



U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

RIC 2007

Fire Research-Integrating Research into Practical Applications

**“Duke Armored Cable Spurious
Actuation Fire Testing Program”**

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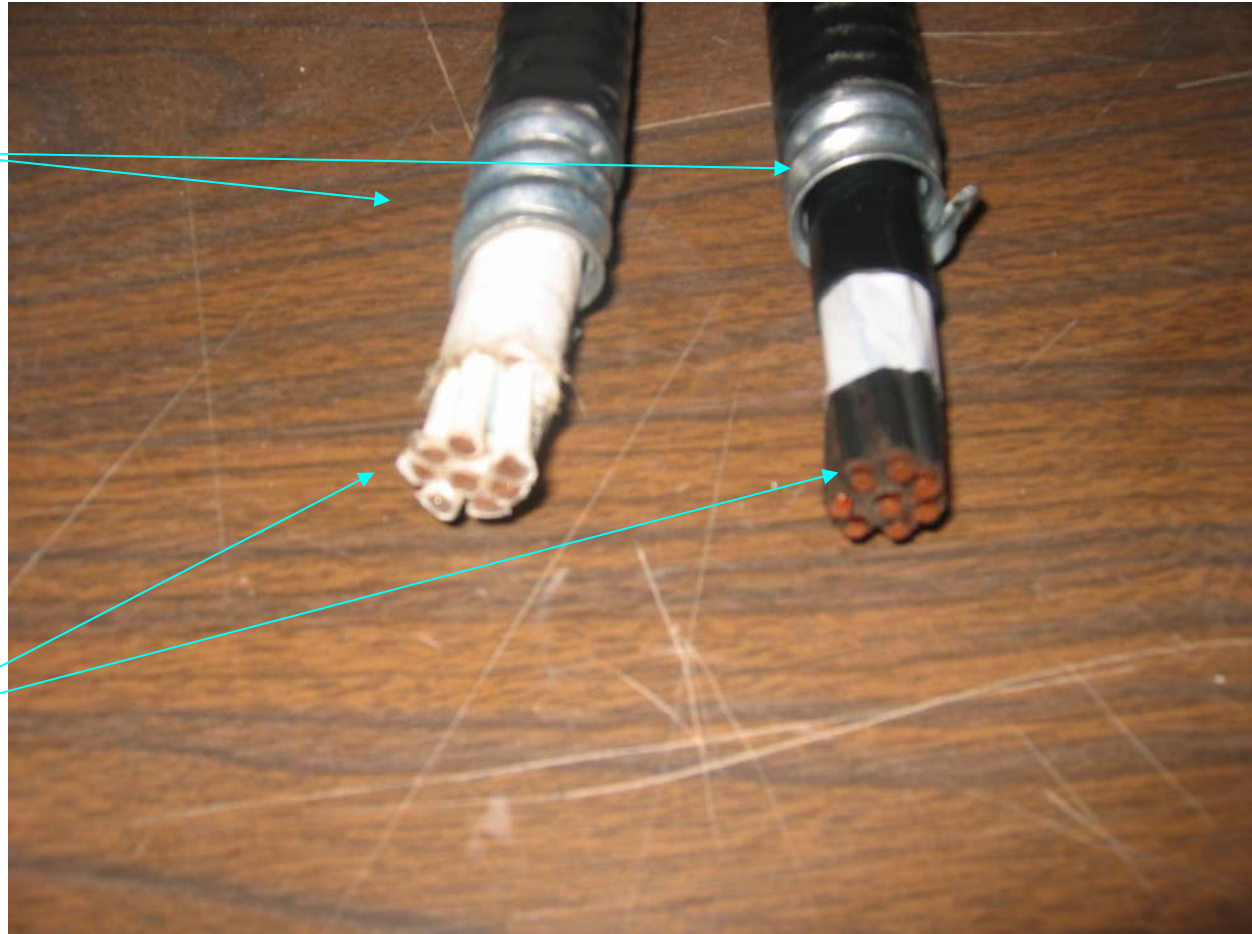
Agenda

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- What is “Armored Cable”?
 - Why do we care?
 - What did we do?
 - What did we learn?
 - How will the results be used?

