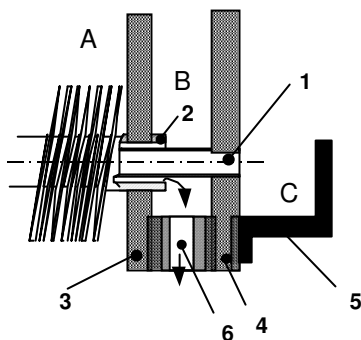
The double-tube technique keeps the cooling circuit from being affected by possible water leakage. The double tube provides a high safety level. In case of leakage, the water goes from the inside of the internal tube to the coaxial space between the two tubes. The water is drained axially to a leakage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

An exchanger comprises a fin-tube block containing :

- a steel frame.
- a fin-tube block crimped mechanically to the tubes.

The tube bundle is roll-expanded in the end plates (parts 3 and 4)

The water distribution in the tubes is provided by two removable water boxes (part 5). A water box is equipped with collars for fitting the inlet and outlet lines. Neoprene seals ensure watertightness between the water boxes and the end plates.



- 1 - Single internal tube
- 2 - External tube with internal grooving and with External fins
- 3 - Internal plate
- 4 - External plate
- 5 - Outside wall of the pressure tank
- 6 - Flow of water or liquid leaks

A - Air

B - Leakage

C - Water

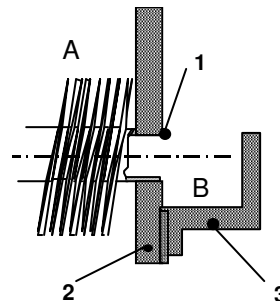
d) Description of Air/Water single tube exchanger

The internal air flow is moved by a fan fixed on the machine shaft. The internal cooling air circulates through the machine and through the air-cooler in a closed circuit. The internal air circulation can be created through natural ventilation (machine class IC 8 A1 W7) or through separate ventilation (machine class IC 8 A6 W7).

An exchanger comprises a fin-tube block containing

- a steel frame
- a fin-tube block crimped mechanically onto the tubes.
- The tube bundle is roll-expanded in the end plates

The water distribution in the tubes is provided by two water boxes. One water box is equipped with collars for fitting the inlet and outlet water lines. Neoprene seals provide watertightness between the water boxes and the end plates.



1 - Tube with fins

2 - End plate

3 - Water bar

A - Air

B - Water

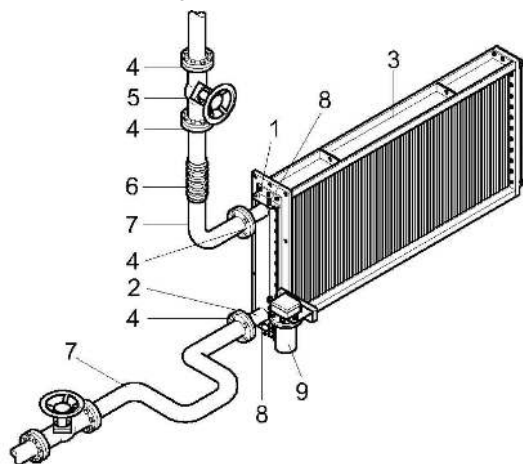
ALTERNATORS

2.7.1 Water Cooler operating condition

a) Water Cooler installation

Assembly example:

- 1 Outlet flange
- 2 Inlet flange
- 3 Water cooler
- 4 Connecting flange
- 5 Tap
- 6 Flexible junction
- 7 Pipe
- 8 Draining and de aeration
- 9 Water leakage detector



Water pipes must be connected stress free

Water pipes must be able to expand without restraint

CAUTION:

FOR MACHINE SUPPORTING A VIBRATION LEVEL HIGHER THAN 5 MM/S RMS WE RECOMMEND THE USE OF HYDRAULIC FLEXIBLE JUNCTION

A pressure limit or must be installed on the system to protect the complete assembly against abnormal over pressure

b) "Standard" operation with water

CAUTION:

WATER SUPPLY MUST BE EFFECTIVE AS SOON AS THE GENERATOR IS ROTATING UP TO THE COMPLETE SHAFT LINE STOP

CAUTION:

WATER SUPPLY MUST BE STOPPED AS SOON AS THE GENERATOR IS STOPPED TO AVOID IMPORTANT CONDENSATION INTO THE GENERATOR

c) "Emergency" operation without water

As an option the machines can be engineered to be able to operate in an "Emergency" mode without water flow. Only machines engineered for this operation case can operate without water flow.

CAUTION :

THIS OPERATING CONDITION CORRESPOND TO A POWER DERATED OPERATING MODE

In such case the machine operate in "open drip proof" mode (cooling ensured by ambient air, with a protection level IP23)

The air inlet and outlet flaps located at the non drive end and drive end side of the machine must be open (concerned openings are marked by specific labels) before running the shaft line

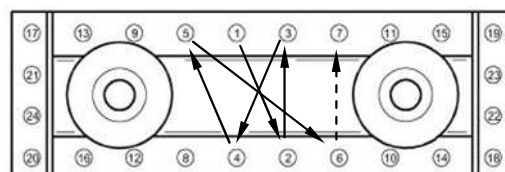
2.7.2 Start-up of the water cooler

a) General points

If the cooler has been stocked for more than 6 months, recheck the correct tightening of the water boxes. The tightening must be done in 4 steps (1st step, tightening at 1/4 of the nominal torque; 2nd step, tightening at 1/2 of the nominal torque; 3rd step, tightening at 3/4 of the nominal torque; final step; tightening at 4/4 of the nominal torque). The tightening must be done "diagonally" using a torque wrench

Bolt	M10	M12	M16	
Nominal torque [Nm]	46	79	193	

"diagonally" tightening principle :



Make sure that the safety devices are operating.

Connect the supply and return lines.

Fill with water, whilst carefully draining the circuit.

CAUTION: (machine with motorized fan only)
WE RECOMMEND THAT THE FREE OPERATION OF THE FAN BE CHECKED (NO FRICTION, NO BLOCKING).

CAUTION:

BEFORE START-UP, CHECK THE CLEANLINESS OF THE COOLER FINS.

Start up the installation (if the other sub-assemblies allow this).

Load the machine (KVA); adjust the water flow-rate to obtain the rated flow-rate (refer to Section 1).

Check the water tightness of the lines and of the exchanger.

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ALTERNATORS		

Check that the temperatures comply with the recommended temperatures.

2.7.3 Maintenance of the water-cooler

a) General points

A regular cooler clogging will have the result to a regular winding temperature increasing

The cooler cleaning period is mainly function of the water purity

In case of used of non recirculated water with risk (eg: river water with algae passing trough the cooler) we recommend a tubes visit after one year of operation. The following visit should be forecasted following the observed dust level.

b) Cleaning

Stop the machine.

Cut off the power 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 oxidation layer which has formed on the surfaces 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)

Proceed to a gasket change

c) Leak detection for a double-tube exchanger

If a leak is detected, it is necessary to ascertain its origin immediately 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 salt-water resistant aluminum bronze or of a synthetic material.

2.7.4 Servicing the water-cooler

a) 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.

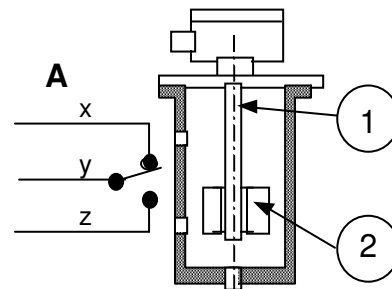
b) Cooler re-assembly

Carry out the operations of the "Cooler Removal" chapter 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.

2.7.5 Cooler protection devices

a) Leak detection (float system)

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



1 - Guide rod

2 - Magnetic float

A – No potential contacts

x - Blue y - Brown z – Black

b) Water temperature sensor (optional)

A temperature sensor may be installed into the water inlet flow of the cooler.

Proposal of adjustment of the water inlet sensor :

Alarm temperature (*) = Water site temp max + 5 °K

Trip temperature (*) = Alarm temperature + 5 °K

c) Water filtering

Water filtering is not ensured by Leroy Somer.

Water filtering must be better than 300 µ

ALTERNATORS

2.8 AIR FILTERS

2.8.0. General

Only use approved filters. Any filter not correctly engineered may conduce to air flow restriction and then to abnormal generator cooling or to dust entering the generator

2.8.1. Cleaning

a) Air filter cleaning period

The cleaning period depends of the site conditions and can change

The cleaning of the filter is requested if the record of the stator winding temperature (using the stator winding sensors) indicates an abnormal increase in temperature.

b) 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 more formation of droplets)

Refit the filter on the machine.

CAUTION:

DO NOT USE WATER WITH A TEMPERATURE HIGHER THAN 50°C, DO NOT USE SOLVENTS.

NOTE :

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

2.18 TERMINAL BOX

2.18.0 Description

Use the attached Terminal box drawing

The main terminal box of the machine is located on the top of the machine.

The neutral and phase wires are connected to the terminals, one terminal per phase and one terminal per neutral line. See "Terminal Box" diagram.

The openings provide access to the terminals.

The gland plates are made of non-magnetic materials in order to avoid circulating currents.

The connection of accessories is achieved by terminal strips. Use a 5 mm maximum screwdriver to work on the blocking screws. See the "Machine Protection Devices" diagram.

If products have to be added in the terminal box (CT's, VT's, Shunt ex) refer to chapter.4.4.3

2.18.1 Electric panel

a) Compounding panel (if compound regulator)

The compounding panel is located in the terminal box

The three current transformers (TI 01, TI 02, TI 03), fitted in the terminal box on three power supply conductors, supply the compounding panel.

