DETECTION OF FIRES IN ELECTRICAL CABLES

by

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Probably the most significant conclusion determined during the discussion is that there is no single answer to the problem. Fire detection, alarm, and extinguishment must be designed to the specific hazard to be protected in order to optimize both the operational effectiveness and economics of the system.

As an analogy, consider the hammer. The hammer is a tool typically used to drive nails, but there are different types of hammers; claw, ball peen, dry wall, tack hammers, sledgehammers, etc. Each has a specific purpose. The amateur carpenter may have only one hammer to use for all purposes. But the professional has many different types and uses all in the way in which they are intended. Likewise, there are many types of fire detection devices, and a sign of the professional is the use of each in its optimum configuration.

The best intervention strategy is to prevent a fire or at least limit its magnitude through the use of better cable insulations. If these means are not possible, then a detection system must be designed to provide early warning for the purpose of extinguishing the fire before significant damage can occur. When designing such a fire alarm system, the following points should be considered.

1. The first consideration should be the risk. The amount of risk will affect the decision on the speed of detection necessary. For low risk situations, slower, more economical detection can be used. One example of this situation might be a cable tray containing cables carrying power to the water coolers within a building. If a fire destroyed these cables, the only consequence might be warm drinking water. For this case, one might consider the use of a line-type heat sensor, which is quite economical and

easy to install and maintain. The purpose of this type of detection is primarily to prevent structural damage to the building and to limit the amount of cable replacement after the fire.

As the risk increases, one may wish to go to smoke detection at standard spacings, smoke detection at reduced spacings, or the mixing of detection types to increase the speed of detection and amount of discrimination against false alarms inherent in the overall system.

2. The second consideration is the type of fire risk prevailing. Specifically with regard to electric cable fires, there are two types of risks that might be encountered. These are external exposure of the cable to a fire originating in other combustible materials or internal over-heating due to overloads or short circuits in power cables. These two types of fire risks can be encountered singly or in combination. For example, limited energy signal cables may only have an external exposure problem, and power cables that are run through concrete tunnels where no combustibles are stored may have only internal exposure possibilities. However, power cables that are run above a suspended ceiling may have both. The type of fire exposure will affect the decision on the type of detection device used because each different type of exposure may produce different signatures. Where the cables being protected are vital to the operation of a facility, one may wish to detect the early pyrolysis products from the decomposition of insulation. Conversely, where the risk is low, and false alarms could be a problem, one may opt to accept slower detection and wait for open flaming.

3. The third decision point is the consideration of the materials being protected. One should look at the expected fire signatures released from the specific materials involved when exposed to the risk as defined above. For example, poly(vinyl chloride) insulation under low-temperature breakdown, applied in a vital system function requiring rapid detection, may lead one to use photoelectric smoke detection, which reponds to the early pyrolysis products given off under low-temperature conditions. Specifically, this detectable substance is a white, hydrogen chloride fog containing no solid particulates.

4. The fourth point involves the conditions normally expected in the protected spaces. Such conditions might be airflow patterns, temperature, and humidity or may involve other equipment and processes that may generate products to

which the detectors selected are sensitive. Because the product to be detected must be transported to the detector before an alarm can be effected, the airflow patterns have great impact on detector placement. In fact, in very still spaces such as unventilated cable tunnels, one might even want to provide forced airflow to assist the combustion products in reaching the detector. Also, where low-thermal-energy fires or high humidities may be encountered, the combustion products often hang low in the protected space. Thus, one might want to place the detectors low within that space.

With regard to background processes one may wish to use signal discrimination through reduced sensitivity, multiple detection modes, or such system connection parameters as cross zoning or priority matrix. These system parameters require the alarm of two detectors on different zones or in adjacent installations. Such systems can be used to provide a presignal on the first alarm but withhold a general alarm, notification of the fire department, or automatic release of an extinguishing agent, until the second detector alarm actuates.

A part of this decision is the consideration of detection speed as a function of risk. Where vital system function is involved, one may want to allow a certain number of false alarms to increase the overall detection speed in case of fire. It is also necessary to consider the amount of damage one could sustain from a fire. This judgment would affect the detection speed consideration.

5. The next consideration is what happens when the alarm occurs. An automatic detector can only notify someone that a fire exists. This notification should be coupled with manual or automatic extinguishment. The use of automatic extinguishment usually involves the need for more discrimination because the extinguishing agents are often costly or can, themselves, cause damage to a protected area. But, additional discrimination often sacrifices some detection speed. As was mentioned earlier, use of prenotification on the first alarm with cross-zone or priority-matrix-type installations can minimize the sacrifice in detection speed while still providing the discrimination necessary for automatic extinguishment.

Manual estinguishment also increases the need for detection speed because it takes a finite time to begin the extinguishment process. Further, the use of manual extinguishment may necessitate a high degree of zoning to allow immediate pinpointing of the precise fire area. For example, if all detectors on one floor of a large building are in the same zone, it is quite difficult to pinpoint the fire other than locating it on the given floor. If, however, the floor is subdivided into a number of zones, the areas that have to be searched to locate the fire are reduced. Additionally, the extinguishing agent to be used on the fire should always be proved for the material involved and the type of fire expected.

6. A final consideration involves the design priorities. If one has a choice between a cable with low flammability (but which produces a fire that is hard to detect once ignited) or a second cable with higher flammability (but which is easier to detect once ignited), one should always choose the low-flammability cable and use proper systems engineering to provide for specific detection needs. This procedure may involve modification of existing detection equipment or possibly even the development of new detection equipment. One should always be able to devise a detector that will do the job, but doing so may involve exotic detection schemes such as chemical "tags" incorporated in the insulation, coupled with special detectors that sense this chemical tag released upon heating. Also, we are entering into the era of the "smart detector." In the next few years, detectors may provide analog readings to computers or contain individual microprocessors that can make decisions based on the signal strength, rates of change, or other parameters. Such smart detectors should increase detection speed for real fires and decrease false alarms.

The key point of the entire discussion is that the intelligent application of a systems design approach is necessary to provide the level of detection performance one requires at a cost consistent with the risk involved. As for the hammer analogy, each and every type of detector and system available has applications where it and it alone is the best. The answer to the question of what detector and system arrangement are necessary must be determined through a logical decision process. This process should always involve a qualified fire protection engineer or system designer who is familiar with all types of detection equipment and the ways in which each works the best.