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NoordzeeWind

NUON

Near Shore Windpark

Wbr/Wm vergunningaanvraag NSW

Bijlage VI:

- Onderhoudsplan -

Bijlage III

Service & Maintenance Manual – NM80 & NM92

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Service & Maintenance Manual – NM80 & NM92

Document opgemaakt ten behoeve van Wbr/Wm vergunningaanvraag Near Shore Windpark.

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Service & Maintenance Manual

NM80/2750 & NM92/2750

TIC 725'002 GB

Preface and revision status

This service manual has been prepared for use by trained NEG Micon service personnel or special external personnel accredited by NEG Micon. The manual describes the procedures for service the wind turbine's components, functions and safety systems. It shows when and how maintenance, adjustments and reporting of service work are to be carried out.

The manual has a detailed table of contents. Chapters 1 and 2 are an introduction, including general safety rules. Chapter 3 describes the service procedures. At the rear of the manual is an appendix with service data, service plans/checklists and extra component instructions. In addition a separate folder contains a drawings appendix for the service manual, together with general drawings and parts lists.

All sections dealing with procedures start with a list of reference documents and specific safety rules.

It assumed in this manual that users have already read the operating manual for the specific wind turbine and have been trained by the NEG Micon Service Department in wind turbine operation and in dealing with possible error situations.

The Service Manual has been prepared by the NEG Micon Development and Design Department and Service Department in consultation with NEG Micon suppliers and in compliance with the relevant requirements from the authorities.

NEG Micon (henceforward called NEGM) urges users of this manual to forward any suggestions for corrections or improvements so that these can be incorporated into the next revision.

Revisions of this manual are indicated on the table below. This page should always be updated and replaced when the manual is revised.

The pages are marked either with a project name/number and revision date at the base of each page, or in the case of standard manuals, with a R&D-TIC code at the base of each page opposite the page number.

Edition	Date	Remarks
001	06-11-2002	
002	27-01-2003	
003		
004		

Table of contents

1 General Information

1.1 The wind turbine and associated manuals

An NEGM wind turbine is a mechanical plant functioning as a power station and supplying electricity to the electricity grid. It is vital for safety that the plant is handled correctly and in accordance with this manual. Compliance with the manual's rules and instructions will ensure the plant a long service life and the minimum operating and maintenance costs.

NEGM's operating and control manual must be read carefully before operating the control system, mounting the tower or maintaining the plant. The safety regulations must also be read and followed scrupulously.

1.2 Liability and guarantee

The turbine owner has general responsibility for the operation and safety of the plant and must prevent all risks of the grid being threatened by its operation. Normally the owner will co-operate with NEGM's Service Department over this, on the basis of a Service Contract.

If major renovation work or the replacement of large parts is to be carried out after the expiry of the guarantee or service period, the owner must contact NEGM's Service Department. It must be borne in mind that detailed knowledge of and experience with lifting equipment, weights and the weight distribution of the different components is necessary to avoid accidental damage or injury to parts or persons during renovation work.

NEGM accepts no liability for direct damage or injury or consequential claims arising where the turbine owner himself carries out work to the plant or has it done by persons not approved by NEGM.

The turbine owner should inspect the plant at regular intervals to familiarise himself with normal operation and noise patterns. In this way, non-conforming operating forms or noises will be immediately reveal problems with the wind turbine, allowing the turbine owner to intervene and report the matter to NEGM's Service Department.

The wind turbine should be kept clean and tidy on safety grounds. This will also make it easier to detect any leakage.

During the period that the turbine is covered by NEGM's guarantee or service contract, service and other work on the plant may only be undertaken by NEGM's service engineers or carried out by persons working under NEGM's instructions and liability.

If the turbine owner carries out work on the plant himself without express consent or instruction from NEGM's Service Department or has the work done by non-authorised persons for whom NEGM can have no responsibility, NEGM's guarantee and liability for service work shall be immediately void.

In this context the word "work" includes all dismounting/mounting of components, set-up changes in the turbine computer and lubrication and bolt tensioning to main components, rotor, yaw system and tower.

Ordinary operation in accordance with the operating manual, visual inspection, cleaning etc. does not fall within this definition of work.

1.3 Service – scope and performance

1.3.1 General

The service procedures consist of a careful check of components, and the testing of the wind turbine's operation and safety systems. Service is carried out in accordance with this Service Manual and the associated Service Plan & Checklist – see Appendix.

The Service Engineer is responsible for ensuring that work is carried out in accordance with this manual and associated service documents. The Area Service Manager is responsible for supervision of the work, and may be contacted by the service fitters, for further advice and guidance in connection with the service work.

- **A – Service**

A – Service is executed 1 to 3 months after commissioning. A – Service is a single event service, and will be executed only once in the Service Life Time of the Wind Turbine.

A – Service is executed ±1 month according to Service Life Plan

- **B – Service**

B – Service is executed 6 months after commissioning, and repeated with one year intervals in the Service Life Time of the Wind Turbine.

B – Service is executed ±1 month according to Service Life Plan

- **C – Service**

C – Service is executed 6 months after commissioning, and repeated with one year intervals in the Service Life Time of the Wind Turbine.

C – Service is executed ±1 month according to Service Life Plan

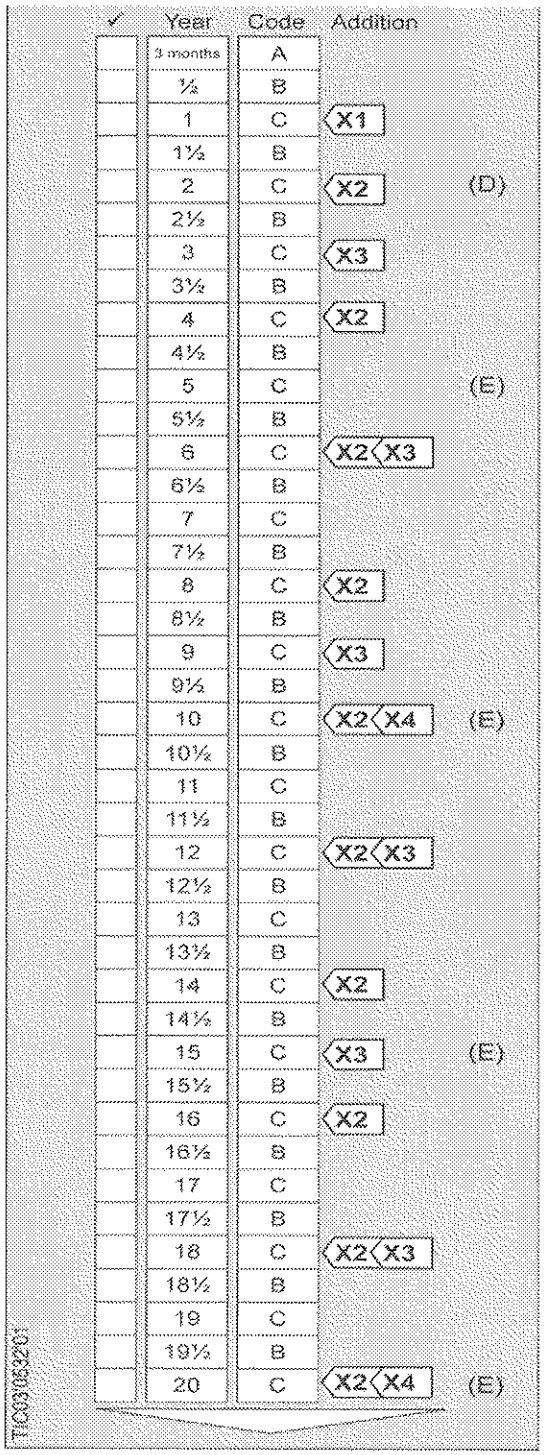
- **X – Service Extensions**

In some occasions an extension to service is needed. Extensions can be executed only once, or repeated through out the Service Life Time of the Wind Turbine.

NOTE – (D) & (E) refers to old naming of service visits at this point in turbine life.

1.3.2 The service life plan

As a helping tool the service plan & check list includes a graphic service life plan (see example below).



1.4 Replacement of parts

The service life of all main components is at least 20 years. Main components are defined as tower, blades, hub, main shaft, gear and generator. However, this does not mean that defects and errors may not arise, as durability is dependent on preventive maintenance and inspection.

1.5 Project-specific data, drawings, parts lists etc.

This manual is valid for the specific turbine type. All illustrations in the manual are location or principle sketches. All components are designated by their usual name. If detailed information is required about serial number, item code/parts lists with associated drawings for a particular project or turbine number should be consulted.

1.6 Service reports

- Service is performed in accordance with the service plan/checklist
- Major deviations are to be reported on a non-conformity report.
- A Service Report must be drawn up, showing materials consumed and spare parts employed for each service visit. The Service Report forms the basis of the customer invoice.
- The logbook located in the turbine is to be completed for each service visit.

2 Safety and safety equipment

2.1 General

A wind turbine is a plant containing rotating mechanical parts with a potential for causing dangerous situations. Certain basic safety rules must therefore be followed when visiting a wind turbine and in general the plant must be treated with respect.

Never inspect the plant or ascend the ladder unaccompanied. For safety reasons there must always be two persons present during any kind of work in the plant.

All persons present must be aware of the location of the others. Before moving to another area of the plant, remember to inform the others of your intentions and make sure they all understand and confirm your message before you move into place.

NOTE: This chapter contains general safety guidelines for working on the turbine. The necessary detail with regard to safety methods/instructions is given in the relevant chapters.

2.2 Site access and general site rules

1. Personnel may not work on the site unless they have taken the necessary safety training courses.
2. There must always be two persons on site apart from visits to the control room or in special cases where a single person is responsible for supervising a wind farm, provided that this person informs the supervisor or other responsible person at NEG Micon before and after carrying out the work.
3. Suitable personal protection equipment (PPE) must always be employed, as noted in Section 2.3. Special PPE for part-tasks is specified in the procedures.
4. Access to the site is prohibited in extreme weather conditions. This includes, but is not restricted to, blizzards, making access dangerous, and storms, with a higher risk of lightning strike.
5. Smoking is strictly forbidden outside the dedicated area.
6. Alcohol and other intoxicants may not be partaken of on site, and persons under their influence shall not be permitted access.
7. All waste, including waste created by engineers and site personnel must be placed in the rubbish bins or covered containers.
8. All forms of incineration of material on site are strictly forbidden.
9. The supervisor prior to starting must approve all welding and other use of flames, and all necessary precautions must be taken.
10. As far as possible, personnel must use the toilet facilities and not the site area for calls of nature.
11. Naked flames are not permitted on the site outside the marked areas.
12. All personnel must inform a "responsible person" before leaving the site.

2.2.1 Access to wind turbine area

Personal protection equipment (PPE): as a minimum, wear safety helmet and safety footwear when accessing the wind turbine.

1. In cold weather there is a risk of ice falling from the wind turbine blades. This is especially so when starting up after a period of low temperatures and low wind speeds. Do not approach a wind turbine if there is any risk of ice on the blades.
2. Fix the open tower door to the hinge to avoid being caught behind a slamming door.
3. Do not approach or remain in a wind turbine during an electric storm or if such storm is imminent.
4. Do not approach a wind turbine for the first hour after an electric storm has passed over due to the risk of static electricity on the blades.

2.2.2 Vehicles

1. All motor vehicles must contain a suitable fire extinguisher.
2. Up-to-date first aid equipment must be available in works vehicles and on work sites. Specially appointed personnel must have taken a suitable first-aid course with regular refresher courses.
3. Vehicles must only use approved access roads to the site.
4. Vehicles must not drive outside the site boundary.
5. Machine operators must not fill machines from a diesel drum: instead they must use a diesel tanker and drip tray.
6. All types of spillage of fuel/oil on the site must be immediately reported to the supervisor to allow prompt remedial action to be taken.
7. Maintenance (except in emergency situations) and oil changes to plant and vehicles are not permitted on site. All worn parts or oil used in emergency repairs must be disposed of responsibly off site.
8. A speed limit of 25 km/h applies to all types of vehicle on site.

2.2.3 Special vehicles

Drivers of special vehicles, such as extra wide or high vehicles, may only drive onto the site with the prior agreement of the supervisor, who will advise as to the preferred route and possible site risks. The supervisor will also arrange for auxiliary vehicles if necessary.

2.2.4 Visitors, public access and safety

All persons present at a wind turbine or on the work site without a work task to perform are defined as visitors. This includes persons employed to work at a different locality making a temporary visit to the site in question. A person present for the purpose of carrying out work to the wind turbine or associated equipment is defined as an employee however short the duration of the work. This person will be registered as a site employee, will receive introductory training and work under the normal rules for employees. All visitors to the site and all suppliers must report to the supervisor on arrival.

Visits may be made only with the supervisor's permission. A competent person must always accompany the visitor. Visitors must wear strong, enclosed shoes, suitable for muddy and stony areas, and must be suitably dressed. They will be assigned personal protection equipment, which they must wear.

2.3 Safety equipment and personal protection

While carrying out work on site, suitable personal protection equipment (PPE) must be worn. This includes, but is not restricted to, the following:

1. Safety helmet.
2. Safety footwear.
3. Ear defenders, where appropriate.
4. Work gloves, where appropriate.
5. Electrically insulated gloves, where appropriate.
6. Clothing suited to weather conditions.
7. Safety harness and lines, for climbing or work at heights
8. Eye protection, as required by the different sub-tasks.
9. Masks for tasks involving the mechanical removal of dust or where the air contains spray particles.
10. Insulation mats for electrical purposes, where appropriate.
11. Lowering hoists must be held in service vans and may be taken up when working in nacelles.

Suppliers must themselves provide all necessary safety equipment for the different tasks, unless otherwise specified in the contract with the customer. Protective clothing must be kept clean and functional, and must be kept in defined locations.

2.4 Prevention of fire

Fire must be guarded against on the whole site, including inside wind turbines, offices and mess rooms.

Comply with the smoking ban outside the office and stores area.

Do not use unofficial heating, lighting or cooking arrangements.

Do not place clothing on or near heaters.

Do not allow accumulations of flammable material or waste.

Use fire blankets when carrying out work with a risk of fire and follow the appropriate safety precautions.

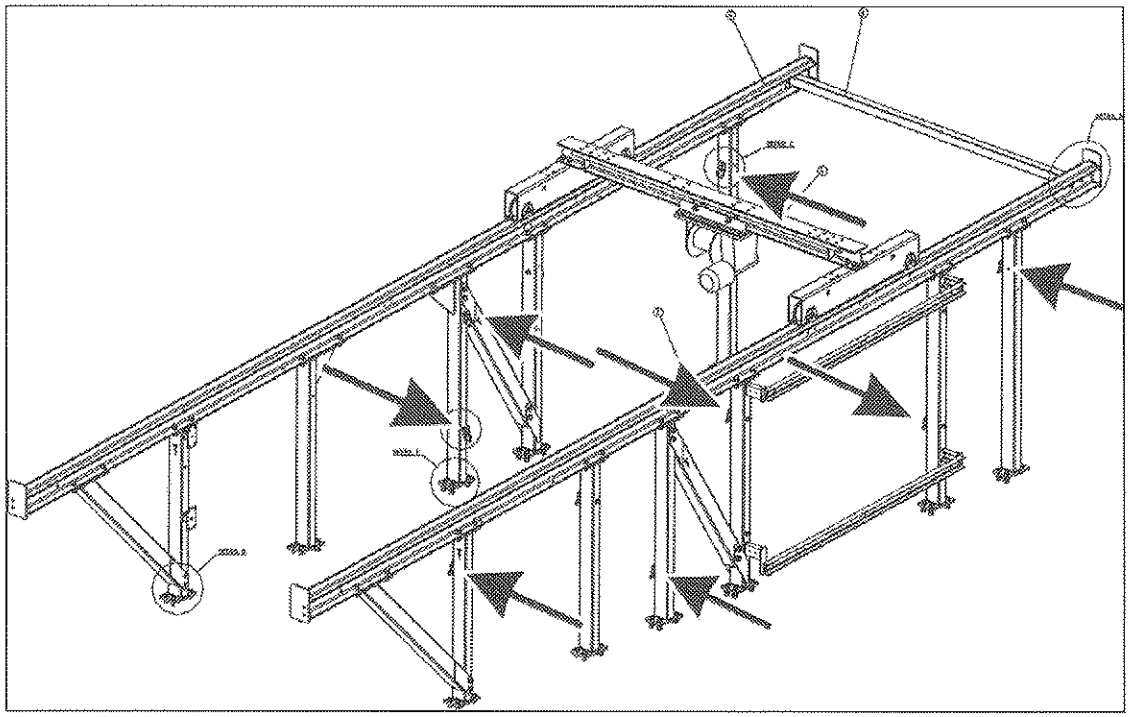
Be familiar with the location and use of fire extinguishers on the site.

Learn the emergency procedures in the case of fire.

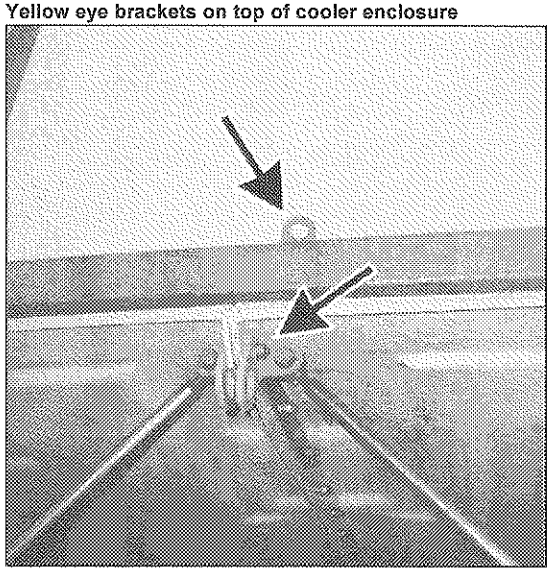
2.5 Working at heights

2.5.1 Hook up points

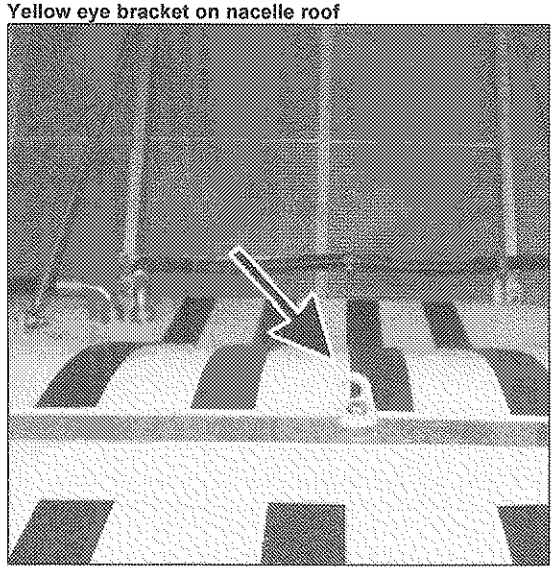
Hook up points in the nacelle are yellow eye brackets fixed to the crane construction



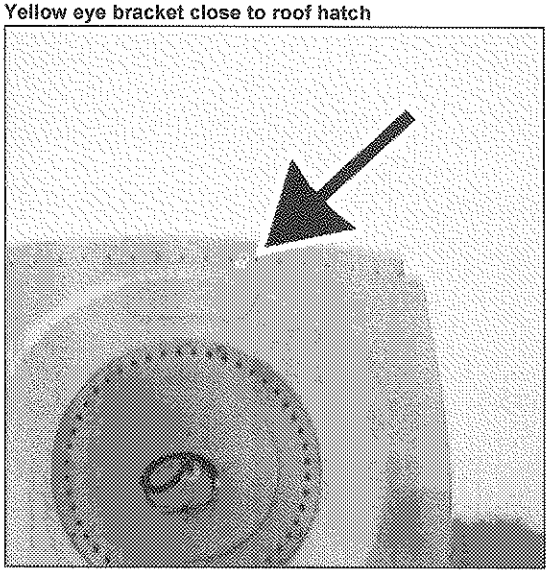
Yellow eye brackets on top of cooler enclosure



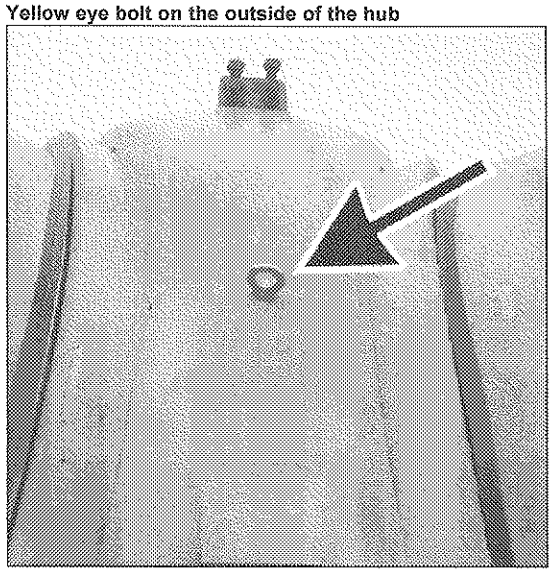
Yellow eye bracket on nacelle roof



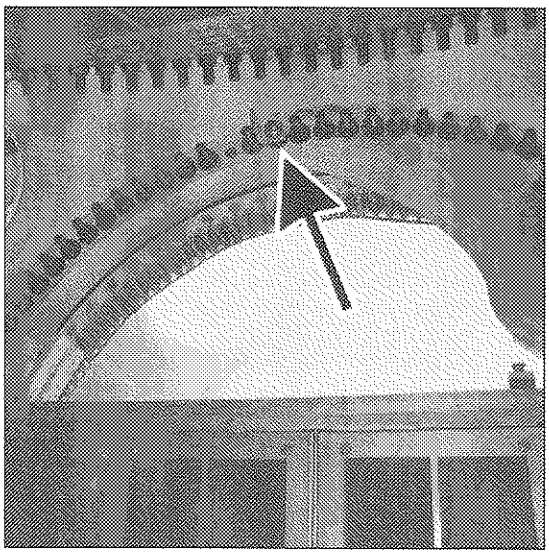
Yellow eye bracket close to roof hatch



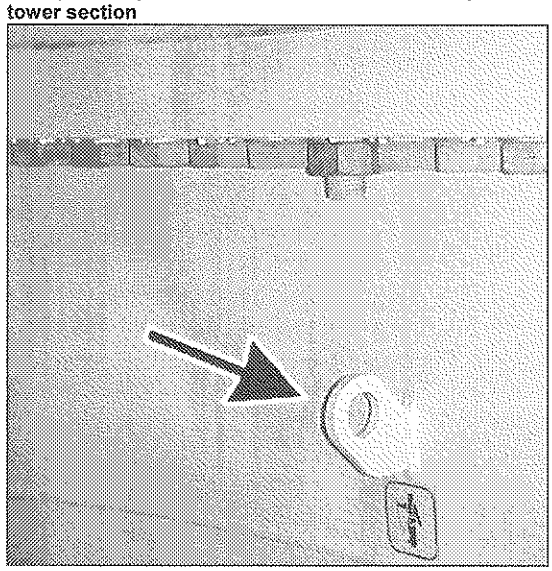
Yellow eye bolt on the outside of the hub



Yellow eye brackets inside hub



Four yellow eye brackets on tower wall in the top of each tower section



2.5.2 Working in the tower

1. When in the tower, you must wear safety footwear and a safety helmet.
2. The safety harness must be fixed to the safety rail or cable when ascending or descending.
3. Before ascending, check that the safety rail and harness are complete. If any form of fault is discovered, ascent must be postponed until the damage has been remedied.
4. When ascending and descending, small tools and other small loose parts must be kept in a bag or box fastened to your body, e.g. to the safety harness. Loose parts must not be carried in pockets. Heavy parts must be transported with the nacelle crane and not taken up manually.
5. Once the hatch between the nacelle and the tower has been closed and secured, it is permitted to disconnect the safety line if there is sufficient screening before the enclosure is mounted.

2.5.3 Working in the nacelle

1. The sky lights must not be opened at wind speeds over 20 m/s.
2. If there is a risk of a person falling from the nacelle, the long strap on the safety line must be fixed to yellow hook up points in the nacelle. If necessary several belts can be joined to secure access to a work position far from the fixing point.
3. When working outside on top of the nacelle or on the hub all tools must be securely fixed to either the safety belt or to one of the yellow hook up points.
4. The mechanical brake is engaged when it is necessary to stop the rotor rotating.
5. A sign in the nacelle indicates the escape route in the case of fire in the tower.
6. In the case of fire in the tower, the escape route is by hoist through the bottom hatch in the bracket section.

2.6 Manual handling and lifting of objects

Manual handling must only be used when there is no alternative. If manual handling is necessary, the following guidelines must be adhered to:

1. If the weight is too heavy, cumbersome or difficult to hold or too unstable for one person to manage, use two persons to lift and carry it.
2. If possible, push or pull the object rather than lifting it. It must be ensured that the object can be pushed or pulled in controlled manner.
3. Wear safety footwear. If possible, wear gloves to protect the hands from sharp edges, splinters etc.
4. It is important to ensure good access to the object to enable it to be lifted correctly. Also make sure that there are no obstacles in the route over which the object is to be transported.
5. If possible, the object must be lifted and carried at between shoulder and hip height.
6. If the object is to be lifted from a position under hip height, bend the knees rather than the back when lifting. Place the feet a shoulder's width apart with the toes forward. Keep your back straight and look up while lifting. The object must be carried as close to the body as possible.
7. Avoid twisting the body when lifting and carrying the object.

