FIRETRACE
AUTOMATIC FIRE SUPPRESSION SYSTEMS

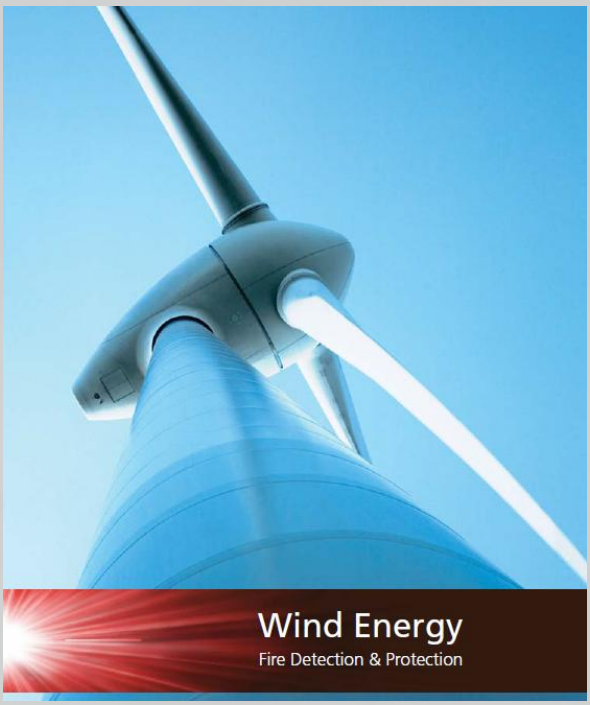
# Automatic Fire Protection for Wind turbines

## "Micro environment" protection

**September 2009**

Details on fires in wind turbines and how to suppress them using FIRETRACE® automatic fire suppression systems

# Background information




Wind energy's impact on world power supplies is rapidly expanding in virtually every country. As this growth continues, the industry faces many challenges in securing support for new facilities. Local concerns often include aesthetic, environmental, and safety concerns. In the area of safety, fire is typically an area of specific concern. Fires in a wind turbine present a very difficult problem. With the turbine unit's location hundreds of meters in the air, suppression of the fire from the ground is nearly impossible even for turbines located in easily accessed locations. For turbines in more challenging locations – or offshore – the likelihood of a timely response is highly unlikely. The usual result: the complete loss of the turbine.

**Until now,** there have not been good fire suppression options for these turbines.

Traditional fire systems have been impractical due to the environment within the wind turbine. The added weight and complexity of these systems would not fit within the nacelle, and the vibration, temperature extremes, dust and airflow resulted in a difficult challenge for systems to effectively detect or suppress a fire.

Wind Turbine Fires are a relatively rare occurrence but almost always result in the total destruction of the turbine. This can be potentially devastating for this emerging form of energy supply to both the turbine manufacturer and also the local government and operators.

The Fire Services can do very little to tackle wind turbine fires once they start – due to the remoteness of the turbine, and the height of the turbines means that reaching the fire is often impossible, and the fire trucks cannot deliver sufficient water pressure to reach let alone extinguish a turbine blaze, this problem is increased with offshore applications as offshore lifting vehicles and weather can dictate repair times.

Once a wind turbine has burned down, it can lead to between nine and twelve months of down time(VDS, 2008-07), and therefore a considerable loss of income for a wind farm operator, according to insurers WindPro. (That said, the major manufacturers will frequently step in and replace the turbine as soon as possible – no company wants a burnt-out turbine 'on show'.) Wind turbines have increased their capacities steadily over the last few years increasing the loss of production during downtime (VDS, 2008-07)
Figures suggest that fire damage accounts for between 9% (Umweltkontor) and 20% (WindPro) of the value of wind power insurance claims.

Reports of wind turbine fires demonstrate that the majority of these fires are centralised in the nacelle of the turbine caused by brake failure or electrical faults within the generator and control system.

As there is very little space and a large amount of technical equipment fires are likely to spread quickly.

If just the nacelle is completely lost the restoration cost can be as much as the original value of the whole turbine (VDS, 2008-07)

**FIRETRACE®** Systems have been installed on a large number of wind turbines around the world, protecting not only brake and bearing systems, but also electrical generators, AHU's, cable runs and other similar high-risk areas.

**FIRETRACE®** provides effective fire protection when needed and ensures peace of mind for operators, manufacturers and local householders/ businesses.

Operators are obliged to give a notice of approval when erecting a wind turbine. It is not always an option to build a different turbine on the same site.

If the wind farm is connected to a main substation then one damaged system could disconnect other turbines, this compiles losses. (VDS, 2008-07)

Fires in wind turbines normally begin one of many ways –

### 1) Electrical fault

The other main cause of fire is technical fault. Tracking the source of a fire, after the event, can take some time**. Typically a fire that starts because of technical reasons will result from overheating, or sparking, in combination with flammable fluid or vapour.

****FIRETRACE®** provides direct evidence of the source of the fire at the point where the FDT burst thus saving valuable time in sourcing the start of the fire.

When power is transferred through either **high or low voltage** switch gear it is possible for the electricity to arc and spread to surrounding flammable components.

Human error can also play a part. In the past, fires have been caused by loose or broken electrical connections, which can introduce sparks or heat. Nearby oil spills, grease, rubber cable linings, plastics covers and any other flammable materials can potentially be ignited.
Fires can also occur as a result of component failure. In 2003 the nacelle of the German1.2 MW Vensys 62 prototype burned down, apparently due to a short circuit in a fail-safe battery pack of the pitch control system.

### 2) Machinery fault

It can also happen that a bearing starts failing and runs dry. The resulting heat build-up in the component can finally – especially if combined with oil and or grease – lead to disastrous fires and consequent installation damage. Insufficient lubrication oil, failing cooling systems and other operational imperfections can also lead to problems which, under certain conditions, may lead to fire. Finally, a fail-safe brake running hot during a sustained brake action could be a potential cause of nacelle fire. Again, a combination of oil with grease spills increases the probability.

### 3) Lightning strike

Lightning does not necessarily lead to fire. Often, when a wind turbine is struck by lightning it can simply lead to repairable damage – typically a turbine blade will be smashed and need to be replaced. Yet if a lightning bolt sparks a fire, it becomes totally destructive. Susceptibility to lightning damage is heavily dependent on a wind turbines location – and its size. According to Birger Madsen of BTM Consult, continental Europe is susceptible to
Lightning strike – there is a relatively high frequency of lightning in the north of Germany and the Alps, while Denmark is rarely affected.

Parts of Japan have experienced severe lightning losses cited was a problem in one area of Japan during a particularly turbulent winter where it was reported ‘Data collected from one winter season in Japan alone reveals losses of horrifying proportions. In just one season, and just one area of Honshu, at least 55 machines had blades destroyed by lightning. The total loss estimate for one year loss for those machines exceeded $5.5 million, and the cost of prevention is approximately one half that value.

As turbine size increases, so does vulnerability to lightning. Offshore wind farms also face a higher risk. Thus, lightning conduction becomes a more essential, and more standard, element of wind turbine blades. In particular, the growing trend towards use of (highly conductive) carbon fibre in the larger

blades – as a way of adding maximum strength with minimal weight – increases vulnerability from lightning.

