NFPA 130 Wire and Cable Requirements
Agenda

Non-emergency circuits
- Chapter 12 wiring requirements – Non-emergency
- FT4/IEEE 1202 vertical flame & smoke release test
- UL 1685 vertical flame & smoke release test

Emergency circuits
- NFPA 130 Chapter 12 wiring requirements – Emergency
- NFPA 130 Chapter 11 design and reliability
- NFPA 130 Chapter 5 & 6 emergency circuits
- NFPA 130 Chapter 10 fire alarm and communications cables
- NFPA 70 areas of assembly
- UL 2196 fire resistive certification & FHIT listings and selection
- What is a complete system?
- Known issues

Installation Pictures

Summary & NFPA 130 2020 to 2023 highlighted changes
1.1.1* This standard shall cover life safety from fire and fire protection requirements for fixed guideway transit and passenger rail systems, including, but not limited to, stations, trainways, emergency ventilation systems, vehicles, emergency procedures, communications, and control systems.

1.2 Purpose. The purpose of this standard shall be to establish minimum requirements that will provide a reasonable degree of safety from fire and its related hazards in fixed guideway transit and passenger rail system environments.

4.2.1* The goals of this standard shall be to provide an environment for occupants of fixed guideway and passenger rail system elements that is safe from fire and similar emergencies to a practical extent based on the following measures:

1) Protection of occupants not intimate with the initial fire development.
2) Maximizing the survivability of occupants intimate with the initial fire development.

4.8* Fire-Life Safety System Integrity. No part of the fire-life safety system critical to the intended system function that addresses an emergency shall be vulnerable to the emergency that it is supposed to address.
12.2 Flame Spread and Smoke Release.

12.2.1 Except as permitted in 12.2.2, all wires and cables used in stations and trainways, including traction power cables, shall comply with one of the following:

1) Must be listed as being resistant to the spread of fire (FT4) and as having reduced smoke emissions (ST1/LS) by exhibiting a char height less than 1.5 m (5 ft) when measured from the lower edge of the burner face, a total smoke released rate over 20 min that does not exceed 150 m², and a peak smoke release rate that does not exceed 0.40 m²/sec (4.3 ft²/sec) when tested using the FT4/IEEE 1202 flame test in either UL 1685 or UL 2556.

2) Must be listed as having adequate fire resistance and low-smoke producing characteristics by exhibiting a flame travel distance that does not exceed 1.5 m (5 ft) and by generating a maximum peak optical density of 0.50 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262.

12.3 Temperature, Moisture, and Grounding Requirements.

12.3.1 Wires and cables except for optical fiber & communications cables, shall comply with both of the following temperature and moisture resistance characteristics:

1) All insulations shall be a moisture- and heat-resistant type carrying a temperature rating of 90°C (194°F).

2) All wires and cables shall be listed and identified for use in wet locations.

12.4.2* All conductors for underground trainways or stations, except radio antennas, train control (signaling) cables, and traction power cables, shall be enclosed in their entirety in armor sheaths, conduits, or enclosed raceways, boxes and cabinets, except in ancillary areas.
FT4/IEEE 1202: Flame Test of Cables

1.1 Scope

This standard provides a protocol for exposing cable samples to a theoretical 20 kW (70 000 Btu/hr) flaming ignition source for a 20 min test duration. The test determines the flame propagation tendency of single conductor and multiconductor cables intended for use in cable trays in industrial and commercial occupancies.

1.2 Purpose

The purpose of this standard is to establish a test protocol and performance criteria to determine the flame propagation tendency of cables in a vertical cable tray.

Flame test requirements:
1. Exposed to flame for 20 mins
2. Max char height of 1.5m (4.9ft)

Additional FT4 requirements:
3. Total smoke released < 150 m²
4. Peak smoke release rate < 0.40 m²/sec

Cables marked **ST1** meet smoke release “Limited Smoke” (LS)
## Non-Emergency Circuits Summary

### Chapter 12 requirements, applicable to all wires/cables

- Cables must be **90°C rated**
- Cables must be **low smoke (ST1) and flame-retardant (FT4/UL 1685)**
- Cables must be **wet** listed (except for fiber optics & communication)
- Cables must have an **armor** or be in a **raceway/conduit** [exception for train control (signal cables) and traction power]
Emergency Circuits Requirements – Chapter 12

- 12.4.4 Emergency power, emergency lighting, and emergency communications circuits shall be protected from physical damage caused by normal system operations.
- 12.4.5 The circuits in 12.4.4 shall be installed in a manner to reduce the likelihood that a single fire or emergency event will lead to failure of the system by using one of or a combination of the following methods:
  1) Circuits consist of fire-resistive cable systems that comply with Section 12.5.
  2) *The circuits shall be encased in concrete to provide protection for 1 hour.
  3) The circuits shall be protected by a fire barrier system that complies with the requirements of UL 1724 when tested for 1 hour.
  4) *The circuits shall be redundant such that system operational capabilities continues.
  5) Multiple circuits shall be separated by a fire barrier with a fire resistance rating of at least 1 hour when tested in accordance with ASTM E119 or UL 263.