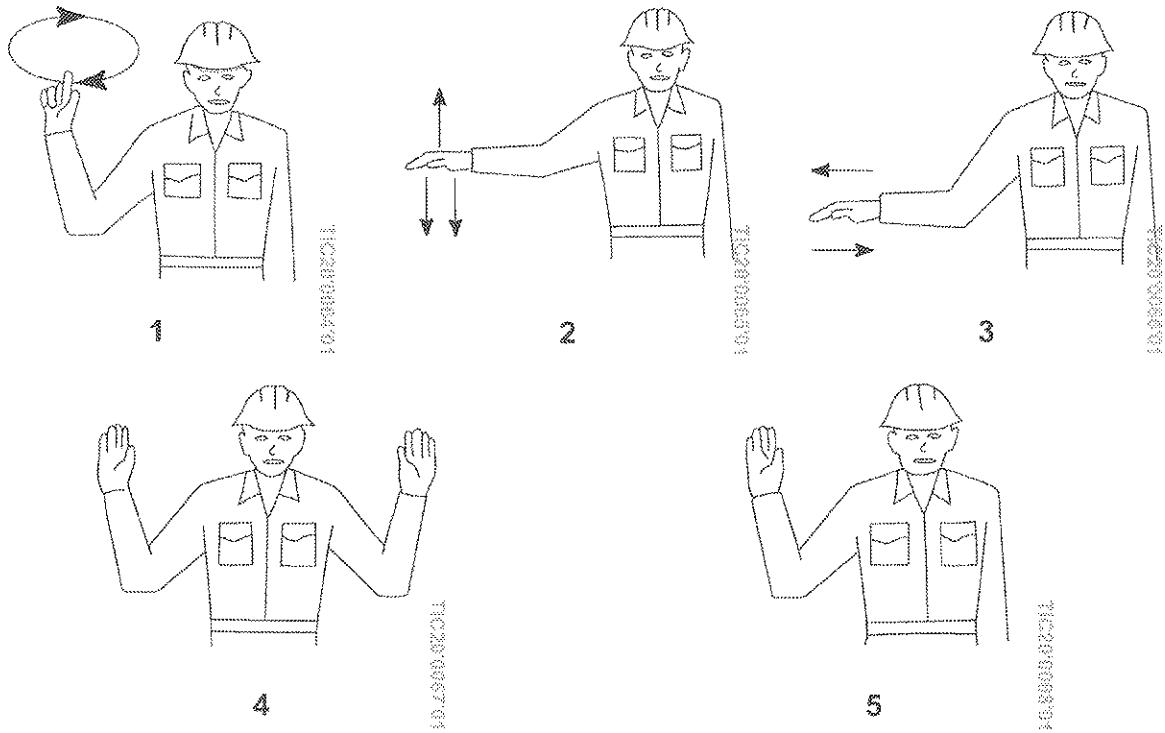
2.7 Rules for mechanical hoists and crane work

1. If possible always use mechanical aids for lifting.
2. Use the service crane for lifting tools and equipment into the nacelle. The rotor must be braked before using the crane.
3. Before lifting with crane, forklift or other mechanical equipment, ensure that the lifting equipment (e.g. crane, forklift, straps, lifting frames) is certified. The lifting equipment must be marked with its maximum lifting capacity. The responsibility for certification and marking of lifting equipment rests with the supplier of the equipment.
4. Machine operators must have a valid and approved licence for operating cranes and forklifts.
5. Rigging may only be carried out by a qualified person. It is this person's responsibility to determine the weight of the object and to select a suitable lift for it.
6. Carry out a visual inspection of the lifting equipment prior to use. Never use defective equipment. Label defective equipment: "DO NOT USE".
7. Plan the lift and make sure all involved personnel understand the plan.
8. Arrange barriers to ensure that no-one walk under a lifted object.

9. Establish and maintain good communication between all involved. Use standard crane signals
10. Persons outside hearing range must use standard crane signals to control the lift.
11. Persons who cannot see each other (e.g. a crane driver and a fitter in the nacelle) must control the lift by radio or telephone.
12. Lifting and control of main components, tower sections, nacelle and rotor may only be carried out by competent, trained personnel.
13. No persons other than those involved in the lift may enter the lifting area.

2.7.1 Crane signals

International recognised crane signals



1. ***HOIST*** – *Lift one hand and move it in circles horizontally*
2. ***LOWER*** – *Lift one hand and move it up and downwards*
3. ***DIRECTION*** – *Show the hand stretched out and move it back and forth in the wanted direction. Also use the sign for jib position and reach.*
4. ***QUICK EMERGENCY STOP*** – *Lift both hands and face the palm of the hands to the crane operator. The sign can be showed by anyone facing the crane operator.*
5. ***STOP*** – *Lift one hand and face the palm towards the crane operator. Keep the hand still.*

2.8 Rules for two-man teams

There must normally be at least two persons for each task. (In special circumstances independent work can be permitted: see safety procedures for independent work).

1. Make sure than all tasks are planned for at least two persons and that the two persons are not isolated from each other during the work (e.g. out of sight or hearing range).
2. If for any reasons one of the team needs a break, the work must be interrupted.
3. Under no circumstances may a person halt the work or leave the area without informing the other.
4. The other person must take on an interventionist role. For example he must regularly call to his colleague if the latter is out of sight.
5. If the two persons are so far from each other as to be out of hearing range, two-way radios or mobile phones must be used. Check that the batteries in the telephone or radio have sufficient charge at the start of work.

2.9 Independent work

In special cases not involving electrical work, service personnel may be permitted to work independently, i.e. without a partner. If independent work is carried out, the following rules must be followed:

1. Only competent personnel may work independently.
2. The independent worker must always have a facility for contacting another person at the company or in the site office via mobile telephone or two-way radio. Check that the batteries in the telephone or radio have sufficient charge before work begins.
3. The independent worker and the person at the company or site office must have agreed an emergency procedure before the worker departs for the site to carry out the task.
4. The independent worker must inform the person at the company when he arrives at the site area and when work is complete and the site left.
5. The person at the company/site office and the independent worker must agree to contact each other at set intervals. If the individual worker does not contact the base person at the agreed time, the last-named must set in motion the agreed emergency procedure and then start to search for the person.

2.10 Rules for electrical work

2.10.1 General

It is only permitted for fitters employed by NEG Micon or NEG Micon's electrical supplier to carry out inspection, testing and repair of electrical installations and equipment. There must always be two persons present when working on live equipment (120V and above).

2.10.2 High voltage

In this manual, high voltage is defined as 1000 V and above, in accordance with international standards.

1. There must always be two persons present when working on high voltage equipment.
2. Before work begins, the electrical equipment must be by a qualified person.
3. The circuit being worked on must be declared "dead" by the use of authorised equipment before work begins. The testing equipment must be tested before and after the circuit has been declared dead.
4. If it is necessary to test a circuit in live state, the testing equipment must be contact-voltage proof.
5. The contact-voltage proof testing equipment must be earthed.
6. The switch controlling the testing equipment must be locked, if possible and the key kept by the person leading the work.
7. There must be a warning notice on the insulation.
8. All instructions regarding the high voltage system must be in writing if possible. If communication is verbal, the instructions must be written down and read back to the originator to make sure that they have been correctly received. Signals or an agreed time interval MAY NOT BE USED for switching equipment on or off.
9. The electrician carrying out this task must have adequate personal protection equipment (PPE), including but not limited to rubber gloves, rubber mats and insulated footwear.
10. Electricians must use insulated electrical tools.

2.10.3 Low voltage

In this manual, low voltage is defined as less than 100V in accordance with international standards.

1. If possible equipment must be isolated before starting work
2. If it is necessary to test a circuit in live state, testing equipment must be contact-voltage proof.
3. If the equipment is controlled by a switch, this must be interrupted wherever possible and the key kept by the person leading the work.
4. If the equipment is controlled by fuses, these must be removed and kept by the person leading the work.
5. Using authorised equipment it must be established before work begins that the circuit to be worked on is dead. The testing equipment must be tested before and after the circuit is declared dead.
6. The electrician carrying out this task must have adequate personal protection equipment (PPE), including but not limited to rubber gloves, rubber mats and insulated footwear.
7. Electricians must use insulated electrical tools.

2.11 High temperatures

High temperature work includes all processes involving welding, burning or grinding in plant containing inflammable material.

SAFETY EQUIPMENT: use safety footwear, head protection, eye protection, long-sleeved upper garments and long trousers, as a minimum.

1. Inform the supervisor that work-involving risk of fire is being undertaken in order to allow co-ordination with other work on site.
2. Take all precautions against fire, such as clearing up flammable materials as far as possible or setting up screens around ignitable material. Fire blankets must be used during work involving risk of fire.
3. It must be ensured that a fire extinguisher is available near the work area.

2.12 Excavation

1. Excavation may only be carried out by trained personnel.
2. The supervisor must be informed ahead of any kind of excavation, to allow co-ordination with other nearby work.
3. Drawings of the area must be studied to reveal the existence and location of cables, piping etc. in the earth.
4. The local authorities must approve the excavation in cases where public authorities may have laid cables, piping etc.
5. A work permit must also be obtained if excavation is to be carried out near underground cables.
6. The area must be cordoned off to prevent access by non-authorised persons.

2.13 Remote control

The wind turbine may be operated by remote control by the owner or by NEG Micon's Installation and Service Department. This also includes a facility for starting up the wind turbine, which is a possible source of injury to personnel inside or near the wind turbine.

WARNING: It is important that service personnel turn the service keys or interrupt the telephonic connection before entering the wind turbine, in order to disable the remote control function.

2.14 Work permit

NOTE: Work permit systems (typically in connection with electrical work) are to be used only in countries where this is required under local regulations and legislation. See further information in the project-specific Health and Safety Manual.

2.15 Maintenance and inspection of cranes, lifting equipment, safety equipment and devices

It is important to ensure that all safety equipment used when installing and servicing the wind turbine is accessible and in good order. The responsibility for this rests with I&S in co-operation with the crane company and any external suppliers.

IMPORTANT: If any kind of problem with the equipment is noted, contact the supervisor immediately.

2.16 Safety instructions

2.16.1 In case of fire

In case of fire in the nacelle or control system, the plant should be evacuated immediately and the power supply shut down at soon as possible at the maximum cutout in the wind turbine or at the transformer station. The manager must be informed without delay, if possible, so that he can take the necessary precautions in relation to the electricity grid.

If possible the fire should be put out with the powder extinguisher.

If the fire cannot be put out, the area should be cordoned off and the police/fire service/service department summoned.

2.16.2 In case of runaway operation

Runaway operation is almost impossible as it would require several circumstance to happen at once: the generator would have to be disconnected or the electricity grid to have gone down, only one or none of the blades tips to have turned in the case of overspeed, the disk brakes to have failed and the wind speed to be very high.

However, if runaway operation should occur, the plant should be evacuated immediately and the surrounding area cordoned off. Do not attempt to remain behind or "save" the plant. The turbine can be replaced, but human life cannot!

Do not approach within 500 m of a runaway plant.

2.16.3 Thunderstorms

During a thunderstorm there is a risk of lightning striking the tower despite the lightning protection equipment.

Do not remain in or near the tower and be prepared for blade parts falling to the ground due to lightning strike.

Once the storm has blown over, wait at least one hour before approaching the tower again. If there is still a crackling sound from the wet blades (i.e. they are still electrically charged) do not approach or touch the plant.

If the tower is struck by lightning and has suffered visible damage, cut off the power supply to the plant and contact the Service Department for further inspection. However, a lightning strike will usually always cause the automatic cut out to trip, with damage only to the MTA block.

2.16.4 In case of unusual noise patterns

It is always important for the turbine owner or operations manager to become familiar with the turbine's noise patterns. Often an unusual noise pattern will reveal that an abnormal or faulty situation has arisen or is developing.

If inexplicable or unusual noises occur during ordinary operation, contact the Service Department. Halt the plant if it is felt that continued operation with an unrecognised noise could develop into something dangerous or cause further repair costs.

2.16.5 Locking the yaw system

The yaw system can be locked in place mechanically by interrupting the automatic cut out on the control panel and locking the cabinet.

The above procedure is necessary when servicing the yaw system or for other service work where yawing is not permitted.

If mechanical locking is needed for major work, one of the yaw motors should be dismounted and a cover plate for gear locking mounted (Service equipment).

2.16.6 Locking the rotor

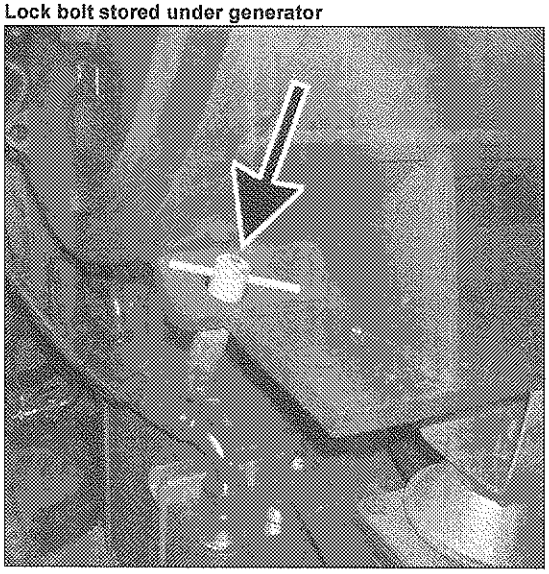
2.16.6.1 Using the locking bolt in the brake disk. (<15m/s)

SAFETY PRECAUTION: Locking bolts in the brake disk may NOT be used at wind speeds over 15 m/s. At least one blade must be in breaking position. See Installation & Service Data.

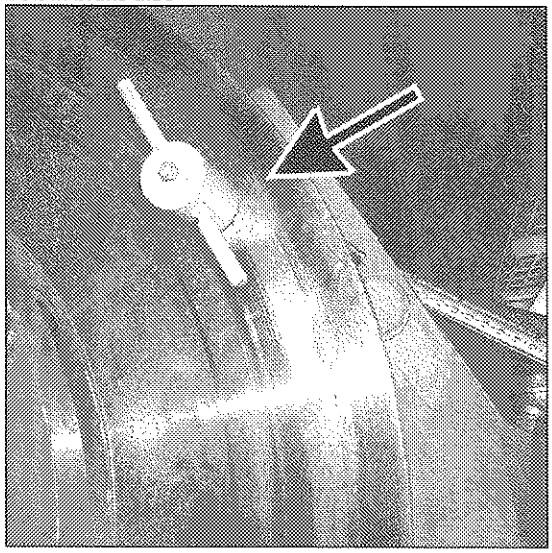
The brake disk has two diametrically opposite holes to take a 24 mm cotter bolt for manual locking of the high-speed gear shaft. Insert the bolt in one of the holes and fix it with the cotter.

When working on the rotor, rotor shaft, and gearbox or when changing the brake lining, the gearbox shafts must be locked with a locking bolt on the brake disk.

Lock bolt stored under generator



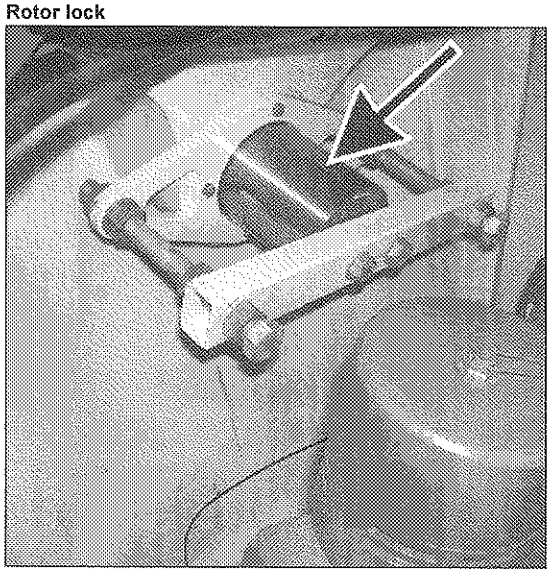
Bolt in brake disc



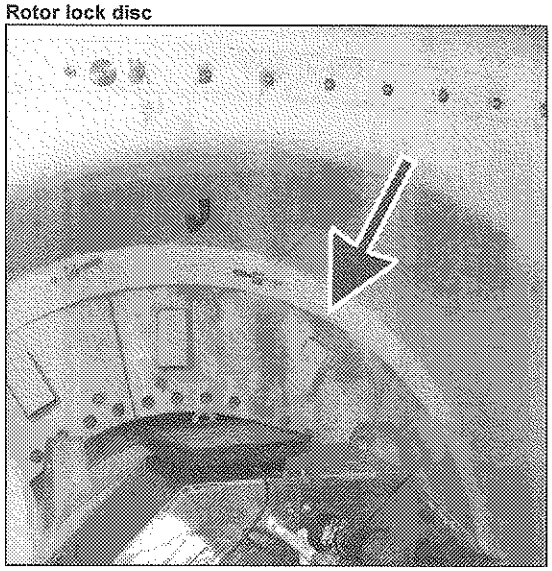
2.16.6.2 Using the rotor lock at the main bearings (<25 m/s)

The rotor lock is mounted in the nacelle and is ready for use. The tip of the lock is conical and makes its way into one of the holes in the rotor lock disc. The lock is pressed into place by means of a wrench.

Rotor lock



Rotor lock disc



IMPORTANT: Always check the weather forecast for the period for which the rotor is to be locked. If severe weather is predicted, try to postpone the work, if possible.

NOTE: the rotor lock is designed for parking a wind turbine for a period, e.g. while replacing a major component. The rotor lock is dimensioned for 25 m/s. If wind speeds have been higher than this over the parking period, the bolts in the rotor/hub assembly and those between the bearing housing and the base frame must be closely checked for damage, especially on their threads, and, if any damage is observed, replaced before wind turbine operation recommences.

SAFETY PRECAUTIONS: Work on mounting or dismounting the rotor lock may not be carried out at wind speeds over 10 m/s TOOLS: Always bring an extra power supply so that mounting can be completed in the event that the wind turbine's power supply fails.

2.16.7 Instructions for use of safety equipment

- Instructions for use of fall protection equipment and lowering equipment are located in the wind turbine.
- See Operating Manual for further information on safety equipment and notices.
- Note that some of the safety equipment and notices described in this manual are special equipment and not included in the standard NEGM consignment.

2.17 Service instructions – Safety Equipment

SAFETY EQUIPMENT: Helmet and protective footwear and fall protection.

NOTE: Some of the following safety equipment is extra equipment, individually designed for the requirements of customers and local authorities and therefore not included in the standard NEG consignment.

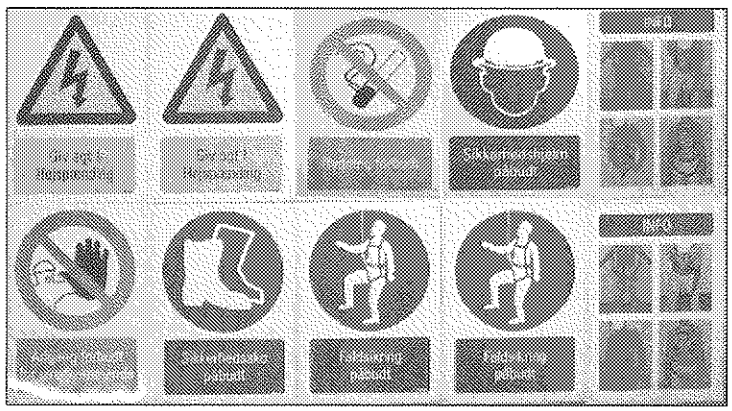
NOTE: There may be special official requirements for safety equipment, which require specially trained fitters/inspectors.

2.17.1 Check of fall protection equipment

- Visual check of fall protection rail/wire on ladder for damage.
- Check that slides lock onto the rail or wire and are lubricated with oil. If the slide does not lock it must be replaced.
- Check of runners, snap hook and shock absorbers for rust, cracks deformation and function.
- Check of all fall protection harnesses for wear and function.

2.17.2 Check of signs and instructions,

- Visual check of signs and instructions. Damaged or lacking signs must be replaced.



2.17.3 Check of other safety components

- Check fixing points, eye bolts handrails and screens for rust, cracks, fixing and other visible damage.

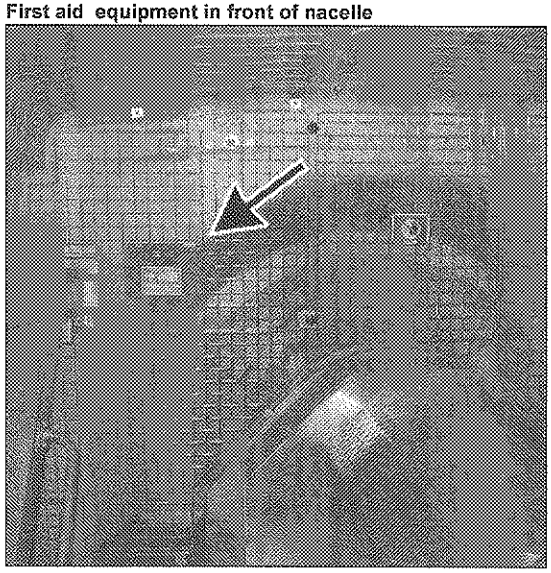
2.17.4 Check of lowering equipment

- Check lowering unit for rust, dirt and damage
- Test of the unit's braking mechanism by pulling on the line. The unit must exert resistance.
- Visual check of bag and line.

2.17.5 Check of first aid equipment

- Check that the contents are correct.

First aid equipment in front of nacelle

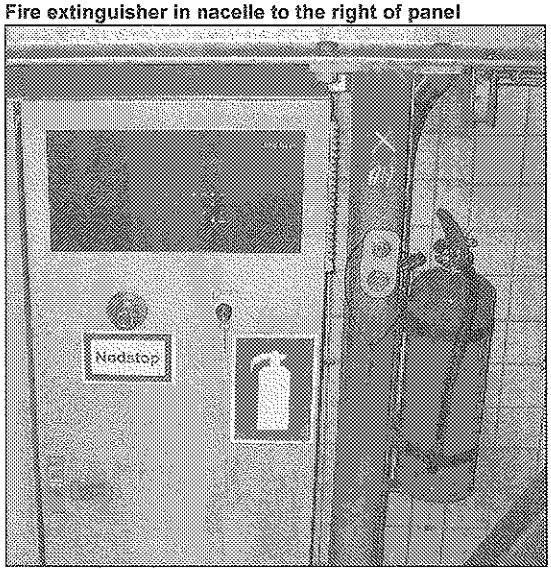


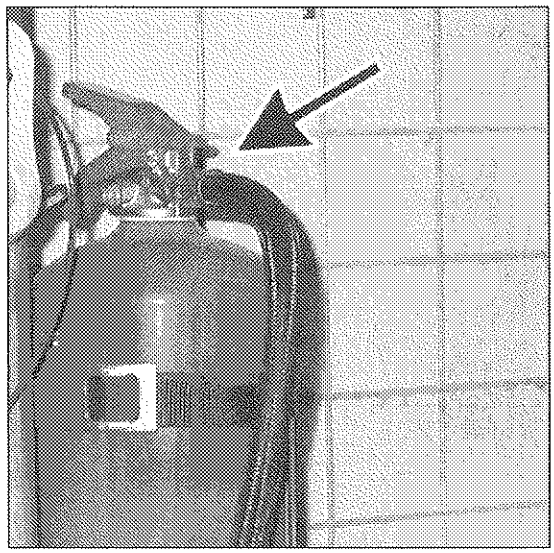
2.17.6 Check of fire extinguishers

- Check that the manometer on the fire extinguisher shows the correct pressure.

- Visual check of handle and split pin for damage.

Fire extinguisher in nacelle to the right of panel





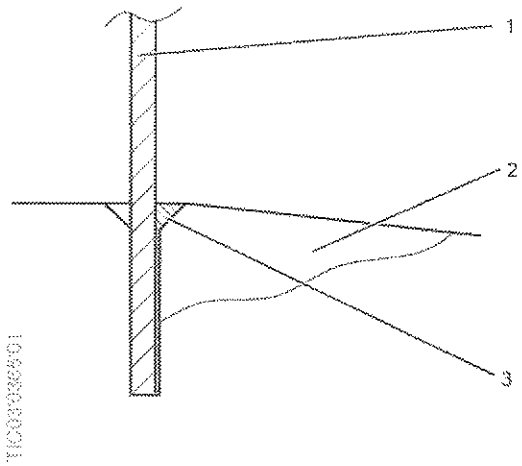
3 Service instructions – Tower

REFERENCES: Appendix, Installation & Service Data, Weight, Dimension & Transport Guide
SAFETY EQUIPMENT: Safety helmet, safety shoes, fall arrest harness

3.1 Foundation

Check the concrete surface for cracks at the transition between the concrete and the embedded section. If any cracks are present in the sealing, they must be repaired with a flexible tar product (ex. Icopal Broisolation no. 2).

Sealing of the embedded section



1. *Embedded section*
2. *Shelling*
3. *Sealing*

3.2 Construction

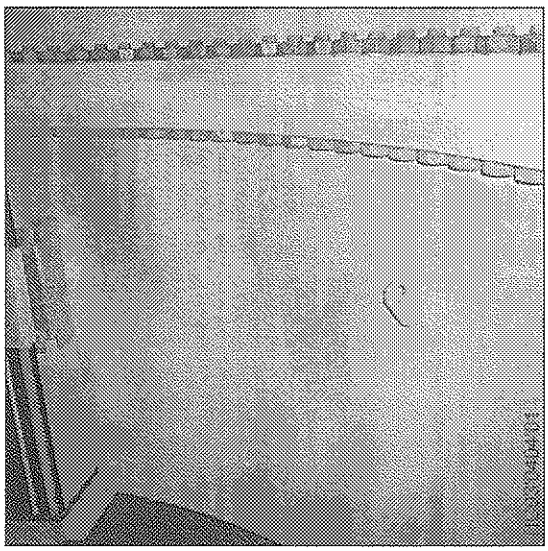
3.2.1 Bolts

IMPORTANT: To avoid damage on the paint work, the tightening tool must be kept free of contact with the tower wall, when tightening the bolts in the flange joints of the tower sections

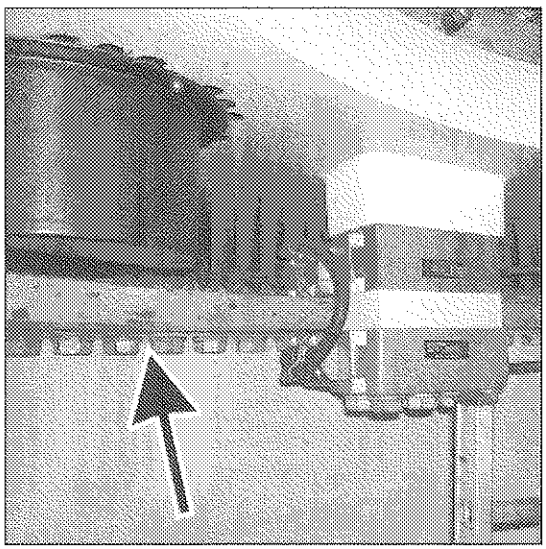
The tightening tool must be kept free of contact with the tower wall

- Retighten the tower bolts between sections in accordance with service plan. Torque tightness in accordance with Installation & Service Data.
- Retighten the tower bolts between the top section and the nacelle (yaw system) in accordance with service plan. Torque tightness in accordance with Installation & Service Data.
- If the bottom section is bolted to the embedded section, retighten bolts. Torque tightness in accordance with Installation & Service Data.
- Damaged bolts and nuts must be replaced in accordance with specification.

Tower section bolt flange joint



Nacelle / tower bolt joint



3.2.2 Welds and flanges

- Visual 10-year inspection of doorframe and welds between doorframe and tower shell.
- Visual inspections of structure around hole just below top flange.
- If cracks are found they must be reported and tested as further specified (contact R&D).

3.2.3 Surface treatment and lubrication

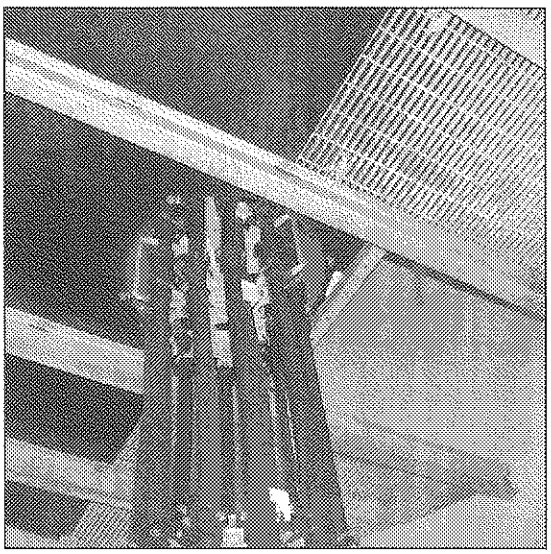
- Check the galvanization and paint work for damage.
- Remove any rust with brush or grind and paint in accordance with paint work specification.
- Lubricate door hinges and lock with oil

3.3 Fitting-out equipment

3.3.1 Platforms

- Check platforms for damage.
- Check and if necessary, retighten fixings for platform stays.