4) **repair work**

Repair work that involves cutting tools or welding can potentially ignite combustible materials up to 10 meters away, according to VDS 3523en fire protection guidelines for wind turbines this is a common cause of fire and often happens hours after the repair work is completed.

**Turbine age**

Another factor that affects susceptibility to fire is the age of the turbine. In the US, thousands of small wind turbines in the 80–150 kW range were installed in previous decades. At that time, it was very uncommon to fit lightning protection systems into the blades.

As a result, lightning incidents resulting in a fire are more likely with these older turbines.

About 85% of all turbines (reckoned on a megawatt-basis) sold worldwide in 2003 were conventional wind systems, with a drive train that typically comprises one or two main Bearings, a main shaft, a gearbox, high-speed shaft, fail-safe brake, and a generator. This type of system requires a large quantity of lubricant (oil). In these machines, the transformer is accommodated either in the nacelle or in the tower base.

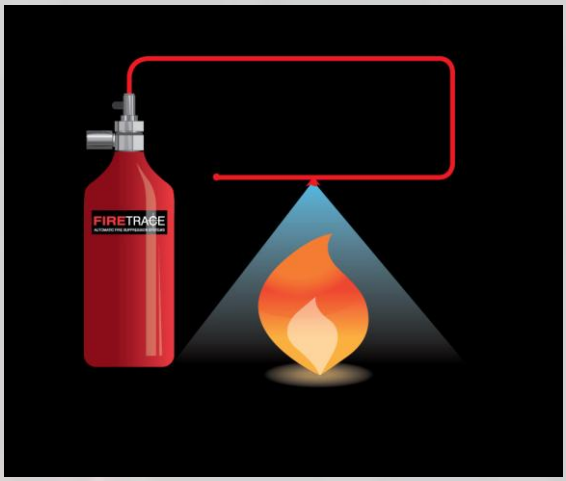
The remaining, approximately 15%, share of the world market in 2003 was made up by turbines that use a direct drive system. These contain a large ring generator, and do not need a gearbox. They therefore have no drive components that require a large amount of oil. On the other hand, the voluminous ring generators contain a significant quantity of (potentially) flammable resins.

In either case, any leakage of fluid can lead to problems.

# How FIRETRACE® works

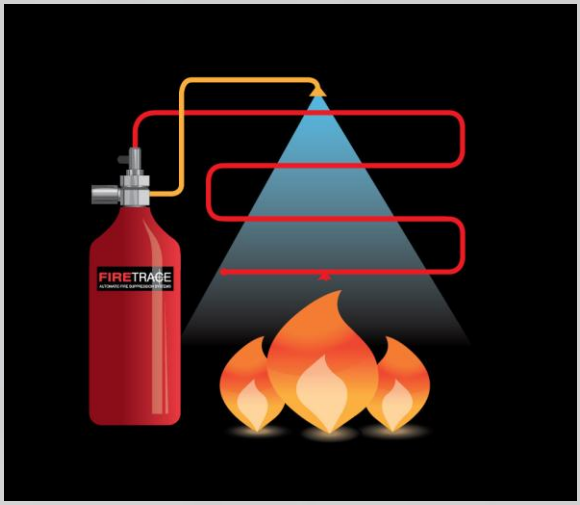
**FIRETRACE®** employs a flexible detection and delivery system called Firetrace Tubing. The tubing is manufactured from specially processed polymer materials to achieve the desired heat detection and delivery characteristics.

The **FIRETRACE®** Tubing, which is pressurized, is placed within an enclosed area above potential fire hazards and secured in place with brackets provided. Extinguishing mediums can be matched to the particular application. Various system sizes are available to accommodate the appropriate amount of agent. The systems require no power to run and require minimum maintenance.




The Direct **FIRETRACE®** system discharges the suppression agent directly from the burst hole in the tube, this will be the closest point to the fire, and will allow the fastest extinguishing time and minimum spread of the fire.

The Indirect **FIRETRACE®** system discharges the suppression agent into the protected area via plumbed diffusers that are initiated by the Firetrace tube bursting, this allows agent to be delivered quickly and directed at a specific point.



# System Choice

There is a useful role for automatic fire extinguishers, functionally coupled to key system functions. Some turbine manufacturers are believed to be looking at incorporating these systems into their products, and the controlled environment within modern nacelles could now make this easier than it might have been in the past.

The **FIRETRACE®** system is unique in the combination of detector and suppression combined requiring no external power source for either monitoring or activation. This consists of a pressurised container commonly consists of a single Novec 1230 (extinguishing agent manufactured by 3M) clean agent direct discharge system with a linear heat/flame detection that is appropriately routed all around the "high hazard" area to provide heat detection in a 360 degree environment.

In the event of a fire, or high temperature rise, the FDT (**FIRETRACE®** Detection Tube) will burst and discharge the agent directly on to the fire at its source, rapidly knocking down any fire. The agent quickly fills the area and cools the fire; it also breaks up the chemical reaction which causes fire.

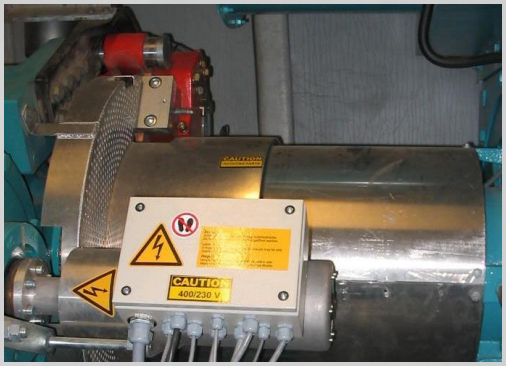
The system is also fitted with a pressure switch that constantly monitors the contents of the container and can be used to sound an alarm or send a signal via a control panel to the operator situated remotely that a system has been discharged, thus alerting the local emergency services at the earliest opportunity.

**FIRETRACE®** Detection Tubing is ideal for fire detection in wind turbines as it tolerates the vibration, dirt, and temperature extremes of the environments in which these operate, this is a key issue for fire detection stated by VDS 3523. Also, being pneumatically operated, they require no power from the control panel to operate and operate even in the event of an electrical failure caused for example by a lightning stick to the turbine. Following a discharge, no cleanup is required and upon inspection the system can be easily recharged and a new FDT tube fitted within hours.

The **FIRETRACE®** system is ideal for localised detection of safety critical or commercially sensitive equipment where the cost of downtime and customer safety is critical to the success of the business. The system can never respond to a false alarm, only a direct heat source will initiate the system.

Considering the lead time and cost of many of the critical components within the wind turbine, the integrity of the **FIRETRACE®** system is ideal to minimise costly repairs and ensure that the wind turbine can be restored to full working use and payback within the shortest period of time.

