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T E C H N I C A L B U L L E T I N

Electrical Circuit Protective Systems (FHIT) New Guide Information

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Introduction

The Guide Information for Electrical Circuit Protective Systems (FHIT) has been expanded to provide additional information regarding with fire resistive cable systems. The FHIT category covers Electrical Circuit Protective Systems consisting of components and materials intended for installation as protection for specific electrical wiring systems, with respect to the disruption of electrical circuit integrity upon external fire exposure. This category deals with systems designed to maintain circuit integrity under a fire conditions.

There are two types of systems: Systems incorporating cable protected with electrical circuit protective materials and systems constructed with fire resistive cable. These may also be called fire wrap systems and fire rated cable systems. The key word is "system". This signifies that there are many parts working together. It is important to understand that only the system parts tested together are qualified as the system. Ratings apply only to the entire protective system assembly, constructted using the combination of components specified in the system. Unless the combination is tested, it is not certified. An example is the use of a wrap system in combination with a fire rated cable system. Therefore, a wrap system cannot be used on a box containing a splice with a fire rated cable. Wrap system are tested where both ends are outside the fire zone. If one or both ends are in the fire zone, heat from the end (s) can build up under the wrap. Since the wrap is designed to keep heat out, in this case, it will also keep the heat in. This can cause a hot spot and cable failure. Individual components and materials are designated for use in a specific system(s) for which corresponding ratings have been developed, and are not intended to be interchanged between systems. Ratings are not assigned to individual system components or materials. As an example, caulk or putty used from one system cannot be interchanged with the caulk or putty specified in another system.

Systems incorporating cable protected with electrical circuit protective materials are evaluated to Subject 1724, "Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems." Systems constructed with fire resistive cable are evaluated to Standard ANSI/UL 2196, "Tests of Fire Resistive Cables." Fire resistive cables with the "CI" marking are evaluated to ANSI/UL 2196. "CI" Cables are Listed under the product categories, Power Limited Fire Alarm Cable (HNIR) or Non-power Limited Fire Alarm Cable (HNHT). The marking information for the cable is detailed in the UL Guide Information for those two categories in the UL Directory for Electrical Construction Equipment Directory (Green Book) as well as the UL General Information for Electrical Equipment Directory (the White Book). UL Listed or Classified products such as Power Limited Fire Alarm Cable (HNIR) or Non- power Limited Fire Alarm Cable (HNHT) with the "CI" marking, Electrical Circuit Protective Systems (FHIT), Fire Resistive Building Assemblies (BXUV) and Fire Resistive Cables (FHJR), as well as all UL product categories, can be located by the four-letter category code in parentheses following the product category title. The Guide Information for each category as well as Listings for these product categories can be accessed on UL's Online Certifications Directory at www.ul.com and entering the four-letter category code at the UL Category Code/ Guide Information search.

The National Electrical Code (NEC) references Listed Systems. However, UL refers to Classified systems for the fire protection methods referenced in this article. Are they the same? Yes. While the terminology is different, Classification complies with the definition of Listed as detailed in NEC Article 100. For purposes of compliance with the NEC, the two types of certification are considered equivalent.

Many issues relate to both wraps and fire rated cables, however since the test protocols are different, these were segregated. Information on this subject can be found in UL's Technical Paper "Electrical Circuit Functionality During a Fire Scenario" by Robert Berhinig and Tom Lichtenstein.

The Electrical Circuit Protective Systems is required to be fastened to a concrete or masonry wall or a concrete floor-ceiling assembly. The fire rating of the wall or floor-ceiling assembly is required to be equal to or greater than the rating of the electrical circuit protective system. This is to ensure that the complete electrical circuit protective system will survive during the fire and the impact of a hose stream exposure. The fire rated system is limited by the weakest link. If the system is fastened to a support structure that will not hold the cables during a fire condition, the cables can fail prematurely.

Wrap Systems

These protective systems are evaluated with respect to fire exposure and with respect to water hose stream performance. Performance criteria are based on temperatures within the enclosure and visual examination after the water hose stream. The test method simulates electrical cables by use of a single bare No. 8 AWG stranded copper conductor. Thermocouples are attached to the copper conductor at a spacing of 6-inches on-center. The temperatures measured by the thermocouples attached to the conductor determine the fire resistive performance of the enclosure surrounding the copper conductor. Ratings, such as 1-hour or 3-hour, are based upon the ability of the enclosure or barrier to limit the average temperature rise along the bare copper conductor to 250°F and limit the temperature rise at any point on the conductor to 325°F. The hose stream test consists of water being delivered through a 1-1/8 inch play pipe nozzle at a pressure of 30 pounds per square inch at a flow rate of approximately 200 gallons per minute. The impact pressure applied to the test sample is approximately 58 pounds per square foot. For acceptable performance, the water stream cannot penetrate through a protective barrier or wrapping resulting in the electrical cable becoming visible.

Classification of these protective systems contemplates installation in interior environments with representative heating and air conditioning, unless stated otherwise in the individual Classifications. Issues with outdoor or uncontrolled environments would be the effects of moisture or rain on the wrap materials, as well as sunlight resistance, and temperature effects. Cables are Listed for the environment they are to be used in (wet or dry), as well as sunlight resistance for outdoor use. Additionally, the temperature rating is specified by the type designation or is printed on the cable.