Rectifier bridges (CR 01, CR 02) rectify the alternating current coming from these three transformers.

An RC circuit (R 01, C 01) acts as a filter; CR 03 protects the system from high voltage spikes.

R 02 is an assembly of two adjustable resistors (adjusted at the factory). Refer to the regulator manual.

L 01 is an adjustable self-inducting coil comprising three coils. The different positions of the jumpers are shown on a plate attached to the self-inducting coil. L 01 is adjusted to supply excitation with no load. Refer to the regulator manual.

b) Booster plate (if shunt + booster regulator)

The booster plate is located in the terminal box.

The three current transformers TI 01, TI 02, TI 03, fitted to three power supply conductors, supply the booster plate.

Rectifier bridges (CR 01, CR 02) rectify the alternating current from these three transformers.

An RC circuit (R 01, C 01) acts as a filter. CR 03 protects the system from high voltage spikes.

R 02 is an assembly of two adjustable resistors (adjusted in the factory). Refer to the regulator manual, section "Principle of Excitation-Regulation".

2.18.2 Automatic voltage regulator

When the automatic voltage regulator is located in the terminal box, it is fitted on a separate plate, insulated from vibration by means of dampening pads. The operation of the regulator is explained in chapter 3.

CAUTION :
THE DAMPENING PADS MUST BE CHECKED PERIODICALLY AND REPLACED EVERY FIVE YEARS

2.18.3 Electrical contact tightening

Applicable for brass thread

Thread	M5	M6	M8	M10	M12	M14	M16
Torque [Nm]	2.5	4	8	20	35	57	87

2.19 PROTECTION DEVICES

2.19.1 Stator protection devices

See "Stator protection" in chapter 2.1.3.

2.19.2 Bearing protection devices

See "Bearing protection" in chapter 2.3.5 or chapter 2.4.9

2.19.3 Cooler protection devices

See "Cooler safety" in chapter 2.7.5

2.20 NAMEPLATES

2.20.1. Main nameplate

The main nameplate is fitted to the stator. It gives the manufacturer's electrical characteristics, the type of machine and its serial number. The serial number is necessary for any contact with the factory

For machines with anti-friction bearings, the quantity of grease, the type and frequency of lubrication are stipulated.

2.20.2. Lubrication nameplate

The machines with Sleeve bearings have a lubrication plate attached to the bearing, giving:

Oil change frequency; Oil capacity of bearing; Oil viscosity.

The machines with anti-friction bearings have a lubrication plate fixed on the stator, giving :

Type of bearing; Grease-change frequency; Quantity of grease.

2.20.3. Rotation direction nameplate

An arrow on the drive end bearing indicates the rotation direction.

3. VOLTAGE REGULATOR AND EXTERNAL AUXILIARIES

The regulator instruction manual may be considered as an independent manual, included in the machine instruction manual.

ALTERNATORS

4. INSTALLATION

4.1 TRANSPORT AND STORAGE

4.1.1 Transport

During the transport the intermittent shocks level applied to the machines must remain below 30 m/s^2

Machines equipped with roller bearing must have their rotor locked during the transport to avoid "false brineling" problem

Machine temperature must remain within the range -20°C to $+70^\circ\text{C}$. Stay down to -40°C during few hours is admitted.

The machine must be protected against bad weather conditions and condensation.

Machines must not be handled at temperature below -20°C

4.1.2 Storage warehouse

The machine must be stored in clean and dry premises which are not subject to abrupt changes in temperature or to high humidity (75% maximum)

The heating resistor must be switched on at all times

Storage at an ambient temperature of $+5$ to $+45^\circ\text{C}$ is recommended.

The machine must not be subject to vibrations higher than 1 mm/s rms

4.1.3 Maritime packing

The synchronous machine is carefully packed in a wooden crate, then hermetically sealed.

Standard maritime packing (For long term storage) as, seaworthy packing with fully watertight sealed film and dessicant (silicagel bags) according Category 4C of SEI standard.

Optional maritime packing (In case of extended storage period), with a special design with double sealing can be used. This packing enable access to the shaft in order to perform the periodic shaft rotation recommended for antifriction bearings (refer to chapter 2.3.2). This packing provides access to the dessicant for periodic change (every 18 months)

Breaking the hermetic protective film discharges Leroy Somer of its long-duration storage guarantee.

4.1.4 Unpacking and installation

DANGER :

THE FOUR LIFTING HOOKS MUST BE USED TO LIFT THE MACHINE WITH SLINGS (ONE HOOK AT EACH CORNER OF THE MACHINE)

Rotors of machines with Sleeve bearings and single-bearing machines, are blocked during transportation so as to avoid any movement. Withdraw the retaining bars. The retaining bar is screwed to the end of the shaft and to the front support.

CAUTION :

ALL THE LOCKING DEVICES PAINTED RED OR WITH RED STICKER MUST BE REMOVED.

The end of the shaft is protected from corrosion. Clean it before coupling.

4.1.5 Storage measures of a site machine

Before stopping the machine for a long period (several months), it is essential to take several precautionary measures:

Refer to chapter 2.3.2 (anti friction machine) or chapter 2.4.2 (sleeve bearing machine)

The heating resistor must be switched on at all times.

For water-coolers, the water flow must be shut off. If the water is not treated and if there is likelihood of freezing, the exchanger must be drained.

For an open machine, it is recommended that the air inlet and outlet be closed.

Before starting the machine up again, it will be necessary to carry out a start-up inspection.

4.2 INSTALLATION OF THE MACHINE

4.2.1 Fitting the coupling (double-bearing machine only)

The coupling must be balanced separately before assembly on the machine shaft. Refer to the balancing instructions in chapter 2.2.5.

The shrinking of the half coupling onto the electrical machine shaft end must be chosen, by the gen-set manufacturer, in such way as it should be removable for maintenance (e.g.: bearing change).

ALTERNATORS

4.2.2 Fitting the stator

Four plates on the frame enable the unit to be fitted to a skid.

The fixing bolts must support the forces created by the static and dynamic loads.

The machine may be positioned by means of 4 dowel pins. The dowel pins make later realignment easier. (The use of pins is optional).

The machine may be aligned through the use of 4 jacking-screws. These jacking-screws allow the machine to be positioned according to the various axes.

4.3 ELECTRIC MACHINE ALIGNMENT

4.3.1 Alignment general points

a) General points

The alignment consist to obtain the driving shaft and the driven shaft coaxial when operating at the nominal conditions (machine rotating ; at its operating temperature)

The machine must be aligned according to the ACEO standard and adhere to the manufacturer's alignment standard for the drive machine.

When heating the machine has its shaft line which grow up. Between stop and rotation the shaft axis location inside its bearing is different. The total axis height elevation is composed of the thermal elevation and of the bearing elevation.

CAUTION:

THE ALIGNMENT MUST BE DONE TAKING IN CONSIDERATION THE SHAFT MOVEMENT CORRECTION

The correct locating of the parts must be obtained by inserting shims under the machine pads..

The double-bearing machines are mounted with bearings (ball or roller) or Sleeve bearings. The axial clearance of the bearings (if the machine has Sleeve bearings) must be distributed as well as possible, taking into account the axial thermal expansion. The Anti friction-bearing machines with a positioning bearing (standard machine) do not have axial play.

The machines are delivered with the rotor mechanically centered (axially and radially) in relation to the stator.

CAUTION :

THE ALIGNMENT STANDARDS OF MANUFACTURERS OF DRIVE MACHINES ARE FREQUENTLY MORE PRECISE THAN THOSE OF THE A.C.E.O

b) Axis height Thermal elevation

$$\Delta H \text{ (mm)} = \lambda_{(\text{K}^{-1})} \cdot H_{\text{(m)}} \cdot \Delta T_{\text{(K)}}$$

$H_{\text{(m)}}$ = Height of the machine axis

ΔT = frame temperature elevation = 30°C

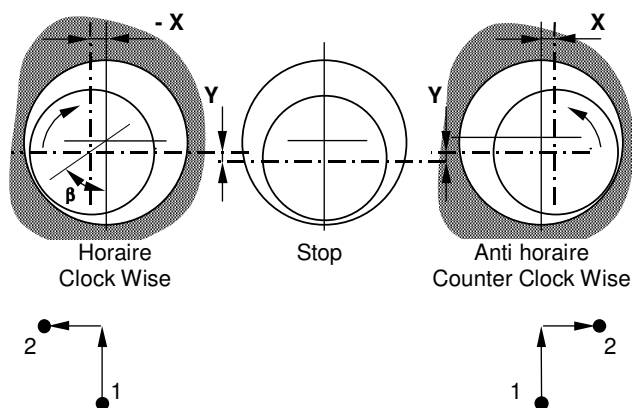
λ = Coefficient of steel elongation = 0.012 K⁻¹

c) Sleeve bearing shaft elevation

The calculated displacement is given in " section 1"

Exact Sleeve bearing elevation due to the oil film :

The machine goes from point "1" to point "2".



Clear : diametrical clearance

Oil film : oil film thickness

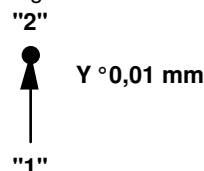
β : Attitude angle

$$X = \left(\frac{\text{Clear.}}{2} - \text{Oil film} \right) \cdot \sin(\beta)$$

$$Y = \left(\frac{\text{Clear}}{2} \right) - \left(\frac{\text{Clear}}{2} - \text{Oil film} \right) \cdot \cos(\beta)$$

d) Anti-friction bearing shaft elevation

Caused by thermal growth of the anti friction bearing.



