FIRETRACE™ | International

THE COMPLETE GUIDE TO WIND TURBINE FIRE PROTECTION

Assessing Risk | Types of Fire Protection Systems | ROI Calculation

ASSESSING RISK

To understand whether installing fire suppression systems in wind turbines is a practical decision for your business, you need to assess four factors:

- The likelihood a wind turbine will catch fire
- The cost of a fire in a wind turbine
- The cost of protection using one or more fire suppression systems
- The ability to prevent an increase in insurance rates at next renewal for mitigating fire risk

FREQUENCY

Several different authorities have reported estimates of the annual rate at which wind turbines catch fire. These include:

- 1 in 6,000 (GCube Insurance, 2015)
- 1 in 1,710 (International Association for Fire Safety Science, 2014)
- 1 in 10,000 (Fire Protection Engineering Magazine, 2019)
- 1 in 2,000 (Wind Power Engineering Magazine, 2020)

For the purpose of this report, we will use the Wind Power Engineering figure, because it is the most recently published.

With wind turbines catching fire at a rate of 1 in 2,000 each year, a typical wind farm with 150 turbines will experience 1-2 fires during an operating span of 20 years.

> *In other terms, the average turbine has a **1 in 100 chance of catching fire** over an expected 20-year life.*

COST OF A FIRE

The cost of a wind turbine fire can vary significantly due to a number of factors, including:

- The size and output of the turbine affected
- Extent of the damage and availability of replacement parts
- Whether or not parts can be salvaged
- If the fire spreads to nearby equipment or vegetation
- If required to temporarily shut down the entire wind farm or complete a root cause analysis

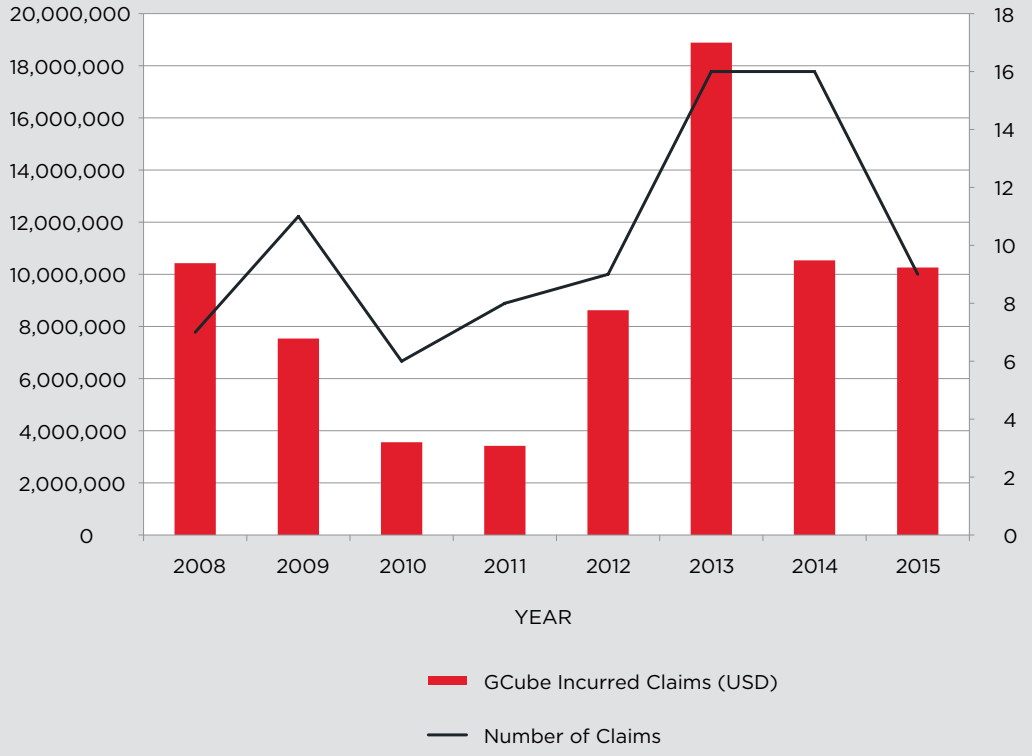
FIRE CLAIMS 2008 - 2015

Between 2008 and 2015, the total amount in fire related damages paid by GCube insurance fluctuated significantly from less than $4M in 2011 to over $18M in 2013.

