

Assuring Survival of Rated Cable

By **Kenneth L. Gentile, P.E.**

Circuits capable of surviving attack from fire are an important consideration when determining operational and regulatory requirements for electrical power and communication systems. While several methods (chases, enclosures, concrete encasement, etc.) are allowed when protecting circuits, this article will explore the use of rated cable assemblies to assure survivability.

Where 1-hour and 2-hour rated cables and assemblies (for expediency the term “rated cables” will apply to all the 1-hour and 2-hour rated cables) are needed but not specified concisely. Costly delays may result from addressing omitted or non-compliant non-rated cable installations. Design engineers, project managers and installing contractors all must be familiar with the types, locations, methods, and inspections necessary for installations of the rated cables on their project.

Familiarity begins by examining the various rated cables and assemblies that are commonly used in the built environment*. Various listings or certifications have been developed to meet requirements of the “application” based sections of installation codes such as NFPA 72, the National Fire Alarm Code; and NFPA 70 The National Electrical Code (NEC). All references in this treatment shall refer to the 2007 edition of NFPA 72 and the 2004 edition of the NEC.

To obtain these listings or certifications, the rated cables must exhibit performance compliant with the listing agency or military specifications. Describing the methods and motivations of these the tests provides valuable insight into the benefits of using rated cables in both required and non-required applications. Identifying the various rated cables is best accomplished by a review of diagrams and descriptions of the physical construction provided by rated cable manufacturers. The labeling, connectors and fittings necessary to determine compliant installation is also diagrammed and described.

Finally, several sections of installation codes and examples that require specific circuits to be 1-hour

or 2-hour rated will be presented. Integrating these last examples with the previous discussions of listing classifications, testing methods, physical construction, and identification should provide a thorough, though not complete, understanding of 2-hour rated cables and assemblies.

Cable types and the national electrical code

The “Special Equipment” and “Special Conditions” articles in the NEC typically either mandate 1-hour ratings or reference the fire alarm code survivability requirements for select circuits (Articles 695, 700, and 760). To address this requirement, manufacturers have developed several wiring and

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cable materials that are listed with a 2-hour rated performance. Wiring and cable materials referenced in The National Electrical Code (NEC) that are provided with a 2-hour survivability rating, and are commonly used in construction applications are:

- Power conductors type RHH with ceramifiable insulation (Article 310 and the tables)
- Metal Clad or Metal Clad, Mineral Insulated (Type MC – Article 330/Type MI – Article 332)
- Fire alarm cables FPL(R) and NPLF(R) (Article 760)

Special note should be taken that not all RHH, MC, FPL, NPLF cables are listed for fire survivability. Only those cables specifically listed to U.L. 2196 or an equivalent standard will provide protection against flame attack. Type FPL and NPLF cables will also bear the NEC designation of “CI” or “CIC” if listed for fire survivability. Characteristics of the Circuit Integrity (CI) and Circuit Integrity Conduit (CIC) cables will be further described when listings are discussed.

*Cables used for thermo-coupling applications also maintain a 2-hour rating but as these types of cables are not common to building installations they are not addressed in this article.



Figure 1. 2-hour Rated RHH Cable. Pic courtesy of TycoControls.

ble Circuits with

Typically type RHH and MC cables are used for power applications for fire pumps (Article 695) and emergency systems (Article 700). Type MC Cable is often selected for use where rated cables are needed in cable tray applications. Type FPL and NPLF are commonly used to meet fire alarm survivability requirements with MC/MI cables also used for some special fire alarm or power applications, usually in classified locations or where intrinsically-safe circuits are required.

Cable construction and testing

Flame survivability is accomplished by three distinct methods of cable construction. The first method is typical of rated cables for power circuit applications. These rated cables have a ceramifiable insulation enclosed by its usual moisture-resistant

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thermoplastic insulation (RHH) or metal clad sheath (MC). When the ceramifiable materials are exposed to excessive heat, the insulation changes from a pliable state to a ceramic state in a process that can be likened to firing clayware in a kiln.