## Hydraulic Braking systems



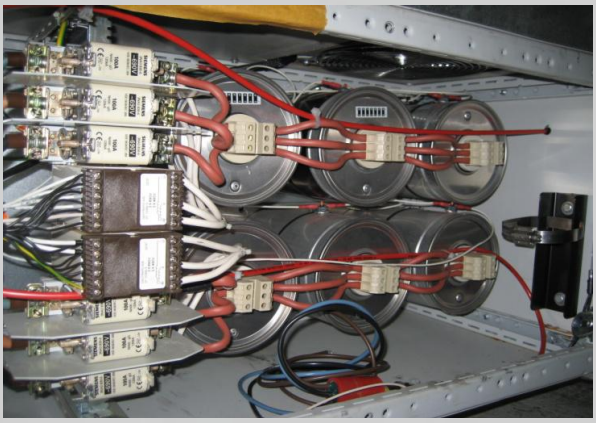

**FIRETRACE®** detection tubing is installed along any part of the internal workings of the wind turbine (for instance, parallel to the hydraulic lines) and delivers Novec Indirectly (ILP Systems) or another fire suppressant to extinguish a fire within seconds of its starting.

This is proven to reduce damage to a minimum. The systems are designed to work automatically, without the need for manual activation and monitoring.

## Main and secondary Capacitor bank Installlation

**FIRETRACE®** detection tubing is installed along the capacitor banks as shown and delivers clean agent directly (DLP System) to extinguish a fire within seconds of its starting.

CO2 is not used in this application to prevent thermal shock to the capacitor banks.



## Electrical Cabinet Installation

The **FIRETRACE** Fire detection tubing is routed within the cabinet in close proximity to all potential problem areas and delivers Novec directly (DLP System)

Upon arcing of a component and outset of the fire, the tube will burst providing instantaneous and direct application of the agent to the source of the fire, thus preventing critical damage to the cabinet / and or escalation of the fire leading to catastrophic failure.

# Agents

The **FIRETRACE®** fire detection system can be offered as either a direct (as per photos) or indirect system, with localised suppression and total envelopment of the fire with a range of agents, including:-

- Novec 1230
- FM-200
- $CO^2$
- Dry Powder
- Foam

Wind turbines are at the forefront of renewable energy and green technology so it is only right that they utilise a clean fire suppression agent. **FIRETRACE®** recommends the use of Novec1230 for many applications as it highly effective, and one of the greenest fire suppression agents available.

## Novec 1230 Fire protection fluid

The extinguishing agent used in **FIRETRACE®** pre-engineered automatic indirect fire suppression units is Dodecafluoro-2-methylpentan-3-one, more commonly known as Novec 1230.
Novec 1230 (1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE) is a colourless low odour fluid, low in toxicity, electrically non-conductive, leaves no residue, and is an extremely effective fire suppression agent. Novec 1230 is included in NFPA-2001, under the generic name FK-5-1-12, and has been evaluated and approved for use in occupied areas as a Total Flooding agent; when used as specified under the U.S. Environmental Protection Agency (EPA) SNAP Program rules.
Refer to the SNAP Program rules for more information.

**Cleanliness**
Novec 1230 is clean and leaves no residue, thereby minimizing after fire clean up along with keeping expensive downtime to a minimum. Most materials such as steel, aluminium, stainless steel, brass, as well as plastics, rubber and electronic components are not affected by exposure to Novec 1230. This agent is also environmentally friendly, having ozone depletion potential (ODP) of 0.00 and an atmospheric lifetime of 5 days (the closest halocarbon alternative is 33 years). (3M, 2003)

**3M™ Novec™ 1230 Fire Protection Fluid Environmental Properties Comparison**

Not for specification purposes

All data other than those for Novec 1230 fluid were compiled from published sources

| Properties | Novec 1230 | Halon 1211 | Halon 1301 | HFC-125 | HFC-227ea | HFC-23 |
|---|---|---|---|---|---|---|
| Ozone Depletion Potential (ODP)[1] | 0.0 | 5.1 | 12.0 | 0.0 | 0.0 | 0.0 |
| Global Warming Potential–IPCC[2] | 1 | 1300 | 6900 | 3400 | 3500 | 12000 |
| Atmospheric Lifetime (years) | 0.014 | 11 | 65 | 29 | 33 | 260 |
| SNAP (Yes/No) | Yes | N/A | N/A | Yes | Yes | Yes |

[1] World Meteorological Organization (WMO) 1998, Model-Derived Method
[2] Intergovernmental Panel on Climate Change (IPCC) 2001 Method, 100 Year ITH

(3M, 2003)

## Physical Properties of NOVEC1230™

**Specific Physical Form:** Liquid
**Odour, Colour, Grade:** clear collarless, low odour.
**General Physical Form:** Liquid
**Auto ignition temperature** *Not Applicable*
**Flash Point** *Not Applicable*
**Flammable Limits - LEL** [*Details:* Non-flammable]
**Flammable Limits – UEL** [*Details:* Non-flammable]
**Boiling point** 49 ºC
**Vapour Density** 11.6 [*Ref Std:* AIR=1]
**Vapour Pressure** 244 mmHg [@ 20 ºC]
**Specific Gravity** 1.6 [*Ref Std:* WATER=1]
**pH** *Not Applicable*
**Melting point** -108 ºC
**Solubility in Water** Nil
**Evaporation rate** > 1 [*Ref Std:* BUOAC=1]
**Volatile Organic Compounds** 1600 g/l [*Test Method:* calculated SCAQMD rule 443.1]

Refer to NFPA-2001 for additional information.

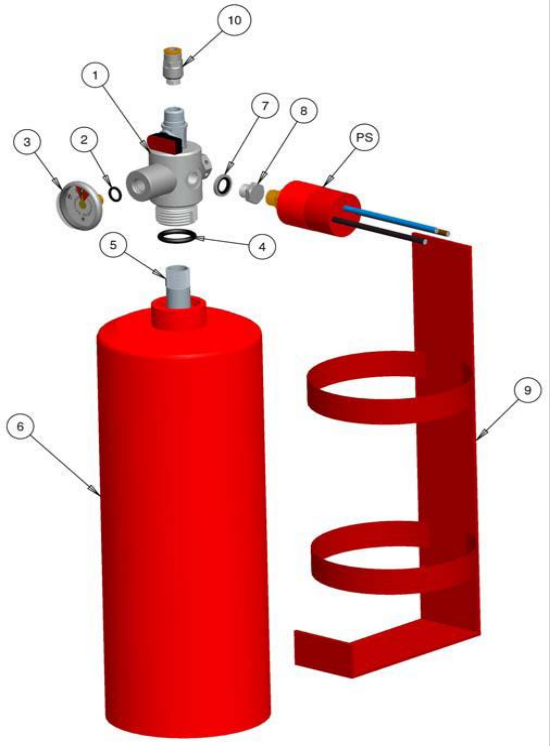
## Cylinders and Valves

**FIRETRACE®** systems can utilise both TPED and D.O.T cylinders made from either aluminium or steel. Each cylinder is finished in red and painted to resist corrosion.

Each cylinder is equipped with a nickel plated brass valve, a pressure gauge to monitor cylinder pressure, and a quarter turn ball valve that interfaces with the **FIRETRACE®** detector tubing.

## Pressure switch

A pressure switch is provided to monitor system pressure, system actuation and/or to energize or de-energize electrically operated equipment. This unit can be connected at the end of the line of the **FIRETRACE®** detector tubing, or on the container valve assembly to provide additional electrical functions as may be required. **FIRETRACE®** recommends that all systems use a pressure switch coupled with some device to alert personnel in the event of a system discharge.




