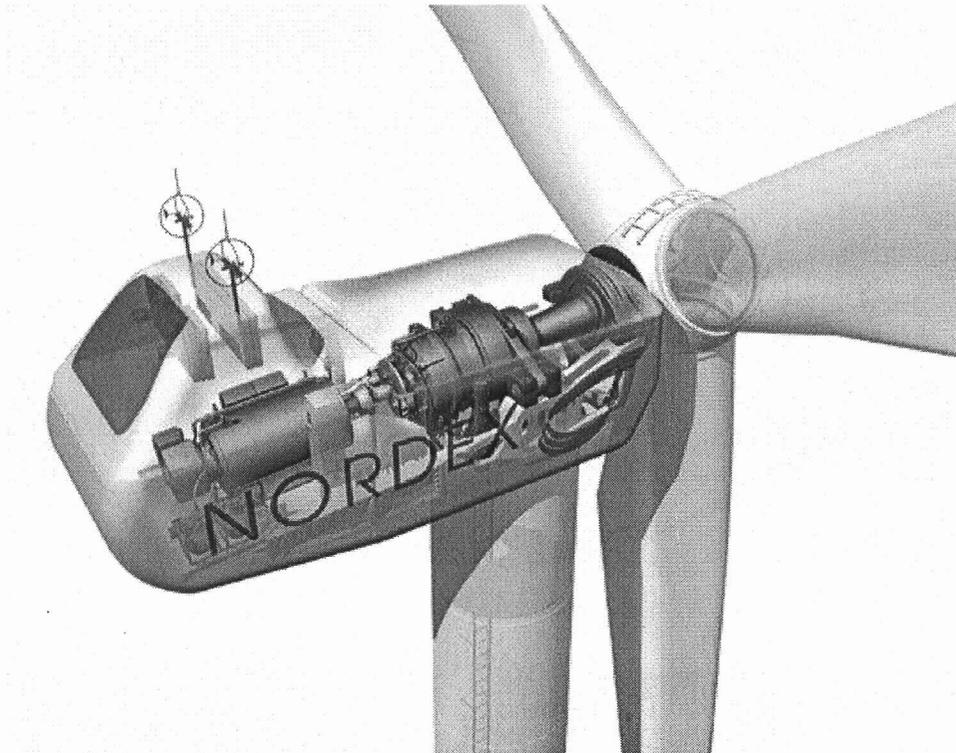


Safety Manual

Rules of Conduct on, in and around Wind Turbines Turbine Classes K06, K07, K08 All Types



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Subject to technical modifications.

This documentation was created with greatest care taking into account the currently applicable standards.

However, due to continuous development, the figures, functional steps and technical data are subject to change without prior notice.

Scope

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1. Conventions

1.1 Symbols and notes

1.1.1 Hazard of personal injury



Unless the instructions and notes are observed, life-threatening injuries will result.



Unless the instructions and notes are observed, serious injuries may result.



Unless the instructions and notes are observed, injuries will result.

1.1.2 Warning of material damage



NOTICE

Warning of damage to components or material

1.1.3 Notes and information



NOTE

Provides additional information, notes and hints



OBSERVE DOCUMENT

Reference to information in other documents

1.1.4 Integrated safety notes and information

Information and safety notes integrated into the text. Indicated by the signal word in bold: Note, Notice, Caution, Warning.

Example

Notice: To prevent damage to the paintwork, the tower sections must not touch the ground.

1.2 Lists and work steps

- Work step
 - ▶ Result of a work step
- List
 - Subordinate list

1.3 Italic text

Identification of proper names: e.g. manufacturer names, document titles.

2. Introduction

This document is confidential and intended for the owner/operator, NORDEX employees and employees of contractual companies.

This document contains general regulations and notes for the safe and risk-free operation as well as execution of all necessary work steps for the erection, commissioning and maintenance of a NORDEX wind turbine (WT).

It applies to all turbine types of the classes K06, K07 and K08, see "Table: Overview of wind turbine classes and types".

For this reason, it is absolutely essential that all persons operating or working on a wind turbine read this document carefully, and act in accordance with the instructions and regulations.

The safety manual must be understood in order to guarantee safety on and around the WT. If questions arise when reading this document, clarify them first and, if required, consult NORDEX.

The respective, specific safety instructions in the technical documentation which, for example, describe the operation or maintenance must also be read and understood.

In addition, the current version of the Document *NX_HS_0002 Instructions for all Work Steps to be Performed in and on Wind Turbines (WT)* is binding for NORDEX employees. The Document *NX_HS_0004* applies for employees from contractual companies.

The Chapters *Special features of K06* and the following apply to trained, specialized personnel, such as service employees.

In the interest of their own safety, the owner/operator should only perform any operations if they or a casualty must be abseiled out of the nacelle in a hazardous situation or if they belong to the group of trained, specialized personnel.

Table: Overview of wind turbine classes and types

Turbine class	Type
K06	N54-Mk3/1000 N60/1300 N62/1300
K07 alpha	S70/1500 S77/1500
K07 beta	N70/1500 N77/1500 N82/1500
K08 beta	N80/2500 N90/2300 N90/2500
K08 gamma	N100/2500

3. Terms and Abbreviations

The following terms and abbreviations are defined in this document:

Term	Definition
Self-contained electrical operating site	Self-contained electrical operating sites are spaces or locations which are used solely to operate electrical systems and are kept locked. Only electrically skilled and electrically instructed persons have access. Persons without electrotechnical training must only enter these rooms when supervised by electrically skilled persons.
Electrically skilled person	An electrically skilled person is somebody who on account of expert training, knowledge and experience as well as the relevant standards is capable of evaluating the tasks allocated and detecting potential risks.
Electrically instructed person	An electrically instructed persons is somebody who has been instructed and, where necessary, trained by an electrically skilled person about the allocated task and potential risks of improper behavior as well as informed about the necessary protective equipment and protective measures.
Trained, specialized personnel	Trained, specialized personnel include those trained, instructed and authorized for the professional execution of work on wind turbines.
PPE	Personal protective equipment
Expert for personal protective equipment against falling from a height	Expert for personal protective equipment against falling from a height is somebody who, on account of expert training and experience, has sufficient knowledge in the field of personal protective equipment against falling from a height and is familiar with the relevant occupational health and safety regulations, accident prevention regulations and generally accepted standards of technology to be able to evaluate whether or not a personal protective equipment against falling from a height is in a safe condition and is applied properly. In Germany, these requirements are fulfilled by anyone who has successfully participated in a training course, in accordance with the BG (Institution for Statutory Accident Insurance and Prevention) policy "Selection, training and proof of capability of experts for PPE against falling from a height" (BGG 906).
WT	Wind turbine

4. Safety regulations

4.1 Intended use

The WT is solely intended to convert the kinetic energy of the wind into electrical energy, and to feed this into an existing electricity network.

The WT must only be used for the intended purpose within the specified performance limits and operating conditions.

Usage outside of these parameters is not permitted.

4.2 General rules

Persons who want to enter the WT and operating or working on the WT must first have read and understood this Safety Manual and the Operating Instructions for the WT.

It is within the interest of your own safety and the safety of the WT to strictly adhere to the safety and operation regulations contained in these documents.



NOTE

The owner must ensure that this Safety Manual and the current Operating Instructions are always available in the WT and are in a usable condition.

4.2.1 Basic occupational safety equipment

Persons who want to enter the WT must have the following basic occupational safety equipment:

- Working suit
- High safety shoes class S3
- Safety helmet
- Safety gloves

This equipment is compulsory for service employees.

Depending on the task in hand, service employees also require:

- 1 pair of safety glasses for work steps involving hydraulic tools
- 1 set of hearing protection, when noisy work is carried out in the tower or nacelle

The personal protective equipment (PPE) must also be used for the ascent in the tower using the vertical ladder or the service lift, or while staying in a fall hazard area, see Chapter 7.1 "Personal protective equipment (PPE)".

4.2.2 Access

The WT is classified as a self-contained electrical operating site.

For this reason, persons who want to enter the WT or must carry out work in or on the WT must meet special requirements.



⚠ DANGER

Persons with pacemaker are not permitted to enter the turbine.



NOTE

The owner of the WT must take suitable measures (e.g. key authorizations) to ensure that unauthorized persons cannot access the WT.

The following persons are authorized to access the WT:

- Electrically skilled persons
- Electrically instructed persons

Persons without electrotechnical training must only enter the WT under the supervision of one of the aforementioned persons.

If the medium-voltage transformer is installed in the tower, then it is located in a separated, locked area, due to the high electrical voltage applied. This must only be entered when de-energized, and by electrically skilled persons only.

4.2.3 Inside/around the WT

When inside the WT or in its direct proximity, safety helmets and high safety shoes must be worn.

All warning and safety signs in the WT and all operating instructions must be strictly followed.

While inside the WT, it must be ensured that unauthorized persons cannot enter the WT. This is achieved by means of corresponding signs.

If more than one person is inside or around the WT, the tower door can be locked from inside.

However, prerequisite for this is that, in case of emergency, access for the emergency services is ensured, e.g. by visibly leaving a key to the turbine in the locked service vehicle.

When inside the WT for prolonged periods, particularly when working in the nacelle, as well as on and in the rotor hub, depending on the general weather conditions, observe changes to the weather.

This is necessary in order to take measures early enough to prevent dangerous situations caused by freshening wind or approaching thunderstorms.

Loose, long hair, loose clothing, or jewelry that may get caught or dragged into rotating parts is not permitted.

Smoking is not permitted in the WT.

4.2.4 Operation

The WT has been designed, built and erected using state of the art technologies and in accordance with the relevant technical standards and regulations.

Despite this, incorrect usage can result in dangerous situations, which can put persons' health and lives, and the WT or other material assets at risk.

For this reason, the WT must only be operated:

- According to its intended use
- In technically sound condition
- In compliance with the operating and maintenance regulations

The owner/operator may only perform operator control actions on the WT after receiving expert instructions.

Operator control actions by the owner/operator are restricted to starting and stopping the WT, and querying WT production data using the software provided by the manufacturer.

Individual components of the WT must only be manually operated by trained specialized personnel, who are trained, instructed and authorized for this purpose.

Operating personnel currently undergoing training must only work on the WT under the supervision of an experienced person.

The successfully completed training must be confirmed in writing.

The WT is operated automatically.

Operational faults are identified by the control system, and trigger corresponding error messages, right through to shutting down the WT.

Faults must only be identified and rectified by trained, specialized personnel.

4.2.5 Ascending to the nacelle



NOTE

- Only persons who are physically capable and have a valid certificate for working at heights are permitted to ascend into the nacelle
- The abseiling equipment must be carried along
- An emergency eyewash bottle must be carried along

It is only permitted to enter the nacelle in the following conditions:

- 10 minute average wind speeds up to
 - 20 m/s for tubular towers
 - 12 m/s for lattice towers
- A second person is present
- Service lift and vertical ladder with fall arrest system are in sound condition (valid test badge or test certificate).

Before ascending into the nacelle:

- Inform the responsible remote monitoring
- Stop the WT and secure it against re-activation
- Disable remote access to the control system
- Put on the personal protective equipment (PPE)

When ascending to the nacelle, at least one mobile communication device (two-way radio, cell phone) must be carried along in order to ensure communication with persons remaining on the ground and, in cases of emergency, with the emergency services.

If no further persons are remaining on the ground, a communication device, which is activated and secured against access by third parties, must be deposited in the tower base.

If there is a service lift in the WT, the following applies:

- The service lift must be generally used for ascending and descending the tower. Only use the vertical ladder if the service lift is out of order.
- The service lift must only be operated by persons instructed in its operation
- It is not permitted to use the service lift and the vertical ladder at the same time, as this would endanger the person using the vertical ladder
- When using the service lift, it is obligatory to always secure against falling from a height. For this purpose, the PPE must be used together with the attachment points in the service lift cage.

The following rules apply when using the vertical ladder:

- Before using the vertical ladder, remove any loose objects from pockets in clothing and either leave these behind or safeguard them against falling out
- It is obligatory to always secure against falling. For this purpose, use the PPE in connection with the fall arrest system
- Before and during the ascent, visually inspect the vertical ladder and fall arrest system for damage
 - If in any doubt, cancel the ascent, and, if necessary, also secure yourself on the ladder upright using the lanyard with energy absorber
 - Immediately inform the responsible service company, FOM and remote monitoring

- Only one person at a time may be on the vertical ladder in the area between two tower platforms
- If a tower platform has an access hatch, this must be closed immediately after passing through it

Rules for using the PPE:

- Only use your own PPE
- All components of the PPE must have a valid test badge
- The PPE must be checked for damage before use
- A PPE that has been put under stress due to a fall must no longer be used, and must be inspected by an expert
- The PPE must be inspected regularly by an expert, at least once a year

4.2.6 Exiting the WT

Owner and operator must restore the operational state of the WT before leaving it.

This means the following:

- Inform the remote monitoring of the intention to leave the WT
- For lattice towers:
 - Bring the service lift cage into the parked position
 - De-activate the supply voltage to the service lift
- For towers with external ascent:
 - Attach the ladder guard and secure it with a lock
 - Store the key for the lock on the bracket for the PPE
- The PPE must be complete and properly stored in the correct place
- If necessary, restart the WT, if it has been stopped manually
- Log off on the turbine PC
- If necessary, re-establish remote access to the control system
- Switch off the lights
- Lock the door in the tower base (tubular tower) or the transformer station (lattice tower)

The same applies to specialized personnel after completion of work on the WT.

The following must also be ensured:

- The rotor lock must be released and the rotor lock bolt secured
- The working rope and the chain for the on-board crane must be hauled in
- If available, the jib of the on-board crane must be in the parked position

- The chain bag of the on-board crane must be secured (K08 only)
- The nacelle roof (K06 and K08 beta) must be closed and secured
- The WT control system must be ready for operation
- Any contamination must be removed, and the WT must be cleared of tools and packaging

If specialized personnel intend to briefly leave the WT, although the work is not yet complete, the following must be ensured:

- Remote access to the WT control system must not be possible
- The WT must be in a safe condition
- The nacelle roof (K06 and K08 beta) must be closed
- Unauthorized persons must not be able to access the WT

4.3 Additional safety regulations for specialized personnel

4.3.1 General

Work steps for erecting, commissioning, and maintaining the WT must only be performed by trained, specialized personnel.

Specialized personnel working on the WT must:

- Regularly take part in rescue training and first-aid training
- Possess a valid certificate for working at heights

During work in the WT, at least 2 employees must be on site at all times.

- Each employee must carry and use their own PPE
- The PPE and, if applicable, the abseiling equipment provided in the WT is only intended for use by the owner
- Hearing protection must be used when carrying out noisy work, particularly in the tower.

When using hearing protection, it must be ensured that those persons present are able to communicate by using hand signals agreed in advance.

- For the period of the completed work, the responsible employee is technically and disciplinary responsible for all subordinate employees.

Before starting the work, he must instruct them in the safety regulations to be observed, and he must ensure that they are adhered to.

- The responsible employee must be familiar with the telephone numbers of the local rescue services and the power utility and keep them readily available
- It must be ensured that all those involved are able to perfectly communicate at all times (if necessary, an interpreter must be used).

An adequate number of two-way radios with uniform frequencies must be available. It must be checked whether or not the frequencies are permitted in the relevant countries where the turbines are erected.

If parts of the WT or the entire WT are switched off during maintenance or repair work, these parts must be secured against automatic or accidental re-activation.



⚠ WARNING

AUTOMATIC RESTART

The WT may be at a standstill due to an error that occurred during idle mode (standby). If the error is no longer active, the WT would automatically restart. Prior to starting work on the WT, perform a manual stop and disable remote access to the control system.

If necessary, for individual turbines, the telephone plug must be removed from the telephone socket. In the case of a wind park, the network plug must be removed, in order to prevent remote access to the control system.

To ensure that the WT can operate correctly and safely, factory-set switching points on monitoring and control components, such as pressure monitoring devices, valves, throttles or control parameters, must only be changed for testing purposes.

Once tests have been completed, the specified values must be reset immediately.

Only use original spare parts from the manufacturer for repair work. It is prohibited to use parts from manufacturers that have not been expressly approved by the manufacturer of the WT.

Any damaged machine components must be replaced. If this is not possible, the WT must not be started again.

If it is necessary to disassemble safety devices in order to execute work steps, these must be re-assembled directly after the work has been completed, and must then be checked for proper functioning. It is not permitted to permanently put safety devices out of service.

Do not transport persons with the on-board crane. Do not stand or walk under suspended loads.

After the work has been completed, thoroughly clean the WT. Remove tools, spare parts and inflammable material such as cloths or packaging. This must be checked by the responsible employee.

In addition, the generally accepted rules on safe and proper execution of work as well as the latest versions of the accident prevention regulations must be observed.

In all countries where turbines are erected the existing national regulations concerning accident prevention and environmental protection must be adhered to.

4.3.2 Working in the separated transformer area (only for WTs with transformer inside tower)

If the medium-voltage transformer is installed in the tower, and if work must be executed in this specially separated area (e.g. maintenance work on foundation screw connections), the following special safety regulations apply:

- Before entering the separated, locked area of the transformer, an electrically skilled person with switching authorization must de-energize this area, including the supply cables for the medium-voltage cables (ring cable), observing the five safety rules.
- Only electrically skilled persons with a valid switching authorization for the medium-voltage switchgear for the corresponding voltage level are authorized to enter the transformer area. Other persons are only permitted to work in this area under their supervision.
- While in the transformer area, the escape route must be kept free at all times. If the WT has a service lift, it must be parked on the next highest platform.

Once the work steps in the transformer area have been carried out, the switch-authorized electrically skilled person must check whether everyone has left the area and that all objects brought into the area have been removed again.

Only after this check the entire system, including the medium-voltage cables, must be connected again.

4.3.3 Using the vertical ladder during erection

During erection, it may occur that the fall arrest system is not yet available, or has not yet been released.

If the vertical ladder must still be used, then special rules of conduct must be adhered to:

- A sign on the vertical ladder must explicitly indicate that the fall arrest system is not yet available, and that the person ascending the vertical ladder must be secured against falling using the lanyard with energy absorber
- Always safeguard yourself against falling by alternately attaching the two ends of the lanyard with energy absorber to the ladder uprights

4.3.4 Work in the nacelle

Immediately after entering the nacelle, the following initial tasks must be carried out prior to performing any maintenance or repair work:

- Switch the service switch on the manual control unit of the Topbox to service mode
- Close the access hatch, if available
- Ensure that the rotor brake is applied and cannot be released by the control system

- Transport the abseiling equipment, which must be carried in the service vehicle, into the nacelle and deposit it ready-for-use in cases of emergency
- Lock the rotor at the rotor shaft

When working with the roof open, all employees in a fall hazard area must secure themselves at one of the marked attachment points in the nacelle, or to the safety rope system, using the lanyard with energy absorber.

There is a falling hazard in the following areas:

- The side of the drive train which faces the open roof edge
- The front and rear end of the nacelle

When working on the roof, the employee must be attached to one of the marked attachment points for personal protection using a lanyard with energy absorber.

When working in the nacelle, the rotor must always be locked at the rotor shaft.

The rotor lock may only be released temporarily for specific work steps.

If the rotor lock on the brake disk is available, it can also be used under specific circumstances.

Work steps on the drive train are only permitted at 10 minute average wind speeds up to 12 m/s.

If a person is working alone in the nacelle, he/she must remain in regular verbal or visual contact with one of the other employees.

It is not permitted to leave the WT when the roof is open.

If it is necessary to stay in the nacelle while the WT is in operation, in order to complete certain work steps (e.g. for test runs), the following rules must be observed:

- The access hatch to the nacelle must be closed (if available)
- All protective covers over rotating parts must be in place, unless they must be removed in order to complete the work steps.
- The working rope and the chain for the on-board crane must be hauled in
- The jib for the on-board crane (K08 beta and K06) must be in the parked position
- The roof must be closed
- The safety harness with lanyards must be taken off
- Tight work clothes must be worn
- Everyone must be in a safe position
- Hearing protection must be worn and reliable communication between the present persons must be ensured

4.3.5 Work on and in the rotor hub

It is only permitted to access the rotor hub and perform work on or in the rotor hub if:

- The 10 minute average wind speed is less than 12 m/s
- The rotor is locked on the rotor shaft
- Additionally, the rotor brake is applied
- Another employee, who can operate the WT control system, is in the nacelle
- Both persons are equipped with a mobile communication device

If the rotor hub is accessed from the outside by crossing the hub (WTs of turbine class K06 and K08), the corresponding instructions must be strictly adhered to, see Chapter 11.5 "Entering the rotor hub" and see Chapter 13.5 "Entering the rotor hub", see Chapter 14.3 "Entering the rotor hub".



WARNING

ROTATING PARTS

Directly after climbing into the rotor hub, the pitch drives, where available, must be de-energized.

If the work to be performed does not allow this, ensure that no body parts, clothing or harness parts come into contact with the slewing bearings and pinions of the pitch system.

4.3.6 Work on the electrical system

Work on the electrical system in the WT must only be performed by electrically skilled and electrically instructed persons.



DANGER

HAZARDOUS VOLTAGE

Potentially lethal voltage in some parts of the WT switch cabinets. Any contact with live parts may cause life-threatening injury.



DANGER

HAZARDOUS VOLTAGE

If the transformer is located in the tower of the WT, there is a potentially lethal high voltage in its immediate vicinity. Even approaching a live part may cause a fatal voltage flashover.

Always de-energize the transformer before entering the separated area

Special regulations apply for work in this area of the tower base, see Chapter 4.3.2 "Working in the separated transformer area (only for WTs with transformer inside tower)".

Work on medium-voltage switchgears must only be performed by electricians with a valid switching authorization.

Electrical equipment on which inspection, maintenance and repair work is to be performed must be switched to zero potential in advance.

In the process, the 5 safety rules must be observed:

- De-energize all components
- Secure to prevent re-activation
- Make sure that all components are de-energized
- Ground and short-circuit
- Cover adjacent live parts

To determine whether all parts have been de-energized, use two-pole voltage testers according to EN 61243-3 (IEC 61243-3).

Devices that comply with this standard (not equipped for current measurement) prevent the development of arc short-circuits.

Always keep the electrical switch cabinets locked. Only authorized persons who are in the possession of a key or special tools are authorized to access these switch cabinets.

It is prohibited to perform any work on live parts or cables. The only exception is troubleshooting performed by specialized personnel with suitable measuring devices.

Never clean electrical equipment with water or similar liquids.

4.3.7 Work on the hydraulic system and with hydraulic tools

Any work on the hydraulic system of the WT must only be performed by trained specialized personnel.

Before starting work, all hydraulic parts of the turbine, including any accumulators, must be depressurized. The hydraulic pump must be secured against automatic activation.

Make sure everything is kept scrupulously clean and prevent dirt and water from entering the system when performing work on the hydraulic system.

Always wear safety glasses when working with hydraulic tools (e.g. hydraulic preloading of screw connections).

4.3.8 Dealing with hazardous substances and environmental protection



OBSERVE MANUFACTURER'S INSTRUCTIONS

When handling hazardous substances such as oils, greases, coolants, or cleaning fluids, observe the manufacturer's safety instructions applying to the product.

The responsible employee must carry the safety instructions and instructions for using the applied hazardous substances.

Any work that is performed on the wind turbine must comply to the regulations of waste avoidance and proper waste treatment and waste disposal.

Especially, make sure that substances hazardous to ground water, such as greases, oils, coolants and solvent-based cleaning fluids cannot penetrate into the ground, into waters or into the sewage system. These substances must be collected, stored, transported, and disposed of in suitable containers.

Remove any oil leaks without delay in order to avoid the risk of slipping and the possible destruction of the concrete foundations.

Determine and eliminate the cause of abnormal leaks.

If this is not possible, the WT must be shut down.

4.3.9 Regulations for crane work

General

The regulations for crane work may be different from one country to another. The responsible employee must find out about country-specific regulations before starting the work, and must inform subordinate employees about these regulations in writing.

A contact person who is familiar with these regulations must be available for consultation.

Regulations on the lifting of components

Only suitable, approved and certified lifting tackles with sufficient load capacity must be used to hoist components.

In order to prevent uncontrolled pendular movements when lifting loads with two cranes, always lift the load with only one crane first, and position the crane hook directly above the lifting tackle before lifting.

No one must stand or walk under the suspended load.

All individuals must maintain an adequate safety distance from suspended loads to prevent injuries from falling objects.



NOTE

Special work under suspended loads, which cannot be completed in a different way, is only permitted at the express direction of a defined responsible person.

Prerequisite for this is a clear agreement with the crane operators and a safety person.

Weather conditions

During thunderstorms, all crane work must be stopped because there is a risk of lightning striking the crane or a component.

Consult the crane operator to determine the maximum wind speed at which crane work is possible.

The limit wind speed for crane work depends on the type of crane, the design of the crane and the wind conditions.

The crane operator is fully responsible during all crane work.

The responsible employee and the crane operator mutually agree when crane work will be stopped due to the wind conditions and when they can be resumed.

4.4 Special obligations of the owner

The owner is particularly responsible for ensuring a high degree of safety when operating the WT and while persons are in the WT.

In particular, the owner must ensure that:

- Only authorized persons have access to the WT, e.g. by means of an appropriate key concept. If no authorized persons are in the WT, it must be kept locked
- This and all other documents stored in the WT by the manufacturer (e.g. the Operating Instructions for the WT and circuit diagrams) are always available in the WT and are in a usable condition
- The signs on and in the WT are in a proper condition, and are replaced when necessary
- The work steps required for WT maintenance are organized and executed on time and in accordance with the manufacturer's specifications
- A specific safety concept has been developed and implemented for themselves and any accompanying person in the WT which is used particularly in case of emergencies
- The WT is stopped as soon as there is a risk of icing, and is only restarted when there is no risk of ice throw

There are specific, periodic inspection obligations for WT safety equipment, various safety devices and turbine components for all countries in which turbines are erected.

Notice: These inspections are not part of the standard maintenance work and must be performed by special experts.

The owner is responsible for organizing these inspections and for checking the proper and timely execution.

