IEEE PES SF Chapter July 2013

Review Fire Resistive Cables

And UL 2196 Issues

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Agenda

- Review NFPA Standard with Fire Resistive Cables
- Review UL 2196 Test Standard
- Review why UL withdrew cable listings
- What is next??

NFPA Standards

- NFPA 70 – National Electric Code (NEC)
- NFPA 72 – National Fire Alarm and Signaling Code
- NFPA 130 - (Standard for Fixed Guideway Transit and Passenger Rail Systems)
- NFPA 502 - (Standard for Road Tunnels, Bridges, and Other Limited Access Highways)

NFPA 70

- Article 695 – Fire Pumps
- Article 700 – Emergency Systems
- Article 708 – Critical Operations Power Systems(COPS)
- Article 725 - Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits

NFPA 70

- Article 770 – Optical Fiber Cables and Raceways
- Article 800 – Communications Circuits

Article 695 – Fire Pumps

659.6(A)(2)

(d) *Inside of a Building. Where routed through a building,* the conductors shall be installed using one of the following methods:

(1) Be encased in a minimum 50 mm (2 in.) of concrete

(2) Be protected by a fire-rated assembly listed to achieve a minimum fire rating of 2 hours and dedicated to the fire pump circuit(s)

(3) Be a listed electrical circuit protective system with a minimum 2-hour fire rating

Informational Note: UL guide information for electrical circuit protective systems (FHIT) contains information on proper installation requirements to maintain the fire rating.

Article 700 - Emergency Systems

700.10(D)

(1) Feeder-Circuit Wiring. Feeder-circuit wiring shall meet one of the following conditions:

(1) Be installed in spaces or areas that are fully protected by an approved automatic fire suppression system

(2) Be a listed electrical circuit protective system with a minimum 2-hour fire rating

Informational Note: UL guide information for electrical circuit protective systems (FHIT) contains information on proper installation requirements to maintain the fire rating.

Article 700 - Emergency Systems

700.10(D)

(1) Feeder-Circuit Wiring. Feeder-circuit wiring shall meet one of the following conditions:

(3) Be protected by a listed thermal barrier system for electrical system components with a minimum 2-hour fire rating

(4) Be protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency wiring circuits.

(5) Be encased in a minimum of 50 mm (2 in.) of concrete

Article 708 – (COPS)

708.10(C)

(2) Fire Protection for Feeders. Feeders shall meet one of the following conditions:

(1) Be a listed electrical circuit protective system with a minimum 2-hour fire rating

Informational Note: UL guide information for electrical circuit protection systems (FHIT) contains information on proper installation requirements to maintain the fire rating.

(2) Be protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours

(3) Be encased in a minimum of 50 mm (2 in.) of concrete

Article 708 – (COPS)

708.14

(7) All cables for fire alarm, security, and signaling systems shall be riser-rated and shall be a listed 2-hour electrical circuit protective system. Riser emergency communication cables shall be Type CMR-CI or a listed 2-hour electrical circuit protective system.

(8) Control, monitoring, and power wiring to HVAC systems shall be a listed 2-hour electrical circuit protective system.

Article 725

725.2

Circuit Integrity (CI) Cable. Cable(s) used for remotecontrol, signaling, or power-limited systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions.

725.179(F)

(F) Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Cables used for survivability of critical circuits shall be listed as circuit integrity (CI) cable. Cables specified in 725.154(A), (B), (D)(1), and (E), and used for circuit integrity, shall have the additional classification using the suffix "-CI". Cables that are part of a listed electrical circuit protective system shall be considered to meet the requirements of survivability.

Informational Note: One method of defining circuit integrity is by establishing a minimum 2-hour fire resistance rating when tested in accordance with UL 2196-2002, Standard for Tests of Fire Resistive Cables.

Article 760

760.2

Fire Alarm Circuit Integrity (CI) Cable. Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions.

760.176(F)

(F) Fire Alarm Circuit Integrity (CI) Cable or Electrical Circuit Protective System. Cables used for survivability of critical circuits shall be listed as circuit integrity (CI) cable. Cables specified in 760.176(C), (D), and (E), and used for circuit integrity shall have the additional classification using the suffix "-CI." Cables that are part of a listed electrical circuit protective system shall be considered to meet the requirements of survivability.

770.179(E)

(E) Optical Fiber Circuit Integrity (CI) Cables. Cables suitable for use in systems to ensure survivability of critical circuits and pathways during a specified time under fire conditions shall be additionally listed as circuit integrity (CI) cable. Cables identified in 770.179(A) through (D) that meet the requirements for circuit integrity shall have the additional classification using the suffix "CI."

800.179(G)

(G) Communications Circuit Integrity (CI) Cables. Cables suitable for use in communications systems to ensure survivability of critical circuits during a specified time under fire conditions shall be listed as circuit integrity (CI) cable. Cables identified in 800.179(A) through (E) that meet the requirements for circuit integrity shall have the additional classification using the suffix "CI."

2014 NEC

- New Article 728 – Fire Resistive Cable Systems
- Additional wording in Articles 725, 760 and 800 making it clear that CI cables need to be marked as an Electrical Circuit Protective System when installed in a raceway.