1 - cold, in rotation, or stopped

2 - hot, in rotation, or stopped

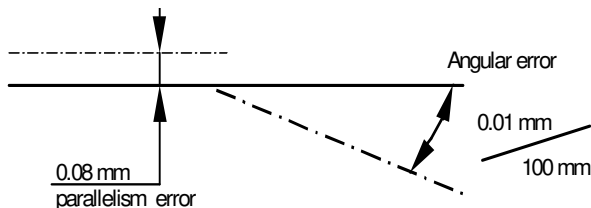
ALTERNATORS

4.3.2 Two bearings machine alignment

a) machines without axial end play (standard)

The alignment must take the tolerances of the coupling into account. A misalignment, acceptable by the coupling, must not create an excess load on the bearing subsequent to the axial and radial stresses outside the tolerances of said bearing.

Shafts alignment limits to follow:



To check the alignment, there are different methods: the "double concentricity" method is described in the "alignment procedure" chapter 4.3.4.

b) machines with axial end play

The alignment must be performed using the same method as for a machine having no axial end play.

CAUTION:

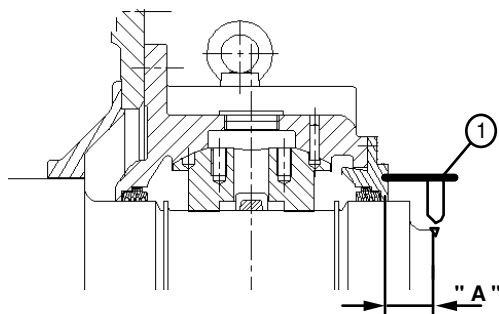
THE ROTOR AXIAL LOCATION MUST BE CHECKED TO AVOID ANY MAGNETIC OFFSET

CAUTION:

THE FAN THRUST OF THE ELECTRICAL MACHINE MUST BE HELD THROUGH THE COUPLING.

A needle fitted on the drive end side bearing must face a groove machined on the shaft. If the needle is missing the distance "A" (distance from the groove up to the first bearing part) is stamped on the shaft enabling checking.

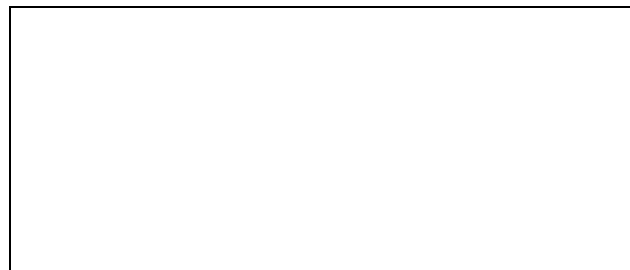
Example for a sleeve bearing machine :



4.3.3 Single bearing machine alignment

a) General points

The alignment consist also to get the rotor of the synchronous machine coaxial to its stator



"A" et "B" give the shaft line alignment

"D" et "E" give the alignment of the stator regarding the rotor.

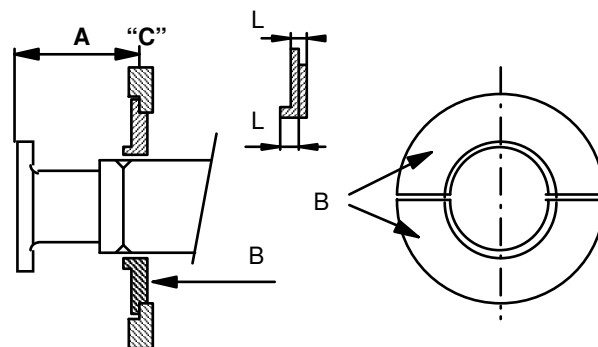
Because of the engineering of the synchronous machine the **only** requested adjustment is "C".

For generators type A60 and A62 "E" can be adjusted (refer to 6.2.1)

b) Single bearing machine

It is imperative to position the rotor axially in relation to the stator in order to achieve correct magnetic centering of the rotor in the stator.

Single-bearing machines are delivered by the ACEO factory with the rotor centered mechanically (axially and radially) in relation to the stator.



Two half-shells (B parts) mounted on the front flange act as a front bearing for the transportation and installation. The outside of the centring half-shells face a groove machined on the shaft.

The half-shells have "L = L" construction symmetry

The length "A" shown on the diagram is stamped on the shaft end (allowing alignment in case of absence of item "B" rings or in case of absence of groove on the shaft)

The length "L" shown on the diagram is stamped on the shaft end.

The side "C" represents the machined side of the bearing.

Remove the centring upper half-shell (upper "B" part).

Fit the electric machine to the drive system centering.

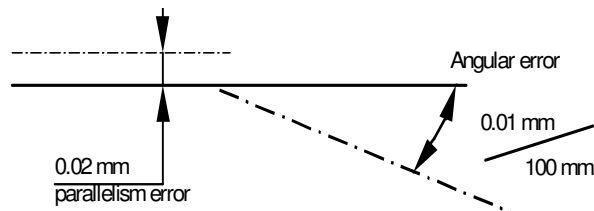
ALTERNATORS

Remove the centering lower half-shell (lower "B" part).

Carry out the alignment by moving the machine assembly by means of lifting-screws mounted on the brackets (see alignment procedure below). Use shims in order to obtain proper alignment.

The centering of the rotor in relation to the stator should be checked by measuring the concentricity of the shaft in relation to the bearing. After having tightened the fastening screws completely, the rotor-stator alignment must be better than 0.05 mm axis-to-axis (that is 0.1 mm reading).

Shafts alignment limits (regarding the drive):



Check the axial positioning of the rotor in relation to the stator. For this verification, use an upturned half-shell ("B" part) (use of the symmetry of the "L = L" part) as shim. The outside of the shim ("B" part) must be facing the groove machined on the shaft to within +/- 1 mm.

Mount the cover plates by replacing the transportation half-shells (delivered separate with the machine) to avoid foreign matter entering in the machine. Make sure the closing plates are correctly centered in relation to the shaft.

4.3.4 Alignment procedure

a) Checking "Double concentricity" alignment method

This method is not sensitive to axial movements. (the alignment methods using axial measure may often be perturbed by small axial movement of the rotor)

It is possible to check the alignment with the coupling installed.

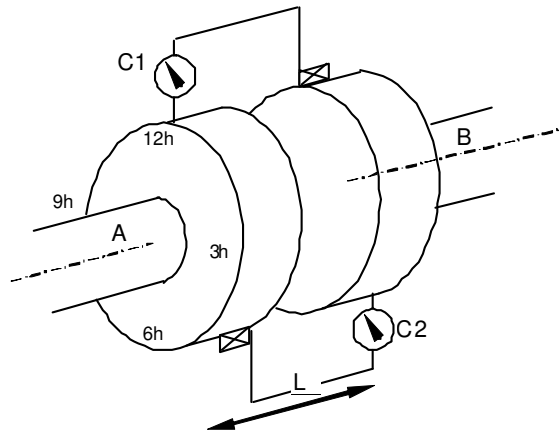
Equipment required :

Two rigid brackets. The rigidity of the two brackets is very important.

Two micrometers

Implementation :

During the measures, both shafts must turn simultaneously in the same direction. (For example : the coupling installed with its screws untightened). By turning both shafts simultaneously, the measurement is not affected by the error resulting from run out of the two shaft ends.



The "C1" and "C2" micrometers are located at an angular difference of 180°.

More the distance "L" is long better should be the sensitivity to detect the angular error

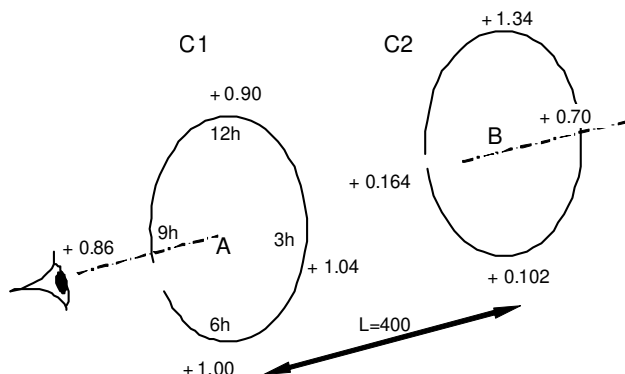
The reading should be performed 4 times for the "C1" and "C2" micrometers : at 12h, 3h, 6h, 9h

It is recommended to record the results and draw the axes for better evaluation, as explained below. Interpretation of measurements by means of an example.

Values given in millimeters. The reading is considered positive (+) when the micrometer stylus is pushed inwards.

ALTERNATORS

MEASUREMENTS



Measurements referring to the vertical plane:

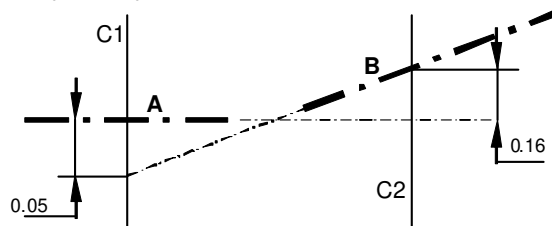
Considering the vertical plane "C1" : The vertical action towards the top of shaft "A" on the micrometer is dominant.

In the plane "C1" the axis "A" is higher than axis "B"
 $(0.9 - 0.1) / 2 = -0.05 \text{ mm}$

In the vertical plane "C2", the vertical action towards the top of shaft "B" on the micrometer is greater.

