



# Damage prevention in wind turbines

Safety regulation S940, effective as of 1 April 2020

## 1 Purpose

This safety regulation provides instructions for the prevention of property damage and business interruption losses and damage limitation in wind turbines. The safety regulation applies to wind turbines supplying the electrical grid with a rated power of 1 MW or greater.

The technical solutions of wind turbines are specific to each manufacturer. This safety regulation handles damage prevention in wind turbines on a general level. The policyholder and insurance company have agreed on the damage prevention measures appropriate for the type of wind turbine in question and in accordance with the safety regulations.

## 2 Obligation to comply with safety regulations

These safety regulations are part of the insurance contract. Both the policyholder and the insured must comply with the safety regulations and its provisions. If the safety regulations are not complied with, the compensation may be reduced or completely denied, in accordance with the Insurance Contracts Act.

The policyholder must ensure that those responsible for work performance are familiar with the contents of these safety regulations.

## 3 Definitions

### Preventive maintenance

Preventive maintenance maintains the wind turbine's functionalities, restores reduced functional capacity before the emergence of errors, and reduces risk of damage. Preventive maintenance comprises the monitoring of environmental conditions, continuous monitoring of the operating conditions of the wind turbine's equipment, regular inspections, and periodic servicing.

### Maintenance programme

The maintenance programme is a device-specific document prepared by the wind turbine's manufacturer on necessary measures related to preventive maintenance, including condition monitoring, inspections, testing, servicing, and operational monitoring.

### Operation

Operation refers to the wind turbine's intended use or standby readiness for the generation of electric power as well as to the maintenance of these functions.

### Inspection

Inspection refers to investigating the functional capacity of the device or site. Inspection also involves testing to confirm that the device is functioning as intended.

### Servicing

Servicing comprises periodic measures taken to maintain the functional capacity of the device or site, as well as measures taken after detection of an error to restore the device to its original functional capacity.

### Condition monitoring

Condition monitoring refers to continuous or periodic monitoring of the device or site in order to confirm that it is functioning as intended. The purpose of condition monitoring is to detect and repair emerging errors before the error prevents the intended operation of the site.

### Protective and control systems

A system designed to detect and prevent risk of loss or damage caused by the wind turbine's operation or by external circumstances.

### Vibration severity

Vibration severity is the effective value of vibration velocity in the frequency range 10 ... 1,000 Hz in accordance with standard ISO 10816-1; 1995 - Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 1 General guidelines or the PSK Standards Association standard 5704 Condition monitoring. Vibration measurement. Acceptance inspection and vibration severity limits. (2002).

## 4 General information

Design of the wind turbine must be based on the International Electrotechnical Commission (IEC) standard 61400-1 Wind turbines - Part 1: Design requirements.

Design and implementation of structures and instrumentation must take into account local environmental conditions, such as temperature and ice formation, more broadly than what is specified in the standard series. The wind turbine must be suitable for wind conditions at the installation site. Wind conditions must take into account wind speed, gust and turbulence.

The wind turbine must have a certificate of conformance with standard 61400-1 issued by an accredited certification body. The certificate of conformity must be based on the document IEC WT 01; IEC Systems for Conformity Testing and Certification of Wind Turbines, Rules and procedures.

Maintenance of the wind turbine must be based on preventive maintenance. Preventive maintenance must include operational monitoring by a competent operating and maintenance personnel, as well as periodic inspections and servicing. Personnel performing preventive maintenance must be authorised to perform the tasks.

Preventive maintenance must be based on a written maintenance programme prepared by the wind turbine's manufacturer. The maintenance programme must specify measures for the operational monitoring, periodic inspection, and servicing of the wind turbine. Performed inspections and maintenance must be documented and made available to the insurance company at each meeting related to losses and risk management.

If a factor endangering the wind turbine's operational reliability is detected during operation or maintenance or by an inspection, the wind turbine must be shut down until the error has been repaired.