- 12.5 Fire-Resistive Cables.
- 12.5.1 Fire-resistive cables shall be certified or listed for no less than 1 hour of operation as tested to UL 2196 using the time-temperature curve of ASTM E119 or UL 263.
- 12.5.2 The fire-resistive cable systems shall comply with all of the following:
  1) The cables shall be tested as a complete system, in both the vertical and horizontal orientation, including all the conductors, cables, splices and raceways, as applicable.
  2) For fire-resistive cables intended for installation in a raceway, the systems shall be tested in the type of raceway in which they are intended to be installed.
  3) Have installation instructions that describe the assembly to be tested so that only those system components included in the test assembly are installed.
11.1 General. 11.1.1 Scope. This chapter defines requirements for the functionality, reliability and availability of control systems and communication systems when exposed to the effects of smoke and fire.

11.1.2 Application. These systems include the following:
1) Train control (signaling systems) as described in 7.2.5, 8.9.2.3, and in this chapter
2) Emergency communication systems as described in 6.4.2, 8.9.2.1, 8.9.2.2, 9.8.4, and Section 9.9
3) Traction power systems as described in 6.4.2, 7.2.5, 9.13.4, and 9.13.5
4) Supervisory control and data acquisition (SCADA) systems as they apply to fire emergencies

11.2. Train Control. 11.2.1* A reliability engineering analysis shall be performed to consider the ability of control systems to maintain communications and the ability to reposition vehicles during a fire emergency.

11.3 Functionality, Reliability, and Availability of Control Systems.
- 11.3.1* Functionality, reliability, and availability of control systems and communications systems during a fire incident shall be considered in addition to normal reliability and availability calculations.
- 11.3.2* To meet the goals for life safety of the occupants, the effects of single points of failure shall be considered.
- 11.3.3* In addition to physical protection from incidents, control, data, and communication cables and related components shall continue functionality during a fire and shall be protected from thermal exposure that would affect their function.
Emergency Circuits in Chapters 5 & 6

Chapter 5 Stations and Chapter 6 Trainways

- 5.4.3 Emergency Communications System. Stations shall be provided with an emergency communications system in accordance with Chapter 10.

- 6.4.8.2 The following systems shall be connected to the emergency power system:
  1) Emergency lighting
  2) Protective signaling systems
  3) Emergency communication system
  4) Fire command center
10.1* General. An emergency communication system shall be provided throughout fixed guideway transit and passenger rail systems in accordance with this chapter.

10.4.3 Two-way wired emergency communications system telephone handsets shall be provided at the following locations:

1) Fire command center, where provided
2) Operations control center
3) Traction power substations
4) Blue light station locations
5) Ventilation plant control rooms
6) Ancillary rooms and spaces as determined by the authority having jurisdiction
7) Other locations along the trainway as determined by the authority having jurisdictions.
Areas of Assembly – Emergency – NEC

What about “above ground” stations?

Part II. Circuit Wiring; 700.10 Wiring, Emergency System.
(D) Fire Protection. Emergency systems shall meet the additional requirements in (D)(1) through (D)(3) in the following occupancies:
1. Assembly occupancies for not less than 1000 persons
2. Buildings above 23 m (75 ft) in height
3. Educational occupancies with more than 300 occupants

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

(1) The cable or raceway is installed in spaces or areas that are fully protected by an approved automatic fire suppression system.
(2) The cable or raceway is protected by a listed electrical circuit protective system with a minimum 2-hour fire rating.
(3) The cable or raceway is a listed fire-resistive cable system.
(4) The cable or raceway is protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency circuits.
(5) The cable or raceways is encased in a minimum of 50 mm (2 in ) of concrete.
Chapter 12 – Fire resistive Function

NFPA 130: Chapter 12

Requires emergency circuits be tested to ANSI/UL 2196 following time/temperature per ASTM E119 to ensure that they perform their **intended electrical function** during a fire in subway tunnel or stations.
## Emergency Circuits – Summary