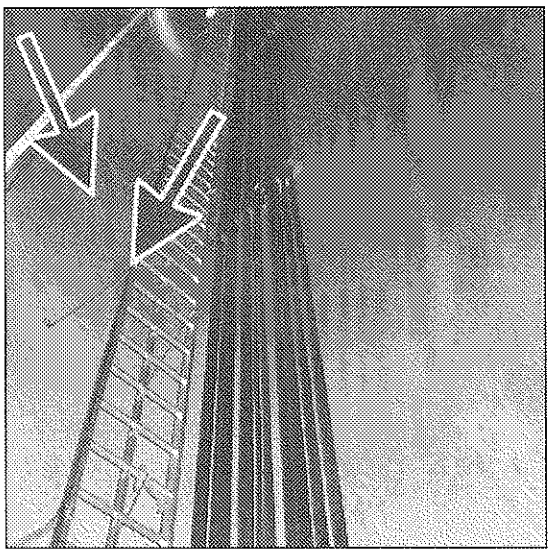
Platform in tower



3.3.2 Ladders

- Check and if necessary, retighten fixings for ladder fittings.

Ladder fixing



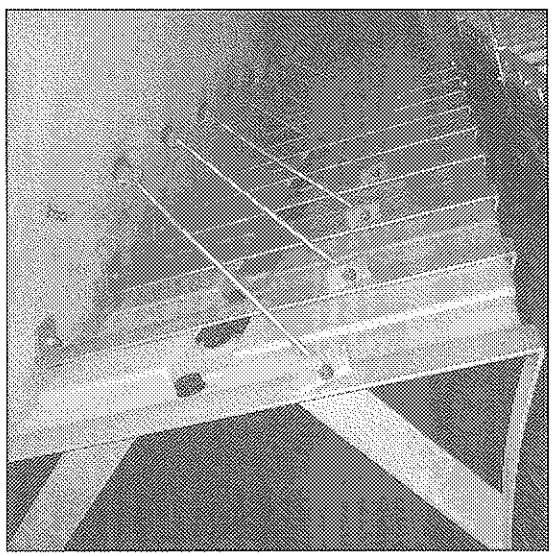
3.3.3 Electrical cabinets, cables, lighting

- See Chapter "Electrical Parts"

3.4 Tower dampers

The tower dampers consist of a number of containers in the tower top, arranged in two columns just below the top platform. The containers are filled with a pre-defined amount of liquid. The volume of the liquid in each container, and the number of containers in each tower varies from tower to tower.

Tower dampers on left side of the ladder



The container at the base of the right-hand column (from the ladder) has a label to the right of its four holes giving the following information:

- The date the containers were filled
- The type of liquid in the containers
- The volume of liquid in liters
- The level of liquid measured from the base of the container during standstill

The containers are numbered from the bottom of the right-hand column up, followed by the bottom of the left-hand column up.

During service:

- Check the containers for any sign of leakage. Especially from the holes at the side of the containers facing the crane.

Measure the liquid level from the base of the containers upwards when the wind turbine is at a standstill. The measured liquid level should agree with the data on the label on the lower right-hand container. Tolerance: +/- 5 mm. The liquid level can be seen through the white polyethylene wall. A torch may be helpful.

If one or more containers are leaking:

- Mop as well as possible
- Check if the leak can be stopped, by turning the plug. If not, empty the leaking containers by removing the screw plug and drilling out the polyethylene in the bottom hole at the side facing the ladder. Ensure a facility for capturing the liquid is by hand. To allow air to enter the container, the screw plug above the liquid level may be removed and the polyethylene in the ½" hole bored out. When no more liquid can be removed, screw the plugs in again. It is impossible to remove all the liquid.

Information including date, wind turbine number and amount of containers from which liquid has been removed must be reported.

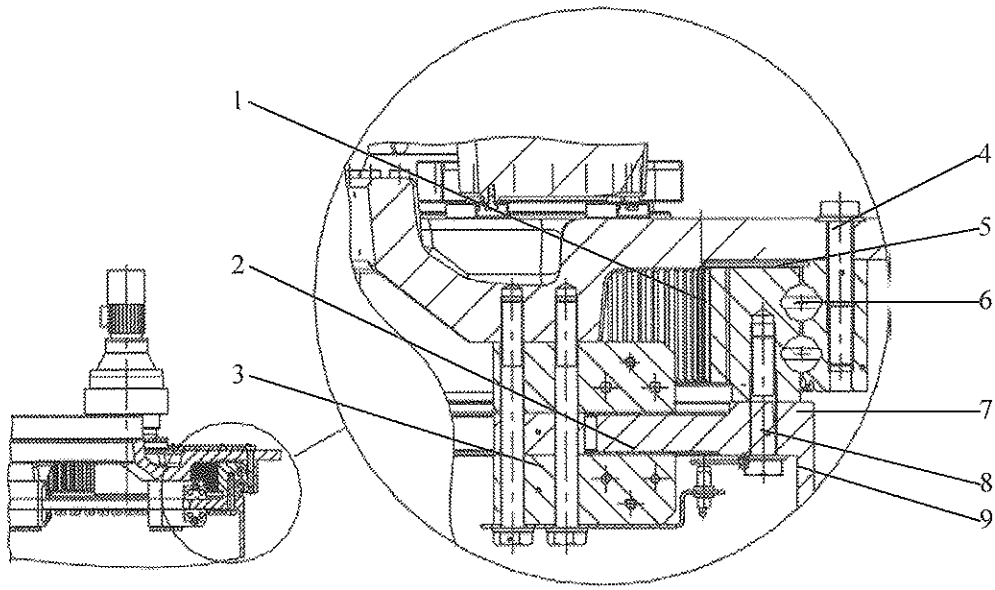
4 Service instructions – Nacelle

4.1 Yaw system

REFERENCES: Appendix Installation & Service Data

SAFETY EQUIPMENT: Safety helmet and safety shoes.

Yaw system



1. *Internal gearing yaw ring*
2. *Brake block*
3. *Brake caliper*
4. *Bolt for yaw ring / nacelle*
5. *Seal*
6. *Yaw bearing*
7. *Top flange with yaw ring*
8. *Bolt for tower top flange / yaw system*
9. *Tower*

4.1.1 Yaw bearing

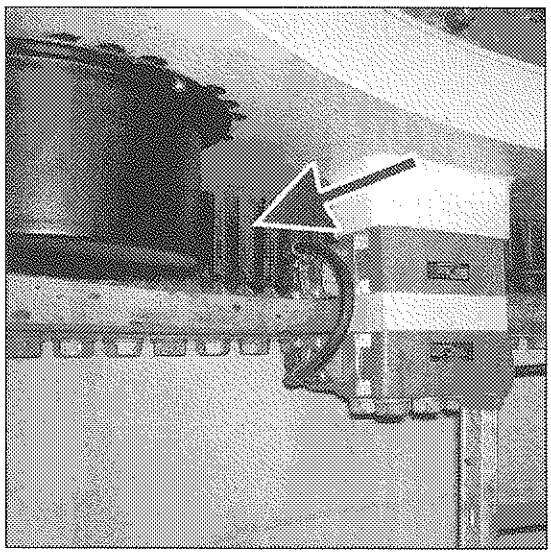
4.1.1.1 Seals

- Visually check seals for cracks and wear.
- If seals are damaged, they must be replaced.
- Clean seals and seal surfaces.

4.1.1.2 Yaw ring

- Check the teeth visually for wear and cracks. Mark and report damaged teeth and assess whether the turbine can continue operations with more frequent inspection intervals.

Yaw ring teeth



4.1.2 Yaw gear

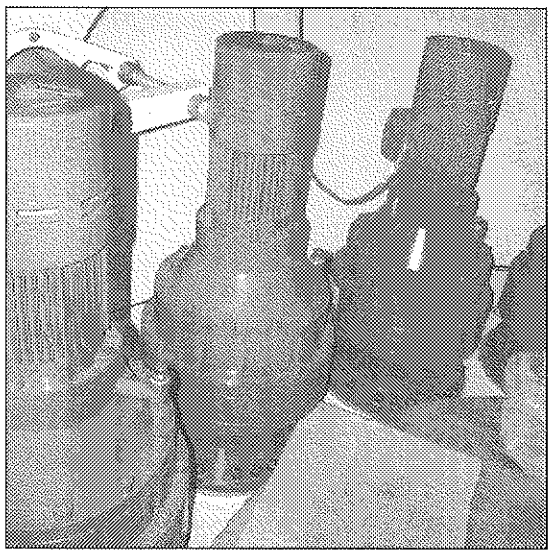
4.1.2.1 Seals

- Check the gear visually for leaks.
- If joints are leaking, retighten the bolts.
- Check the gasket at the exit shaft.
- If the gasket is leaking, report this and decide if it is necessary to change the gasket – or if the turbine can continue to operate with more frequent inspection intervals.

4.1.2.2 Yaw motor

- Function test

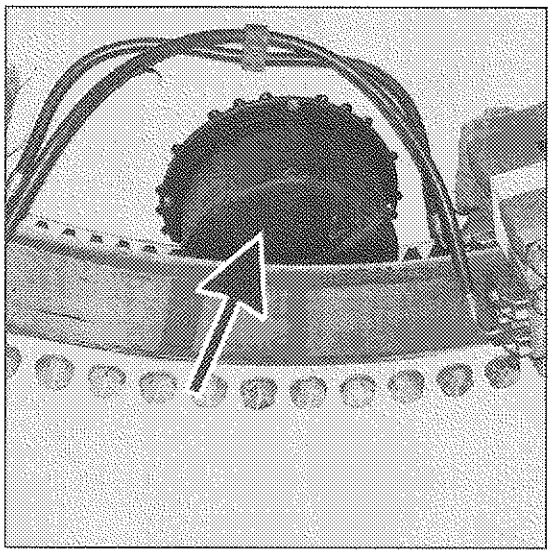
Yaw motors



4.1.2.3 Yaw pinions

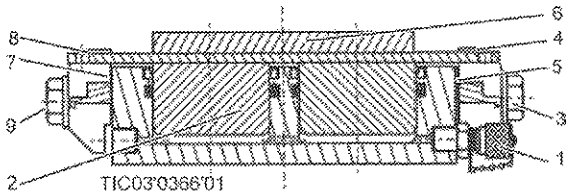
- The Teeth of the pinion that is hidden behind a cover must be checked visually for wear and cracks.

Yaw pinion behind cover

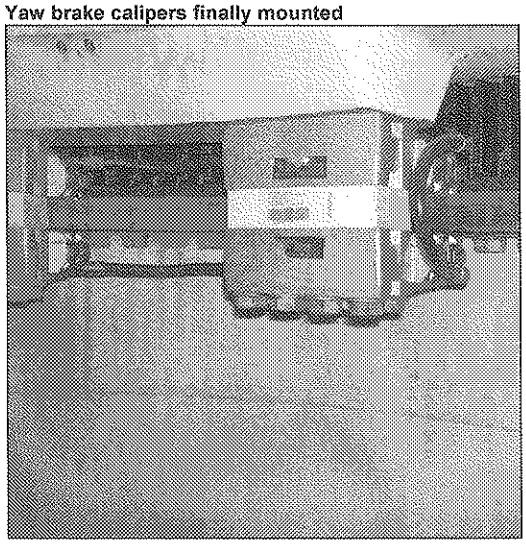


4.1.3 Yaw brake

yaw brake (½ calliper)



Yaw brake calipers finally mounted

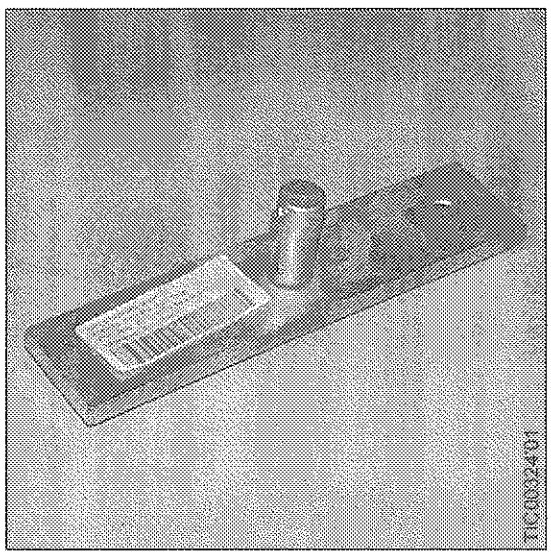


1. *Lower pad location stop*
2. *Shim*
3. *M16 screw*
4. *Pistons*
5. *Lining*
6. *Upper pad location stop*
7. *Shim*
8. *M16 screw*
9. *Bleeding screw*

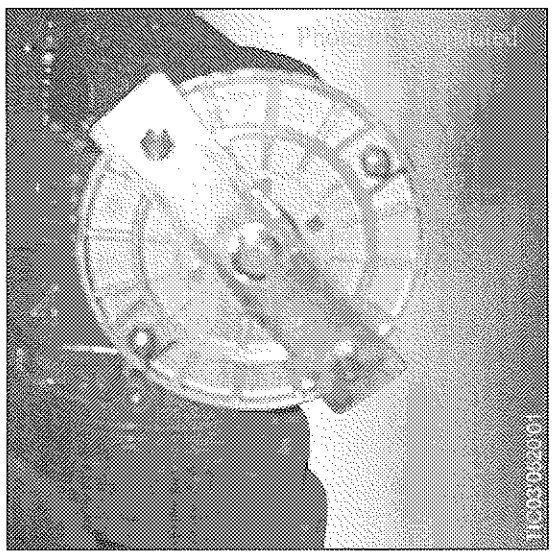
4.1.4 Brake lining

- Thickness of the brake lining must be min. 3 mm (new 10 mm).
- If the brake lining has come loose from the holder, it must be replaced.
- REMEMBER to fit the yaw lock when repairing yaw brakes. The mounting procedure is as follows: 1) Remove motor 2) Fit lock into shaft hole i gear 3) Bolt the lock to the gear flange.

Yaw lock



Mounted yaw lock



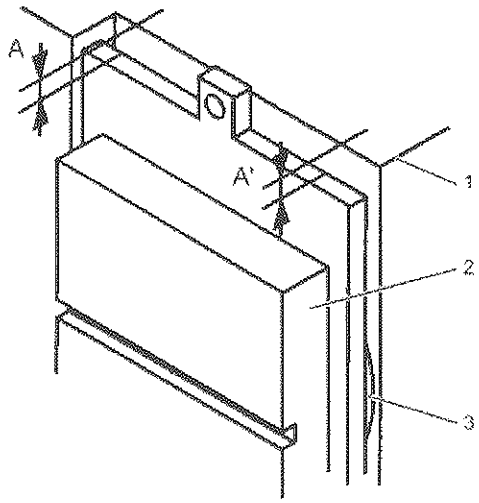
4.1.5 Replacing brake lining

4.1.5.1 Replace pads

1. Remove the upper pad location stop (the one on the same side as the bleeding screw) from each half caliper by removing the M16 screw.
2. Carefully push in the pistons by using a lever between the pad and the brake disk, resting on the latter.
3. Remove the lower pad location stop from each half caliper by unscrewing the M16 screw.
4. Remove the worn pads and their shims. The shims are not reusable.
5. Replace the lower pad location stop without shim and tighten the M16 screw (Torque tightening acc. Installation & Service Data)
6. Put the new pads in place

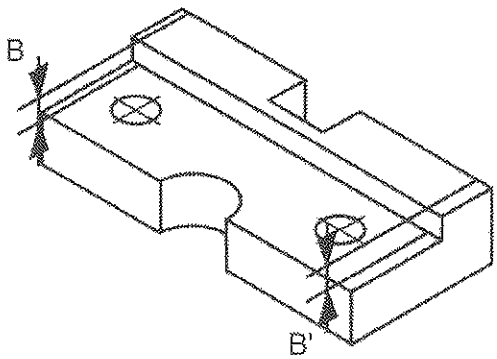
4.1.5.2 Determination of shim thickness

Measuring the distance between the upper face of the body and the upper face of the pad



TIC030367/01

Measuring the recess in the pad location stop



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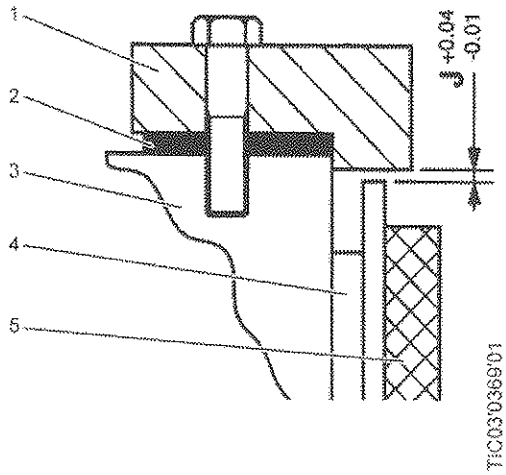
1. *Body*
2. *Lining*
3. *Piston*

Final mounting



1. *Pad locating stop*
2. *Shim (E mm Thick)*
3. *Body*
4. *Piston*
5. *Lining*

On each half caliper (Referring to the illustrations above):

1. Measure the distance (A) between the upper face of the body and the upper face of the pad by using a depth gauge. This measurement must take place at 2 different locations (A and A').
2. Measure the distance (B) on the pad locating stop by using a depth gauge. This measurement must take place at 2 different locations (B and B').
3. The thickness (E) of the shim is calculated as follows:

$$E\,[mm] = \frac{(B-A) + (B'-A')}{2}$$

The tolerance of E is: $^{+0.04}_{-0.01}$

4. The shim of thickness E is made from the set of shims delivered with the new lining pads. Measure the shim thickness E with a digital caliper.

4.1.5.3 Final mounting

1. Mount the upper pad locating stop with its shim of the calculated thickness. Tighten the M16 screw (Torque tightening according to Installation & Service Data).
2. The remaining gap J (refer to illustration above) is measured with a thickness gauge set. A 0.03 mm tightening of the pad is allowed on one point only.

4.1.6 Bleeding the caliper

A flexible hose fitted at both ends with a M16x 2 union is needed for bleeding the caliper.

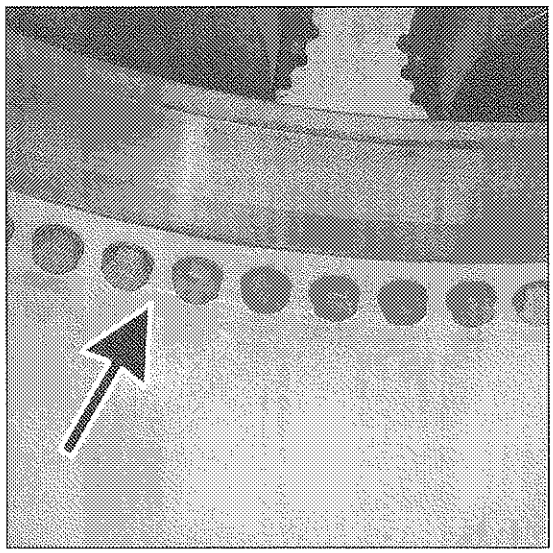
1. Connect one end of the flexible hose to the bleeding screw, and the other end back into the reservoir of the hydraulic unit.
2. Power up the unit.
3. Slowly loosen the bleeding screw, and create an oil stream through the pipe.

4. Let the stream flow until it is clear and free of air.
5. Re-tighten the bleeding screw, and remove the the hose.
6. If necessary, refill with oil.

4.1.7 Brake flange (ring)

- Check that grease from the yaw system is not escaping to the brake flange. If it is, clean the flange.

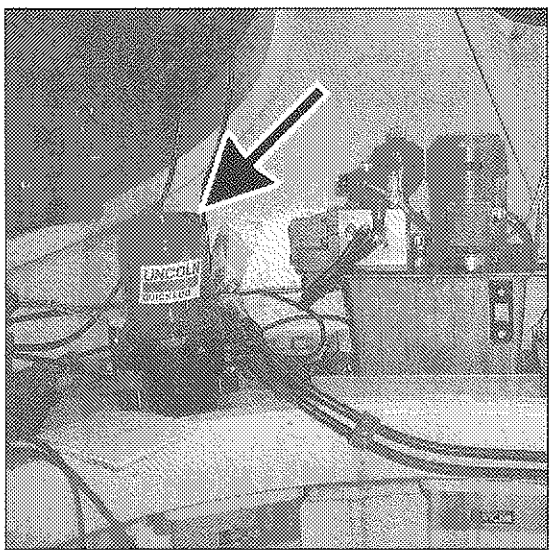
Brake flange



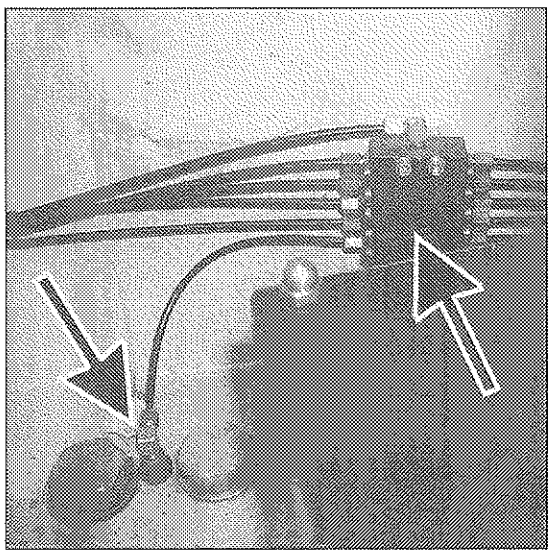
4.1.8 Automatic lubrication of the yaw bearing

The WTG is be equipped with an automatic lubrication system for greasing the the yaw bearing. The unit is re-filled according to "Service Plan & Checklist" and "Installation & Service Data".

Automatic lubrication system mounted next to the hydraulic station for the yaw brakes



Grease manifold and grease feed line to lubrication point on the machine base frame over the yaw bearing



For service and maintenance instructions for the automatic lubrication system please refer to section "Automatic lubrication of Main Bearing"

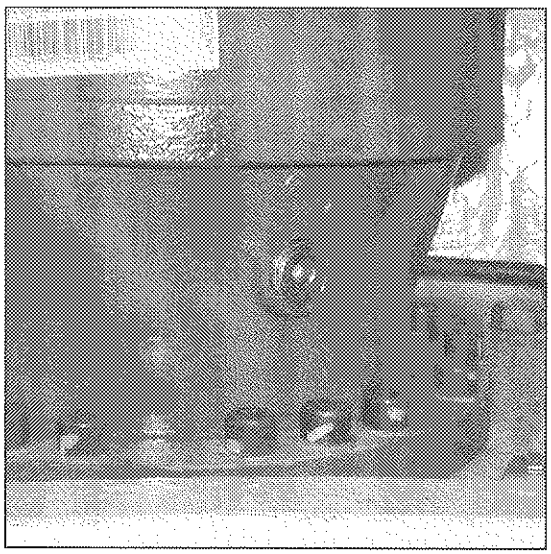
4.1.9 Lubrication of yaw ring (internal gearing)

The toothed rim and the yaw gear pinions are lubricated manually with grease according to "Service Plan & Checklist" and "Installation & Service Data".

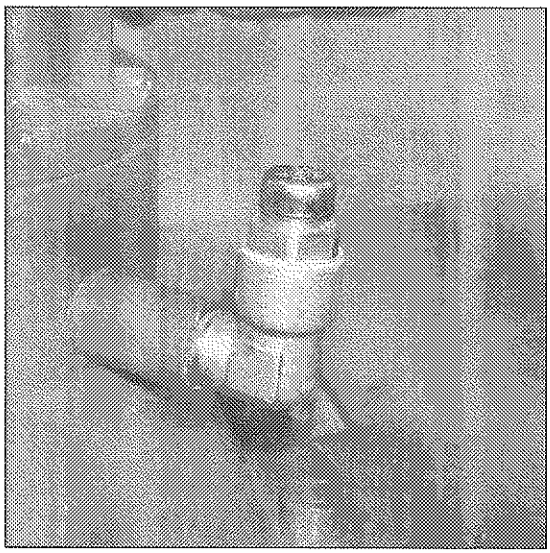
4.1.10 Lubrication and oil level in yaw gear

- Normally it is unnecessary to lubricate the yaw gear, of whatever type, as the pinion step, worm gear and planet step are lifetime lubricated.

Drainage hole in yaw motor



Oil filler neck and air relief on yaw motor



- The cogwheel step in the yaw gear has been lubricated with grease compound in accordance with the lubricant list and need only be checked if the gear has lost grease.
- If the gear has lost lubricant or grease due to leakage or repair, it must be refilled/lubricated in accordance with the lubricant list.

4.1.11 Bolts in the yaw system

4.1.11.1 Bolt joint, yaw bearing ring/base frame

- Retighten the bolts in accordance with the service plan. Torque tension in accordance with Appendix - Installation & Service Data.
- Loose bolts must be reported.
- Loose or defective bolts must be replaced.

4.1.11.2 Bolt joint, yaw gear/base frame

- Retighten the bolts in accordance with the service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts.

4.1.11.3 Bolt joint, brake calliper/base frame

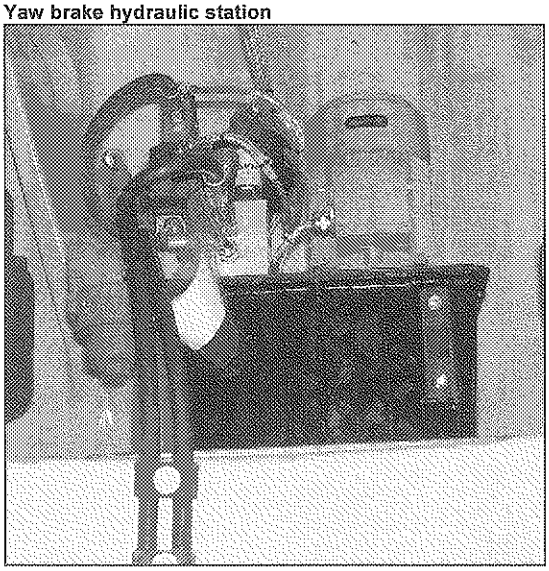
- Retighten screw bolt joint brake caliper/base frame in accordance with the service plan.
- Torque tension in accordance with Installation & Service Data.

