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July 23, 2019

New Hampshire Site Evaluation Committee
Attention: Pamela G. Monroe, Administrator
21 South Fruit St., Suite #10
Concord, NH 03301

Re: Antrim Wind Energy LLC – Wind Turbine Fire Protection System

Dear Ms. Pamela G. Monroe:

Antrim Wind Energy LLC (AWE) has received final approval for the fire suppression system in the turbine nacelles from the State Fire Marshal and Town of Antrim Fire Department. The final fire suppression plan does contain confidential information of third parties that AWE is obligated to protect under confidentiality agreements with those third parties. Specifically, the price of the Fire Trace system is confidential information, and the photographs of the inside of Siemens nacelles are confidential information. This information is also exempted from public disclosure under RSA 91-A:5 (IV) as "confidential, commercial or financial information."

Accordingly, AWE is attaching two versions of the final, approved fire suppression plan to this letter: (i) a complete unredacted copy together with a letter from the TransAlta operations team detailing notification protocols requested by the Fire Marshall; and (ii) a redacted (public) copy of the same plan with only the FireTrace price information and Siemens nacelle photographs redacted. AWE respectfully requests that only the redacted version be available to the public.

Should you have any questions, please feel free to contact me.

Regards,

TRANSALTA CORPORATION

Julie Turgeon, P. Eng.
Supervisor, Wind & Solar Operations

Encl. Public and confidential versions of AWE_Final Approved Firetrace Fire Suppression

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May 2, 2019

Attention: State Fire Marshal and Town of Antrim Fire Department

Re: Antrim Wind Energy LLC – Wind Turbine Fire Protection System

Dear Mr. Antsey and Chief Gale:

In accordance with the requirements of the SEC Certificate, Antrim Wind Energy will install automatic fire suppression equipment supplied by Firetrace in the nacelles of all turbines at the Antrim Wind Farm. Consistent with previously agreed upon proposals, Firetrace will provide a direct delivery fire suppression system with detection/discharge tubing running through two electrical cabinets. The system uses 3M 1230 Fire Protection Fluid to extinguish the fire while leaving no residue.

The Firetrace system is monitored using two pressure monitoring switches:

- The first switch will detect if the system pressure has dropped rapidly, indicating the tubing has burst and there is a fire. This will activate the emergency stop on the turbine and alert TransAlta's Wind Control Centre. The Wind Control Center provides 24/7/365 monitoring services for all of TransAlta's wind turbines. The Wind Control Center will immediately notify the Town of Antrim Fire Department if this alarm is activated. Contact information will be embedded in the Site Operations procedures and amended when necessary.
- The second switch is a pressure monitoring switch that will signal if the pressure is dropping slowly. This indicated that service is needed on the Firetrace system, and a technician will be dispatched within 48-72 hours.
- The Firetrace suppression system is in addition to the fire protection systems included in Siemens Wind turbines, which include numerous smoke detectors throughout the turbines. The Wind Control Center will also immediately notify the Town of Antrim Fire Department in the event that a smoke alarm signal is detected.

A full technical description and installation plan of the Firetrace system is available in the attached document "Firetrace Automatic Fire Suppression - March 2019".

The SEC Certificate requires the review and approval of the turbine fire suppression plan by your offices prior to erection. After the last meeting concerning this topic, the only remaining item to be provided by Antrim Wind was this letter confirming the notification protocols listed above. We respectfully request your reply approving the nacelle fire suppression system as soon as possible, and no later than May 10th, 2019 in order to maintain project schedule.

Regards,



TRANSALTA CORPORATION

Julie Turgeon P. Eng., Supervisor, Wind & Solar Operations



Automatic Fire Suppression

Fire Suppression by:



March 2019



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Overview:

Antrim Wind Energy has requested Firetrace International provide a fire suppressions system design and layout for the Siemens 3.2 MW wind turbine. The following proposal is based on the Firetrace previous installations on similar wind turbines. The areas and scope of coverage can be adjusted based on Antrim Wind Energy recommendations and customer request.

Firetrace has more than 250,000 systems installed globally with a track record of successful detection and suppression of fires in many applications. With more than 5,000 systems installed protecting wind turbine components, electrical cabinets, transformers etc. Firetrace has a proven track record for being the most cost effective and reliable fire suppression solution on the market. To date Firetrace has successfully suppressed 10 fires in energized wind turbine. Details on our wind turbine installations are at the end of the proposal.

Our field experience also includes protection of industrial machinery, mass transit, off-road heavy machinery, electrical cabinets (i.e. underground mining, airport), server room, military vehicles and other volatile areas that are not easily protected by other fire suppression solutions.