*(must comply w/ non-emergency requirements as well)*

<table>
<thead>
<tr>
<th>Non-Emergency (Applicable to all wires/cables)</th>
<th>Emergency Circuits (1 hr. FRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cables must be <strong>90°C rated</strong></td>
<td><strong>UL 2196 1-hr Fire-resistive cable system</strong></td>
</tr>
<tr>
<td>Cables must be <strong>low smoke</strong> and <strong>flame-retardant</strong></td>
<td>Concrete encasement, 1-hr protection</td>
</tr>
<tr>
<td>Cables must be <strong>wet</strong> listed (except for fiber optics communication)</td>
<td>1-hr Fire-barrier per UL 1724</td>
</tr>
<tr>
<td>Cables must have an <strong>armor</strong> or be in a <strong>raceway/conduit</strong> [exception for train control (signal cables) and <strong>traction power</strong>]</td>
<td>Redundant systems</td>
</tr>
<tr>
<td></td>
<td>Multiple circuits separated by 1-hr fire-barrier</td>
</tr>
</tbody>
</table>
• Environment: Large scale wall oven (14 x 15 x 3 [ft])
• Temperature Profile: Slow Rise Follows ASTM E119
• Cable are energized at application voltage (50, 72, 120, 480 or 600V)
• ULc-S139 at 600V
• Water impact test after fire test
E119 Time-temperature curve

- 1000°F @ 5 minutes
- 1300°F @ 10 minutes
- 1550°F @ 30 minutes
- 1700°F @ 60 minutes (NFPA 130)
- 1850°F @ 120 minutes (NFPA 502)

<table>
<thead>
<tr>
<th>Metal</th>
<th>Melting Point (°F)</th>
<th>Melting Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>1,218</td>
<td>659</td>
</tr>
<tr>
<td>Copper</td>
<td>1,981</td>
<td>1,083</td>
</tr>
<tr>
<td>Steel</td>
<td>2,500</td>
<td>1,371</td>
</tr>
</tbody>
</table>
UL 2196 Test Wall Video
Fire Test Certification – Furnace Aftermath
Emergency Circuit Cable Types

**MC/RC90**
- Applications:
  - Emergency Power Circuits
  - Emergency Lighting
  - HVAC & Smoke EVAC Control Circuits
  - Fire Alarm Backbone/Fire Alarm
  - Generator Automatic Transfer Switches (ATS) Control Panel

**RHW-2**
- Applications:
  - Emergency Power Circuits
  - Emergency Lighting
  - HVAC & Smoke EVAC Control Circuits
  - Fire Alarm Backbone/Fire Alarm
  - Generator Automatic Transfer Switches (ATS) Control Panel

**Coax**
- Applications:
  - BDA or DAS Systems
  - Emergency Responder Radio Communication Systems (ERRCS)

**Armored**
- Applications:
  - Emergency Communication in Transit Tunnels and Platforms
  - Emergency communication and emergency signal for jet fan sensors

**Ethernet**
- Applications:
  - Area of Refuge (AoR) 2-way Communications
  - Digital Signage
  - IP Cameras

**CI/CIC**
- Applications:
  - Emergency Voice Alarm Communications (EVAC)
  - Smoke & Fire Alarm Systems
  - Fireman's Telephone Systems
Splicing – Per FHIT system listing & FRR information

Metal Clad cable splicing
- Block splice
- Fused block splice
- Tape splice

RHW-2 Splicing
- Tape splice

Hybrid RHW-2 to MC splicing
- Block splice
- Fused block splice

CI/CIC
- Tape splice
Hybrid Splice Box
What is Complete System? NEC Article 728

728.4 General. Fire-resistive cables and conductors and their components shall be tested and listed as a complete system, shall be designated for use in a specific system, and shall not be interchangeable between systems.

728.5 Installations. Fire-resistant cable systems installed outside the fire-rated rooms that they serve, such as the electrical room or the fire pump room, shall comply with the requirements of 728.5(A) through (H) and all other installation instructions provided in the listing.

(A) **Mounting.** The fire-resistant cable system shall be secured to the building structure in accordance with the listing and the manufacturer’s installation instructions.

(B) **Supports.** The fire-resistant cable system shall be supported in accordance with the listing and the manufacturer’s installation instructions.

(C) **Raceways and Couplings.** Where fire-resistant cable is listed to be installed in a raceway, the raceway enclosing the cable, any couplings, and any connectors shall be listed as part of the fire-resistant cable system. The raceway fill for each system shall comply with the listing requirements for the system and shall not be greater than the fill permitted in Chapter 9, Table 1.

