Fire protection solutions for wind turbines
From fire risk to investment risk

In recent years the use of wind energy has become established with high growth rates and good prospects for the future. Simple rotors have become more and more powerful high-tech power stations. Nowadays the design of new performance classes plus their offshore locations require a high level of investment - and the protection of the investment against interruptions in operation and even total loss. Up till now manufacturer, operator and fire brigades have been helpless when dealing with the risk of a fire.

The nacelle, the heart of wind turbines (WT), contains generators, gears, brakes, switch cabinets, transformers and converters, and so represents a especially high fire risk.

Risks
- Business interruptions or total loss of the wind turbine with all the economic consequences for operator, manufacturer and insurance.
- Damage to image and uncertainty among investors and the general public.

Fire protection
If a fire starts as the result of overheating of components, electrical faults or a lightning strike, the fire will find plenty of combustible material in the form of mineral oils, lubricants, plastics and electronic components.

Long response times, poor access routes and the extreme hub height of modern wind turbines: Access to the fire source as a must for successful extinguishing is rarely possible for the fire department, particular when normally fire ladder systems only reach to a height of about 30-50 m.

If components in the nacelle ignite, further spread of fire can no longer be prevented, with total loss of the wind turbine often being the result. Fire fighting by the fire department is therefore mainly limited to just control burning off.

And with offshore facilities any outside help would in any event arrive too late.
Minimax fire suppression for wind turbines
Minimax has worked with proven and tested components to develop effective protective solutions for wind turbines – both for retrofitting in existing towers and for installation in new facilities. In doing so the special challenges, such as permanent vibrations and extreme temperature gradients, were taken into account.

The protection schemes were realistically tested in our own research center in a 1:1 test for their suitability for practical use.

When you are deciding which of the protection schemes developed by Minimax is the appropriate solution for your wind turbine, our competent engineers are here to advise you.
Phased approach - modular construction

Regardless of whether it’s sprinkler systems, gas suppression systems, fire prevention systems or fire detection systems, Minimax can draw upon its own unique range of tested and certified components and systems from its own development and production facilities. Our six-stage fire protection scheme has proved itself for decades, especially for wind turbines.
Structural fire protection
Coating the power cables with KBS coating prevents the spread of fire along the cables. Cable transits are filled out with KBS Sealbags fire protection pillows to make them fire-resistant and smoke-gas tight. Fire bulkheads on cable transits and on selected tower segments stop the spread of fire.

Fire extinguishers
The extinguishing gas carbon dioxide is the only extinguishing agent used in manual fire extinguishers that extinguishes without leaving any residue at all and can even be used with sensitive hardware. CO₂ extinguishers are therefore used to protect switch cabinets in nacelle and tower. The Minimaxol foam fire extinguisher, with its particularly adhesive and resistant foam characterized by a high extinguishing capability on solid and liquid materials, is suitable for the protection of the remaining areas in the nacelle.

Fire detection systems with machine shutdown and suppression control
The job of automatic early detection of fires at danger points is taken on by fire gas, smoke or heat detectors. The aim of fire detection equipment is early detection with a high level of false alarm prevention. The particular fire detection equipment used is tailored to the requirements of the danger zone. As soon as a detector detects a fire, the fire detection control panel gives a potential free contact to the wind turbines controls, which in the event of an alarm initiates the shutdown processes. Acoustic and optical means of alarm display the danger situation on site while simultaneously forwarding a message to a permanently manned post.

For automatic suppression system control the fire detection control panel is expanded with modules for this. These are fitted with redundant processor technology.
If the fire risk is not resolved by switching off the system another detector in the extinguishing zone gives the alarm, the suppression system is automatically activated. Furthermore manual call points for manual release can be installed for each suppression zone.
Technologies used

**Inert gas suppression system**
The Minimax Oxeo inert gas suppression equipment is an ideal fire protection solution for wind turbines. The inert gas used forces out the oxygen required for a fire, extinguishes quickly and leaves no residue, and is electrically non-conductive. This suppression technology is particularly suitable for local protection of the switch cabinets and encapsulated transformers in the nacelle and tower sections of wind turbines. In the event of fire a predetermined quantity of inert gas is released in the affected areas within a specified interval.

**Water mist systems**
The water mist system allows the implementation of protection schemes which guarantee the maximum level of safety with a minimal use of water. The water mist nozzles are installed in such a way as to protect system parts such as main bearings, gearing, brakes and generators. So that operational safety can be guaranteed all year round, the water is provided with an anti-freeze which allows dependable use in conditions of up to -30 degrees Celsius. The extinguishing agent is an aqueous solution which is sprayed via special nozzles. The fine atomization multiplies the total area of the extinguishing agent. This efficiently cools the fire source and environment. The evaporation of the extinguishing agent not only binds a large quantity of heat but also hinders the supply of oxygen to the fire source. This results in an additional smothering effect.

The quantity of extinguishing agent released by the Minifog system is so small that as a rule no substantial extinguishing agent retention equipment is required.
Monitoring and visualization

The use of a web-based monitoring and control module as an integrated component of the FMZ 5000 mod 12 fire detection control panel. The Web Module allows messages to be displayed and archived via the web browser on a PC from a control panel which can be located anywhere. Time synchronization between fire detection control panel and Scada is possible. Remote diagnostics allows service interventions, especially cost-intensive ones, to be optimally scheduled and the availability of the wind turbine to be increased. In addition the Inveron software can be used to clearly view, monitor and control the fire detection and alarm systems of entire wind farms on the PC upon customer request. Inveron allows events from Minimax fire detector and control panels to be transmitted for remote monitoring. The user sees additional information and help for each message on the screen and can therefore introduce the necessary measures based on the sound information he has received.
Advantages at a glance

- Avoids long downtimes and expensive business interruptions thanks to early (earliest) fire detection
- Use of proven and dependable products in compliance with current standards and directives
- Latest state of the art
- Very high level of personal and system protection via fire protection solutions tailored to the type of wind turbine