In the plane "C2" the axis "B" is higher than axis "A"
 $(0.134 - 0.102) / 2 = 0.16 \text{ mm}$

The respective position of the axes is as follows:



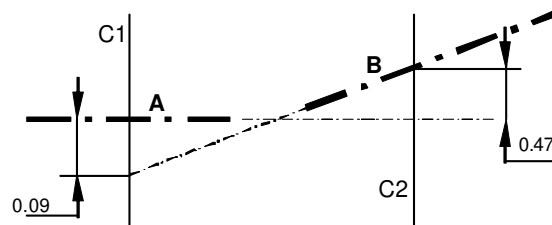
Regarding the vertical plane the angular alignment error is:
 $(0.16 + 0.05) * 100 / 400 = 0.0525 \text{ mm}/100\text{mm}$ (not acceptable)

Measurements referring to the horizontal axis:

In the plane "C1" the axis "B" is further to the right than "A"
 $(0.104 - 0.86) / 2 = 0.09 \text{ mm}$

In the plane "C2" the axis "B" is further to the left than "A"
 $(0.70 - 1.64) / 2 = -0.47 \text{ mm}$

The representation of the shafts is as follows:



Regarding the horizontal plane the angular error is:
 $(0.47 + 0.09) * 100 / 400 = 0.14 \text{ mm}/100\text{mm}$ (not acceptable)

In the both planes the parallelism error is:

$\sqrt{5^2 + 9^2} = 0.103\text{mm}$ or $\sqrt{16^2 + 47^2} = 0.496\text{mm}$ (not acceptable)

4.4 ELECTRICAL CONNECTIONS

4.4.0. General points

The installation must comply with the electrical diagrams. Refer to the attached the electrical diagrams.

Check that all the protection devices are correctly connected and in good working order.

The assembler has the responsibility to mechanically and electrically protect the generator within the best practice rules and to secure any operation over the defined tender (respect of capability curve ; overspeed ...)

For low-voltage machines, power supply cables must be connected directly to the machine terminals (without adding washers etc)

For high-voltage machines, power supply cables should be connected to separate terminals or to current transformer terminals.

NOTE:

THE GLAND PLATE IS MADE OF NON MAGNETIC MATERIAL.

CAUTION

DO NOT ADD WASHERS TO THE POWER SUPPLY CABLE TERMINALS OTHER THAN THOSE USED BY THE MANUFACTURER OF THE ELECTRIC MACHINE

Check that the lugs are tightened.

CAUTION

ALL CURRENT TRANSFORMERS MUST BE CONNECTED OR SHUNTED

CAUTION

THE VOLTAGE TRANSFORMER MUST NEVER BE SHUNTED

CAUTION

THE INSTALLED POWER CABLES MUST BE FIXED AND SUPPORTED IN SUCH A WAY AS TO BE ABLE TO WITHSTAND THE VIBRATION LEVEL REACHED BY THE GENERATOR IN OPERATION (refer to Vibration chapter)

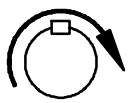
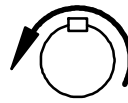
The power cables must not stress (push, pull, bend ...) the generator terminals

4.4.1. Phase-sequence

a) Standard units ; IEC 34-8

Except by special request of the customer, the phase-sequence is carried out using the IEC 34-8 standard. An arrow located on the front bearing indicates the direction of rotation.

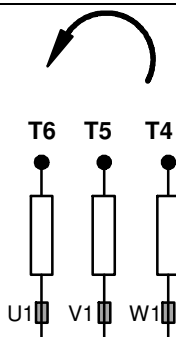
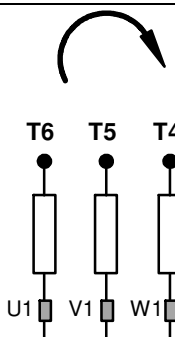
In the terminal box a specific marking plate indicates the specific generator phase sequence.

Clockwise rotation viewed from the shaft drive end	Counter clockwise rotation viewed from the shaft drive end
The phases are marked: U1, V1, W1.	The phases are marked: U1, V1, W1.
Viewed from the front of the terminal box the terminals are : U1, V1, W1	Viewed from the front of the terminal box the terminals are : U1, V1, W1
The installer connects : L1 --> U1 L2 --> V1 L3 --> W1	The installer connects : L3 --> U1 L2 --> V1 L1 --> W1
	

b) On request ; NEMA

An arrow located on the front bearing indicates the direction of rotation.

In the terminal box a specific marking plate indicates the specific generator phase sequence.

Counter clockwise rotation viewed from the stator connection (NEMA) (Clockwise rotation viewed from the shaft drive end following IEC)	Clockwise rotation viewed from the stator connection (NEMA) (Counter clockwise rotation viewed from the shaft drive end following IEC)
The cables are marked: U1, V1, W1.	The cables are marked: U1, V1, W1.
The terminals are marked : T3, T2, T1	The terminals are marked : T3, T2, T1
Viewed from the front of the terminal box the cables are : U1, V1, W1	Viewed from the front of the terminal box the cables are : U1, V1, W1
The installer connects : L1 --> (U1) T3 L2 --> (V1) T2 L3 --> (W1) T1	The installer connects : L3 --> (U1) T3 L2 --> (V1) T2 L1 --> (W1) T1
	

4.4.2 Insulating distances

Products not delivered by ACEO and then installed in the terminal box must meet the electrical insulating distances.

This applies to power cables and lugs, and to added transformers, etc.

Nominal Voltage	500 V	1 KV	2 KV	3 KV
Phase-Phase in the air (mm)	25	30	40	60
Phase-Earth in the air (mm)	25	30	40	60
Phase-Phase Creeping (mm)	25	30	40	70
Phase-Earth Creeping (mm)	25	30	40	70

Nominal Voltage	5 KV	7,5KV	12,5KV	15 KV
Phase-Phase in the air (mm)	120	180	190	190
Phase-Earth in the air (mm)	90	120	125	125
Phase-Phase Creeping (mm)	120	180	190	190
Phase-Earth Creeping (mm)	120	180	190	190

4.4.3 Added products in the terminal box

This may apply to site added customer CTs ; VTs etc.

ACEO must be informed if some appliances have to be installed in the generator terminal box.

The products not delivered by ACEO and then installed in the terminal box must meet the electrical insulating distances. Refer to chapter 4.4.2.

The installed appliances must be able to withstand vibration.

5. START-UP

5.0 START-UP SEQUENCE

The generator start up (commissioning) must follow the following sequences:

5.0.1 Static checks

Machine fixing as per chapter 5.2

Alignment as per chapter 5.2

Cooling as per chapter 5.2

Bearing lubrication as per chapter 5.2

Electrical connections as per chapter 5.1.0 and chapter 5.1.2

Winding insulation as per chapter 6.3.2

5.0.2 Rotating checks

a) Rotating checks not excited

Run the generator without excitation by steps to verify the bearings temperature as per chapter 5.2

At the nominal speed (not excited) measure the vibrations. Check that the vibration level is in accordance with the generator (as per chapter 5.2.1) and duty request.

b) Rotating checks at no load excited

In AVR manual mode; Voltage adjustment; check the excitation current value (refer to AVR manual and to the generator test report)

In AVR automatic mode; Voltage adjustments; Voltage range; check the excitation current value (refer to AVR manual and to the generator test report)

At the nominal speed (excited) measure the vibrations. Check that the vibration level is in accordance with the generator (as per chapter 5.2.1) and duty request.

c) Generator and site safeties

Proceed to the site safeties adjustment (over voltage relay, over current relay, differential protection; negative sequence relay...). The setting points are not under our responsibility.

Check the synchronizer setting following chapter 5.1.3

For any operation at a speed exceeding the nominal range (generally the main frequency +3%) the generator excitation must be shut off (refer to the electrical diagram)

d) Rotating checks at full load

Operating In parallel with the mains

Adjust the Power Factor

Load the generator step by step. :

Check the excitation current at 25%of the rated load

Check the excitation current at 100%of the rated load

At the nominal speed (full load) measure the vibrations.

Check that the vibration level is in accordance with the generator (as per chapter 5.2.1) and duty request.

