About Me

• 3 years at 3M
  • 3M Fire Protection Products, Senior Application Engineer
  • Specialized in Duct Wrap and Endothermic Mat
• Prior to 3M:
  • Facilities Management, Safety and Engineering with ExxonMobil
• Mechanical Engineering B.S.
An Introduction to Endothermic Technology

Critical Building Systems
- Power Circuits
- Communication Circuits
- Fuel Oil Piping
- Structural Steel

Questions
What is Endothermic Technology?

• Endothermic Reaction
  • Heat Energy Absorption
  • Releases Chemically Bound Water at Elevated Temperatures
  • Creates a Cooling Effect

Endothermic process absorbs heat energy through the release of chemically bound water. This slows down heat transfer and helps protect items that have been wrapped with 3M™ Interam™ Endothermic Mat.
Endothermic Technology in a Fire Test
Temperature (F) vs. Time (minutes)

Endothermic Reaction

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Critical Systems
Building Critical Power Circuits
Critical systems’ power circuits require fire-resistance ratings:

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The code, 2015 & before, used to say:

1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a fire-resistance rating of not less than $X$ hour.

2. Construction having a fire-resistance rating of not less than $X$ hour.

$X$ hours either 1 or 2, depends on application
1 Scope
1.1 The intent of this Standard is to evaluate the integrity of power, control, instrumentation, and data cables for their ability to maintain circuit integrity when subjected to standard fire test exposure and associated hose stream test.
And what products/listings are there for UL 2196?

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<td>FHJR.R40176</td>
<td>RADIO FREQUENCY SYSTEMS INC</td>
<td>FIRE-RESISTIVE CABLE</td>
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1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than $X$ hour.

2. **Electrical circuit protective systems** shall have a *fire-resistance rating* of not less than $X$ hour. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

3. Construction having a *fire-resistance rating* of not less than $X$ hour.

$X$ hours either 1 or 2, depends on application.
What are my **Electrical circuit protective systems** options?

UL 1724 – Outline of Investigation for Fire Tests of Electrical Circuit Protective Systems

-OR-

What is UL 1724? Circuit Integrity

1 Scope
1.1 These requirements cover the fire test investigation of electrical circuit protective systems of various materials and construction.

June 23, 1986

3M Company
Mr. Randall C. Kosa
Senior Product Development Engineer
767-16 3M Center
St. Paul, MN 55144

Our Ref: R10122, 86RX2519

Subject: Type E50-D Endothermic Mat In 3 Hr Fire Rated Electrical Circuit Protective Systems For Conduit, Junction Box And Cable Bundle Air Drop Systems

Dear Mr. Kosa:

The subject of this Letter Report is the fire test investigation of electrical circuit protective systems installed beneath a concrete floor assembly. The object of this investigation was to develop heat transfer and physical fire performance data for the electrical circuit protective systems described in this Letter Report.

The test program consisted of constructing a concrete floor assembly with two electrical circuit protective systems. The electrical circuit systems consisted of a steel conduit system and a steel junction box with a cable bundle air drop system containing insulated and bare electrical conductors. Each electrical circuit system was wrapped with five layers of an endothermic mat material. The floor assembly was subjected to fire exposure and hose stream tests in accordance with the Outline of Proposed Investigation for Fire Tests of Electrical Circuit Protective Systems, UL Subject 1724. The fire exposure and hose stream tests were conducted on February 6, 1986.
1. Scope*

1.1 These test methods cover fire-test-response.

1.2 These fire-test-response test methods provide information on the temperatures recorded on the electrical system component within a fire-resistive barrier system during the period of exposure.
3M™ Interam™ Endothermic Mat Testing
ASTM E1725
(Electrical System Components)

Visual Inspection After 3-Hour Fire Test
Cables and jacketing intact
In essence...

