Wind Turbine Fires

Dwindling fossil fuel supplies and changes in global climate have increased the interest in renewable energy. Wind energy is one of the renewable energy sources that is experiencing substantial growth worldwide. In the United States wind turbine energy production has increased over 700% in the past ten years.

These wind turbines experience failures and setbacks, which can lead to accidents that include both property and personnel loss. One recognized factor for these accidents is fire.

Fire is second only to blade failure and is one of most common factors causing property and personnel loss.

A total of 337 fire incidents were reported and the table below presents the total by year:

Year	Before 2000	2000-2004	05	06	07	08	09	10	11	12	13	14	15	16	17	*18
No.	7	62	14	12	21	17	18	13	20	19	24	19	19	28	24	19

** to 30 September 2018 only* http://www.caithnesswindfarms.co.uk/AccidentStatistics.htm

Even though the reported number is small, it represents a high cost in lost production, valuable assets, and in some cases personnel. Wind turbine fire almost always result in a total loss and a single turbine can cost as much as four million dollars. Then there is lost production due to downtime if the turbine is restored or replaced. Finally, these fires have the potential to emit toxic fumes as their construction material burns. Reports suggests that burning debris from the wind turbine fires causes damage to nearby properties, farms, and forests. The loss in the power will disrupt the daily life of people which causes a spiral of other financial losses and public trust.

Statistics show that 90% of the fires originate in the nacelle of a wind turbine. The nacelle region houses the three elements of the fire triangle in the form of fuel (oil and polymers), oxygen (wind), and ignition source (electrical, mechanical, and lighting) all in a confined small compartment within close proximity of each other.

The nacelle carries the main “fuel load” within a turbine. It is constructed of polymers and contains insulation and a variety of cables and oil. As per the industry report a single 1.5 MW wind turbine nacelle can contain up to 900 liters of lubricating oil including cooling and cleaning fluids, excluding the transformer oil reservoir which is located at the base of the tower which can contain up to an additional 2,200 liters of Class B material.

Fires in a turbine are difficult to combat due to their height and their construction in remote locations. With regard to offshore wind turbines an added obstacle is transporting the response crew to fight the fires due to their location.

Research suggests that the main ignition sources for fires in turbines are:

- Lightning strike
- Electrical malfunction
- Mechanical failure
- Maintenance activities (like hot work etc.)

When a fire ignites in the wind turbine it can spread quickly due to high volumes of air flow, which provides a supply of oxygen to the fire that helps it grow rapidly. Thus, the suggested fire protection solution for wind turbines would include both passive and active fire protection measures.

Passive Fire protection of wind turbines involves:

- Installation of lightning protection systems.
- Selection of noncombustible materials in the construction
- Compartmentalization of the nacelle area
- Using noncombustible hydraulic and lubrication oils
- Installing monitoring systems to check condition of the machinery

Active Fire protection of wind turbines involves:

- Fire detection and alarm systems
- Fire suppression systems

A suggested fire alarm system would include smoke detectors, automatic shutdown interconnections for the turbine itself and system monitoring by a supervisory control and data acquisition (SCADA) system.

Most widely used fire suppression systems in wind turbines are Novec 1230 systems and aerosol systems.

Active fire suppression systems installed in the turbines must be easy to install and maintain in order to keep the costs low, space and weight considerations in check and must be considered while choosing a suppression solution.

Offshore wind turbines use Active Fire-Fighting System (AFFS) that detect fires and automatically and extinguish them. These systems require less human intervention: they use intelligent fire detection and suppression through preprogrammed values and algorithms.

Electrical systems used on the turbines are protected by circuit breakers, busbars, residual current devices, semiconductor fuses, and/or current monitoring devices.

Industry Standards used in fire protection of wind turbines are:

- *NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*. (Mostly used in North America)
- *Directive 2006/42/EC.* (Mostly used in Europe)

Third party certification labs like DNVGL have created specifications for the certification of fire protection systems for wind turbines (DNVGL-SE-0077.)

There are many obstacles that must be overcome in order to provide better fire protection for wind turbines including:

- Currently there no legal requirements to provide fire detection or suppression measures on wind turbines.
- Poor statistical records for wind turbine fires are hindering the research effort.
- Inadequate information about fire protection of wind turbines in the codes and standards.
- Training of response teams is not keeping in step with current and projected industry growth.

Our future dependency on this renewable energy will continue to grow with the decrease in the fossil fuels. Some protection technology has seen enhanced development, but in general, the industry is not keeping pace. In order to meet the growing energy demands, stakeholders in the wind power industry must come together and work towards a common goal of protecting wind turbines from fire accidents.

Source:

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