Firetrace carries European Conformity (CE), Factory Mutual (FM), Underwriters Laboratories (UL) and 28 other international approvals for many systems. In all cases Firetrace system components have been vigorously tested to ensure product quality and effectiveness.

In order to meet the highest standards required by the United States military Firetrace has also undergone extensive shock and vibration testing and an ISO:9001 certified organization.

Firetrace is a targeted fire suppression solution reaching the heart of the fire at the source versus a total flood application that would mean the fire has spread beyond the cabinet or local area. Firetrace experience is in very extreme volatile environments which is why Firetrace is such a great fit for the wind turbine application.

The Firetrace linear pneumatic detection is what sets our solution apart from other fire suppression solutions. Firetrace detection tubing offers the flexibility to route the tubing throughout hazards, allowing for immediate detection and suppression at the heart of the fire. The linear pneumatic detection tubing is fully pressurized and requires no power to protect the equipment. A simple pressure switch is utilized to indicate there has been a pressure loss and a signal sent to your controls for response and shut down of the turbine.

System Details:

Our solution is a closed loop system meaning that the only way the system will activate is with tubing rupture due to fire. There is no reason to reset the system when the turbine comes back on line as the system requires no power, providing, 24/7 protection.

The following are the two methods of detection and suppression offered by Firetrace:

- **Direct Delivery System**

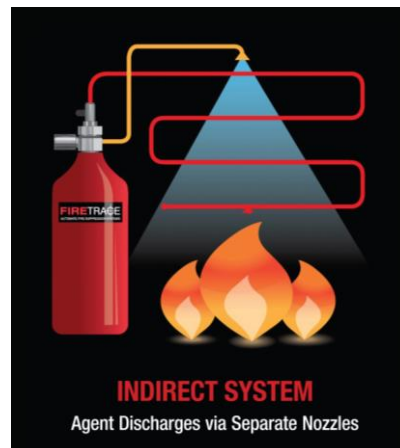
With the Direct Delivery System, the Firetrace Linear Pneumatic Detection Tubing is both the fire detection and agent suppressant delivery system. The portion of the tube nearest the hottest point of the fire ruptures, forming an effective discharge “nozzle”. The pressure drop in the tube releases the entire contents of the cylinder through this nozzle.

- Wind application recommendations include control panel(s), capacitor cabinets, converter cabinets and other enclosed environments in the wind turbine.

- **Indirect Delivery**

With the Indirect Release System, the Firetrace Linear Pneumatic Detection Tubing is used only as a detection device. The fire suppression agent is delivered via copper tubing, stainless steel tubing or braided hose. Once the tube “bursts”, the suppressant is discharged through strategically placed nozzles within the protected enclosure.

- Wind application recommendations include the hydraulic station, transformer, brake and other exposed areas in the wind turbine.



How the detection tubing works:

- Flexible
 - Allows us to detect/suppress hard to reach areas of the equipment that may otherwise be unprotected
- Self-contained
 - No electricity required offering uninterrupted protection 24/7
- Detection
 - Designed to activate by open flame or ambient heat
- Suppression
 - Connects easily to monitoring system to alarm discharge and event
 - Electrically non-conductive



Extinguishing Agent:

Firetrace utilizes 3M Novec 1230 Fire Protection Fluid as our agent of choice in the protection of wind turbines. Benefits of 3M Novec 1230:

- Health & Safety - Concentration calculations are based on the necessary amount of agent to successfully suppress a fire while taking into account health and safety of employees present during discharge.
- Agent Effects - Residue free, non-corrosive, electrically non-conductive.
- Environmental Characteristics - ozone depletion potential of 0, global warming potential of 1.

Environmental Considerations:

Firetrace solutions will not be impacted by shock, vibration, dust, debris, salt or temperature variations.



System Monitoring:

Firetrace will utilize a pressure switch for monitoring of the fire detection and suppression system. The pressure switch will monitor the overall system pressure, upon rupture of the tubing due to high heat or flame the pressure switch will signal to the wind turbine emergency shut down or SCADA controls for immediate shut down that an incident has occurred while simultaneously discharging the fire suppression agent.

Firetrace will provide a secondary pressure switch that will monitor service pressure. A signal will be sent to smoke detection signal to trigger wind turbine reaction and local technician inspection of system.

Firetrace does not require any power which allows our system to be active even when the turbine is shut down. Upon powering up of the turbine the Firetrace solution will require no additional reset or activation as the system will remain active at all times.