NFPA 72

National Fire Alarm and Signaling Code

Chapter 12 Circuits and Pathways

12.4.3 Pathway Survivability Level 2. Pathway survivability

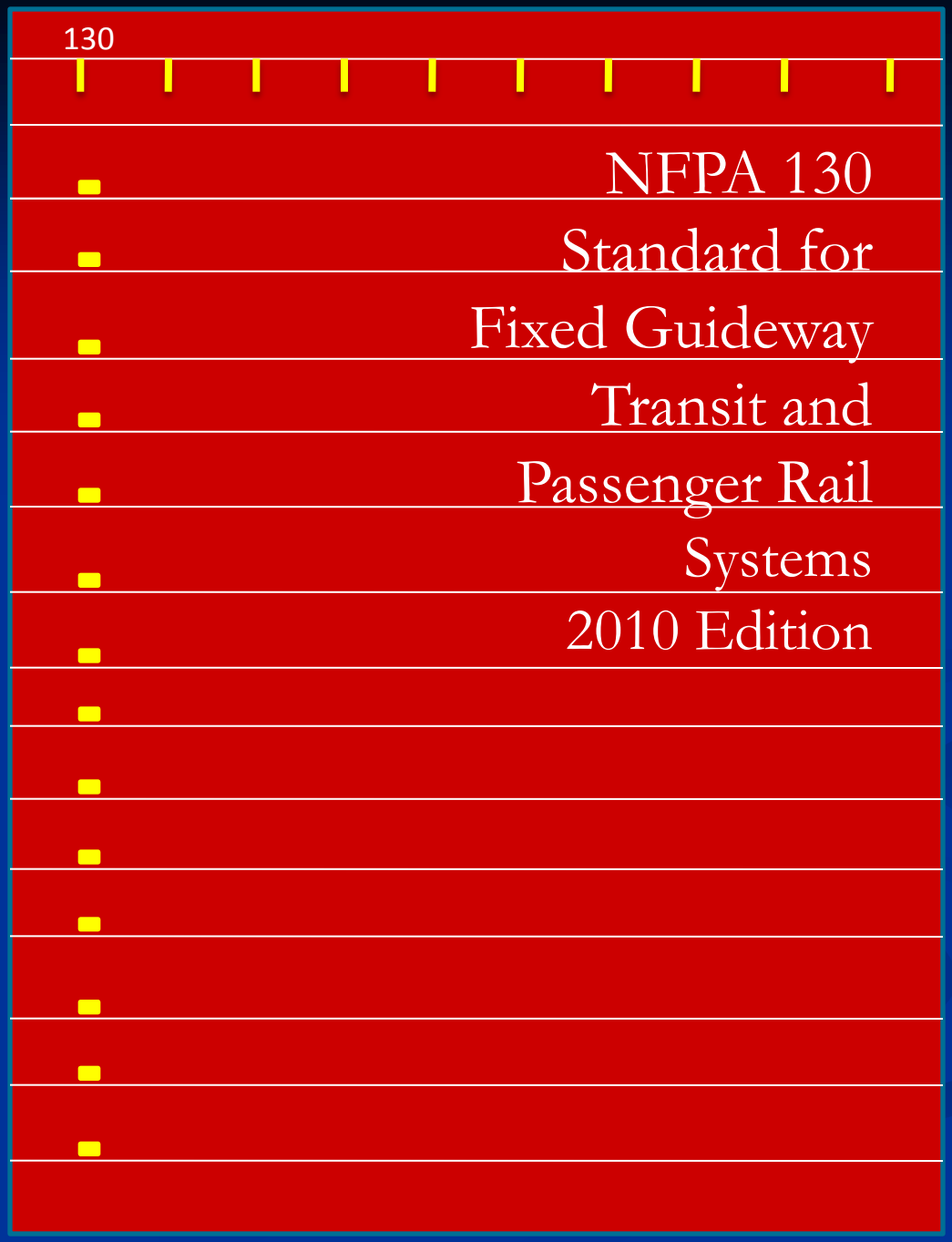
Level 2 shall consist of one or more of the following:

(1) 2-hour fire-rated circuit integrity (CI) cable

(2) 2-hour fire-rated cable system [electrical circuit protective system(s)]

(3) 2-hour fire-rated enclosure or protected area

(4) 2-hour performance alternatives approved by the authority having jurisdiction


130
NFPA 130
Standard for
Fixed Guideway
Transit and
Passenger Rail
Systems
2010 Edition

NFPA 130

- Emergency Lighting, Emergency Communication and Emergency Power for Ventilation must be able to survive a fire
  - Chapter 5 Stations
  - Chapter 6 Trainways
  - Chapter 7 Ventilations

Chapter 6 – Trainways (Tunnels)

6.3.3.2.8 The emergency lighting and communications circuits shall be protected from physical damage by system vehicles or other normal system operations and from fires in the system for a period of not less than 1 hour. The circuits shall be protected from ASTM E119 fire conditions by any of the following:

(1) Suitable embedment or encasement

(2) Routing external to the interior underground portions of the system facilities

(3) Diversity in system routing (such as separate redundant or multiple circuits separated by a 1-hour fire barrier) so that a single fire or emergency event will not lead to a failure of the system

(4) Use of a listed fire-resistive cable system with a minimum 1-hour rating in accordance with 6.3.3.2.10 (UL 2196)

EURO TUNNEL FIRE 1996

EURO TUNNEL FIRE 1996

502

NFPA 502 Standard for Road Tunnels, Bridges, and Other Limited Access Highways

2011 Edition

NFPA 502 Chapter 12

12.1.1 The electrical systems shall support life safety operations, fire emergency operations, and normal operations.

12.1.2 Emergency circuits installed in a road tunnel and ancillary areas shall remain functional for a period of not less than 1 hour for the anticipated fire condition, meeting one of the following methods:

NFPA 502 Chapter 12

12.1.1 The electrical systems shall support life safety operations, fire emergency operations, and normal operations.

12.1.2 Emergency circuits installed in a road tunnel and ancillary areas shall remain functional for a period of not less than 1 hour for the anticipated fire condition, meeting one of the following methods:


SOUTH
5
Los Angeles
Sierra
Hwy
1/4 MILE
CHP

UL 2196

STANDARD FOR SAFETY

Tests for Fire Resistive Cables

Fire Test Certification

Large scale testing UL2196 is performed at Underwriters Laboratories (UL)

UL documents the test results and installation techniques in the Electrical Circuit Protective System. (FHIT)

UL 2196 Assumptions

- Passing the smallest qualifies the largest
  - Assumption is the smallest is most difficult to pass
  - Passing 2 14AWG qualifies up to 750MCM
    - Also qualifies single or multiple conductors
- Passing in EMT qualifies IMC and Rigid
  - Assumption is that EMT is the thinnest wall and most difficult to pass.

UL 2196 GuideInfo

ONLINE CERTIFICATIONS DIRECTORY

FHIT.GuideInfo
Electrical Circuit Protective Systems

View Listings Page Bottom

Electrical Circuit Protective Systems

Guide Information for Fire Resistance Ratings

GENERAL

This 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 exterior fire exposure.

Ratings apply only to the entire protective system assembly, constructed using the combination of components and materials specified in the individual system. Components and materials are designated for use in a specific individual system 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. For example, caulk or putty used from one system cannot be interchanged with the caulk or putty specified in another system.

Electrical circuit protective systems are intended 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 intended 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 fire and hose stream exposure.

UL 2196 GuideInfo

SYSTEMS CONSTRUCTED WITH FIRE-RESISTIVE CABLE

These protective systems are investigated with respect to fire exposure and water hose stream performance. Performance criteria are based on functionality of the cable during the fire and after the water hose stream. ANSI/UL 2196, "Tests for Fire Resistive Cables," describes two fire exposure conditions. The normal temperature rise (to ANSI/UL 263, "Fire Tests of Building Construction and Materials") is intended to represent a fully developed interior building fire. The rapid temperature rise (to ANSI/UL 1709, "Rapid Rise Fire Tests of Protection Materials for Structural Steel") is intended to represent a hydrocarbon pool fire. If not stated otherwise in the individual system , the normal temperature rise exposure was used. There are two hose stream levels: low impact and normal impact. The low-impact fog nozzle hose stream is applied only to cable 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.

CI cable is tested on steel rings to simulate installation in free air. If CI cable is intended to be installed in a raceway it is so tested. CI cable that has been tested in a raceway will be specified in the system.

Each design of fire-resistive cable is tested per ANSI/UL 2196. 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., are construction details that are also provided. Cable is UL Listed to a National Electrical Code Type and constructed to a UL Standard for the cable (such as Type MC per ANSI/UL 1569, "Metal-Clad Cables"; Type RHH/RHW to ANSI/UL 44, "Thermoset-Insulated Wires and Cables"; Type FPL per ANSI/UL 1424, "Cables for Power-Limited Fire-Alarm Circuits"; Type NPLF per ANSI/UL 1425, "Cables for Non-Power-Limited Fire-Alarm Circuits"; and Type TC per ANSI/UL 1277, "Electrical Power and Control Tray Cables with Optional Optical-Fiber Members").