**ITEM DESCRIPTION**

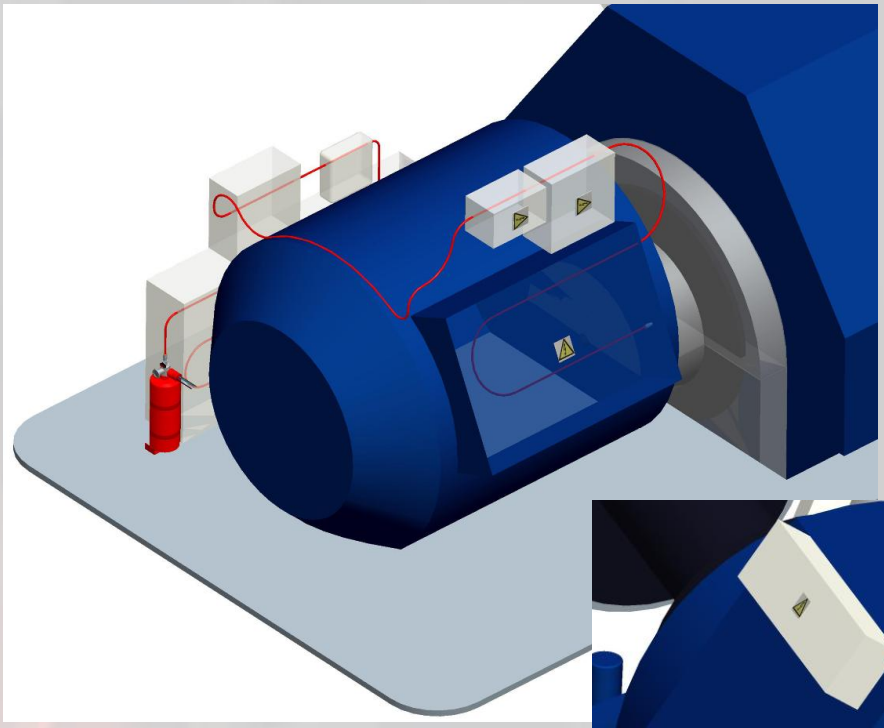
1 DLP Valve
2 O-Ring, Pressure Switch/Pressure Gauge
3 System Gauge
4 Collar O-ring DLP
5 Siphon Tube
6 Low Pressure Cylinder
7 Bonded seal (pressure switch on valve)
8 Plug, pressure switch port on valve
9 Low Pressure System Bracket
10 HP Slip-on union connector valve, man rel, EOL
PS Pressure Switch

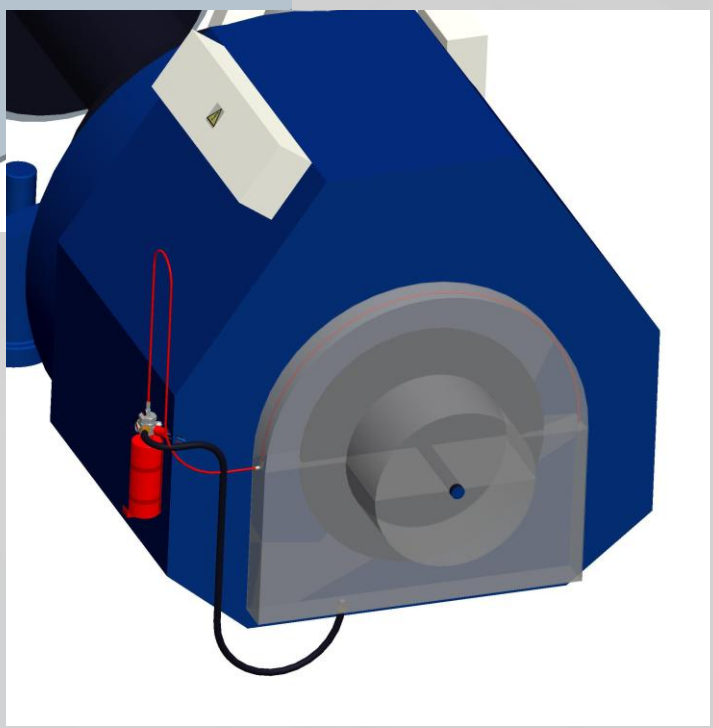
Full technical details upon request.

# Common Applications

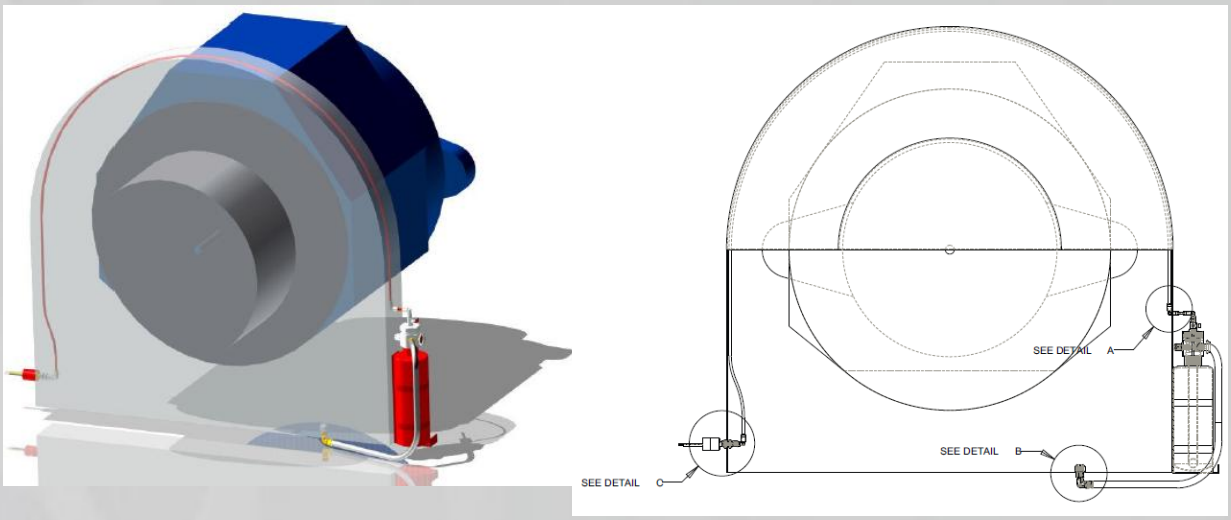
**FIRETRACE®** systems are suitable for many applications including but not exclusive of:

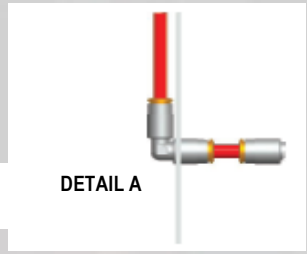
- Brake System
- Switchgear and control Cabinets
- Turbine Control Unit
- Hydraulic Power Unit
- Generators
- Transformers

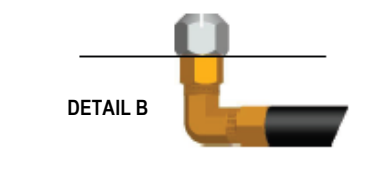


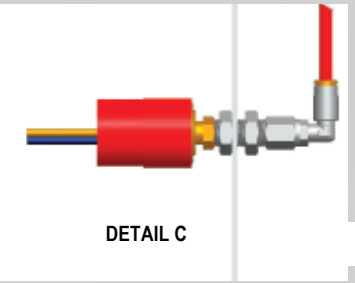


# Brake System




The brake system can be protected using a medium or large size Novec 1230 ILP system. The shroud that covers the system provides both an excellent detection tubing location and volume enclosure. Installation of the detection tubing along the inside of the upper portion of the shroud places the tubing within inches of the rotor and will provide excellent detection time. Placement of the nozzle should be somewhere on the shroud that can provide coverage to both sides of the rotor at one point. The rotation during operation will cause the discharge to cover and cool all 360° of the rotor. The shroud will keep the agent concentration at a high level for an appropriate amount of time.