4.1.11.4 Bolt joint, hydraulic unit/base frame

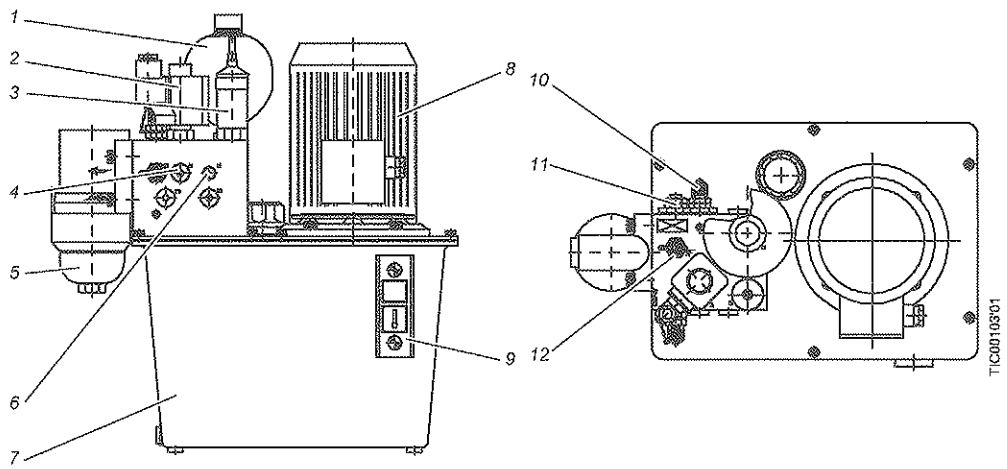
- Retighten screw bolt-joint hydraulic unit/base frame in accordance with the service plan.
- Torque tension in accordance with Installation & Service Data.

4.2 Yaw brake hydraulics

Yaw brake hydraulic station

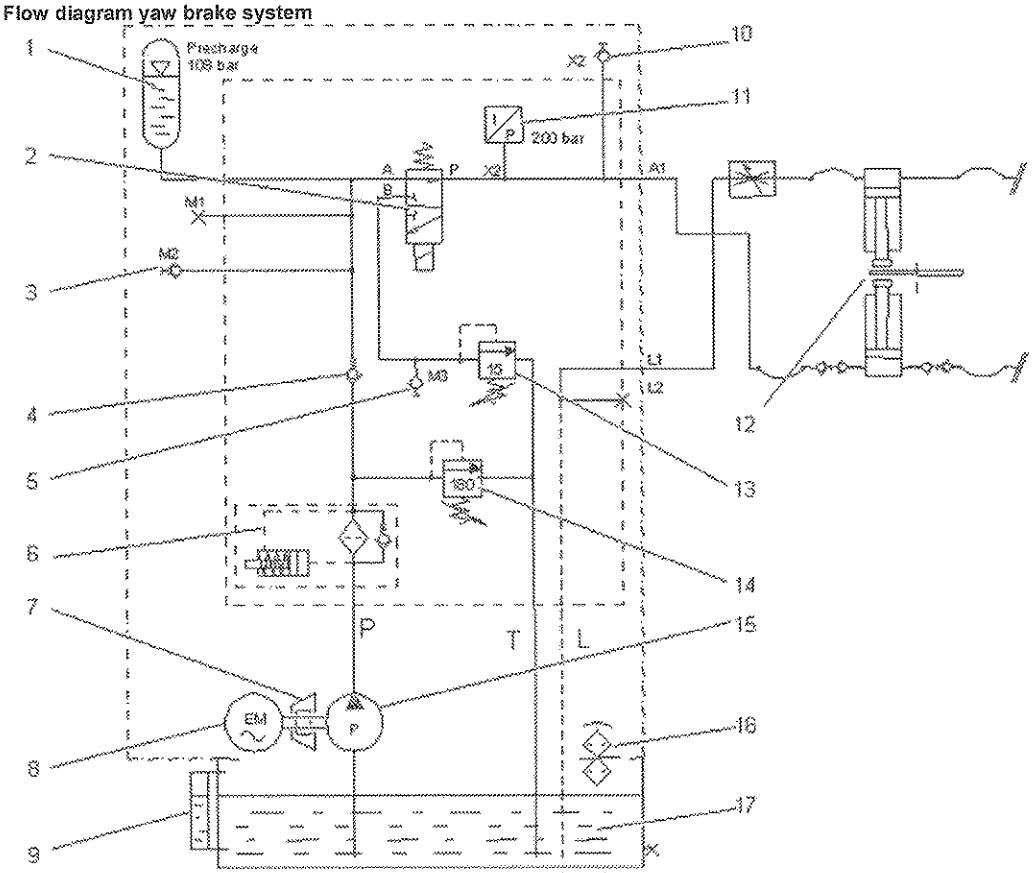


Yaw brake hydraulic station



1. *Accumulator*	5. *Filter*	9. *Sight glass (level indicator)*
2. *Valve*	6. *Outlet caliper*	10. *Test connector (M1 & M2)*
3. *Pressure transmitter*	7. *Oil tank*	11. *Relief valve*
4. *Level indicator*	8. *Motor*	12. *Test connector (M3)*

Flow diagram yaw brake system



1. *Accumulator*	7. *Coupling / cluctch housing*	13. *Relief valve*
2. *Valve*	8. *Motor*	14. *Pressure valve*
3. *Test connector*	9. *Level indicator*	15. *Gear pump*
4. *Check valve*	10. *Test connector*	16. *Filler caps / breather*
5. *Test connector*	11. *Pressure transmitter*	17. *Oil tank*
6. *EPE filter*	12. *Brake caliper (1 of 4)*	

4.2.1 Hydraulic oil

- Check the oil level through the sight glass on the side of the unit. If oil level is too low, refill with oil of the same type.
- Take an oil sample every second year. If necessary change the oil. See list of lubricants in appendix "Installation & Service Data".

4.2.2 Filter

- Inspect and replace if necessary (indicator) or otherwise according to the service plan.

4.2.3 Set pressures for valves

- Check the set pressures with a manometer. Any deviation should be reported and repaired.

4.2.4 Check of pressure transmitter

- Check that the control display agrees with the manometer

4.2.5 Pre-pressure in accumulator

Check the pressure by monitoring the pressure build up. With 0 bar in the accumulator start the pump. The pressure can be discharged by means of the needle valve on port L1. The pressure build up will happen very rapidly until the pre-charge pressure is reached. Hereafter the pressure build up will happen slowly.

4.2.6 Seals of hydraulic system

- Check all gaskets and screwed joints visually for leakage. Retighten leaking screw joints.
- Check that the hose between the brake pump and brake calipers has been mounted so as to avoids wear.

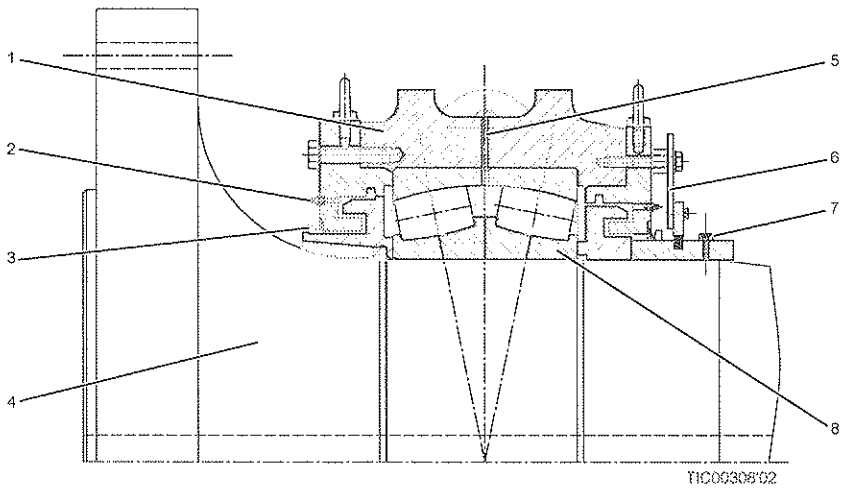
IMPORTANT: Never repair or service the brakes without having read and understood the manual. Never dismantle pressure switches, accumulators or couplings, as there is hydraulic pressure in each of these.

NOTE: Remember to mount the yaw lock.

4.3 Main shaft, main bearings

REFERENCES: Installation & Service Data

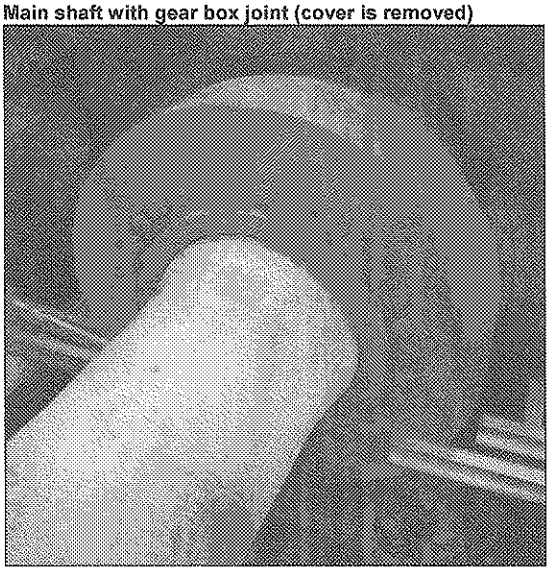
Main shaft



1. *Bearing housing*
2. *Lubrication channel*
3. *Lip seal*
4. *Main shaft*
5. *Lubrication channel*
6. *Lightning conductor*
7. *Scanner bolt*
8. *Main bearing*

4.3.1 Main shaft

Main shaft with gear box joint (cover is removed)



Main shaft with main bearing housing

4.3.1.1 Inspection of main shaft

- Inspect the main shaft for corrosion protection and repair any damage.

4.3.2 Main bearing

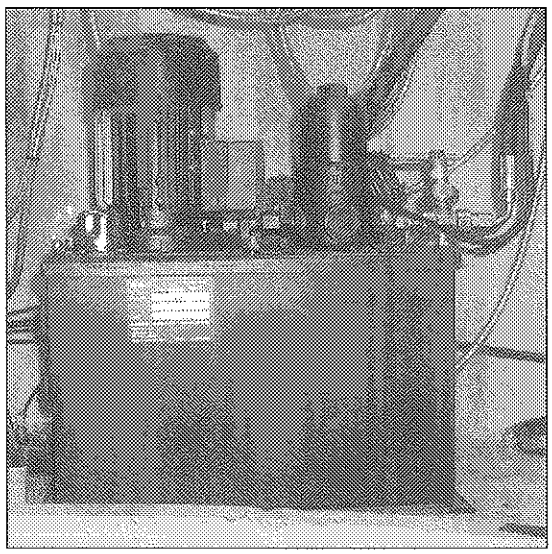
4.3.2.1 Main bearing housing and lip seal

- Check the bearing covers and retighten if necessary.
- Check the bearing housing for corrosion protection. Repair damage.
- Check lip seal for cracks.
- The lip seal must be adjusted so that the lip is just against the bearing cover (after lubrication). The distance from the bearing cover to the outer edge of the lip seal must be 20 mm.

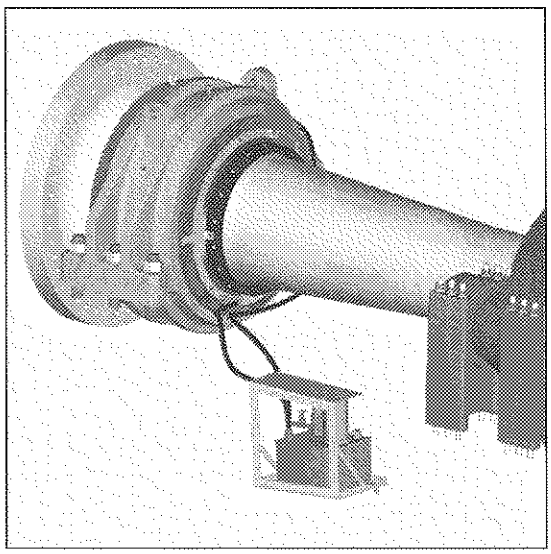
4.3.3 Oil lubrication system

The WTG is equipped with an automatic oil lubrication system for the main bearing and the yaw bearing.

Automatic lubrication system mounted next to the hydraulic station for the yaw brakes



Lubrication point and grease feed line on the main bearing house



4.3.3.1 Inspecting the system

IMPORTANT: Do not use trichlorethylene, perchlorethylene or similar solvents for cleaning the system.
NOTE: Whenever work is done on the lubrication unit, particular attention should be given to absolute cleanliness. Dirt in the system will cause problems.

4.3.3.2 Oil level, Oil pump and filter

NOTE: Functional test - please see later chapter

- Check the oil pump for direction of circulation and leakage.
- Check oil level and refill if necessary – DO NOT mix oil types – see Installation & Service Data
- Change filter according to service plan
- Take oil sample according to service plan and procedure described for gear oil
- Renew oil according to Installation & Service Data & serviceplan

4.3.3.3 Hoses and fittings

- Check the hoses for leaks and fittings for tightness
-

4.3.4 Main shaft and main bearing bolts

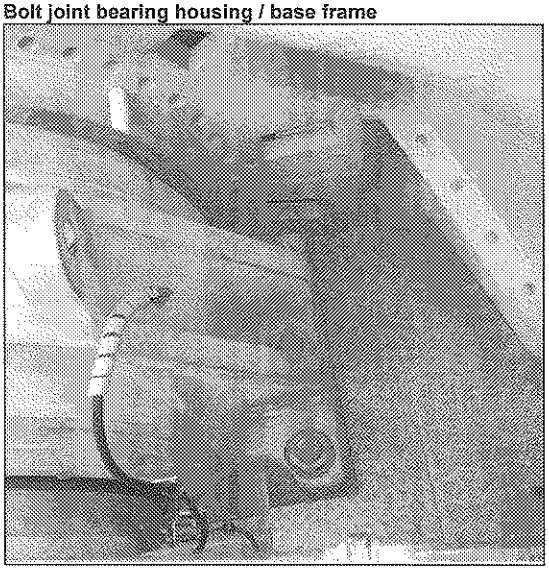
4.3.4.1 Bolt joint, blade hub/main shaft

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts with new in accordance with specifications.
- After tightening apply corrosion protection to bolt heads and cover with caps.

4.3.4.2 Bolt joint, bearing housing/base frame

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts with new.

Bolt joint bearing housing / base frame

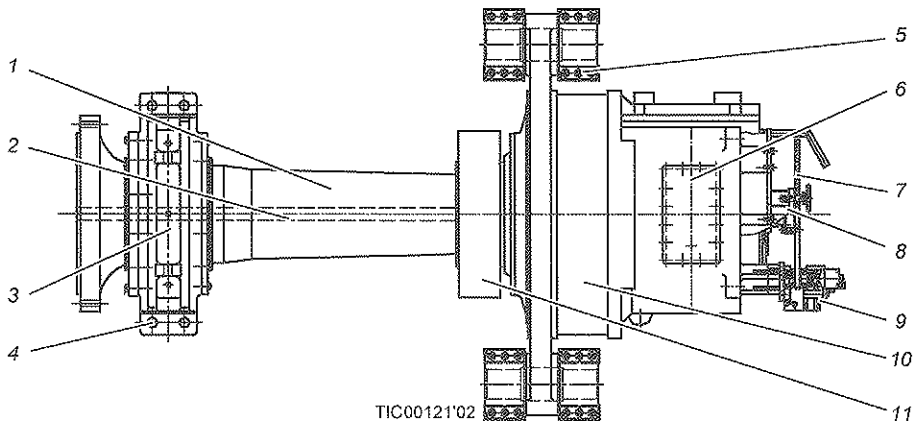


4.4 Gear box

REFERENCES : Appendix – Installation & Service Data

SAFETY EQUIPMENT: Safety helmet and safety shoes.

Gear box, main shaft & main bearing



1. *Main shaft*
2. *Hole through shaft*
3. *Main bearing*
4. *Bearing housing bolts*
5. *Gear stay bolt*
6. *Vent cover*
7. *Brake disc*
8. *Slip ring*
9. *Brake caliper*
10. *Gear box*
11. *Taper bushing*

4.4.1 Gearbox housing and pinion

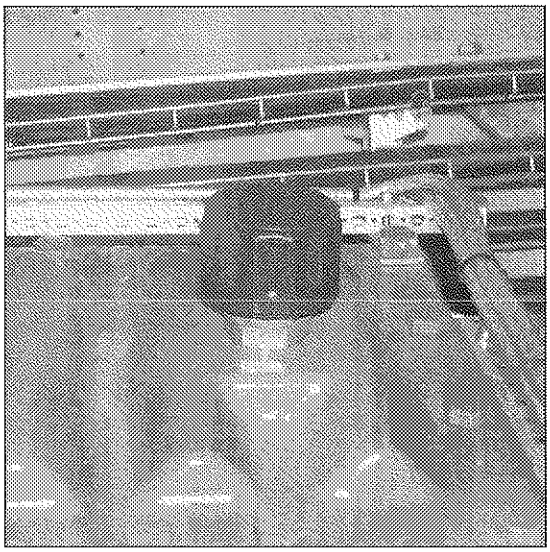
4.4.1.1 Seals

- Check shaft seals for leakage.
- Report any significant oil loss and assess whether it is necessary to replace gaskets or allow the turbine to continue with increased frequency of oil level checks.

4.4.1.2 Venting

- The vent cover in the gearbox lid must be checked and cleaned if necessary. Blockage may lead to overpressure in the gearbox, resulting in oil spillage.

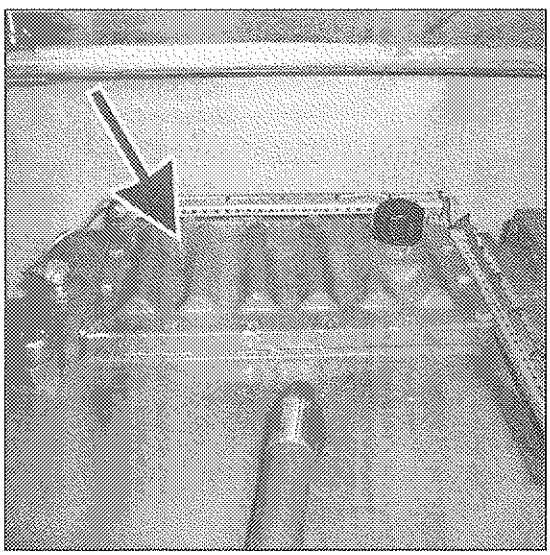
Vent cover on gearbox



4.4.1.3 Pinion

- Remove the gearbox inspection hatch to allow visual inspection of gearwheels.

Gearbox inspection hatch

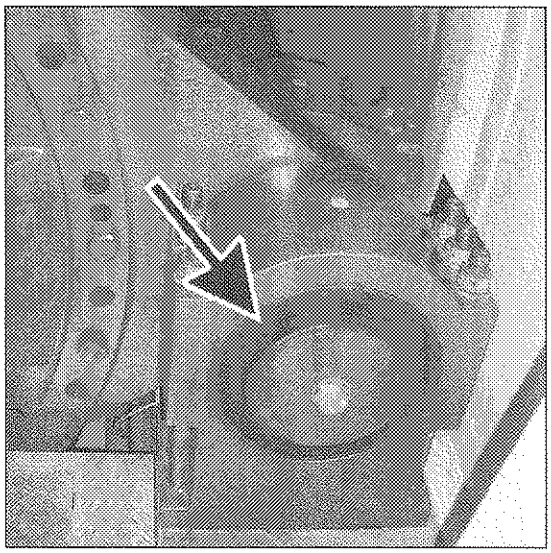


- Check that the contact surfaces are free of pitting and that the teeth engage over their whole width. Any signs of incipient wear must be reported, indicating wind turbine no., gearbox no, operating hours and a description of the non-conformity and its extent. A colour photo of the damage may be included. NEG Micon's Service Department will then in co-operation with the gear manufacturer assess the extent of the damage and initiate any necessary action.
- Make sure the lid is fitted correctly so that the vent cap is above the low-speed step. Faulty fitting will lead to oil being forced out of the cap. Make sure the gearbox and lid fit closely.

4.4.2 Gear mounting

- The rubber element of the gear mounting should be checked visually for cracks and signs of perishing, and replaced if necessary. The coupling and generator must then be realigned.

Rubber element of gear mounting



4.4.3 Gearbox bolts

4.4.3.1 Bolts in the taper bushing

- Retighten the bolts in the taper bushing between the main shaft and gearbox in accordance with the bolt tension list in the Appendix – Installation & Service Data.

4.4.3.2 Screw bolt joint, gear stay/base frame

- Retighten the bolts in accordance with the service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts with new in accordance with specifications. After tightening, apply corrosion protection to bolt heads and fit caps.

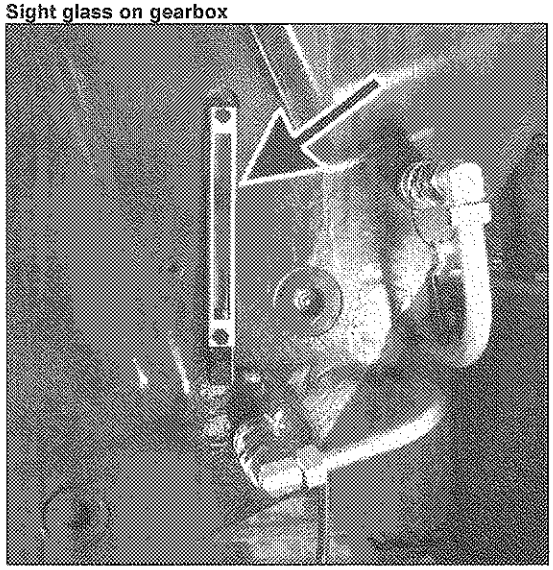
4.4.4 Gear oil and oil cooling system

REFERENCE: Appendix Installation & Service Data

4.4.4.1 Oil level

- Check the oil level through the sight glass when the turbine is at a standstill.

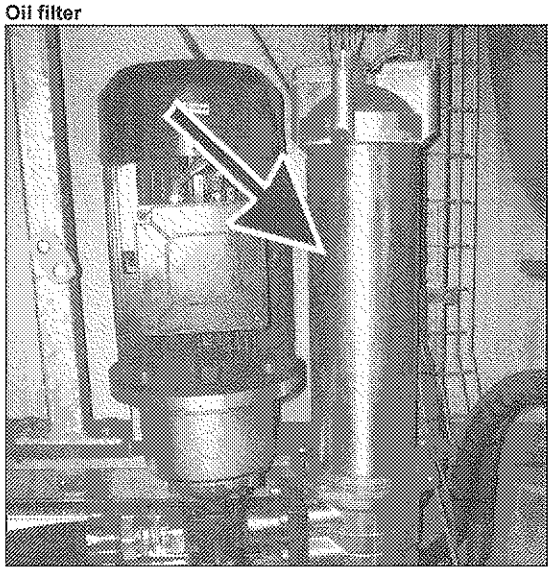
Sight glass on gearbox



- If oil level is too low, refill with oil of the same grade and manufacturer, as indicated in the Installation & Service Data.

4.4.4.2 Replacing the oil filter

Oil filter



- Change the filter in accordance with Installation & Service Data/service plan.
- Change the filter if the filter alarm is given.
- Check that the filter type is correct

NOTE: Clean up any oil spills.

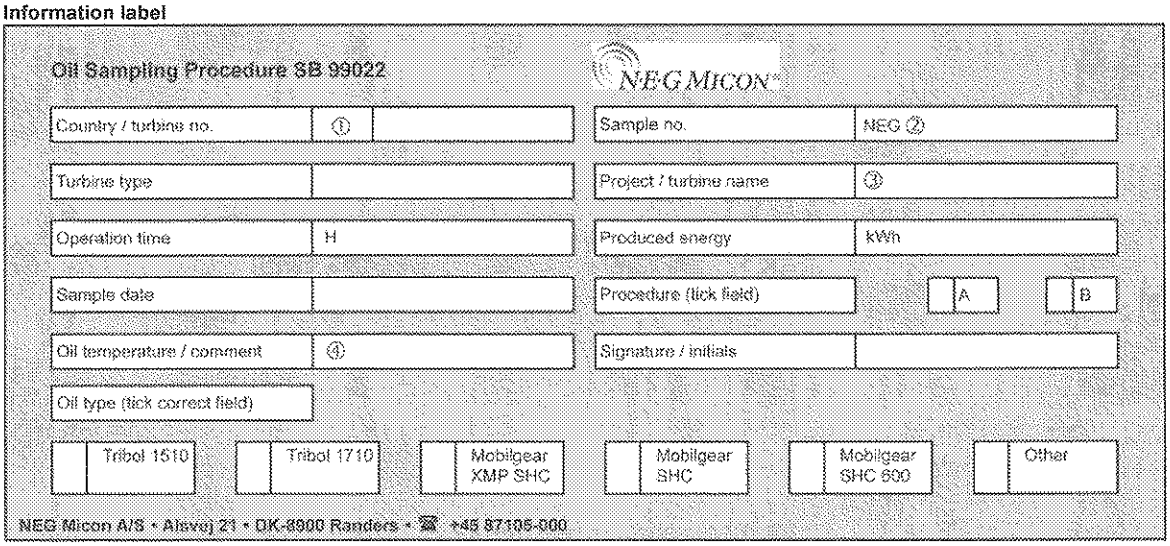
4.4.4.3 Oil samples

- The samples must be taken no later than 10 minutes after the wind turbine has come to a complete standstill. If the wind turbine is stationary on arrival, this must be noted on the label of the sample bottle.
- Oil sump temperature must be higher than 40 °C at the time of sampling. Verify the temperature with the control system. The temperature must be noted on the label on the sample bottle.
- The relevant procedure will depend on the individual lubrication system. The following procedures have been defined and the procedure used must be noted on the label of the sample bottle. It is very important that residues, which have accumulated at the sampling site, are removed before the actual sample is taken.

1. Clean the drain cock externally with a clean cloth.
2. Start the pump.
3. Empty at least 0.5 L from the drain cock into a suitable container.
4. Now fill the sample bottle.
5. Pour the oil from the sample bottle into the waste bucket in order to flush the sample bottle.
6. Refill the sample bottle and screw on the cap tightly.Attach the label to the sampling bottle.
7. Check the oil level in the gearbox and top up if required
8. Send the waste oil already collected for destruction.

The label pasted on the bottle must contain the following information:

Information label

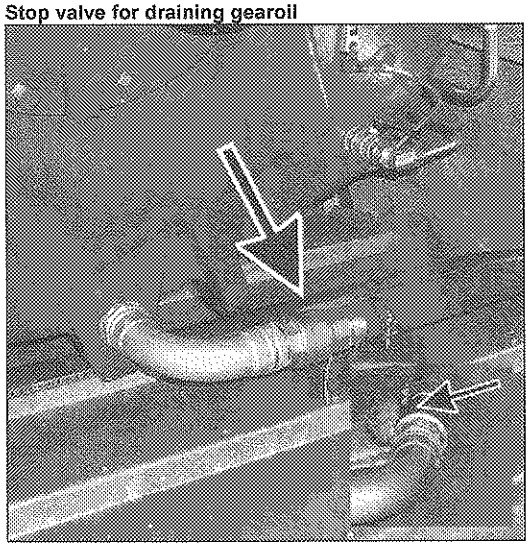


1: International country code of turbine site, e.g. -DK for Denmark and -D for Germany
2: Number for tracing sample in Concorde, to be completed by NEG Micon Service Stock
3: Turbine or project name incl. possible local no., e.g. Sylthom C1, Rærup #3
(Use owner's name only if there is no project or turbine name)
4: Oil sump temperature taken by the controller and comments, e.g.
55°C - sample taken at 55°C in oil sump, no comments. 25°C / stopped - sample taken at 25°C in oil sump, turbine had stopped more than 10min before sample was taken.