Where indicated in the system, the ampacity reduction due to the electrical circuit protection system has been determined for

normal ambient temperature operating conditions in accordance with IEEE 848-96 (reaffimed 2003), "Procedure for the Determination of Ampacity Derating of Fire Protected Cables." If not specified in the individual system, the effect of the electrical circuit protection system on the ampacity of the electrical conductors has not been investigated. Wrap materials affect the thermal circuit, and may require lowering the allowable current to account for this. If no derating factor is provided by test, a conservative value should be used. NRC information notice 93-40 and 94-34 indicate that derating can be at least 20% to 65% depending on many factors.

The specifications for the protective system and its assembly are important details in the development of the ratings. Information concerning these details is described on the individual systems.

Many details that effect system operability is provided in the system, but complete instructions for installation are provided by the manufacturer. The products used in these systems are to be installed in accordance with the applicable accompanying instructions.

Fire Rated Cable Systems

These protective systems are evaluated with respect to fire exposure and water hose stream performance. The Standard ANSI/UL 2196 describes two fire exposure conditions. The normal temperature rise (to ANSI/UL 263(ASTM E 119) is intended to represent a fully developed interior building fire. The rapid temperature profile to ANSI/UL 1709(ASTM E 1529) is intended to represent a hydrocarbon pool fire. Unless otherwise noted, the ANSI/UL 2196 fire exposure was used. There are two hose stream levels, normal and low impact. The low impact fog nozzle hose stream is applied only to cable to be marked with the –CI suffix. The normal impact hose stream, applied with a standard taper, smooth-bore playpipe, is applied to all other types of cable and is the same as used in Subject 1724 for wrap systems. Performance criteria are based on functionality of the cable during the fire and after the hose stream. The hose stream is meant to simulate an impact. It should be noted that an impact could occur at any time. For test purposes, it is conservative for the impact to occur at the end of the test, and to then confirm functionality.

Fire Alarm Circuit Integrity (CI) cable is defined in NEC Section 760.2 as "Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions." Cables can be non-power limited fire alarm cables (Type NPLF) or power limited fire alarm cables (Type FPL). They are marked with the fire alarm cable type and "CI (max voltage ___)" to identify that it is suitable for use as circuit integrity cable at the maximum voltage to ground indicated. Some cables are marked "CIC". This is not a NEC Type but rather a manufacturer's designation. This should not be confused with CI cable. When "CIC" cables are fire rated, they are part of a system listing. CI cables may also be shown in system listing to demonstrate that these cables can also pass UL 2196 requirements when installed in a raceway.

CI cable is tested on steel rings spaced 24 inches on center. At the conclusion of the test, the water stream is applied through a 1-1/2 inch fog nozzle with the minimum discharge being 75 gallons per minute. The impact pressure applied on the "CI" cables is approximately 0.2 pounds per square foot. CI cables are tested in free air to simulate this installation method. If "CI" cable is to be installed in raceway it shall be so tested. CI cable that has been tested in a raceway will be specified in the system listing. Jackets for CI cables may be designed to swell and form a hard ash. This may help a cable pass on rings, but may not be suitable for installation in conduit. Testing the CI cable in conduit, would then demonstrates that the cable would continue to operate when installed in this configuration. Requirements for support distances should also be followed to ensure functionality. If the supports fail, the cable can fail. All other system issues as discussed below should be followed to ensure functionality.

Each different design of fire resistive cable is tested per Standard ANSI/UL 2196. In order to determine what has been qualified, the system contains the construction details of the tested configuration. One-conductor and multi-conductor constructions are tested separately, as well as shielded or unshielded, and stranded or solid conductors. The system contains the construction details of the tested configuration. The minimum conductor size, minimum number of conductors, UL Type, voltage rating, etc. is also construction details that are provided. Cables are UL Listed to a NEC Type and constructed to a UL standard for the cable (such as Type MC per UL 1569, Type RHH/RHW to UL 44, Type FPL per UL 1424, Type NPLF per UL 1425, Type MI per CSA 124 and Type TC per UL 1277).

Cables are tested as a complete system. The system includes the cable or raceway support, couplings, boxes/conduit bodies, optional splices, vertical supports, grounds, pulling lubricants, cable tray, etc.

Cable or raceway supports need to hold the cable in place during the fire and hose stream test. The system components (such as hardware, clamps, and strut) are normally stated to be made of steel so that these components do not melt in the fire. It is the case that all components of the system need to function for the duration of the fire and the subsequent impact of a hose stream test. For cable tray, steel tray should be used. Some steel tray may be fabricated by brazing the rungs to the side rails, and brazes may not be suitable for hourly fire ratings. Welded or clamped joints should be used. In a fire, steel may still deflect under load. Minimum thickness of steel when significant is specified. Other metals such as aluminum melt at around 1200°F (depending on the alloy), so it would not be suitable near or above its melt temperature for a support. Plastic coated clamps can fail to hold a raceway in place when the plastic burns off. Also, special clamps may be needed when securing a cable that has a polymeric jacket (to account for the jacket burning away in the fire).