5.0.3 GENERATOR START UP CHECK LIST

TYPE		SERIAL N°	
Voltage		V	Frequency Hz
			Speed rpm
Output Power		kVA	Power Factor

STATIC CHECKS

Mechanical checks

- Direction of Rotation Clock Wise ☐ or Anti-clock Wise ☐
- Mechanical Fixing of the generator ☐
- Coupling - Alignment to the engine ☐
- **Cooling** : Coolant flow and level ☐
- Air inlet and exhaust free ☐
- **Bearing lubrication** : Sleeve Bearings Lubrication (flow ; level ; oil type) ☐
- or Anti-friction Bearings Greasing ☐
- Temperature sensors (correct readings) ☐
- Space Heaters ☐

Type of AVR : 1F ☐ 2F ☐ 3F ☐

Electrical connections between alternator, AVR and main panel :

- Output power cables connections following phase order ☐
- Terminal box connections ☐
- AVR detection voltage ☐
- Supply power and excitation terminals ☐
- Network detection (3F only) ☐
- Command signals (equalisation and synchronisation for 2F and 3F) ☐
- Excitation polarity and booster ☐
- Protective devices : (Bearing oil level fault detectors; Temperature sensors, etc) ☐
- External accessories (e.g.. remote potentiometer) ☐

ALL CURRENT TRANSFORMERS MUST BE CONNECTED

Windings insulation

- Insulation test of the : Stator ☐ Rotor ☐ Exciter armature ☐ Exciter field ☐
- Measured values in MOhms

All works must be carried out by a qualified and authorized person.
For more information, please refer to the service manual

Tested by :

Date & Signature :

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ROTATING CHECKS

WITH EXCITATION - AT NO LOAD CONDITIONS

- Verification of the bearings temperature °C ☐
- In manual mode : Voltage adjustment ☐
 Excitation current check ☐
- In automatic mode : Voltage Setting (referring to nominal voltage) ☐
 Excitation current check ☐
- Parallel coupling : Adjustment to parallel operation (3F) ☐

A FAULTY SYNCHRONISING CAN BE THE ORIGIN OF DAMAGES (HIGH MECHANICAL OVER-TORQUE)

- Maximum acceptable values for synchronisation to the mains :

Maximum frequency shift	0,1 Hz		☐
Maximum Phase offset	10 °		☐
Maximum voltage (P.N.) difference	5% of Un		☐

Control / Adjustment of the site safeties

- Over-voltage, ☐
- Over-current (by short-circuit on stator in separate excitation mode), ☐
- Negative sequence relay, ☐
- Over-speed, ☐
- Differential protection (in static conditions), ☐
- Other protective device. ☐

CHECK THAT ALL SAFETY EQUIPMENT OPERATES CORRECTLY

WITH EXCITATION - LOADED

- Voltage stability ☐
- Adjustment of the Power Factor ☐
- Verification of the excitation current versus load from 25% to full load at rated PF. ☐
- Maximum load value kVA PF
- Vibrations measurements in : mm/s RMS. ☐ or other unit

At nominal speed measure the vibrations

Drive End	H		V		A	
Non Drive End	H		V		A	

All works must be carried out by a qualified and authorized person.
For more information, please refer to the service manual

Tested by :

Date & Signature :

ALTERNATORS

5.1 ELECTRICAL START-UP INSPECTION

5.1.0 General points

Electrical connections (auxiliaries, safeties and power connections) must comply with the diagrams provided.

Refer to chapter 4

DANGER:
CHECK THAT ALL SAFETY EQUIPMENT OPERATES CORRECTLY.

5.1.1 Winding Insulation

The insulation and the polarization index must be measured on start up and then each year

To measure the insulation refer to the chapter.6.3.2

5.1.2 Electrical connections

The phases must be connected directly to the machine links (with no spacers or washers, etc).

Make sure that the lugs are sufficiently tightened.

CAUTION:
ALL CURRENT TRANSFORMERS MUST BE CONNECTED

5.1.3 Parallel operation

a) Definition of parallel operation

• Between machines

Parallel operation is possible if the power ratio between the smallest machine and the largest machine is less than or equal to 10.

• With the mains

The "mains" is defined as a source of power greater than or equal to ten times the output of the machine with which it will be coupled.

b) Possibility of parallel operation

Parallel operation, if planned at the outset, does not cause any problems if several basic rules are followed.

c) Parallel coupling

CAUTION:

AN IMPROPER COUPLING CAN BE THE ORIGIN OF DAMAGES (HIGH MECHANICAL OVERTORQUE AND OVER CURRENT)

At the coupling the following values must not be overpass:

Max frequency shift : 0,1 Hz

Max phase offset : 10° (electrical angle)

Max voltage (phase - neutral) between machines :
(at phase offset =0) 5 % of the nominal voltage

In case of faulty coupling, of mains fugitive disappearing inducing a faulty coupling over what it is acceptable by the generator, ACEO cannot be considered as responsible of the damages.

5.2 MECHANICAL START-UP INSPECTION

5.2.0 General points

a) Alignment ; fixing ; prime mover

The installation must comply with the manufacturer's installation rules for drive machine (alignment, mounting).

An arrow at the drive end, end shield, indicates the direction of rotation.

b) Cooling

The air inlet and exhaust must be unobstructed.

The cooling auxiliaries (water circulation in the cooler, etc) must be operating.

c) Lubrication

Lubrication must be carried out :

- anti friction bearings, refer to chapter 2.3
- Sleeve bearings, refer to chapter 2.4

5.2.1 Vibrations

The vibration measurement must be taken on each bearing in the three directions. The measured levels must be lower than the specified values indicated in the chapter 2.1.3

Adjust the sensor as per chapter 2.1.3

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6. PREVENTIVE MAINTENANCE

6.1 MAINTENANCE SCHEDULE

The purpose of the general maintenance schedule below is to help establish the maintenance schedule particular to the installation. The suggestions and recommendations are to be followed as closely as possible in order to maintain the machine efficiency and in order not to reduce the service life of the machine.

The maintenance operations are detailed in the chapters relative to the subjects concerned (Example: bearing, see chapter 2).

LUBRICATION AND PREVENTIVE MAINTENANCE SCHEDULE

Frequency of maintenance

	Days	Hours	Comments
STATOR Winding temperature Bolts tightening Cleaning air inlet and outlet Insulation Polarisation index	1	 8000 (*1) 1000 8000 (*1) 8000 (*1)	Refer to 2.1.3 Refer to 6.2.2 Refer to 6.2.3 Refer to 6.3.2 Refer to 6.3.2
ROTOR Insulation Cleaning diodes Diodes tightening Polarisation index		8000 (*1) 8000 (*1) 8000 (*1) 8000 (*1)	Refer to 6.3.2 Refer to 7.4 Refer to 2.2.4 Refer to 6.3.2
TERMINAL BOX Cleaning Regulator assembly Bolts tightening		8000 (*1) 8000 (*1) 8000 (*1)	 Applicable if mounted in the terminal box Refer to 6.2.2
SLEEVE BEARINGS Oil leak Oil temperature Oil level Oil drain Bolts tightening	 1 1 1	 8000/16000 8000 (*1)	Following technical specification in "Section 1" Refer to 2.4.9 Refer to 2.4.10 Refer to 2.4.5 Following environment cleanness; Refer to 2.4.5 Refer to 2.4
ANTI FRICTION BEARINGS Re greasing Bearing temperature	 1		Following technical specification in "Section 1" Refer to 2.3.3 ; See lub plate; grease at least every 6 months Refer to 2.3.5

(*1) : Or once a year

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LUBRICATION AND PREVENTIVE MAINTENANCE SCHEDULE (following)

	Days	Hours	Comments
COOLER Leakage level Water temperature Cleaning	1 1		Following technical specification in "Section 1" Refer to 2.7.5 Refer to 2.7.5 Refer to 2.7.3 ; following site condition
VIBRATION DAMPERS		8000	Voir 2.6.2 ; 2.6.3 ; 2.7.0.a ; 2.18.2 ;
FILTERS Cleaning		1000	Following technical specification in "Section 1" Refer to 2.8 & following " Section 1"
FAN-MOTOR Bearing Re greasing			Following technical specification in "Section 1" Refer to motor lub plate ; following" Section 1"
PROTECTION DEVICES		8000 (*1)	Refer to 2.19 et "Section 1 ; (sensors ,)

(*1) : Or once a year

ALTERNATORS

6.2 MECHANICAL MAINTENANCE

To obtain additional information on the maintenance of sub-assemblies, refer to the chapters dealing with the sub-assemblies concerned.

6.2.1 Air gap check

a) General points

The direct air gap check is not always possible because of a lack of access. When the air gap can be reached the measure can be fastidious because of paint and resin coating on the checked surfaces

To make the measure more reliable and easy the air gap check will be done onto the exciter :

Air gap < 1 mm max offset : 0.1 mm

1 mm ≤ Air gap max offset 10% of air gap

b) Double bearing machine

Verification of the air gap is not necessary. The rotor is mechanically centered by its construction. Even after dismantling and reassembling the machine, the rotor will return to its position without verification of the air gap.

The exciter air gap of generators type A60 and A62 are site adjustable.

c) Single bearing machine

When the machine is delivered, the rotor is mechanically centered in the stator (see chapter on alignment). After dismantling the machine, it will be necessary to center the rotor in the stator, by using the two half-shells (delivered with the machine) as explained in the chapter 4.3.3.

If you do not have 1/2 shells, use a dial indicator to check the concentricity between the shaft (machined surface) and the front bearing (machined surface).

6.2.2 Bolts tightening

Check the tightening of the sleeve bearing fixing bolts (refer to chapter 2.4)

Check the tightening of the rotating diodes (refer to chapter 2.2.4)

Check the tightening of the terminal box accessories (refer to chapter 2.18)

If no torque value is specified into the concerned chapter the following values can be used

Bolt : Steel / Steel (greasy thread)			
Ø nominal (mm)	Torque (mN)	Ø nominal (mm)	Torque (mN)
3	1,0	18	222
4	2,3	20	313
5	4.6	22	430
6	7.9	24	540
8	19.2	27	798
10	37.7	30	1083
12	64.9	33	1467
14	103	36	1890
16	160		

Steel and copper alloy Plugs (greasy thread)			
Ø nominal (inches)	Torque (mN)	Ø nominal (inches)	Torque (mN)
G3/8	30	G1 ¼	160
G1/2	40	G1 ½	230
G3/4	60	G2	320
G1	110	G2 ½	500

6.2.3 Cleanliness

The whole machine must be kept clean.

CAUTION :

ALL THE CLEANING PERIODS INDICATED IN THIS MANUAL MAY BE CHANGED (INCREASED OR DECREASED) ACCORDING TO SITE CONDITIONS

The air inlet and air outlet surfaces must be maintained clean (Louvers can be cleaned as per the filters) refer to chapter 2.8.