What is “Armored Cable”?

Spiral wound
Interlocked
steel armor

Individually
Thermoset
insulated
conductors



What is Armored Cable?

- Multi-conductor electrical cable that utilizes a protective metallic armor barrier as an integral part of the cable
 - Provides physical protection from damage
 - Provides an electrical isolation barrier since armor is typically grounded
 - Provides electrical fault damage propagation barrier

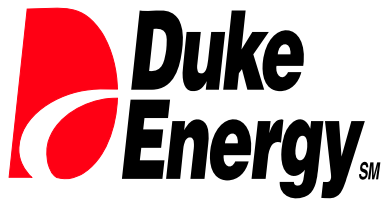


Why Do We Care?

- Duke Power utilizes armored cable almost exclusively throughout their nuclear stations for:
 - Power Cable
 - Control Cable
 - Instrumentation Cable

Why Do We Care?

- Duke has filed a Letter of Intent to transition the nuclear fleet to a Performance-Based, Risk-Informed Fire Protection Program in accordance with 10CFR50.48(c) and NFPA-805
- Spurious Actuation probability is a required input for the Fire Probabilistic Risk Assessment (PRA) being performed as part of the NFPA-805 transition



Why Do We Care?

- Previous industry cable fire testing only provided limited information on armored cable spurious actuation probability
 - There was some doubt about the validity of some of the previous testing
- Previous testing did not cover many of the installed configurations in use at Duke plants
 - Ungrounded AC circuits or control power sources
 - DC circuits or control power sources
 - Unjacketed armored cables

What did we do?

- Performed a series of fire tests of armored cable
 - Test Plan included 20 separate fire tests; we performed 17
 - Testing performed at Intertek Testing Services, NA (formerly known as Omega Point Labs) in Elmendorf, Texas
 - Test Plan was reviewed and commented on by NRC
 - NRC observed testing



Armored Cable Fire Testing

- Specifically chose test variables to establish sensitivity with respect to certain key attributes:
 - With and without PVC outer jacket
 - Grounded and Ungrounded AC circuits
 - 8 multiple conductor & 37 multiple conductor
 - 125 VDC power source
- All tests were performed with some key constants:
 - Grounded armor and cable tray
 - Tray loading
 - Fire size, location and target layout



Armored Cable Fire Testing - continued

- AC circuits were set up to model MOV control circuits
 - 600VAC/120VAC Control Power Transformer
 - 120VAC Reversing Starter
- Set-up is very similar to NEI/EPRI testing performed previously at Omega Point
- 350KW fire inside steel enclosure
- Horizontal Cable Tray with 90 degree elbow



Armored Cable Fire Testing - continued

- DC circuits were set up to model 4160V Circuit Breaker control circuits
 - One 125VDC close coil
 - One 125VDC open coil
- DC circuits were ungrounded

View of tray prior to test



View of cables leaving test enclosure



View of one of the Data Acquisition Computers



View of the Enclosure during fire test



View of Cable Tray during Fire Test



What Did We Learn?

- Results:
 - **None** of the grounded AC circuits produced a spurious actuation
 - 42 separate cables tested (Forty 8-c, Two 37-c)
 - 48 separate circuits
 - Ungrounded AC circuits behaved in a similar manner to un-armored Thermoset control cable (~0.3 spurious actuation probability)
 - Ungrounded DC circuits appeared to exhibit at least as high spurious actuation probability

What Did We Learn?