These special inspections apply to:

- The owner's PPE
- The abseiling equipment stored in the WT
- The fall arrest system for the vertical ladder
- Specific pressure tanks of the hydraulic system
- The service lift
- The on-board crane
- The fire extinguishers and, if available, the automatic fire alarm and fire extinguishing system
- The first-aid kits

Detailed information, e.g. on inspection periods, is included in the Maintenance Report.

5. Warning and safety instructions inside the WT

Corresponding signs inside the WT provide warnings about possible dangerous situations, see "Table: WT signs".

Furthermore, signs containing operating notes and rules of conduct are attached to various turbine components. These must be observed at all times.



NOTE

The owner is responsible for ensuring that the signs in and on the WT are in a usable condition and are replaced when necessary.

Table: WT signs

Sign/symbol	Meaning
	Warning of a falling or slip hazard
	Warning of a crushing hazard
	Warning of hazardous voltage
	Keep off this area
	First-aid kit
	Fire extinguisher

6. Residual risks

NORDEX WT's correspond to the state of the art technology and have high safety standards.

Despite this, certain risks remain when the WT is operated, and particularly when performing maintenance work in and on a WT.

Slip hazard due to ice

In icy conditions, there is an increased risk of slipping when approaching the WT, and particularly when using the external staircase.

In this weather conditions, watch your step accordingly when approaching the WT or take actions to avoid slipping on iced floor.

Ice throw

The primary residual risk when operating the WT is the risk of ice throw during the cold season.

The owner must ensure that the WT is stopped if there is a risk of icing. It must only be restarted when the owner/operator on site is convinced that there is no longer a risk of ice throw.

If there is a risk of ice throw, take particular caution when approaching the WT. In particular, avoid standing or walking below the rotor blades.

For this reason, particularly in locations with an increased risk of icing, it is advisable to equip the WT with an ice sensor, which is optionally available.

In this case, the control system automatically switches off the WT in the corresponding weather conditions. However, still proceed with the same caution as described above when restarting the WT.

Falling objects

When working at heights, it is possible that objects are dropped accidentally.

For this reason, it is forbidden to stand or walk underneath persons working at heights.

Falling into the safety harness

When working at heights, it is possible that persons fall into the safety harness, despite adhering to all rules of conduct.

In this case, a quick rescue is necessary in order to prevent the risk of a suspension trauma and any associated health risks for the person affected.

Tripping and slipping

There is an increased risk of tripping, especially in the nacelle and the rotor hub due to the different height and width of steps, as well as the limited space.

Minor leaks, grease or climatic influences may also cause a risk of slipping.

For this reason, particular caution is advised while staying and moving in the WT.

7. Safety equipment

The WT is equipped with various pieces of safety equipment to ensure safety when inside the WT.



NOTE

The safety equipment must be regularly inspected by an expert in accordance with the manufacturer's specifications.

For safety equipment that is permanently stored in the WT, the owner of the WT must take responsibility for completing these inspections.

7.1 Personal protective equipment (PPE)

Next to the standard protective clothing, which includes at least high safety shoes, safety gloves and a safety helmet, personal protective equipment (PPE) is required, particularly when using the vertical ladder.

It protects against falling while standing or walking in a fall hazard area.

NORDEX provides the PPE for the owner and one accompanying person. It is stored in the tower base, next to the entrance door on the wall of the tower, and must be returned there after use, see Fig.1.



NOTE

The scope of supply of the PPE depends on the applicable contract.

7.1.1 Inspection/maintenance

The PPE must be checked once a year by an expert.

The owner is solely responsible for organizing and checking the inspection of the owner's PPE, see Chapter 4.4 "Special obligations of the owner".



Fig. 1 PPE next to entrance door

7.1.2 Components of the PPE

The PPE consists of the following parts:

- 1 fall arrester
- 1 lanyard with energy absorber (Y rope)
- 1 fall arrester, permitted for use with the respective fall arrest system in the tower

Additional equipment for service employees:

- 1 adjustable work-positioning lanyard
- 1 hub rope
- 1 head torch

In EU member states, the PPE must comply with the standards EN 361 (safety harnesses), EN 353-1 (fall arrest systems) and EN 354 (lanyards).

Safety harness

The safety harness for the owner has an abdominal lug in the middle of the abdominal strap for attaching the fall arrester, and a dorsal lug on the backplate, e.g. for rescue purposes, see Fig.2.

The two lateral lugs of the abdominal strap can be used, for example, for an equipment bag.

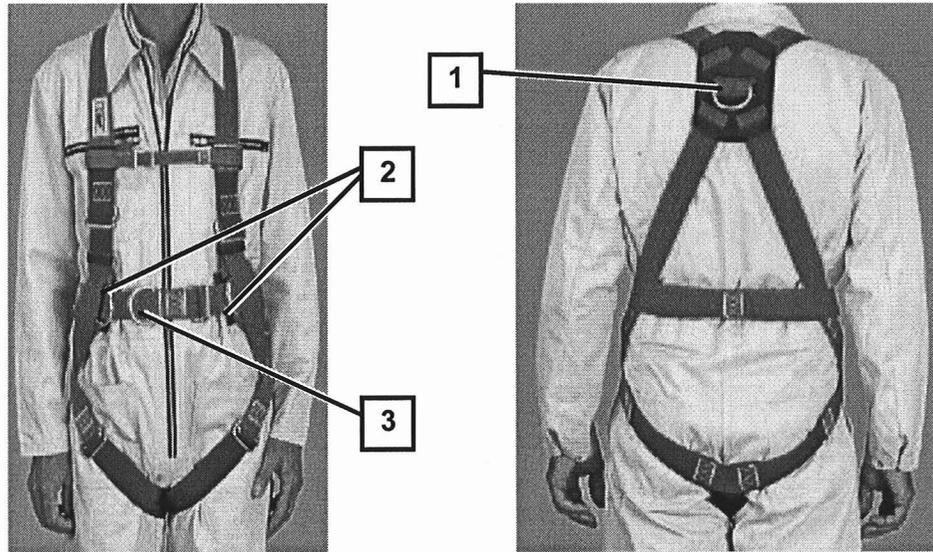


Fig. 2 Safety harness for the owner (similar to photo)

- 1 Dorsal lug on backplate
- 2 Lateral lugs
- 3 Abdominal lug on abdominal strap

Lanyard with energy absorber ("Y rope")

The lanyard with energy absorber serves for safeguarding at a fixed attachment point, for example when there is a fall hazard during a change of location.

The lanyard with energy absorber has 2 large snap hooks for attaching to an attachment point, and 1 small snap hook for hooking in the dorsal lug on the backplate of the safety harness, see Fig.3.

The energy absorber behind the small snap hook ensures that the fall of a person is arrested smoothly.

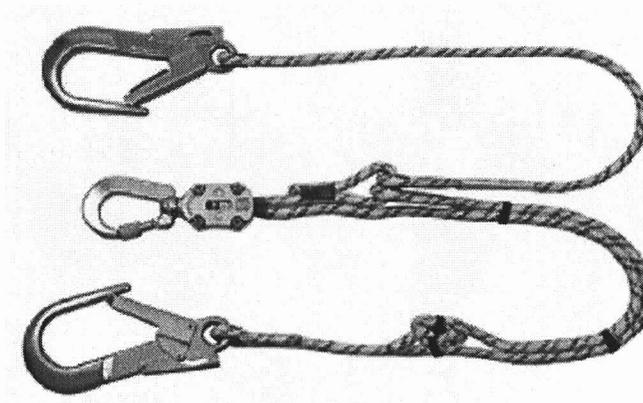


Fig. 3 Lanyard with energy absorber

Adjustable work-positioning lanyard (Service only)

Service employees require a further piece of safety equipment in addition to the fall arrest equipment (fall arrester or lanyard with energy absorber) in order to secure themselves in awkward positions where there is falling hazard. This also ensures they have both hands free to perform the necessary work.

For this purpose, 1 adjustable work-positioning lanyard with flexible edge protection is provided, see Fig.4.

The adjustable work-positioning lanyard is attached to the lateral lugs on the safety harness.

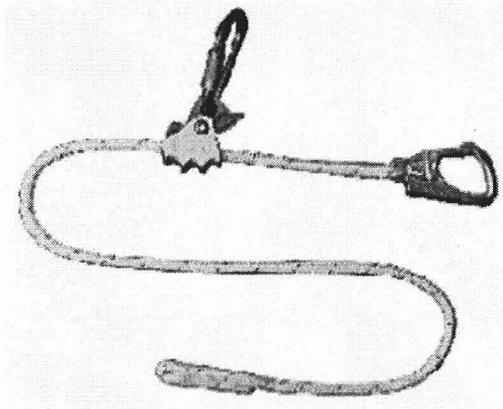


Fig. 4 Adjustable work-positioning lanyard with flexible edge protection

7.1.3 Handling the safety harness



NOTE

The handling of the PPE is explained using the PPE for the owner as an example.

In principle, the same procedure applies to other versions of the safety harness.

- Attach the lanyard with energy absorber to the dorsal lug at the backplate of the safety harness using the small snap hook and secure it
- Attach the large snap hooks to the lateral lugs on the left and right side
- Put on the safety harness like a jacket, see Fig.5



Fig. 5 Fastened safety harness (similar to photo)

- Pull the abdominal strap through the strap buckle and secure it
- Guide the leg straps through the legs from behind and insert them into the lateral buckles
- Fasten the chest strap
- Pull all straps tight so that the safety harness fits tightly around the body



NOTE

Rule of thumb for correct strap tension:
A flat hand may fit between strap and body, but not a fist.

7.2 Additional equipment for service employees (K06 and K08)

Special, additional equipment is required for WTs of turbine classes K06 and K08 when climbing into the rotor hub. This must be carried in the service vehicle.



NOTE

For WTs of turbine class K07, no additional equipment is required.
In this case, the rotor hub is entered from the inside of the nacelle, through the spinner.

7.2.1 Hub rope, including accessories

In the case of WTs of turbine classes K08 and K06, use the hub rope with its accessories as additional protective equipment to secure yourself when climbing into the rotor hub, see Fig.6.

The hub rope is a fall arrester on a moveable guide with flexible edge protection and a length of 10 m. It must be stored together with the webbing sling in an equipment bag.

For handling instructions, see Chapter 11.5.1 "Attaching the hub rope" and see Chapter 13.5.1 "Attaching the hub rope".

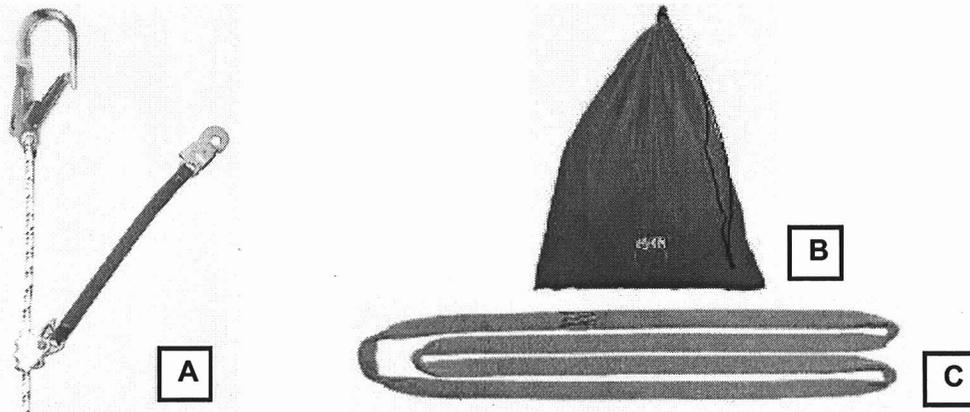


Fig. 6 Hub rope, including accessories

- A Hub rope
- B Storage bag
- C Webbing sling

7.2.2 Hub ladder (K06)

WTs of turbine class K06 are not equipped with firmly mounted hub ladders.

For this reason, a modified pilot ladder is required as a hub ladder, in addition to the hub rope and its accessories, see Fig.7.

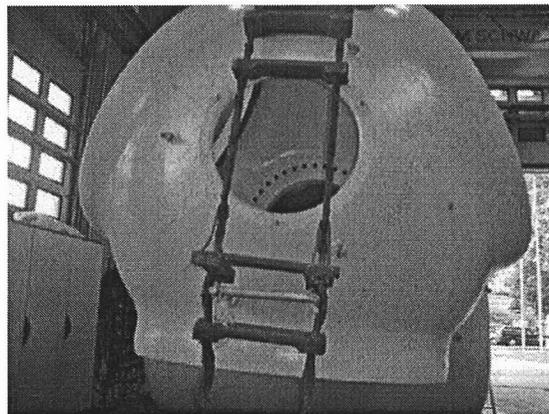


Fig. 7 Hub ladder K06

7.3 Abseiling equipment



NOTE

For handling the abseiling equipment, see Chapter 9.7 "Leaving the nacelle in hazardous situations (abseiling)"

If the service lift or vertical ladder with the fall arrest system cannot be used for descending from the nacelle, the nacelle can be only be exited by abseiling down to the ground.

For the owner of the WT, the abseiling equipment required for this purpose is provided in sealed packaging inside a sealed aluminum box.

This aluminum box is located on the top platform of the tower, tied down with a strap, see Fig.8.

Note: Service employees must carry their own abseiling equipment in the service vehicle. Except for the aluminum box, this consists of the same components as the abseiling equipment for the owner of the WT.

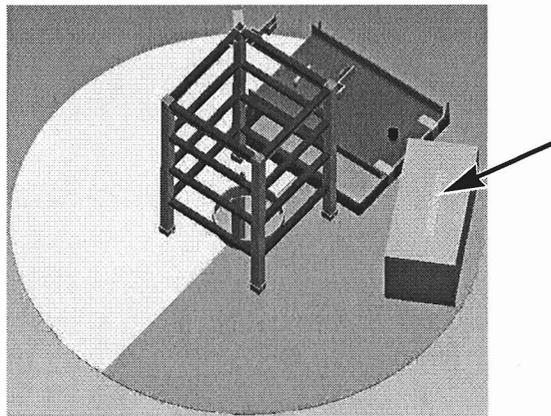


Fig. 8 Location of the abseiling equipment on the top tower platform

7.3.1 Equipment/accessories

The abseiling equipment consists of a transport bag, the descender with a 140 m rope, and a 1.5 m work-positioning lanyard for attaching the descender, see Fig.9.

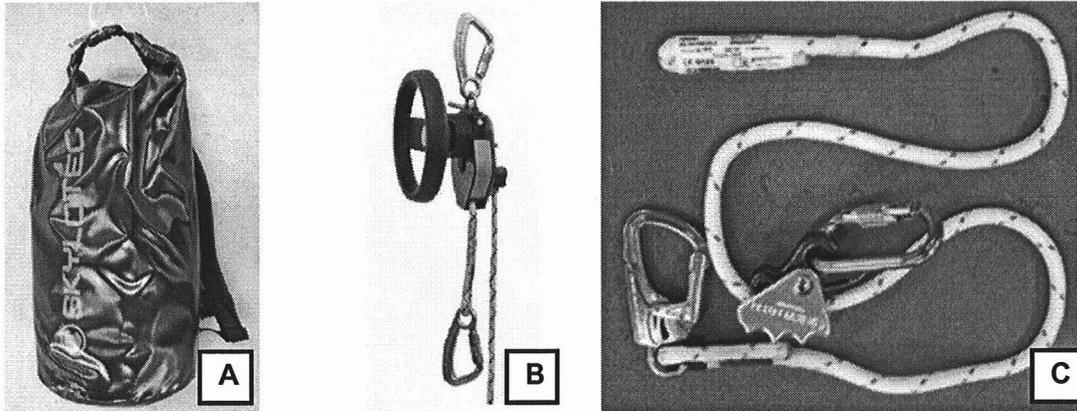


Fig. 9 Main components of the abseiling equipment

- A Transport bag
- B Descender
- C Work-positioning lanyard

The abseiling equipment also contains the following accessories:

- 1 edge protection for WTs (K06 and K08) for guiding the rope over the edge of the nacelle wall, see Fig.10
- 2 snap hooks and 1 rope clamp as alternative lifting tackles, see Fig.10.

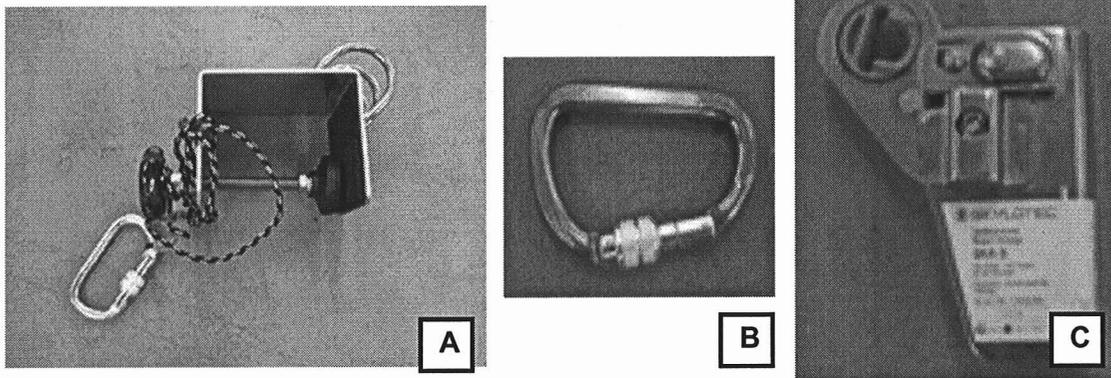


Fig. 10 Accessories for abseiling equipment

- A Edge protection (K06 and K08)
- B Snap hook (2x, similar to photo)
- C Rope clamp

Individual pieces of equipment may differ, e.g. a webbing sling for attachment instead of a work-positioning lanyard, see Fig.11.

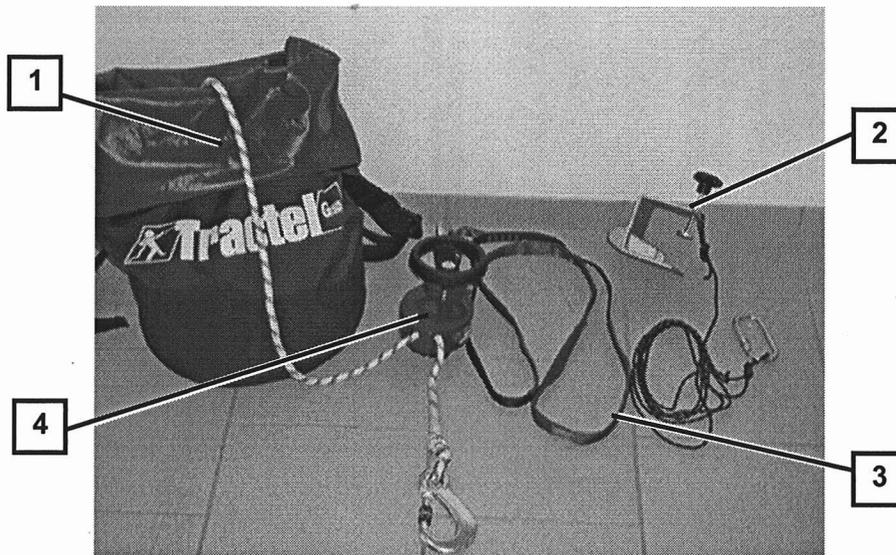


Fig. 11 Abseiling equipment, older version

- 1 Transport bag
- 2 Edge protection with safety rope
- 3 Webbing sling
- 4 Descender including rope with the required length

7.3.2 Inspection/maintenance

The abseiling equipment must be inspected **once a year** by an expert, in accordance with the manufacturer's instructions.



NOTE

The WT owner is solely responsible for organizing and checking these inspections, see Chapter 4.4 "Special obligations of the owner".

7.4 Fire extinguisher

At least 2 fire extinguishers are available in the WT for quickly fighting incipient fires:

- 1x in the tower base, next to the door
- 1x in the nacelle

These are ABC powder fire extinguishers, which are used to extinguish burning solids and liquids, as well as fires in electrical systems of **up to 1,000 V**.

The WT can also be optionally equipped with a fire alarm and a fire extinguishing system.

7.5 First-aid kit

Generally, there are 2 first-aid kits in the WT for treating injuries:

- 1x in the tower base, next to the door
- in the nacelle, either on the nacelle wall (turbine class K07) or on the front end of the Topbox

8. Safety devices

The WT is equipped with various safety devices, which are particularly necessary for the safe execution of maintenance work.

8.1 Fall arrest system

The WT is equipped with a vertical ladder, which has a fall arrest system.

Like the PPE, the fall arrest system must be inspected regularly by an expert.

The owner is responsible for organizing these inspections, see Chapter 4.4 "Special obligations of the owner".

8.1.1 Fall arrest systems used

NORDEX WTs can be equipped with 3 different fall arrest systems, see Chapter 8.1.2 "Attaching the fall arrester":

- 1 fall arrest rail in the center of the vertical ladder
- 1 safety rope next to the vertical ladder
- 1 safety rope in the center of the vertical ladder (Latchways system)

Each fall arrest system has a special fall arrester.

Notice: When using the vertical ladder, only the fall arrester permitted for the installed fall arrest system must be used.

The fall arrester must be connected directly to the abdominal lug on the safety harness.

Note: Refer to the operating instructions of the safety harness for which abdominal lug must be used to connect the fall arrester.

In case of a fall, the fall arrester locks in place after just a few centimeters. The delayed reaction reduces the high loads to which the falling person is subjected and their fall will be arrested safely.

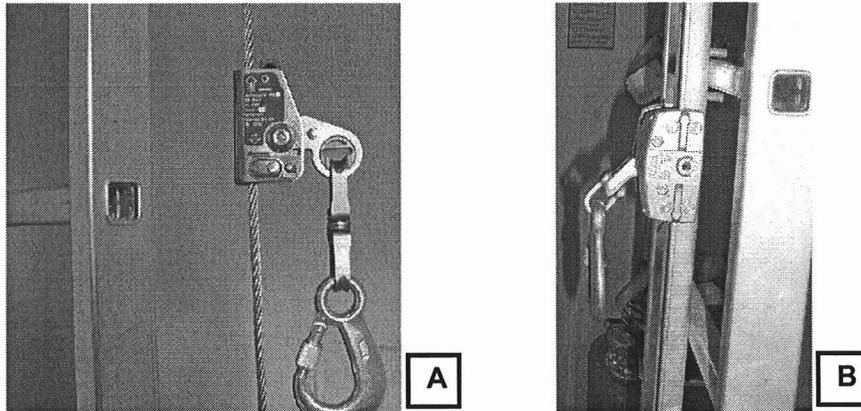


Fig. 12 Fall arrester

- A On the safety rope next to the vertical ladder
- B On the fall arrest rail

8.1.2 Attaching the fall arrester

Safety rope next to the vertical ladder

- Completely loosen the knurled thumb screw on the fall arrester
- Push the ratchet down and open the fall arrester
- Place the open fall arrester around the safety rope
 - Make sure that the fall arrester is in the correct mounting position
 - The "up" arrow on the fall arrester must point upward

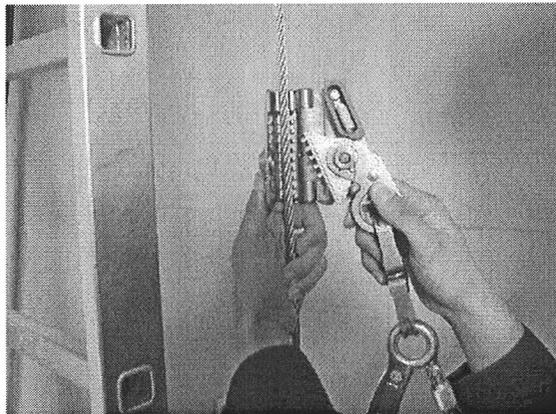


Fig. 13 Attaching the fall arrester to the safety rope

- Close the fall arrester so that the ratchet locks in place
 - Note:** This is easier if you slightly lift the snap hook
- Manually retighten the knurled thumb screw
- Perform a functional test

Safety rope in the center of the vertical ladder ("Latchways" system)

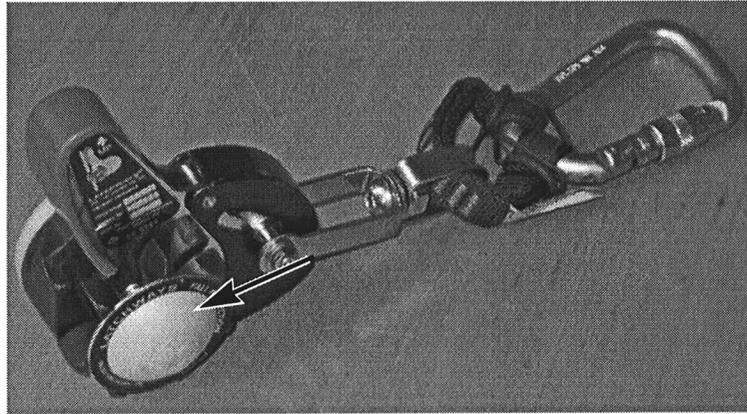


Fig. 14 Fall arrester "Latchways" system with tooth washer (arrow)

- Hook the fall arrester in the abdominal lug on the abdominal strap
- Use your right hand to hold the fall arrester in a hanging position, and use your thumb to operate the ratchet release mechanism

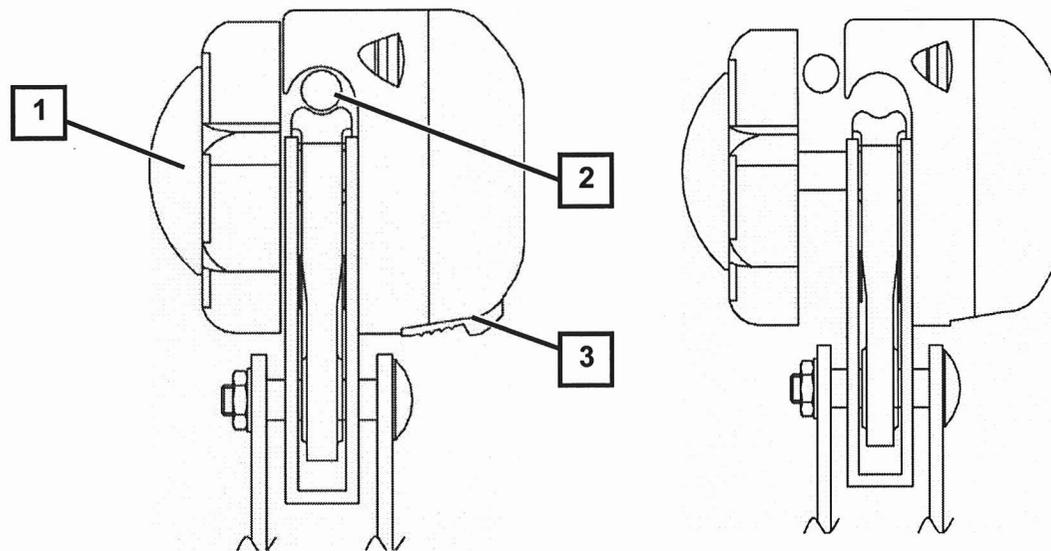


Fig. 15 Fall arrester, "Latchways" system (left closed, right open)

- 1 Tooth washer
- 2 Safety rope
- 3 Ratchet release mechanism

- Use your left hand to remove the left part of the fall arrester (tooth washer) to the side
- Slide the fall arrester onto the rope, so that the rope runs through the inside of the housing

- Operate the ratchet release mechanism with your thumb and press both halves of the fall arrester together
- Check that the fall arrester is properly locked, and can no longer be pulled apart
- Carry out a suspension test

Fall arrest rail with fall arrester

The fall arrester can be attached or removed at the top or bottom end of the fall arrest rail.