Installation & Commissioning:

FT will provide training and certification to Eolian Renewables staff, O&M team or a Firetrace local distributor to perform installation and maintenance on fire suppression solutions.

Maintenance Requirements:

Maintenance requirements include a semi-annual visual inspection of tubing, pressure gauges and cylinder.

With the Service Pressure Switch Indication is added the semi-annual inspection is reduced to an annual inspection of the system.

Installation Service and Maintenance Guide included prototype installation.



Scope of Coverage:

Firetrace International would like to provide our experience and expertise in protecting Siemens wind turbine with our automatic fire suppression systems. The following pages provide sample coverage areas that Firetrace systems are able to protect in the Siemens wind turbine utilizing 3M Novec 1230 Fire Protection Fluid. The area and scope of coverage can be adjusted based on the needs identified by Siemens and following a hazard assessment by Firetrace International.

Firetrace provides modular fire suppression allowing for selection of component to be protected based on customer request.

Sample coverage included in this presentation for the Siemens wind turbine:

- Nacelle – AA3 and AA24

The Firetrace system is totally “stand alone” and does not require any outside power source for operation. The Firetrace system uses 3M Novec 1230 a highly recognized clean agent leaving no residue after discharge or cause for concern for employee or equipment safety. It has zero Ozone Depletion Factor (ODP) and the lowest Global Warming Potential (GWP) of any chemical based clean agent of just 1.

The system should be connected to the Siemens emergency stop via a 2 wire pair from the pressures switch to initiate shut down of wind turbine in the event of activation of the Firetrace system. The Service Pressure Switch Indication should be connected to a smoke detection signal or the like that would indicate to turbine controls that the system needs to be inspected due to low pressure. The inspection can occur in 48-72 hours from signal. Final terminal connections for Service and Activation signals TBD.



System Design Description Siemens Wind Turbine Nacelle – AA3 and AA24 Cabinet

System Components:

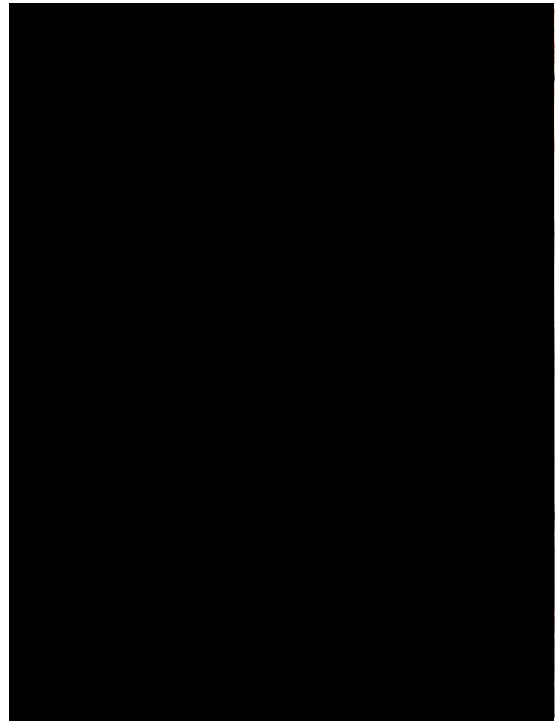
Firetrace Direct Low Pressure (DLP) 10lb system with flame and heat detection.

Design Details:

- Firetrace cylinder should be mounted right left side of the AA3 securing to the floor while the routing the Firetrace linear detection into the cabinet.
- Firetrace linear detection tubing should be routed throughout the interior space of the cabinetry for both AA3 and AA24 cabinets. Multiple cabinets can be protected with one Firetrace cylinder by routing the linear detection tubing to each of the cabinets planned for protection.
- The DLP systems allows for detection of flame and heat utilizing our proprietary linear pneumatic detection tubing. Once the tubing is ruptured, the 3M Novec 1230 should be discharged directly on to the fire via the Firetrace linear pneumatic detection rupture point.
- The Pressure Switch Module should be connected to the Siemens emergency stop via a 2 wire pair from the pressures switch to initiate shut down of wind turbine in the event of activation of the Firetrace system. The Service Pressure Switch Indication should be connected to a smoke detection signal or the like that would indicate to turbine controls that the system needs to be inspected due to low pressure. The inspection can occur in 48-72 hours from signal. Final terminal connections for Service and Activation signals TBD.