Rated cables with ceramifiable materials do not require special fittings or connectors other than that the insulation type makes the overall cable size larger than the typical RHH or MC cables and must be installed in conduit. Conduit, raceway and metal clad fittings must then be sized accordingly.

Metal clad/mineral insulated cable assemblies have a solid, heat-resistant mineral insulation surrounding the copper conductor and enclosed by a metal sheath (Figure 2). As a result, brass fittings and the manufacturer's specified epoxy or resin must be used to terminate the conductors.

The CI and CIC cables have a high-heat resistant insulation enclosed by the usual FPL or NPLF insulation (Figure 3). This insulation becomes "ash-like" to protect the conductor when exposed to high heat. Some type CI cables may be installed in conduits as well as not in conduit depending upon the specific listing; while CIC cables can only be used where installed in conduit. Otherwise, the listings of the respective cables are no longer valid. In all other aspects, the CI and CIC cables must comply with the listing applications of the suffix for FPL and NPLF and can be either shielded or unshielded. If the cables are to be used as riser cables, the "R" suffix and listing must be present. To install CI cables in plenums, conductors



Figure 2. PVC Jacketed Metal clad/Mineral insulated Cable.

with the "P" suffix and plenum-rated listing must be used.

Applicable codes and examples

As previously mentioned, the NEC and National Fire Alarm Code are the source of the most often cited mandatory requirements for survivable circuits. Incorporated by reference by the adopted building codes throughout the United States and many other locations, the circuit survivability requirements of these two codes must be accommodated where applicable. As mentioned initially, the requirements for circuit survivability in the codes may be addressed by means other than the use of rated cables. The discussion and examples that follow, therefore, will assume that rated cables are the select protection method.

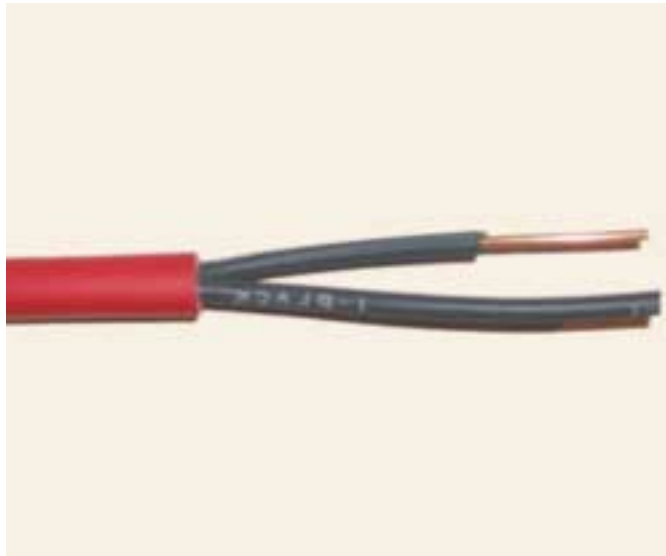
The NEC and National Fire Alarm Code are the source of the most often cited mandatory requirements for survivable circuits.

Survivability requirements for those power circuits not associated with the fire alarm system, are specified for Fire Pumps (NEC 695.6.B) and for the feeder circuits of legally mandated emergency systems in assembly occupancies of more than 999 persons, and most high-rise buildings (NEC 700.9.D).

Note that the rated cables would not be necessary where:

- Feeder circuits are encased in 2-inches of concrete.
- Fire pump feeder circuits originate in the same room as the fire pump.

Figure 3. 2-hour Rated FPL-CI Cable. Pic courtesy of TycoControls.



- Feeder circuits serve legally required stand-by electrical systems of Article 701.
- The entire circuit is installed, compliant with NEC methods, in areas protected by automatic sprinklers.

These and other methods mean that in many facilities, the effort and expense associated with rated cables for power circuits can be avoided by proper coordination in the facility design.

Consider, for example, installation of a fire pump in a room remote from the main electrical switchgear. If the feeder can be encased in deck-

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ing or below floor slabs, adequate survivability from fire is achieved. If the pump is retro-fit, however, in an unsprinklered existing building, rated cables may be the preferred option.