To remove the fall arrester, the ratchet on the fall arrest rail must first be opened, see Fig.16.

- Slide the fall arrester onto the fall arrest rail from below
 - Note:** The snap hook must point towards the ground.
- Carry out a suspension test

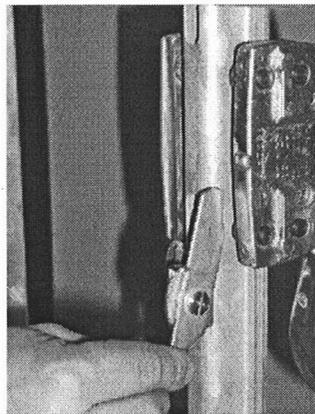


Fig. 16 Ratchet on the fall arrest rail

Fall arrester with release mechanism (Haca)

The fall arrester with release mechanism can be attached and removed at any point on the fall arrest rail.

- Open the cover
- Push in the locking pin
- Pull the right half of the fall arrester to the side
- Attach the fall arrester to the fall arrest rail
 - Note:** The arrow on the fall arrester must point upwards
- Release the right half, so that both halves pull together
- Check that the rollers are sitting correctly on the fall arrest rail
 - Note:** The locking pin must be completely disengaged again

- Carry out a suspension test

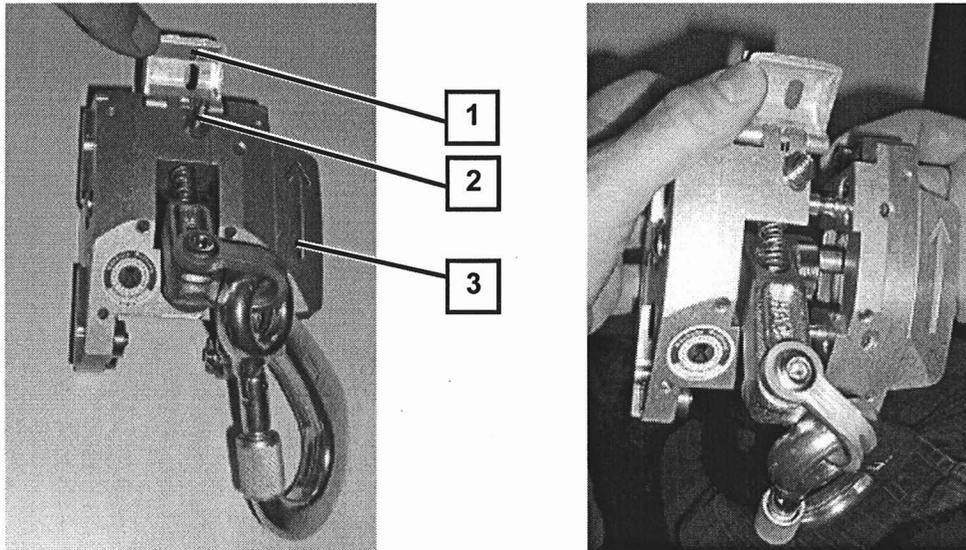


Fig. 17 Fall arrester (Haca)

- 1 Cover
- 2 Locking pin
- 3 Arrow marking

8.2 Rotor lock

The rotor lock is used to reliably mechanically lock the entire drive train. It prevents risks to persons working in the nacelle and rotor hub due to rotating parts of the drive train.

WTs of all turbine classes are equipped with a rotor lock on the rotor shaft.

This consists of 1 or 2 bolts and the rotor lock disk, which is located on the rotor shaft.

With the rotor at standstill, the bolt/s are inserted into one of the drill holes in the rotor lock disk.

WTs of turbine class K08 can have an additional rotor lock on the brake disk. This must only be used under certain conditions.

Notice: The rotor lock must only be operated by trained specialized personnel.

8.3 Attachment points

There are specific attachment points in the WT for the PPE to safeguard against falling. These attachment points are indicated with yellow paint, or with red paint in WTs that have been operational for a longer period of time.

In the nacelle, the attachment points are lifting lugs on rotor bearing and gearbox, see Fig.18.

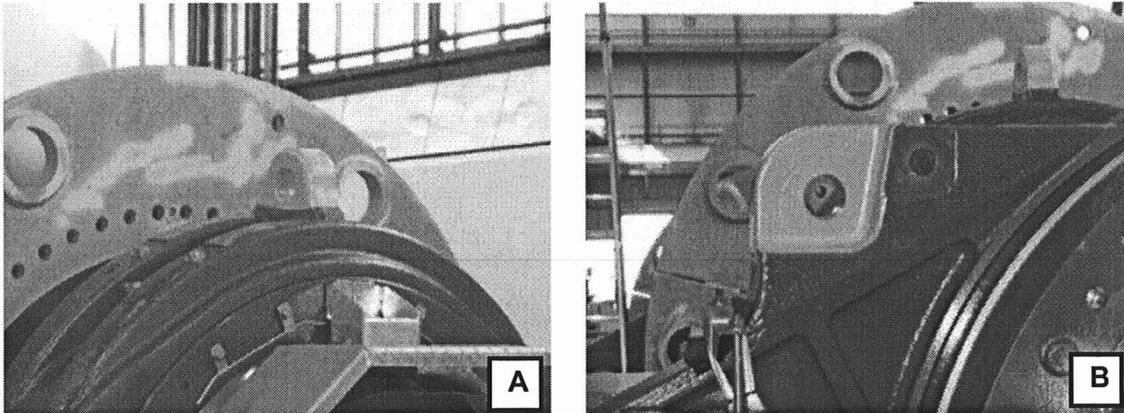


Fig. 18 Attachment points in the nacelle (example)

- A Lifting lug on rotor bearing
- B Lifting lug on gearbox

In WT's of turbine class K08, the lifting lugs on the generator are also permitted as attachment points, see Fig.19.

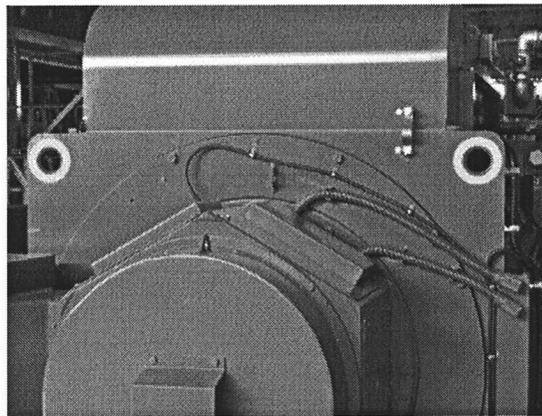


Fig. 19 Attachment points on generator (K08)

Additional attachment points K08 beta

WT's of turbine class K08 can be additionally equipped with a safety rope system, see Fig.20.

In this case, the safety rope serves as a continuous attachment point.

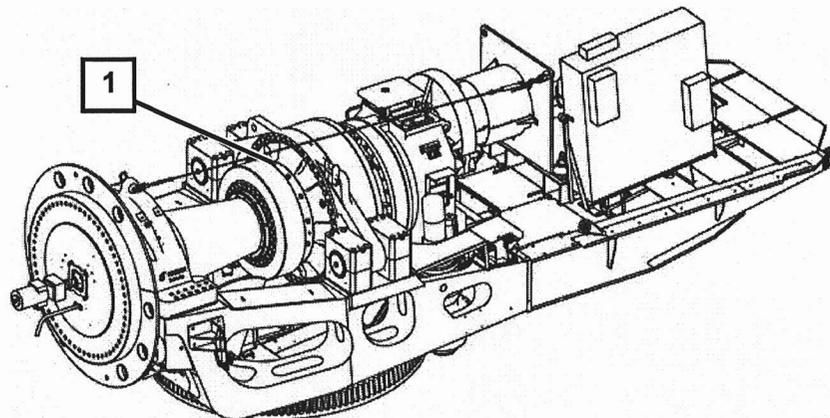


Fig. 20 WT with safety rope system (example)

1 Safety rope

If a sign indicates that the cross bolt for the front roof prop in a WT of the K08 beta turbine class is a permitted attachment point, this can be used to attach persons, particularly when rescuing a casualty in the nacelle.

Both roof props must be mounted in this case. Without props, the cross bolt is not permitted as an attachment point.

Eyebolts marked as attachment points are located in the tower and on the nacelle roof.

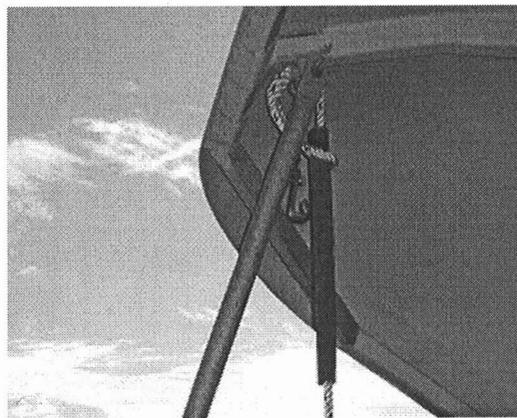


Fig. 21 Attachment point at the roof (K08 beta)

Additional attachment points for personal protection K08 gamma

- At the front of the machine frame
- Post 1 of the crane structure
- Post 4 of the crane structure (at the crane hatch)
- On the crane rail
- On the roof

- At the rotor hub access hatch

8.4 Emergency stop switches

There are several emergency stop switches in the WT. They serve to stop the WT as quickly as possible in hazardous situations.

Pressing an emergency stop switch interrupts the *safety chain* of the WT, which is a hard-wired series connection of various monitoring devices.

The interruption of the safety chain leads to an emergency stop of the WT. This brings the rotor to a standstill as quickly as possible and disconnects the generator and converter from the grid.

The emergency stop switches lock in place when pressed.

The knob must be turned to the right to reset the switch to its original position.

To return the WT to the operational state, the safety chain must be additionally reset directly on site.

The emergency stop switches are located at different points in the WTs of each turbine class. For detailed information, refer to the operating instructions of the respective WT.

8.5 Access hatch switch

Specific turbine types have an access hatch switch at the access hatch to the nacelle, see Fig.22.

This is activated when the access hatch is opened. It puts the WT into service mode and the rotor brake is applied.

In this way, the access hatch switch ensures that the rotor is at a standstill before entering the nacelle.

If, contrary to the regulations, the WT has not been stopped before ascending to the nacelle, the access hatch switch triggers one of the braking programs when the access hatch is opened. This stops the WT as quickly as possible.

Once the access hatch has been closed, the rotor brake is released again.

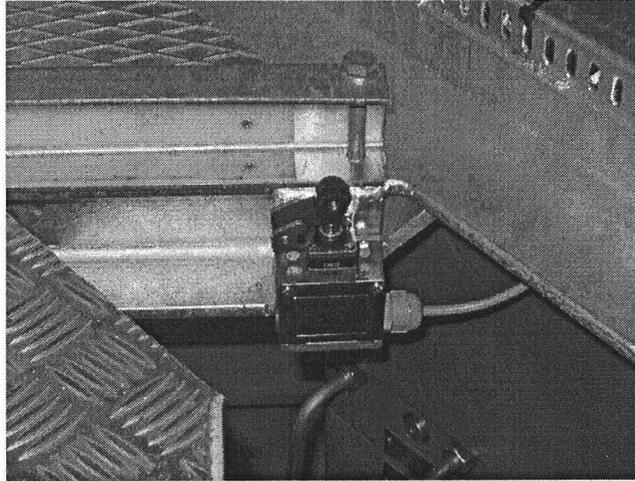


Fig. 22 Access hatch switch (example)

8.6 Area limit switches and battery disconnectors in the rotor hub

WTs with pitch systems (K07, K08) are equipped with various options for deactivating the pitch drives.

K07

The following is located on each pitch box for the respective pitch drive:

- 1 mains switch for disconnecting the pitch power supply
- 1 battery switch for disconnecting the battery voltage

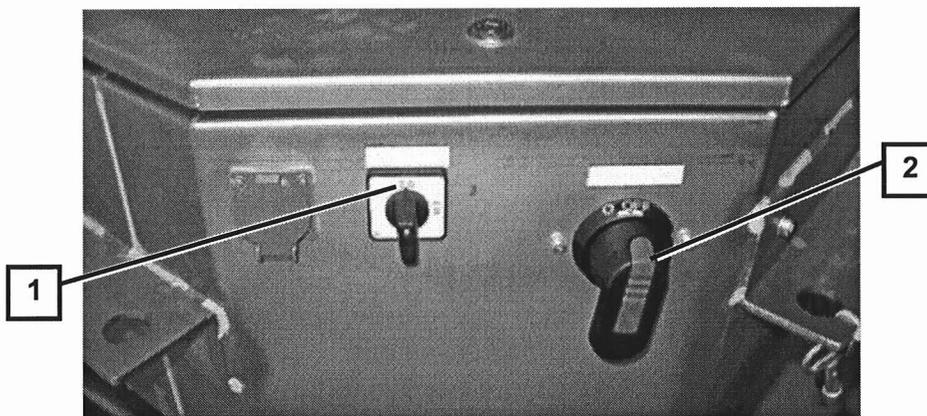


Fig. 23 Pitch box K07

- 1 Mains switch
- 2 Battery switch

If all battery switches are activated, a de-activation of one of the mains switches also leads to an emergency pitch run of all 3 pitch drives using the batteries - also including the pitch drive whose mains switch has been de-activated.

If the emergency pitch run for one of the pitch drives must be prevented, its battery switch must first be de-activated before one of the mains switches is de-activated.

K08 with 2 battery boxes per pitch drive

Each pitch box has 1 area limit switch for completely disconnecting the respective pitch drive.

At the same time, the pitch supply voltage for the other two pitch drives is disconnected but their emergency pitch run using battery voltage is also triggered.

The emergency pitch run can only be prevented if the fuses for the battery voltage in the respective pitch boxes are opened in advance.

Like the emergency stop switches, the area limit switches lock in place when pressed.

The knob must be turned to the right to reset the switch to its original position so that the pitch supply voltage is reconnected.

K08 with 1 battery box per pitch drive

Each pitch box has 1 area limit switch for completely disconnecting the respective pitch drive.

Each battery box has 1 battery disconnecter for disconnecting the battery voltage.

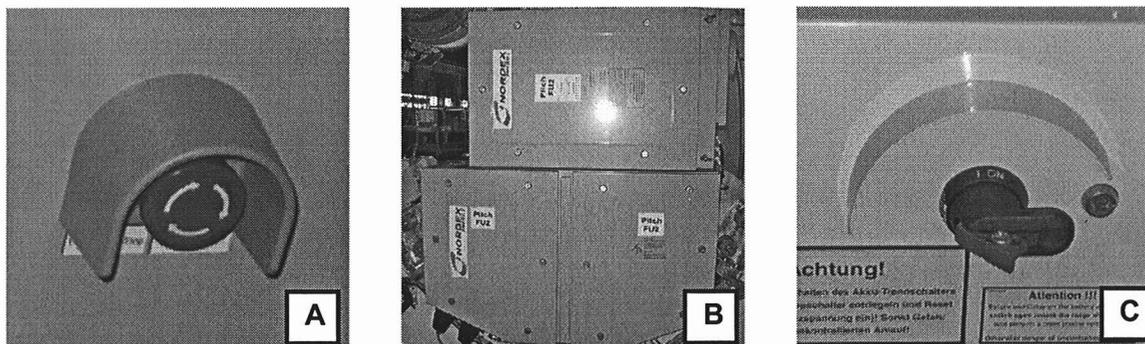


Fig. 24 Pitch boxes K08 (example)

- A Area limit switch
- B Battery box and pitch boxes
- C Battery disconnecter

Each area limit switch also disconnects the pitch supply voltage for the other two pitch drives. However, these remain connected to the battery voltage.

Activating an area limit switch also triggers an emergency pitch run for the other two pitch drives, provided all battery disconnectors are activated. This can be prevented by disconnecting any battery disconnector in advance.

Like the emergency stop switches, the area limit switches lock in place when pressed.

The knob must be turned to the right to reset the switch to its original position.

For pitch 1 systems, it is sufficient to release the area limit switch to re-activate the pitch supply voltage.

For pitch systems as of pitch 2, the blue reset button on pitch box 1 (pitch FU 1) must be additionally pressed afterwards.

If a previously de-activated battery disconnector is to be re-activated, the pitch supply voltage must be reconnected first before the battery disconnector is re-activated.

8.7 Rotor brake selector switch

WTs of turbine class K08 with active rotor brake are equipped with a "rotor brake selector switch" on the Topbox.

It is used for switching between automatic and manual operation of the rotor brake.

Switching over from automatic to manual operation triggers a fast braking and an immediate application of the rotor brake.

The rotor brake can now only be released by using the *Release Brake* button on the manual control unit.

The wind turbine control system can now no longer access the rotor brake.

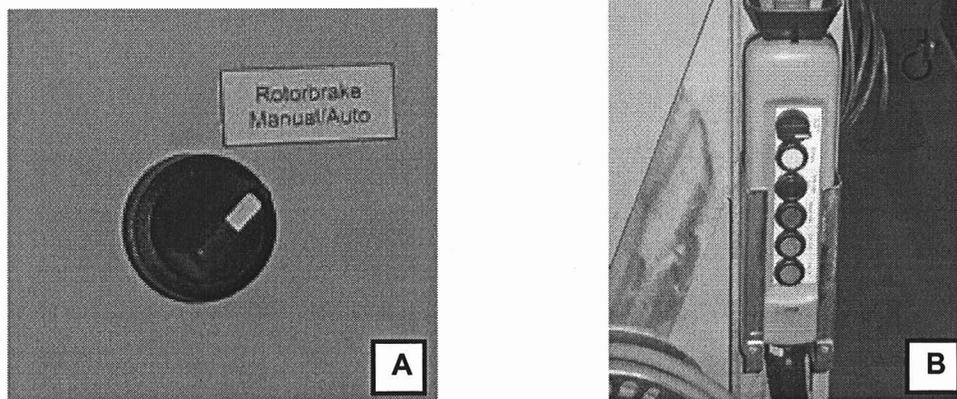


Fig. 25 Operational controls on the Topbox (example)

- A Rotor brake selector switch
- B Manual control unit

8.8 Emergency lighting

The WT is equipped with emergency lighting in the tower and nacelle if the power supply of the WT should fail.

The emergency lighting switches on automatically with a maximum delay of 15 seconds and ensures that the WT is lit for at least 1 hour.

This ensures a safe descend from the nacelle.

9. Behavior in specific situations

9.1 Grid failure



DANGER

FALLING HAZARD

There is a danger of falling and of injury when using the vertical ladder without sufficient lighting.

The emergency lighting in the WT is ensured for only 1 hour.

The descent into the tower base must be completed within one hour after the grid failure.



OBSERVE DOCUMENT

Work Instructions *F010_002 Wind Turbines Without Grid Connection or With Locked Drive-Train*

In the case of a grid failure, the lighting in the WT is automatically switched to emergency lighting.

If there is a grid failure during service work on the WT, and if it cannot be foreseen when the power supply will be restored, proceed as follows:

- Stop all work in the rotor hub and nacelle
 - If the cabin roof is open, close and lock it
 - Proceed as described in the Work Instructions *F010_002*
 - Descend to the tower base
 - Inform the responsible remote monitoring
-

9.2 Thunderstorm



DANGER

LIGHTNING STRIKE

During thunderstorms, there is a danger to life inside or close to the WT caused by lightning strike.

In case of an approaching thunderstorm, leave the WT or do not enter it.

Once the thunderstorm has passed, be aware of crackling noises as you approach the WT, as these are a result of electrostatic charging.

Only enter the WT when these noises have stopped.

A WT is at high risk from lightning strikes.

The WT itself is adequately protected against damage by comprehensive lightning protection measures. However, persons inside or in the proximity of a WT are still at risk.

- Initially, proceed as in a grid failure
- Leave and lock the WT
- Wait at a safe distance from the WT until the thunderstorm has passed

Do not re-enter the WT until the thunderstorm has passed.

9.3 Fire



FALLING TURBINE PARTS

In case of a fire in the nacelle or on the rotor, parts may fall off the wind turbine.

In case of a fire, nobody is permitted within a radius of 500 m from the turbine.



NOTE

The WT is equipped with ABC powder fire extinguishers for fighting incipient fires.

At least one fire extinguisher is located in the tower base near the door and another in the nacelle near the Topbox.

This makes it possible to extinguish burning solids and liquids, as well as fires in electrical systems of up to 1,000 V.

These fire extinguishers are not suitable for extinguishing a fire on the high-voltage elements, see Chapter 9.3.2 "Fire in medium-voltage switchgear or transformer".

9.3.1 Fire in the WT

- Remove any persons from the danger area
- If possible, disconnect the burning object from the grid
- Fight the fire with available means if there is any chance of success
- If the fire cannot be extinguished or if there is no chance of success, call the fire department
- Inform the responsible remote monitoring

9.3.2 Fire in medium-voltage switchgear or transformer



⚠ DANGER

HIGH VOLTAGE

Parts of the medium-voltage switchgear and the medium-voltage transformer are subject to high voltage.

Do **not** attempt to extinguish such fires with the fire extinguishers found in the WT.

These are only suitable for equipment up to 1,000 V.

- Immediately disconnect the WT
Note: If this is not possible, inform the responsible power utility and have the wind turbine disconnected from there.
- Evacuate the WT
- Call the fire department

9.4 Accident

- Remain calm
- Take care of your own safety
- Take action to prevent further casualties
- Rescue casualties from the danger area
- Perform first-aid
- Inform the rescue service
- Inform the responsible remote monitoring

Electrical accidents

- Immediately disconnect the voltage in the WT
Note: If this is not possible, the power utility must be informed to switch the wind turbine to zero potential
- Only use non-conductive devices for any rescue attempts
- Continuously check the consciousness and breathing (circulation) of casualties
- Always seek medical treatment, even after minor electrical accidents

9.5 Oil spill



WARNING

SLIP HAZARD

Move particularly carefully and, where possible, avoid stepping on oil-polluted surfaces.

- Stop the WT
- Inform the responsible remote monitoring

Further measures, to be carried out by service employees only

- Locate the leak
- If possible, seal the leak or block the flow of oil elsewhere
- Properly remove any escaped oil
- Replace damaged parts
- Remove any contamination
- If oil has penetrated into the soil, inform the responsible local authorities and agree further measures with them

9.6 Earthquake

If the WT is located in an area with earthquake hazard, the following rules of conduct must be observed.

Earthquakes during work on the WT

- Immediately leave the WT
- Wait at a safe distance until the end of the earthquake
- Do not re-enter the WT until it has been checked for damage and no safety risk has been established

After an earthquake

- Stop the WT
- Check the WT, particularly the tower and foundation, for external damage
- Inform the responsible remote monitoring, and agree further procedure with them

9.7 Leaving the nacelle in hazardous situations (abseiling)



NOTE

The following explanations only apply to NORDEX employees and employees of commissioned subcontractors.

The owner must create and use an own safety concept to be used on the WT. A corresponding training course can be taken at NORDEX to familiarize oneself with the abseiling equipment.

There are 2 escape routes out of the nacelle:

- Descending inside the tower via the vertical ladder
- Abseiling outside the tower, if descending inside the tower is not possible

Warning: Do not use the service lift during a fire or an earthquake.



- If the rotor has not been stopped prior to abseiling out of the nacelle, there is a danger to life
- Before abseiling, ensure that the rotor has been locked or, at the very least, is secured with the rotor brake

It is possible to abseil out of the nacelle as follows for WTs of turbine type

- K06 and K08 beta: When the roof is open, over the edge of the nacelle wall
- K07: Through the transport hatch in the rear part of the nacelle
- K08 gamma: Through the transport hatch (crane hatch) in the rear part of the nacelle or via the roof

9.7.1 Attaching the edge protection (K08 beta and K06)



NOTE

This edge protection is the edge protection of the abseiling equipment. In some WTs there is also an edge protection for using the working rope, which is stored in the nacelle.