(D) **Cable Trays.** Cable trays used as part of a fire-resistant cable system shall be listed as part of the fire-resistant cable system.

(E) **Boxes.** Boxes or enclosures used as part of a fire-resistant cable system shall be listed as part of the fire-resistant cable system and shall be secured to the building structure independently of the raceways or cables listed in the system.

(F) **Pulling Lubricants.** Fire-resistant cable installed in a raceway shall only use pulling lubricants listed as part of the fire-resistant cable system.

(G) **Vertical Supports.** Cables and conductors installed in vertical raceways shall be supported in accordance with the listing of the fire-resistant cable system and in accordance with 300.19.

(H) **Splices.** Only splices that are part of the listing for the fire-resistant cable system shall be used. Splices shall have manufacturer’s installation instructions.

728.60 – Equipment Grounding Conductor.
Key points for system selection

- **NFPA 70 (NEC)** article 728, **NFPA 130** article 12.5.3 & **UL 2196** article 5.1.1.14 all **require testing fire-rated cables as a complete system**.
- Fire-rated systems must be tested as complete systems to ensure performance in the event of a fire. Changes may invalidate the listing, increasing the associated risks and liability.
  
  NFPA 70, article 728.4 regarding fire-resistive cable systems does not allow interchangeability between systems (in line with the above).

**Number of wires in a conduit:**
- All conductors must be accounted for the fire-load, including ground wires.
- For instance, three-phase Y (with 3-phase-to-phase wires, 1 neutral and 1 ground, totaling 5 conductors). Some FHIT systems that allow more than 4-wires to be installed in conduit.

**System connectivity & completeness:**
- If branching out/splicing is needed for lights or any other loads, then a splice/junction box is needed.
- Ensure that the FHIT system has listed splice boxes if one is to be used in the project. Some FHIT systems allow it.
- Some systems may require upsizing the conduit for the vertical orientation, lowering the fill ratio.

**Overcurrent protection devices:**
- If the fuse is located outside the fire-rated splice box, or if one is not present, the fire will likely melt the wiring/harness and short the circuit. It would trip the overcurrent protection device at the beginning of the circuit and disable the phase down the line.

**Fire-rated voltage:**
- The rated voltage should be verified by inspecting the UL FHJR file (not the product catalog, which in some instances lists the standard voltage rating instead of the fire-rated circuit voltage).
### Steps to locate fire-resistant cables & systems

Navigate to the UL website: [https://iq.ulprospector.com/](https://iq.ulprospector.com/) & filter for the FHIT category

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Company Name</th>
<th>Notes</th>
<th>UL CCN Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIT.1082C</td>
<td>TEC International LLC</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.120</td>
<td>Marmon Wire &amp; Cable Inc</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.120A</td>
<td>Marmon Wire &amp; Cable Inc</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.120AM</td>
<td>Marmon Wire &amp; Cable Inc</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.120M</td>
<td>Marmon Wire &amp; Cable Inc</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.1250</td>
<td>AMERICAN POLYWATER CORP RADIO FREQUENCY SYSTEMS INC ALLIED TUBE &amp; CONDUIT CORPORATION</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
<tr>
<td>FHIT.130</td>
<td>Marmon Wire &amp; Cable Inc CHAMPION FIBERGLASS INC AMERICAN POLYWATER CORP</td>
<td></td>
<td>Electrical Circuit Integrity Systems</td>
</tr>
</tbody>
</table>
Select the FHIT system to verify listed equipment, including splice boxes (examples below depicts systems from different manufacturers)
Cable in Conduit Systems

Examples

Select the FHIT system to verify listed equipment, including # of conductors (examples below depicts systems from different manufacturers)
## Selection Steps

**FHJR Construction Information - Select based on application needs**

<table>
<thead>
<tr>
<th>No. of Conductors or No. of Conductors x No. of Grounds</th>
<th>AWU/Amper Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image of table with columns for selection steps]</td>
<td></td>
</tr>
</tbody>
</table>

- **Metal Clad**
- **Conduit Hybrid**
- **Conduit**

---

**Metal Clad**

**Conduit**

**Conduit Hybrid**
Known Issues

Empirical knowledge leading complete systems testing

• Supporting methods and distances
• Bends and routing through the walls
• Cable materials science and selection
• Galvanized / Zinc conduit
Installation Photos
Installation Photos
Installation Photos
Installation Photos
Installation Photos
### Wire and Cable Requirements Recap & Including a NFPA 502 Summary