## Example BOM's

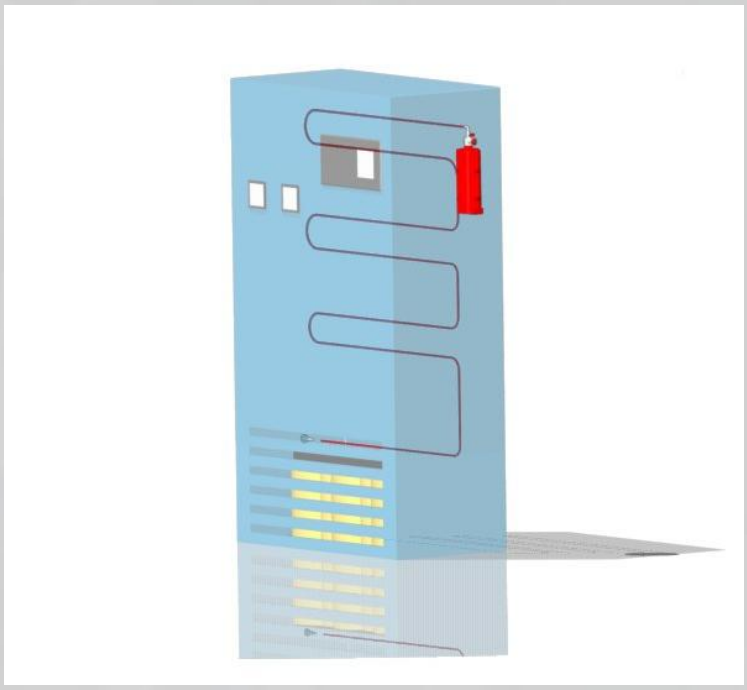
### CE Equipment

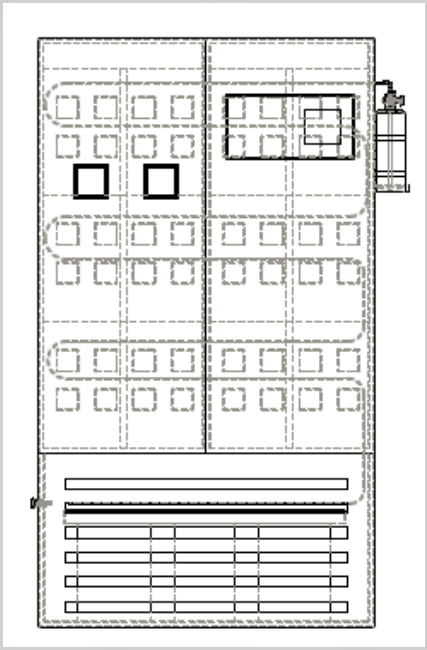
| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890104 | 1 x 2kg Indirect Low Pressure Novec System CE |
| 1 | 85810 | 1 Nozzle- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821610 | 1 x 10 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |
| 5 | 843568 | Kopex flexible conduit mtr - Tube Protection |

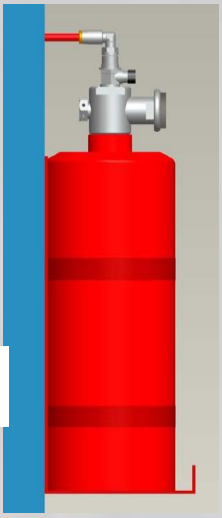
### D.O.T Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 895105 | 1 x Medium 5lb Novec Indirect Low Pressure System D.O.T |
| 1 | 851201 | 1 Nozzle- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821610 | 1 x 10 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |
| 5 | 843568 | Kopex flexible conduit mtr - Tube Protection |

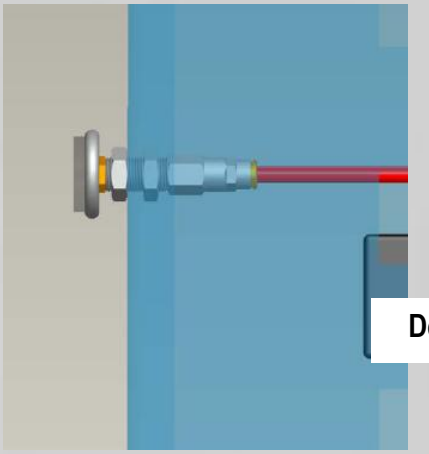
# Switch gear and control panels







Detail “A”



Detail “B”

The recommended system for use in electrical equipment would be a direct low pressure system (DLP) using a clean agent such as Novec1230. The reason for using a direct system is that you can pinpoint the fire and apply the agent directly to the fires source while it is still a small fire, this means that there is minimal damage to the component in the panel and can reduce the downtime of the panel. You can also use one system to cover multiple cabinets or enclosures.

Typically fires in electrical panels start from loose connections and faulty wires, when there is power running through them the electricity can ark. This arced electricity is extremely hot and causes the plastic coatings on the wires to burn and spread to other components. One thing to note is that low voltage and high voltage connection and equipment are both fire risks and deserve equal amounts of protection. By running the tubing directly above any connections and components such as transformers you will minimise the time it takes to detect the fire.

### Importance of pressure switches

It is vital that a pressure switch is incorporated into the system which will shut the power off in the event of a fire. If power is running through a loose connection which has arced it will be extinguished by the **FIRETRACE®** system, however if power is still running through the wires after the fire has taken place it is likely that the fire will re-ignite.