- Take the edge protection out of the transport bag
- Fasten the safety rope of the edge protection to a fixed point
- Screw the edge protection to the nacelle wall

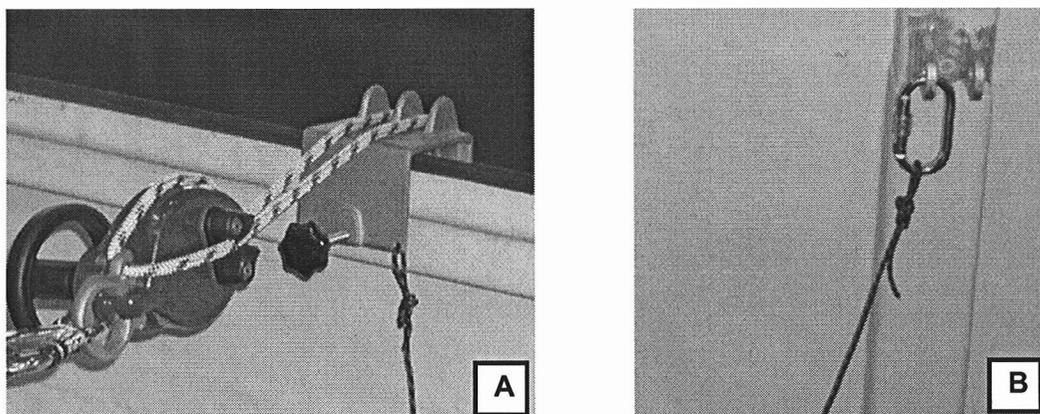


Fig. 26 Edge protection (example)

- A On the nacelle wall (with rope ends already positioned)
- B Safety rope of the edge protection

9.7.2 Fastening the descender

DANGER

JAMMING ROPE

Before using the rope, check it for knots and kinks

Otherwise there is a risk that the abseiled person does not reach the ground



NOTE

Depending on the equipment, the descender is attached with a webbing sling or a work-positioning lanyard.

The attachment point depends on the turbine type.

Finally, secure the rope in the cam cleat.

- Remove the webbing sling or the work-positioning lanyard from the transport bag
- Fasten the webbing sling or work-positioning lanyard
- Take the descender out of the transport bag
- Attach the descender, depending on the turbine type
 - see "Attaching the descender, K08 beta" page 57
 - see "Attaching the descender, K06" page 58
 - see "Attaching the descender, K07" page 59
 - see "Attaching the descender, K08 gamma" page 59
- Screw the knurled nut down to secure the hook of the descender to prevent accidental opening

- To secure it, guide the long end of the rope via the diverter hook through the cam cleat of the descender, see Fig.27
- Throw down the transport bag with the rope from the nacelle

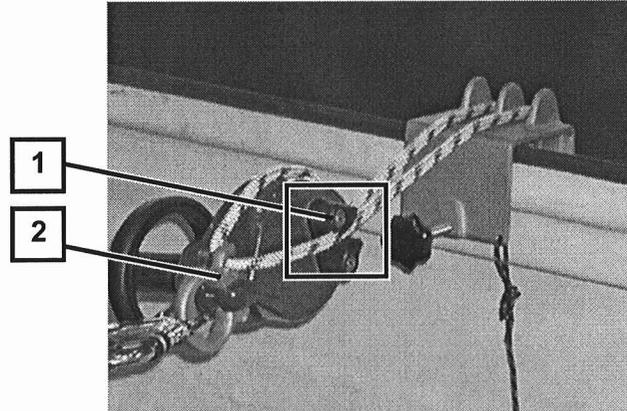


Fig. 27 *Securing the rope on the descender: rope end guided through cam cleat (example with edge protection)*

- 1 Cam cleat
- 2 Diverter hook

Attaching the descender, K08 beta

DANGER

The cross bolt on the front roof support is not suitable as an attachment point if the props are not mounted.

Only use the cross bolt as an attachment point when the props are mounted.



NOTE

If a sign indicates that the cross bolt for the front roof prop is a permitted attachment point, this can be used to attach persons, particularly when rescuing a casualty in the nacelle.

Prerequisite is that the roof has been secured with props as detailed in the regulations.

- Pull the webbing sling or work-positioning lanyard through the left lifting lug of the gearbox, see Fig.28
- Attach the hook of the descender to the work-positioning lanyard or webbing sling, see Fig.29

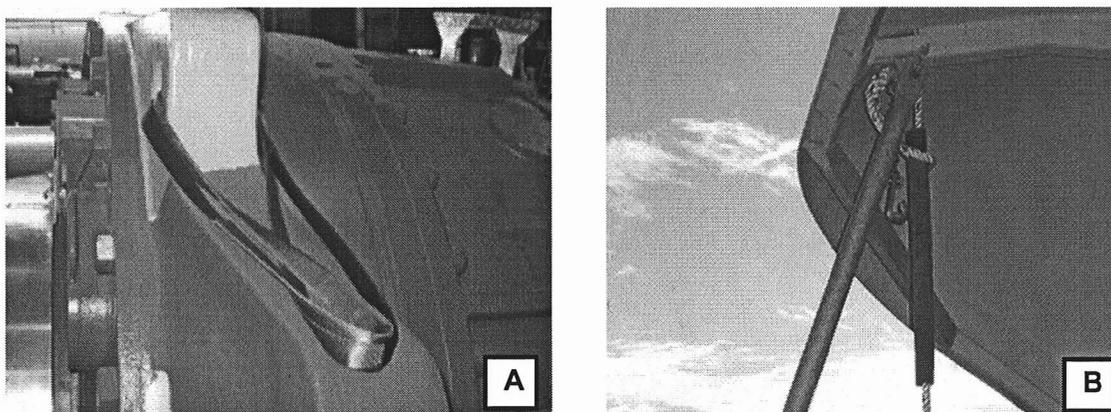


Fig. 28 Attachment options for webbing sling and work-positioning lanyard for turbine class K08 beta

- A Webbing sling attached to lifting lug of gearbox
- B Work-positioning lanyard on front roof support

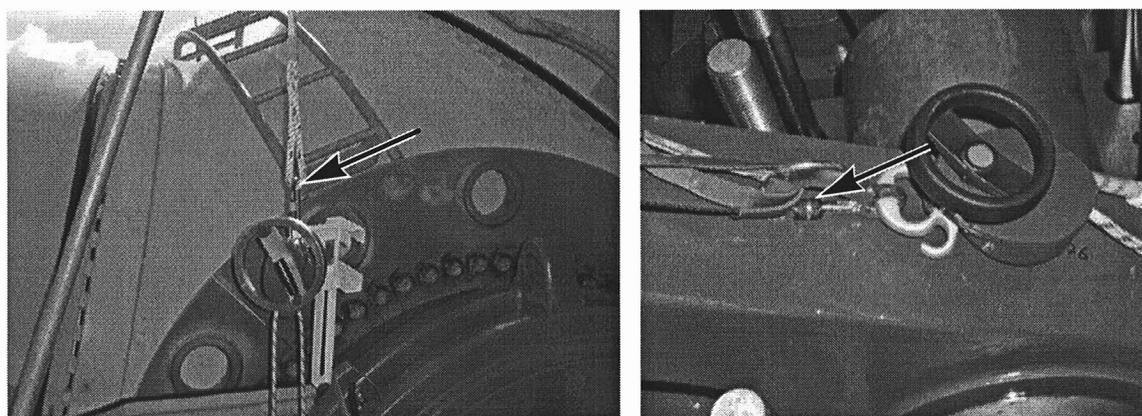


Fig. 29 Descender K08 beta on work-positioning lanyard and webbing sling with knurled nut (arrow)

Attaching the descender, K06

- Pull the webbing sling or work-positioning lanyard through the left lifting lug of the gearbox (looking toward the rotor hub), see Fig.30
- Attach the hook from the descender to the two eyes of the webbing sling or to the work-positioning lanyard

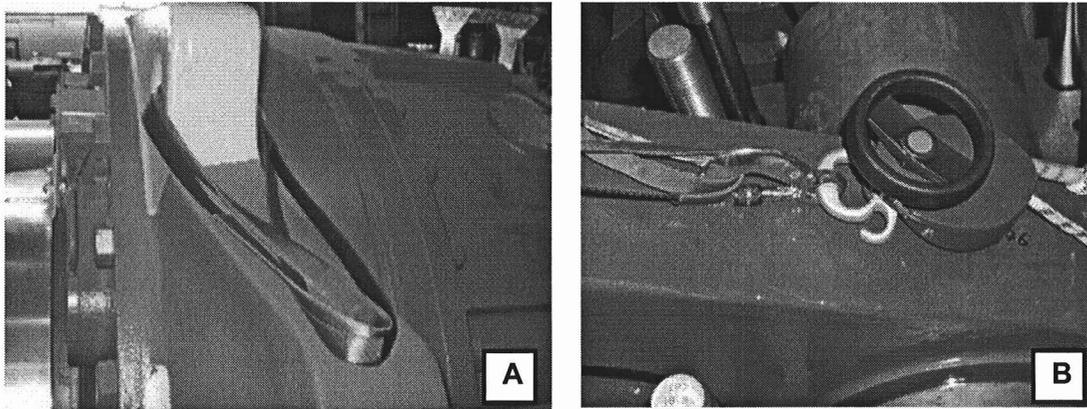


Fig. 30 Fastening the descender for K06

- A Attaching the webbing sling
- B Descender on webbing sling with knurled nut

Attaching the descender, K07

- Place the webbing sling or work-positioning lanyard over the craneway, see Fig.31
- Attach the hook from the descender to the two eyes of the webbing sling or to the work-positioning lanyard

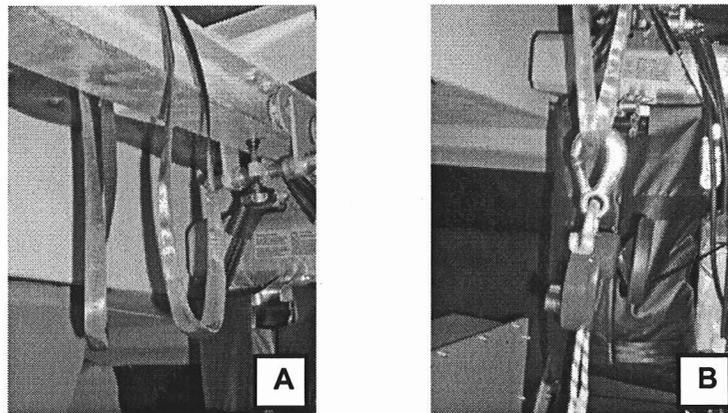


Fig. 31 Fastening the descender for K07

- A Webbing sling fastened to craneway
- B Descender on webbing sling

Attaching the descender, K08 gamma

- Attach the webbing sling or work-positioning lanyard above the crane hatch, see Fig.32
- Attach the hook of the descender to the work-positioning lanyard or webbing sling

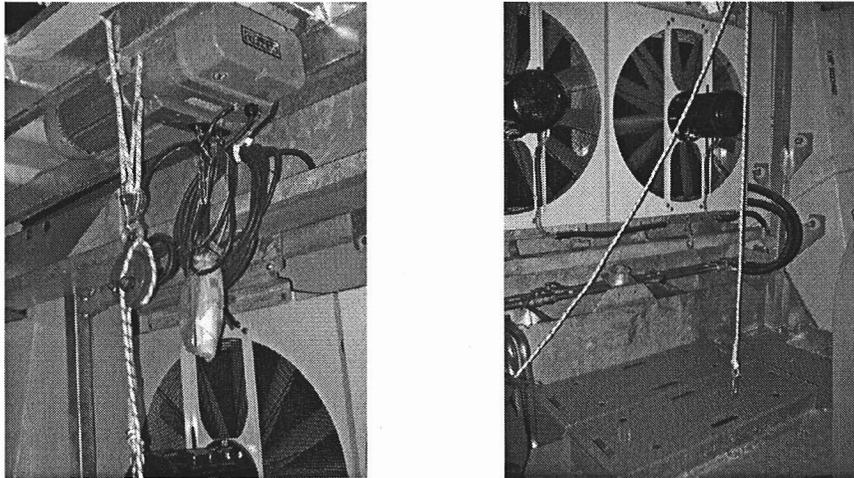


Fig. 32 Fastening the descender for K08 gamma

9.7.3 Abseiling yourself

- Hook the short rope end of the descender into the chest lugs of the safety harness and secure it
- Pull the long rope end out of the cam cleat
- Abseil yourself
 - Over the edge of the nacelle wall (K06 and K08 beta)
 - Through the transport hatch (K07 and K08 gamma)

9.7.4 Abseiling casualties



NOTE

The procedure for abseiling a casualty described in the following only applies if the casualty is conscious and can be transported whilst hanging in the safety harness.

Otherwise, height rescue workers must be requested.



SUSPENSION TRAUMA

Hanging in the safety harness for a longer period may lead to a fatal suspension trauma.

Once the casualty has been lowered, place him in a sitting position until the ambulance arrives, but for at least 20 minutes.

Under no circumstances put the casualty directly into a horizontal position.

Inform the ambulance explicitly about the suspected suspension trauma.

- Request an ambulance and helpers to receive the abseiled person on the ground
- Hook and secure the hook from the short rope end of the descender onto the dorsal lug on the backplate of the casualty's safety harness
- Move the casualty over the edge of the nacelle wall (K06 and K08) or through the transport hatch, hanging in the safety harness (K07 and K08 gamma)
- Pull the long rope end out of the cam cleat
- Lower the casualty
 - The descender brakes automatically
 - The long rope end can also be guided manually via the diverter hook on the descender
- Ask the casualty to move the legs, if possible, in order to maintain blood circulation
- On the ground, unhook the casualty from the rope together with a helper and put him in a sitting position, see Fig.33



Fig. 33 Casualty in a sitting position

- After approx. 20 minutes, slowly stretch the casualty's legs and, if possible, place him/her in a horizontal position
- Transfer the casualty to the ambulance for medical care
- Inform the ambulance explicitly about the suspected suspension trauma

10. Ascending inside the tower

WARNING

It is only permitted to ascend into the nacelle in the following conditions:

- 10-minute average wind speeds up to 20 m/s for tubular towers and
- 12 m/s for lattice towers
- A second person is present



WARNING

ICY VERTICAL LADDER

In the case of icing on the vertical ladder, the risk of injury increases due to slipping and falling into the safety harness.

The vertical ladder must not be used in the case of icing.

10.1 Preparing for the ascent



DANGER

FALLING HAZARD

A PPE either with an invalid test badge or which has been damaged or strained by a fall must no longer be used.

Replace the PPE immediately and have it checked by an expert.

- Inform the responsible remote monitoring about the intended ascent.
- Stop the WT and disable remote access to the WT.
Note: To do this, see the operating instructions of the respective WT type.
- Remove any loose objects from pockets and clothing and leave them behind in the tower base or secure them from falling down during the ascent
- Make sure that the test badge of the safety harness is valid, and that the safety harness does not show any signs of damage
- Put on the safety harness as described under "Safety equipment" see Chapter 7.1.3 "Handling the safety harness"
- Visually inspect the vertical ladder and fall arrest system as far as possible, make sure that there is no visible damage and that the test certificate is valid

In the case of damage or an invalid test certificate, proceed as follows:

Owner/operator

- Stop preparations for the ascent

The vertical ladder must not be used until it is released again by an expert.

- Have an expert rectify the damage to the vertical ladder and release the vertical ladder again

Service employee

- Stop preparations for the ascent

The vertical ladder must not be used until it is released again by an expert.

- Inform the responsible employee immediately
- Have an expert rectify the damage to the vertical ladder and release the vertical ladder again

10.2 Using the vertical ladder



DANGER

FALLING HAZARD

If the service lift and the vertical ladder are used at the same time, there is a danger of falling from a height.

If a service lift is available it must be always used for ascending and descending the tower. Only use the vertical ladder if the service lift is out of order.



DANGER

FALLING HAZARD

If the vertical ladder is used without fall arrest system, there is a danger of falling.

The vertical ladder must only be used while wearing the PPE, while secured with the fall arrester permitted for the respective fall arrest system, and carrying the lanyard with energy absorber.



DANGER

FALLING HAZARD

No more than two persons at one time must be secured to the safety rope of the fall arrest system of Latchways.


DANGER

During the ascend: Do not allow your full body weight to rest in the fall arrester.

Always stay in contact with the vertical ladder at at least 3 points: 2 feet and 1 hand or 2 hands and 1 foot.


NOTE

- Wear safety gloves during the ascend.
 - The vertical ladder has a foldable rest platform about every 9 m.
-
- In the case of lattice towers, unlock the ladder guard on the vertical ladder, remove it and place it on the side
 - Attach the fall arrester permitted for the respective fall arrest system to the fall arrest system
 - Check whether the fall arrester works properly
 - Attach the snap hook of the fall arrester to the abdominal lug in the middle of the abdominal strap, and secure it using the knurled nut
 - Check the personal protective equipment for correct fit and perform a suspension test
 - Make sure that there is no other person on the vertical ladder in the section up to the next platform.
Otherwise, wait until the other person has reached the next platform and, if applicable, closed the hatch again
 - Start the ascent.
Pull lightly on the fall arrester to release the locking mechanism
 - During the ascent, keep checking regularly whether the vertical ladder and the fall arrest system are fully functional and do not show any signs of damage.
 - When reaching the next platform, open the hatch upward (if applicable), climb through, and close the hatch again


DANGER
FALLING HAZARD

When leaving the vertical ladder without fall protection, there is a danger of falling.

Before detaching from the fall arrester, attach the lanyard with energy absorber to a suitable attachment point, e.g. bracket or upright of the vertical ladder.

Using the vertical ladder without fall arrest system

**⚠ DANGER****FALLING HAZARD**

If the vertical ladder is used without fall arrest system, there is a danger of falling.

If the fall arrest system is not available, use a lanyard with energy absorber for securing.

**⚠ DANGER****FALLING HAZARD**

The rungs of the ladder are not permitted as attachment points.
Connect the lanyard to one of the ladder uprights.

If the vertical ladder must be used without the fall arrest system being available (e.g. during erection), the persons using the vertical ladder must be secured using the lanyard with energy absorber of the PPE.

Proceed as follows:

- Start the ascent
- At a height of about 1 m, connect one end of the lanyard with energy absorber to a ladder upright as high as possible
- Only climb the vertical ladder so far that you can still reach the first snap hook of the lanyard
- Attach the second end of the lanyard as high as possible on the vertical ladder upright
- Release the first snap hook of the lanyard
- Move further up the vertical ladder, as described, and alternately secure yourself with the two snap hooks

10.3 Using the service lift

**⚠ DANGER****FALLING HAZARD**

If the service lift and the vertical ladder are used at the same time, there is a danger of falling from a height.

If a service lift is available it must be always used for ascending and descending the tower. Only use the vertical ladder if the service lift is out of order.


⚠ DANGER
FALLING HAZARD

If the service lift is used without fall protection, there is a danger of falling.
 In the service lift cage, always secure yourself by attaching the lanyard with energy absorber to one of the attachment points.

⚠ WARNING

Improper use of the service lift may lead to wind turbine damage and put the life and health of persons at risk.

Only instructed persons are permitted to operate the service lift.

⚠ WARNING

Objects in the operating area of the service lift may lead to turbine damage.
 Before and when using the service lift, always make sure that the operating area of the service lift is clear.

In the case of lattice towers, some preparations must be made before using the service lift. This is because the service lift cage is parked approx. 8 m above the ground.

The service lift cage can only be reached via the vertical ladder.

- Switch on the operating voltage for the service lift
 The switch (-1F1) is located in the switch cabinet room of the transformer station, in the fuse box on the left wall.
- Use the vertical ladder to climb to the service lift cage
 To do so, proceed as described in the following, see Chapter 10.2 "Using the vertical ladder" (among others removing the ladder guard, using the fall arrester).

To use the service lift, proceed as follows:

- Before using the service lift, familiarize yourself once more with its operation, particularly in the event of a fault, using the operating instructions provided on site
- Enter the service lift cage
- Attach the lanyard with energy absorber to one of the attachment points in the service lift cage
- Start the service lift

10.4 Entering the nacelle



NOTE

Specific turbine types have an access hatch switch, see Chapter 8.5 "Access hatch switch".

- Prior to leaving the vertical ladder or the service lift, attach yourself with the lanyard with energy absorber to a suitable attachment point, e.g. ladder upright
- Release yourself from the fall arrester or the attachment point in the service lift
- If necessary, remove the fall arrester upwards out of the fall arrest rail, or from the fall arrest system, and hang it on the top rung until descending
- Step onto the top platform and close the hatch
- After the hatch has been closed, detach the lanyard from the attachment point
- Open the access hatch into the nacelle (depending on the design, slide it open or push it upwards)
- Ascend into the nacelle
- Switch the service switch on the manual control unit of the Topbox to service mode
- Close the access hatch into the nacelle

11. Special features of K06



NOTE

Types:

- N54-Mk3/1000
- N60/1300
- N62/1300

11.1 Operating the rotor brake without system pressure

The following describes how the rotor brake can be operated if the hydraulic unit is not ready for operation, meaning there is no system pressure.

When there is no pressure, the rotor brake is closed.

If the hydraulic unit of the WT is not ready for operation, the rotor brake can be released using a hydraulic hand pump and the spring assembly can be locked open by screwing on a nut.

NOTICE

DAMAGE TO HYDRAULIC SYSTEM

When operating the rotor brake using a hand pump, observe the following:

- Observe the maximum operating pressure of the rotor brake
- The hydraulic oil used in the hydraulic hand pump must be identical to the hydraulic oil of the WT
- Use a 5 μ filter for filtering the hydraulic oil

WARNING

SPURTING HYDRAULIC OIL

The hydraulic system may be under pressure.

Prior to working on hydraulic lines, depressurize the hydraulic system.

- Ensure that the hydraulic system is depressurized
- Release the hydraulic hose of the brake system from the hydraulic supply line

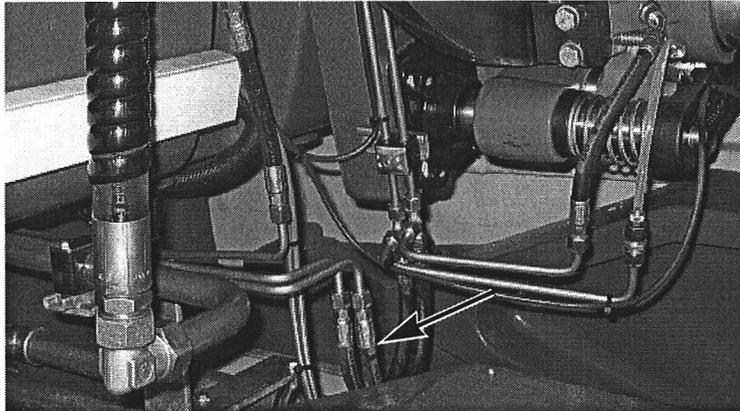


Fig. 34 Hydraulic supply line

- Absorb escaping hydraulic oil with a cloth
- Connect the hydraulic hand pump to the hydraulic hose
- Fit a protective cap to the hydraulic supply line
- Apply and release the rotor brake by either building up or releasing pressure using the hand pump

If the rotor brake is to remain released for prolonged periods of time it can be locked in the open position. To do so:

- On both brake calipers, remove the protective cap from the bolt in the spring assembly

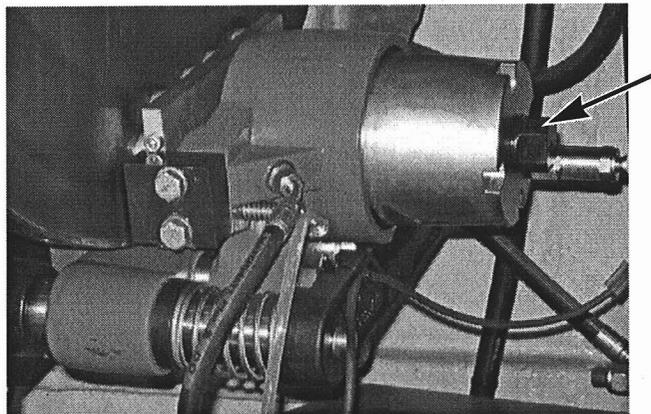


Fig. 35 Protective cap on the bolt in the spring assembly

- On both brake calipers, screw the nut A/F 36 fitted to the brake caliper onto the bolt in the spring assembly

Once the work is complete:

- Restore the operational state of the rotor brake
- Vent the brake hydraulic circuit

- If necessary, refill any lost hydraulic oil

11.2 Operating the rotor lock

The rotor lock is a device for mechanically locking the rotor.

It prevents personal injuries in the nacelle and the rotor hub resulting from contact with rotating parts of the drive train.

WARNING

The rotor lock must only be engaged in 10 minute average wind speeds up to a maximum of 12 m/s.

NOTICE

GEARBOX DAMAGE

If the rotor is locked for more than 24 hrs, observe the current revision of the Work Instructions *F010_002*.

WTs of turbine class K06 have 2 rotor lock bolts, which are positioned on the left and right of the rotor bearing.

These must be inserted manually into the corresponding drill holes in the rotor lock disk.

WARNING

Danger of life-threatening injuries and serious wind turbine damage.
The rotor shaft must always be locked using both rotor lock bolts.

Locking the rotor



Fig. 36 Storage location of the left rotor lock bolt

- 1 Locking screw
- 2 Rotor lock bolt

- Ensure that the manual control for the rotor brake is activated, the rotor brake is closed, and the rotor is locked
- Loosen the locking screw on both rotor lock bolts
- Push one of the rotor lock bolts to just before the rotor lock disk
- Release the rotor brake



NOTE

For instructions on operating the rotor brake without hydraulic pressure, see Chapter 11.1 "Operating the rotor brake without system pressure"

- Align the rotor lock disk
- Re-apply the rotor brake again
- Insert each rotor lock bolt into a drill hole in the rotor lock disk

NOTICE

The rotor lock bolts must only be inserted into the rotor lock disk with the rotor shaft at a standstill.

- Tighten the locking screws to lock the rotor lock bolts

Releasing the rotor lock

- Make sure that the rotor brake is applied
- Loosen the locking screws

- Pull both rotor lock bolts from the rotor lock disk
- Check that the rotor lock bolts have been completely retracted, and that the rotor lock disk can turn freely
- Secure the two rotor lock bolts with the locking screws

11.3 Operating the roof

The roof on WT of turbine class K06 can be opened. It is necessary to open it in order, for example, to transport pieces of equipment into the nacelle or perform various maintenance work.

The roof is fastened to the right nacelle wall (when looking towards the rotor hub) by means of hinges, and secured with 2 locks on the left nacelle wall.

To open the roof, open the locks, then open the roof via the hinges using the hydraulic system, and secure it with 2 props.