Cable is tested as a complete system. The system includes the cable and/ 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. The hardware, clamps, strut, etc., are generally stated to be made of steel.

Systems that require a raceway are tested with the minimum raceway diameter and the minimum raceway type with their respective coupling(s).

UL 2196 GuideInfo

Raceways having larger diameters are acceptable. Raceways with greater wall thickness are also acceptable. Intermediate metal conduit (IMC) or rigid metal conduit (RMC) are acceptable for use in systems where electrical metallic tubing (EMT) is specified.

The raceway is intended to be connected together using the coupling type referenced in the system, such as steel setscrew type for EMT or threaded types of coupling for IMC and RMC. No other couplings are intended to be used unless noted in the specific system. For example, a compression coupling is not intended to be used in place of a steel setscrew coupling for EMT unless otherwise specified in the system. If IMC or RMC is substituted where EMT is specified, the raceway should be connected together with threaded types of couplings.

If a box, conduit body, supports (such as a grip), splice or other components are tested, it is noted in the system. Otherwise, the hourly fire rating applies only to continuous lengths of cable and/or raceway with couplings 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, ANSI/NFPA 70, "National Electrical Code" (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 conduit body or a box will be required. Items such as conduit bodies and boxes, if found acceptable, are described in the system. Since boxes are tested with a single raceway, each individual raceway should have an independent box used for pull points or splices. If a splice is tested, it is also described in the system. Boxes should be sized per the method described in the NEC.

The supports are an important part of the systems and each individual system has specific support requirements. The maximum distance between the supports is described in the individual systems and are not intended to be exceeded even if an alternate raceway is used. For example, if 5-feet spacing between supports is specified for EMT, this same support distance should 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 conduit/raceway unless otherwise noted in a specific system. Spacing of the tray support should also be the same as the raceway support spacing unless otherwise noted.

The support requirements are for both the horizontal and vertical configuration unless otherwise noted in a specific system. The supports for both the vertical or horizontal configuration are intended to be the support to the cable/conductor. Cable installed in a vertical raceway is not supported by the raceway. This is in contrast to MI or MC cable, where a support on the outside of the cable also supports the conductors. The ability of cable to support the equivalent cable weight of the maximum distance between cable supports without breaking the conductor, and compatibility/mechanical considerations of the cable support mechanism may be investigated in the test by simulating the weight of the vertical cable run. When so investigated, the maximum vertical distance tested and the cable support mechanism (s) are detailed in the system.

Compatibility of materials used in fire-rated systems is also a concern. Some materials can provide carbon residue that is conductive, or conductive gases 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 the system. The system will specify the manufacturer of an allowable ground wire. If not specified, the ground should be the same as the fire-rated wire described in the system. Use of any other ground wire violates the system fire rating. For example, THHN ground wire is not intended to be used with a fire-rated system unless specified in the system. If a pulling lubricant has been tested with the system, it will be so noted in the system.

These systems are intended to be installed in accordance with all provisions of the NEC and as amended by the details of each individual system (such as type of supports and distance between supports).

UL 2196 2-hours Circuit Integrity test

Environment: Large scale wall oven (14 x 15 x 3)

Temperature Profile: Slow Rise Follows ASTM E119

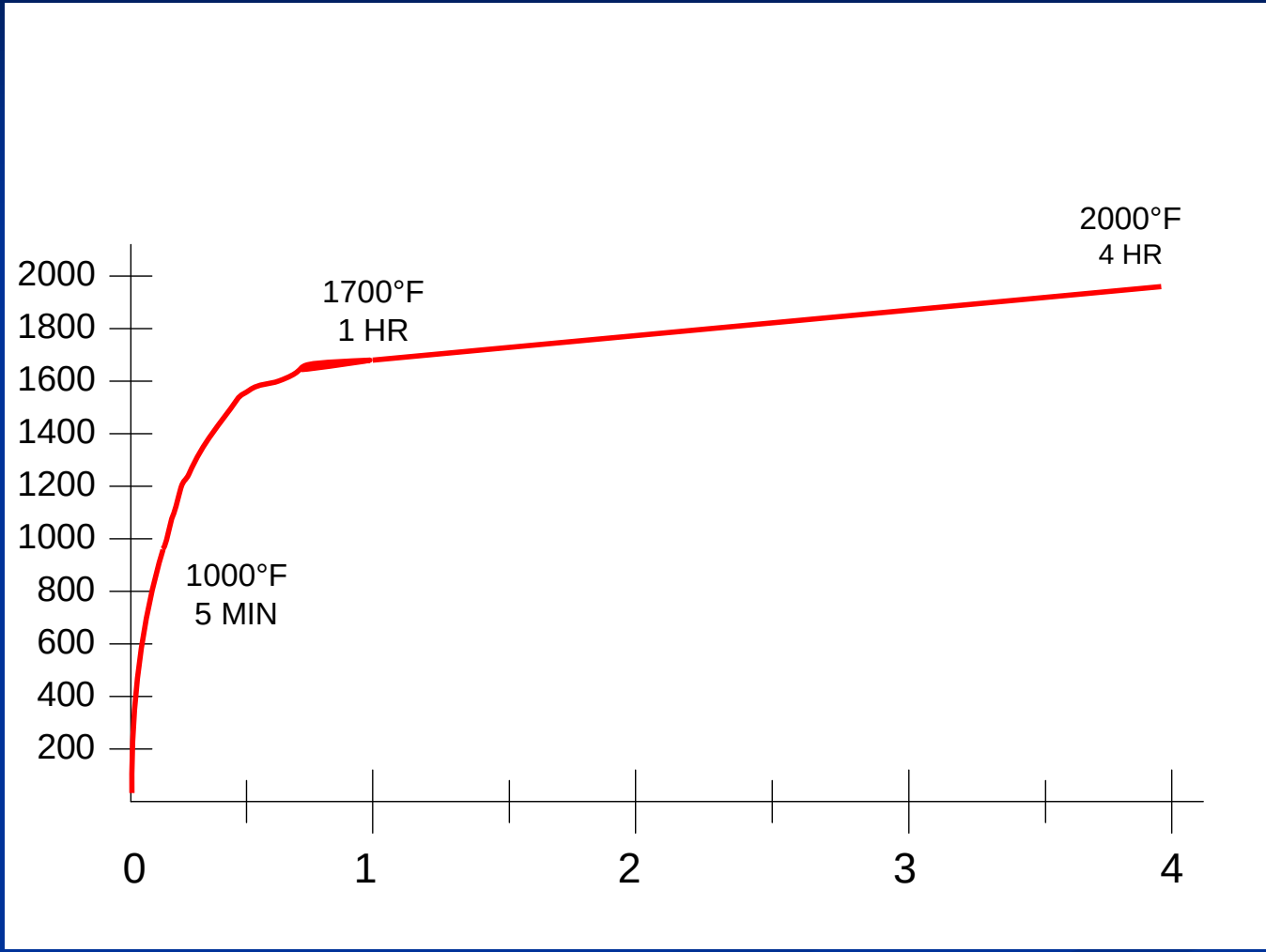
- 1000^0F @ 5 minutes
- 1700^0F @ 1 hour (Specified in NFPA 130)
- 1850^0F @ 2 hour