The wind turbine must be shut down in a controlled manner if

- wind speed exceeds the maximum permitted value specified by the manufacturer
- vibration severity exceeds the maximum permitted value specified by the wind turbine's manufacturer
- increase of vibration severity over time exceeds the maximum permitted value specified by the wind turbine's manufacturer, despite the absence of change in the turbine's power generation
- a malfunction or error is detected in the wind turbine's rotor blades, main bearing, gearbox, generator, electrical system or other device integral to the operation of the wind turbine
- a change occurs in some other system or structural component of the wind turbine, as the result of which
- the wind turbine must be shut down in accordance with the manufacturer's manual
- the wind turbine's fire detection system issues a fire alarm
- the wind turbine's fire extinguishing system is activated.

The wind turbine must have in place at least two separate and independent shutdown systems.

## 5 Transport

Transport must be performed in accordance with a transport plan drafted on the basis of the wind turbine manufacturer's transport manual. The transport plan must specify requirements for the transport route and the measures to be taken to ensure that the route is suitable for transporting the wind turbine's components. Transported components must be protected against mechanical and environmental stresses. Transported components

must be secured and supported in accordance with the manufacturer's instructions. Components must be inspected at the assembly site for damage during transport. Possible transport damage must be repaired before the component can be used in accordance with the manufacturer's instructions.

## 6 Installation

Assembly, erection and installation of the wind turbine must be performed in accordance with the manufacturer's assembly instructions. Installation may not be performed in environmental conditions that differ from the permitted values for the wind turbine or its assembly device. Installation of the wind turbine must be directed by a person authorised by the turbine manufacturer. The installation must be documented. Installation documentation must specify the acceptance inspections performed, the implementation of the installation, tests conducted on safety systems, and values of initial measurements.

## 7 Connection to grid

The wind turbine and wind farm must be equipped with protections required by the electrical grid operator. The functionality of the protections must be inspected before the wind turbine is connected to the electrical grid and during operation in accordance with the maintenance programme.

## 8 Safety during operation

A rescue plan must be in place for the wind turbine. The wind turbine must be equipped with up-to-date safety instructions and signage. Maintenance personnel must receive training on the rescue plan and safety instructions. The safety instructions must include detailed directions to the wind turbine or the turbine's GPS coordinates for reporting emergencies.

The wind turbine may be accessed only by persons authorised by the manufacturer and by persons designated by the wind turbine operator who have received safety training. Persons designated by the wind turbine operator who have not received safety training may access the wind turbine only under the supervision of a designated safety officer. Appropriate personal protective equipment must be worn at all times in the wind turbine. Persons working in the wind turbine must have access to an emergency evacuation device.

Equipment bays must be kept in good order and clean in order to ensure safety at work and to avoid accidents.

## 9 Protective and control systems

The wind turbine must be equipped with the following protective and control systems

- lightning protection in accordance with section 9.1
- electrical protection in accordance with section 9.2
- operational monitoring in accordance with section 10.1
- fire detection system in accordance with section 11.4
- automated fire extinguishing system in accordance with section 11.5

## 9.1 Lightning protection

The wind turbine must be protected against lightning in accordance with IEC Technical Report 61400-24 Wind turbine generator systems - Part 24: Lightning protection.

## 9.2 Electrical protections

The wind turbine must be protected with the following electrical protections:

- over-voltage and under-voltage protectors that function to ensure that voltage remains within permitted limits
- over-frequency and under-frequency protectors that function to ensure that voltage frequency remains within permitted limits
- loss of mains protection that functions to prevent islanding of the wind turbine
- generator overcurrent and ground-fault protectors and reverse power protector to shield the generator against short circuit and ground fault and prevent the generator from acting as a motor
- generator stator temperature control that shuts down the generator when temperature exceeds the permitted limit.

# 10 Prevention of breakage damage

## 10.1 Operational monitoring

### 10.1.1 Monitoring of environmental conditions

Wind speed must be measured at all times. If wind speed exceeds the maximum permissible value specified by the manufacturer, the wind turbine's rotor blades must be brought to a standstill automatically. The wind turbine must be equipped with at least two ice-resistant wind speed sensors.