> *In 2015, GCube estimated the average wind turbine fire costs **$4.5M**.*

GCube estimates that the average wind turbine fire costs $4.5M. Most wind turbine fires originate in the nacelle, making them extremely difficult to fight. Nacelle fires typically result in a total loss of the turbine.

> *More recent estimates of wind turbine fires put the average cost around **$7-8M**.*

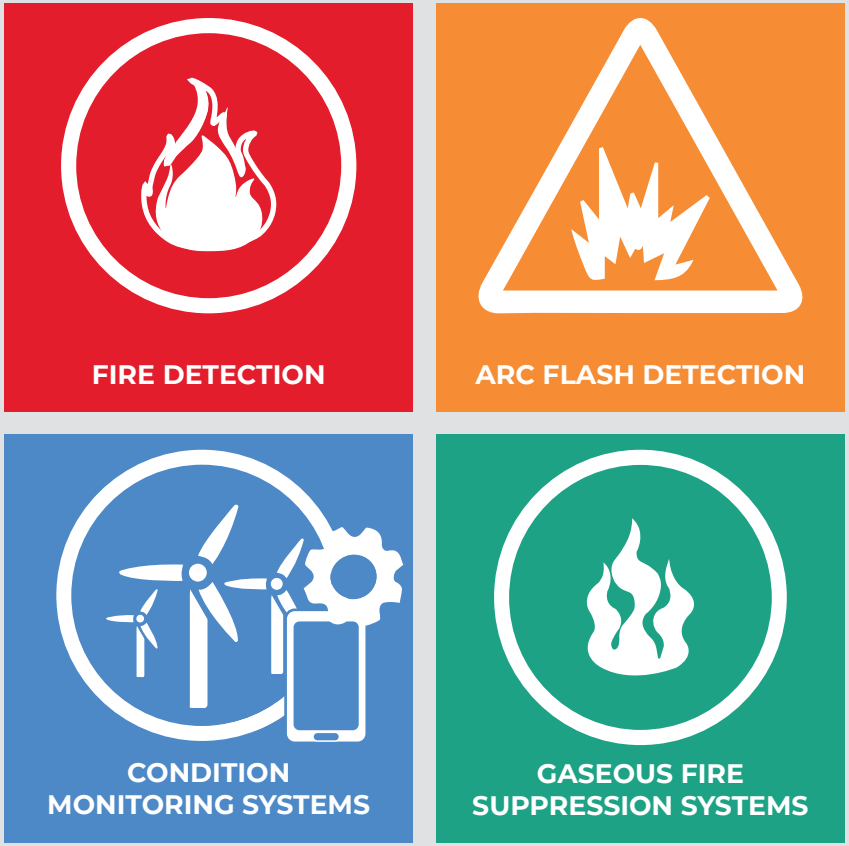


Source: GCube December 2015 Report - Towering Inferno, Global Trends In Wind Turbine Downtime Events

TYPES OF PROTECTION

Several different technologies can be used for fire protection in wind turbines. These include fire detection, arc flash detection, condition monitoring systems, and gaseous fire suppression systems. Most technologies focus on fire prevention. Only fire suppression systems, like those offered by Firetrace, can mitigate fire damage once a fire has started.

Firetrace systems target specific ignition sources in the wind turbine. This allows a flexible, modular approach to fire protection that can be customized for different turbine makes and models.