4.4.4.4 Changing the gear oil

- Drain the oil through the base cock while still hot.
- Remove the top lid of the gearbox to check whether there is any sludge residue in the base. Remove the magnetic plug from the bottom of the gearbox and clean.
- Flush any sludge or impurities out of the gearbox and cooling system before filling with new oil.
- Refill with new filtered oil through the hole in the top cover.
- Check if there are any leaks from the gearbox where it has been opened.
- If different oil from the recommended type is used, approval must be obtained from the gearbox manufacturer together with a written procedure for changing the oil from the oil supplier.

Stop valve for draining gearoil



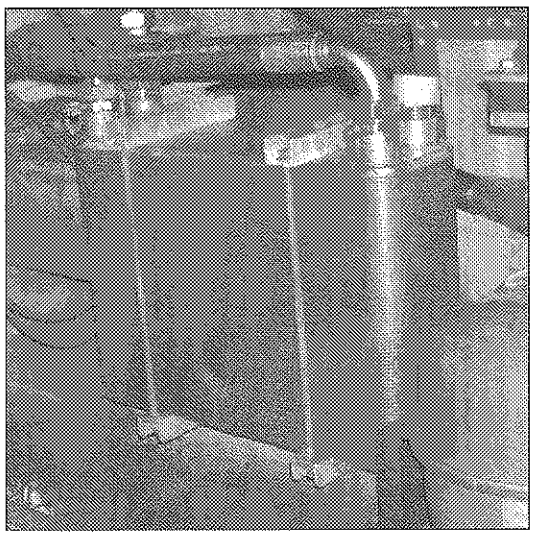
4.4.4.5 Oil pump/seals

- Check the oil pump for direction of circulation and leakage.
- If hoses or pump leak, they must be repaired or replaced.

4.4.4.6 Heat exchanger

- Check the heat exchanger and hoses for leakage.
- In the case of leaks, retighten or replace.

Heat exchanger

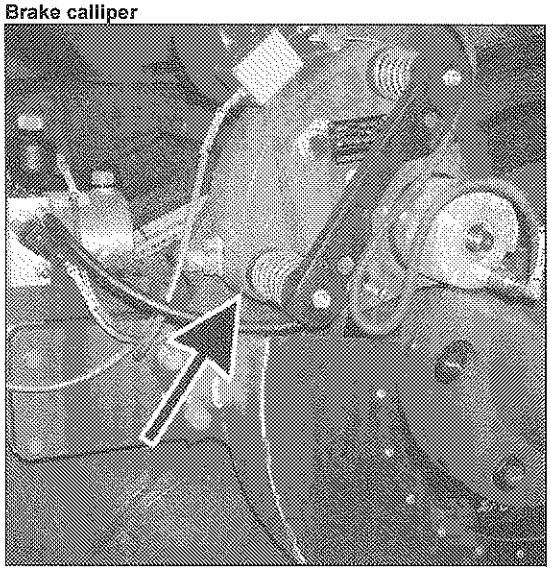


4.5 Disc brake system

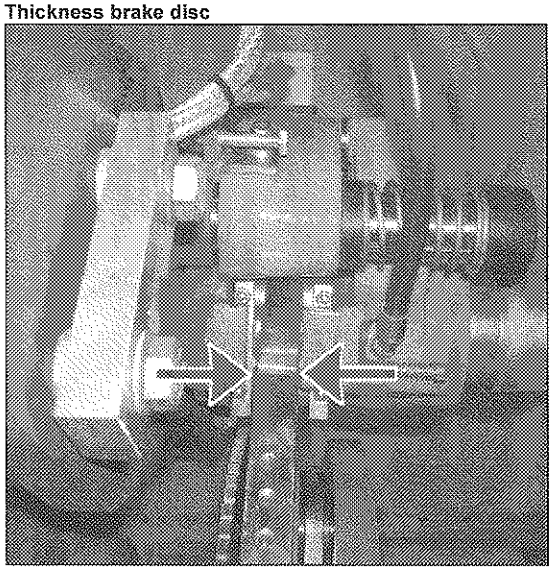
REFERENCES: Appendix - Installation & Service Data

SAFETY EQUIPMENT: Safety helmet, safety shoes and fall protection.

Brake calliper



Thickness brake disc



4.5.1 Brake disc

- Check the thickness of the brake disk in accordance with Installation & Service Data.
- The contact surfaces must be smooth and free of cracks when visually inspected.
- Check the brake disk for throw-out with a gauge. The maximum value is given in the Installation & Service Data.

4.5.2 Brake calliper and brake blocks

- Check the clearance between both brake linings and the brake disks.
- If the total gap between the blocks and the brake disks is more than 2 mm, adjustment must be carried out.
- Check the brake calipers for distortion, wear and cracks.

4.5.2.1 Adjusting the gap between brake blocks and brake disc (wear adjustent).

- Activate the hydraulic station so that the brake blocks are completely raised.
- Remove the orange cover Ø 40, and instead mount a M24 flange nut on the protruding centre bolt, tightening it by hand.
- Release hydraulic pressure from the brake.
- Using a hook spanner, adjust the large coupling until the clearance between disk and blocks is a total of 1.0 mm. Measure with a feeler blade at the centre of the blocks.
- Apply hydraulic pressure to the brake
- Remove the M24 flange nut and mount the orange cover Ø40.
- Deactivate the hydraulic station, lowering the brake.

4.5.2.2 Check of brake lining.

- If there is less than 4 mm of lining on each brake block, these must be replaced. For replacement use blocks of type MIBA MD 550. Temperature sensors in the brake linings are of type "180 °C".

4.5.2.3 Replacing brake blocks:

- Adjust the large coupling right back as described above.
- Remove the wiring to the temperature sensor.
- Mount the new blocks – remember to turn the curved edge towards the calliper.
- Mount the temperature sensor wires
- Adjust the brake until the total gap is 1.0 mm. See above.

4.5.3 Disk brake bolts

4.5.3.1 Brake hub/brake disk

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data. Replace defective or corroded bolts with new.
- After tightening, apply corrosion protection to bolt heads and fit caps.

4.5.3.2 Brake bracket/gearbox

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data. Replace defective or corroded bolts with new.

4.5.3.3 Brake hub/clamping element

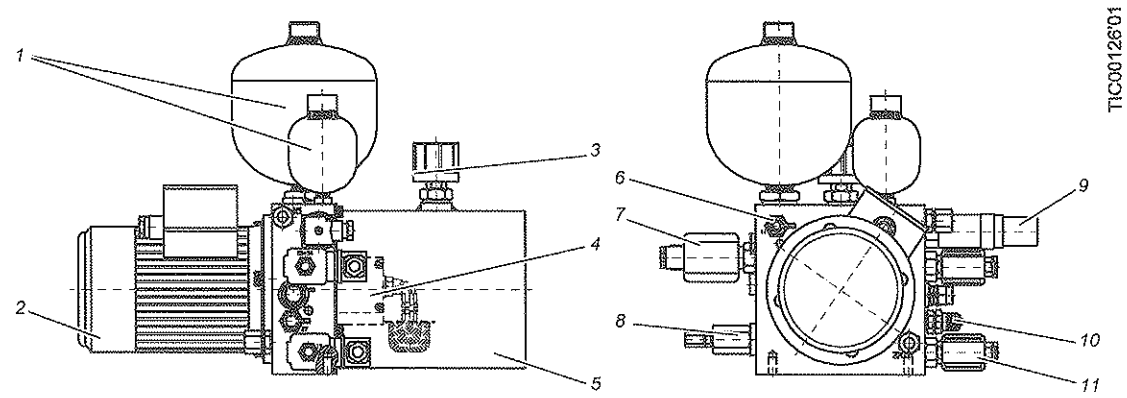
- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.

4.5.3.4 Brake/bracket

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data. Replace defective or corroded bolts with new.

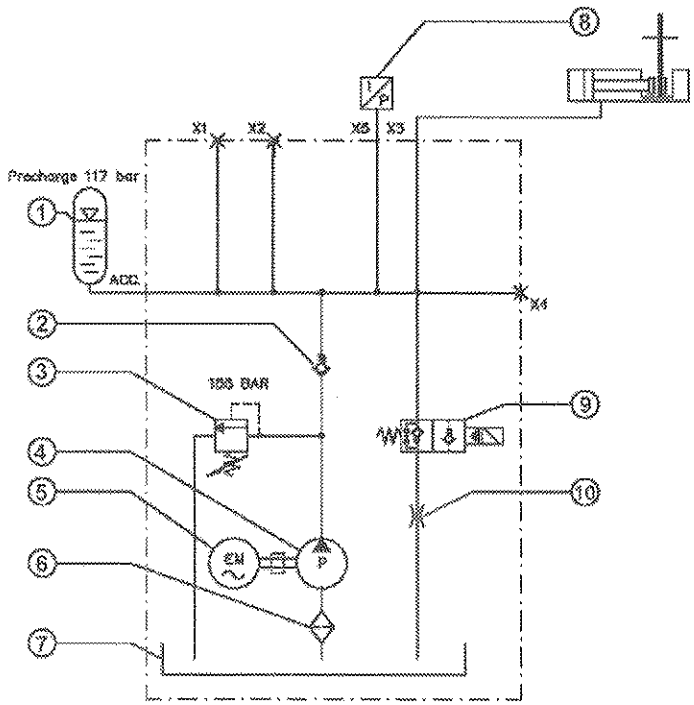
4.5.4 Brake hydraulics

Brake hydraulics



1. *Acummulators*
2. *Motor*
3. *Air filter*
4. *Pump*
5. *Oil tank*
6. *Test connector*
7. *Valve*
8. *Pressure reduction valve*
9. *Pressure transmitter*
10. *Test connector*
11. *Solenoid valves*

Diagram of brake hydraulics



1. *117bar accumulator*
2. *Check valve*
3. *Relief valve*
4. *Gear pump*
5. *Electrical motor*
6. *Suction strainer*
7. *Tank*
8. *Pressure transmitter*
9. *Solenoid valve*
10. *Throttle*

4.5.4.1 Hydraulic oil

- Check the oil level: When the station is pressure-free (brake on), the tank must be at least half full.
- Check the tank lid dipstick. Oil must appear on the dipstick.

4.5.4.2 Sealing of hydraulic system

- All gaskets and screwed joints should be checked visually for leakage. Leaking joints must be retightened and gaskets replaced.

4.5.4.3 General when checking hydraulic system

- All measured pressures, before and after any adjustment, must be noted in the report.
- Before starting service, the rotor must be secured with the rotor lock.
- When draining or filling oil, and when replacing the components, everything must be kept as clean as possible.

4.5.4.4 Overflow valve

- Start the pump and increase the pressure until the overflow valve opens (manometer shows constant pressure). Read off the pressure. The pump will stop when the time limit is reached.
- Check that the pressure does not fall when the pump stops. (A fall will occur immediately after the pump has stopped, but pressure must stabilise quickly.)

4.5.4.5 Accumulator

- Once the station is pressure-free, start the pump. The pressure will then quickly rise to the pre-load pressure of the accumulator, after which it will rise more slowly. Read off the pressure at which the change occurs.
- If the pressure is outside of the tolerance range, the accumulator must be replaced.

4.5.4.6 Replacing the filter/suction strainer

- Operating problems with the station may be due to blocked filters. The problem may present as excessive pumping time (suction strainer). The filter should be replaced one year after erection of the turbine. Further inspection/replacement should be carried out only in the case of irregular operation.

4.5.4.7 Suction strainer

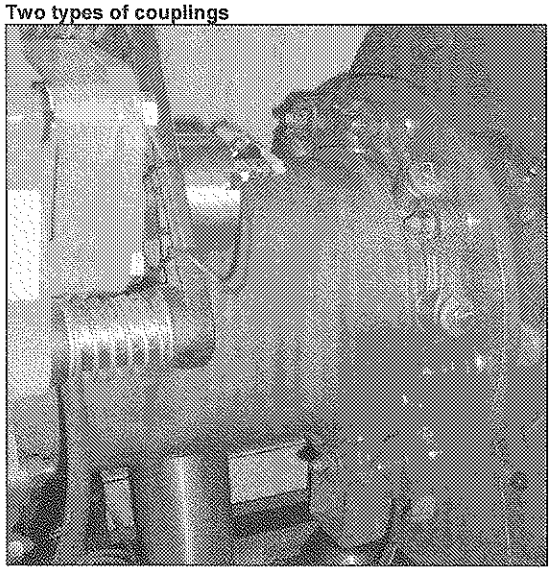
- Replace the whole station and take it back for repair at the workshop.

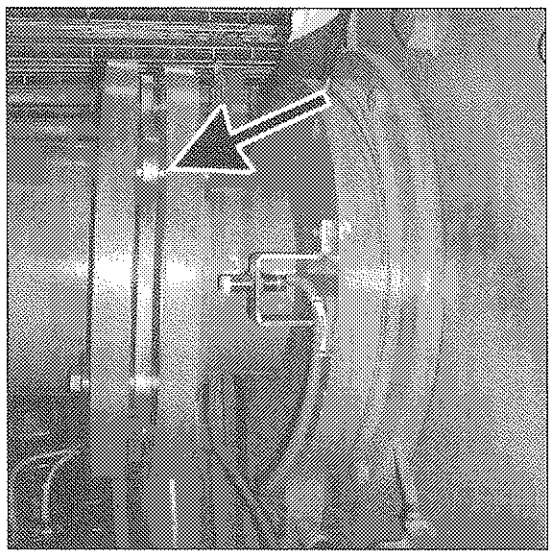
4.5.4.8 Cables and hoses

- Electrical cables and hydraulic hoses should be checked for softness and mechanical damage.

4.6 Coupling

Two types of couplings





4.6.1 Centaflex elements

- Check the rubber elements visually for cracks.
- Report small cracks and assess whether it is necessary to replace the coupling element or whether the turbine can continue operation with more frequent inspection intervals.
- In the case of large cracks, replace the coupling element.
- Check paintwork for damage.

4.6.2 Spacing

- The spacing between the brake disk and the generator hub must correspond to coupling length ± 1 mm.
- This can only be checked when the coupling has been removed.

4.6.3 Coupling bolts

4.6.3.1 Screw bolt joint, brake disc / coupling

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data. Replace defective or corroded bolts with new.
- After tightening apply corrosion protection to the bolt heads and provide with caps.

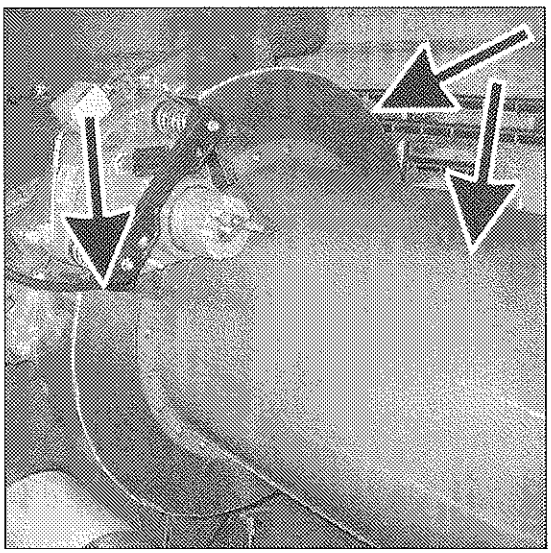
4.6.3.2 Screw bolt joint, coupling/brake disk/generator hub

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts with new in accordance with specifications. After tightening apply corrosion protection to the bolt heads and fit caps.

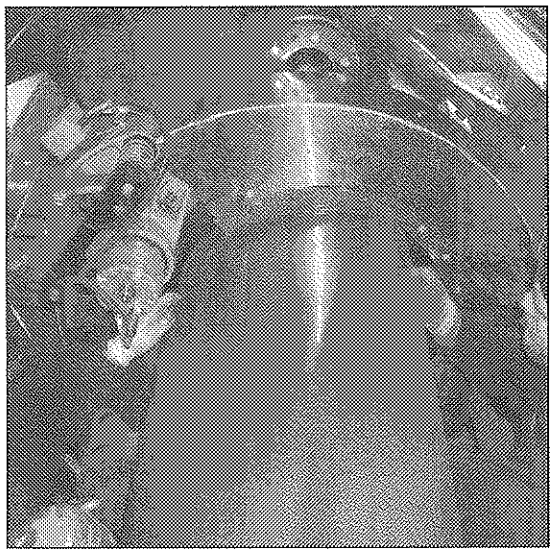
4.6.4 Cover

- Visual check of cover for damage
- Check bolts on cover for tightness

Cover for high speed shaft (brake disc upper part, brake disc lower part and shaft part)



Cover for coupling being removed



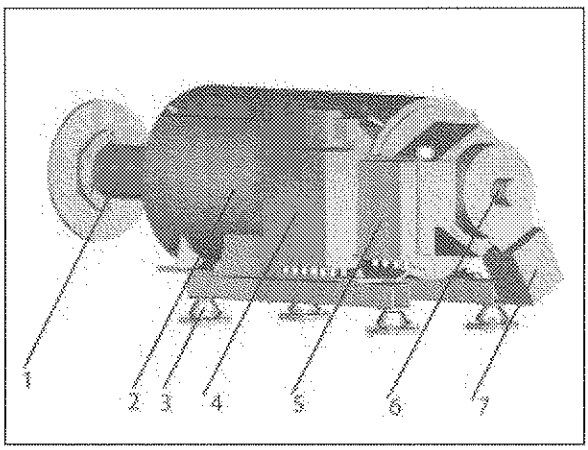
4.7 Generator

REFERENCES : Appendix – Installation & Service Data

SAFETY EQUIPMENT: Safety helmet and safety shoes.

SAFETY PRECAUTIONS: No work on the generator while the turbine is in operation.

Generator

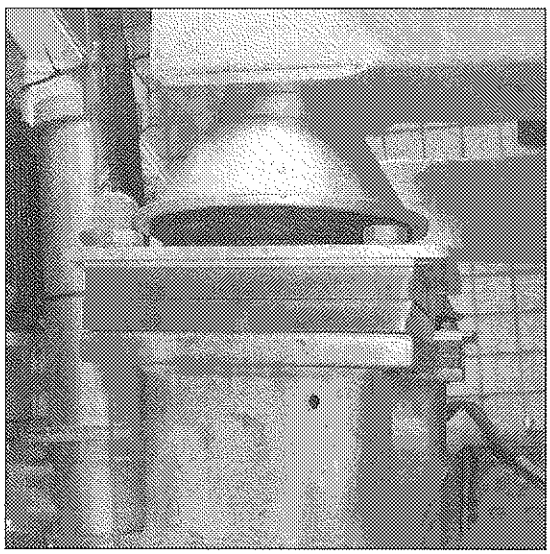


1. *Shaft*
2. *Generator body*
3. *Rubber damper*
4. *Terminal box stator*
5. *Terminal box rotor*
6. *Sensor*
7. *Ventilation of slip ring compartment*

4.7.1 Alignment of generator

- If there are any signs that the alignment is outside the tolerance of ± 1 mm with respect to the centering of the generator shaft, alignment must be checked with alignment equipment.
- This must be done with the coupling removed.
- Poor alignment may be due to a change of characteristics in the rubber dampers in the gear mounting, coupling and generator mounting.

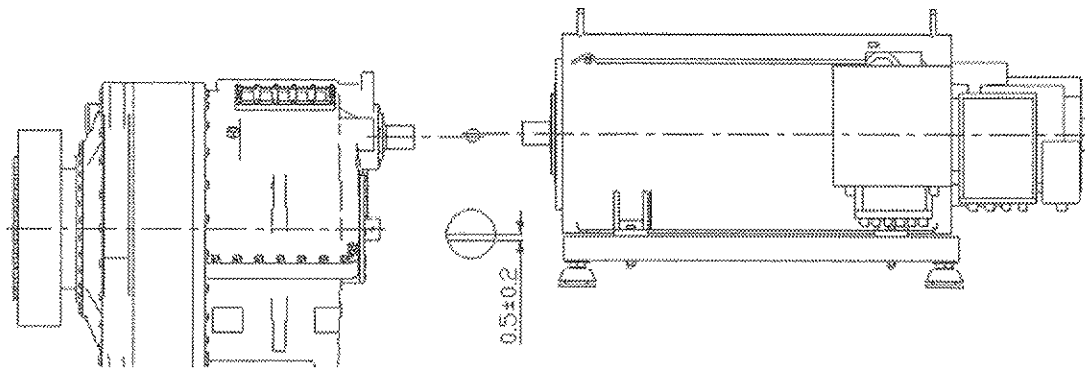
Generator rubber damper



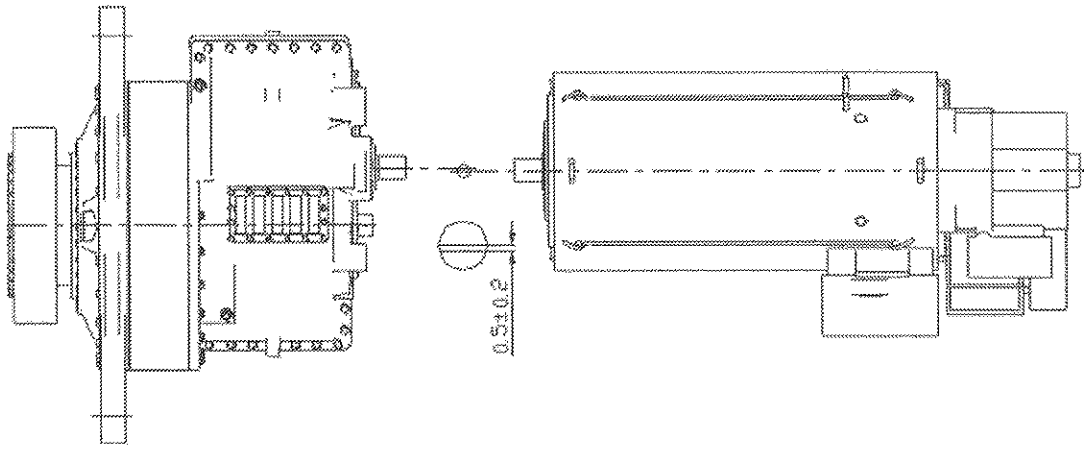
4.7.1.1 Alignment of generator with rotor

The following figures show how to align the the generator with the rotor mounted

Alignment of generator with mounted rotor, side view



Alignment of generator with mounted rotor, top view



Vertical alignment

The procedure for vertical alignment of the generator is the same if it is adjusting the front end or the rear end of the generator.

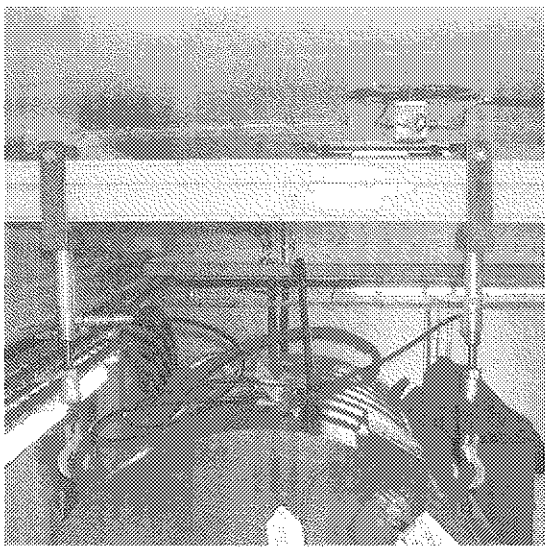
It is impossible to predict the extent of what has to be adjusted. This becomes obvious during the alignment process.

It is often only the front end that has to be adjusted vertically but it could become necessary to adjust both the front end and the rear end vertically and horizontally.

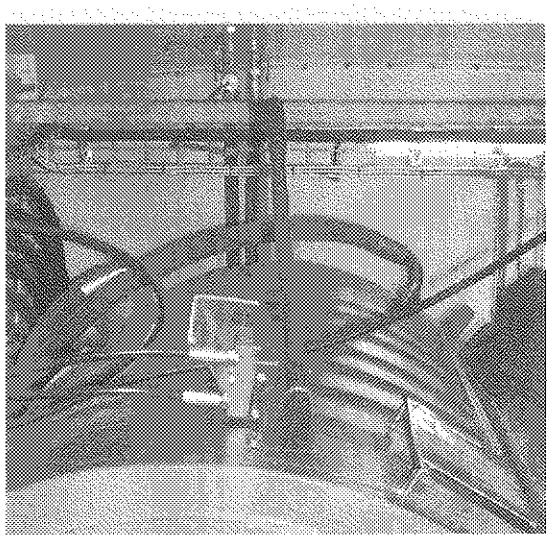
The alignment process starts with the mounting of the special hydraulic lever tool. It is mounted on the crane and the hooks are attached to the front of the generator. The chain in the right side of the generator (viewed from behind) has to be one link longer than the one in the left side.

The handle and cylinder is placed on top of the generator.

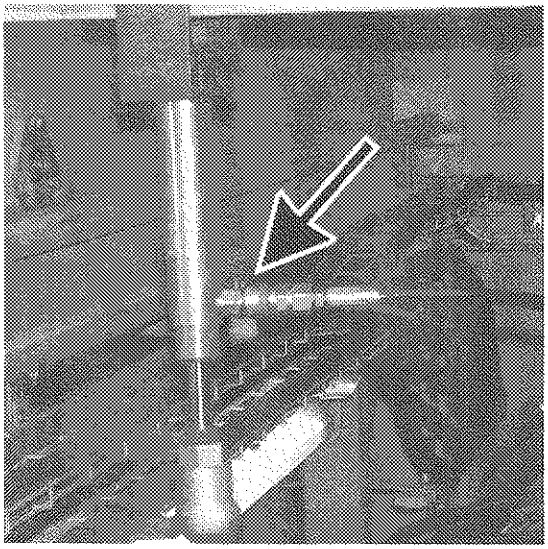
The special line up tool is installed



Hydraulic lever cylinder and handle

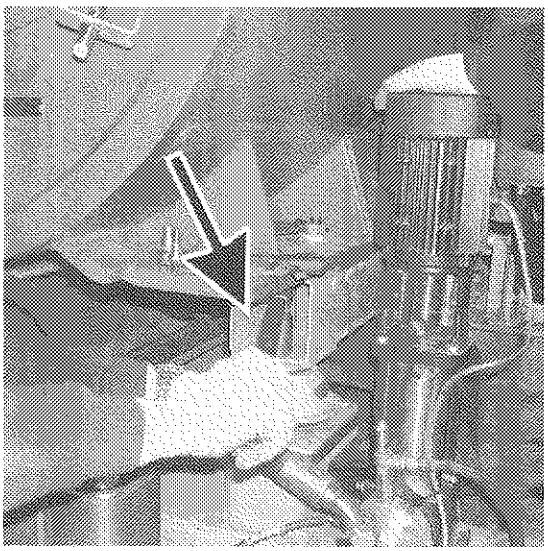


Working cylinder

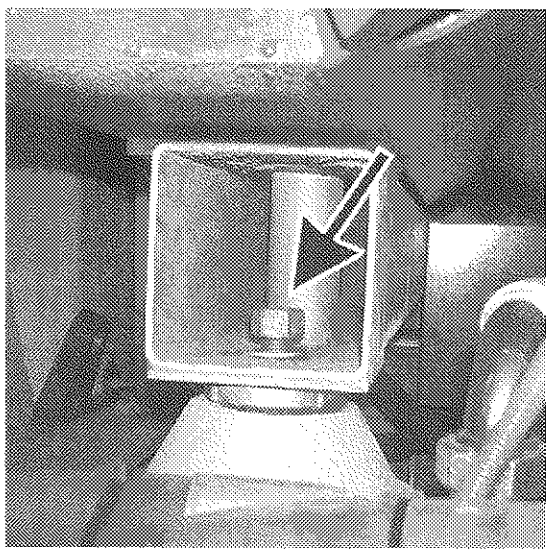


The bolts that hold the rubber dampers are loosened in each side of the generator.