Temperature and air humidity in the engine room must be monitored. Temperature and relative humidity in the engine room must conform to the manufacturer's design values.

### 10.1.2 Condition monitoring

Vibration severity and temperature of the main bearing and gearbox and generator bearings must be monitored at all times. Vibration severity may not exceed 7.1 mm/s or the highest permitted value specified by the manufacturer. Temperature may not exceed the highest permitted value specified by the bearings' manufacturer.

Temperature of the generator's stator must be monitored at all times. Temperature may not exceed the highest permitted value specified by the generator's manufacturer.

Oil level, pressure and temperature in the lubricant and hydraulic oil system must be monitored at all times. The values must be within the permissible limits specified by the manufacturer.

The control centre for communications on condition monitoring must be implemented in accordance with standard series IEC 61400-25 Communications for monitoring and control of wind power plants.

## 10.2 Inspection

The wind turbine's equipment must be inspected in accordance with the manufacturer's maintenance programme. Inspections must be carried out by the wind turbine's manufacturer or other competent maintenance personnel. Inspection measures and observations must be documented. Inspection of the wind turbine must include a sensory inspection to detect oil or coolant leaks, abnormal operation, vibration or abnormal noise. If deviations from normal values are detected in the sensory inspection, detailed nondestructive testing (NDT) must be carried out to investigate the cause of the deviation and the necessary maintenance measures.

The wind turbine's maintenance programme must instruct on the following inspections and their intervals:

- visual inspection of the rotor blades
- inspections of the main shaft and main bearing
- inspections of the gearbox
- inspections and electric measurements of the generator
- inspections of the lubricant and hydraulic oil system
- inspections of the rotor blade brake and shutdown device
- inspection of the transformer
- inspections of the tower's structures and base
- inspections and testing of electrical protections
- inspection and testing of lightning protection
- inspections and testing of condition monitoring instruments
- inspection of fire extinguishing equipment
- inspection of the fire detection system
- inspection of the fire extinguishing system.

Inspections must place particular emphasis to ensure that the following areas are in order:

### 10.2.1 Rotor blades

- No visually detectable cracks or signs of wear are present in the rotor blades.

### 10.2.2 Main shaft and main bearing

- No corrosion is present on the surfaces of the main shaft and bearing.

### 10.2.3 Gearbox

- No cracks or significant signs of wear are present on the gearwheel tooth surfaces
- Tooth contact marks must be even in all cogs
- Bearings and their surfaces are free of impurities and corrosion, clearance between bearings is within permitted limits
- The amount of lubricant is at a correct level
- An oil analysis must be performed to ensure that the oil is free of wear particles, water or acidic compounds.

#### 10.2.4 Generator

- Insides of the generator must be clean and free of corrosion
- Insulations and coils are undamaged and clean
- Slot wedges are correctly fastened
- The rotor cap is free of cracks
- Bearings and their surfaces are free of impurities and corrosion, clearance between bearings is within permitted limits
- The amount of lubricant is at a correct level
- An oil analysis must be performed to ensure that the oil is free of wear particles, water or acidic compounds
- The clearance and positioning of the stator and rotor are within the manufacturer's values
- Insulations and coils are in order based on insulation resistance and impedance measurements
- The generator's cooling system is free of corrosion.

#### 10.2.5 Lubricant and hydraulic oil system

- The lubricant and hydraulic oil system is free of corrosion
- The amount of lubricant and hydraulic oil is at a correct level
- An oil analysis must be performed to ensure that the oil is free of wear particles, water or acidic compounds.

#### 10.2.6 Rotor blade brake and shutdown device

- The brake device is clean
- Brake device components subject to wear have sufficient margin for wear
- Regulators function as intended, if the wind turbine is stopped by adjusting the rotor blade angle or by means of tip brakes.

#### 10.2.7 Tower structure and base

- The structures are free of degrading corrosion
- NDT inspections of critical bolted joints and welded seams, as specified by the designer/manufacturer
- The base is free of cracks or movement.