Opening the roof



PERSONAL INJURY AND DAMAGE TO THE NACELLE

The roof of the nacelle offers a large surface for the wind to act upon.

- Opening the roof is only permitted at 10 minute average wind speeds up to 12 m/s.
- With freshening wind, do not open the roof downwind



NOTE

If it rains, the nacelle should be positioned perpendicular to the wind direction so that the roof is opened against the wind, offering some degree of protection.

It is recommended to open the cabin roof as a team of two. Proceed as follows:

- Inform all persons in the nacelle that you intend to open the roof



DANGER OF FALLING WITH ROOF OPEN

While staying in a fall hazard area, secure yourself at one of the marked attachment points in the nacelle.

- Open the two locks on the left nacelle wall, see Fig.37

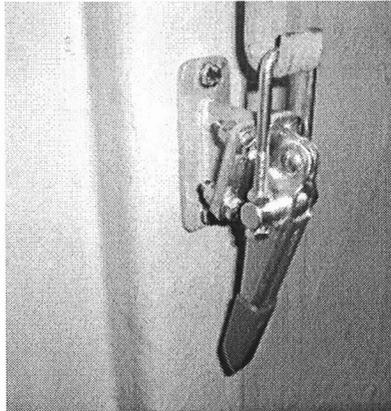


Fig. 37 Lock on the left nacelle wall

- Using the hydraulic system, open the roof so far that the bolts of the roof lock can still be easily reached

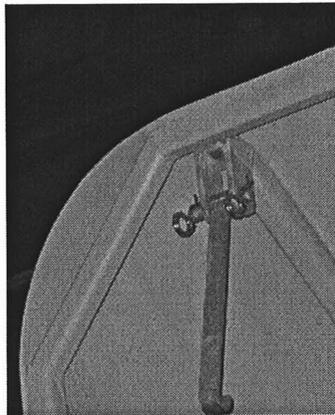


Fig. 38 Bolt for roof prop, example N60

- Remove the props from the brackets on the left nacelle wall and push them onto the bolts of the roof locks
Ensure that the props are secured on the bolts
- Continue to open the roof until the props can be pushed onto the bolts for the locks on the nacelle wall

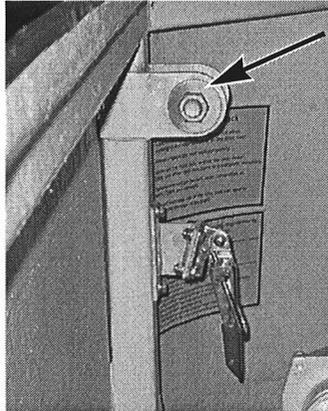


Fig. 39 Bolt for prop on nacelle wall

- Place the props on the bolts of the locks on the nacelle wall
Note: Ensure that the props are secured on the bolts.

Closing the roof

To close the roof, proceed as follows:

- Ensure that the edge of the nacelle wall is clear and the roof can be closed without obstruction
- Remove the props from the bolts on the nacelle wall.
- Lower the roof using the hydraulic system until the props can be removed from the roof
- Remove the props and place them on the brackets
- Lower the roof completely
- Hook the two locks of the roof lock into the left nacelle wall and lock them

11.4 Operating the roof hydraulics for turbine class K06

The roof on a WT of turbine class K06 can be operated using system pressure or the hand pump of the hydraulic unit.

Opening the roof



NOTE

For opening the roof, see Chapter 11.3 "Operating the roof".
 Only the operation of the roof hydraulics is described here.

- Attach the handle provided with the hydraulic unit across the double valve 460.0 so that the pin is positioned at the side facing away from the generator

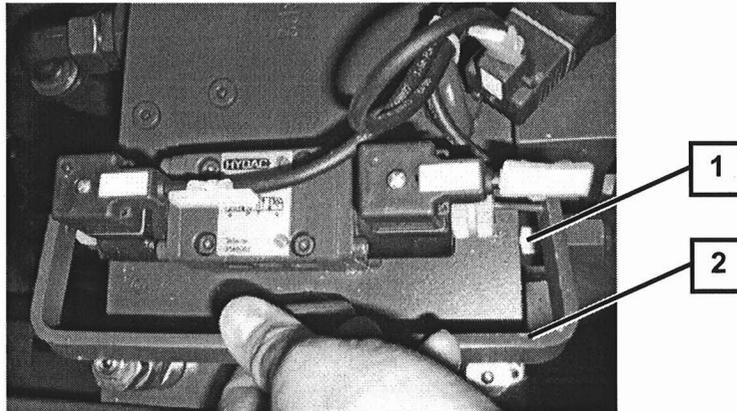


Fig. 40 Handle on the hydraulic unit

- 1 Pin
- 2 Handle

- Move the pin toward the generator.
If system pressure is available, the roof opens.
- If no system pressure is available: Attach the extension pipe to the hand pump of the hydraulic unit and build up pressure by pumping so that the roof opens, see Fig.41

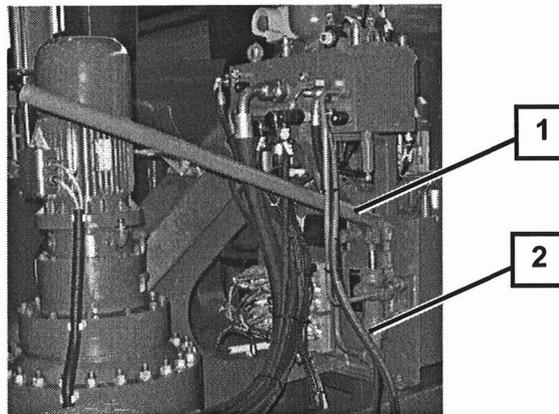


Fig. 41 Hydraulic unit of turbine class K06

- 1 Extension pipe
- 2 Hand pump

- If the roof is completely opened, remove the handle and place it back

Closing the roof



NOTE

For closing the roof, see Chapter 11.3 "Operating the roof"
Only the operation of the roof hydraulics is described here.

- Turn the handle across the double valve 460.0 until the pin is positioned at the side facing away from the generator
- Move the handle toward the rotor hub
If system pressure is available, the roof closes.
- If no system pressure is available: Attach the extension pipe to the hand pump of the hydraulic unit and build up pressure by pumping so that the roof closes
- If the roof is completely closed, remove the handle and place it back. If the hand pump has been used, remove the extension pipe and place it back

11.5 Entering the rotor hub

It is necessary to enter the rotor hub in order to perform maintenance or repair work on the rotor blades and hydraulic system.

In the case of WT's of turbine class K06, you must climb over the rotor hub and enter from the outside.

For this purpose, special additional equipment is required, see Chapter 7.2 "Additional equipment for service employees (K06 and K08)". This must be carried in the service vehicle.

In the interest of the safety of the person performing the work, a second person who can operate the WT controls must be located in the nacelle.

WARNING

Work on the drive train and in the rotor hub is only permitted at 10 minute average wind speeds of less than 12 m/s.

WARNING

If the rotor is suddenly set into motion, this may result in life-threatening or severe injuries.

Before entering the rotor hub always lock the rotor on the rotor shaft using the rotor lock, and ensure that the rotor brake is also applied.

For operating the rotor lock, see Chapter 11.2 "Operating the rotor lock".

WARNING

FALLING OBJECTS

Make sure that nobody is present in the area underneath the turbine when climbing onto the rotor hub.

Make sure that there are no loose parts that may fall down.

Secure any tools you carry on you.

11.5.1 Attaching the hub rope

In the case of WT's of turbine class K06, the respective service employee must be secured using the hub rope when crossing the rotor hub, see Chapter 7.2 "Additional equipment for service employees (K06 and K08)".

- Make sure that the additional equipment required for crossing the rotor hub is in sound condition, and any test badges are valid



DANGER

FALLING HAZARD

A PPE either with an invalid test badge or which has been damaged or strained by a fall must no longer be used.

Replace the PPE immediately and have it checked by an expert.

- Attach the hub rope directly to the lifting lug on the rotor bearing

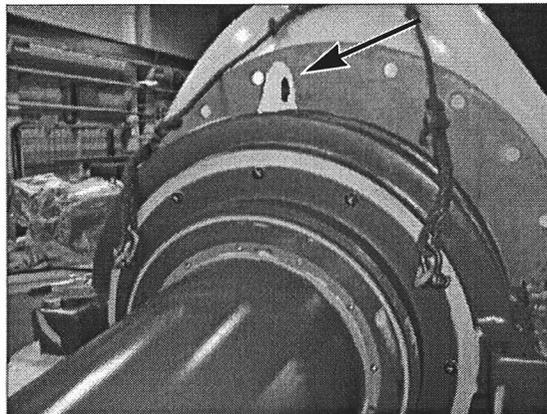


Fig. 42 Lifting lug on rotor bearing

11.5.2 Crossing the rotor hub

To access the rotor hub, proceed as follows:

- Turn the rotor out of the wind (nacelle perpendicular to wind)
- If it is not already open, open and secure the roof



DANGER

FALLING HAZARD

If the roof is open, there is a danger of falling.

While staying in a fall hazard area, secure yourself at one of the marked attachment points in the nacelle

- Check whether the rotor is locked in such a way that the step on the rotor hub is in the bottom position

Note: A red arrow indicates this on the rotor hub. It must be visible from the nacelle, and located in the top position.

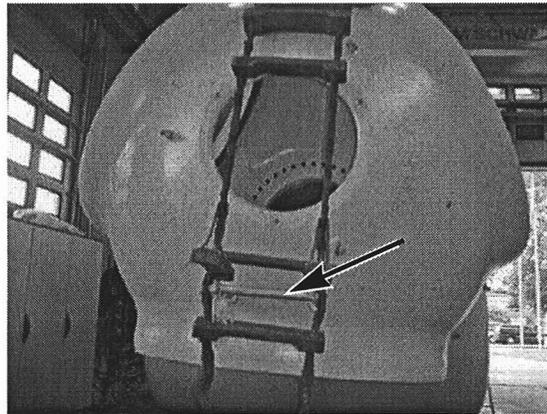


Fig. 43 Step on the rotor hub

- If this is not the case, release the rotor lock, turn the rotor hub and lock the rotor again
- Attach the hub ladder to the eyebolts on the rotor bearing, and lower it across the rotor hub

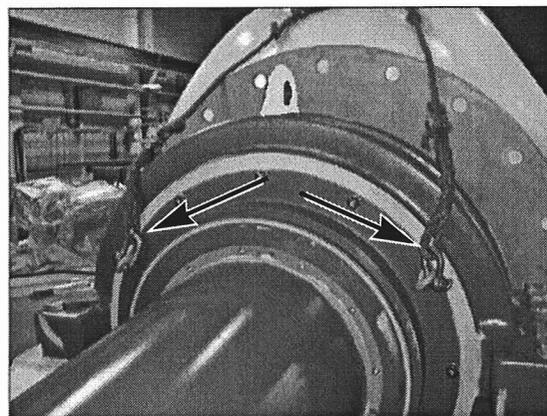


Fig. 44 Eyebolts on the rotor bearing



⚠ DANGER

FALLING HAZARD

There is a danger of falling when crossing the rotor hub.

When crossing the rotor hub, always use the hub rope attached to the rotor bearing to secure yourself against falling. The hub ladder and the three eyebolts around the entrance to the rotor hub are not suitable as attachment points for securing oneself against falling.

- Ensure that the hub rope is attached to the lifting lug on the rotor bearing

- Check the the guided-type fall arrester for proper functioning
- Hook the snap hook of the guided-type fall arrester of the hub rope into the chest lug of the safety harness and secure it
- Carrying the lanyard with energy absorber, step onto the hub ladder and carefully move up the hub ladder toward the rotor hub access. Move the guided-type fall arrester along step by step, so that in the event of slipping the height of fall is as low as possible
- Check the step on the rotor hub for tight fit, and if it is safe, step onto the step

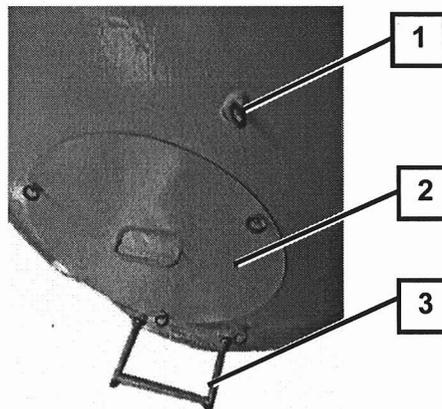


Fig. 45 Rotor hub entrance

- 1 Eyebolt
- 2 Rotor hub hatch
- 3 Step

If the step is damaged, the service employee must decide whether to continue the access into the rotor hub or to abort. The damage must always be reported to the responsible employee.

- Loosen and unscrew the two upper eye nuts on the rotor hub hatch. If necessary, loosen the rotor hub hatch stay in advance
- Only loosen the third eye nut so that the rotor hub hatch can be pivoted downward
- Enter the rotor hub
- Attach the lanyard with energy absorber at a suitable location in the rotor hub



⚠ DANGER

FALLING HAZARD

In the rotor hub is a danger of falling within 2 m of the rotor hub access. When working in this area secure yourself using the lanyard with energy absorber.

- Release the guided-type fall arrester of the hub rope from the safety harness, and attach it at a suitable location inside the rotor hub

For the return into the nacelle, secure yourself and proceed in the same manner as described above:

- Hook the snap hook of the guided-type fall arrester of the hub rope into the chest lug of the safety harness and secure it
- Release the lanyard with energy absorber from the attachment point in the rotor hub
- Step out of the rotor hub onto the hub ladder
- Re-attach the hub hatch
- Move upwards on the hub ladder. In the process, move the guided-type fall arrester along step-by-step
- Enter the nacelle
- Secure yourself by attaching the lanyard with energy absorber to one of the attachment points in the nacelle
- Release the hub rope from safety harness and attachment point
- Bring in the hub ladder and release it from the attachment points

11.6 Transporting objects into the nacelle

NORDEX WT's are equipped with an on-board crane for transporting objects into the nacelle.

If the objects to be transported are not too heavy, they can also be transported using the working rope.



WARNING

FALLING OBJECTS

Do not stand or walk in an appropriate radius under suspended loads

The on-board crane must only be operated by instructed persons.

On-board cranes can differ in design from one WT to the next. Always refer to the operating instructions stored in the WT.

If the working rope is used on WT's of turbine type K06, use the edge protection, see Chapter 11.6.2 "Using the edge protection for the working rope", if available.

If this is not available, other arrangements must be made so as not to damage the edge of the nacelle wall and the sponge rubber seal on the wall.

NOTICE

Risk of damaging the edge of the nacelle and the sponge rubber seal.
Do not guide the working rope over the unprotected edge of the nacelle wall.

11.6.1 Using the on-board crane**NOTE**

The following applies to the standard version of the on-board crane for WT's of turbine class K06 - the pillar jib crane with a working load limit of up to 250 kg.

NOTICE**PENDULAR MOVEMENTS**

Danger of damage to the tower and objects to be transported due to uncontrolled pendular movements.

Secure the load to be transported with an additional rope from the ground, and keep it clear from tower and nacelle.

In order to use the on-board crane, proceed as follows:

- Remove the power supply cable rolled up on the crane pillar and connect it
- Turn the crank lever on the manual lifting jack to lift the crane jib out of the bracket on the gearbox

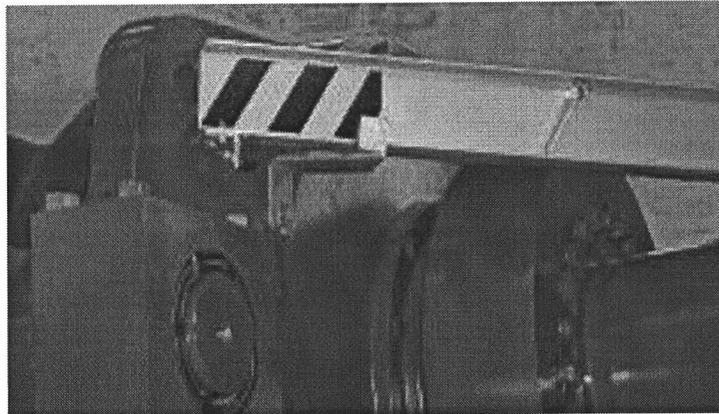


Fig. 46 Crane jib in parked position

- Unhook the safeguard for the chain hoist
- Slew the crane jib far enough out of the parked position so as to be able to move the chain hoist right forward
- Move the chain hoist on the crane jib forward until the ratchet is activated

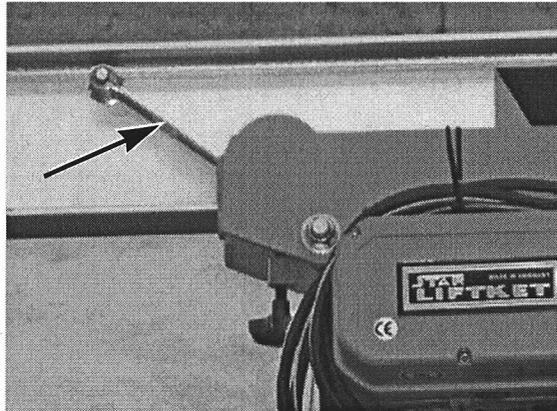


Fig. 47 Ratchet

- Attach the working rope to the crane hook and lower it to the ground
- Use the working rope from the ground to keep the crane hook clear of nacelle and tower, in order to avoid damage
- If necessary, load the crane hook with the crane drum and ensure that the crane hook safety latch is closed
- Remove the securing bolt for the crane pillar from the gear rack bracket

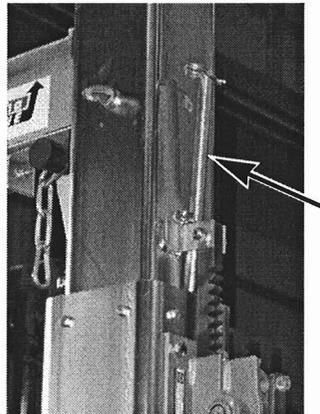


Fig. 48 Securing bolt in the gear rack bracket

- Fully extend the crane pillar using the manual lifting jack, and insert the securing bolt through the drill holes that become visible in the crane pillar

⚠ WARNING

Risk of injury and material damage due to failure of the self-locking function of the gear rack drive.

Only use the extended crane pillar when the securing bolt is inserted.

- Slew the crane jib over the nacelle wall and use the snap hook to secure it to the eyebolt on the crane pillar

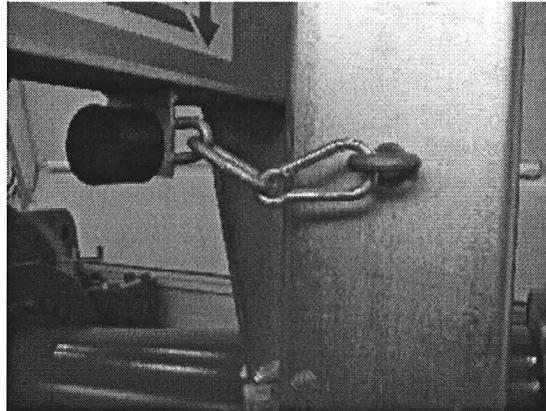


Fig. 49 Securing the crane jib

The chain hoist is now ready for operation and can be operated from its keyboard.

After using the on-board crane, it must be returned to the parked position and secured there.

- Retract the crane hook
- Release the crane jib's safeguard from the crane pillar
- Slew the crane jib into the nacelle until the crane hook can be reached
- Remove any loads hanging on the crane hook
- Bring in the working rope and release it from the crane hook
- Open the ratchet and move the chain hoist toward the crane pillar
- Secure the chain hoist with the snap hook on the crane jib
- Remove the securing bolt from the crane pillar and store it in the bracket of the gear rack
- Position the jib over the bracket on the gearbox, and use the manual lifting jack to lower it
- Pull the power supply cable out of the power outlet and roll it up on the crane pillar

11.6.2 Using the edge protection for the working rope

The edge protection must be used to protect the edge of the nacelle wall and the sponge rubber seal when using the working rope to transport objects into the nacelle with the roof open.

- Remove the edge protection from its storage location
- Lay it over the edge of the nacelle wall
- Secure it with the palm grip

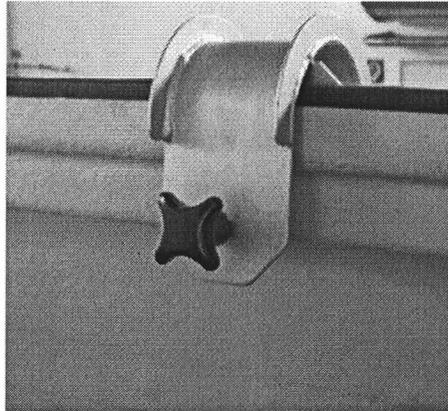


Fig. 50 Edge protection in use

After use, return the edge protection to the storage location and secure it there.

12. Special features of K07 alpha



NOTE

Types:

- S70/1500
 - S77/1500
-

12.1 Operating the rotor brake without system pressure

The following describes how the rotor brake can be operated if the hydraulic unit is not ready for operation, meaning there is no system pressure.

When there is no pressure, the rotor brake is closed.

If the hydraulic unit of the WT is not ready for operation, the rotor brake can be released using a hydraulic hand pump and the spring assembly can be locked open by screwing on a nut.

NOTICE

DAMAGE TO HYDRAULIC SYSTEM

When operating the rotor brake using a hand pump, observe the following:

- Observe the maximum operating pressure of the rotor brake
 - The hydraulic oil used in the hydraulic hand pump must be identical to the hydraulic oil of the WT
 - Use a 5 μ filter for filtering the hydraulic oil
-

⚠ WARNING

SPURTING HYDRAULIC OIL

The hydraulic system may be under pressure.

Prior to working on hydraulic lines, depressurize the hydraulic system.

- Ensure that the hydraulic system is depressurized
 - Release the hydraulic hose of the brake system from the hydraulic supply line
-

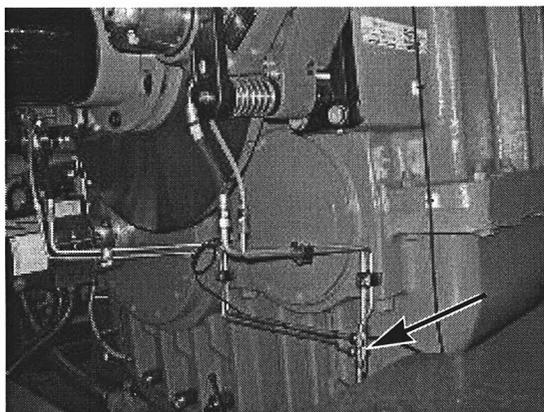


Fig. 51 Hydraulic supply line

- Absorb escaping hydraulic oil with a cloth
- Connect the hydraulic hand pump to the hydraulic hose
- Fit a protective cap to the hydraulic supply line
- Apply and release the rotor brake by either building up or releasing pressure using the hand pump

If the rotor brake is to remain released for prolonged periods of time it can be locked in the open position. To do so:

- On both brake calipers, remove the protective cap from the bolt in the spring assembly

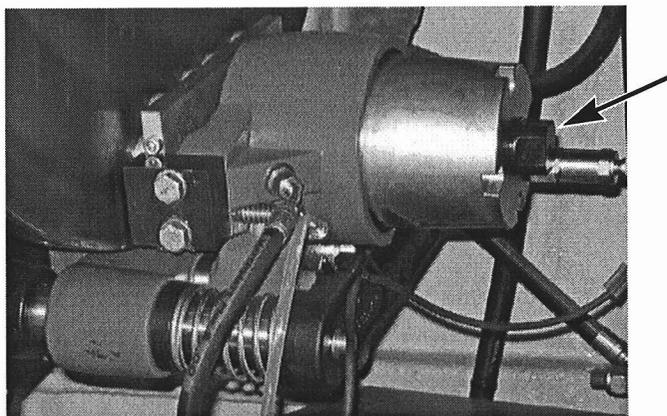


Fig. 52 Protective cap on the bolt in the spring assembly

- On both brake calipers, screw the nut A/F 36 fitted to the brake caliper onto the bolt in the spring assembly

Once the work is complete:

- Restore the operational state of the rotor brake
- Vent the brake hydraulic circuit

- If necessary, refill any lost hydraulic oil

12.2 Operating the rotor lock

The rotor lock is a device for mechanically locking the rotor. It prevents personal injuries in the nacelle and the rotor hub resulting from contact with rotating parts of the drive train.

WARNING

The rotor lock must only be used at 10 minute average wind speeds of up to a maximum of 12 m/s, whereby WTs with pitch systems must have at least two rotor blades in the feathering position.

NOTICE

GEARBOX DAMAGE

If the rotor is locked for more than 24 hrs, observe the current revision of the Work Instructions *F010_002*.

WTs of turbine class K07 have two rotor lock bolts, which are located to the right and left on the rotor bearing, and are inserted into corresponding drill holes in the rotor lock disk using an operating screw each.

WARNING

The rotor shaft must always be locked using both rotor lock bolts.

Locking the rotor

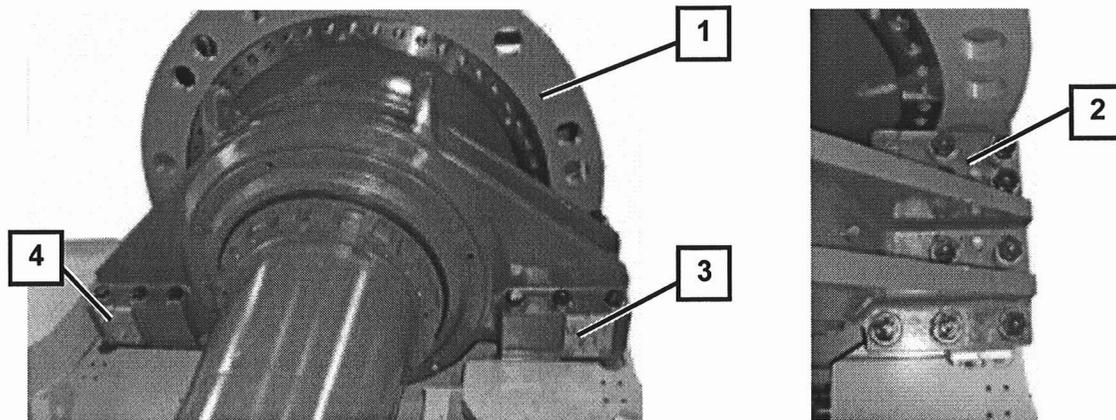


Fig. 53 Rotor shaft with rotor lock disk (WT of turbine class K07)

- 1 Rotor lock disk
- 2 Locking screw for right rotor lock bolt
- 3 Operating screw for right rotor lock bolt
- 4 Operating screw for left rotor lock bolt

- Ensure that the manual control for the rotor brake is activated, the rotor brake is closed, and the rotor is locked
- Release the locking screw for the left rotor lock bolt

NOTICE

The left rotor lock bolt must be engaged first, followed by the right rotor lock bolt.