Bolt loosened (must be loosened in both sides)

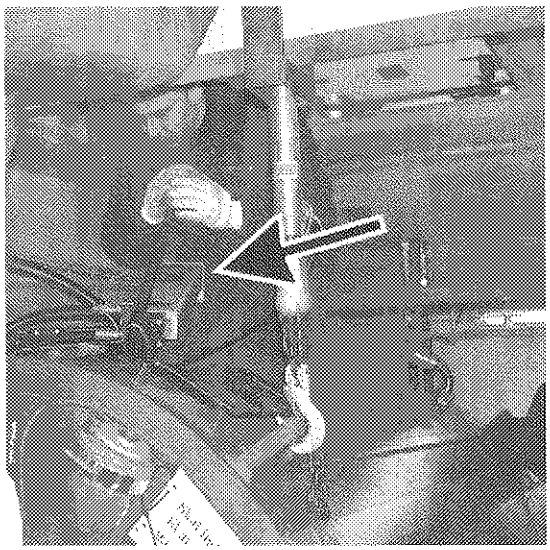


Bolt loosened (must be loosened in both sides)

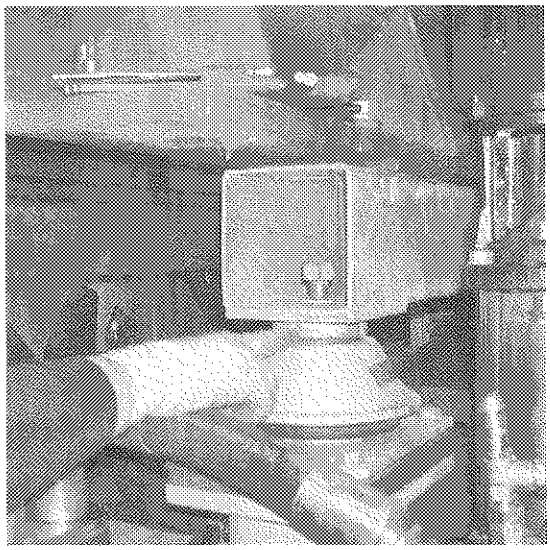


Then the generator is lifted at the relevant end and the adjuster washer turned.

The generator is lifted



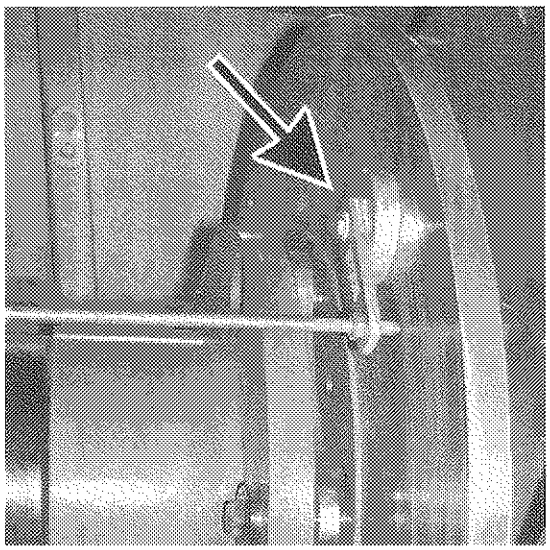
The adjuster washer is turned



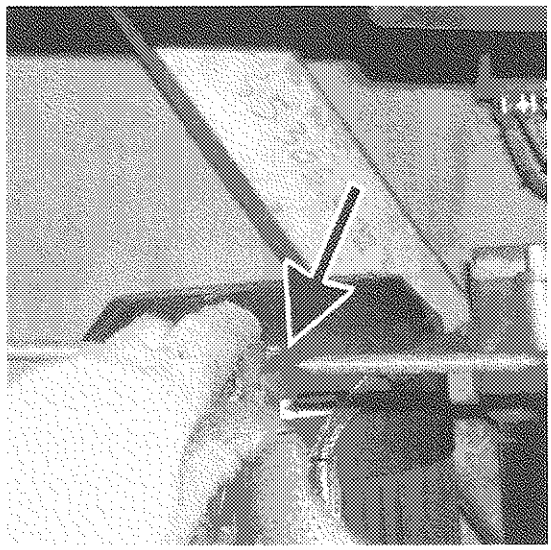
One measurement pin is attached on the part of the coupling that is fixed to the generator. The other part is mounted on the brake disc. Do not attach to the shaft between the brake

The generator is lowered again and two measurements is executed- right underneath the high speed shaft and right above the shaft.

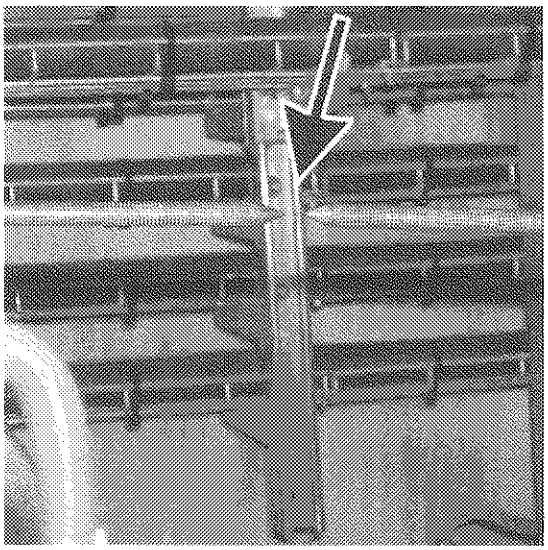
Measuring pin mounted on the brake disc



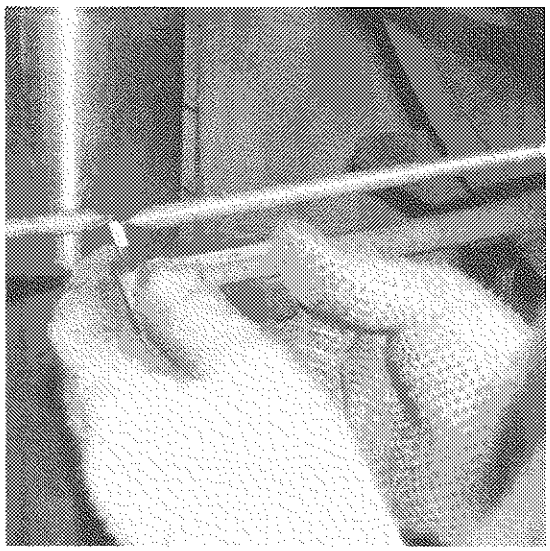
Measure taken underneath



Measure taken right above the shaft



x



After that the bolts are re-torqued.

The above procedure is repeated until the measure is within the tolerance (see drawing).

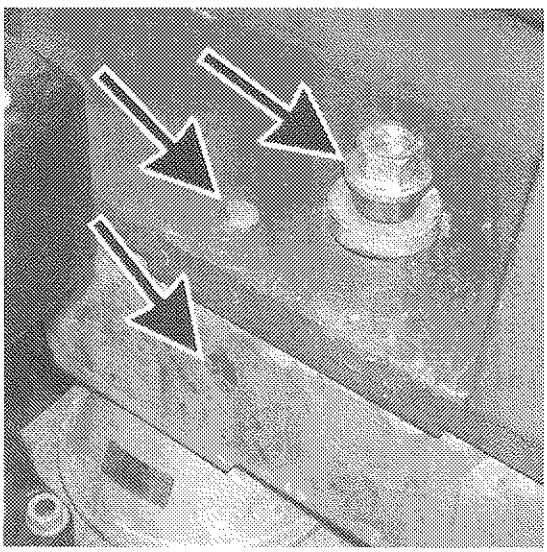
Horizontal alignment

If a horizontal alignment has to be done the procedure is as folows.

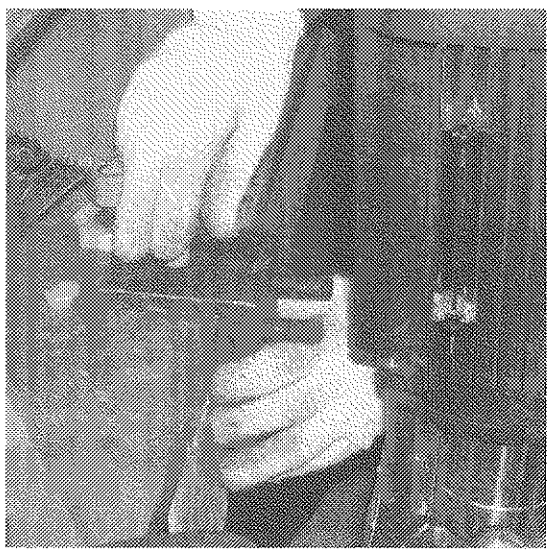
Loosen the bolt that is holding the generator horizontally.

Mount the special alignment tool on the generator and on the frame on which the generator rests.

Bolt and holes for the special alignment tool



Mounting the special alignment tool

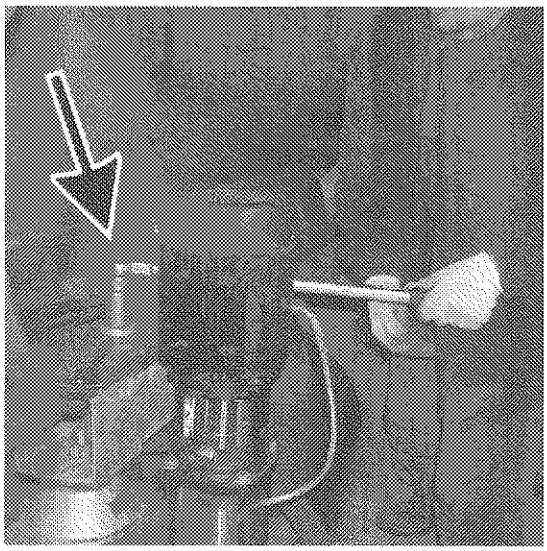


The bolt that holds the generator vertically is loosened.

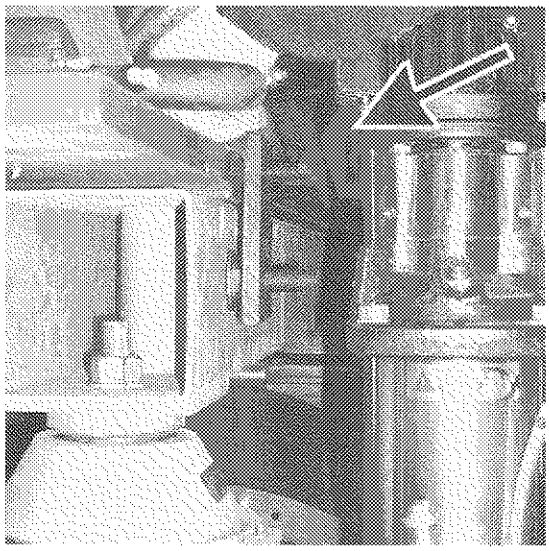
A measurement is taken with the pins on each side of the generator to see how much movement is needed.

The adjuster screw is turned with an Allen key until the difference is within the tolerance (see drawing).

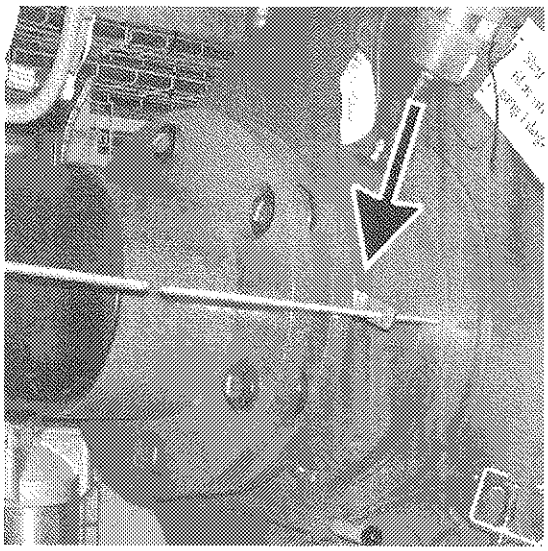
Loosening the bolt



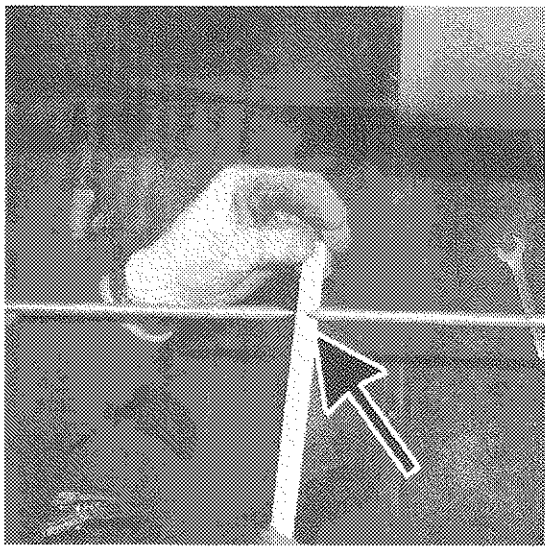
Adjustment screw on the side of the generator



Measuring pins turned into position on left side.

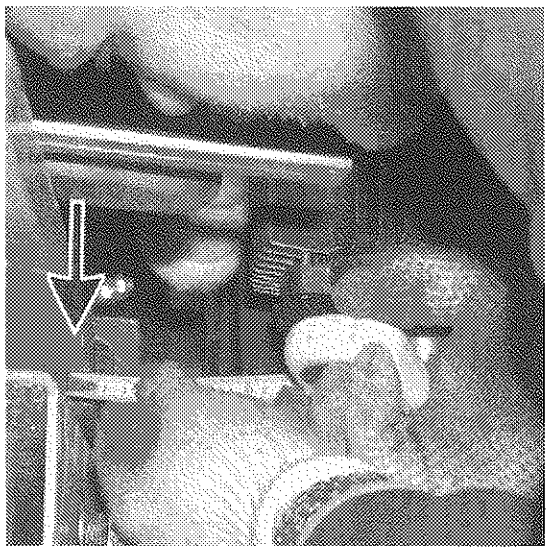


Technician measuring the horizontal difference



A technician measures and notes the distance that the generator has been moved horizontally.

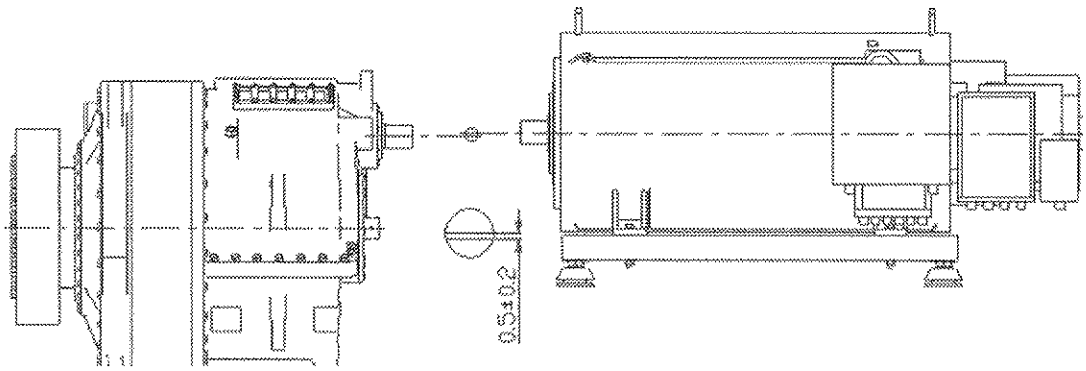
Technician measuring and noting the horizontal movement on the adjustment tool



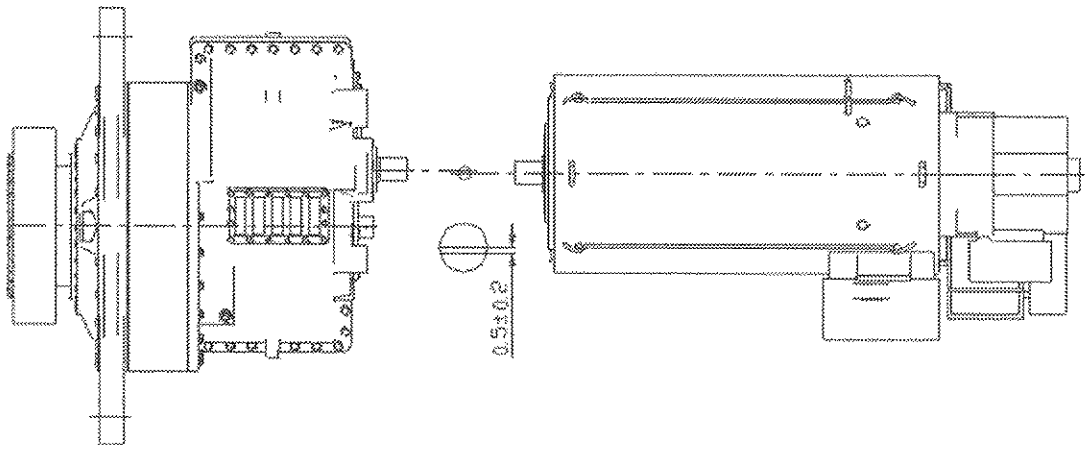
4.7.1.2 Alignment of generator without rotor

The following figures show how to align the generator without the rotor mounted. The process is as described above.

Alignment of generator without rotor, side view



Alignment of generator without rotor, top view



4.7.2 Lip seal

- Check the lip seal on the shaft end and adjust so that the lip lies against the cover.
- If necessary, lubricate the lip with bearing grease.

4.7.3 Cleaning the generator

- If the cooling surfaces or ventilator on the generator are covered with dirt or other matter, they must be cleaned.

4.7.4 Lubricating generator bearings

- Generator bearings are lubricated with grease through the lubrication nipple in accordance with Installation & Service Data. The generator must rotate during lubrication.

4.7.5 Generator bolts

4.7.5.1 Screw bolt joint, generator/cross member

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts and nuts with new.

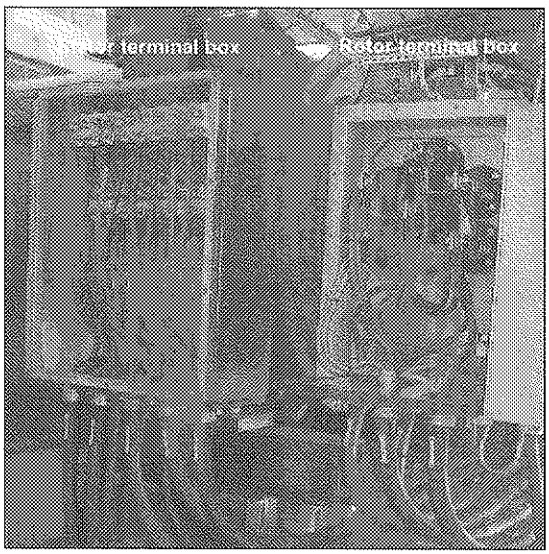
4.7.5.2 Screw bolt joint, cross member/rubber damper

- Retighten the bolts in accordance with service plan. Torque tension in accordance with Installation & Service Data.
- Replace defective or corroded bolts and nuts with new.

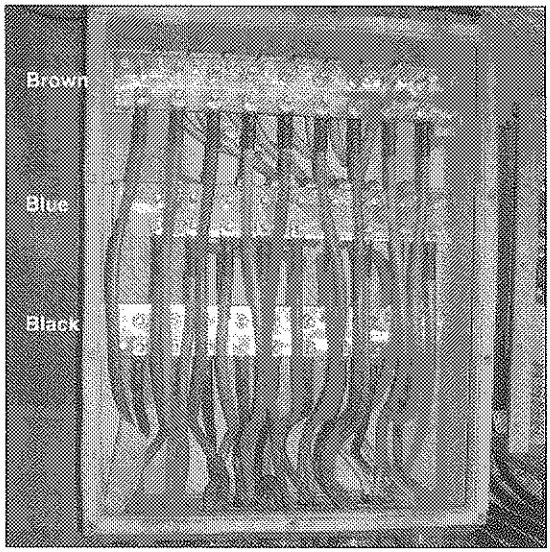
4.7.5.3 Main cable connection terminal

- Retighten the terminals in accordance with service plan. Torque tension in accordance with Installation & Service Data.

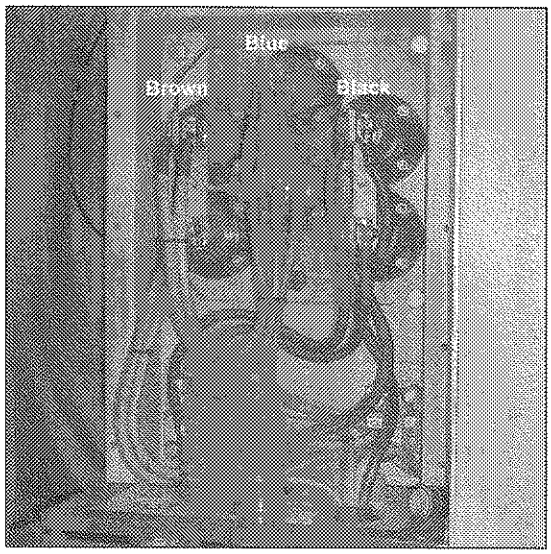
Terminal boxes on generator



Terminal box for stator circuit



Terminal box for rotor circuit



4.8 Cooling system

REFERENCES: Appendix - Installation & Service Data, servicing plan, component documentation

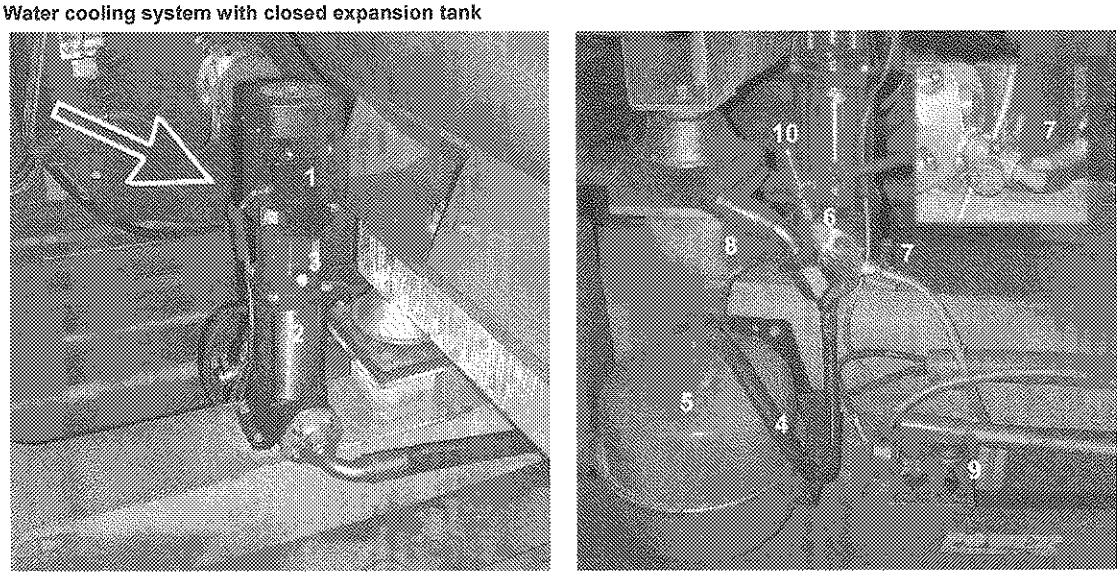
SAFETY EQUIPMENT: Safety helmet, safety shoes and rubber gloves

SAFETY: Whenever handling cooler fluid, rubber gloves and protective goggles must be worn. Coolant must not be handled at temperatures over 40 °C. In the case of accident, flush with plenty of clean water

WARNING: The system is always under pressure. Be careful, and always follow instructions when disassembling parts.

TOOLS: Hand pump for cooling system.

Water cooling system with closed expansion tank



1. *Motor*
2. *Pump*
3. *Test nipple*
4. *Expansion hose*
5. *Expansion tank*
6. *Manometer*
7. *Fill and drain cock*
8. *Temperature sensor (PT100*
9. *Hand pump*
10. *Safety valve*

4.8.1 Working with the system

The system is always under pressure, so care needs to be taken when removing hoses and fittings. Relieve the pressure by draining the expansion tank (approx. 3 litres will flow out). Check the fluid level by reading the pressure on the water pump manometer. Coolant can be sampled from the drain cock on the water pump.

4.8.2 Water pump/seals

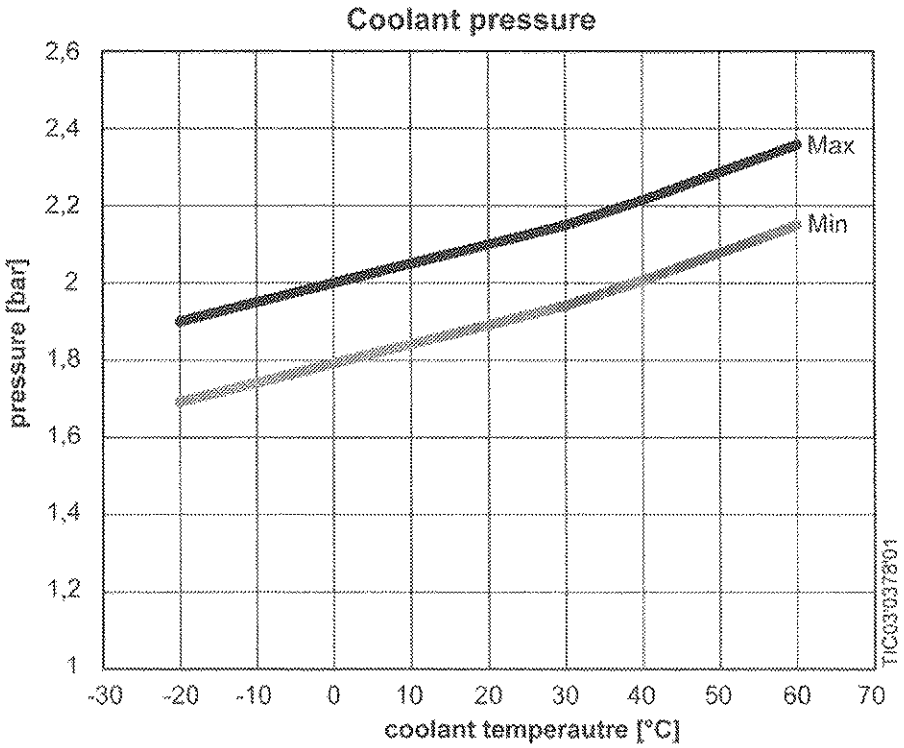
Check the water cooler and hoses for leaks. Repair or replace if leaks are found.