#### 10.2.8 Transformer

- Visual inspection of the transformer to detect possible overheating or leakage of insulating fluid
- Inspecting that the connectors are secure
- Inspecting the operation of the transformer's cooling system.

#### 10.2.9 Electrical protections

- The operation of electrical protections must be tested in accordance with the manufacturer's manual.

#### 10.2.10 Lightning protection

- Lightning protection must be inspected and tested to ensure its functioning from the rotor blade to the ground.

#### 10.2.11 Condition monitoring instruments

- Inspection and testing in accordance with the manufacturer's manual.

#### 10.2.12 Fire extinguishing equipment

- Hand-held fire extinguishers must be inspected by a fire extinguisher retailer accredited by the Finnish Safety and Chemical Agency (Tukes).

#### 10.2.13 Fire detection system

- Inspection and testing in accordance with the manufacturer's manual.

#### 10.2.14 Automatic fire extinguishing system

- Inspection and testing in accordance with the manufacturer's manual. Thermal imaging of the wind turbine's electrical installations must be performed within the warranty period. After this, thermal imaging must be renewed annually.

### 10.3 Servicing

Servicing must be carried out by the wind turbine's manufacturer or other competent maintenance personnel. Servicing measure must be documented.

If issues that endanger the wind turbine's operational reliability are detected in the inspection of a device, the device must be serviced in accordance with the maintenance programme. In connection with servicing, devices and components of the wind turbine that are near their maximum permitted operating hours must be replaced in accordance with the maintenance programme.

## 11 Prevention of fire damage

Due to reasons of fire safety, smoking is prohibited in all areas within the wind turbine.

### 11.1 Fire extinguishing equipment

For the purpose of performing maintenance, the wind turbine's engine room must be equipped with at least two frost-resistant handheld water fire extinguishers with a fire class of 43 A 233 BC and suitable also for extinguishing fires involving electrical voltage. Due to risk of contamination, powder fire extinguishers should not be used in wind turbines, but the turbine should be equipped with handheld fire extinguishers.

### 11.2 Hot work

Work methods used in maintenance may not cause a risk of fire. However, if hot work must be performed, hot work safety must be implemented in accordance with standard SFS 5900 Fire precaution of hot works during assembly, maintenance and repair work. In deviation of the standard, water fire extinguishers reserved for maintenance may be used as fire extinguishing equipment in hot work.

Hot work safety must include at least the following precautions:

- the site of hot work must be clear of flammable materials
- cracks and holes in the structures must be sealed
- any flammable materials and surfaces must be covered
- electrical cables and oil pipes must be covered
- sparks, splashes and heat must be prevented from spreading or being conducted into the environment

- water fire extinguishers reserved for maintenance must be in standby at the hot work site
- fire watch must be kept by a designated watchman at all times during the work
- fire watch must be continued after completion of hot work for at least two hours without interruption.

Persons performing hot work must have a valid hot work card as proof of completing a hot work safety certificate with approval.

### 11.3 Use of flammable liquids

In situations where highly flammable or flammable liquids must be used during maintenance work, the premises must be continuously ventilated. Splashes of liquids must be cleaned immediately. When using liquids, care must be taken to ensure that discharge of static electricity does not cause ignition. Immediately after maintenance has been carried out, all flammable materials used and formed during servicing must be removed from the wind turbine.

### 11.4 Fire detection system

The wind turbine's engine room must be protected with a fire detection system when the turbine's rated power is 1 MW or greater. Fire detection must be based on the detection of smoke. The fire detection system must use a two-stage sensor in which the first sensor (or exceeding the sampling system's alarm limit) alerts the wind turbine's control room and the second sensor (or exceeding the sampling system's alarm limit) issues a fire alarm to the control room and shuts down the wind turbine. Fire alarms are not forwarded to the emergency response centre. Fire alarms issued by the fire detection system must be immediately reported to the emergency response centre, which will then call in rescue services.