**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

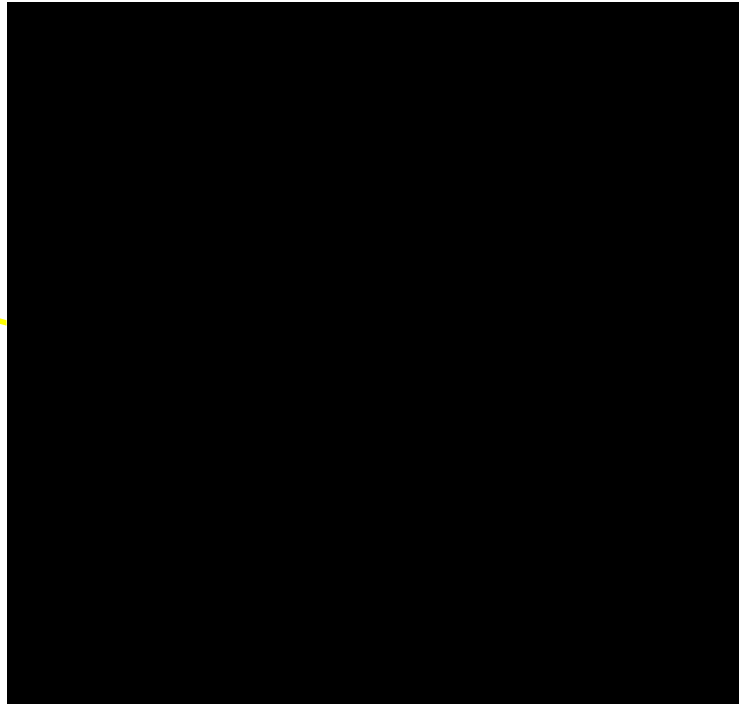
AA3 Cabinet Overview



**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

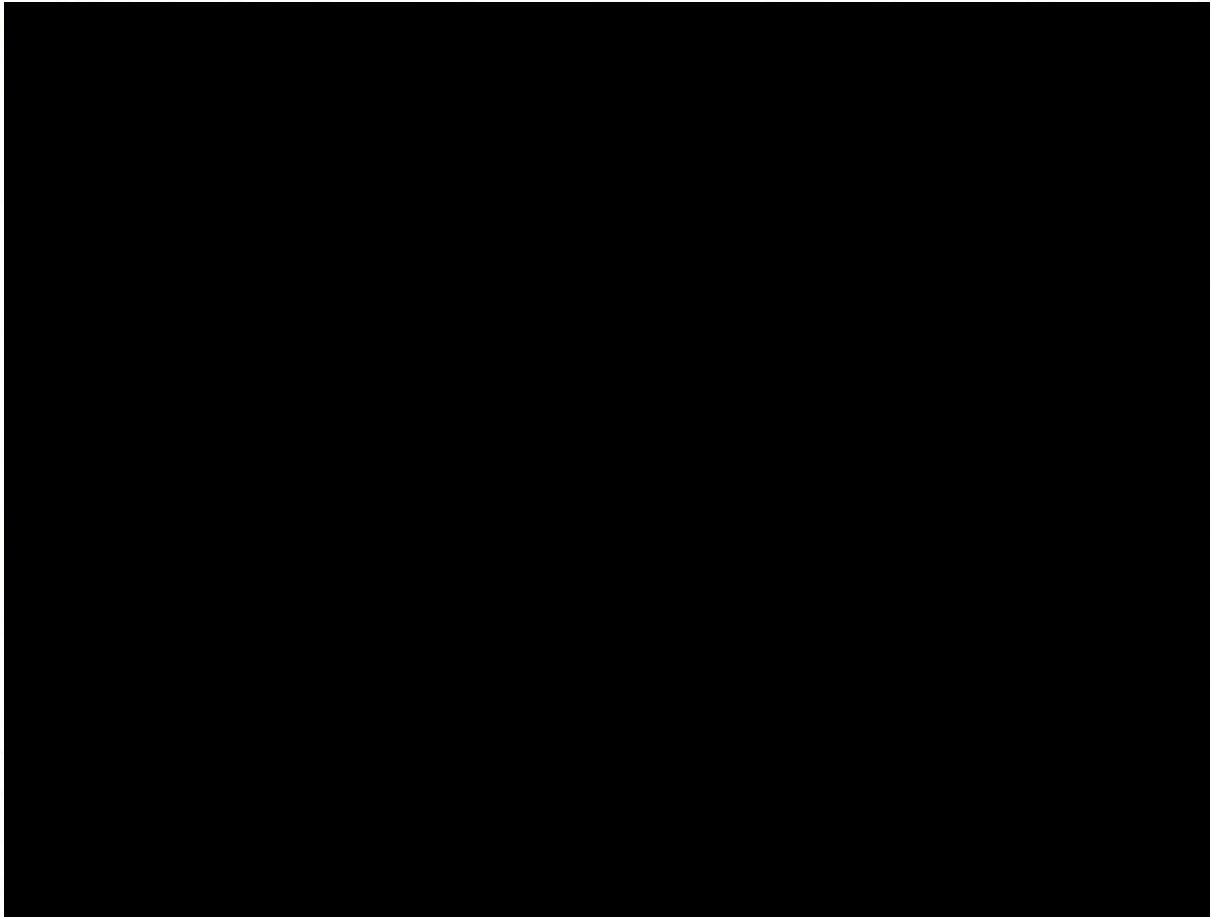
*Cylinder Placement Option
Right Rear Floor of AA3 Cabinet*