Checking the water level:

- Read the pressure on the water pump manometer. The pressure must conform to the coolant level diagram.
- If the pressure is too high: lower the pressure by draining off coolant.
- If the pressure is too low: raise the pressure with pressure test kit/TP-50 Power.

NOTE: if the pressure is too low, test the cooling system for leaks. If there are no leaks, the expansion tank may be defective, and must be inspected/replaced.

Checking coolant levels



Coolant may be diluted with a glycol/water mixture in accordance with Installation & Service Data

4.8.3 Water pump/seals/fittings

- Check the water pump for leaks and direction of circulation. If leaks are found, the pump must be repaired or replaced.
- All fittings must be treated with anti-corrosive – apply if necessary. Take particular care with external fittings.

4.8.4 Coolant check

- Check anti-freeze properties with a spectrometer (see Installation & Service Data for acceptance values)
- Check the anti-corrosive properties of the coolant by measurement of pH-value using litmus paper etc. (See Installation & Service Data for acceptance value).
- If the concentration or pH value is inadequate, top up with anti-freeze or demineralized water until the concentration is correct.
- Change the coolant every three years.

IMPORTANT: When changing the coolant, old coolant must be disposed of in a responsible way. Do not dispose of the old coolant on site, and do not pour it down the drain.

4.8.5 Replacing components in cooling circuit

4.8.5.1 Replacing the water pump

- Close the shut-off valves on both sides of the water pump, and drain the contents of the expansion tank (approx. 3 litres will flow out).
- The pump can now be replaced.

NOTE: New gaskets must always be mounted along with the new pump.

4.8.5.2 Check/replacement of expansion tank

- Check the expansion tank by draining the expansion tank of coolant. (approx. 3 litres will flow out).
- Next check the gas pressure with a manometer connected to the valve at the top of the tank. The gas pressure must be approx. 1.5 bar.
- If the pressure is lower, top up until the pressure is 1.5 bar.
- Wait two minutes and then check the pressure. If the pressure has dropped, the tank is useless and must be replaced.
- Finally adjust the pressure of the coolant in accordance with the diagram on fig."Checking coolant levels" using pressure test kit/TP-50 Power.

4.9 Base frame and enclosure

4.9.1 Welds and corrosion protection

- Welds do not require regular inspection, but defects should be reported and repaired in accordance with the specification for the welding seam in question.
- Visual inspection of corrosion protection. Remove rust with a brush or grind and paint in accordance with painting specification.

4.9.2 Bolts

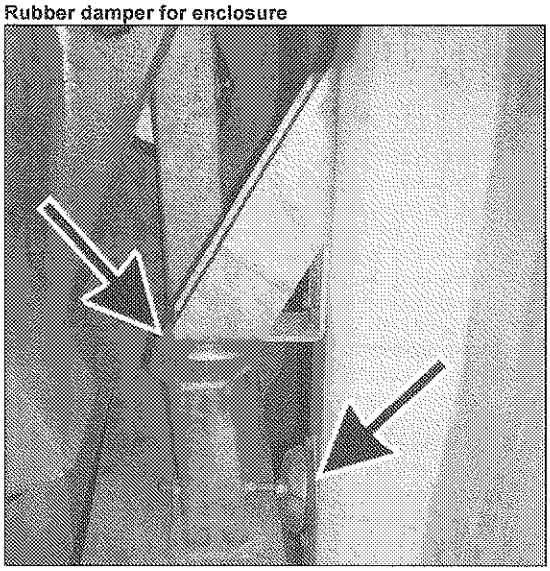
4.9.2.1 Screw bolt joint, cast/welded part

- Retighten the bolts in accordance with service plan. Tighten bolts in accordance with torque specifications in Installation & Service Data.

Bolt joint cast / welded part

4.9.2.2 Screw bolt joint, enclosure/rubber dampers

Rubber damper for enclosure



- Retighten the bolts in accordance with service plan. Tighten bolts in accordance with torque specifications in Installation & Service Data.

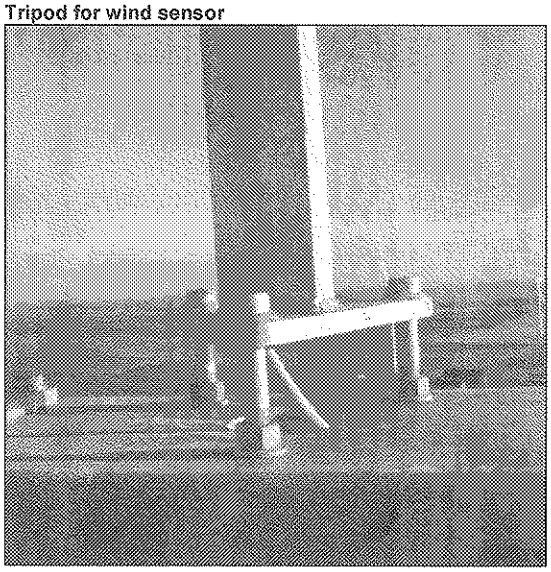
4.9.2.3 Screw bolt joint, rubber damper/base frame

- Retighten the bolts in accordance with service plan. Tighten bolts in accordance with torque specifications in Installation & Service Data.

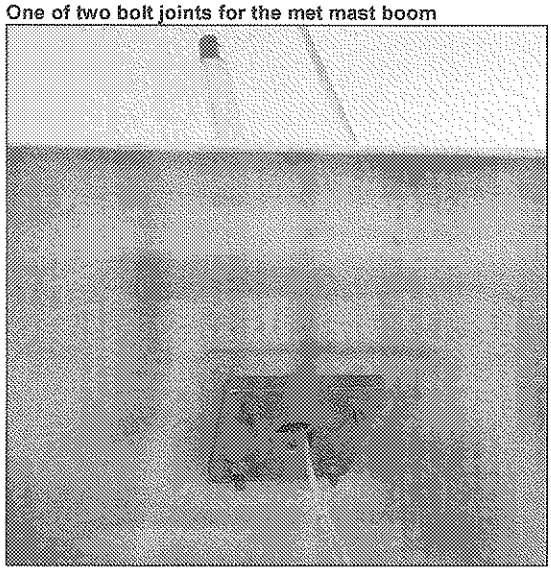
4.9.2.4 Met mast bolt joint

- Retighten bolts in accordance with the service plan & check list

Tripod for wind sensor



One of two bolt joints for the met mast boom



5 Service instructions - Rotor

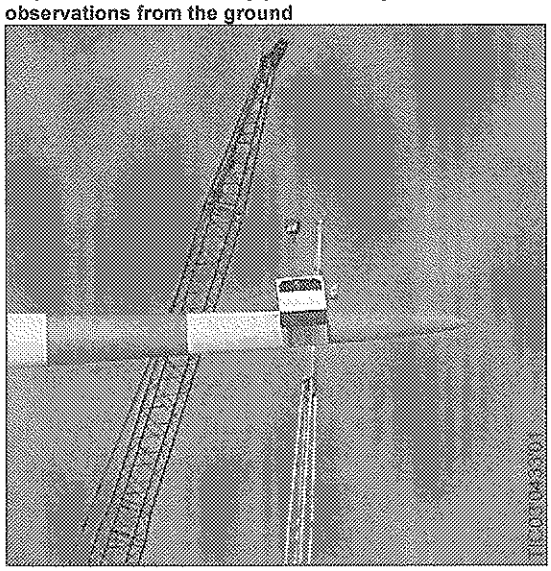
REFERENCES: Appendix - Installation & Service Data
SAFETY EQUIPMENT: Safety helmet, safety shoes and fall protection.
TOOLS: Binoculars, camera

5.1 Blades

5.1.1 Fibre glass part

The blades are inspected with binoculars from the ground. If anything critical is observed, the inspection is extended to a lift inspection of the blades.

Inspection from lift is only performed by critical observations from the ground



- Check leading edge for cracks, pinholes and scratches and repair
- Check trailing edge for cracks and scratches and repair
- Check surfaces for scratches, and pinholes and scratches and repair.

NOTE: If any additional parts such as vortex generators, stall strips etc. are mounted on the blades, check for missing parts and proper mounting.

5.1.2 Hub connection

- Check corrosion on all metallized parts (only at the root end of the blade) and repair.
- Check corrosion marks on the sealing for the flange and embedded bearings. If any marks repair sealing. (Sealing has to be water proof)

5.1.3 Lightning conducting system.

When lightning receptors are struck by lightning, they are exposed to very high temperatures, which are capable of evaporating some of the material from the lightning receptor. Lightning receptors are therefore shaped and mounted in a way that makes replacement possible. Replacement of lightning receptors is performed as follows:

- Remove the old receptor from the tip by means of a special tool. Use the two small holes in the surface of the receptor, if they are intact. Alternatively the old receptor must be removed by drilling.
- Remove the old sealer from the hole for the receptor and degrease thoroughly.
- Grind the new receptor to a mat finish on the sides and degrease thoroughly.
- Apply two droplets of adhesive to receptor thread (Loctite 243). Install the receptor in the thread and tighten it by means of a special tool. Use the two small holes in the surface of the receptor.
- Fill the groove between the receptor and the blade as well as the two small holes in the surface with a sealer. Groove and holes are filled from bottom to top to avoid air holes under the surface. Remove excess sealer, if any.

5.1.4 General Maintenance

After some time of use, it is inevitable that a border will be shaped on the front edge of the blade, consisting of insects and dirt.

This border might have a negative influence on the effect of the blades, and if it is requested that it is removed the following instruction can be recommended:

- The blades are cleaned with Yacht Cleanser which is a highly content rated cleansing agent without grinding mediums, based on water, that can be thinned with water.
- Hereafter Yacht Polish, which is a wax fluid with grinding mediums, is used. This polish cleans and polishes in 1 (one) working operation. For extreme difficult spots and rooted dirt, Yacht Rubbing can be used.
- To obtain the best possible result of this treatment, it is recommended to finish off with Yacht Wax, which is a wax fluid without grinding mediums. This wax protects and preserves the blade.
- You may be contempt with only giving Yacht Wax on the front edge of the blade.
- We draw your attention to the fact, that the instructions on the labels are followed.
- If there are scratches etc. these have to be repaired.
- If it is necessary to repair damages on the surface of the blades, please follow the instructions given in the enclosed Guidance to Repair of Fibreglass-reinforced Polyester.

Since a wind turbine blade is a heavy dynamic loaded construction it is important to inspect the blades regularly in order to repair any damage before it reaches a critical stage.

5.1.5 Repair Instructions for glass fibre reinforced polyester.

Sanding of damaged area:

- The damaged area is sanded (sandpaper with grain size 80-120) until the surface is completely clean. The area is then washed with acetone in order to remove the slip and to ensure complete dryness.

Building-up of damaged area :

- If the damaged area has a depth exceeding approx. 1 mm, it is necessary to build up the area with fibre glass reinforced polyester until the built-up area is approx. 0.5 - 0.8 mm lower than the surrounding surface. If a fibreglass mat with a weight of 450 g/m2 is used, each fibre glass laminate will have a thickness of approx. 1 mm. When the fibre glass laminate has hardened, gelcoat is used to complete the building-up process.

The actual process is as follows:

1. Always make sure that the polyester has been accelerated (cobalt naphtanate added). Mixing 1-2 cm^3 with approx. 5 drops of catalyst (hardener) does this. If the consistency of the mixture remains constant after 20-30 minutes at 18-20° C, the polyester cannot be used until accelerator (cobalt naphtanate) has been added. Contact your polyester supplier.
2. Never mix more than can be used within 15 minutes.
3. Use 15 - 20 ml hardener (1.5 - 2,0%) for each kilogram of polyester. After thorough mixing, t. mixture is applied with a brush to the sanded area. The fibre glass mat is then placed on top and worked-up with a metal roller until the fibreglass is saturated. This procedure is repeated until the sanded area is against level with the surrounding area (see point 2).
4. When the fibre glass laminate has hardened, gelcoat is applied (layer thickness 0.5 - 1.0 mm, hardener 2.0 -2.5%), until the entire repaired area is higher than the surrounding areas
5. The repaired area is then wet-sanded (sandpaper grain size 300) until the repaired area is almost flushed with the surrounding area. Sanding is then completed with wet sandpaper grain size 600.

NOTE: Always remember to use abundant water when wet-sanding. After the last sanding, the repaired area should be polished 2-3 times with wax, giving the surface a smooth and glossy finish.

5.2 Hub structure

5.2.1 Visual Inspections

Check the surface of the hub for:

- Paint quality
- Serious rusting
- Cracks

NOTE: Check that rotor lifting holes are greased.

5.2.2 Blade Bearings

5.2.2.1 Visual Inspection

Check the inner & outer seals all the way round each bearing. There should be no sign of rusting, wear or grease coming out and the seal should look uniform all the way round.

5.2.2.2 Grease Sampling from Blade Bearing

A grease sample should be taken from each bearing as follows:

- Remove one grease collection container (inc. adapter)
- Wipe away excess grease
- Take sample (min. 10cc) using clean syringe
- Put the sample in a clean airtight bottle, label and send off in accordance with normal practices. Grease is Molykote Long term 2 plus.

5.2.2.3 Blade Bearing Greasing System TAC 2 Parameters

During the commissioning of the turbine the greasing system is set to deliver a full reservoir of grease into the bearings in the first three months of running. This was achieved by setting the pump interval parameter in the TAC 2 to turn the pump on once every 4 hours.

At the first service this setting must be changed to a 27 hour pump interval which will pump a reservoir of grease into the bearings over a period of one year.

5.2.2.4 Blade Bearing Greasing System

- Remove, empty and refit the grease collector bottles. After a year all bottles should be at least ¼ full.

Grease collection bottle

- Refill the grease pump using Molykote Long Term 2 Plus (LT2 Plus) grease. The grease should be pumped into the grease nipple at the bottom of the grease pump reservoir. The reservoir should be filled up until the plunger is level with the top of the Lincoln Label (300mm from screw on base of reservoir).
- Using the TAC 2 manually operate the grease pump.
- Check that the grease pump operates, by listening in the hub.
- Check along the route of the grease lines for leaks. Tighten fittings where necessary.

6 Service instructions – Electrical parts

REFERENCES: Appendix, Installation & Service Data, diagrams in Control system documentation,

SAFETY EQUIPMENT: Helmet and protective footwear.

TOOLS: Approved electrically protected hand tools appropriate for the task.

SAFETY PRECAUTIONS: Render the wind turbine voltage-free with the maximum cut out before work begins.

WARNING! Note that there will still be voltage on the input terminals of the cables from the transformer and electricity grid.

6.1 Electrical parts in tower

6.1.1 Temperature sensors in the tower base

The following Pt100-sensors have to be tested. It's done by applying a short circuit at the individual temperature sensors. Check in 'Temperature' menu that the value goes low. The port name TOI1.xxx refer to the TOI located in the tower base.

Sensors located at tower base:

- (TOI1.300) Transformer W1 temperature
- (TOI1.303) Transformer W2 temperature
- (TOI1.306) Transformer W3 temperature
- (TOI1.310) Transformer room temperature
- (TOI1.313) Tower base temperature
- (TOI1.316) Main panel temperature
- (TOI1.400) Operation panel temperature
- (TOI1.403) Converter ambient
- (TOI1.406) Stator filter temperature
- (TOI1.710) Converter grid side 1
- (TOI1.712) Converter grid side 2
- (TOI1.715) Converter generator side 1
- (TOI1.717) Converter generator side 2

6.1.2 Test of humidity sensor at towerbase

- (TOI1.202) Humidity sensor tower base

6.1.3 Test of lightning detector

1 Test of 'Jomitek' lightning detector box:
2 Take of the top cover of the 'Jomitek' box, and fix it preliminary with 2 screws in one end of the cover. By careful so that the wires to the front do not destroyed, of fall off.
3 Insert Connect battery in box
4 Warning!! Be careful the box contents 230V, so components around the transformer is under tension

5 Put the cover back on.
6 Remove supply to 'Jomitek' box, and check that both signals TOI1.530 'Lightning detector' and TOI1.531 'Lightning detector fault' goes OFF
7 Reconnect power, and enter 'Service->Manual test' and press Enter at 'Manual reset lightning sensor', check that output TOI1.837 'Reset lightning sensor' goes ON and that 'Jomitek' box reset's by putting both outputs ON.

6.1.4 Main panel and operation panel

- Open main panel door, this shall trip the stator circuit breaker and the input 'Main panel door open' shall be low, TOI 1 506.

- Retighten bolts in mounting
- Retighten wire and cable connections
- Check warning notices are mounted
- Check the cabinet for leaks and rust and dirt. Repair any leaks. Check plug and power cables at the inlet to the cabinet.
- Visual check of components for visible damage.

6.1.5 Other cabinets

- This includes other electrical equipment such as input cabinets with main knife switch, fuses and other equipment installed in the wind turbine.
- Retighten bolts in mounting.
- Check cabinets for leaks and rust and dirt. Repair any leaks.
- Repush all sockets in cabinets

6.1.6 Cables and cable mountings

- Retighten bolts in cable clamps and supports for race ways in nacelle.
- Check cables are not damaged, e.g. cracks or faulty insulation.

6.1.7 Crane in top of tower

- Lower the hook and check the links closest to the crane for wear.
- Check the hook for wear and cracks.

6.1.8 Lighting

- Check that all light fixtures are intact and working.

6.2 Electrical parts and sensors in nacelle

6.2.1 Test of temperatures

The following Pt100-sensors have to be tested. It's done by applying a short circuit at the individual temperature sensors. Check in 'Temperature' menu that the value goes low. The port name TOI2.xxx refer to the TOI located in the nacelle.

Sensors located in the nacelle:

- (TOI2.300) Generator W1 temperature
- (TOI2.303) Generator W2 temperature
- (TOI2.306) Generator W3 temperature
- (TOI2.310) Generator bearing front
- (TOI2.313) Generator bearing rear
- (TOI2.316) Generator slip ring box
- (TOI2.400) Gear bearing front 1
- (TOI2.403) Gear bearing rear 1
- (TOI2.406) Gear intermediate front 1
- (TOI2.416) Gear intermediate rear 1
- (TOI2.740) Gear bearing front 2
- (TOI2.742) Gear bearing rear 2
- (TOI2.745) Gear intermediate front 2
- (TOI2.747) Gear intermediate rear 2
- (TOI2.410) Main bearing temperature
- (TOI2.710) Water temperature before cooler
- (TOI2.712) Water temperature after cooler
- (TOI2.715) Gear oil temperature
- (TOI2.717) Gear oil temperature after exchanger
- (TOI2.720) Generator inlet temperature
- (TOI2.725) Ambient temperature
- (TOI2.727) Nacelle temperature
- (TOI2.730) Control panel temperature

6.2.2 Test of pressure/humidity sensors

When checking pressure, remove the cap on the transducer, and check in main menu, that the corresponding pressure goes low.

- (TOI1.202) Humidity sensor tower base
- (TOI2.702) Humidity sensor nacelle
- (TOI2.102) Gear oil pressure
- (TOI2.103) Gear oil filter pressure
- (TOI2.202) Shaft brake pressure
- (TOI2.203) Yaw brake pressure

6.2.3 Check connections at hub hatch

- Check connections of the hub hatch switches. When hatch is opened, the emergency line has to be tripped, and input on TOI2.608 'Hub hatch closed' must go low.
- Check the 'Hub hatch override' switch (TOI2.607).

6.2.4 Check connections at shaft brake

Test of connections is done by disconnecting 1 wire at the assembly box for each test.

- Check sensor for 'Shaft brake hot' (input 508 on TOI2 in control panel)
- Check sensor for 'Shaft brake worn' (input 509 on TOI2 in control panel)

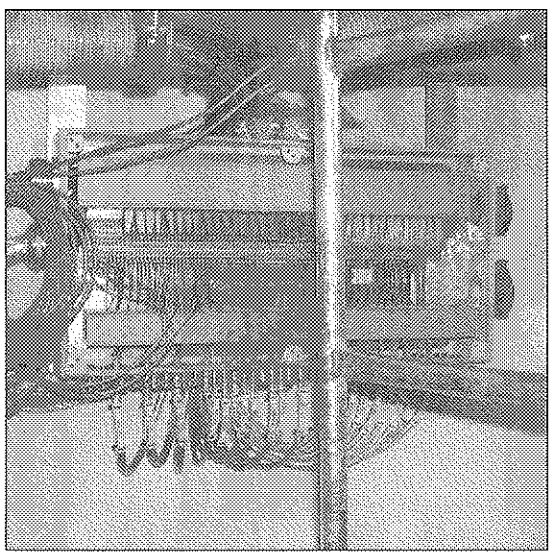
6.2.5 Others

- Check sensor 'Gear oil level' input (input 506 on TOI 2 in control panel)
- Check sensor 'Gear oil filter clogged' input (input 613 on TOI 2 in control panel)
- Check sensor 'Off-line filter clogged' input (input 512 on TOI 2 in control panel)
- Check sensor 'Drip tray level' input (input 625 on TOI 2 in control panel, is normally OFF)
- Open main panel door, this shall trip the stator circuit breaker and the input 'Main panel door open' shall be low, TOI 1 506.
- Check rotor RPM signals with a screwdriver, noting that the 'Puls 1' is flashing correctly on TAC85, and also measured by the TAC.
- Check generator RPM signals with a screwdriver, noting that the 'Puls 1' is flashing correctly on TAC84, 'Puls 2' on TAC 85. Also note that the TAC measures generator RPM.
- **Count pulses per revolution both on rotor and generator.**
  Check that it matches what is typed in the computer in:
  'Configuration -> Set generator speed parameters -> Generator pulses/revolution'
  'Configuration -> Set rotor speed parameters -> Rotor pulses/revolution'.

6.2.6 Control panel and other junction boxes

- Check for loose wires
- Retighten wiring terminals
- Check the box for dirt and signs of leakage.

Top box (opened) in the front end of the nacelle



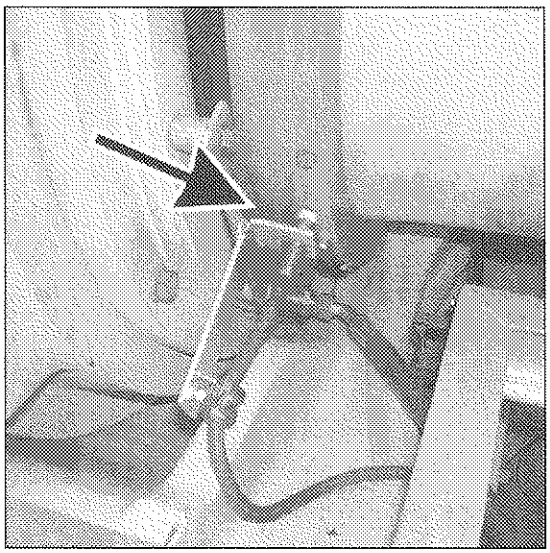
6.2.7 Cables/wiring

- Check cables and wiring for damage such as cracks and faulty insulation.
- Check that wiring is correctly mounted

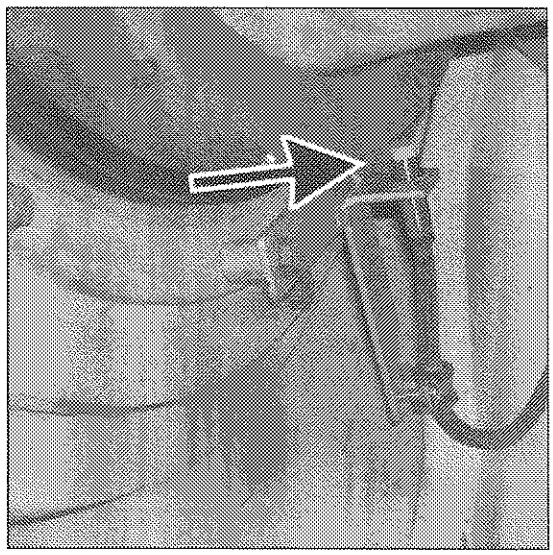
6.2.8 RPM sensors – Rotor

- Check that the distance between the sensor and the scanning points is correct.

Sensor for rotor rpm



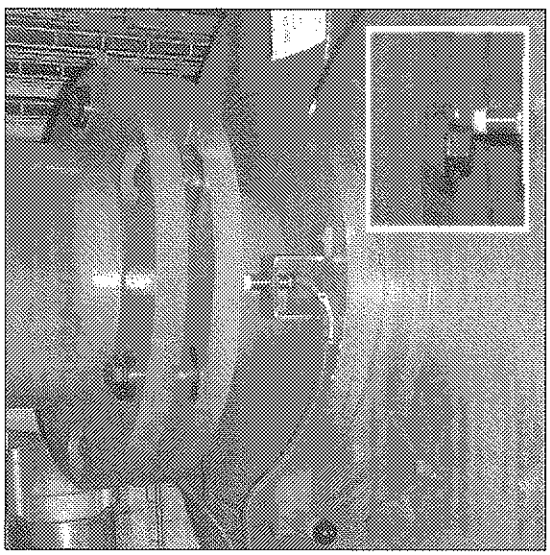
Sensor for rotor rpm



6.2.9 RPM sensor - Generator

- Check that the distance between the sensor and the scanning points is correct.
- Check the fixings of sensor, sensor fittings and scanning plate.

Sensor for generator rpm

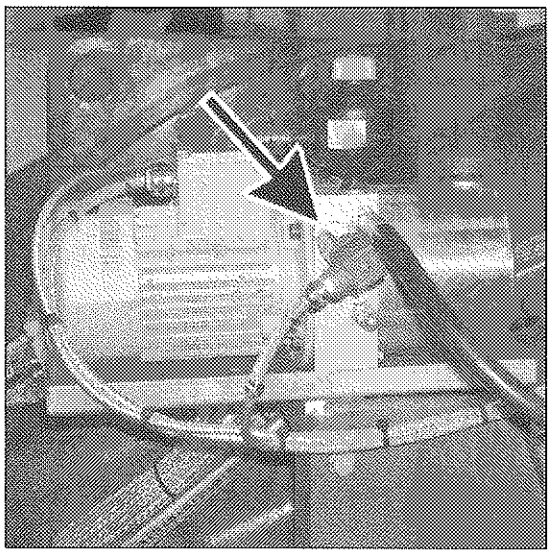


6.2.10 Pressure switch/plug

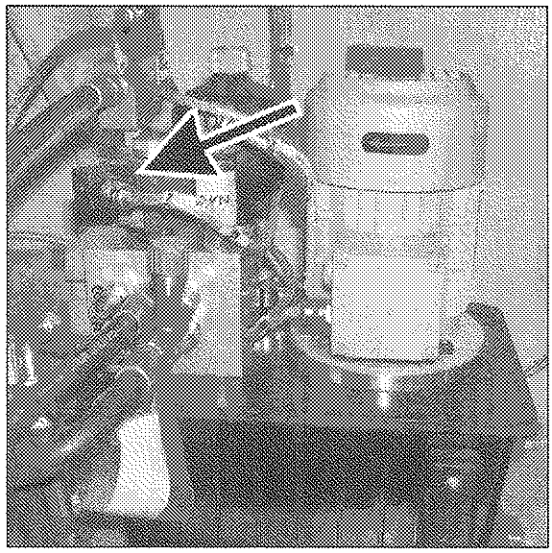
- For the pressure switches and transmitters heck the switch and plug for verdigris and rust. In the case

of verdigris or rust, clean or replace.

