In previous articles we discussed the fire alarm control panel, devices that place it into alarm and the most common devices that are “turned on” by the panel. The main feature that distinguishes a fire alarm control panel from burglar alarm or switching panels is that the fire alarm panel is supervised, which means that it has the ability to monitor its own integrity.

Unlike the burglar alarm panel, which has only two conditions, normal and alarm, the fire alarm control has a number of conditions or states. These are: normal, alarm, trouble, and (fairly recently) supervisory. The normal and alarm states are obvious.

The supervisory state monitors sprinkler devices so the panel can indicate that a waterflow device, such as gate valve, is in an off-normal condition. It is desirable to know that someone turned off the water supply to a sprinkler system (or forgot to turn it back on after service), but there is no need to create an alarm condition. Other supervisory devices can monitor water tanks for freezing, low or high water levels, etc. The supervisory condition results in a signal that differs from both alarm and trouble conditions, although the supervisory condition may share the trouble sounder.

The last state or condition is the trouble condition. This condition is characterized by a yellow light on the panel accompanied by the sounding of an audible device, such as a buzzer or piezoelectric sounder, which may be silenced or acknowledged temporarily. Upon correction of the trouble condition, the sounder will re-energize, indicating that the panel is back to normal. Returning the silencing switch to normal or pressing the acknowledgment button will silence the sounder and return the panel to a quiescent condition. This is known as “ring back”, a phrase that was common in the past, but not used very frequently nowadays.

Trouble signals are caused by numerous things. Some of these are a break in the field wiring, AC power failure, battery disconnection or failure, ground faults, open fuses, removal of plug-in detectors, disarrangement of panel switches, etc.

We have seen how supervised circuits of conventional fire alarm panels operate with the aid of end of line devices that maintain a current flow through the supervised circuit. Addressable systems operate in a different manner and will be the subject of a future article. The current flow through the supervised field circuit must be maintained through the field wiring. This is why conventional fire alarm systems must be wired in a prescribed manner.

Terminations to a detector or appliance must be made by cutting the field wires at their respective terminals. In other words, one wire must bring current into a terminal of the detector or appliance, and a second wire must exit from the same terminal and connect to the next device. See Figure 1. If a field wire is not cut, but looped around a screw, there will be no interruption of the supervised current should the head of the screw shear off. The device will be disconnected from the circuit but there will be no trouble indication. The panel will never know that the device is disconnected. If the field wire is cut and both ends connected to two separate terminals, the shearing of a screw head or loss of a wire crimp lug will cause the ends to separate and a trouble condition will immediately result.

One termination method is to have two screw terminals on the same metal terminal plate with the plate providing continuity between the screws. See the illustration at the bottom of Figure 1. Thus the “in” wire will connect to one screw and the “out” wire to the second. Pressure plate terminals are also widely used. Two wire ends are stripped and inserted under a pressure plate. A screw holds the plate down and maintains continuity between the wires. See Figure 2 for a description of the proper and improper terminations with this type of terminal.

Another method of termination is with four (4) pigtail connections, two for the “in” wiring and two for the “out” wiring. See additional illustrations in Figure 2 for both improper and proper methods of connecting the pigtails. An “X” shows the unsupervised wire which, if cut, will remain undetected.

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Wiring to initiating devices in a conventional system or notification appliances in addressable or conventional systems must be made in an “in and out” fashion. Branching or “T-tapping” is not permitted in these circuits. Again, the reason for this is that the current must flow in and out of each device and finally through the end of line device so supervision is maintained. Therefore, removal of a device from the circuit or a break in the wiring will interrupt the supervisory current and create a trouble condition. If a “T-tap” is used, a break in the “T-tap” branch will go undetected, since the supervisory current will not be interrupted. Figure 2 also shows both proper and improper methods of connection. An “X” indicates a break that will go undetected.

Note that “T-tapping” is permitted in an addressable system, since the microprocessor polls all addressable devices and will promptly detect a missing device.

A third method of wiring is commonly used with plug-in style two-wire conventional smoke detectors. One wire goes in and out of one base terminal, usually a pressure plate type of terminal. The other wire connects to a second terminal in the base and exits from a third. The detector has a built-in jumper that maintains contact between the second and third terminals, so if the detector is unplugged, it will cause a break in the wiring resulting in a trouble signal.

The type of wire used for field wiring should conform to the codes in effect in the area. These codes are almost always based on Article 760 of the National Electrical Code, NFPA 70, but some states make additional requirements. One state not only specifies the acceptable types of wire, but also specifies the insulation color, with DC power, initiating circuit wiring, initiating circuit return (Class A) wiring, notification appliance circuits, etc. all having different insulation color requirements! The prudent thing to do is to consult with the Authority Having Jurisdiction, such as wiring inspector, fire marshal, etc.

Until recently, solid or bunch-tinned stranded wire, 18 gauge minimum, UL Listed for fire alarm use, were the only types of wire acceptable for fire alarm. The reasoning behind this requirement was that solid or bunch-tinned stranded wire would be most likely to break cleanly, giving an instant trouble indication. If a stranded cable were to be damaged, leaving only one strand intact, the one strand would conduct supervisory current and maintain normal operation. During alarm, a notification appliance circuit could draw enough current to burn out the single strand, with a resultant failure at the most critical time. Now the NEC contains exceptions allowing stranded wire under certain circumstances. In addition, communication cable is also allowed in certain instances.

Power limited and non-power limited wiring also comes into account. There is no hard and fast simple rule about what types of circuits are power limited. The only way an installer can make this determination is that power limited and non-power limited designations are printed by the manufacturer on the control panel door label or on the terminals themselves. A typical label might state: “All circuits are power limited with the exception of the AC input, battery and city box connection”.

Again, consult the local Authority Having Jurisdiction about the wire hierarchy chart in the NEC, if your State Code is based on the NEC.