CAUTION :

DIRT ENTERING THE MACHINE MAY POLLUTE AND THUS REDUCE THE ELECTRICAL INSULATION

The rotating diodes must be kept clean. The rotating diodes cover has to be clean. Refer to chapter 7.4

6.3 ELECTRICAL MAINTENANCE

6.3.1 MEASURING INSTRUMENTS

a) Instruments used

- AC voltmeter 0-600 Volts
- DC voltmeter 0-150 Volts
- Ohmmeter 10E-3 to 10 ohms
- Megohmmeter 1 to 100 MOhms / 500 Volts
- AC Ammeter 0- 4500 A
- DC Ammeter 0-150 A
- Frequency meter 0-80 Hz

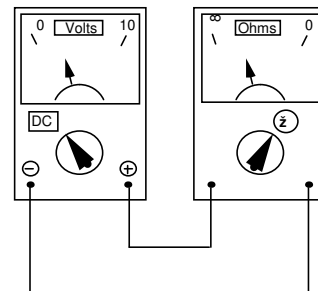
Low resistance can be measured by means of an appropriate ohmmeter or by using a Kelvin or Wheatstone bridge.

NOTE :

The identification of the equipment polarity may differ from one ammeter to another.

b) Identification of ohmmeter polarity

In many testing procedures, the ohmmeter polarity is important (diode test, etc) and must be known. As a second instrument, you must use a voltmeter in the "direct current" position, in order to check the polarity of the ohmmeter connections. Proceed as explained below :



6.3.2 Insulation check of the winding

a) General

The insulation resistance enables the status of the machine insulating to be verified.

The following measurements can be taken at any time without any damage to machine insulating material.

The insulation check must be done :

Before the start up

After a long standstill

As soon as an abnormal operation occurs.

If the measurement indicates a poor result we advise contacting our Service department.

To perform the measurement the generator must be stopped.

If the insulation resistance is less than that required, it is necessary, to clean and to dry the machine (refer to chapter 7.5).

DANGER :

BEFORE ANY WORK THE RULES CONCERNING THE SAFETY OF MATERIALS AND PERSONS MUST BE APPLIED (TOTAL LOCKING OF THE GENERATOR FUNCTIONS, GROUNDING OF THE PHASES ...)

b) Armature insulation measure

Disconnect the three phases at the generator terminals.

CAUTION

**ALL ACCESSORIES MUST BE DISCONNECTED (AVR , EMC FILTER ;;;)
REFER TO THE ELECTRICAL DIAGRAM TO IDENTIFY THE ACCESSORIES TO DISCONNECT**

ALTERNATORS

The measurement has to be taken between one phase and the earth.

	Machine nominal voltage	
	$U_n \leq 2400 \text{ V}$	$U_n > 2400 \text{ V}$
Applied test voltage (DC)	500 V DC	1000 V DC

The measured value at 25°C must be over

$$3 (U_n + 1) \text{ M}\Omega$$

where U_n (the nominal voltage) is in Kilovolts. (e.g. : a generator of 6.6 KV must have an insulation resistance greater than 22.8 MΩ).

If the minimum insulation level is not reached, dry the windings (refer to chapter 7.5)

c) Field insulation measurement

Disconnect the two ends of the field at the rotating diodes bridge

The measurement should be taken between one end of the field winding and the earth.

The applied test voltage must be of 500 V DC.

The measured value must be over 20 MΩ.

If the minimum insulation level is not reached, dry the windings (refer to chapter 7.5)

d) Exciter insulation measurement

CAUTION

ALL ACCESSORIES MUST BE DISCONNECTED (AVR , EMC FILTER ;;;)

REFER TO THE ELECTRICAL DIAGRAM TO IDENTIFY THE ACCESSORIES TO DISCONNECT

To measure the exciter field insulation disconnect the two ends of the exciter field at the terminals located on the top of the exciter.

To measure the exciter armature insulation disconnect the two ends of the exciter armature at the rotating diodes bridge

The measurement should be taken between one end of the field winding and the earth.

The applied test voltage must be of 500 V DC.

The measured value must be over 20 MΩ.

If the minimum insulation level is reached, dry the windings (refer to chapter 7.5)

e) Polarization index

The polarization index enables the status of the machine insulating to be verified and gives an indication of the pollution of the winding.

A poor polarization index may be corrected by a cleaning and drying of the winding

The following measurements can be taken at any time without any damage to the machine insulating material.

CAUTION

ALL ACCESSORIES MUST BE DISCONNECTED (AVR , EMC FILTER ;;;)

REFER TO THE ELECTRICAL DIAGRAM TO IDENTIFY THE ACCESSORIES TO DISCONNECT

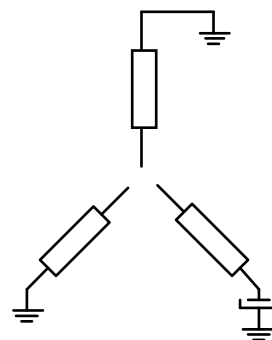
NOTE:

It must be done using a stable DC source.

Use a specific polarization index appliance under 500 or 1000 DC volts (refer to " insulation of the winding" chapter for the correct applied voltage)

Open the winding star point

Disconnect AVR cables from the stator terminals



Apply the requested voltage

After 1 minute record the Insulating resistance

After 10 minutes record the Insulating resistance

--

The polarization index must be higher than 2.

Proceed for each phase

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7. SERVICING

7.1 GENERAL SERVICING

DANGER :
BEFORE WORKING ON THE GENERATOR, MAKE SURE THAT THE START-UP CANNOT BE ACTIVATED BY ANY MANUAL OR AUTOMATIC SIGNAL

DANGER:
BEFORE WORKING ON THE MACHINE, MAKE SURE THAT YOU HAVE UNDERSTOOD THE OPERATING PRINCIPLES OF THE SYSTEM. IF NECESSARY, REFER TO THE APPROPRIATE CHAPTERS IN THIS MANUAL.

CAUTION:
GIVEN THE POWER FACTOR APPLIED TO THE MACHINE, A VOLTMETER OR KILOWATT METER DOES NOT NECESSARILY SHOW THE KVA LOAD OF THE MACHINE.

7.2 TROUBLESHOOTING

7.2.0 General points

When a defective part is replaced with a spare part, make sure that it is in good condition.

7.2.1 Regulator trouble-shooting procedure

Refer to the enclosed regulator manual.

7.3 ELECTRICAL TESTS

7.3.1 Stator winding test

See chapter 6.3

7.3.2 Rotor winding test

See chapter 6.3

7.3.3 Excitation armature winding test

See chapter 6.3

7.3.4 Excitation field winding test

See chapter 6.3

7.3.5 Rotating diode bridge test

See chapter 2.2

7.3.6 Electric panel test

Use electrical diagrams for assistance.

7.4 CLEANING THE WINDINGS

7.4.0 General points

The cleaning of the winding is an heavy service operation which has to be engaged only if necessary.

The cleaning of the windings become necessary as soon as the insulation resistance and/or the polarization index are not satisfactory (refer to chapter 6.3.2)

7.4.1 Coil-cleaning product

a) General

A long term efficient cleaning can only be done in a work floor if equipped with specialized devices. A site cleaning, because less efficient, can be considered only for a transient period.

CAUTION:
SOLVENTS, WHICH ARE HIGHLY CHLORINATED AND SUBJECT TO HYDROLYSIS IN DAMP ATMOSPHERES ARE PROHIBITED. THEY QUICKLY BECOME ACIDIFIED, PRODUCING CORROSIVE AND CONDUCTIVE HYDROCHLORIC ACID.

CAUTION:
DO NOT USE TRICHLORETHYLENE, PERCHLORETHYLENE, OR TRICHLORETHANE

Avoid mixtures sold under various trademarks which often contain white spirit (which evaporates too slowly) or chlorinated products (which are likely to become acidified).

CAUTION:
DO NOT USE ALKALINE PRODUCTS. THEY ARE DIFFICULT TO RINSE AND CAUSE REDUCTION OF INSULATION RESISTANCE BY FIXING THE HUMIDITY

b) Cleaning products

Use pure de-greasing and volatile agents which are well-defined such as :

Gasoline (without additives)
Toluene (slightly toxic) ; inflammable
Benzene or benzine (toxic ; inflammable)
Ciclohexaire (non-toxic; inflammable)
Soft water

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7.4.2 Cleaning the stator, rotor, excitation system and diodes

a) using specific chemical product

The insulation and the impregnation system are not damaged by solvents (see the list of authorized products above).

It is essential to avoid entry of cleaning agents into the slots. Apply the product with a brush, sponging frequently in order to avoid accumulation in the housing. Dry the winding with a dry cloth. Allow the traces to evaporate before reassembling the machine.

CAUTION:

AFTER CLEANING THE GENERATOR, DRYING IS IMPERATIVE TO RECOVER THE CORRECT WINDING INSULATION

b) Rinsing using soft water

Hot soft water (less than 80°C) used under pressure (less than 20 bars) can be used.

CAUTION:

AFTER CLEANING THE GENERATOR, DRYING IS IMPERATIVE TO RECOVER THE CORRECT WINDING INSULATION

7.5 DRYING THE WINDING

7.5.0 General points

All electric machines must be stored under dry conditions. If a machine is placed in damp surroundings, it must be dried before it is put into service. Units operating intermittently or placed in areas with high temperature variations, are exposed to dampness and must be dried very thoroughly if necessary.