Pressure transmitter shaft disc brake



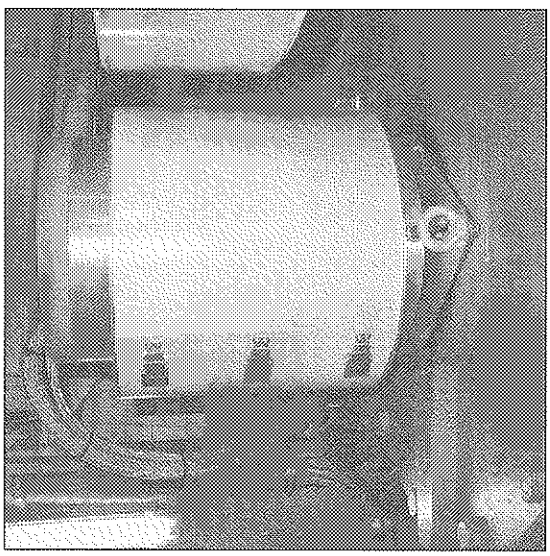
Pressure transmitter yaw brake hydraulics



6.2.11 Slip rings

- The slip rings are checked for dust by removing the cover. Clean carefully for dust if necessary. Beware the high voltage.
- If the blade hydraulics does not work properly there may be a problem with the slip rings – replace the unit and send the old part to the workshop.

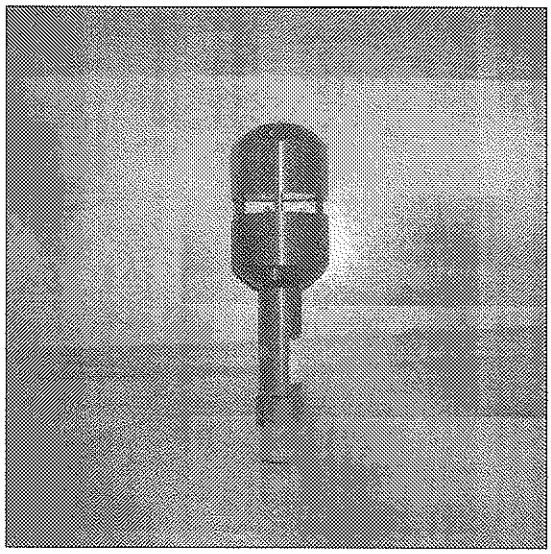
Enclosed slip ring unit – side view



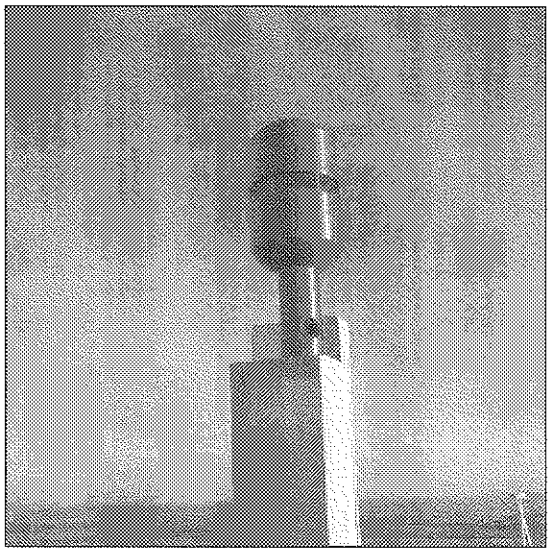
6.2.12 Wind sensors

Check that the wind sensors are clean so that air can pass unhindered. Check that the sensor is properly attached.

Wind sensor



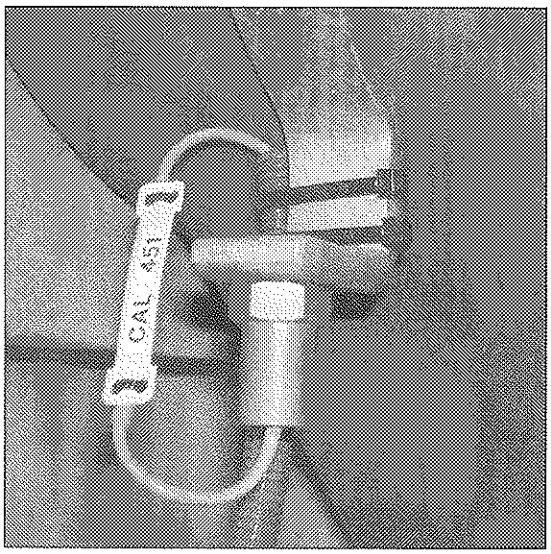
Wind sensor mounted on meteorology boom



6.2.13 Vibration sensor for TAC84 on gear box

Check that the bolt joints are tight.

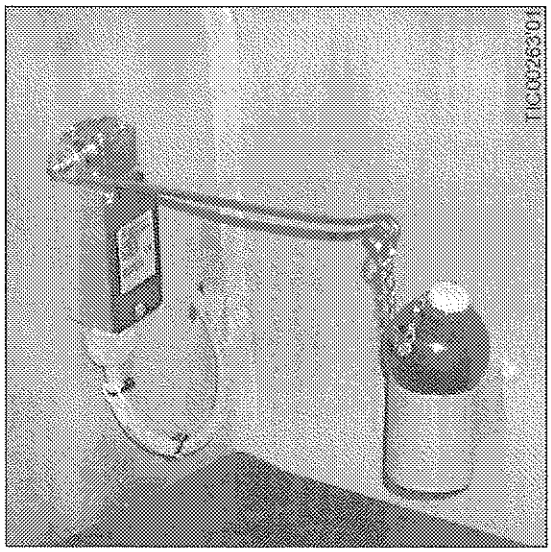
Accelerometer for TAC84 placed on gear stay



6.2.14 Ball vibration sensor

- Check the mechanical function of the ball vibration sensor by lowering the ball. The switch should be easily moved.

Ball vibration sensor

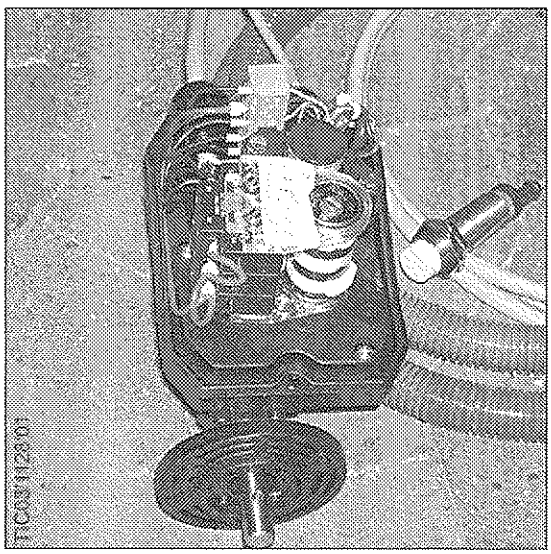


6.2.15 Nacelle crane

Activate the crane in the nacelle.

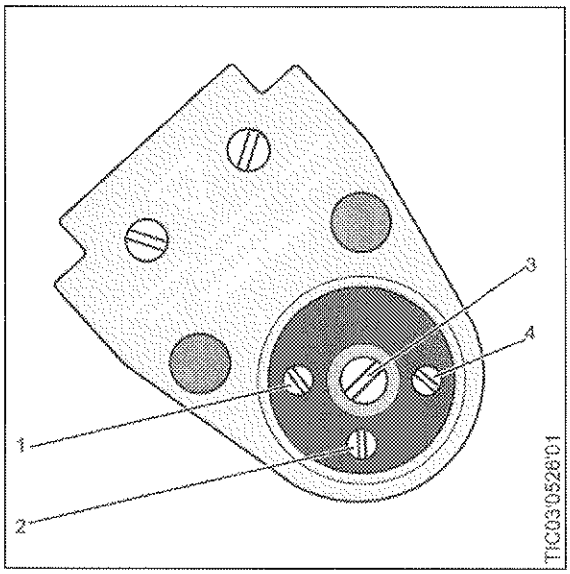
6.2.16 Adjustment of rewind box

Rewind box after removal of cover – model with decoder



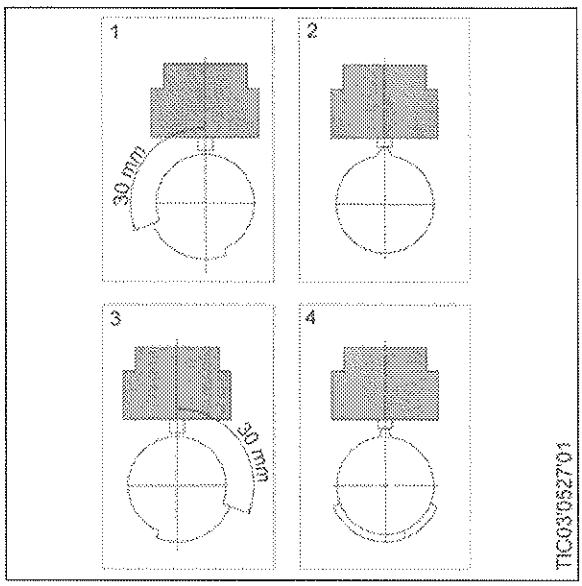
1. The center bolt is loosened to allow adjustment of the cam discs.
2. The cam discs are adjusted with the three adjustment screws. (refer to the following illustrations).

Placement of the adjustment screws



- *Adjustment of the front cam disc (untwist CW)*
- *Adjustment of the middle cam disc*
- *Center bolt for cam discs*
- *Adjustment of the rear cam disc (untwist CCW)*

Adjustment of the cam discs



1. *Front cam disc (untwist CW – yaw clock wise): The disc is adjusted so the edge of the cam is 30 mm to the left of the centerline of the switch.*
- *Middle cam disc (zero position): The disc is adjusted so that it actuates the switch.*
- *Rear cam disc (untwist CCW – yaw counter clock wise): The disc is adjusted so the edge of the cam is 30 mm to the right of the centerline of the switch.*
- *All three cam discs seen from the front.*

Important: *Remember to tighten the center bolt for the cam discs after adjustment.*

6.2.17 Testing the rewind box

6.2.17.1.1 Test of yawing clock wise (CW)

3. The nacelle is yawed counter clock wise (CCW) until the untwist CW-switch is between the cam on the middle cam disc (zero position) and the cam on the front cam disc (CW).
4. Yawing is manually stopped.
5. The untiwst switch is manually actuated. A screwdriver can be useful for this purpose.
6. The nacelle now yaws clock wise until the zero position switch is actuated, and the yawing stops.

6.2.17.1.2 Test of yawing counter clock wise (CCW)

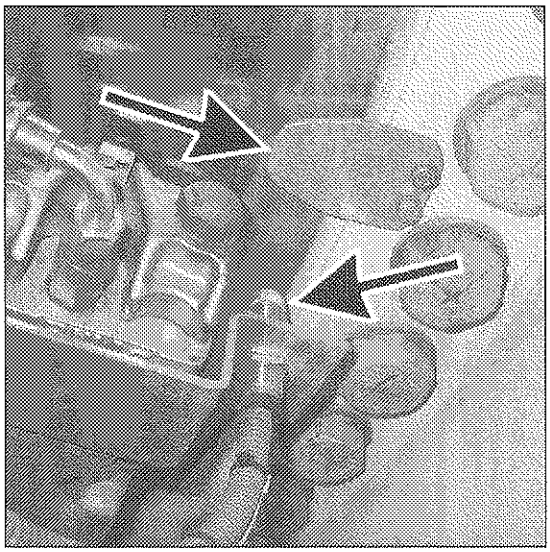
7. The nacelle is yawed clock wise (CW) until the untwist CCW-switch is between the cam on the middle cam disc (zero position) and the cam on the rear cam disc (CCW).
8. Yawing is manually stopped.
9. The untiwst switch is manually actuated. A screwdriver can be useful for this purpose.
10. The nacelle now yaws counter clock wise until the zero position switch is actuated, and the yawing stops.

6.2.18 Yaw sensor and nacelle position bracket

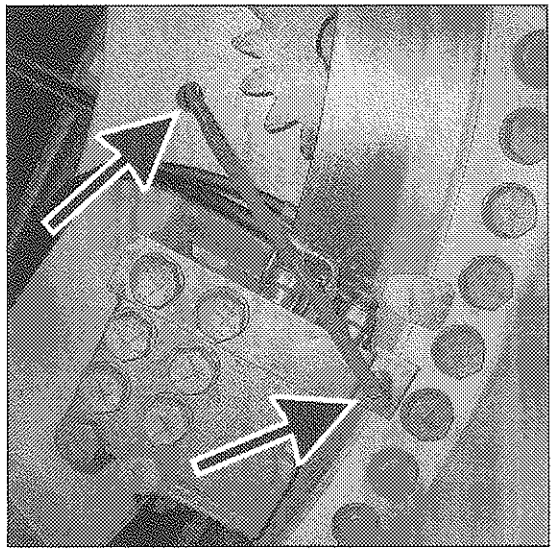
- Check that the distance between the inductive sensor and the scanning points is correct.
- Check the fixings of sensor and sensor fittings

.

Inductive sensor mounted on brake caliper and 0-degrees bracket mounted on tower flange



Loom with wires from inductive sensor



1. The nacelle is yawed to align the sensor and the nacelle position bracket.
2. The actual yaw angle compared to north is determined using a compass.
3. The yaw angle is keyed in to "Reset nacelle position" in the "Service" menu under WTG set up.

6.2.19 Yawing counter

- Check that the yawing counter counts the correct way when yawing is performed.

6.2.20 Adjust the "Reset angle nacelle" sensor to 0°

6.2.21 Wind sensors

- Check that the wind sensors are clean and without damages.

6.2.22 Test of control panels

- Check all manual functions on the operating panels in the tower and nacelle.
- Check that the filters are clean
- Check that no parts are loose
- Check the cable insulation for cracks or signs of high temperature

6.3 Electrical parts and sensors in Hub

6.3.1 Limit Switches

6.3.1.1 Visual Check of Condition

- Visually check the condition of the limit switches, fastners and brackets. Record any defects and repair.

6.3.1.2 Functional test

1. Using the TAC test facility drive the pitch to the FINE limit switch.
2. The TAC will record the pitch angle at which the switch is operated.
3. The batteries will then return the pitch to the FEATHER pitch position and operate the first feather limit switch.
4. Record the Pitch angle for each blade at which the FINE limit switch operates.
5. Record the Pitch angle for each blade at which the FEATHER limit switch operates.

NOTE: FEATHER limits are staggered at pitch angles of 95, 90, and 85 degrees on blades 1, 2, and 3 respectively.

6.3.2 Electrical Systems

Warning!! The supply to the hub panels must be isolated including the battery supply using the isolator on each axis box and the hub supply isolator in the nacelle.

6.3.2.1 Visual Inspection of Cabling

- Inspect the condition of all cables in the hub, report any abrasion or damage.
- Ensure all cabling is properly secured replace any tye-wraps or P clips that have broken or are missing.

6.3.2.2 Visual Inspection of Connectors

- Visually inspect the condition of the following connectors and make sure that they are secure:

  a. All connectors on the hub control box.
  b. All connectors on the Axis boxes on each blade.
  c. Connectors on the motor of each blade.

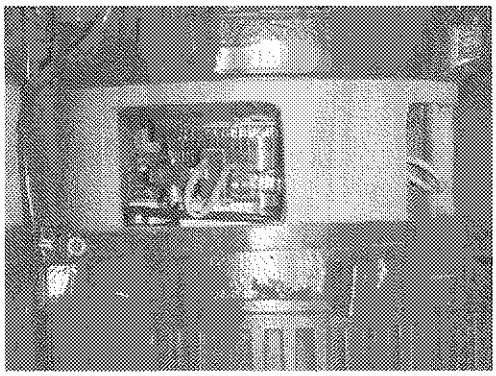
  Report any defective components and repair.

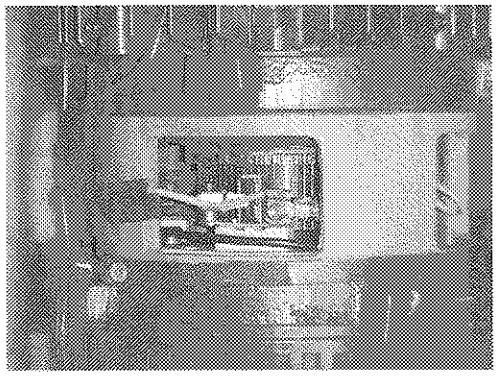
6.3.2.3 Visual Inspection of Hub Panels

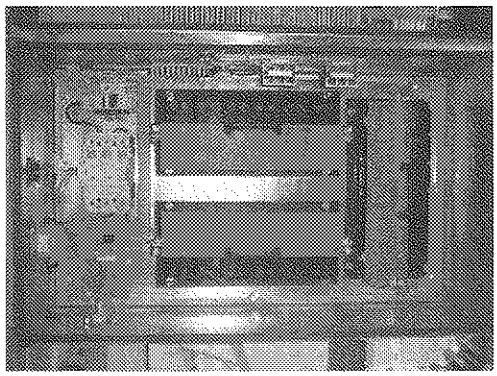
- Inspect the hub axis and control panels, check for loose components, moisture ingress, loose internal cabling or any other damage.
- Push all socket mounted componets to ensure the are firmly in their sockets.
- Report any defective components and repair.

6.3.2.4 Pitch-motor brushes

Check the pitch motor brushes every 3 years and replace.







6.3.2.5 Battery Checks

- The battery system is a self checking system and will alarm if the DC system on any blade drops below 80% of the nominal 216 volts DC. However annually the voltage should be checked as follows:

1. Turn off battery charger by opening fuse (-1F4) in the hub control box.
2. Turn on the battery isolator for the blade to be tested. (-2Q1)
3. Check the voltage between terminals on contactor –3K1:1 and –3K1:5 using a DVM.

The voltage should be in the range 216 to 195 V DC. Which is checking that the voltage is 90% of nominal. Record results for each blade.

6.3.2.6 Lighting Checks

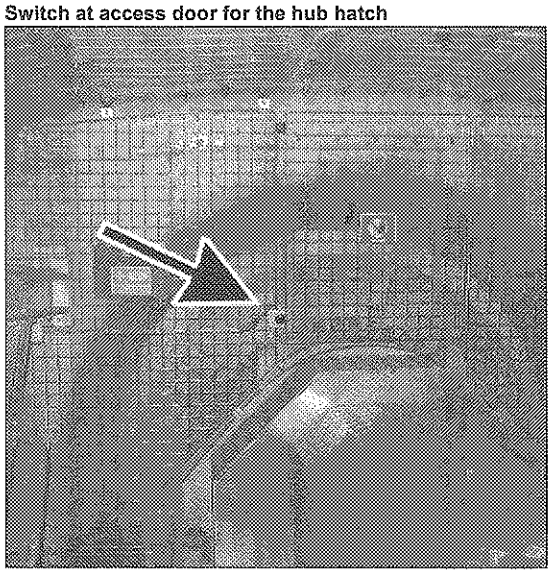
- Turn on the lights and check that they are all operational with no damage or defective elements.
- Repair as required.

6.4 Safety test

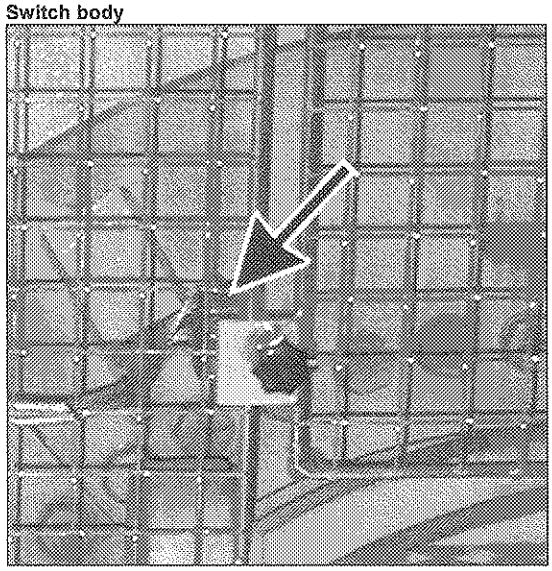
6.4.1 Check connections in the wire netting door in the front of the nacelle

- Check connections of the switches in the door which gives access to the hub hatch in the front of the nacelle. When the door is opened, the emergency line has to be tripped, and input on TOI '613 Hub hatch closed' must go low.

Switch at access door for the hub hatch



Switch body



6.4.2 Check connections at hub hatch

- Check connections of the hub hatch switches. When hatch is opened, the emergency line has to be tripped, and input on TOI2.608 'Hub hatch closed' must go low.
- Check the 'Hub hatch override' switch (TOI2.607).

6.4.3 Check connections at shaft brake

Test of connections is done by disconnecting 1 wire at the assembly box for each test.

- Check sensor for 'Shaft brake hot' (input 508 on TOI2 in control panel)
- Check sensor for 'Shaft brake worn' (input 509 on TOI2 in control panel)

6.4.4 Test of safety and emergency line

The emergency line is the line with all operator emergency stop buttons. Breaking this will also apply the shaft brake.
The Safety line will cause pitch to shutdown by batteries and converter disconnected.

For testing of the 2 systems, switch the 'Service key' on.
Activate all operator emergency stops in turn. Check that each stop causes an emergency stop (alarm 602 'Emergency stop'), reset line after each test.
They are placed at:

- Operation panel in tower-base
- Control panel in nacelle
- Switch at hatch to hub

Activate all safety-chain units in turn. Check that each stop causes alarm 603 'Safety stop', reset line after each test. The units are TAC 85 (take module out)

6.4.5 Test of shaft brake system

Note, the output on TOI 'Shaft brake valve 1' is passing an 'inverter relay' before applied to the shaft brake valve on the hydraulic unit, meaning the signals are opposite by looking on the TOI output and the valve.

1 Set Service key on
2 Under 'Service->Manual test' press Enter at 'Manual start/stop shaft brake pump'
3 Output 'Shaft brake Valve 1' shall go off (release) and 'Shaft brake pump' running under pressure control for start/stop pump. Test rotational direction of pump.
4 Press 'Enter again for 'Manual start/stop shaft brake pump'. System shall go off -> 'Shaft brake valve 1' ON, and pump stopping disregarding pressure

7 Replaceable wear parts

This section comprises a list of replaceable wear parts and their expected lifetime.

Turbine type: NM80 & 92/2750 50 Hz Description	Item no.	One WTG for 20 years [pcs.]	One WTG for the first 5 years [pcs.]	Expected lifetime years E138 [years]
Rotor				
battery pack complete (width version) 6x7,2Ah each	3492100	10	6	3
Main bearing				
Sealing ring front	35300-004	4	1	10
Lightning conductor with brush	1404000	6	1	3
Slipring				
Brushes for slipring		3	1	7
Lubrication system				
Filter FMP0651A10N	3222900	20	5	1
Cooling system				
Filter unit (oil) 2600 R 010 BN3HC/-V-B4-KE50	3530100	20	5	1
Circulating pump, water	3591900	2	0	10
Mechanical brake				
Mechanical indicator	3510900	6	1	3
Sinter brake pad	15301-035	6	1	3
Positioning System, Svendborg BrakesSystem F/MS-300 - 1 set in bag	2610200	2	0	10
Pad retraction springs	3597200	6	1	3
Bolt, M18 x 2,5 x 50	3410000	2	0	10
Spring pack, BSFH 340-X-210 "EE"	3597300	4	1	5
Gasketkit f/BSFH monospring 300	2787500	4	1	5
Nut M24	3597500	2	0	10
Mechanical brake Hydraulic				
Electr. Motor 4AP71-4-B5-400/690	2920900	2	0	10
Pump for NTK 1500 hy-unit K 0,25-D-48TR	17300-703	2	0	10
Oil-Filter SFP-1/2"+F+A=100	2927600	20	5	1
Press. Transmitter MBS33060G1756	3167700	1	0	15
GS02-11-0-1- NO solenoid Valve	13302-206	2	0	10
HJ4-0788 Reliefvalve	2913200	2	0	10
Check valve VUH14 OD4403000901	2934700	2	0	10
Yaw system Brake				
Set of pads US 2-5	3479300	6	1	3
Pad locating stop	3601800	8	2	10
Pad holding screw HM16	3601900	16	4	10
Lock washer of screw (11.51)	3602000	16	4	10
O ring	3602200	8	2	10
Anti-extrusion ring	3602300	8	2	10
Cap seal	3602400	8	2	10
Yaw system Brake Hydraulic				
Electr. Motor 4AP71-4-B5-400/690	2920900	2	0	10
Gear pump HLDP/G 0505 D	3599100	2	0	10
EPE Filter 250F10P10F-NVOP	313400	10	2	2
Pressure Valve VM15 (V3.889.04.A)	2704100	2	0	10
Check Valve OD.44.02.00.09.01	19300-176	2	0	10
Relief Valve VM 15	2705300	2	0	10
Press. Transmitter MBS33060G1756	3167700	2	0	10
Magnetic valve V3D-CE	17301-700	2	0	10
Yaw Gear				
Gasket ring 120x150x12 L NBR (output)	3630100	6	1	10
Gasket ring 40x62x10 L NBR(input)	3630200	6	1	10
Generator				
Relubrication DE	3525600	19	5	1
Relubrication NDE	3525600	19	5	1
Brush	3525900	19	5	1
Earthing brush	3526000	5	1	4

8 References

This manual has been prepared on the basis of and refers to a number of other NEG Micon documents and supplier documentation. The named documents are to be regarded as background information for this manual.

- NMCS - Document 4002134 Tightening Torques
- NMCS - Controller manual for NEG Micon PRVS turbines
- NMCS - Controller manual NM80 & NM92
- AVN–K09 Yaw hydraulics manual
- AVN–B16 Brake hydraulics manual
- Svendborg Brakes Manual
- Winergy Manual
- Loher Operating Instructions Manual Generator
- LM 388P – Installation and maintenance manual for 38.8 rotor blades
- LM 448P – Installation and maintenance manual for 44.8 rotor blades
- QI 09.374 GB Bolt Assembly Instruction for Rotor, Nacelle and Tower
- QI 19.011 GB – Settings for TAC 84 Vibration Guard
- QI 19.022 GB – Settings for TAC 85 Over speed Guard
- QR - Standard I&S Tools and Lifting Equipment
- QI 09.031 Paint repair (Painting specification – repair of paint work)

Appendix

Appendix – Installation & service data
Appendix – Weights, Dimensions & Transport Guidelines
NMCS - Parameter List
NMCS - Stop and Reset Functions
Appendix – Parameter list
Appendix – Electrical diagrams