Cylinder could be mounted on the right side of the cabinet secured to the floor.



**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

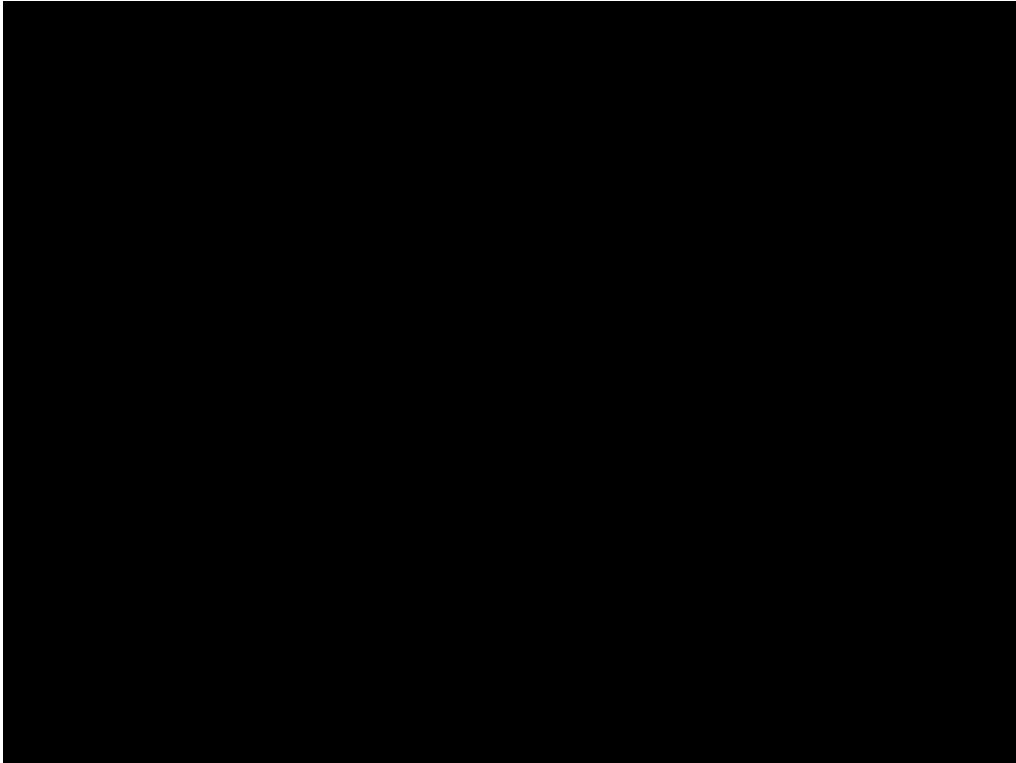
AA3 - Firetrace Linear Detection Tubing Placement





