



DESIREE-FIRE

Direct Current Electrical Shorting In Response to Exposure-FIRE

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Conference

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 **Office of Nuclear
Regulatory Research**





DESIREE-FIRE

- Experimental testing program to evaluate direct current (dc) circuit response to fire exposure.
- Cooperative research project with EPRI
- Sandia National Laboratories is conducting the testing

Need for Testing

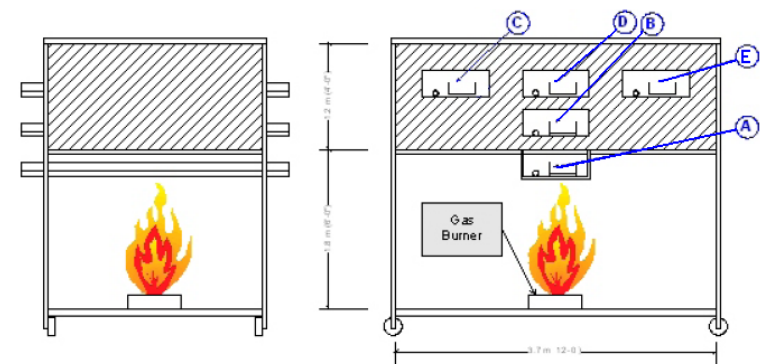
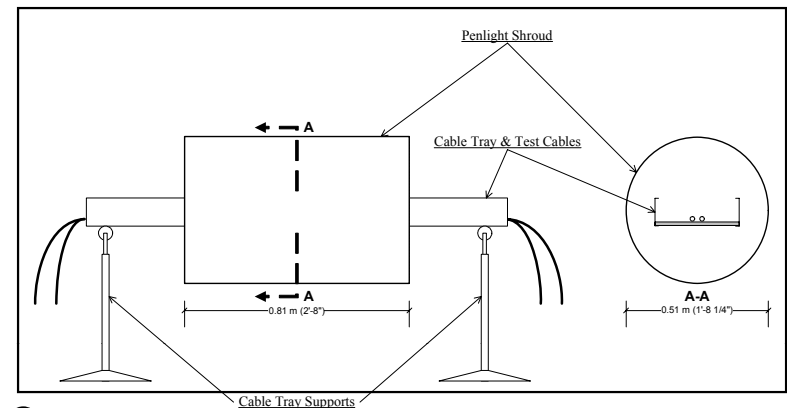
- Lack of data and uncertainties extrapolating alternating current (ac) results to dc circuits
- Numerous safety related systems commonly powered with dc
- Duke testing in 2006 indicated that dc circuits may react differently than ac circuits to fire-induced failures

Public Comment / Peer Review

- Project plan developed in September 2008
- 30 day public comment period
- Extensive peer review comment period (2 months)
- Most of the review related to dc electrical circuit instrumentation and representation of actual NPP applications

Testing Schedule

- Small-Scale
 - July to September 2009
- Intermediate-Scale
 - September to November 2009
- Draft Report
 - Early 2010



Benefits of working with EPRI

- 125Vdc Battery Bank from TSC
- Vintage (1970's) Kerite FR & HTK (FAQ 53)
- 200+ feet of armored cable
- 15kV circuit breaker
- Large coil (similar to PORV)
- 1" coil assembly (similar to head vent valve)

Test Configuration

Realistic Setup

- Large station battery
- Realistic cable lengths and sizes
- Typical “DC rated” protective devices
- Representative sample of equipment