Cable are energized at application voltage

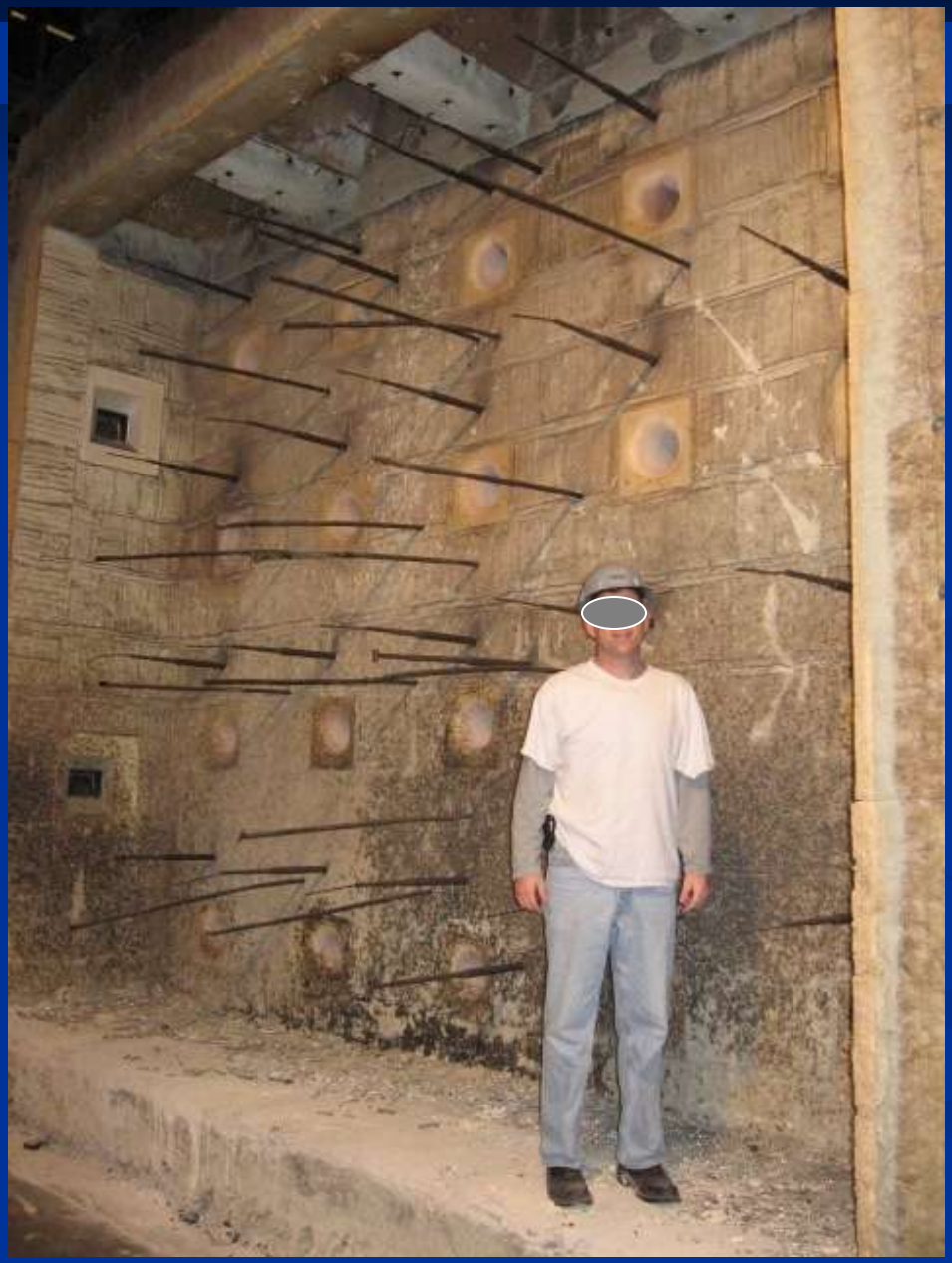
- 120V or 480V light bulbs set up

Water impact test after fire test

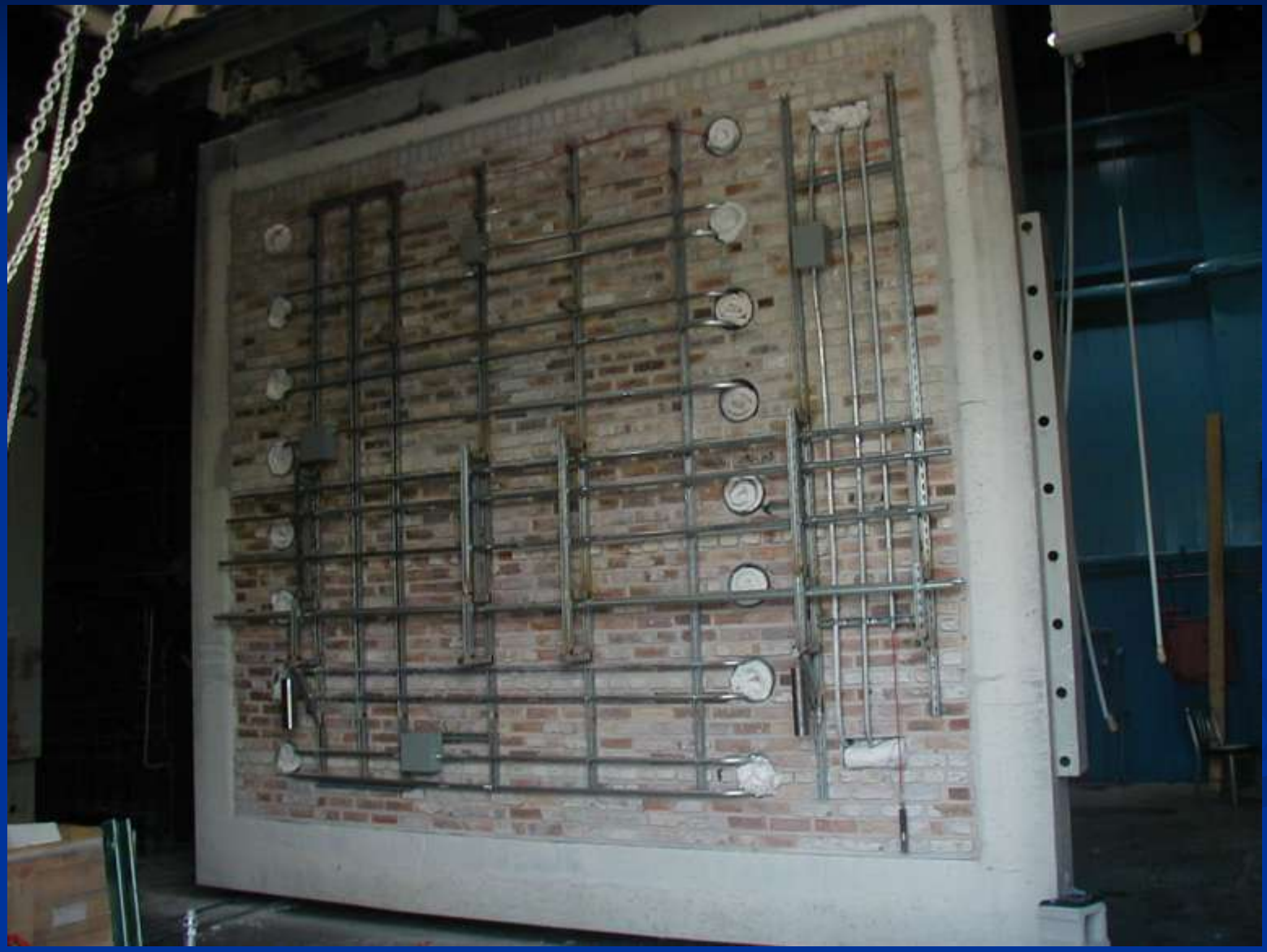
Time/Temperature Curve UL 2196



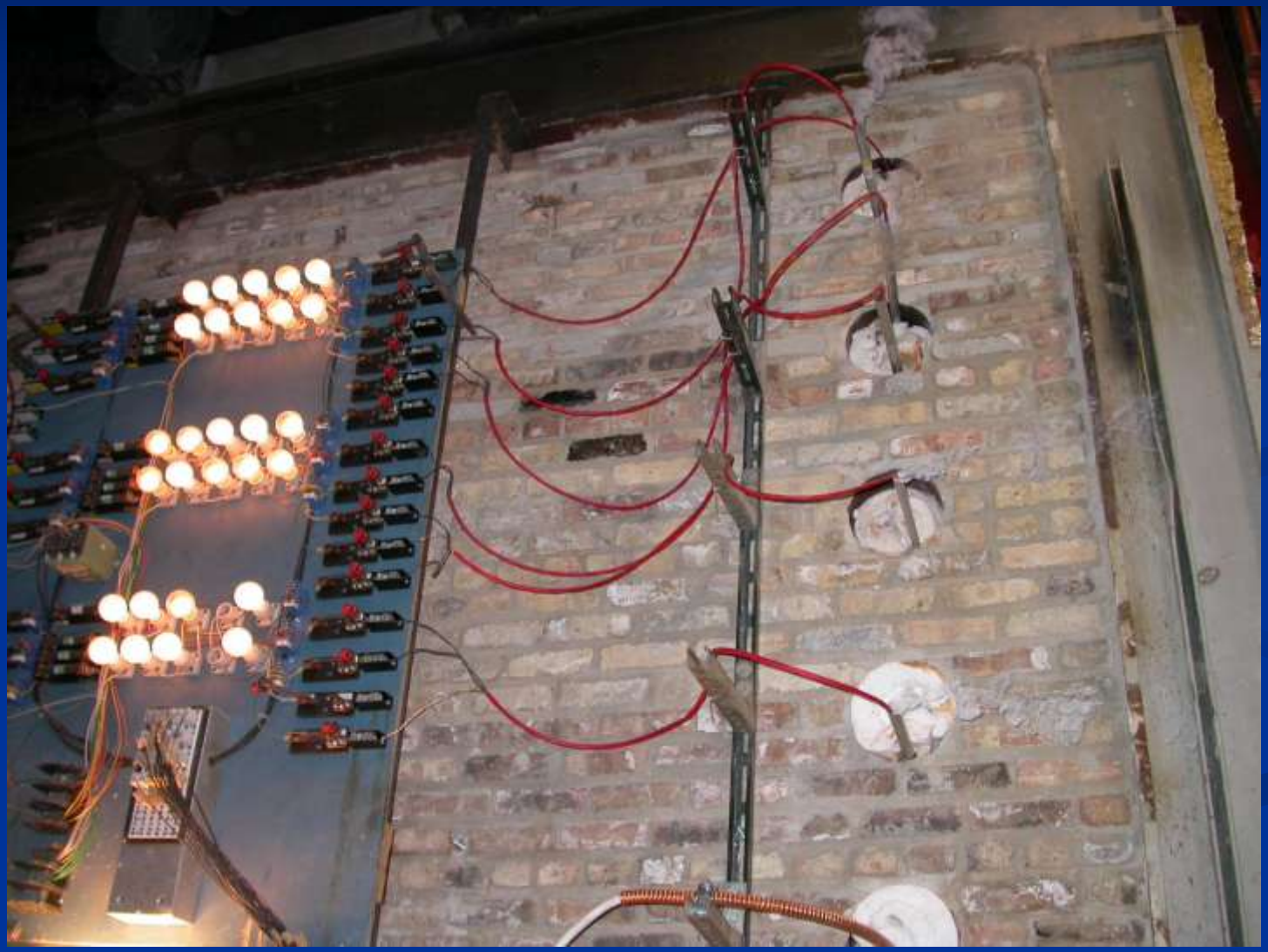
UL 2196 - 20 Gas Burners



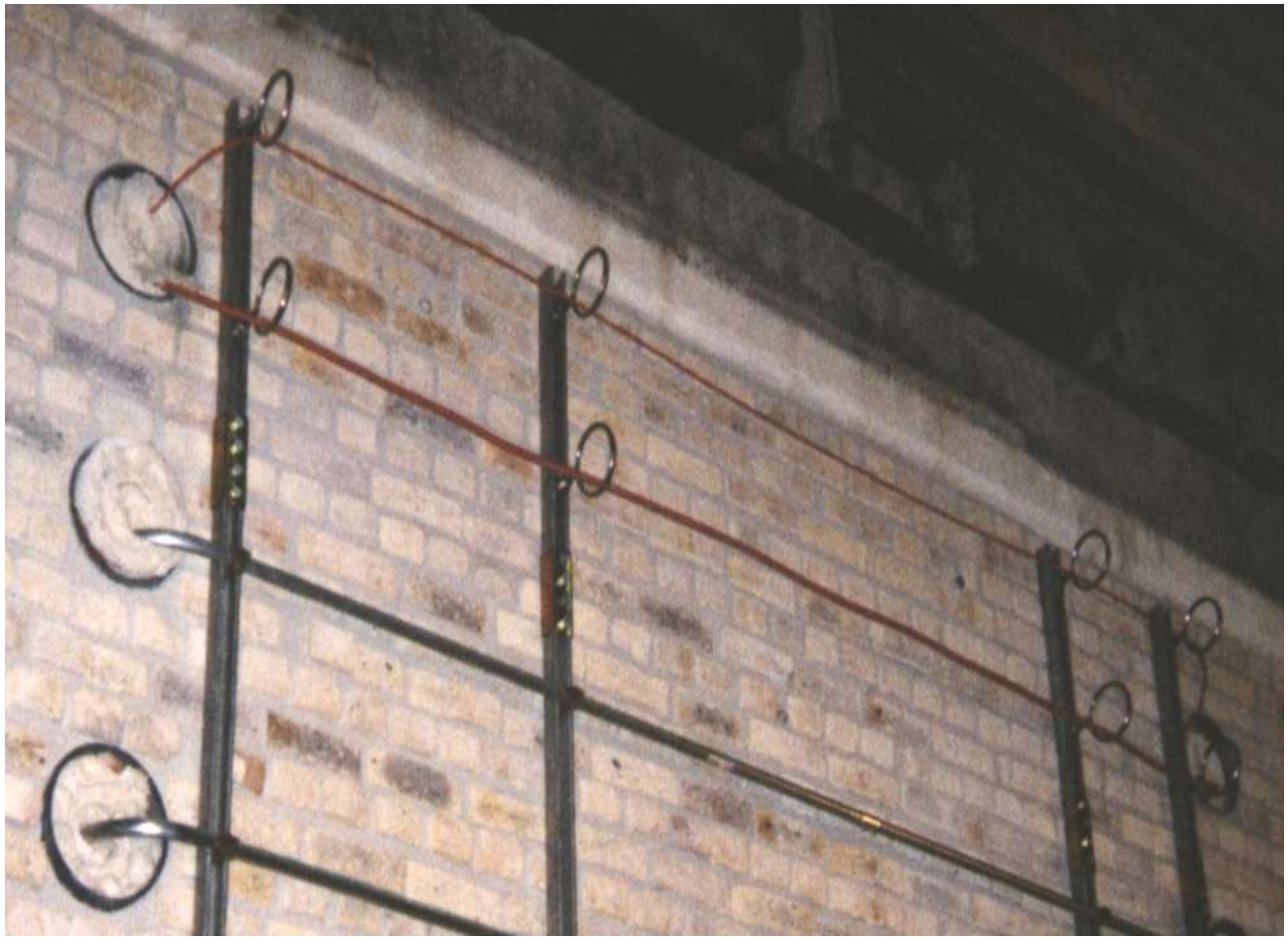
Wall Setup



Back side of wall



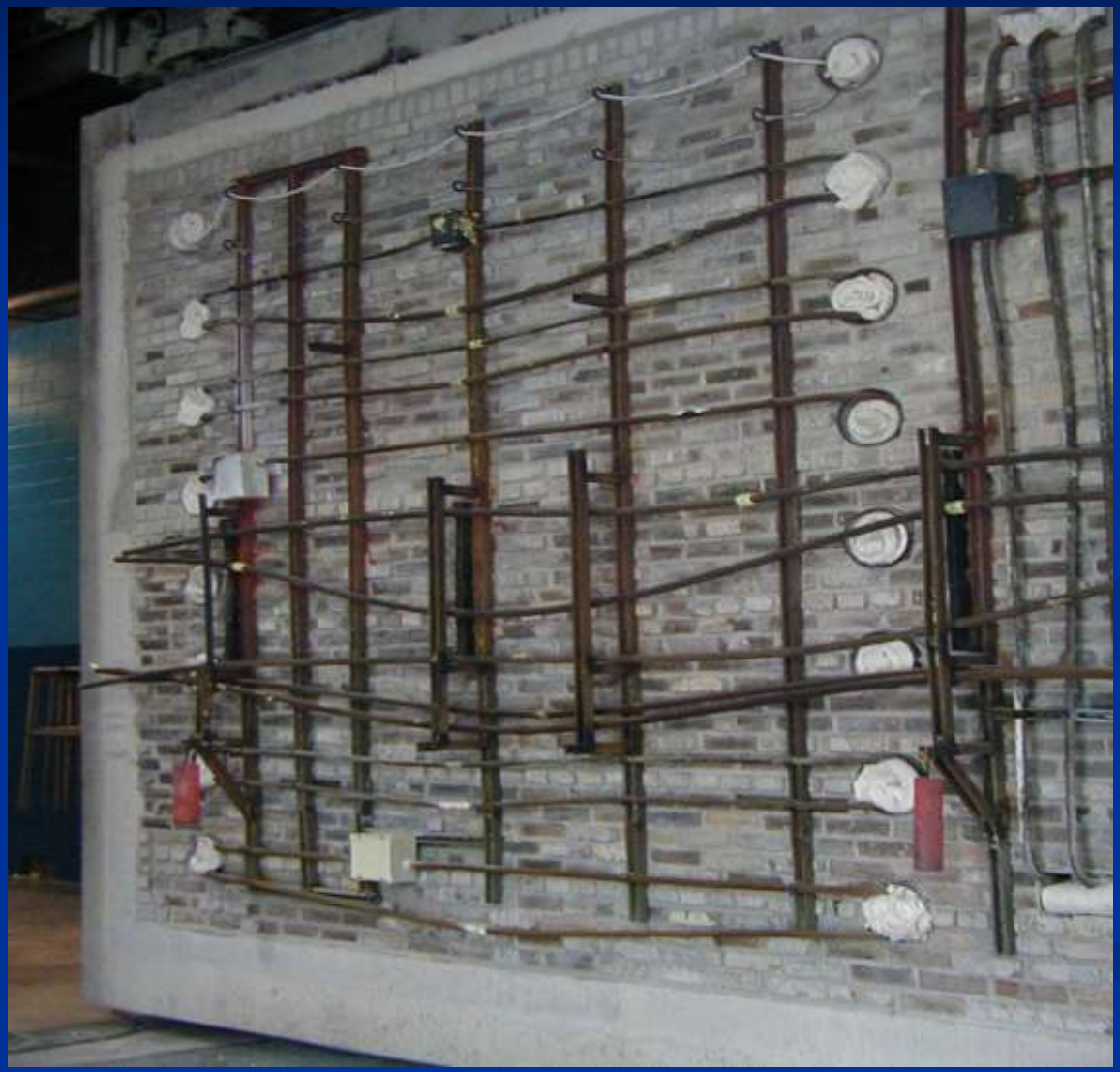
CI Cable Installed on Wall



UL 2196 Video

UL 2196 – After 2 Hours

UL 2196 – After 2 Hours



Water Impact Test

Fog Nozzle Spray

CI Cable after UL 2196 Test

Tested as a complete System

Historically, conduit systems used EMT to qualify

Before the Fire

After 2-hour @ 1850°F

2. **Conduit**** — 1/2 in. diameter min trade size steel such as rigid metal conduit (RMC), intermediate metal conduit (IMT) or electrical metallic tubing (EMT). May also use Listed flexible steel conduit not to exceed 6 ft. in length.

2A. **Conduit Coupling**** — Threaded steel coupling or electrical metallic tubing fitting-coupling, steel set screw type or steel compression type.

2B. **Pull Box**** — (Optional Not Shown) - Steel pull box. Cable(s) to be installed with offset.

2C. **Conduit Body**** — (Optional Not Shown) - Steel conduit body.

2D. **Pulling Lubricants** — (Optional Not Shown) Polywater "J", LZ, LZW, may be used with cables listed in this system. Polywater Dyna Blue, Ideal Yellow 77 may be used with cables installed in min. 3/4 in. EMT conduit.

2E. **Seal** — (Not Shown) Optional seal may be installed per the manufacturer's instructions.

3. **Fire Resistive Cables*** — One or more 14 AWG min, single conductor Type RHH/RHW/RHW-2 cables .