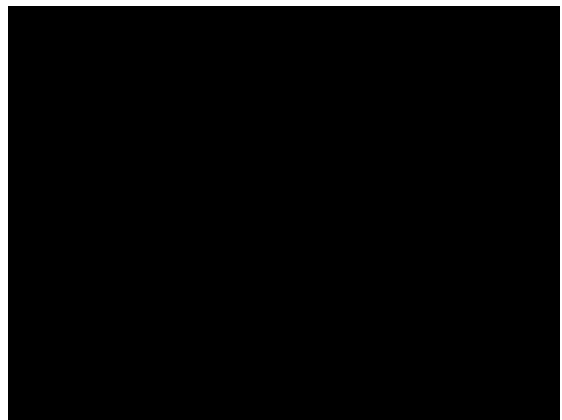
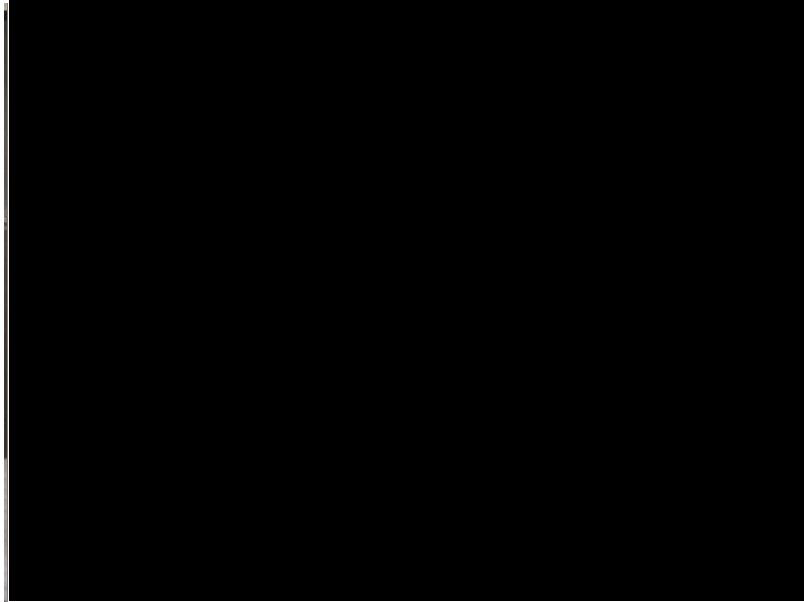
**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

AA24 Cabinet Overview



**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

AA24 - Firetrace Linear Detection Tubing Placement



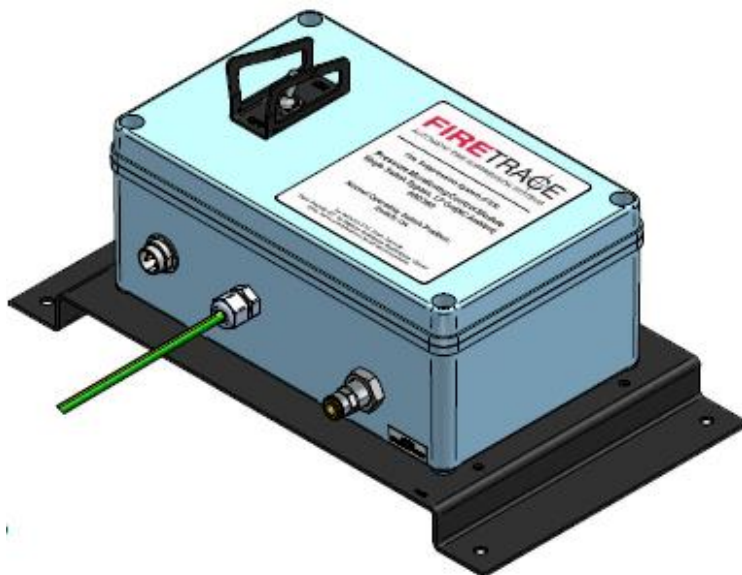
**System Design Layout
Siemens Wind Turbine
Nacelle – AA3 and AA24 Cabinet**

*Firetrace Pressure Switch Overview
Activation and Service Signal
Dual Pressure Switch*

Firetrace Dual Pressure Switch monitors both Activation and Service signal with a simple normally open or normally closed switch.

Firetrace provides harness length to match the pressure switch module and to reach the connection points necessary to signal to the turbine controls. The pressure switch module is typically mounted near the cylinder.

- Service indication switch reduces requirement for service inspection to 1 time per year instead of 2 times per year.
- Bypass switch is part of pressure switch module and allows for bypass during service and no signal sent to turbine controls.
- Robust nature of the pressure switch module box allows for securing on the outside of the component and utilizes various harness lengths with shielded wires.
- Open signal was selected for both Service and Activation Signals final confirmation of terminal connections and length of harness required TBD.





Estimated Cost Per Turbine

<i>System Design</i>	<i>Number of Systems</i>	<i>System Cost</i>
<i>Nacelle – AA3 and AA24 Cabinets</i>	<i>1</i>	██████████
<i>Sub-Total</i>	<i>1</i>	
<i>Installation for up to 2 systems</i>		██████████
<i>Total</i>		██████████

- ***Firetrace provides modular fire suppression allowing for selection of component to be protected based on customer request***
- Equipment includes junction and harness for turbine shut down and pressure monitoring, Firetrace Nitrogen Fill Adapter, Firetrace Tube Cutter, necessary brackets, zip ties, and tubing protection
- Installation to be performed by trained and certified distributor
- Final operations, maintenance and install instruction guide will be provided for the Siemens 3.2MW wind turbine at completion of the install
- Terms net 30 days, FOB Scottsdale, AZ
- Lead time for delivery 45-60 days for customized pressure switch module

