NFPA 805 Non-Pilot LAR REVIEWS

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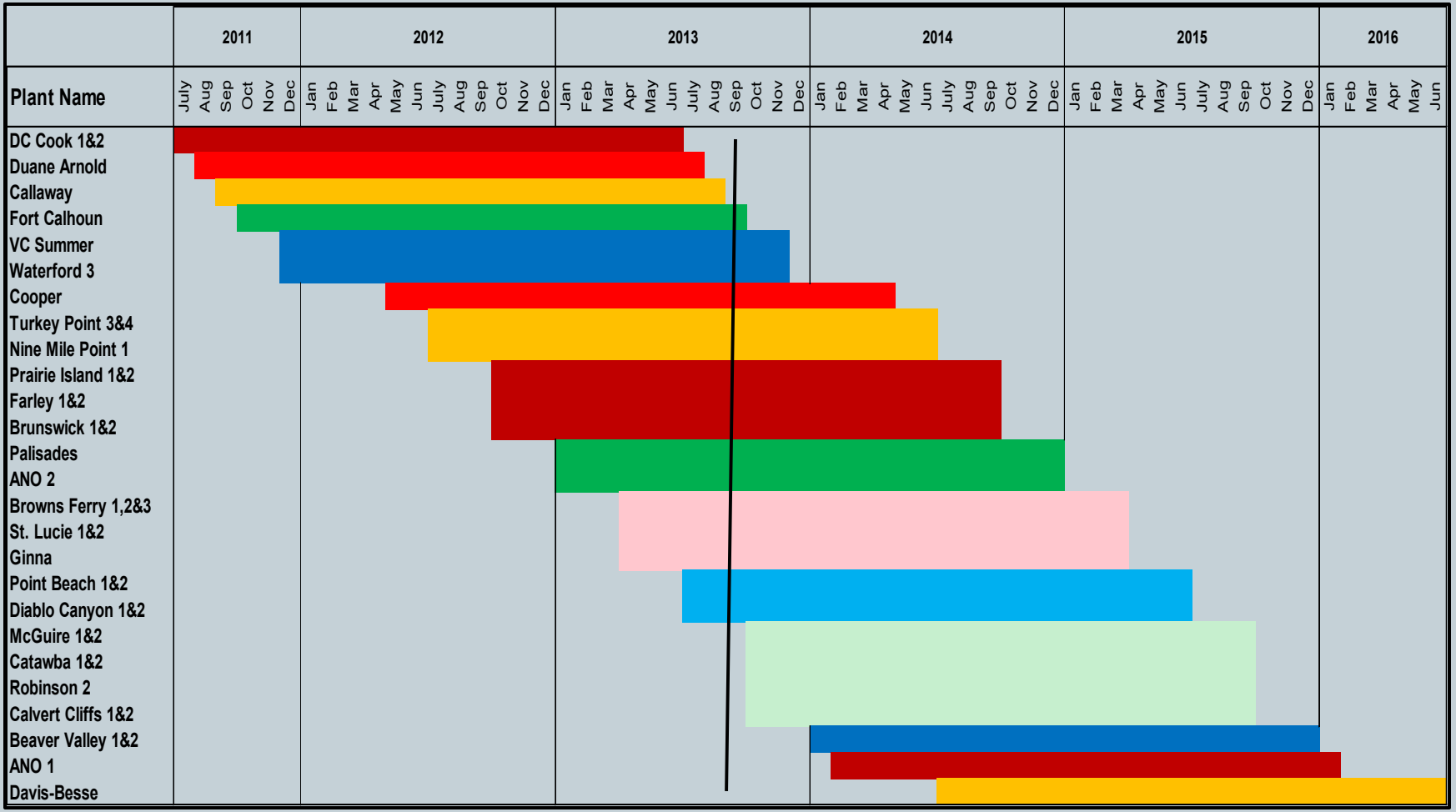
SR. FIRE PROTECTION ENGINEER
U.S. NUCLEAR REGULATORY COMMISSION

FIRE PROTECTION INFORMATION FORUM
SEPTEMBER 16, 2013

NFPA 805 Non-Pilot LAR Reviews

- Key Messages
  - Two (2) Year Reviews
  - One (1) License Amendment Approved
  - Eighteen (18) LARs under Review
  - Seven (7) Additional LARs to be submitted

NFPA 805 Non-Pilot LAR Reviews



NFPA 805 Non-Pilot LAR Reviews

- Duane Arnold - License Amended
- DC Cook 1&2 – Final Concurrence
- Callaway – Safety Evaluation in Concurrence
- Ft Calhoun – Safety Evaluation under Review
- VC Summer – Safety Evaluation Prep.