### Example BOM's

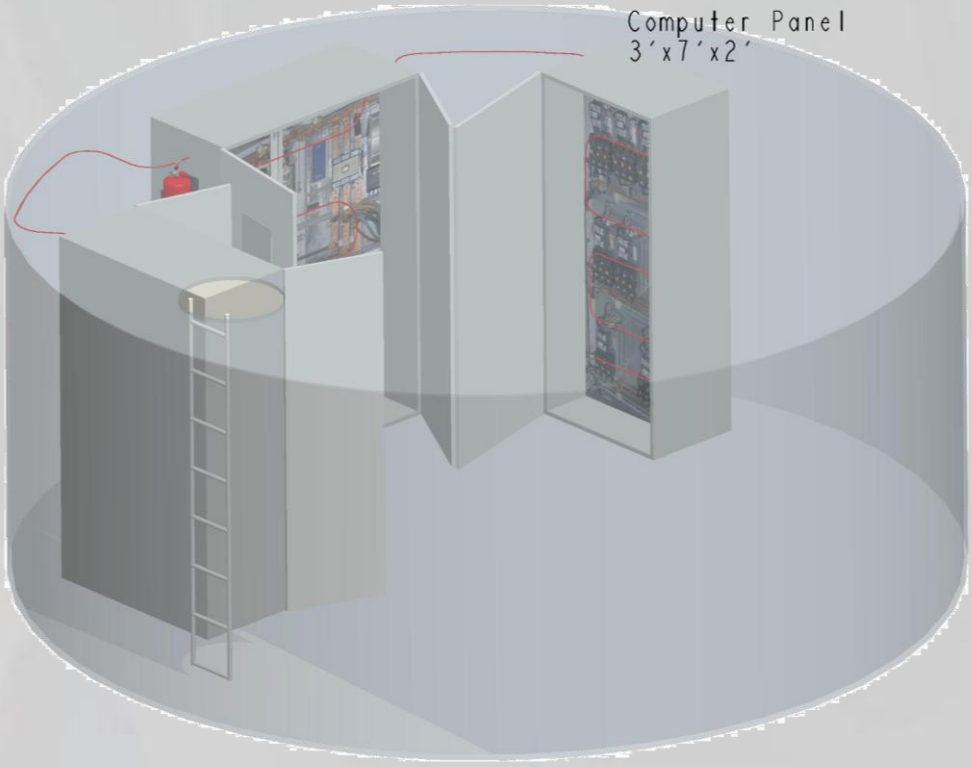
### CE Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890005 | 1 x 2kg Direct low pressure Novec System CE |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

### D.O.T Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 895005 | 1 x Medium 5Lb Novec Direct Low Pressure System D.O.T |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

# Turbine control unit




Control units at the base of the turbine can be protected using direct low pressure Firetrace systems, and is typically used to protect and electrical equipment associated with the turbine. A single **FIRETRACE®** system can be used to protect multiple cabinets by routing the **FIRETRACE®** detection tubing in several directions and into multiple enclosures

**Example BOM**

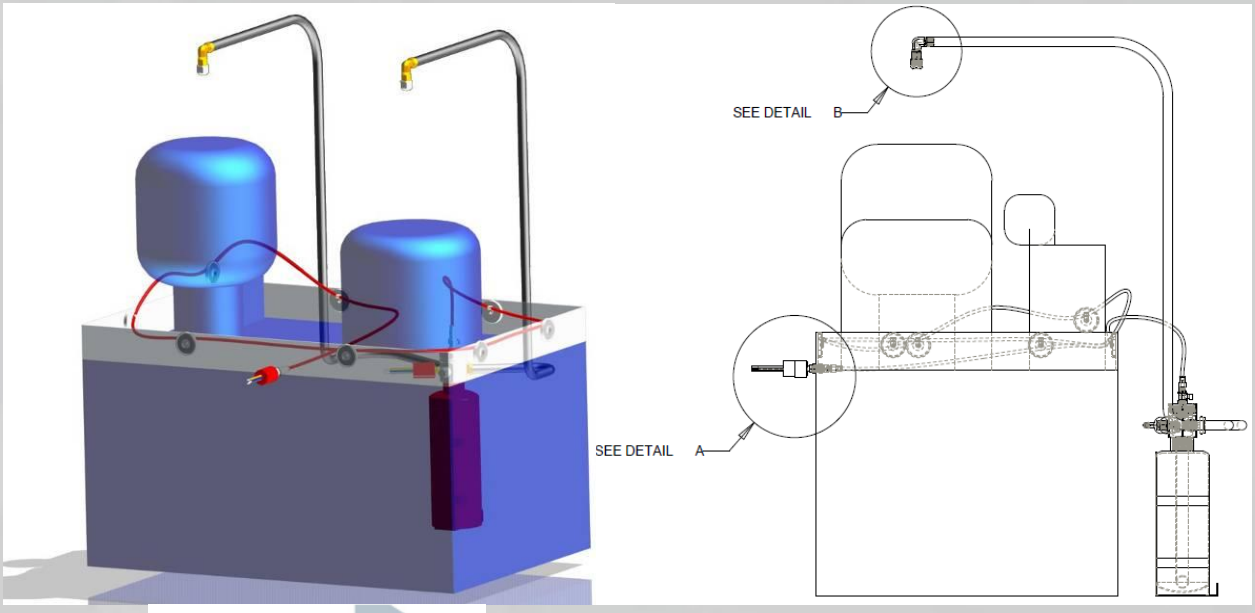
**CE Equipment**

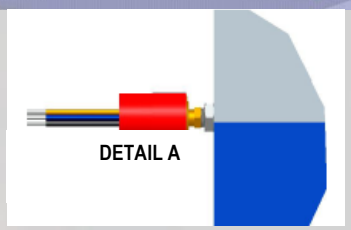
| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890009 | 1 x 5kg Direct low pressure Novec System CE |
| 1 | 823630 | 1 x 30 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

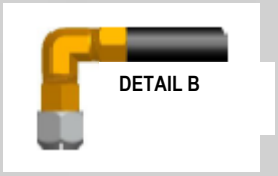
**D.O.T Equipment**

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 895009 | 1 x Large 10Lb Novec Direct Low Pressure System D.O.T |
| 1 | 823630 | 1 x 30 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

# Hydraulic Power Unit




The Hydraulic Power Unit (HPU) can be protected using a medium or large size Novec 1230 ILP system. Typically there is no enclosure, which prevents total flooding of the unit and requires treatment as a local application. The detection tubing should be secured to the top surfaces of the HPU so that it is in close proximity to each component. The discharge nozzles must be mounted above the HPU in a way that will provide total coverage to all of the top surfaces. Since there is not an enclosure to use, custom mounting brackets may be required to properly place the nozzles in this way.

### Example BOM's

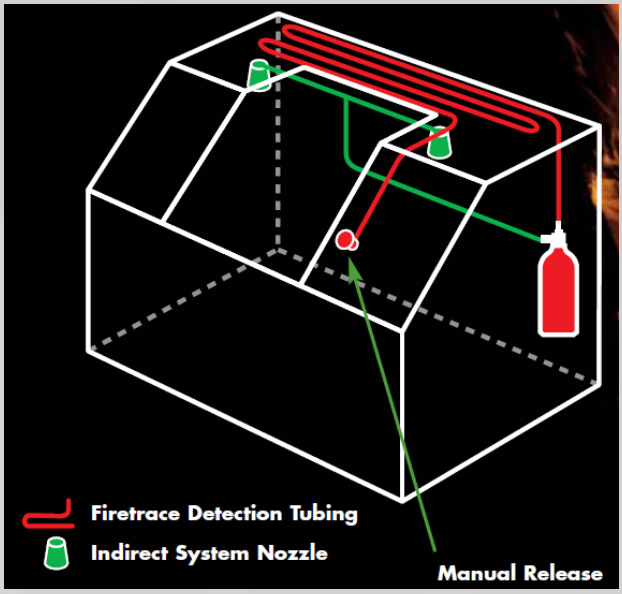
### CE Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890108 | 1 x 5kg Indirect Low Pressure Novec System CE |
| 1 | 858102 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

### D.O.T Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 895109 | 1 x Large 10lb Novec Indirect Low Pressure System D.O.T |
| 1 | 851202 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

# Generators




Generators can be protected using either large Novec systems or high pressure $CO^2$. The detection tubing will be installed inside the generator as close to any potential hazards as possible, typically fires are caused by small electrical faults or by leaked oils and fluids igniting on hot surfaces. Either 2 or 4 nozzles can be spaced equally within the cabinet to suffocate and cool the fire. A pressure switch can also be used to shut down the generator to cut off airflow and also to stop fuel being pumped if the origin of the fire was due to a leak.