Code used to allow only fire-resistive cables tested to UL 2196

It’s evolved now to allow conventional cables with a fire-resistive envelope around them [Electrical Circuit Protective Materials] tested to:

- UL 1724  (Products in UL FHIY with UL FHIT listings)
- ASTM E1725  (e.g. UL XCLF and Intertek AF)
Said another way:

**Fire-Resistive Cables**
- UL 2196
  - FHJR (Fire-Resistive Cable)
- FHIT (Electrical Circuit Integrity Systems)

**Electrical Circuit Protective Systems**
- UL 1724
  - UL FHIY (Electrical Circuit Protective Materials)
  - UL FHIT (Electrical Circuit Integrity Systems)
- ASTM E1725
  - UL XCLR (Batts and Blanket)
  - UL XCLF (Thermal Barrier Systems)
  - Intertek AF (Applied Fireproofing)
# Building Code and System Index

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Note: IBC references are from the 2018 edition
Ampacity Derating and Why it Matters

- Passive fire protection materials placed on or near an energized electrical conductor interfere with heat dissipation.
- Larger cables should be installed when using ceramic fiber as fire protection to conduct the same amount of power.
- While ceramic fiber may be less expensive than E-Mat, the total installed costs for the project may end up being higher.

<table>
<thead>
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<th>ADF</th>
<th>Fireproofing Material, 1 Hour ASTM E 119 Exposure</th>
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<tr>
<td>Item</td>
<td>3M Interam E-5A-4</td>
</tr>
<tr>
<td>4&quot; Conduit</td>
<td>8.96%</td>
</tr>
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</table>

REFERENCE: *Nuclear Regulatory Commission Information Notice 93-40
Methods Comparison

Fire Resistive Cable (UL 2196)
- Limited product options
- Higher replacement costs

Ceramic Insulation
- Cheaper Material
- May degrade cables

Endothermic Mat
- Protects all cables
- Allows for future upgrades
What to ask

Does this project have:
• Smoke Control equipment?
• A Fire Pump?
• An Emergency or Standby Power System?
• Fire Service Access Elevators?
• Occupant Evacuation Elevators?
• Is it an Air Traffic Control Tower?

What kind of wire has been spec’d?

If UL 2196, what is the plan for protecting the pull boxes & splices?

If conventional cables, what’s the plan to fire protect these circuits?
Critical Systems
Emergency Radio Signals

AKA:
- Distributed Antenna Systems (DAS)
- Auxiliary Radio Communications Systems (ARCS)
- Bi-Directional Amplifier (BDA)
Distributed Antenna System Protection

The Challenge

Modern building construction is not conducive to efficient radio transmission.

Steel, concrete and high tech glass create “radio opaque” conditions that render radio systems useless.
Distributed Antenna System Protection
The Opportunity

First Responders utilize radio systems to communicate during an emergency incident. These systems must be operable, without interference, throughout ALL parts of a building.
Fire Department Communication System, IFC 907 (‘15)

Signals into and out of building must be at least 95% of what’s at the exterior.

Buildings that can’t support this level of coverage need either:

* Radiating Cable System
* Distributed Antenna System w/ Signal Boosters (Bi-Directional Amplifier (BDA))

If supplemental coverage is needed, it should be per NFPA 72 and shall operate between:

- fire command center
- elevators
- elevator lobbies
- emergency and standby power rooms
- fire pump rooms
- areas of refuge
- inside interior exit stairways at all levels

IFC 907.2.13.2
Circuits and Pathways, Sec 12.4

Emergency Communications Systems, Sec 24.3

Pathway Survivability

Level 0  Nothing
Level 1  Sprinklered
Level 2  2 Hour Cable/Cable System
Level 3  2 Hour Cable/Cable System + Sprinklered

Emergency Communication Systems

24.3.13.7 Two-way in-building wired emergency communications systems shall have a pathway survivability of Level 2 or Level 3.

Exception: Level 1 shall be permitted where the building is less than 2-hour fire-rated construction.
Pathway survivability became less prescriptive in the 2018 version of code.

It still says the enclosure has to match the building’s fire ratings.
Future Code: NFPA 1225

Stanards for Emergency Services Communications

Please note: NFPA 1225 is in a custom cycle due to the Emergency Response and Responder Safety Document Consolidation Plan (consolidation plan) as approved by the NFPA Standards Council. As part of the consolidation plan, NFPA 1225 is combining Standards NFPA 1061 and NFPA 1221. For consolidated draft and revision cycle information, see the Next Edition tab.