7.5.1 Drying method

a) General points

During the drying operation measure the winding insulation and the polarization index each 4 hours.

To survey the insulation progress, record the measured values and plot the obtained progress function of the time.

When the insulation value becomes constant, the machine can be considered as dry.

When the resistance is constant, it may be assumed that the machine is dry. This operation may take up to 24 hours, depending on the size of the machine and on the degree of dampness. This may even take up to 72 hours.

CAUTION:

**TAKE FIRE-PREVENTION MEASURES DURING THE DRYING OF THE MACHINE.
ALL THE CONNECTIONS MUST BE TIGHTENED.**

b) Drying generator stop

The procedure "Drying generator in rotation" should be preferred to the following one if it is possible to run the generator at its nominal speed

Several thermometers must be positioned onto the winding and the temperature must not exceed 75°C (167°F). If one of the thermometers exceeds this value, immediately reduce the heating effect.

Dry by using an external source of heat, for example, heaters or lamps.

Leave an opening for an exhaust for the damp air.

c) Drying generator in rotation

Disconnect the machine from the mains

Short circuit the machine stator at the machine terminals

Disconnect the Voltage regulator and short-circuit the booster.

Install an amp meter on the short-circuited winding.

Run the machine at its nominal speed (to air cool the machine)

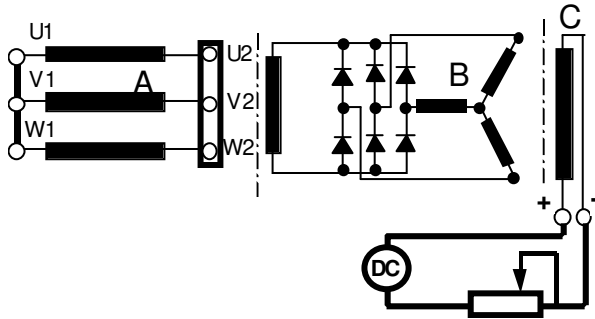
Energized the machine (exciter field) using an separate excitation source. Use a DC source (batteries ...)

Adjust the excitation current to get the nominal current at the stator (machine armature).

Warm up during 4 hours, stop and leave it to cool down (winding temperature < 50°C)

Check the winding insulation and the polarization index

If necessary conduct another drying period...



A - Stator
B - Rotor
C - Exciter

7.6 RE-VARNISHING

CAUTION:

RE VARNISHING MUST ONLY BE CONSIDERED IF ABSOLUTLY NECESSARY. A RE VARNISHING OPERATION DONE ON A WINDING STILL DIRTY OR NOT PERFECTLY DRY MAY CONDUCE TO A DEFINITIVE LOSS OF INSULATION

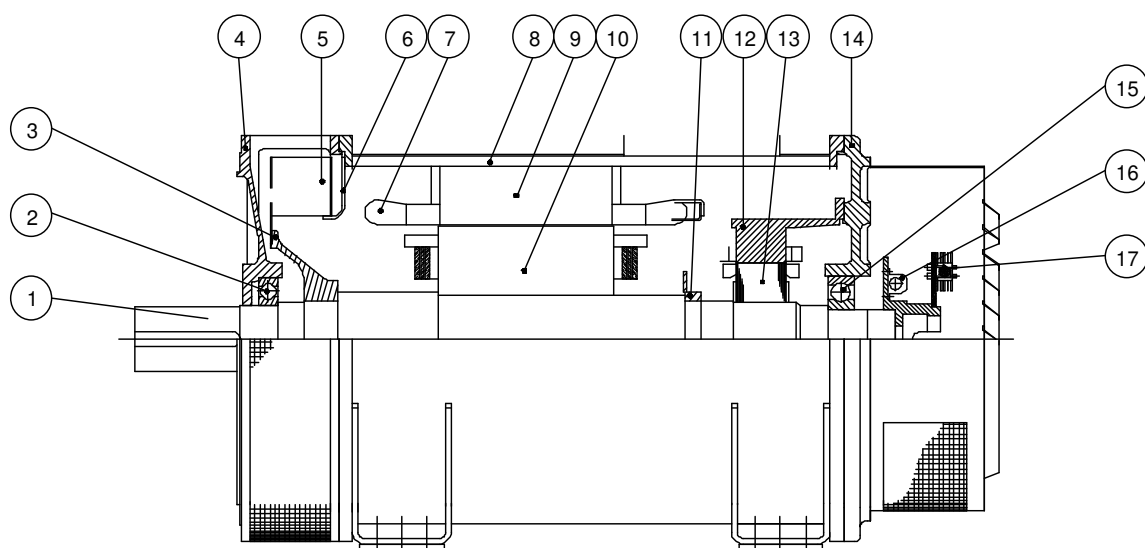
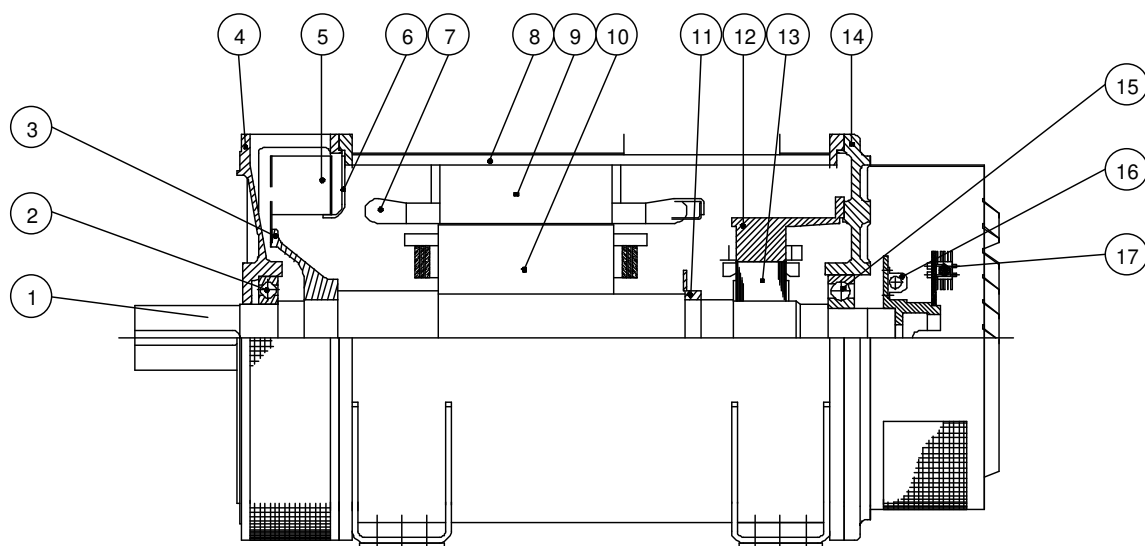
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10. TYPICAL CUT VIEWS

10.1 MACHINE CUT VIEWS

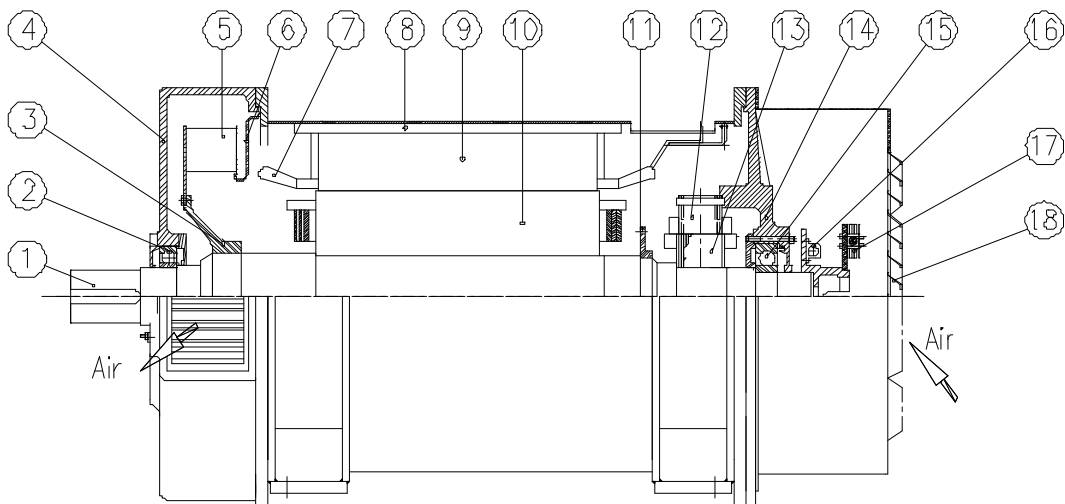
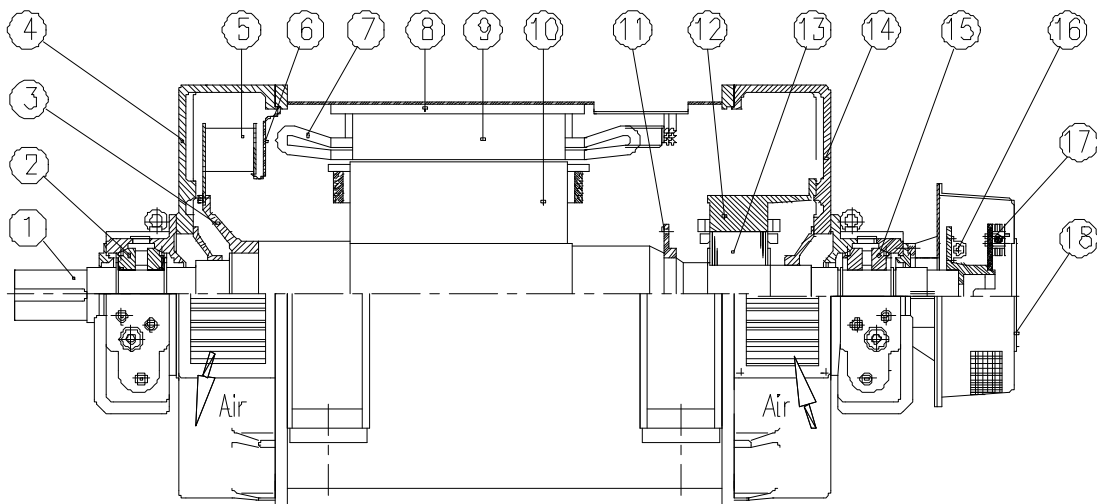
10.1.1 Machine type A52