- Extend the left rotor lock bolt by turning the operating screw until just before the rotor lock disk
- Release the rotor brake



NOTE

For instructions on operating the rotor brake without hydraulic pressure, see Chapter 12.1 "Operating the rotor brake without system pressure"

- Align the rotor lock disk
- Re-apply the rotor brake again
- Insert the left rotor lock bolt into the rotor lock disk

NOTICE**RISK OF TURBINE DAMAGE**

The rotor lock bolts must only be inserted into the rotor lock disk with the rotor shaft at a standstill.

- Tighten the locking screws to lock the rotor lock bolts.
- Proceed in the same way for the right rotor lock bolt.

Releasing the rotor lock

- Make sure that the rotor brake is applied
- Loosen the locking screws
- Retract the right rotor lock bolt from the rotor lock disk by turning the operating screw
- Retract the left rotor lock bolt from the rotor lock disk by turning the operating screw
- Check that the rotor lock bolts have been completely retracted, and that the rotor lock disk can turn freely
- Secure the two rotor lock bolts with the locking screws

12.3 Entering the rotor hub

It is necessary to enter the rotor hub in order to perform maintenance or repair work on the rotor blades and pitch system.

For WT's of turbine class K07, the rotor hub is covered with a spinner, so that the rotor hub is accessed from the inside of the nacelle through the spinner.

In the interest of the safety of the person performing the work, a second person who can operate the WT controls must be located in the nacelle.

⚠ WARNING

Work on the drive train and in the rotor hub is only permitted at 10 minute average wind speeds of less than 12 m/s.

⚠ WARNING

If the rotor is suddenly set into motion, this may result in life-threatening or severe injuries.

Before entering the rotor hub always lock the rotor on the rotor shaft using the rotor lock, and ensure that the rotor brake is also applied.

For operating the rotor lock, see Chapter 12.2 "Operating the rotor lock"

12.4 Transporting objects into the nacelle

NORDEX WT's are equipped with an on-board crane for transporting objects into the nacelle.

If the objects to be transported are not too heavy, they can also be transported using the working rope.

In the case of WT's of turbine class K07, the transport hatch in the bottom rear part of the nacelle is used for this purpose.



DANGER

SUSPENDED LOAD

Danger of injury due to falling objects.

Do not stand or walk under suspended loads.

The on-board crane must only be operated by instructed persons.

On-board cranes can differ in design from one WT to the next. Always refer to the operating instructions stored in the WT.

12.4.1 Using the on-board crane



NOTE

The following applies to the standard version of the on-board crane for WT's with a working load limit of up to 250 kg.

NOTICE

UNCONTROLLED PENDULAR MOVEMENTS

Danger of damage to the tower and objects to be transported due to uncontrolled pendular movements.

Secure the load to be transported with an additional rope from the ground, and keep it clear from tower and nacelle.

The on-board crane for WT's of turbine class K07 has a fixed crane rail.

This means only the chain hoist must be moved and secured in the respective end positions using the locking screw.

The chain bag does not need to be secured separately.

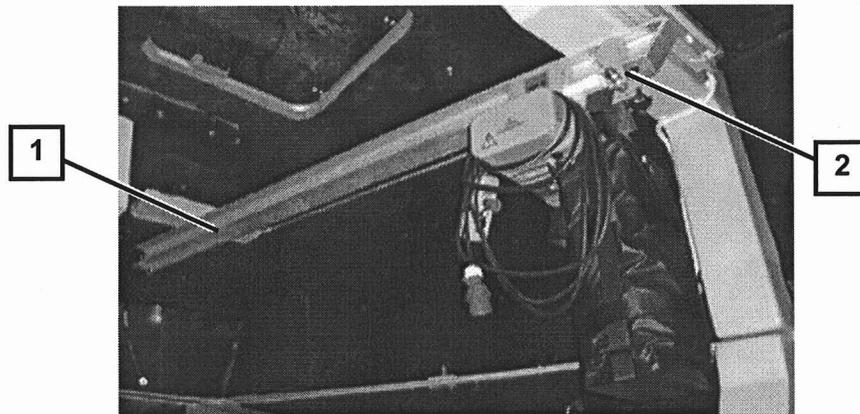


Fig. 54 Chain hoist for turbine class K07:

- 1 Crane rail
- 2 Locking screw

In order to use the on-board crane, proceed as follows:

- Roll out the rolled up power supply cable and connect it
- Loosen the chain hoist locking screw
- Move the chain hoist over the transport hatch
- Attach the working rope to the crane hook and lower it to the ground
Use the working rope from the ground to keep the crane hook clear of nacelle and tower, in order to avoid damage
- If necessary, load the crane hook with the crane drum and ensure that the crane hook safety latch is closed

The chain hoist is now ready for operation and can be operated from its keyboard.

After using the on-board crane, it must be returned to the parked position and secured there.

- Retract the crane hook
- Remove any loads hanging on the crane hook
- Bring in the working rope and release it from the crane hook
- Loosen the chain hoist locking screw
- Move the chain hoist into the parked position
- Fasten the chain hoist with the locking screw
- Remove the power supply cable from the power outlet, and roll it up

12.5 Operating the hydraulic unit

When releasing the pressure using the vent screws make sure not to loosen them more than half a turn.

If the pressure does not drop, tighten and loosen the screws again.

13. Special features of K08 beta



NOTE

Types:

- N80/2500
- N90/2300
- N90/2500

13.1 Operating the rotor brake without system pressure

The following describes how the rotor brake can be operated if the hydraulic unit is not ready for operation, meaning there is no system pressure.

In the case of WT's of turbine class K08, a differentiation must be made between WT's with passive rotor brake and with active rotor brake.

13.1.1 WT's with active rotor brakes

In the case of a grid failure, the active mechanical rotor brake is normally released, and can no longer be applied automatically.

It can be applied manually using the hand pump on the hydraulic unit, and released again using a valve.

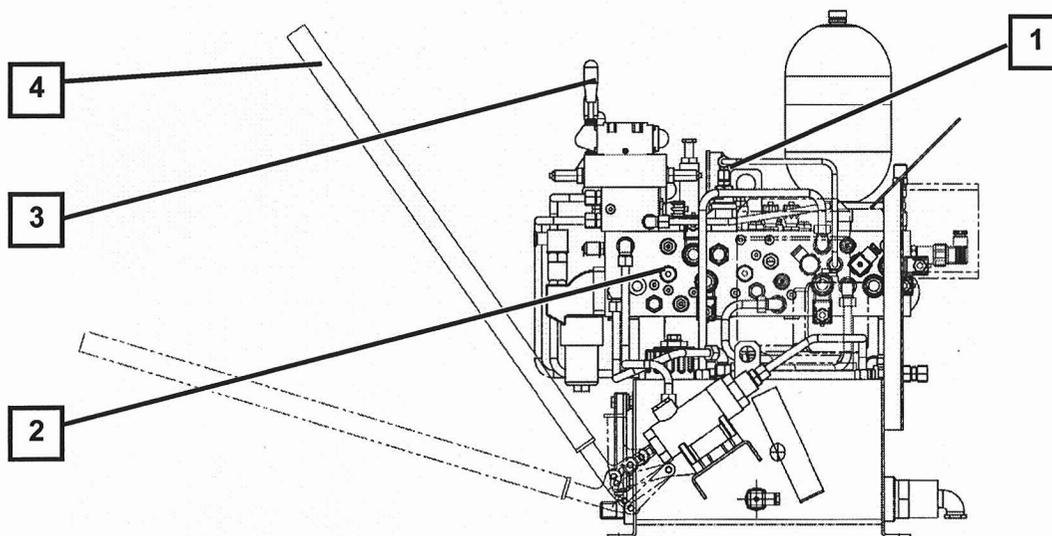


Fig. 55 Hydraulic unit for active rotor brake

- 1 Pressure gage
- 2 Valve 810.2
- 3 Valve 610
- 4 Lever of the hand pump with extension pipe

Applying the rotor brake

- Move the lever of valve 610 to the "Rotor Brake" position
- Remove the extension pipe from the bracket and attach it onto the lever of the hand pump
- Build up the pressure using the hand pump until a value of 115 bar is displayed on the pressure gage
- Shift the lever of valve 610 back to the center position

Releasing the rotor brake

- Open valve 810.2
- After the pressure has been released, close the valve 810.2 again



NOTE

It is not possible to start up the WT if valve 810.2 is open.

13.1.2 WTs with passive rotor brakes

The following describes how the passive rotor brake can be operated if the hydraulic unit is not ready for operation, meaning there is no system pressure.

When there is no pressure, the passive rotor brake is applied.

If the hydraulic unit of the WT is not ready for operation, the rotor brake can be released using a hydraulic hand pump and the spring assembly can be locked open by screwing on a nut.

NOTICE

DAMAGE TO HYDRAULIC SYSTEM

When operating the rotor brake using a hand pump, observe the following:

- Observe the maximum operating pressure of the rotor brake
- The hydraulic oil used in the hydraulic hand pump must be identical to the hydraulic oil of the WT
- Use a 5 μ filter for filtering the hydraulic oil

WARNING

SPURTING HYDRAULIC OIL

The hydraulic system may be under pressure.

Prior to working on hydraulic lines, depressurize the hydraulic system.

- Ensure that the hydraulic system is depressurized

- Remove the hydraulic hose from one of the two brake calipers and absorb escaping hydraulic oil with a cloth

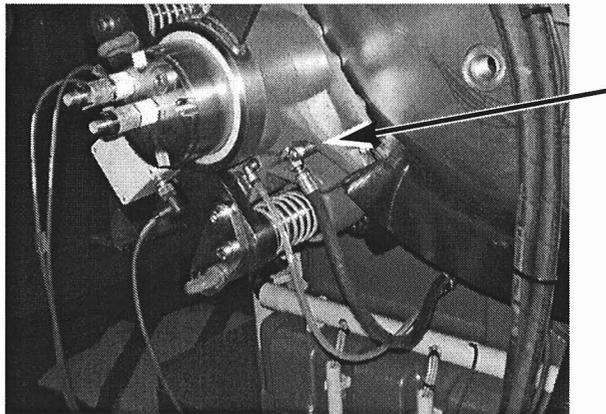


Fig. 56 Hydraulic hose port

- Seal the hydraulic hose with a cap in order to prevent dirt from entering and hydraulic oil from escaping
- Connect the hydraulic hand pump to the brake caliper
- Open the brake caliper by building up pressure using the hydraulic hand pump
- Remove the connection cable of the middle sensor for checking the brake pad thickness

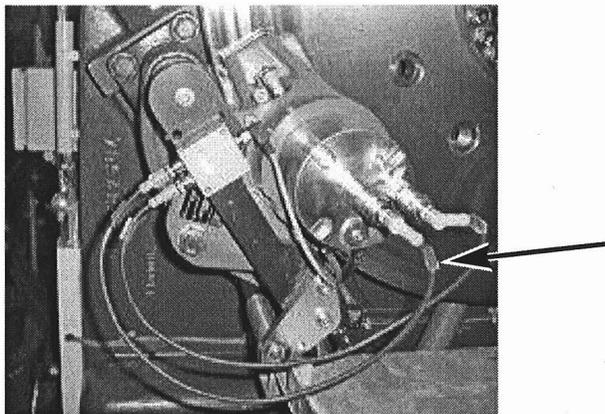


Fig. 57 Sensor for checking the brake pad thickness

- Remove the sensor (wrench size 24 mm)
- Screw the locking screw (hexagon screw M18x50 ISO 4017; stored in the vicinity of the brake) into the drill hole to secure the brake caliper in the open position

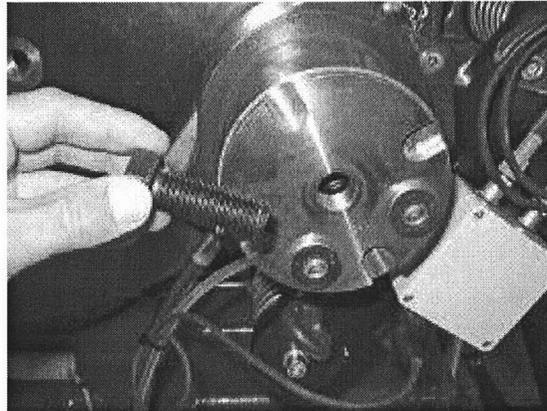


Fig. 58 Locking screw

- Remove the hydraulic hand pump and close the hydraulic port on the brake caliper with a cap
- Proceed in the same way for the second brake caliper

After work has completed

- Restore the operational state of the rotor brake
- Vent the brake hydraulic circuit
- If necessary, refill any lost hydraulic oil

13.2 Operating the rotor lock

The rotor lock is a device for mechanically locking the rotor. It prevents personal injuries in the nacelle and the rotor hub resulting from contact with rotating parts of the drive train.

WARNING

The rotor lock must only be used at 10 minute average wind speeds of up to a maximum of 12 m/s, whereby at least two rotor blades must be in the feathering position.

NOTICE

GEARBOX DAMAGE

If the rotor is locked for more than 24 hrs, observe the current revision of the Work Instructions *F010_002*.

All WT's of turbine class K08 have a rotor lock bolt for the rotor lock on the rotor shaft. This is integrated on the left of the machine frame, and is inserted hydraulically into the rotor lock disk on the rotor shaft.

In addition, WTs with active brake can also be equipped with a rotor lock on the brake disk.

13.2.1 Rotor lock on the rotor shaft

WARNING

If the mechanical design allows it, the rotor lock bolt must always be secured in both positions (inserted and retracted) using the securing bolt.

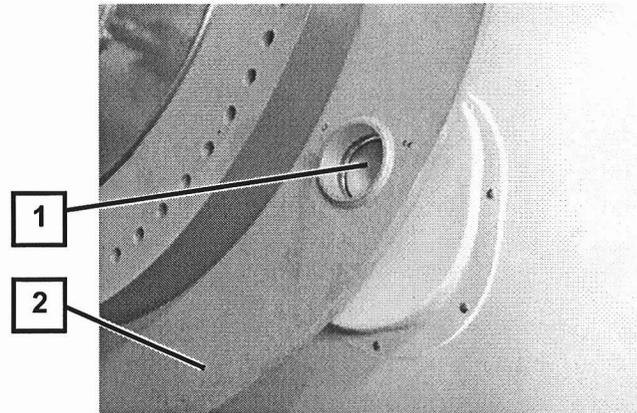


Fig. 59 Rotor lock on rotor shaft (WTs of turbine class K08)

- 1 Rotor lock bolt
- 2 Rotor lock disk

Aligning the rotor

- Ensure that the manual control for the rotor brake is activated, the rotor brake is closed, and the rotor is locked



NOTE

For instructions on operating the rotor brake without hydraulic pressure, see Chapter 13.1 "Operating the rotor brake without system pressure"

- By actuating the *Release Brake* button on the manual control unit of the Topbox, temporarily release the rotor brake and position the rotor so that one of the markings on the rotor shaft is aligned with the marking on the rotor bearing housing, see Fig.60

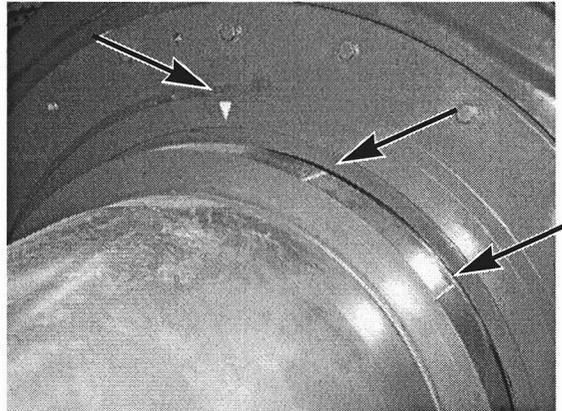


Fig. 60 Markings on rotor shaft and rotor bearing housing

- Make sure that the rotor brake is applied again

If system pressure is available, the rotor brake is applied as soon as the *Release Brake* button on the manual control unit is released.

If no system pressure is available, the rotor brake must be manually applied again after the manual release.

- Remove the securing bolt from the mechanism of the rotor lock bolt, see Fig.61

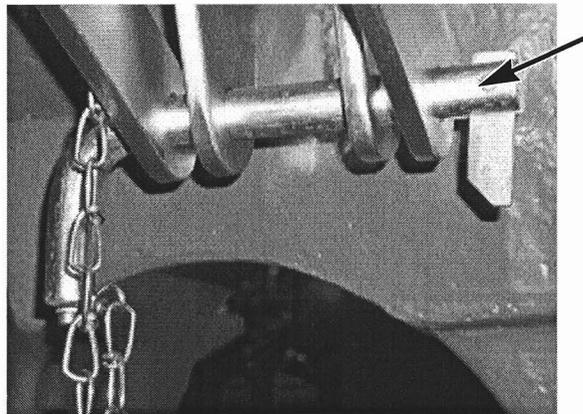


Fig. 61 Securing bolt on rotor lock bolt

- Remove the extension pipe from the bracket and attach it onto the lever of the hand pump

Locking the rotor with the active rotor brake

- Shift the lever of valve 610 on the hydraulic unit to the "Rotor lock" position

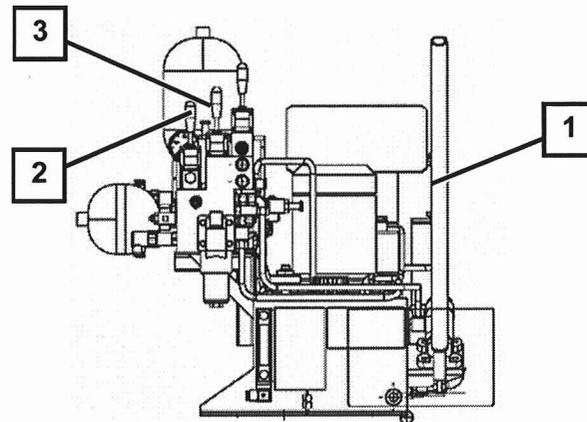


Fig. 62 Hydraulic unit for active rotor brake

- 1 Extension pipe for hand pump
- 2 Valve 600
- 3 Valve 610

- Shift the lever of valve 600 into the "Extend locking cylinder" position and hold. The lever is spring-centered and does not lock so that it would return automatically to the center position.

NOTICE

DAMAGE TO THE MECHANICAL STRUCTURE

Prior to inserting the rotor lock, the rotor must be stopped and precisely aligned in accordance with the markings.

- Extend the rotor lock bolt into the rotor lock disk by operating the hand pump
- If the pump resistance increases noticeably, check whether the rotor lock bolt has been correctly inserted into the rotor lock disk. Otherwise, retract the rotor lock bolt and re-align the rotor
- Release the lever of valve 600 so that it returns to the center position
- Secure the rotor lock bolt with the securing bolt

Locking the rotor with the passive rotor brake

NOTICE

DAMAGE TO THE MECHANICAL STRUCTURE

Prior to inserting the rotor lock, the rotor must be stopped and precisely aligned in accordance with the markings.

- Turn the lever of valve 280 on the hydraulic unit to the right as far as it will go, see Fig.63
- Pull the lever of valve 290 on the side of the hydraulic unit upwards, see Fig.63

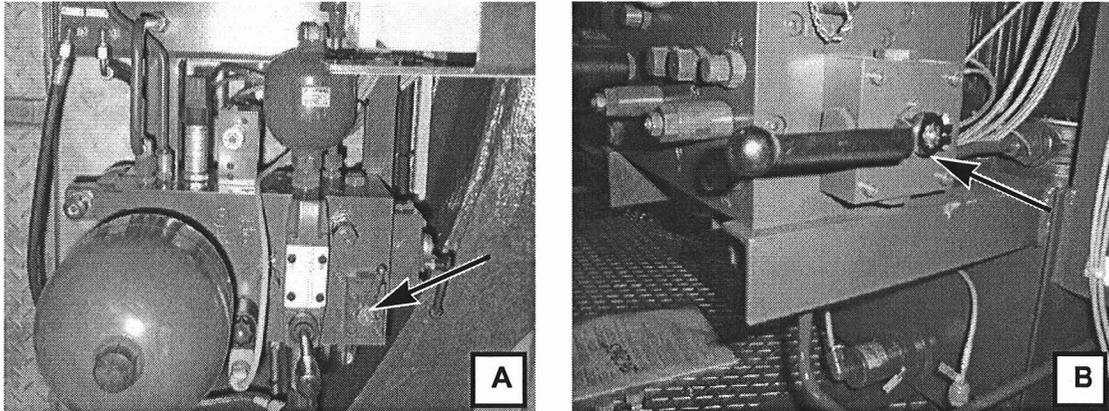


Fig. 63 Locking the rotor

A Valve 280

B Valve 290

- Extend the rotor lock bolt into the rotor lock disk by operating the hand pump
- If the pump resistance increases noticeably, check whether the rotor lock bolt has been correctly inserted into the rotor lock disk. Otherwise, retract the rotor lock bolt and re-align the rotor
- Secure the rotor lock bolt with the securing bolt

Releasing the rotor lock

To release the rotor lock, proceed as follows:

- Make sure that the rotor brake is applied
- Adjust the valves on the hydraulic unit

Active brake:

- Shift the lever of valve 610 to the "Rotor lock" position
- Shift the lever of valve 600 into the "Retract locking cylinder" position and hold

Passive brake:

- Push the lever of valve 290 on the side of the hydraulic unit downwards
- Use the hand pump to retract the rotor lock bolt from the rotor lock disk
- If the pump resistance increases noticeably, make sure that the rotor lock bolt has been retracted from the rotor lock disk

Otherwise:

- Temporarily release the rotor brake by actuating the "Release brake" button on the manual control unit of the Topbox in order to release the tension



NOTE

For instructions on operating the rotor brake without hydraulic pressure, see Chapter 13.1 "Operating the rotor brake without system pressure"

- Make sure that the rotor brake is applied again
- Continue to pump until the rotor lock bolt is fully retracted
- Only for active brake:
 - Release the lever of valve 600 so that it returns to the center position
 - Shift the lever of valve 610 to the center position
- Remove the extension pipe from the hand pump and place it in the bracket
- Secure the rotor lock bolt with the securing bolt

13.2.2 Rotor lock on brake disk

The rotor lock on the brake disk is only available for WT's with active rotor brake.

NOTICE

RISK OF TURBINE DAMAGE

The rotor lock on the brake disk must only be used with the following restrictions:

- The 10-minute average wind speed is less than 12 m/s.
- It is not permitted to leave the WT while the rotor is locked on the brake disk.
- It is not permitted to perform any work in the rotor hub, on the rotor brake or on torque-transferring components and their respective bearing seats.
- The rotor blades are in feathering position and must not be pitched.
- The rotor brake is applied.

To lock the rotor on the brake disk, proceed as follows:

- Ensure that the manual control for the rotor brake is activated, the rotor brake is applied, and the rotor is locked



NOTE

For instructions on operating the rotor brake without hydraulic pressure, see Chapter 13.1 "Operating the rotor brake without system pressure"

- By actuating the *Release Brake* button on the manual control unit of the Topbox, temporarily release the rotor brake and align the brake disk so that the rotor lock bolt can be inserted through the brake caliper halves
- Make sure that the rotor brake is applied again
- Remove the rotor lock bolt from the bracket on the brake caliper and insert it through the two brake caliper halves and the brake disk

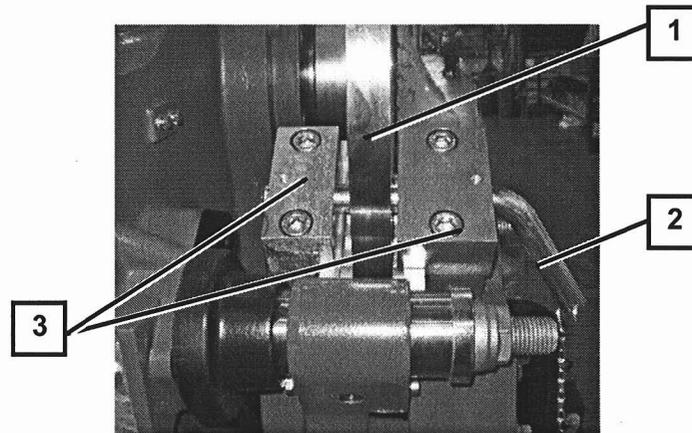


Fig. 64 Rotor lock on brake disk

- 1 Brake disk
- 2 Rotor lock bolt
- 3 Brake caliper halves

⚠ WARNING

Risk of injury and damage to the mechanical structure.
Prior to inserting the rotor lock bolt, the rotor must be stopped.

- Secure the rotor lock bolt with the spring cotter
- To release the rotor brake, proceed in reverse order.
- Make sure that the rotor brake is applied
 - Remove the spring cotter from the rotor lock bolt
 - Remove the rotor lock bolt and store it in the bracket on the brake caliper

13.3 Operating the roof

The roof on WT's of turbine class K08 can be opened.

It is necessary to open it in order, for example, to transport pieces of equipment into the nacelle or perform various maintenance work.

The roof is fastened to the right nacelle wall (when looking towards the rotor hub) by means of hinges, and secured with 2 locks on the left nacelle wall.

To open the roof, open the locks, then open the roof via the hinges using the hydraulic system, and secure it with 2 props.

Opening the roof



DANGER

FALLING HAZARD

There is a danger of falling when the roof is open.

While staying in a fall hazard area, secure yourself at one of the marked attachment points in the nacelle.