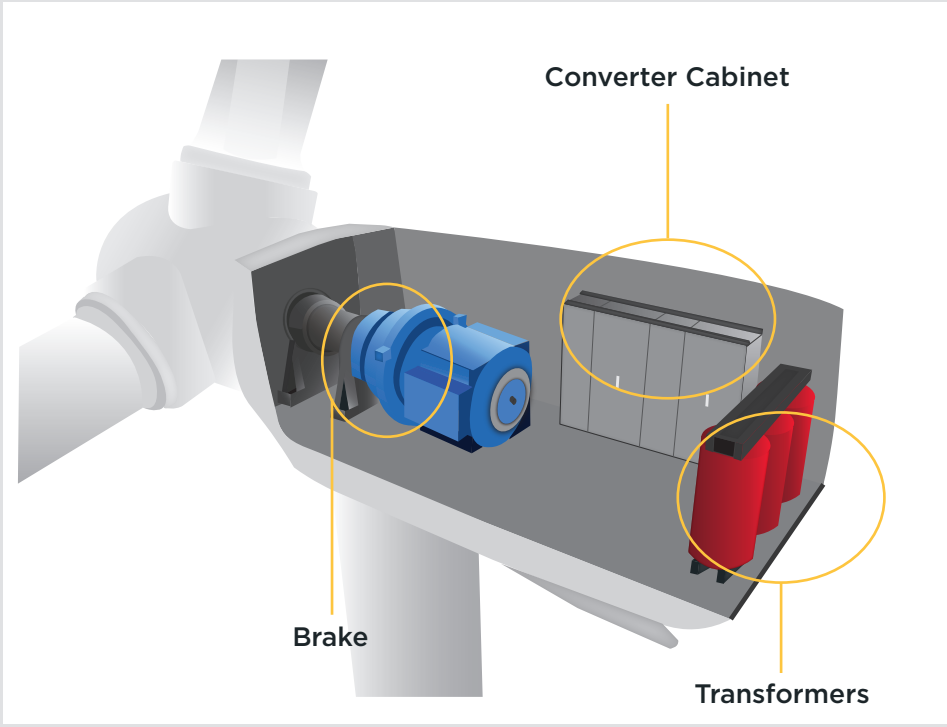


IGNITION SOURCES

Broadly speaking, there are three primary ignition sources – or areas of risk – in a typical wind turbine:

- The converter and capacitor cabinets in the nacelle
- The transformer
- The nacelle brake area
- The hydraulic area is sometimes, but not often, considered a fourth ignition source

Of the three ignition sources in a wind turbine, most fires start in the converter cabinet or capacitor cabinet, located in the nacelle. According to Renewable Energy Loss Adjusters (RELA), electrical faults are the leading cause of fires: “This involves anything from short circuit, overloading, cable failure, and crimping failure to generator failure.”



COMMON APPLICATIONS OF FIRE SUPPRESSION SYSTEMS

CONVERTER AND CAPACITOR CABINET PROTECTION

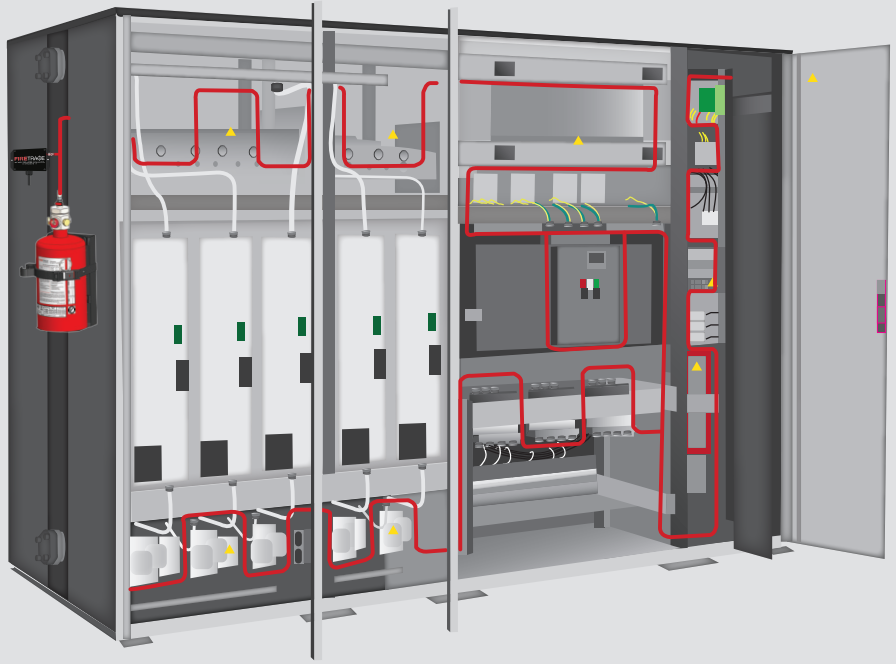
Because most fires start in the converter cabinet or capacitor cabinet, most wind turbine owners protect these areas first. Generally, both cabinets can be protected using a single Firetrace system. This is made possible by the design of the Direct Low Pressure (DLP) system, with flexible detection tubing that can be routed throughout the bank of cabinets. Suppression gas is delivered directly through the tubing.