Requirements for fire alarm circuit survivability are found in NFPA 72, the National Fire Alarm Code and often it's provisions have been misapplied. To determine which circuits require protection, the first prescription is found in the Protected Premises requirements (Chapter 6):

6.9.10.4.1* Fire alarm systems used for partial evacuation and relocation shall be designed and installed such that attack by fire within an evacuation signaling zone shall not impair control and operation of the notification appliances outside the evacuation signaling zone. Performance features provided to ensure survivability shall be described and technical justification provided in the documentation submitted to the authority having jurisdiction with the evaluation required in 6.4.3.1.

The first sentence of this paragraph is the prerequisite for survivability. Only systems that

have "partial evacuation" or in other words; buildings where the activation of horns, speakers or strobes is limited to segmented areas; are required to provide survivable circuits. Common examples of these types of buildings include health care facilities that often have separate evacuation zones and high-rise buildings with "floor of, floor above, and floor below" or similar evacuation schemes. Since most fire alarm systems activate a "general alarm" throughout the building, 2-hour rated protection for circuits is not required.

Where rated cables (or equivalent, compliant measures) are required, the conductors that require protection are:

6.9.10.4.2 All circuits necessary for the operation of the notification appliances shall be protected until they enter the evacuation signaling zone that they serve....

The "All" in **6.9.10.4.2** includes initiating device circuits, signaling line circuits for addressable initiating devices, and notification appliance circuits for all equipment in the evacuation zone. This paragraph also clearly limits survivability requirements to outside of the zone. Circuits installed completely within their evacuation zone, or those portions of the circuits that are located within their evacuation zone are not subject to survivability requirements. Finally, power circuits for remote power supplies located outside of the evacuation zone must also be protected (**4.4.1.9.3.1(B)**).

The other requirement for survivable fire alarm circuits is found in **6.10.1.16**. New to the code to assist responders, survivability must be incorporated for "All circuits necessary for the operation of two-way telephone communication systems". All fire-fighter telephone circuits, replacement fire alarm systems, must now be protected.

To better understand the application of these requirements, consider a high-rise building with "floor of, floor above, and floor below" occupant

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notification (Figure 4). Since each floor is its own evacuation zone, it is wired with dedicated notification appliance circuits that only serve a single floor. These circuits need only be survivable from the panel to the riser and up the length of the riser itself.

A signaling line circuit, that serves initiating devices on multiple floors would need to be protected at any location that would prevent alarm operation of any other evacuation zone