Test Configuration



Test Configuration



Test Configuration



Test Configuration



Approach

Similar to CAROLFIRE

- Small-scale radiant exposure
- Intermediate-scale live fire tests

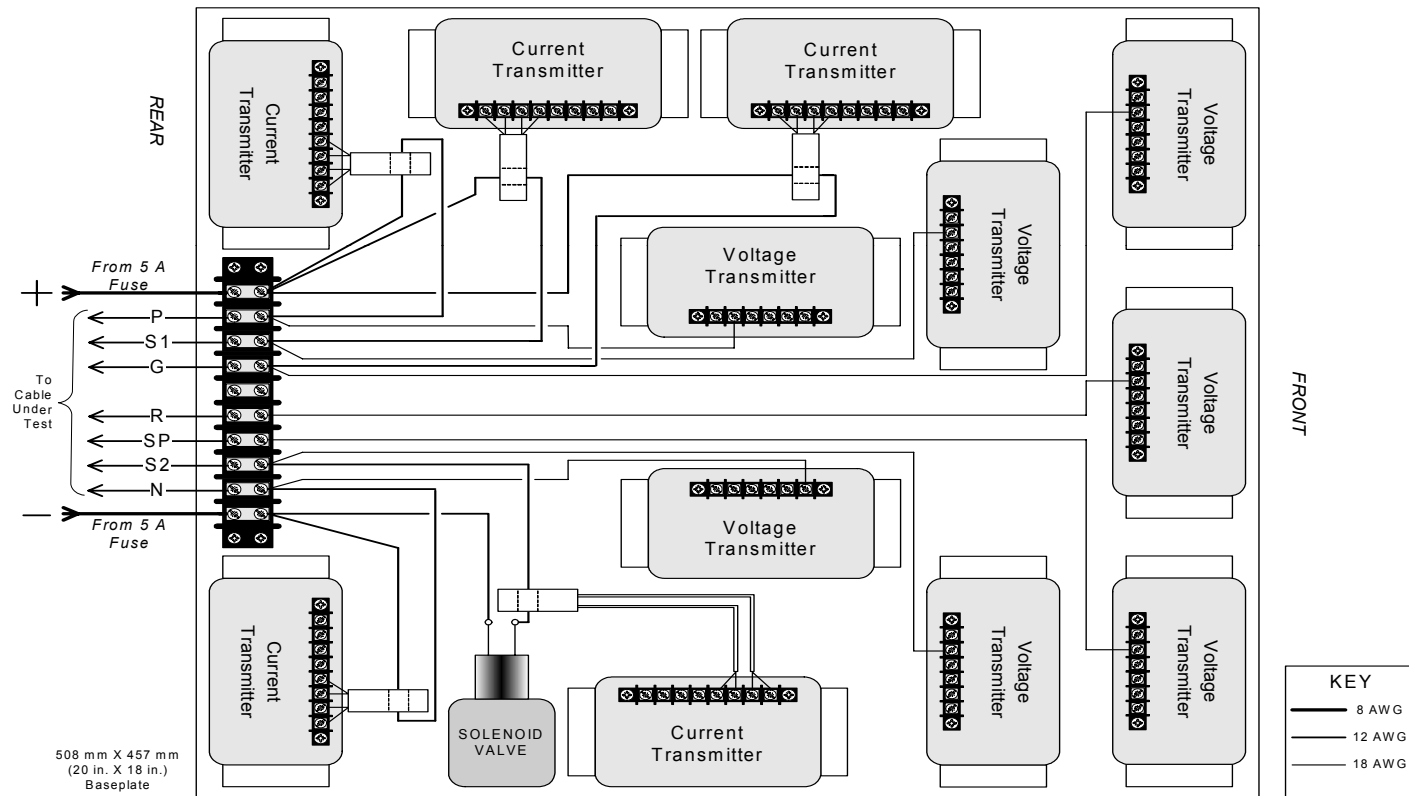
Numerous dc circuits evaluated

- DC motor starter (MOV)
- Small pilot DC SOV (ASCO red-hat)
- 15 kV circuit breaker (complete breaker assembly)
- 1" SOV
- Large coil (similar to PORV)
- Instrumentation loop

Approach & Scope



Test Circuit and Data Collection



DCCCS COMPONENT LAYOUT FOR SMALL DC SOV CIRCUIT

Key Test Objectives

Characterize DC

- Realistic circuits and configuration
- Inter-cable shorting
- Interactions with ground plane
- Multiple proper-polarity, coincident hot shorting
- Ground detection circuit

Follow up testing

- Role of CPTs
- Kerite cable characteristics
- Instrument circuits

Objectives – Analysis of Data

What is Success?

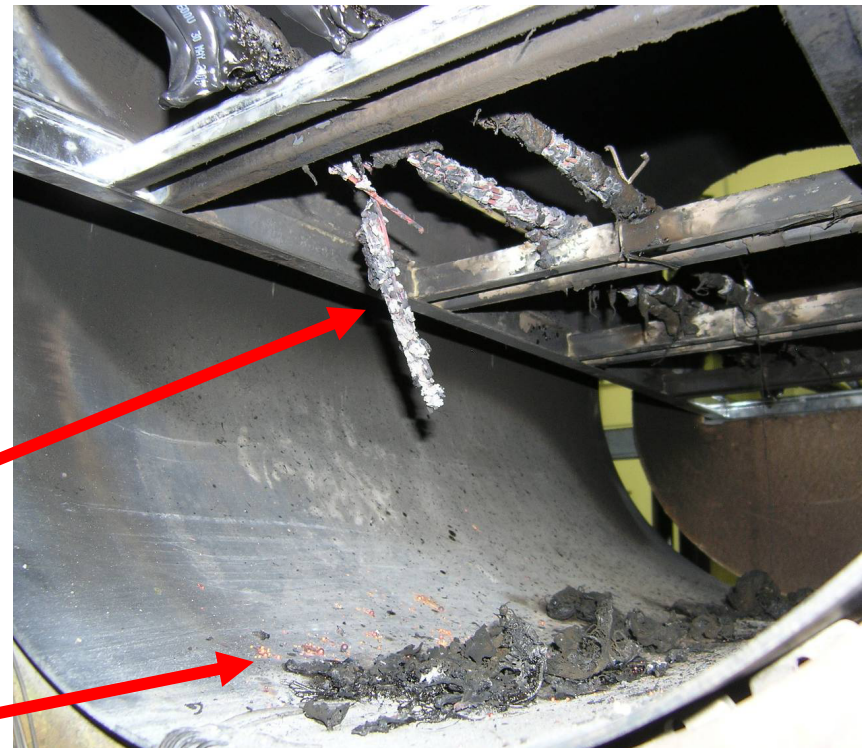
- Adequate DC data and quality to support analysis
- Resolve CPT issue
- Resolve Kerite cable issue
- Better answer for inter-cable hot shorts of thermoset cable
- Definitive position/likelihood for multiple, proper-polarity