Current Edition: Proposed Standard
## Cable Types

<table>
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<tr>
<th>Radiating “Leaky” Cables</th>
<th>Non-Radiating</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Transmit signal along the length of the cable</td>
<td>• Transmit/Receive radio signals at discrete points</td>
</tr>
<tr>
<td>• Have to be run in free air or in non-metallic conduit</td>
<td>• The conduit and junction boxes can be wrapped</td>
</tr>
<tr>
<td>• !!! Do not wrap these cables !!!</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Radiating “Leaky” Cables](image1.png)

![Diagram of Non-Radiating Cables](image2.png)
What are alternate options & are they effective?

1. CI cable (circuit integrity) – Maybe - refer to NFPA 70 Section 725
2. Plenum rated cables – No – they are limited to flame spread & smoke density
3. Rated enclosure as per NFPA 1221 – Maybe – also is difficult to implement in some scenarios
Methods Comparison

Shaft Enclosure
- Larger space requirements
- Labor intensive installation

Endothermic Mat
- Directly applied to system/pull boxes
- Allows for future upgrades
What to ask

Does this project/jurisdiction require Emergency Responder Communication Systems? Yes…

Is the existing system strong enough to cover all parts of the building? No…

Is a wired communication system being used? Yes…
Radiating? Those are vulnerable.
Distributed Antennae System? We help with Survivability.
Critical Systems
Fuel Oil Piping
Fuel Oil Pipe Protection

The Situation

• Some facilities have a need to maintain power in the event of an outage (i.e. hospitals, data centers) and install a generator system

• The generator requires a fuel source which is not always able to be located in the same room

• Piping is routed through the building connecting the tank with the generator
Fuel Oil Pipe Protection
The Challenge

- These mechanical systems are typically installed in a containment pipe.

- This pipe has to be welded/tested/enclosed in… gypsum?

- Space constraints and coordination are a constant issue.
Code Requirements: Pre 2018

- Various codes required some form of protection for fuel oil pipe. Especially for piping servicing emergency generators.

- The protection requirements range from:
  - ‘protect from physical damage’
  - ‘approved method or assembly that has a fire-resistance rating of not less than 2 hours’
  - ‘enclosed in construction having a 2-hour fire-resistance rating’

- Primary codes: IBC, IMC, IFC, NYC

- Other related codes:
  - NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
  - NFPA 30 – Flammable and Combustible Liquids Code
  - NFPA 31 – Standard for the Installation of Oil-Burning Equipment
  - NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines
  - NFPA 70 – National Electrical Code® (NEC)
  - NFPA 110 – Standard for Emergency and Standby Power Systems
Superstorm Sandy: October 22 – November 2, 2012

CBS article - ‘What caused generators to fail at NYC hospitals?’
“ There are few places in the U.S. where hospitals have put as much thought and money into disaster planning as New York. And yet two of the city’s busiest medical centers failed a fundamental test of readiness during superstorm Sandy this week: They lost power.”

NYU Hospital’s Backup System Undone by Key Part in Flooded Basement
http://www.propublica.org/article/nyus-backup-system-undone-by-key-part-in-flooded-basement

Lessons from Storm Sandy: When Hospital Generators Fail, In the wake of superstorm Sandy, much of New York City was plunged into darkness. What happened to the patient?
“New York University Langone Medical Center was forced to evacuate patients due to power outages during the peak of the storm. “We lost power when ConEd cut [it], and our auxiliary generator malfunctioned,” says Lorinda Klein, the NYU Langone Medical Center spokesperson. “As a result, we have had to transfer 215 patients to neighboring hospitals and they are still in the process of doing that now. The staff is working admirably and they are exhausted.”

Why Do Hospital Generators Keep Failing?

Why Power Is So Tricky for Hospitals During Hurricanes
www.livescience.com/24489-hospital-power-outages-hurricane-sandy.html

Computer World Article discussing generator failures at 2 Hospitals and 1 Data Center during Superstorm Sandy
NYC Building Code for Fuel-Oil Piping and Storage
Mechanical Code Chapter 13

- NYC Mechanical Code requires fuel piping to be enclosed in a 4-inch thick concrete shaft (MC 1305.9.1)

- Exception: At ‘Horizontal offsets’ the piping shall be “enclosed in construction* having a 2-hour fire-resistance rating”. (MC 1305.9.3)

- MC 1305.11.1.3 Inside of buildings; above the lower floor. Fuel-oil above the lowest floor inside of a building shall be limited to 330 gallons (1249 L) per story. The maximum quantity shall include oversized piping as described in 1305.9.12. Piping installations shall comply with the requirements of Section 1305.9.