The fire detection system must be designed and installed in accordance with the following publications, as applicable:

- Fire detection system planning and installation, FK-CEA 4040: 2009 - 01
- CEN/TS 54-14:en, Fire detection and fire alarm systems. Part 14: Guidelines for planning, design, installation, commissioning, use and maintenance, or
- Sähkötieto Oy, Paloilmoittimen suunnittelu- ja asennusohje 2009

The fire detection system sensors must be positioned in a way that ensures that in the event of fire the fire alarm is raised as early as possible. The sensors must be positioned to cover all parts of the engine room and tower with intermediary structures that may slow down the spread of smoke. Sensors must also be placed inside electrical equipment cabinets. Ventilation of the engine room must be taken into account in the placement of sensors. Components of the fire detection system must conform to standard series SFS EN 54.

### 11.5 Automatic fire extinguishing system

The wind turbine's engine room must also be protected with an automatic fire extinguishing system when the turbine's rated power is 2 MW or greater. The automatic fire extinguishing system may be locally applied or a

total flooding system. The extinguishing agent must be water mist or gas. In this case, personnel damages must be avoided. In deviation of the planning and installation standard or guideline, the extinguishing period must be at least 10 minutes, and the fire extinguishing system's alarm can be connected only to the wind turbine's control room. Activation of the fire extinguishing system must always be immediately reported to the emergency response centre, which will then call in rescue services. Where applicable, the fire extinguishing system must be designed and installed in accordance with a planning and installation standard or guideline for automatic fire extinguishing systems published by

- European Committee for Standardization (CEN)
- Finnish Standards Association (SFS)
- Insurance Europe (CEA)
- VdS Schadenverhütung (VdS)
- National Fire Protection Association (NFPA)
- Factory Mutual (FM) or
- International Organisation for Standardization (ISO).

### 11.6 Other factors affecting fire safety

Factors that improve the wind turbine's fire safety include:

- the engine room's structures (exterior and interior surfaces and insulation) are made of non-flammable materials
- lubricant and hydraulic oils are non-flammable or have a high flash point
- insulations of electrical cables in the engine room and tower are made of a fire-resistant material that does not form smoke gases or corroding gases in high temperatures
- areas susceptible to oil or other fluid leaks are equipped with collection basins to prevent leaks from spreading to the engine room
- no redundant flammable materials are stored in the engine room
- the engine room and top of the tower are fire compartmentalised with EI 60 conformant structures
- the machinery rooms in the tower's frame are fire compartmentalised with EI 60 conformant structures and equipped with safety measures similar to the engine room.

## 12 Prevention of vandalism

### 12.1 Doors

The door to the site must be sufficiently secure to ensure that break-in to the site is not possible without tool-assisted destruction of the door structures. The door frame must be supported to the wall structure at the lock and hinge. The hinge side of the door must be equipped with at least three hinge bolts fitted to the frame or door panel if the hinges from the outside can be disassembled. The gap between the lock side of the door and the frame must not be more than 5 mm when the door is locked. Door locks of non-rebated doors must be protected by a lock guard.

## 12.2 Locking

Single-leaf exterior doors to the wind turbine must be locked with a door lock and security lock. The lock must be double-locked when the wind turbine is unmanned. The security lock may be substituted by a Class 4 padlock. When using a padlock, fixings approved for the padlock type must be used. Doors must be locked with a lock tested in accordance with standard SFS-EN 12209 or SFS 7020. Double doors to the wind turbine must be locked so that the active door leaf is locked to the inactive leaf, as with single-leaf doors. In addition, opening the inactive door leaf must be prevented with a panic bolt installed on the inside of the door.

## 12.3 Windows and openings

Window panes situated at a height less than four metres from the ground must be secured and the window closed in a manner which ensures that the glass pane or window or its guard cannot be removed or opened from the outside without damaging the window. Window panes must be of Class P4A impact-resistant glass or, alternatively, the window opening must be protected by a fixed or locked steel grille or steel mesh.

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