- General Insights:
 - DC Circuits require significantly more study
 - DC test circuits did not accurately reflect plant circuit designs (anti-pump interlock)
 - Larger Multi-conductor cables using Ungrounded AC circuits may experience higher spurious actuation probabilities than smaller cables with only one circuit per cable
 - Removing outer PVC jacket has little or no impact on spurious actuation probability



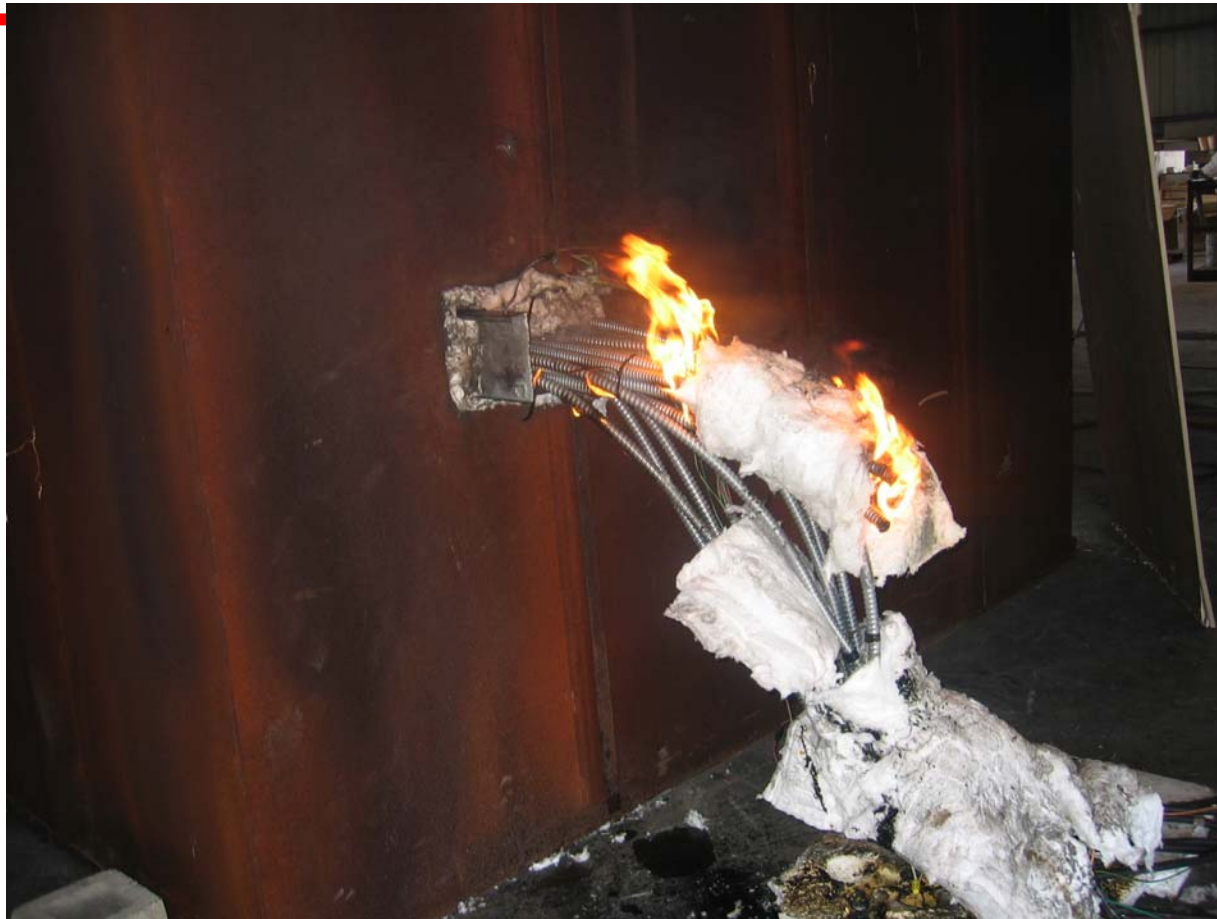
How Will The Results Be Used?

- Test results will be used to generate spurious actuation probabilities for the various configurations used in the plant
 - Used in Fire PRA to define Fire Risk for NFPA-805 Transition

View of door end of tray burning



View of other end of tray burning



View of tray burning without burner