Preliminary Results

- Open Circuits

Open Circuit

Copper Slag



Preliminary Results (2)

- Arcing & Cable Ignition
 - Electrical failure appears to be more energetic than in AC testing
 - In most cases arcing appears to act as the pilot for cable ignition
 - Electrical arcing also appears to cause adjacent cables to ignite in some tests

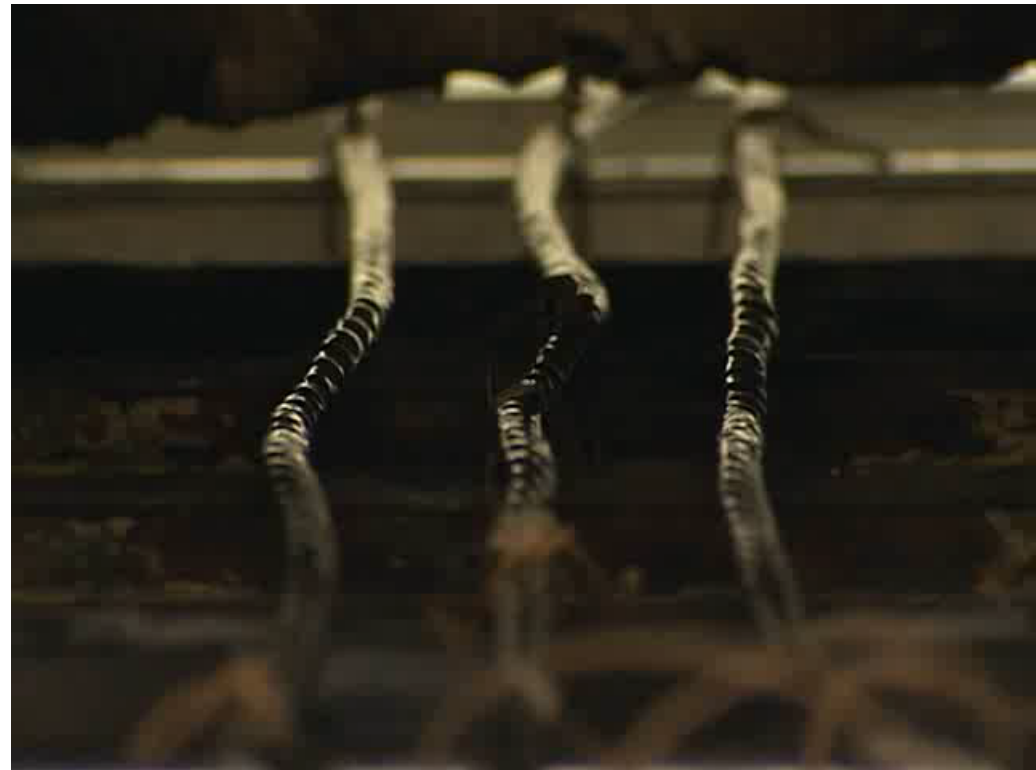
Preliminary Results (3)

- Fuse sizing
 - Initial observations indicate that larger fuses (15-35A) take longer to clear than small 5-10A fuses
 - In some tests the 35A fuses did not clear, instead electrical arcing caused an open circuit in cable conductors

15kV Circuit Breaker Test #29

Tefzel 7/c
12AWG

Breaker
Actuation



Preliminary Results (4)

- Grounding
 - DC battery bank is ungrounded
 - In at least one test, a fuse cleared on one test circuit with a subsequent spurious actuation
 - This could be possible by having the cable tray act as a conduction path between the energized and de-energized cables.
 - Analysis will be required to determine the root cause of this particular spurious actuation

Test Report

- NUREG/CR similar to CAROLFIRE report will contain test results, including all data files
- Report will not provide failure probabilities, but will provide summary tables

Follow-on Work

- Expert Elicitation and Phenomena Identification and Ranking Table (PIRT)
- PIRT will rank the importance of various aspects related to fire-induced cable damage

Objectives – Analysis of Data

- Expert Elicitation will re-evaluate original spurious op probabilities (EPRI Report 1006961)
- Incorporate DC results
 - Spend time to Re-evaluate DC motor starter (MOV)
 - Small pilot DC SOV (ASCO red-hat)
 - 15 kV circuit breaker (complete breaker assembly)
 - 1" SOV
 - Large coil (similar to PORV)
 - Instrumentation loop