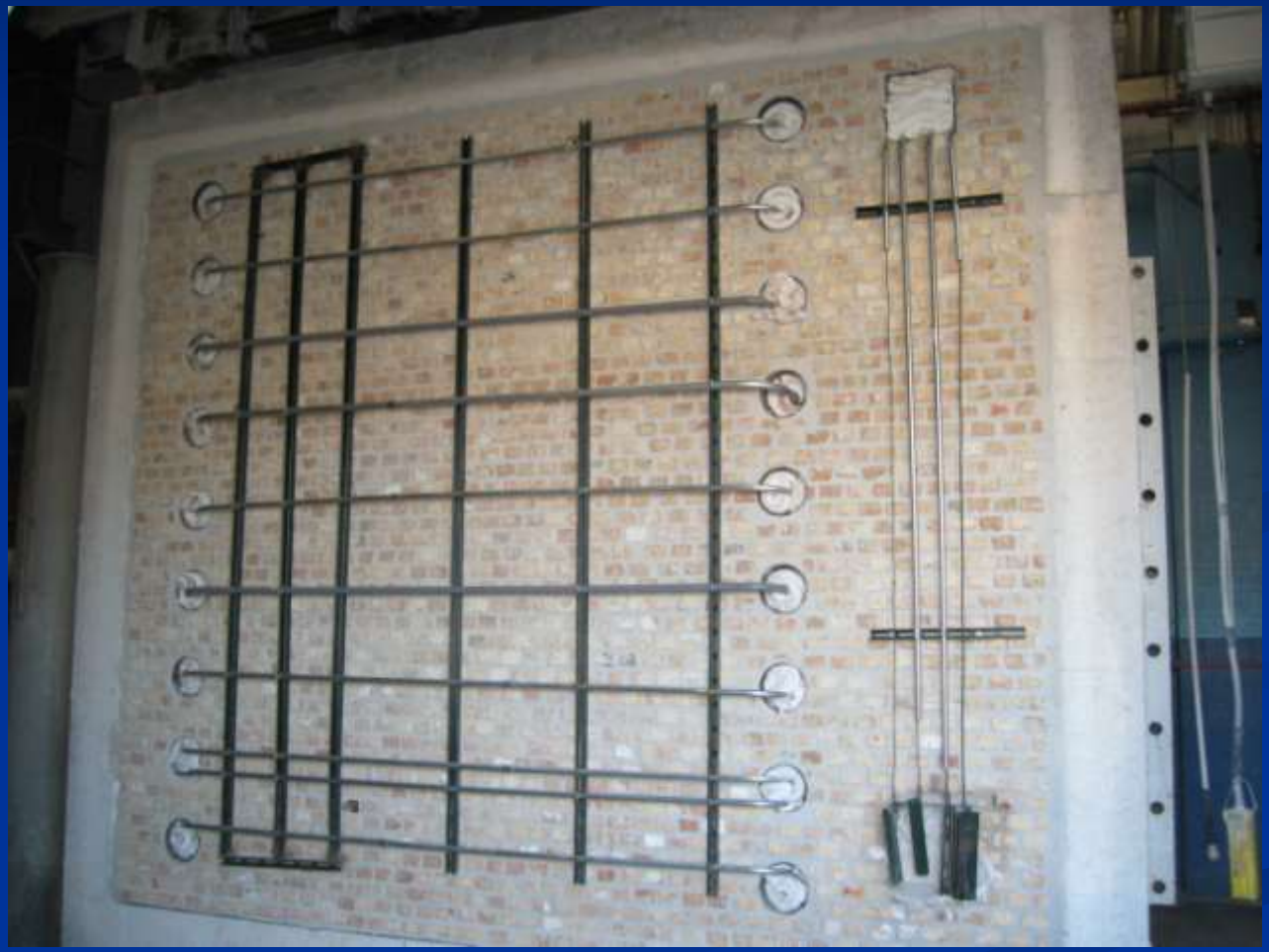
3A. **Splice**** — (Optional Not Shown) A taped field splice in a NEMA type 1 enclosure, min. dimensions 8-1/4 by 6-1/4 by 4-1/4 in., to be installed in accordance with manufacturer's installation instructions. The conduit size is to be min. 1/2 in.

As an alternate, a terminal block field splice in a NEMA type 1 enclosure, min. dimensions 8-1/4 by 6-1/4 by 4-1/4 in., to be installed in accordance with the manufacturer's installation instructions. The splice may be installed with optional with optional SR tape. The conduit size is to be min. 3/4 in.