* Construction has been interpreted by some to mean a “rigid wall assembly”, such a gypsum shaft wall.
Application Acceptance

• NYC OTCR asked to consider test data from ASTM E1725, the test standard for critical electrical circuits used by the Nuclear Regulatory Commission.

• OTCR and FDNY both wanted a standard specifically for fuel oil.

• 3M approached UL about developing such a standard and conducted ‘beta testing’ in support.
Tested & Listed Systems

UL created a new test method, UL 1489.

The 2015 Ed. of the IBC and IFC were modified to add ‘piping protective systems’ for the fuel oil line servicing emergency generators in high rise buildings.
2018 International Building Code
CHAPTER 27 ELECTRICAL
SECTION 2702
EMERGENCY AND STANDBY POWER SYSTEMS

[F] 2702.1.2 Fuel-line piping protection.
Fuel lines supplying a generator set inside a high-rise building shall be separated from areas of the building other than the room the generator is located in by an approved method, or an assembly that has a fire-resistance rating of not less than 2 hours. Where the building is protected throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1, the required fire-resistance rating shall be reduced to 1 hour.
The code (2021 Ed.) will say:

2021 International Building Code
CHAPTER 27 ELECTRICAL
SECTION 2702
EMERGENCY AND STANDBY POWER SYSTEMS

[F] 2702.1.2 Fuel line piping protection. Fuel lines supplying a generator set inside a building shall be separated from areas of the building other than the room the generator is located in by an approved method or one of the following methods:

1. A fire-resistant pipe-protection system that has been tested in accordance with UL 1489. The system shall be installed as tested and in accordance with the manufacturer's installation instructions, and shall have a rating of not less than 2 hours. Where the building is protected throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2, the required rating shall be reduced to 1 hour.

2. An assembly that has a fire-resistance rating of not less than 2 hours. Where the building is protected throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2, the required fire-resistance rating shall be reduced to 1 hour.

3. Other approved methods.

Add new standard(s) as follows: UL 1489-2016 Fire Resistant Pipe Protection Systems Carrying Combustible Liquids
# Building Code References for Applications

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Note: IBC references are from the 2015 edition
Methods Comparison

Rated Enclosure
- Larger footprint required
- Labor intensive installation

Endothermic Mat
- Directly applied to piping
- Maintain access to system
What to ask

Does this project have an Emergency Power System?

What is the fuel source for the Emergency Power System?

IF FED BY LIQUID FUEL SYSTEM:

Is the fuel piping routed through the building?
Critical Systems
Structural Steel
In ASTM E119 the goal is to keep the average steel temperature below 1000F (538C) and any individual point below 1200F (649C).

The number of layers can be increased or decreased depending on the hourly rating required for the application.
Endothermic Technology for Structural Steel

• Beams
• Columns
• Tubular Steel (Pipes)
• Block-outs

Note: layering requirements depend on mass of steel and fire exposure.
Methods Comparison

SFRM
- Low Cost
- Spray Equipment and Water Supply
- Long Cure Times

Intumescent Coatings
- Low Thickness Required
- Specific environmental conditions for install
- Cure time needed

Endothermic Mat
- Easy to cut/conform around complex geometries
- No need to cure
- Can overlap existing materials
What to ask

Does this project have an unmet structural fireproofing issues?

Do you have limited access where traditional spray applied methods will not work?

Are you looking for solutions for complex geometries or interfering items?

Do you have any renovation projects that will require structural steel fireproofing?
Features and Benefits

• Easily installed
  • No surface preparation required
  • Can easily be cut to size (with scissors, shears or utility knife)
  • Re-enterable for quality inspections or for future rework and retrofitting
  • Flexible (Can be applied to various shapes and sizes)
• Fulfills a variety of fire protection needs
  • Used in both interior and exterior applications
  • Increase protection rating just by adding layers
  • Ideal for electrical system with low ampacity derating
• Designed to endure harsh environment
  • Seismically tested
  • Virtually maintenance free (Labor and time savings)
Thank you

Samantha Peterson
SLPeterson2@mmm.com
www.3m.com/emat
Questions?
Thank You!

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