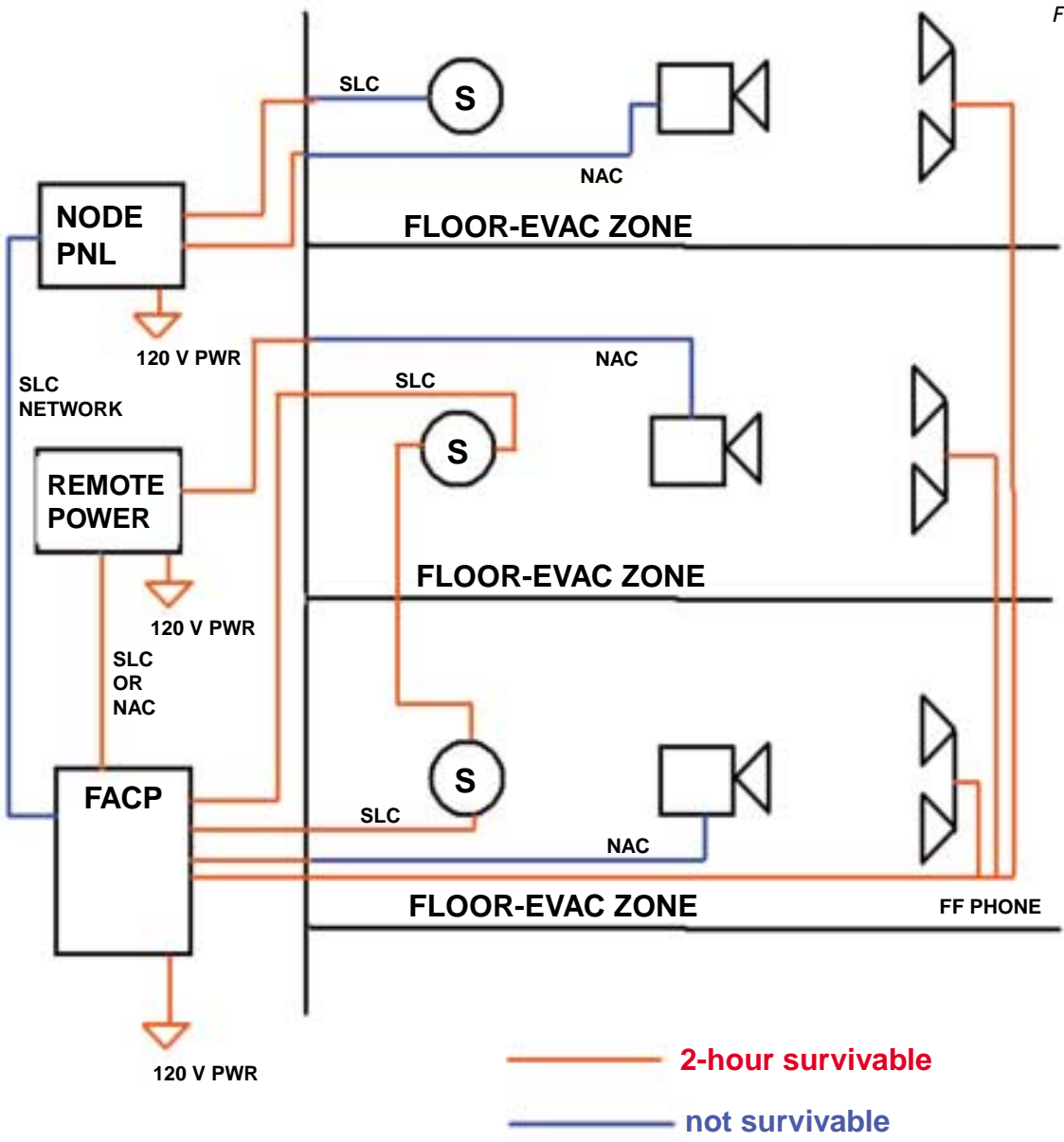


Figure 4

notification appliances. Remote power extenders for strobes or similar remote equipment, would require protection of their power line circuits. Signaling line network circuits between panel nodes would not require protection if the panel nodes are capable of local operation when isolated from the network.

The 2007 edition of the National Fire Alarm Code provides for numerous options for meeting the circuit survivability requirements. Though this article has dealt with rated cable assemblies, design professionals should be aware of all the possible methods. These are listed as:

- 1 A 2-hour fire rated circuit integrity (CI) cable
- 2 A 2-hour fire rated cable system (electrical circuit protective system)
- 3 A 2-hour fire rated enclosure
- 4* Performance alternatives approved by the authority having jurisdiction
- 5 Buildings fully protected by an automatic sprinkler system installed in accordance with *NFPA 13, Standard for the Installation of Sprinkler Systems*, and with the interconnecting

wiring or cables used for the operation of notification appliances installed in metal raceways and in accordance with Article 760 of *NFPA 70*

Option "(1)" is new to the 2007 edition as type "CI" cable is new cable type recognized in for the first time in the 2004 National Electrical Code (NFPA 70) and option "(5)" has been elevated in status from its previous place in the 2002 code as an "exception" to other methods.

Conclusion

As has been presented, the survivability of circuits from attack by fire is maturing. Development of the products available as 2-hour rated cables and assemblies are improving performance of such rated cables. New options in the codes prescribing survivability, such as installation of fire alarm circuits in conduits where the building is sprinklered, permit design professionals leeway in design development and code compliance. All that remains is for engineers, architects, project managers, and installers to maintain an awareness of where and how circuit survivability must be maintained. **IFP**

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