WARNING

Hazard of personal injury and damage to the nacelle.

The roof of the nacelle offers a large surface for the wind to act upon.

- Opening the roof is only permitted at 10 minute average wind speeds up to 12 m/s
- With freshening wind, do not open the roof downwind



NOTE

If it rains, the nacelle should be positioned perpendicular to the wind direction so that the roof is opened against the wind, offering some degree of protection.

It is recommended to open the cabin roof as a team of two. Proceed as follows:

- Inform all persons in the nacelle that you intend to open the roof
- Open the two locks on the left nacelle wall

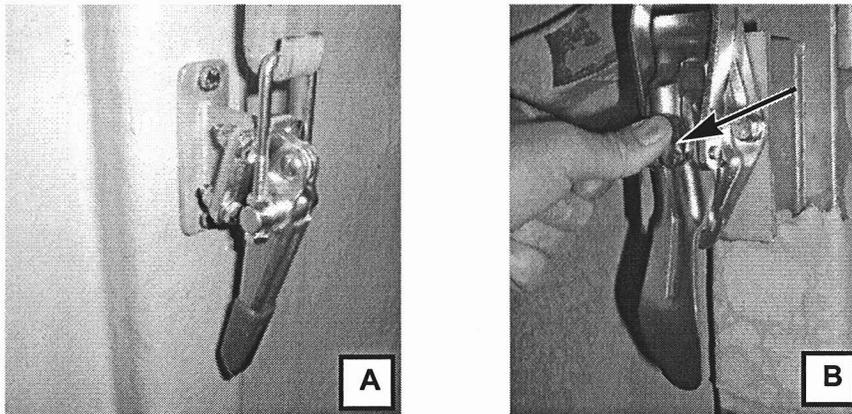


Fig. 65 Lock on the left nacelle wall

- A Old design
- B New design with locking mechanism (arrow)

In the new design, slide the locking mechanism upwards, thus releasing the latch.

- Using the hydraulic system, open the roof so far that the bolts of the roof lock can still be easily reached

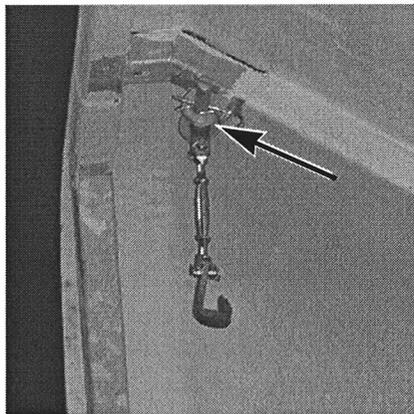


Fig. 66 Bolt for roof prop, example N90/2500

- Remove the props from the brackets on the left nacelle wall and push them onto the bolts of the roof locks
Ensure that the props are secured on the bolts.
- Continue to open the roof until the props can be pushed onto the bolts for the locks on the nacelle wall

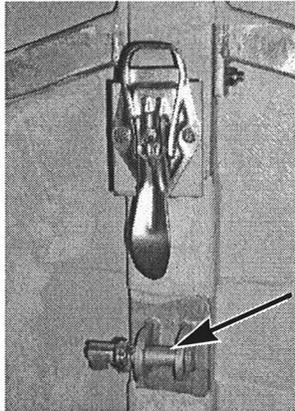


Fig. 67 Bolt for prop on nacelle wall

- Place the props on the bolts of the locks on the nacelle wall
Ensure that the props are secured on the bolts.

Closing the roof

- Ensure that the edge of the nacelle wall is clear and the roof can be closed without obstruction
- Remove the props from the bolts on the nacelle wall
- Lower the roof using the hydraulic system until the props can be removed from the roof
- Remove the props and place them on the brackets
- Lower the roof completely
- Hook the two locks of the roof lock into the left nacelle wall and lock them

13.4 Operating the roof hydraulics for turbine class K08

The roof on a WT of turbine class K08 can be operated using system pressure or the hand pump of the hydraulic unit.

However, the handling of the hydraulic unit for a WT with active rotor brake is slightly different from that for WTs with passive rotor brake.

13.4.1 WTs with active brake

Opening the roof



NOTE

For opening the roof, see Chapter 13.3 "Operating the roof".
Only the operation of the roof hydraulics is described here.

- Shift the lever of valve 610 to the center position

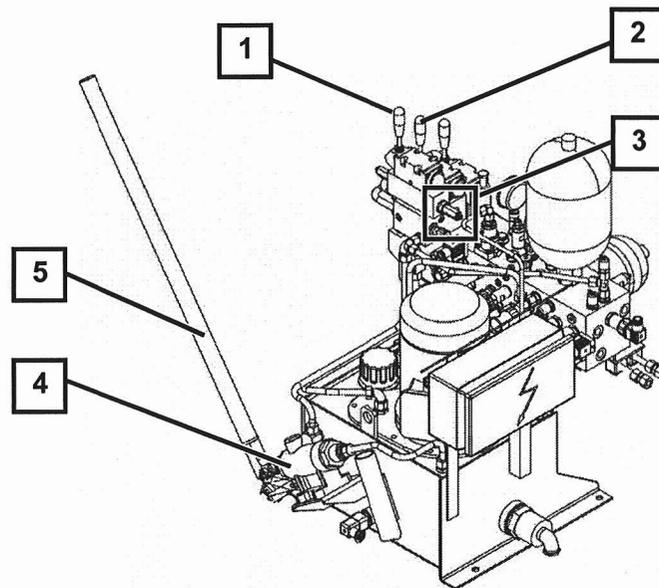


Fig. 68 Hydraulic unit for active rotor brake

- 1 Valve 640
- 2 Valve 610
- 3 Hand wheel 670
- 4 Hand pump
- 5 Extension pipe

- Provide hydraulic pressure:
 - Operation with system pressure: Slightly open the hand wheel 670
 - Operation with the hand pump: Remove the extension pipe from the bracket, attach it onto the lever of the hand pump and start pumping



NOTE

The hand wheel 670 has a throttling function. It can be used to control the speed at which the roof moves.

- Release the hydraulic pressure. To do this, shift the lever of valve 640 to the "Open roof" position and hold
The roof opens slowly.



NOTE

Valve 640 is spring-centered and does not lock. It returns automatically to the center position

- Once the required roof position has been reached, release the lever of the valve 640 so that it returns to the center position

The roof remains in this position

- Only for operation with system pressure:
Close the hand wheel 670

Closing the roof

- Shift the lever of valve 610 to the center position
- Provide hydraulic pressure:
 - Operation with system pressure: Slightly open the hand wheel 670
 - Operation with the hand pump: Remove the extension pipe from the bracket, attach it onto the lever of the hand pump and start pumping
- Release the hydraulic pressure. To do this, shift the lever of valve 640 to the "Open roof" position and hold
 - ▶ The roof closes slowly
- Once the required roof position has been reached, release the lever of the valve 640 so that it returns to the center position
 - ▶ The roof remains in this position

Once the roof has been closed:

- Only for operation with system pressure:
Close the hand wheel 670
- Only for operation with hand pump:
Remove the extension pipe from the hand pump and place it in the bracket

13.4.2 WTs with passive brake

Opening the roof

- Only for operation with system pressure:
Open valve 240.2

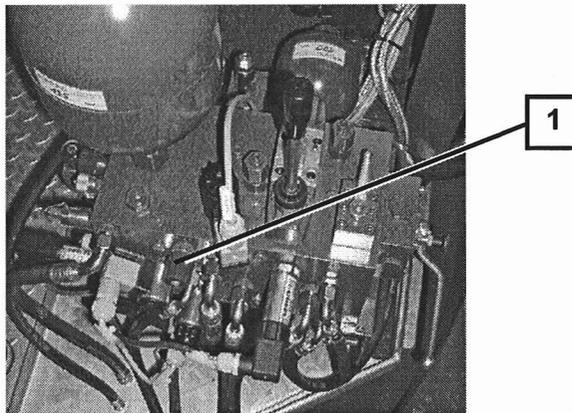


Fig. 12 Hydraulic unit for passive rotor brake

1 Valve 240.2

- Only for operation with hand pump
 - Shift the lever of the valve 280 counter-clockwise to the left
 - Remove the extension pipe from the bracket, attach it onto the lever of the hand pump and start pumping

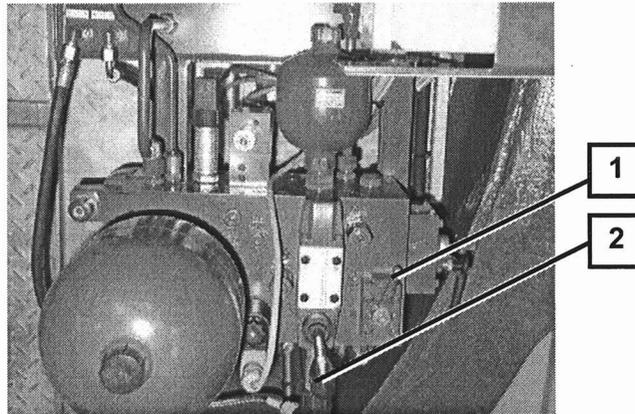


Fig. 69 Hydraulic unit for passive rotor brake

- 1 Valve 280
- 2 Valve 310

- Release the hydraulic pressure: Shift the lever of valve 310 towards the rotor shaft
 - ▶ The roof opens slowly
- Once the required roof position has been reached, shift the lever of valve 310 away from the rotor shaft
 - ▶ The roof remains in this position

Closing the roof



NOTE

For closing the roof, see Chapter 13.3 "Operating the roof"

To close the roof, proceed as follows:

- Only for operation with system pressure: Open valve 240.2
- Only for operation with hand pump
 - Shift the lever of the valve 280 counter-clockwise to the left
 - Remove the extension pipe from the bracket, attach it onto the lever of the hand pump and start pumping

- Release the hydraulic pressure: Shift the lever of valve 310 towards the rotor shaft
 - ▶ The roof closes slowly
- Once the required roof position has been reached, shift the lever of valve 310 away from the rotor shaft
 - ▶ The roof remains in this position

Once the roof has been closed:

- Only for operation with system pressure: Close valve 240.2.
- Only for operation with hand pump:
 - Shift the lever of valve 280 clockwise into the right position again
 - Remove the extension pipe from the hand pump and place it in the bracket

13.5 Entering the rotor hub

It is necessary to enter the rotor hub in order to perform maintenance or repair work on the rotor blades and pitch system.

In the case of WT's of turbine class K08, you must cross the rotor hub on the outside.

In the interest of the safety of the person performing the work, a second person who can operate the WT controls must be located in the nacelle.

WARNING

Work on the drive train and in the rotor hub is only permitted at 10 minute average wind speeds of less than 12 m/s.

WARNING

If the rotor is suddenly set into motion, this may result in life-threatening or severe injuries.

Before entering the rotor hub always lock the rotor on the rotor shaft using the rotor lock, and ensure that the rotor brake is also applied.

For operating the rotor lock, see Chapter 13.2 "Operating the rotor lock"



WARNING

FALLING OBJECTS

Make sure that nobody is present in the area underneath the turbine when climbing onto the rotor hub. Make sure that there are no loose parts that may fall down. Secure any tools you carry on you.

13.5.1 Attaching the hub rope

In the case of WT's of turbine class K08, the respective service employee must be secured using the hub rope when crossing the rotor hub, see Chapter 7.2 "Additional equipment for service employees (K06 and K08)".

- Make sure that the additional equipment required for crossing the rotor hub is in sound condition, and any test badges are valid



⚠ DANGER

FALLING HAZARD

A PPE either with an invalid test badge or which has been damaged or strained by a fall must no longer be used.

Replace the PPE immediately and have it checked by an expert.

K08 without safety rope system

- Pull the webbing sling through the lifting lug on the rotor bearing

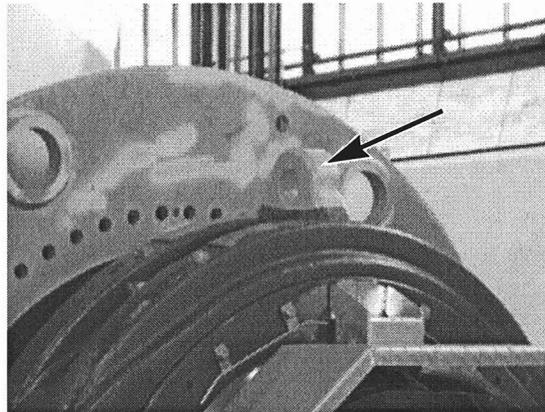


Fig. 70 *Lifting lug on rotor bearing*

- Hook the hub rope into both ends of the webbing sling using the large snap hooks and secure it

K08 with safety rope system

- Hook and secure the hub rope with the large snap hook directly onto the attachment lug of the safety rope system on the rotor bearing lifting lug

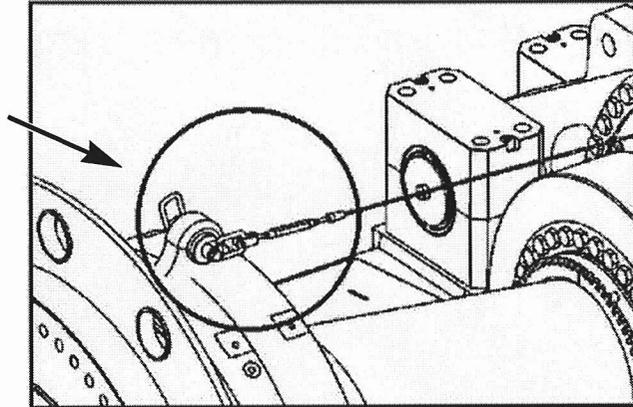


Fig. 71 Attachment lug of swivel hoist ring of safety rope system

13.5.2 Crossing the rotor hub



⚠ DANGER

FALLING HAZARD

There is a danger of falling when the roof is open.

While staying in a fall hazard area, secure yourself at one of the marked attachment points in the nacelle.



⚠ DANGER

FALLING HAZARD

When crossing the rotor hub, always use the hub rope attached to the rotor bearing to secure yourself against falling.

For extra safety, use the lanyard with energy absorber.



⚠ DANGER

FALLING HAZARD

If icing occurs on the hub ladder, this increases the risk of injury due to slipping and falling into the safety harness.

Stop crossing the rotor hub.



⚠ DANGER

FALLING HAZARD

Incorrect attachment to the hub cage can cause injury or material damage if a person slips.

Only use the hub cage brackets as attachment points.



DANGER

FALLING HAZARD

In the rotor hub is a danger of falling within 2 m of the rotor hub access.
When working in this area secure yourself using the lanyard with energy absorber

To access the rotor hub, proceed as follows:

- If it is not already open, open and secure the roof, see Chapter 13.3 "Operating the roof"
- Check whether the rotor is locked in such a way that one of the hub ladders is at the top position

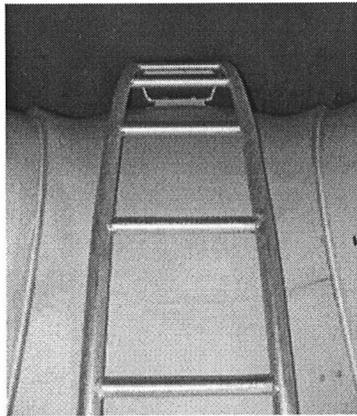


Fig. 72 Hub ladder in position

- If this is not the case, release the rotor lock, turn the rotor hub and lock the rotor again, see Chapter 13.2 "Operating the rotor lock"
- Ensure that the hub rope is attached to the lifting lug on the rotor bearing
- Check the the guided-type fall arrester for proper functioning
- Hook the snap hook of the guided-type fall arrester of the hub rope into the chest lug of the safety harness and secure it
- Visually check the hub ladder. Check for any missing screws, deformations, breaks or damaged welding seams
- Prior to using the hub ladder, rectify any damage which impairs the safety and stability of the hub ladder
If this is not possible, stop crossing the rotor hub and commission the necessary repair work.
- Release the lanyard with energy absorber, which is attached to the backplate of the safety harness with a snap hook, from the attachment point in the nacelle, and connect it to the hub ladder for extra security

- Climb onto the hub ladder. During this process, make sure that the hub rope is protected against mechanical damage by the protective tube at the contact point on the rotor lock disk.
- On the hub ladder, move with appropriate care toward the rotor hub access. Move the guided-type fall arrester along step by step, so that in the event of slipping the height of fall is as low as possible
- Detach the lanyard with energy absorber and attach it further down on the hub ladder
- Proceed in this manner until you reach the hub cage

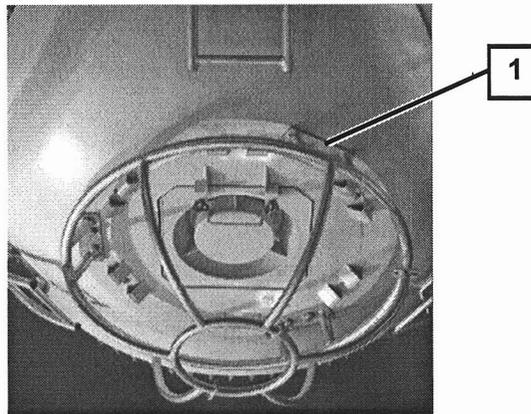


Fig. 73 Hub cage in front of the access hatch

1 One of the three brackets (attachment points)

- Visually check the hub cage. Check for any missing screws, deformations, breaks or damaged welding seams.
In the case of any damage, the service employee must decide whether to continue the access into the rotor hub or to abort. The damage must always be reported to the responsible employee.
- Enter the hub cage and attach the lanyard with energy absorber to a hub cage bracket for extra security
- Loosen the cage nuts on the access hatch and fold the fastening bolt
- Fold the access hatch inwards until the locking mechanism locks in place
- Release the lanyard with energy absorber from the last attachment point and enter the rotor hub
- Make sure that the access hatch is properly secured by means of the retention hook
- Attach the lanyard with energy absorber at a suitable location in the rotor hub
- Detach the guided-type fall arrester of the hub rope from the safety harness and hook it to the hub cage

For the return into the nacelle, secure yourself and proceed in the same manner as described above:

- Hook the guided-type fall arrester of the hub rope in the chest lug of the safety harness
- Release the lanyard with energy absorber from the attachment point in the rotor hub, and attach it to one of the hub cage brackets for extra security
- Climb out of the rotor hub into the hub cage
- Close the access hatch, fold the fastening bolt, and tighten the cage nuts
- Leave the hub cage and move up the hub ladder. In the process, move the guided-type fall arrester along step-by-step, and feed the lanyard with energy absorber after it
- Enter the nacelle
- Release the lanyard with energy absorber from the hub ladder and attach it to an attachment point in the nacelle
- Release the hub rope from safety harness and attachment point

13.6 Transporting objects into the nacelle

NORDEX WT's are equipped with an on-board crane for transporting objects into the nacelle. Objects can also be transported using the working rope.



DANGER

SUSPENDED LOAD

Danger of injury due to falling objects.

Do not stand or walk under suspended loads.

NOTICE

RISK OF DAMAGE TO NACELLE AND SPONGE RUBBER SEAL

Do not guide the working rope over the unprotected edge of the nacelle wall.

Use an edge protection.

The on-board crane must only be operated by instructed persons.

On-board cranes can differ in design from one WT to the next. Always refer to the operating instructions stored in the WT.

If the working rope is used on WT's of turbine type K08, use the edge protection, see Chapter 13.6.2 "Using the edge protection for the working rope".

If the edge protection is not available, other arrangements must be made so as not to damage the edge of the nacelle wall and the sponge rubber seal on the wall.

13.6.1 Using the on-board crane

The following applies to the standard version of the on-board crane for WTs of turbine class K08 - the pillar jib crane with a working load limit of up to 250 kg.

NOTICE

UNCONTROLLED PENDULAR MOVEMENTS

Secure the load to be transported with an additional rope from the ground, and keep it clear from tower and nacelle.

In order to use the on-board crane, proceed as follows:

- Remove the power supply cable rolled up on the crane pillar and connect it
- Turn the crank lever on the manual lifting jack to lift the crane jib out of the bracket on the gearbox

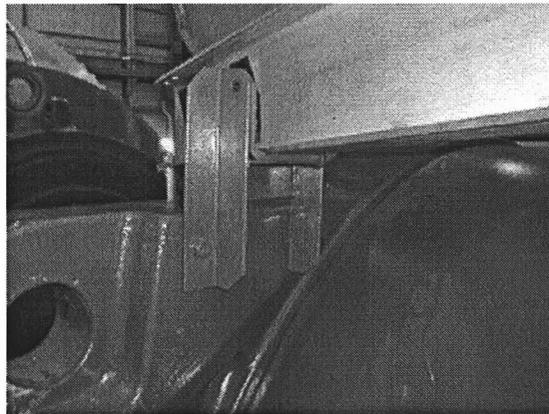


Fig. 74 Crane jib in parked position

- Power supply cable rolled up on the crane pillar
- Unhook the safeguard for the chain hoist

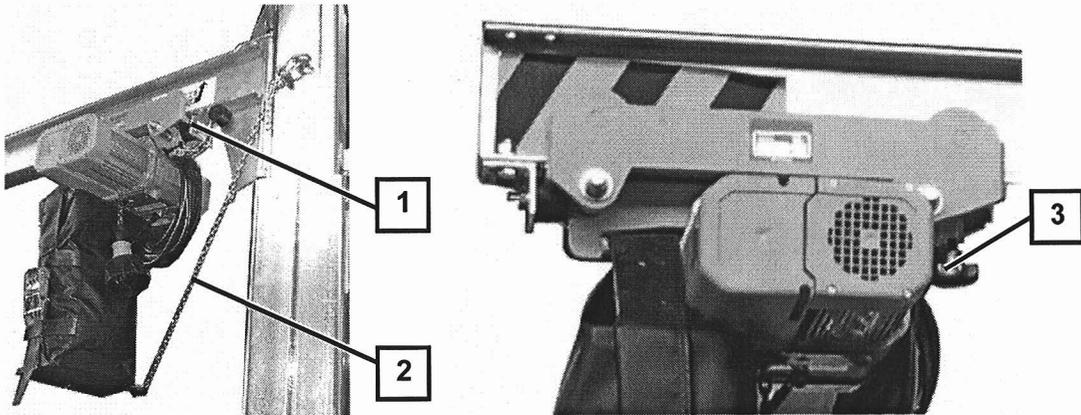


Fig. 75 Chain hoist

- 1 Safeguard of the chain hoist
- 2 Safety chain for chain bag
- 3 Locking screw

- Release the safety chain on the chain bag from the eyebolt on the crane pillar
- Loosen the chain hoist locking screw
- Slew the crane jib far enough out of the parked position so as to be able to move the chain hoist right forward
- Move the chain hoist on the crane jib forward until the ratchet is activated

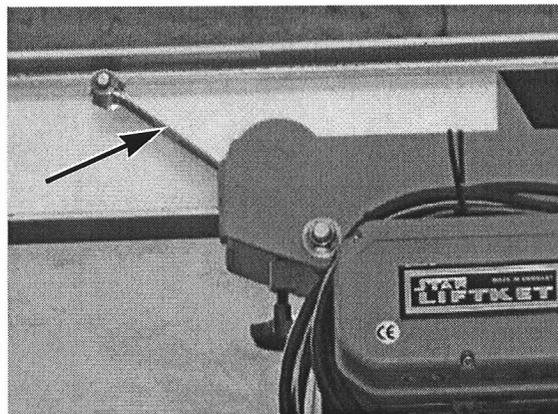


Fig. 76 Ratchet

- Attach the working rope to the crane hook and lower it to the ground
- Use the working rope from the ground to keep the crane hook clear of nacelle and tower, in order to avoid damage
- If necessary, load the crane hook with the crane drum and ensure that the crane hook safety latch is closed
- Remove the securing bolt for the crane pillar from the gear rack bracket

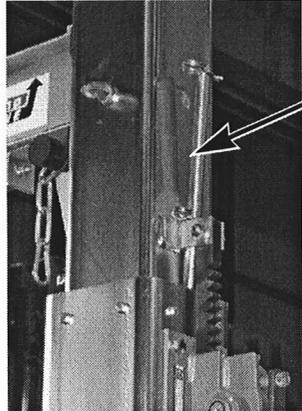


Fig. 77 Securing bolt in the gear rack bracket

- Fully extend the crane pillar using the manual lifting jack, and insert the securing bolt through the drill holes that become visible in the crane pillar

⚠ WARNING

Risk of injury and material damage due to failure of the self-locking function of the gear rack drive.

Only use the extended crane pillar when the securing bolt is inserted.

- Slew the crane jib over the nacelle wall and use the snap hook to secure it to the eyebolt on the crane pillar

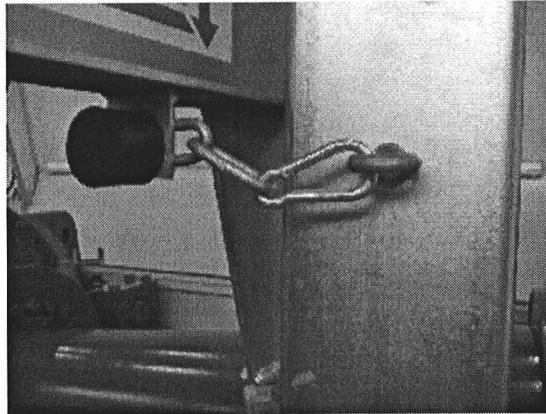


Fig. 78 Securing the crane jib

- Remove the chain hoist's power supply cable from the crane pillar, and connect it to the 400 V power outlet on the Topbox

The chain hoist is now ready for operation and can be operated from its keyboard.

After using the on-board crane, it must be returned to the parked position and secured there.

- Retract the crane hook
- Release the crane jib's safeguard from the crane pillar
- Slew the crane jib into the nacelle until the crane hook can be reached
- Remove any loads hanging on the crane hook
- Bring in the working rope and release it from the crane hook
- Loosen the chain hoist locking screw
- Open the ratchet and move the chain hoist toward the crane pillar
- Fasten the chain hoist with the locking screw
- Secure the chain hoist with the snap hook on the crane jib
- Secure the chain bag on the crane pillar's eyebolt using the safety chain
- Remove the securing bolt from the crane pillar and store it in the bracket of the gear rack
- Position the jib over the bracket on the gearbox, and use the manual lifting jack to lower it
- Pull the power supply cable out of the power outlet and roll it up on the crane pillar

13.6.2 Using the edge protection for the working rope

In WT's from turbine class K08, an edge protection for the working rope can be stored in the nacelle.