Systems that require a raceway are to be tested with the minimum raceway diameter and the minimum raceway type with their respective coupling(s). Raceways having larger diameter are acceptable. Raceways with greater wall thickness are also acceptable. That is to say that if 1/2" Electrical Metallic Tubing (EMT) is tested, 1/2" or larger sizes can be used. Also, thicker raceway of the same material can also be used, such as Intermediate Metal Conduit (IMC) or Rigid Metal Conduit (RMC). The raceway must be connected together using the coupling type listed in the system, such as steel setscrew type for EMT or threaded types of

coupling for IMC and RMC. No other couple shall be used unless noted in the specific system. As an example, a compression coupling shall not be used in place of steel setscrew coupling for EMT unless otherwise specified in the system.

If a box, conduit body, supports (such as a grip), splice or other component is tested, it will be noted in the system. Otherwise, hourly fire rating applies only to continuous lengths of cable passing completely through a fire zone and terminating a minimum of 12 inches beyond the fire rated wall or floor bounding the fire zone. For systems installed in a raceway, the NEC requires not more than 360 degrees of bends without a pull point (such as conduit bodies or boxes). Therefore, for most practical installations, a box or a conduit body will be required. Each of these is tested separately, and if a system passes with either of these, it will be listed in the system. Since boxes are tested with a single raceway, each individual raceway shall have an independent box used for pull points or splices. If a splice is tested, it will also be listed in the system. The box should be sized per the NEC. The box should not be bigger than necessary, since the cable can droop within the box. It is advisable to leave some slack in a box and to follow all special instructions from the manufacturer because of the lack of support in the box.

The supports are an important part of the systems and each individual system has specific support requirements. The maximum distance between the supports is listed in the individual systems and should not be exceeded even if an alternative raceway is used. As an example, if 5 feet spacing between supports is specified for EMT, this same support distance shall be used with any other raceway (IMC, RMC, etc), unless stated otherwise in the system or a lesser support spacing is specified in the NEC. The type of support and the distance between the steel supports is unique to that specific system and is for all sizes/types of cable and/or raceways unless otherwise noted in a specific system. Support of tray should also be the same as the raceway spacing unless otherwise noted.

The support requirements are for both the horizontal and vertical configuration unless otherwise noted in a specific system. This distance for vertical or horizontal are intended to be support to the cable/conductor. Cables installed in raceway, are not self- supporting. A support on the outside of a raceway does not support the cables inside. This is in contrast to a MI or MC cable, where a support on the outside of the cable also supports the conductors. Therefore, a cable can be run 100 feet in length vertically, but if supports are put on a MI or MC cable every 4 feet, the conductors are supported every 4 feet.

For a conduit run of 100 feet, supporting the conduit every 5 feet does not support the cables. Therefore, in order to determine functionality of the complete system for long vertical runs, vertical testing is required for cables in raceway. UL 2196 does not have test methods for this case, and is the subject of a proposed revision to the Standard. The ability of cable to support the equivalent cable weight of the distance specified in NEC Table 300.19 (or a lesser distance), with out breaking the conductor, and compatibility/mechanical considerations of the support mechanism is to be addressed in the test. If longer vertical distances are tested, they will be shown in the system along with the support mechanism details. For cables installed in raceway, a support method is required on the cable for long vertical installations per NEC Table 300.19. One such support method is a basket grip. Note a box will be required for this support method. Compatibility of the support, as well as mechanical concerns would be tested. A support may be made of materials that will release gasses that could cause the cable to fail. The support may crush the cable in a fire, and cause a failure. A support may or may not hold a cable in place during a fire. If it does not, this can be accounted for when the number of supports is specified.

Compatibility of materials used in fire rated systems is also a concern. Some materials can provide carbon residue that is conductive, or conductive gasses that can cause premature failure. A dedicated raceway is the required configuration unless otherwise noted in the system (such as the option of bare ground wires, or insulated ground wires). The bare or insulated ground wire may be of special manufacture to be compatible with system. The system will specify the manufacturer of an allowable ground wire. If not specified, the ground shall be the same as the fire rated wire listed in the system. Use of any other ground wire violates the system fire rating. As an example, THHN ground wire shall not be used with a fire rated system unless specified in the system. Also, a standard bare ground wire may loose strength in a fire, whereas a fire rated bare ground wire will not. Pulling lubricant is routinely used on cables to be installed in raceway. If a pulling lubricant has been tested with the system, it will be so noted in the system. There are other options, such as jackets on type MC or MI cables. If these options were tested, they will be noted in the individual system.

These systems shall be installed in accordance with all provisions of the National Electric Code, as amended by the details of each individual system (such as type of supports and distance between supports) and the guide information.

Summary

The changes made to UL Guide Information for Electrical Circuit Protective Systems provides additional information regarding the requirements of a system for the newer fire rated cables in conduit. This information will allow AHJs to determine what systems have been tested with what options. This paper then explains the significance of the options in a typical installation.

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