NACELLE BRAKE AREA PROTECTION

The nacelle brake area is also relatively straightforward to protect in most wind turbines. Firetrace recommends an Indirect Low Pressure (ILP) system for nacelle brake area protection. This system also detects fires using flexible detection tubing, but it delivers suppression gas through separate nozzles.

TRANSFORMER PROTECTION

The transformer area, which is larger, may require a more robust system with multiple cylinders to ensure suppression agent effectiveness.



When installing a direct low pressure system on a capacitor cabinet or converter cabinet, route the flexible detection tubing around all possible ignition sources.

COSTS OF FIRE SUPPRESSION SYSTEMS

Firetrace systems are available to purchase directly from leading wind turbine manufacturers. This allows project construction capital to be used toward the installation of fire suppression systems for new wind projects. Aftermarket installations are also feasible due to the simple design of the systems. Firetrace recommends budgeting $5,000 per turbine for aftermarket installations as an initial estimate.

GUIDELINES FOR RECOMMENDING FIRE SUPPRESSION SYSTEMS

Although each customer will be different, we believe that the following table provides practical guidelines for the recommendation of fire suppression systems.

This analysis assumes that a typical wind turbine is valued at $1M per MW. Given that most turbine fires result in a total loss of the turbine, this is the investment that is at risk with a wind turbine fire. We have also assumed a rate of 1 fire per 2,000 turbines per year, based on data from Wind Power Engineering Magazine presented earlier in this report.

This approach leads to stronger protection for larger and more expensive wind turbines. As the size and capacity of wind turbines increases both on shore and off shore, owners and operators should re-evaluate their approach to fire protection.

	TURBINE CAPACITY	TURBINE COST	RECOMMENDED INVESTMENT*	RECOMMENDED LEVEL OF PROTECTION
ON SHORE RANGE	1MW	$1M	$ 10,000.00	Capacitor & Converter Cabinets
	2MW	$2M	$ 20,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area
	3MW	$3M	$ 30,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area + Transformer
	4MW	$4M	$ 40,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area + Transformer
	5MW	$5M	$ 50,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area + Transformer
OFF SHORE RANGE	6MW	$6M	$ 60,000.00	Capacitor & Converter Cabinets and Nacelle Brake Area + Transformer
	7MW	$7M	$ 70,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area + Transformer
	8MW	$8M	$ 80,000.00	Capacitor & Converter Cabinets + Nacelle Brake Area + Transformer

*Based on cost of a wind turbine, rate of fire at 1 in 2,000 per year, and typical turbine lifetime of 20 years

FIRE SUPPRESSION AGENTS FOR WIND TURBINES

Feature Comparison	Recommended Clean Agent	Inert Gas	Aerosol	Foam	ABC Dry Chemical
No cleanup required After activation, fire suppression agent does not require cleaning up because it is safe for equipment and does not leave residue.	☑	✓	✗	✗	✗
Safe for sensitive equipment Fire suppression agent is safe for electronics and does not degrade turbine components over time.	☑	✓	✗	✗	✗
Safe for environment Agent has a low global warming potential (GWP) and ozone depletion potential (ODP)	☑	✗	✓	✗	✓
<10 seconds to suppress fire Systems with this agent can suppress a fire in under 10 seconds, maximizing the protection of the turbine after a fire starts.	☑	✗	✗	✓	✓
Safe for occupied areas This agent is safe for employees to be near in an enclosed area and does not have harmful, or fatal, side effects	☑	✓	✗	✗	✗

HOW FIRE SUPPRESSION CAN IMPROVE YOUR INSURANCE RATES

By not having a fire suppression system, you can expect more total loss claims from fire. While your insurer may pay you a large claim after a fire, the increases to your policy can be quite large. The money has to come from somewhere. After a fire claim, you can expect to see:

1. Increased premiums
2. Increased deductibles
3. Restrictions in cover

Fire suppression systems can reduce your fire loss risk, and in turn save your insurer millions in claims. While it is difficult to reduce your premiums in this hardened insurance market, it is reasonable to communicate to your underwriter how they benefit from you having fire suppression systems. You have a strong argument for your insurers reducing an increase in premiums/deductibles or maintaining your current rate to incentivize you to install fire suppression systems.

Fire suppression systems can provide a strong return on investment even without insurance incentives, but as your insurer benefits so much from you mitigating fire loss then it is fair to prove the business case for incentives to them.

Talk to an expert at Firetrace.

FIRETRACE™ International

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