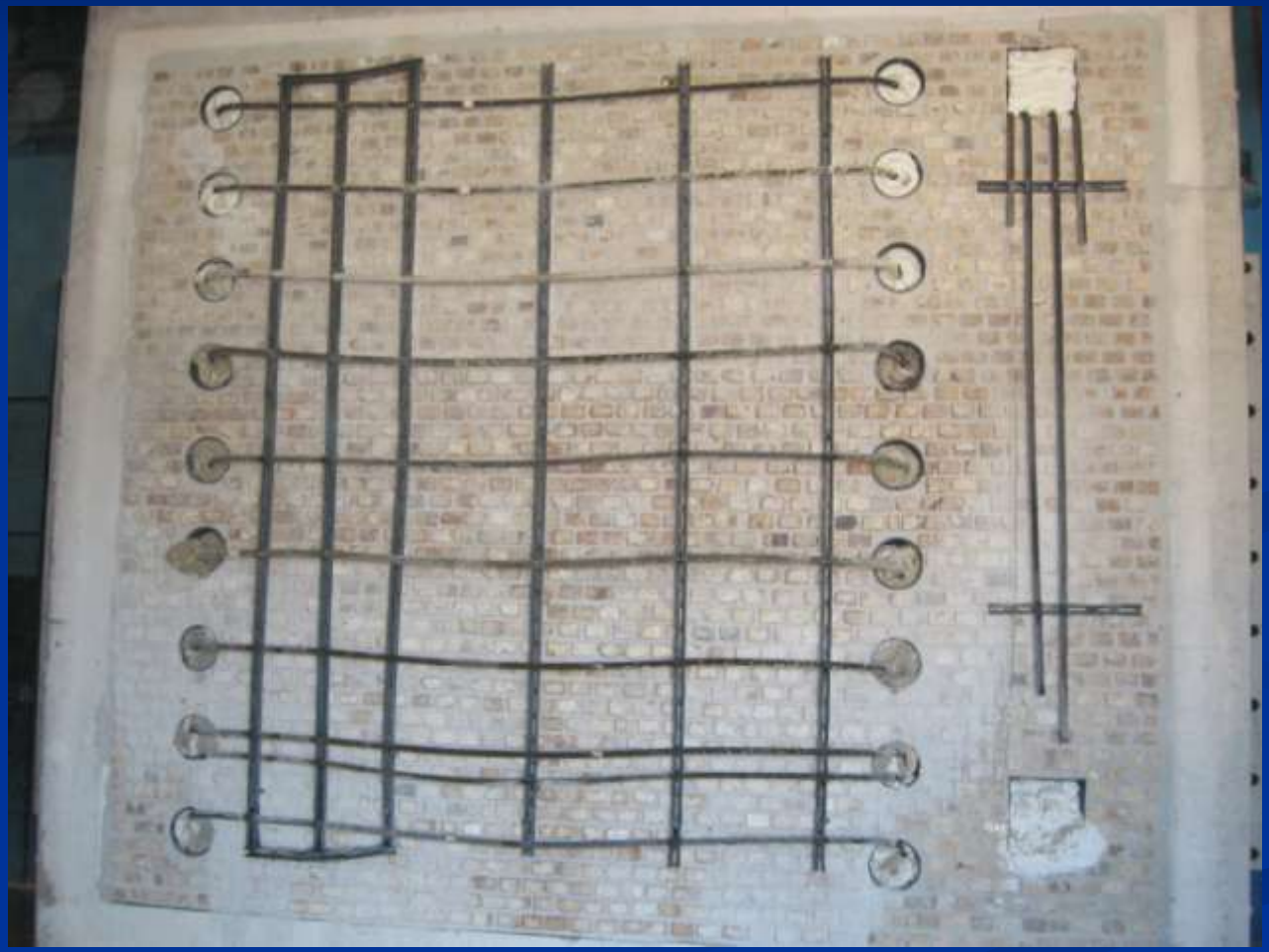
UL 2196 Fire Test FLAW

- Systems that require a raceway are tested with the minimum raceway diameter and the minimum raceway type with their respective coupling(s).
- Raceways having larger diameters are acceptable. Raceways with greater wall thickness are also acceptable. Intermediate metal conduit (IMC) or rigid metal conduit (RMC) are acceptable for use in systems where electrical metallic tubing (EMT) is specified.

UL 2196 Test Using RMC



UL 2196 Test Using RMC



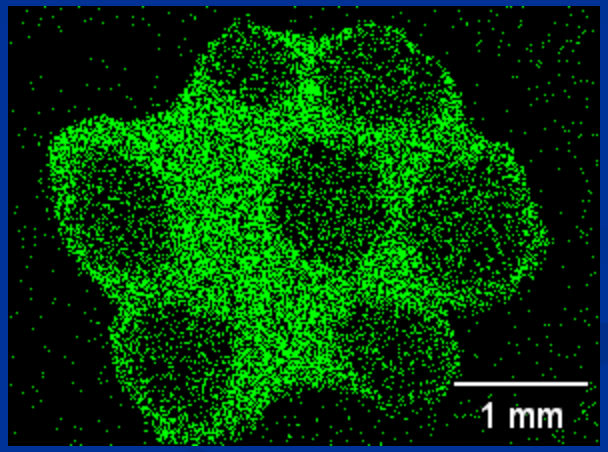
RHW 12 AWG in RMC

Vertical Test

Zinc Analysis by UCONN

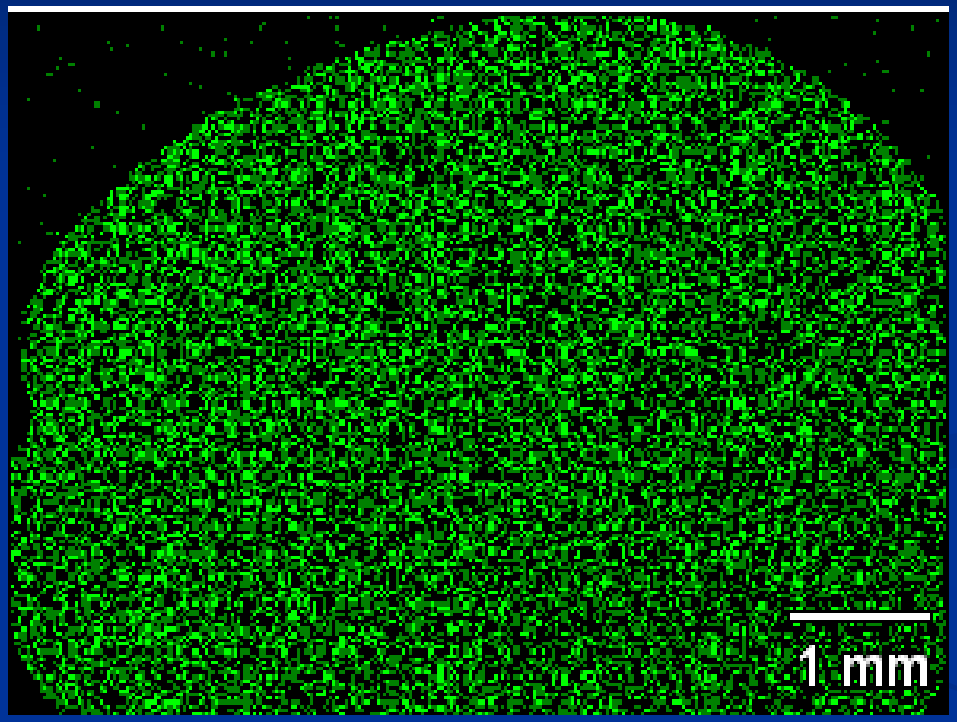
Zinc Analysis by UCONN

Zinc Analysis by UCONN



8 AWG – 16% zinc

Zinc Analysis by UCONN



12 AWG -31% zinc

UL Response

Sent to all manufacturers on June 12, 2012 (10 months)

Citation from letter:

UL has learned of a compatibility issue when Classified Fire-resistive Cables are used in Electrical Circuit Protective Systems where zinc is used as an interior coating in steel conduits, raceways and other system components. Specifically, at high temperatures a zinc coating may interact with copper conductors creating a brass alloy that melts at a lower temperature than copper conductors alone, thereby affecting the integrity of the electrical system. Consequently, the combination of certain Fire-resistive Cables as described in specific Electrical Circuit Protective Systems may not comply with UL 2196 in the presence of zinc. Therefore, UL is taking immediate action to revise all Electrical Circuit Protective System designs to indicate that system components that come into contact with the fire-resistive cable are to contain an interior coating free of zinc unless the designs have been so tested.

UL Statement 9/12/2012 Suspends all cable listings to UL 2196

- **Fire Resistive, Fire Resistant and Circuit Integrity Cables**
- UL has recently conducted research on a wide array of current products and systems originally certified under UL 2196, *Tests for Fire Resistive Cables* and ULC-S139, *Standard Method of Fire Test for Evaluation of Integrity of Electrical Cables* and determined that they no longer consistently achieve a two-hour fire-resistive rating when subjected to the standard Fire Endurance Test of UL2196 or ULC-S139. Consequently, UL and ULC will not be able to offer certification to the currently existing program related to these standards.
- As a result, manufacturers are no longer authorized to place the UL mark or ULC mark on the following products:
- UL Classified Fire Resistive Cable (FHJR)
- ULC Listed Fire Resistant Cable (FHJRC)
- UL Listed cable with "-CI" suffix (Circuit Integrity)

Where do we go from here

- UL has an Interim Test Program
- Only 2 cables have been approved
  - MI Cable – System 1850 – 2 hours
  - MC Cable – System 120 – 1 hour
- Testing in raceways will be more difficult because of all the different variables
- CI Cable will have limited application unless tested as a sytem

Questions