SAMPLE SYSTEM CALCULATIONS: Cabinet Protection

Application Information-

- Cabinet Volume: 1.90 m³ [67.10 ft³]
 1.43 m³ [50.50 ft³]
 1.20 m³[42.38 ft³]
- Temperature Range: 20°F - 140°F
- Airflow: Minimal
- Agent: 3M Novec 1230 Fire Protection Fluid
 - NOAEL – 10%
 - MEC Class B – 4.5%
 - Safety Factor – 1.3

Calculations-

Due to the nature of 3M Novec 1230, it requires more agent at lower temperatures (concentration is reduced as a function of temperature). Therefore, the calculations for the required quantity of agent need to be done at the lowest anticipated temperature. In addition, the agent concentration increases as temperature increases. This requires the calculations for human exposure limitations be done at the highest anticipated temperature. There is a minimal risk of exposure as these systems are in cabinet.

A single system will be used to protect all cabinets. Detection and suppression will only occur in one cabinet and the system will not provide simultaneous protection for each cabinet.

Amount of agent required:

Minimum Extinguishing Concentration (MEC) of 3M Novec 1230 for Class B hazards is 4.5%. The required safety factor must be applied in order to determine design concentration:

$$4.5\% \times 1.3 = 5.85\%$$

$$W_{lb} = V/s (C/(100-C))$$

where $V = 67.10 \text{ ft}^3$
largest volume

$$s = 1.03442 \text{ ft}^3/\text{lb}$$

$$C = 5.85\%$$

Solving for W_{lb} :

4.03 lb @ 20°F Min. amount of agent required to reach design concentration at 20°F

Because the systems being used will be putting 5lbs of 3M Novec 1230 into the space, the quantity of agent is sufficient to protect the room at the design concentration using MEC = 4.5% and the required Safety Factor. Using 5lbs of agent in the equation above and solving for C, in the smallest cabinet in the range, yields a concentration of 10.88 % at 20°F. While this is slightly above the NOAEL for 3M Novec 1230, a volume of 42.38 ft³ is considered “unoccupiable”.

Concentration of 5 lbs 3M Novec 1230 at 140°F:

$$W_{lb} = V/s (C/(100-C)) \quad \text{where} \quad \begin{aligned} V &= 42.38 \text{ ft}^3 \\ s &= 1.32734 \text{ ft}^3/\text{lb} \\ W_{lb} &= 5 \text{ lb} \end{aligned}$$

Solving for C:

13.54% @ 140°F Max. concentration **inside the cabinet** at highest anticipated temperature.

* NOAEL for 3M Novec 1230 is 10% *

This is the concentration within the cabinet which is effectively an unoccupiable space. With a total volume of 100 m³, the nacelle could reach a concentration of 0.19% should the system discharge the agent throughout the entire volume at 140°F, i.e. with the cabinet doors open.

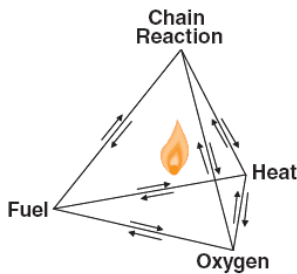


Novec™ 1230 Fire Protection Fluid

Extinguishing mechanism of Novec 1230 Fluid

3M™ Novec™ 1230 Fire Protection Fluid was developed as a sustainable clean extinguishing agent for use in total flooding applications. This unique agent is a replacement for halon and first generation halon alternatives.

**Figure 1:
The Fire Tetrahedron**



In order to understand how Novec 1230 fluid extinguishes a fire, it is important to review the principal aspects of fire chemistry. Four components— fuel, oxygen, heat and the combustion chain reaction – are often referred to as the “fire tetrahedron,” seen in Figure 1.

All four of these factors are required in the correct combination for a fire to ignite and sustain burning. The fire tetrahedron shows that a fire can be extinguished by breaking one or more of the links between these components or by changing the balance between them:

1. By interrupting the combustion chain reaction
2. By containing or eliminating the source of fuel
3. By cutting off or diluting the source of oxygen
4. By removing sufficient heat from the fire

Halons extinguish fire primarily by the first mechanism. When exposed to flame temperatures, a bromine atom is cleaved from of the halon molecule, chemically inhibiting the combustion chain reaction. Inert gases such as argon and nitrogen extinguish fire mainly by the third mechanism, diluting the oxygen level below 15 volume percent, the level required to support combustion.

