The Hidden Fire Risk – Electrical Cables

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Introduction

Electrical cables pass through all areas of plant and facilities carrying essential power supplies and control to electrical and electronic equipment required to ensure operation of the plant or facility. These electrical cables are routed via risers, ducts, ceiling voids and open areas in cable trays, cable channels, conduits or even openly along support structures.

Seldom is the fire risk potential of these cables considered in the overall fire safety of plant and facilities even though they provide a conduit for fire spread and a potential source of ignition.

Electrical cables can be considered in two distinct categories of fire risk namely:

- a source of ignition and combustibility, and
- an exposure risk

Electrical Cables a Source of Ignition

The statistics of the National Fire Protection Association, available for 1993 to 1997 are that 41,200 home structure fires per year are attributed to electrical distribution. These electrical distribution fires account for 336 civilian deaths, 1446 civilian injuries, and $643.9 million in direct property damage per year. These figures include a proportional distribution of fires with unknown equipment involved in ignition, but do not include power cords or plugs which are attributed to specific appliances. The 41,200 structure fires account for 9.7% of total home structure fires in the period, placing electrical distribution 5th out of 12 major causes. The $643.9 million in property damage represents 14.4% of total damage, putting electrical distribution in second place (behind incendiary or suspicious causes). Earlier statistics compiled for 1985. 1994 by FEMA showed very similar results: electrical distribution was the fifth-ranked cause of fires, the fourth-ranked cause of fire fatalities, and the second-ranked cause of property loss.

The electrical distribution causes are itemized in Table 1.

Table.1. Causes of US residential fires due to electrical distribution

Cause of fire	**%**
Fixed wiring	34.7
Cords and plugs	17.2
Light fixtures	12.4
Switches, receptacles, and outlets	11.4
Lamps and light bulbs	8.3
Fuses, circuit breakers	5.6
Meters and meter boxes	2.2
Transformers	1.0
Unclassified or unknown electrical distribution equipment	7.3

These are statistical references to homes in the US. Industrial plants have higher voltages and much larger cable distributions than the average home.

A consideration of the failure mechanisms reveals that there are only a few main ways that electrical insulation, or combustibles close by to electric distribution components, can be ignited, although there are diverse aspects to each:

- arcing
- excessive ohmic heating, without arcing
- external heating.

Some ignition types involve a combination of mechanisms, so they must not be viewed as mutually exclusive causes of fire.

Arcing
The causes of arcs can be many, but the primary ones are:
- carbonization of insulation (arc tracking)
- externally induced ionization of air (created by flames or an earlier arc)
- short circuits

Excessive Ohmic Heating
The causes of excessive ohmic heating can be subdivided into:
- gross overloads
- excessive thermal insulation
- stray currents and ground faults
- over-voltage
- poor connections

External Heating
Most cases of external heating involve the wire or wiring device as the victim of fire and not as the initiator of fire. This however can result in induced faults in the electrical cables. What is apparent from the above is that electrical cables can be the cause of fire initiators in plants and facilities. As electrical cables are routed throughout the plant or facility fires can be initiated in many and various areas. The major fire risk is that these fires can develop in *'hidden areas'* such as cable ducts, risers, cable spreading areas, cable basement or tunnels, ceiling voids, etc. Most of these areas are not occupied and are hidden from everyday observation by personnel, occupants and electronic surveillance equipment such as CCTV.

Where fires are initiated in hidden areas the potential is that these fires can travel over large distances and the fire can develop substantially before being detected or observed. Fire detection is normally by visual observation of smoke reaching an opening or by installed fixed fire detection systems, which is not always installed in these areas, or investigation of an electrical fault or loss of power. Once observed the difficulty is getting to the source of ignition and extinguishing the fire. The other risk is that these fires can by conduction, convection or direct flame impingement cause the ignition of other combustibles.

The primary purpose of fire protection measures is early detection of fires to limit damage and reduce exposure to occupants and other property or equipment. Response time by on-site personnel or local fire brigades is therefore essential to effective fire protection.

Exposure Risk
The exposure risk is both from the electrical cables and to the electrical cables.
As previously discussed the electrical cables are a potential exposure throughout the plant or facility to other combustibles or equipment due to their proximity and routing.

The other risk is that essential or strategic electrical cables can be exposed from external fires. Where strategic or essential power supplies or control cables are routed through areas which have an inherent high or medium fire risk classification these cables are at risk. A detailed risk assessment needs to be done to determine the impact of the loss of these cables. Some of the considerations are:

- Could result in loss of production?
- How long would it take to replace equipment and cables to re-instate production (downtime)?
- Is there spare or emergency capacity?
- Is there standby power supplies and what do they serve?
- Do control cables provide vital control functions that cannot be lost?
- Is the facility a public facility and the safety of the public is a concern?

It is important that these and other considerations are fully analysed to assess the potential risk exposure.

There is another concern regarding exposure from electrical cables which is the insulation material used on cables. Especially older plants and facilities the probability is that cable insulation is PVC (polyvinylchloride) or they contain PVC. PVC in fire conditions emits toxic and corrosive gases. These gases are a threat to life safety and in the longer term can result in corrosion problems for the plant or facility.

Fire Protection Measures

The first priority is *'fire detection'* it is essential that early detection of the fire is achieved to control the effects of fire. The installation of fixed fire detection systems in areas which are not occupied or are hidden is important. Generally, fire detection systems are installed in areas that are occupied to give occupants adequate time to evacuate in the event of a fire.

The second priority is ensuring that fires cannot spread along cable routes. This can be achieved by installing appropriate fire barriers where cables pass through different levels, fire zones or plant areas. Where there are long cable runs especially vertical cable runs fire breaks can be made along the cable using fire resistant or fire retardant materials.

The third priority is ensuring that strategic or vital cables cannot be exposed from external fires. This can be done by protecting the cables in specific areas using fire resistant boxing systems or spraying the cables in these areas with fire intumescent materials.
Where there is large cable spreading areas i.e. basement or cable tunnels consideration should be given to installing fixed fire suppression systems.

Summary

Electrical cable fires or ignition sources are prevalent in all industries, facilities and homes and should be considered in all fire safety measures. Electrical cables have been neglected as a potential fire source and fire statistics support this. This is a known fire risk and there are products, materials and methodologies available to address this very important aspect of fire safety.