The edge protection must be used to protect the edge of the nacelle wall and the sponge rubber seal when using the working rope to transport objects into the nacelle with the roof open.

The edge protection is stored inside the nacelle on the center fastening on the left nacelle wall (when looking towards the rotor hub).

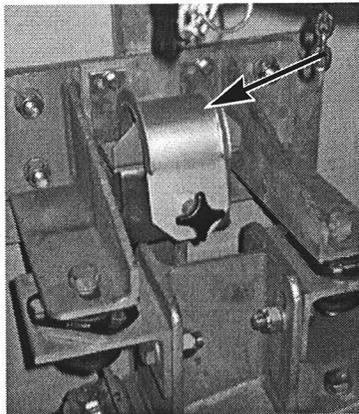


Fig. 79 Edge protection in storage location

- Remove the edge protection from its storage location
- Lay it over the edge of the nacelle wall
- Secure it with the palm grip

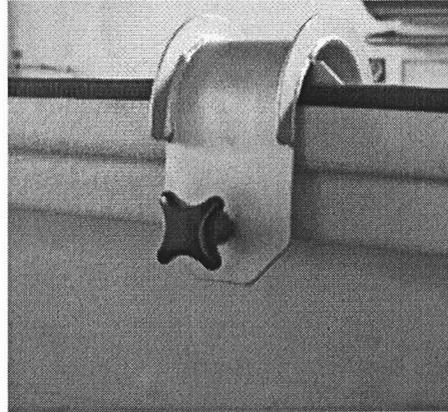


Fig. 80 *Edge protection in use*

- After use, return the edge protection to the storage location and secure it there

14. Special features of K08 gamma



NOTE

Types:

- N100/2500

14.1 Operating the rotor brake without system pressure

The following describes how the rotor brake can be operated if the hydraulic unit is not ready for operation, meaning there is no system pressure.

In the case of a grid failure, the active mechanical rotor brake is normally released, and can no longer be applied automatically.

It can be applied manually using the hand pump on the hydraulic unit, and released again using a valve.

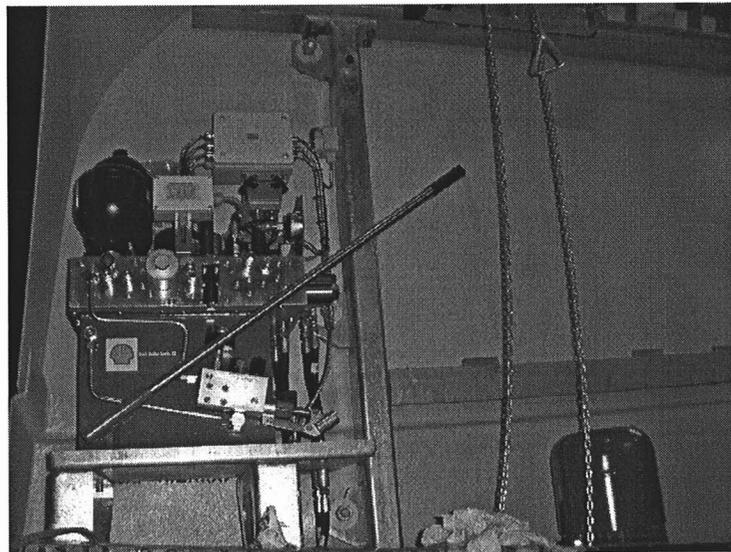


Fig. 81 Hydraulic unit for rotor brake and yaw brakes

14.1.1 Applying the rotor brake (manually)

The rotor brake is not applied by default.

- Move the lever of valve no. 610 on the hydraulic unit
- Remove the extension pipe from the bracket and attach it onto the lever of the hand pump
- Build up a pressure of 115 bar by using the hand pump

The rotor brake is applied.

**NOTE**

In the case of long-term work, before a person enters the rotor hub and prior to carrying out longer work on the rotor, on the rotor brake or on the gearbox, insert the rotor lock bolt on the rotor shaft.

14.1.2 Releasing the rotor brake

- Open valve 810.2
- After the pressure has been released, close the valve 810.2 again

**NOTE**

It is not possible to start up the WT if valve 810.2 is open.

14.2 Operating the rotor lock

The rotor lock is a device for mechanically locking the rotor. It prevents personal injuries in the nacelle and the rotor hub resulting from contact with rotating parts of the drive train.

WARNING

The rotor lock must only be used at 10 minute average wind speeds of up to a maximum of 12 m/s, whereby at least two rotor blades must be in the feathering position.

NOTICE**GEARBOX DAMAGE**

If the rotor is locked for more than 24 hrs, observe the current revision of the Work Instructions *F010_002*.

14.2.1 Rotor lock on the rotor shaft

- Let the rotor run at idle until the marking on the rotor lock disk is aligned with the center axis of the rotor bearing
- Apply the rotor brake
- Insert the rotor lock bolt into and through the rotor lock disk using a hexagon socket screw key
- Completely screw in the securing bolt



NOTE

The rotor lock bolt is only fully extended when the securing bolt is completely screwed in.

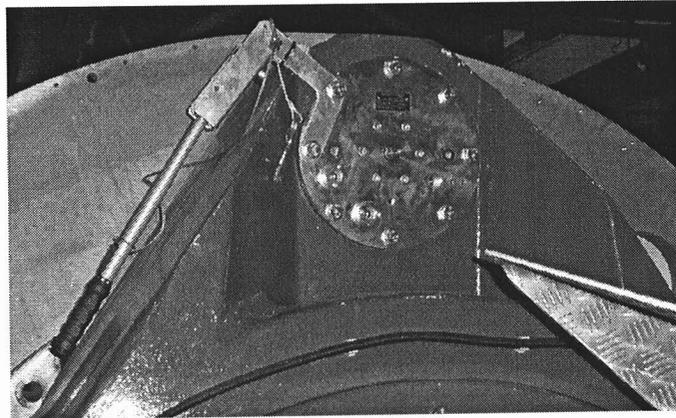


Fig. 82 Mechanical rotor lock on rotor shaft

14.2.2 Rotor lock on the brake disk



This rotor lock on the brake disk is only an auxiliary lock and must not be used on its own to climb into the rotor hub.

Work in the rotor hub, on the rotor and on the drive train is only permitted when the rotor lock is engaged and secured on the **rotor shaft**.



NOTE

Only use the rotor lock on the rotor lock disk if:

- Wind speed < 12 m/s
- The rotor has stopped
- The rotor blades are in the feathering position
- The hydraulic brake is charged with holding pressure
- The rotor lock bolt is secured with the spring cotter

1. Applying the rotor brake

- If the WT has already been commissioned up to this point: Move the service switch on the manual control unit of the Topbox into the "Service" position

This applies the rotor brake and locks the rotor.

Otherwise apply the rotor brake manually.

2. Aligning the brake disk

- If the WT has already been commissioned up to this point: Press the *Release brake* button on the manual control unit of the Topbox

This briefly releases the brake so that the brake disk can be positioned.

In the case of a grid failure the brake must be operated manually.

- Align the brake disk until the lock bolt can be inserted through the brake caliper halves and one of the 3 drill holes in the brake disk.

3. Locking the rotor

NOTICE

Prior to inserting the lock bolt, the rotor must be stopped.

-
- Remove the rotor lock bolt from the bracket on the brake caliper
 - Insert the lock bolt through both brake caliper halves and the brake disk and secure with the spring cotter

14.3 Entering the rotor hub

It is necessary to enter the rotor hub in order to perform maintenance or repair work on the rotor blades and pitch system.

In the interest of the safety of the person performing the work, a second person who can operate the WT controls must be located in the nacelle.

WARNING

Work on the drive train and in the rotor hub is only permitted at 10 minute average wind speeds of less than 12 m/s.

WARNING

If the rotor is suddenly set into motion, this may result in life-threatening or severe injuries.

Before entering the rotor hub lock the rotor on the rotor shaft using the rotor lock, and ensure that the rotor brake is also applied.

For operating the rotor lock, see Chapter 14.2 "Operating the rotor lock"



WARNING

FALLING OBJECTS

Make sure that nobody is present in the area underneath the turbine when climbing onto the rotor hub.

Make sure that there are no loose parts that may fall down.

Secure any tools you carry on you.

- Fold down the ladder in the nacelle, see Fig.83
- Open the hatch in the nacelle and secure yourself at the yellow attachment points for personal protection on the roof, see Fig.84

Warning: Do not attach yourself to the hand rails. Only secure yourself against falling at the yellow attachment points for personal protection.

- Cross the nacelle roof toward the rotor hub
 - Open the access hatch, see Fig.85
- Notice:** The lock must be properly locked in place so that the hatch is not able to automatically shut again.
- Climb backwards into the rotor hub

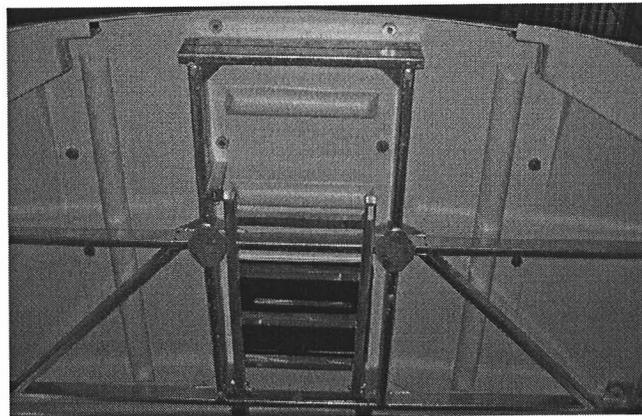


Fig. 83 Hatch and ladder in the nacelle

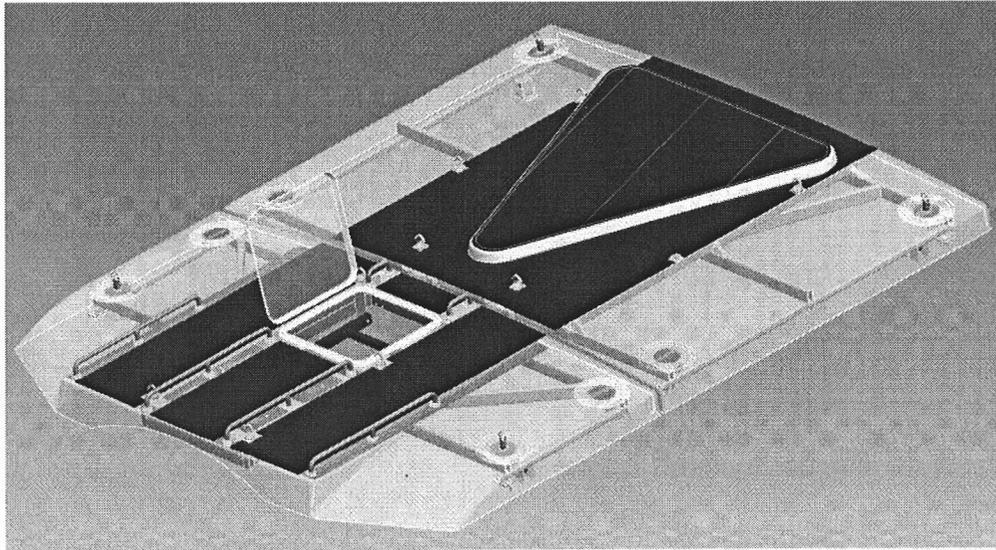


Fig. 84 Nacelle roof: crossing to the rotor hub

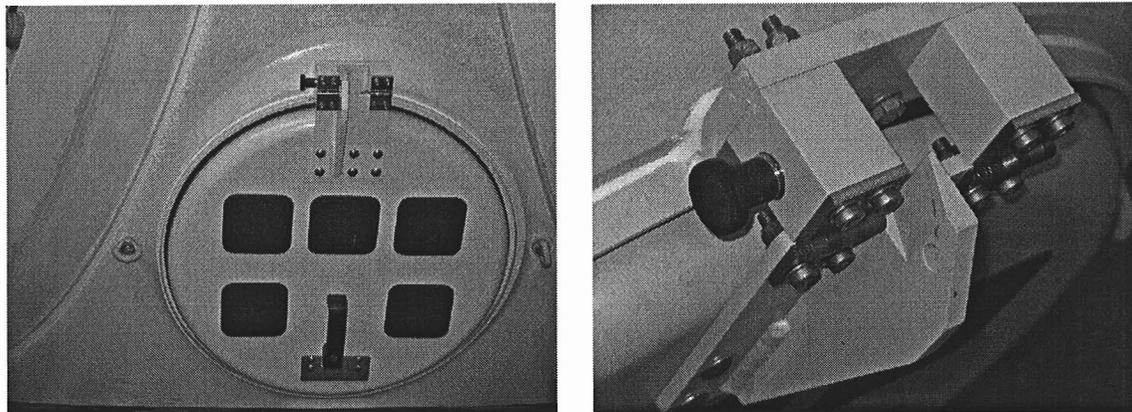


Fig. 85 Access hatch rotor hub

14.4 Transporting objects



⚠ DANGER

SUSPENDED LOAD

- Do not stand or walk under suspended loads
- The working load limit stated on the crane must not be exceeded
- Carried loads must be immediately put down after the transport process has been completed

Objects are transported from the ground into the nacelle using an electric chain hoist, see Fig.86.

For transporting objects within the nacelle, NORDEX WT's are equipped with a manually operated on-board crane, see Fig.88.

Both cranes are designed for a maximum load capacity of 1,000 kg.

14.4.1 Using the electric chain hoist

The electric chain hoist is operated via a manual control unit with emergency stop function

- Secure yourself at the attachment points for personal protection (post 4 left/right)
- Remove the cover plates and secure them
- After completing the crane operation, close the crane hatch again with the cover plates

NOTICE

PENDULAR MOVEMENTS

Secure the load to be transported with an additional rope from the ground, and keep it clear from tower and nacelle.



NOTE

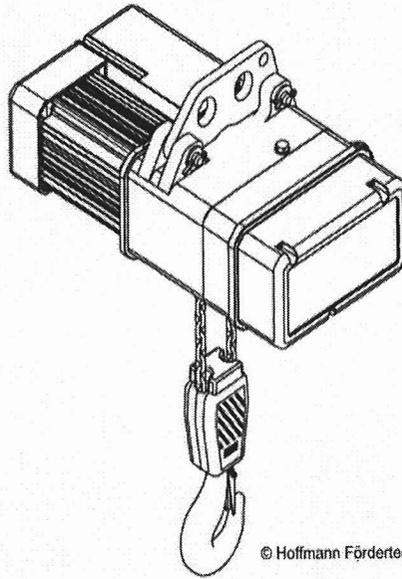
The electric chain hoist must only be operated by trained and instructed personnel.

Always refer to the operating instructions deposited at the electric chain hoist. Observe the manufacturer's instructions on safety and operation.



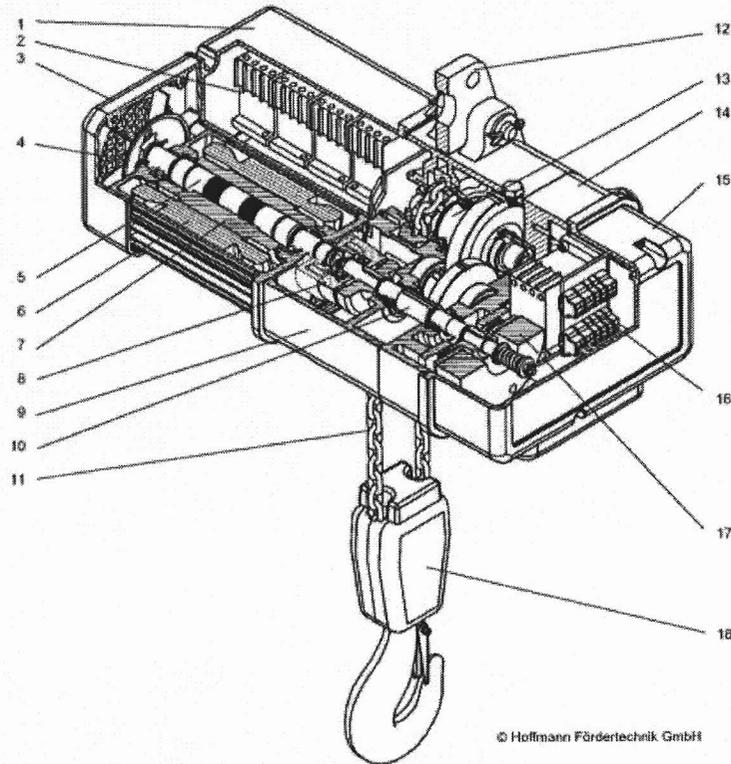
OBSERVE DOCUMENT

Manufacturer's documentation



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Fig. 86 *Electric chain hoist*



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Fig. 87 *Electric chain hoist: main components*

- 1 Cap for control
- 2 Control
- 3 Cap for fan
- 4 Fan
- 5 Shaft
- 6 Stator
- 7 Rotor
- 8 Clutch assembly
- 9 Housing
- 10 Pinion shaft 1
- 11 Load chain
- 12 Lifting lug
- 13 Output shaft with sprocket wheel
- 14 Gearbox cover
- 15 Cap gearbox
- 16 Terminal board for power supply, manual control unit and motorized trolley
- 17 Brake assembly
- 18 Hook block

14.4.2 Using the on-board crane



NOTE

The on-board crane must only be operated by trained and instructed personnel.

Always refer to the operating instructions deposited at the on-board crane. Observe the manufacturer's instructions on safety and operation.



OBSERVE DOCUMENT

Manufacturer's documentation

The on-board crane EBK 1000 (single-girder bridge crane) is operated only manually.

The load can be lifted and lowered and moved on 2 axes.

The load is lifted by a chain hoist with a crane hook.

The on-board crane EBK 1000 - 3.2 is equipped with a spur gear chain pulley block by Yale which can be operated via a hand-gear trolley, see Fig.90.

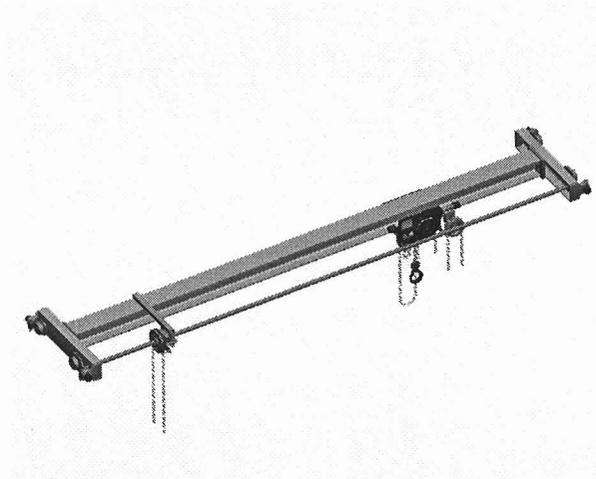


Fig. 88 On-board crane K08 gamma

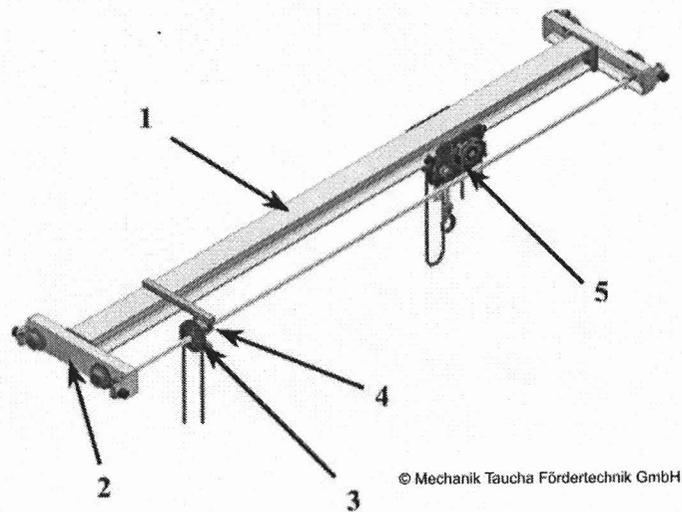


Fig. 89 On-board crane: main components

- 1 Main girder
- 2 End carriage with guide rollers and buffer
- 3 Hand-gear trolley for crane operation
- 4 "Fall out" protection for the chain of the hand-gear trolley for crane operation
- 5 Spur gear chain pulley block with hand-gear trolley and locking device

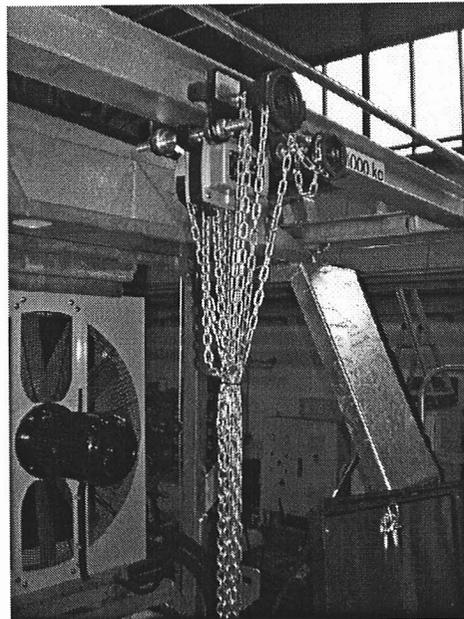


Fig. 90 Spur gear chain pulley block with hand-gear trolley and locking device

15. Revision Index

15.1 Introduction

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Table of turbine types moved here (from Terms and abbreviations) • Sentence "applies to all turbine types of the classes K06, K07 and K08" added • Nordex N100 added to turbine types • Turbine types K07 beta added 	5655 2855 5608	Graumann

15.2 Terms and abbreviations

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Table turbine types removed, moved to chap. Introduction 	5655	Graumann

15.3

Rev.	Date	Modification	AST	Author
01	03/03/ 2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Safety shoes "class S3" added • Pt. Ascending to the nacelle: The abseiling equipment must be carried along • Pt. Ascending to the nacelle: An emergency eyewash bottle must be carried along • Pt. Ascending to the nacelle: Obligation to use the service lift more emphasized; prohibition and warning of using vertical ladder and service lift at the same time • Pt. Ascending to the nacelle: Visual inspection of vertical ladder/for damage: also inform service company, not only remote monitoring and FOM • Section "General": Safety note modified • Section "Working in the separated transformer area": Under the supervision of an electrically skilled person with switching authorization, also other persons are allowed to work there, e.g. for maintenance work on the tower bolts. • Section "Work on the electrical system": Safety notes modified • Section "Regulations for crane work": Work under suspended loads in special situations included again, at the direction of a defined responsible person 	5655	Graumann Simon

Rev.	Date	Modification	AST	Author
01	03/03/ 2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Chap. "Safety instructions in the WT documentation" removed (included in the general chap. "Conventions") • Def. added: Warning of hazardous voltage 	5655	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/ 2010	Conversion to FrameMaker	5655	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Section "Components of the PPE": Hub rope and head torch additionally for service employees added • Section "Components of the PPE": The scope of supply of the PPE depends on the applicable contract. - note added • Fall arrester: "similar to photo" added (type-independent) • Snap hook/abseiling equipment: "Similar to photo" added (locking snap hooks are actually no longer permissible) 	5655 5557	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Section "Fall arrest systems used": Note added on referring to the operating instructions of the respective safety harness on which lug the fall arrester must be attached. • Section "Attaching the fall arrester": Fall arrest rail system standardized to "Haca" ("standard" fall arrester removed) • Section "attachment points": Fig. Attachment points in the nacelle "Lifting lug on the left side of the gearbox" removed • Figures added • "Pitchsteuerschrank" durch "Pitchbox" ersetzt • Attachment points for K08 gamma added 	5655 2855	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Safety notes moved to beginning of chapter • Notes and figures for K08 gamma added (e.g. attaching the descender) over the crane hatch in the nacelle • Chap "Attaching the descender" restructured (sorted by turbine classes) 	5655 2855	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Using the service lift: "area around the service lift"-->"operating area of the service lift" 	5655	Graumann

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Operating the rotor brake without system pressure largely standardized for all classes • Section "Operating the roof hydraulics": Opening the roof with system pressure • Section "Operating the roof"/opening the roof: Additional warning note, do not open the roof downwind with freshening wind • Section "Using the on-board crane" changed to subsection of "Transporting objects into the nacelle" • Section "Using the edge protection for the working rope" also changed to subsection of "Transporting objects into the nacelle" • Operation on-board crane: Corrected, remove power supply cable first, then wind up • Bremskaliber-->Bremssattel (Terminologie) 	4935 5655 4951	Graumann Simon

Rev.	Date	Modification	AST	Author
01	03/03/2010	<ul style="list-style-type: none"> • Conversion to FrameMaker • Operating the rotor brake without system pressure largely standardized for all classes • Section "Using the on-board crane" changed to subsection of "Transporting objects into the nacelle" • Section "Using the on-board crane": missing work steps added (move chain hoist into parked position over transport hatch) • Section "Using the on-board crane": "pillar jib crane" removed, not applicable • "Operating the hydraulic unit": When releasing the pressure using the vent screws make sure not to loosen them more than half a turn. If the pressure does not drop, tighten and loosen the screws again • Bremskaliber-->Bremssattel (Terminologie) 	5655 4935	Simon Graumann

Rev.	Date	Modification	AST	Author
		<ul style="list-style-type: none"> • Conversion to FrameMaker • Operating the rotor brake without system pressure largely standardized for all classes • Section "Using the on-board crane" changed to subsection of "Transporting objects into the nacelle" • Section "Using the edge protection for the working rope" also changed to subsection of "Transporting objects into the nacelle" • Operation on-board crane: Corrected, remove power supply cable first, then wind up • Bremskaliber-->Bremsattel (Terminologie) 	4935 5655	Simon Graumann

Rev.	Date	Modification	AST	Author
00	03/03/ 2010	Created	2855	Graumann