- | | | | |
|---|---------------------|----|-------------------------|
| 1 | Rotor | 10 | Polar wheel |
| 2 | Bearing (drive end) | 11 | Balancing disc |
| 3 | Fan hub | 12 | Exciter field |
| 4 | Drive end shield | 13 | Exciter armature |
| 5 | Fan | 14 | Non drive end shield |
| 6 | Fan screen | 15 | Bearing (non drive end) |
| 7 | Stator winding | 16 | Rotating resistances |
| 8 | Stator ribs | 17 | Rotating diodes |
| 9 | Stator lamination | 18 | Diode bridge cover |



10.1.2 Machine type A53 ; A54

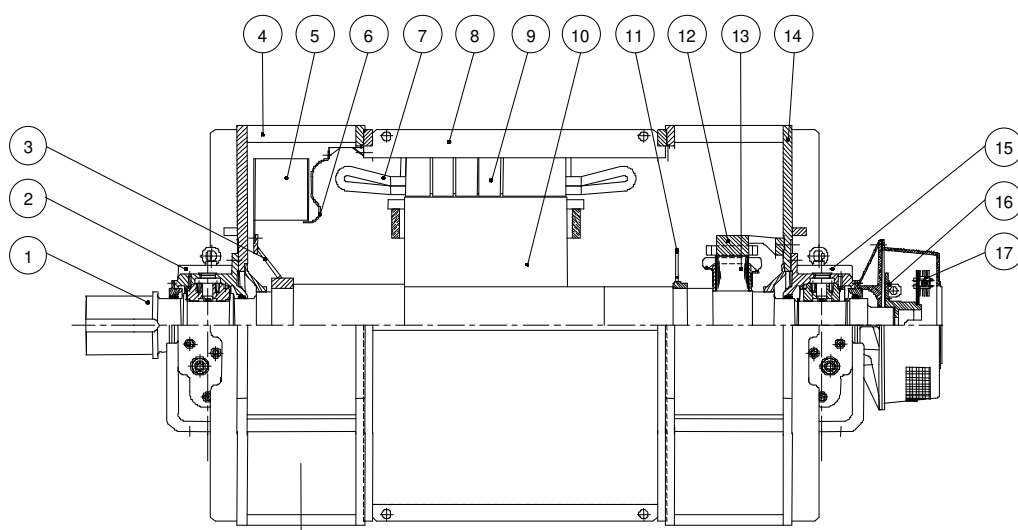
- | | | | |
|---|---------------------|----|-------------------------|
| 1 | Rotor | 10 | Polar wheel |
| 2 | Bearing (drive end) | 11 | Balancing disc |
| 3 | Fan hub | 12 | Exciter field |
| 4 | Drive end shield | 13 | Exciter armature |
| 5 | Fan | 14 | Non drive end shield |
| 6 | Fan screen | 15 | Bearing (non drive end) |
| 7 | Stator winding | 16 | Rotating resistances |
| 8 | Stator ribs | 17 | Rotating diodes |
| 9 | Stator lamination | 18 | Diode bridge cover |



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10.1.3 Machine type A56 ; A58

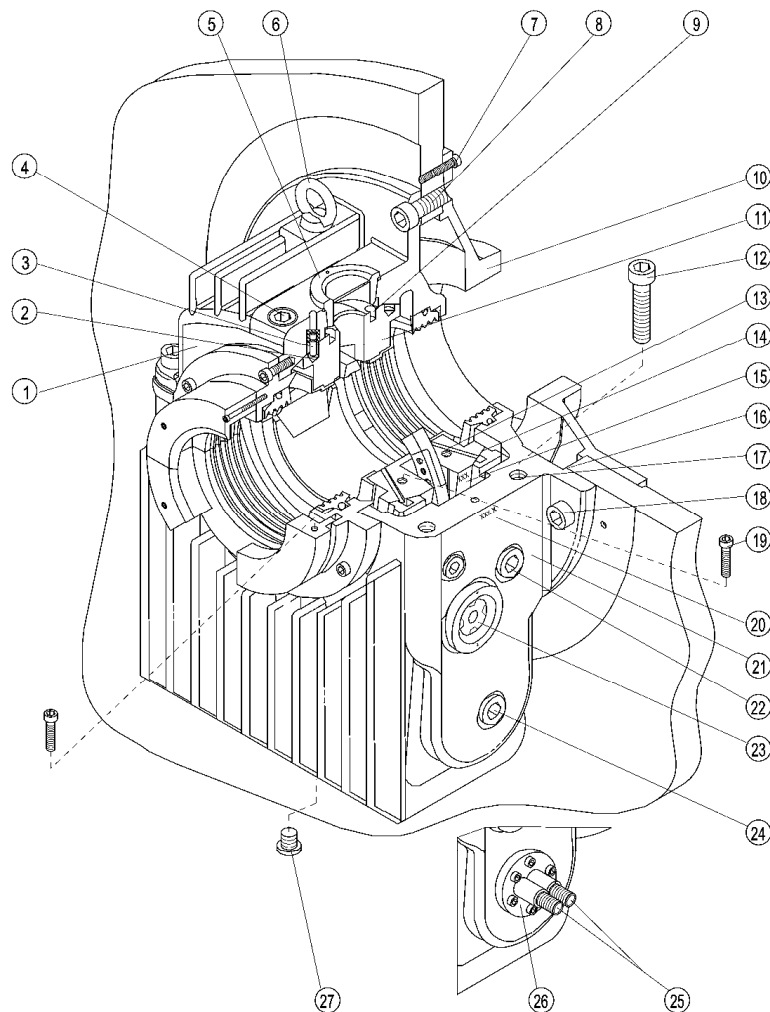
- | | | | |
|---|---------------------|----|-------------------------|
| 1 | Rotor | 10 | Polar wheel |
| 2 | Bearing (drive end) | 11 | Balancing disc |
| 3 | Fan hub | 12 | Exciter field |
| 4 | Drive end shield | 13 | Exciter armature |
| 5 | Fan | 14 | Non drive end shield |
| 6 | Fan screen | 15 | Bearing (non drive end) |
| 7 | Stator winding | 16 | Rotating resistances |
| 8 | Stator ribs | 17 | Rotating diodes |
| 9 | Stator lamination | 18 | Diode bridge cover |



10.2 FLANGED SLEEVE BEARING

10.2.1 Self lubricating bearing

- | | | | |
|----|--|----|---|
| 1 | Top half of the housing | 15 | Engraved number - bearing shell |
| 2 | Positioning pin hole | 16 | Recess |
| 3 | Positioning pin | 17 | Tap hole |
| 4 | Oil filler hole | 18 | Screw |
| 5 | Top sight glass | 19 | Split line screw - bearing shell |
| 6 | Eye bolt | 20 | Engraved numbers - bearing housing |
| 7 | Screw | 21 | Bottom half of the housing |
| 8 | Screw | 22 | Connection hole for temperature measurement of the journal part |
| 9 | Tap hole (in the top and bottom halves of the shell, up size 14) | 23 | Oil sight glass |
| 10 | Machine seal | 24 | Connection hole for the oil sump temperature measurement |
| 11 | Top half of the shell | 25 | Out/Inlet cooling water (Type ExW _{xx}) |
| 12 | Split line screw - bearing housing | 26 | Oil cooler (Type ExW _{xx}) |
| 13 | Bottom half of the shell | 27 | Oil drain plug |
| 14 | Spherical seating | | |



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10.2.2 Oil circulation bearing

- | | | | |
|----|--|----|---|
| 1 | Top half of the housing | 16 | Recess |
| 2 | Positioning pin hole | 17 | Tap hole |
| 3 | Positioning pin | 18 | Screw |
| 4 | Connection hole for the thrust part oil supply (optional) | 19 | Split line screw - bearing shell |
| 5 | Top sight glass | 20 | Engraved numbers - bearing housing |
| 6 | Eye bolt | 21 | Bottom half of the housing |
| 7 | Screw | 22 | Connection hole for temperature measurement of the journal part |
| 8 | Screw | 23 | Oil inlet connection hole |
| 9 | Tap hole (in the top and bottom halves of the shell, up size 14) | 24 | Connection hole for the oil sump temperature measurement |
| 10 | Machine seal | 25 | Out/Inlet cooling water (Type ExW _{xx}) |
| 11 | Top half of the shell | 26 | Oil cooler (Type ExW _{xx}) |
| 12 | Split line screw - bearing housing | 27 | Oil drain plug |
| 13 | Bottom half of the shell | 28 | Metal tabs (optional for EFZL _x) |
| 14 | Spherical seating | 29 | Oil outlet connection hole |
| 15 | Engraved number - bearing shell | 30 | Oil outlet pipe |
| | | 31 | Marking |