Novec 1230 fluid, like other halocarbon halon alternatives, extinguishes principally via the fourth mechanism – removing heat from the fire. Upon discharge, Novec 1230 fluid creates a gaseous mixture with air. This agent/air mixture has a heat capacity much larger than that of air alone. A higher heat capacity means that this gas mixture will absorb more energy (heat) for each degree of temperature change it experiences.

At a proper system design concentration, the agent/air mixture absorbs sufficient heat to upset the balance of the fire tetrahedron. The amount of heat the fire loses to the surroundings is increased by the presence of the agent. This causes the combustion zone to cool to the point that the fire extinguishes. Novec 1230 fluid has the highest heat capacity of any commercially available halon alternative, resulting in the lowest extinguishing concentrations for a given fuel.



Benefits of 3M Novec 1230 Fire Protection Fluid:

- Halon replacement
- Most environmentally friendly clean agent available
- No residue is left after discharge
- Electrically non-conductive
- The temperature range and effectiveness far exceeds other clean agents available in the industry
- Based on calculations for each automatic fire suppression system provided by Firetrace International there is no concern for employee safety
 - No Observable Adverse Effects Level (NOAEL) is a concentration of less than 10%, none of our provided systems will reach this concentration level
- Ozone depletion potential of 0
- Global warming potential of 1

Sample Firetrace Installations

- 117 Gamesa G8x– Infigen Energy
Protecting PLC cabinet
- 45 Gamesa G8x – E.ON Climate & Renewables
Protecting PLC and converter cabinet
- 36 Vestas V82's Nebraska Public Power
Protecting three control cabinets down tower
- 1 Vestas V80 Next Era Energy Resources
Protecting main control panel and two capacitor cabinets
- 1 Vestas V80 TransAlta
Protecting main control panel and two capacitor cabinets
- 37 Vestas V90 3MW Turbine - Roaring 40's Australia
Protecting transformer and control cabinet
- 6 GE 1.5MW Turbine - Whitewater Energy
Protecting lower tower converter cabinet
- 20 Nordex N80's - Central Scotland
Protecting electrical panels in nacelle and down tower
- 33 GE 1.5MW Turbine - Valero Refinery
Protecting lower tower converter cabinet, nacelle control cabinet, and rotor/stator junction boxes
- 56 Vestas V100 Consumers Energy
Protecting main control cabinet, transformer and brake

Results 10 Successful Fire Saves



Immediate Release

Firetrace Saves Another Wind Turbine

SCOTTSDALE, Ariz. – February 10, 2011 – A Firetrace automatic fire suppression system successfully detected and suppressed a fire in a wind turbine converter cabinet. The turbine, owned by Whitewater Energy Corporation at the Karen Avenue Wind farm in Palm Springs, Calif, was the second fire incident in one of their 1.5MW turbine converter cabinets.

“There is absolutely no damage to the cabinet or internal components, other than the failed component, however we will not be turning the turbine on until we have replaced the fire suppression system and ensure that the cabinet is properly protected in the event of another incident,” said Ken Hamilton, Site Supervisor for the Palm Spring wind farm.

The Firetrace systems were installed in all six Whitewater 1.5MW turbine converter cabinets in late 2009 following a catastrophic fire that caused more than \$243,000 in damaged equipment and downtime (lost revenues & production tax credits). The Firetrace systems were just a small fraction of that cost to protect the converter cabinets of all of the turbines.

Downtime in an industry that depends on the availability of wind is a big concern when talking about replacing costly equipment. Firetrace was able to rush a replacement system to their facility and the turbine was up and running the following day.



What makes the Firetrace system so unique is the linear pneumatic detection tubing that can be routed throughout the equipment, ensuring immediate detection and suppression of a fire at the source. The Firetrace solution is automatic, requiring no external power, providing uninterrupted protection even in the most remote locations. Due to the compact size and unique detection method the systems are able to tolerate dirt, vibration and temperature extreme typical in this environment.

These Firetrace systems utilizes 3M™ Novec™ 1230 Fire Protection Fluid; one of the most environmentally friendly agents available on the market with zero ozone depletion. Novec leaves no residue after discharge, safe for employees if present in the event of a discharge and electrically non-conductive.

Firetrace International has more 150,000 systems installed, protecting critical equipment, worldwide. Specializing in commercial, industrial and military fire protection solutions, Firetrace systems can be found in wind, vehicle, aerospace, machine, electrical, server and laboratory applications. The systems are available in multiple sizes and Firetrace recommends a hazard assessment to determine the most accurate combination of systems for the identified fire risks.