## Example BOM's

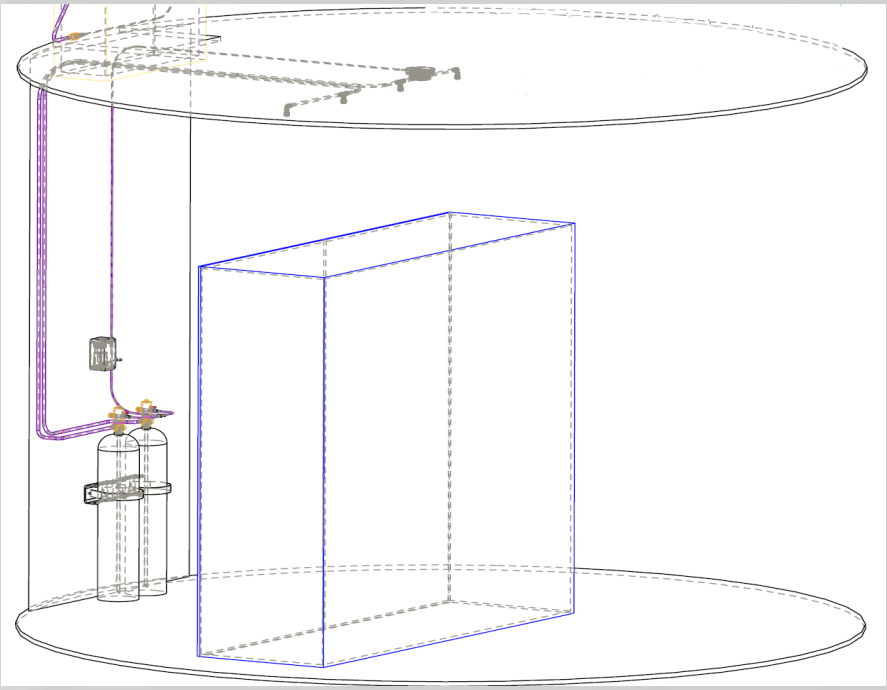
### CE Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890209 | 9kg Indirect High pressure CO2 System CE |
| 1 | 859702 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

### D.O.T Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 896009 | 1 x 20lb CO2 - Indirect High Pressure System D.O.T |
| 1 | 859702 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821615 | 1 x 15 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

# Transformers



Transformers in the power industry are under constant use and are capable of building up great amounts of heat. Many transformers are full of oil and if it leaks or overheats this oil can ignite and spread. To protect transformers large indirect Novec or $CO^2$ systems can apply agent locally to the transformer and cool the oil and hot surfaces down. The agent will be distributed via fixed nozzles positioned to locally flood the area around the transformer.

**Example BOM's**

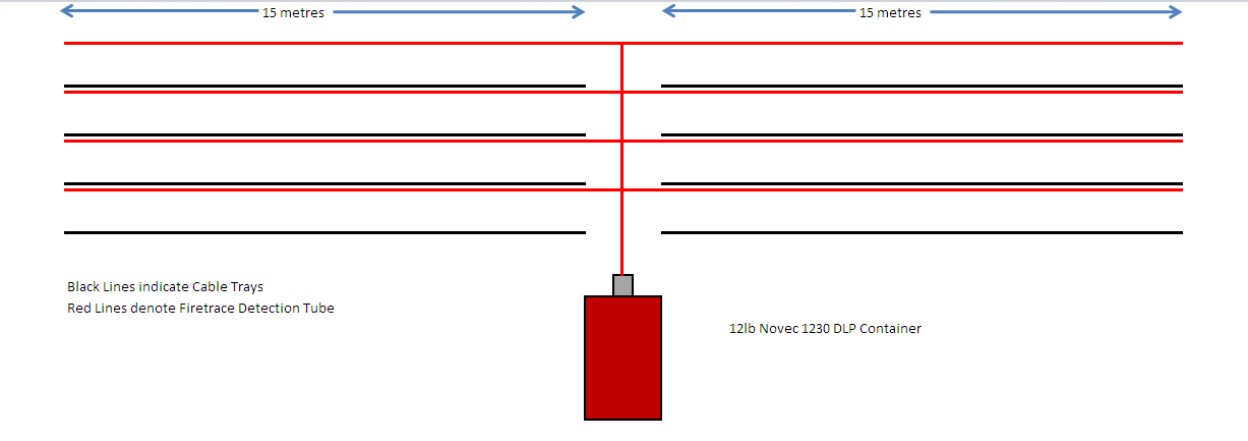
**CE Equipment**

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 890209 | 9kg Indirect High pressure CO2 System CE |
| 1 | 859702 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821610 | 1 x 10 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |
| 1 | 400312 | Solenoid - 12VDC equivalent |

**D.O.T Equipment**

| Quantity | Part No. | Description |
|---|---|---|
| 1 | 896009 | 1 x 20lb CO2 - Indirect High Pressure System D.O.T |
| 1 | 859702 | 2 Nozzles- Discharge Kit inc Pipe/Fittings/Nozzle(s) |
| 1 | 821610 | 1 x 10 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |
| 1 | 400312 | Solenoid - 12VDC equivalent |

# Cable trays




A fire in an underground tunnel can be a devastating event. With limited access and difficult working conditions, fire and smoke can rapidly become a deadly enemy against your equipment and personnel working within the tunnel environment.

Cable trays can be protected using direct low pressure **FIRETRACE®** systems using Novec. By running the detection tubing over the top of the cables it is in a prime position to detect and suppress the fire while it is still in its infant stages. This means that instead of using massive amount of agent to flood the entire tunnel or room a small directed amount of agent will suffice. As with all **FIRETRACE®** systems these can be integrated with pressure switches in order to cut power after a fire

### Example BOM's

### CE Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 3 | 890005 | 1 x 2kg Direct low pressure Novec System CE |
| 3 | 823630 | 1 x 30 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

### D.O.T Equipment

| Quantity | Part No. | Description |
|---|---|---|
| 3 | 895005 | 1 x Medium 5Lb Novec Direct Low Pressure System D.O.T |
| 3 | 823630 | 1 x 30 meters 4/6 Firetrace Detection Tube Kit (FT Tube + Fittings) |

# FIRETRACE® Detection Tubing (FDT)

At the heart of all **FIRETRACE®** systems is the Firetrace Detection Tubing, or FDT. This flexible, pneumatic tubing is the primary fire detection and unit activation method used in all **FIRETRACE®** Automatic Suppression Systems. It is flexible enough to be used in the most difficult installations, yet durable enough to withstand harsh conditions and continue to perform as intended.


**Firetrace Detection Tubing**

The FDT is a linear, pneumatic, fire detection device that responds to a combination of heat and radiant energy generated by a fire. When exposed to these conditions, the properties of the FDT in this localized area change. The material becomes softer and weaker than the surrounding areas. In this weakened state, the gas contained inside of the FDT is able to burst through, releasing the pressure in the entire length of FDT. This rupture and depressurization of the FDT is what activates the rest of the system, which discharges the fire suppression agent.