<table>
<thead>
<tr>
<th>Non-Emergency (Applicable to all wires/cables)</th>
<th>Emergency Circuits (1 hr. FRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cables must be <strong>90°C rated</strong></td>
<td>UL 2196 1-hr Fire-resistive cable system</td>
</tr>
<tr>
<td>Cables must be <strong>low smoke (ST1)</strong> and <strong>flame-retardant (FT4/UL 1685)</strong></td>
<td>Concrete encasement, 1-hr protection</td>
</tr>
<tr>
<td>Cables must be <strong>wet</strong> listed (except for fiber optics &amp; communication)</td>
<td>1-hr Fire-barrier per UL 1724</td>
</tr>
<tr>
<td>Cables must have an <strong>armor</strong> or be in a <strong>raceway/conduit</strong> [exception for train control (signal cables) and traction power]</td>
<td>Redundant systems</td>
</tr>
<tr>
<td></td>
<td>Multiple circuits separated by 1-hr fire-barrier</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Emergency (Applicable to all wires/cables)</th>
<th>Emergency Circuits (2 hr. FRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cables must be rated for the application temperature</td>
<td>UL 2196 2-hr Fire-resistive cable system</td>
</tr>
<tr>
<td>All cables must be <strong>low smoke</strong> and <strong>flame-retardant</strong></td>
<td>2-hr Fire-barrier per UL 1724</td>
</tr>
<tr>
<td>Wet listed</td>
<td>External routing</td>
</tr>
<tr>
<td>Cables must have a <strong>armor</strong> or be in a <strong>raceway/conduit</strong></td>
<td>Diversity in the system</td>
</tr>
<tr>
<td>Shall emit <strong>less than 2% acid gas</strong></td>
<td></td>
</tr>
<tr>
<td>Subject</td>
<td>2023 Version</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Station definition</td>
<td>3.3.56 – “A <strong>building</strong> designed for the purpose of loading and unloading”…</td>
</tr>
<tr>
<td>Enclosed Station (no change)</td>
<td>3.3.56.1 – “A station or portion thereof that does not meet the definition of an open station”</td>
</tr>
<tr>
<td>Open Station (no change)</td>
<td>3.3.56.2 – “A station that is constructed such that it is directly open to the atmosphere and smoke and heat are allowed to disperse directly into the atmosphere”</td>
</tr>
<tr>
<td>Flame Spread and Smoke Release Requirements</td>
<td>12.2.2 – Exceptions allowed for circuits encased in at least 2 in thick concrete and for open stations or open trainways</td>
</tr>
<tr>
<td>Temperature and Moisture Requirements</td>
<td>12.3.1 – 90°C WET Listing exception for fiber <strong>optical</strong> &amp; communications cables (Dec 20, 2024)</td>
</tr>
</tbody>
</table>

*NFPA 130 – 2023 vs. 2020 Highlights*
## NFPA 130 – 2023 vs. 2020 Highlights

<table>
<thead>
<tr>
<th>Subject</th>
<th>2023 Version</th>
<th>2020 Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency power, lighting and communication circuits protection</td>
<td>12.4.4 – Protected against physical damage caused by normal operations</td>
<td>12.4.4 – Protected from physical damage by system vehicles or other normal system operations and from fires in the system for at least 1 hour...</td>
</tr>
<tr>
<td>1-hour fire conditions circuit resistance per ASTM E119 curve</td>
<td>One or a combination of the following: 1) Fire-resistive cable systems in accordance with Section 12.5 (UL 2196 criteria, 1 hr.) 2) Encased in concrete that provides 1 hour protection 3) Fire barrier in accordance with UL 1724 when tested for 1 hour 4) Redundant systems such that system operational capability continues 5) Multiple circuits shall be separated by a fire barrier with a fire resistance rating of at least 1 hour</td>
<td>Any of the following: 1) Embedded in concrete or protected by a fire barrier in accordance with UL 1724 2) Routed outside the enclosed portion of the system 3) Diversity in routing 4) Fire-resistive cable systems in accordance with Section 12.5 (UL 2196 criteria)</td>
</tr>
<tr>
<td>Fire resistive cables</td>
<td>12.5.2 (1) – Cable shall be tested as <a href="#">complete system</a>, in both vertical and horizontal orientation, including all the conductors, cables, <a href="#">splices</a>, and raceways, as applicable.</td>
<td>12.5.3 (1) – Tested as <strong>complete system</strong>, in both the vertical and horizontal orientation, of conductors, cables, and raceways, as applicable.</td>
</tr>
</tbody>
</table>

*Note: [complete system](#) refers to the entire system, including conductors, cables, splices, and raceways.*
Questions?