**FDT after Detection**

Since the FDT is the fire detection device, it needs to be installed in a location where it will be exposed to the fire conditions. Fast detection times are key to the **FIRETRACE®** Systems, so the FDT should be installed as close as possible to the hazard without obstructing any moving objects in the environment. Because of the flexibility of the FDT, it can be installed anywhere a bundle of cables or wires are run. The FDT can be installed surrounding the hazard or sometimes even on the hazard itself.

The FDT material is a non-porous, non-conductive, blend of proprietary resins. This unique blend of materials gives the FDT the following attributes

- Excellent Physical Durability and Flexibility
- High Pressure Performance
- Wide Temperature Range
- Good Chemical Resistance*
- Excellent UV Resistance

*Tests on chemical resistivity performed by Oxford University

The standard FDT is red in colour and 4/6mm ID/OD in size. It can also be made available as a clear tubing, for use in special applications where visibility is not desired. For applications requiring a larger flow rate, a 6/8mm ID/OD size of the red FDT is available.

# FIRETRACE® *Detection Tube Testing*

**Leakage rate:**

The FDT passed the Underwriters Laboratories and Factory Mutual Research long term leakage tests. Twelve sample systems, each with 52 feet of FDT were weighed and then placed in a secure storage area. The maximum allowable leakage rate was 0.0075 ounces leakage over a period of one year. Each quarter of a year, 4 random samples were selected and weighed. At the end of the full year, all twelve samples were weighed. There was no measurable leakage. The FDT passed the test.


**Exposure to UV radiation:**

Samples of FDT, each 12 inches in length, were subjected to the UV Light and Water Test in accordance with ASTM 154 utilizing the UVB 313 Lamp. Test duration was 1000 hours. Following this test, the samples were examined for cracking or deterioration. None was found. These same samples were then subjected to a hydrostatic test of six times the normal operating pressure (150 x 6 = 900 psi) of the tubing for a period of one minute. There was no burst or leakage as a result of this test. Pressure was then raised to 1000 psi for a period of one minute with no burst. Each sample was then raised to burst pressure. Average burst pressure of the twelve samples was 1200 psi.

**Aging Test:**

A total of twelve samples of FDT, each twelve inches in length, were subjected to an air-oven aging test for 180 days at 212°F (100°C). Following this test, the samples were examined for cracking or deterioration. None was found. These same samples were then subjected to a hydrostatic test of six times the normal operating pressure (150 x 6 = 900 psi) of the tubing for a period of one minute. There was no burst or leakage as a result of this test. Pressure was then raised to 1000 psi for a period of one minute with no burst. Each sample was then raised to burst pressure. Average burst pressure of the twelve samples was 1200 psi.

**30 Day Extreme Temperature Leakage Test:**

A total of twelve fully charged FIRETRACE® Indirect systems, charged with FM-200™ Clean Extinguishing Agent and super pressurized with nitrogen to 150 psi and including 24 inches of detection tubing (also charged to 150 psi) were exposed to the temperature extremes, 0°C (32°F) to 54.44°C (130°F), for a period of 30 days. A total of six charged systems were exposed to 0°F and six charged systems were exposed to 130°F. Weight (in grams) was recorded before and after the test. There was no loss of weight noted of any of the samples at the end of the test. Following this test the systems were discharged with a standard propane torch impinging on the FDT. System actuation was within two seconds and in each case, discharged as intended.

# Approvals & Listings


**FIRETRACE®** International's systems carry several internationally recognised approvals and listings and have been independently tested by third parties for exposure to many types of chemicals, solvents and UV radiation. As an **ISO 9001** accredited company you can be sure of the fact that all systems are manufactured and tested in a quality environment.

**Australia** – SSL Listing No. AFP 1368 Scientific Services Laboratory, Victoria, Australia
**Austria** – Prufstelle fur Brandschutztechnik
**Bahrain** – State of Bahrain Ministry of the Interior, Protection and Prevention Section
**Belgium** – ANPI/NVBB Rapport D'essai no. SPT/ME 020/1987.12.08
**China** – CNACL No. China National Accreditation of Laboratories
**Czech Rep** – Strojirensky Zkusebni Ustav S.P Engineering Test Institute
**Denmark** – Danish Institute of Fire Technology
**France** – CNPP GC01 0017 CNPP IE 99 5585
**Germany** – BAM/TUEV Approval
**Greece** – Approval Report 44672 701.6
**Hungary** – Belugyminiszterium Tuezoltosag Orszagos Parancnoksag Szum 188/31/1999
**Israel** – The Standards Institution of Israel Test Certificate 8013107171
**Italy** – TESI No. 094/B Tecnologie Sviluppo Industriale
**Netherlands** – TNO Netherlands Project Ref 006.10329.01.02
**Romania** – SC Instal Somet SA Act de Omologare No. 7/2000
**Qatar** – Civil Defence
**Sweden** – SBF 128:1 Swedish Bus Approval
**United States** - Factory Mutual Approval / UL & ULC Listing

# Frequently Asked Questions

**What pressure is the system working to?**

**FIRETRACE®** systems are typically pressurised with dry nitrogen to around 13.4Bar (195psi), this will vary slightly on some models

**What happens if I have more than one fire simultaneously in the turbine area?**

Dependent upon the design of the installation, if a fire is started due to a lightning strike there may be simultaneously a hydraulic fire and a capacitor bank fire, in this case if two systems are installed, each will suppress the relevant fire locally.

**If the system puts out the fire, why does the operator need to know there has been a problem?**

Often the source of a fire in a nacelle can be electrical, or down to a mechanical fault with parts. If the turbine were to continue to operate after a system had extinguished a fire, then the faulty unit could re-ignite a fire situation and you would then have a situation of a fire with no-further protection. By stopping the turbine and alerting the operator, standard safety practice can be implemented preventing further damage to the turbine.

**If the system is activated, do I need to replace the whole system?**

No. Should you have the unfortunate incident of a fire, the system will operate as intended and some works will obviously need to be carried out to bring the system back into operation again. This involves re-charging the contents of the container via an approved agent, or for speed purposes, replacing the container with an identical one that is already filled.

The Fire Detection Tube will not normally need to be replaced, as the burst point can be cut from the tube and the tube can then be re-connected with a straight adapter. The system can then be pressurized and reset for use. In theory, your system could be operational again within only a few hours and at minimal cost.

**Will the FM 200 or Novec cause any damage?**

No. There is no chemical residue that will affect the performance of electrical systems within the Nacelle; however it is recommended that routine maintenance of the hydraulics and lubrication should be undertaken at the time of inspection.

# References

**NFPA 2001. 2008.** *standard on clean agent fire extinguishing systems.* massachusetts : s.n., 2008.

**3M. 2003.** *Novec 1230 fire protection fluid.* st paul : s.n., 2003.

*nany smith article.* **Vries, Eize de. 2003.** s.l. : renewable energy world, 2003.

**VDS. 2008-07.** *Wind turbines fire protection guidlines.* amsterdamer : german insurance assosiation, 2008-07. VDS 3523en.