NFPA 805 Non-Pilot LAR Reviews

- Technical Review
  - Waterford 3
  - Cooper
  - Turkey Point 3&4
  - Nine Mile Point 1
  - Farley 1&2
  - Brunswick 1&2
  - Palisades
  - Arkansas Nuclear One 2
  - Ginna

NFPA 805 Non-Pilot LAR Reviews

- Regulatory Audit
  - Browns Ferry 1, 2, & 3
  - St. Lucie 1&2
  - Prairie Island 1&2*
- Acceptance Review
  - Point Beach 1&2
  - Diablo Canyon 1&2

* Not Scheduled

NFPA 805 Non-Pilot LAR Reviews

- LAR Submittals (Sept. 30)
  - Calvert Cliffs 1&2
  - McGuire 1&2
  - Catawba 1&2
  - Robinson 2
- LAR Submittals (2014)
  - Beaver Valley 1&2
  - Arkansas Nuclear One 1
  - Davis-Besse

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PRA EXPERT ELICITATION
HOT SHORT CABLE FAILURE LIKELIHOOD ESTIMATES

Gabriel Taylor
Sr. Fire Protection Engineer

NEI Fire Protection Information Forum
Philadelphia, PA Sheraton Downtown
September 15-18, 2013

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Project Objective

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- Advance the state-of-the-art for quantification of fire-induced circuit failure model likelihood analysis

- Use expert judgment and recent test results to quantify
  - conditional hot short-induced spurious operation likelihood estimates
  - conditional probability of spurious operation duration

Process

- NUREG/CR-6372, Senior Seismic Hazard Analysis Committee (SSHAC)
  - Level 2 +
    - "+" represents addition of peer review group and workshops
- Balanced group of experts (NRC-RES & EPRI)
  - Technical Integration Team
    - Ray Gallucci, David Miskiewicz, Mano Subudhi, Gerardo Martinez
  - Proponent Experts
    - Dennis Henneke, Steve Nowlen, Gabriel Taylor, Kiang Zee
  - Resource Experts
    - Dan Funk, Steve Nowlen, Gabriel Taylor
  - Participatory Peer Review Panel (PPRP)
    - Robert Cavedo, Nathan Siu, Jing Xing
  - Technical Support Staff
    - Marty Stutzke, Nick Melly, Tammie Pennywell, David Gennardo

Process Overview

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- Five, 3-day workshops held between January 2012 and May 2013
- Used results from NUREG/CR-7150 Vol. 1 and test data
- Workshop #2 allowed proponents to present and defend their estimates or models.
- After workshop #2, technical integration team determined direction on how to use proponent input
- BNL combined proponents input and developed draft report

Single vs. Double Break

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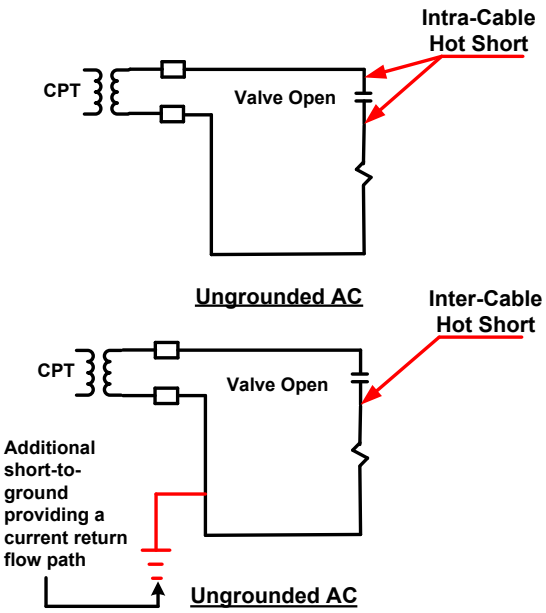
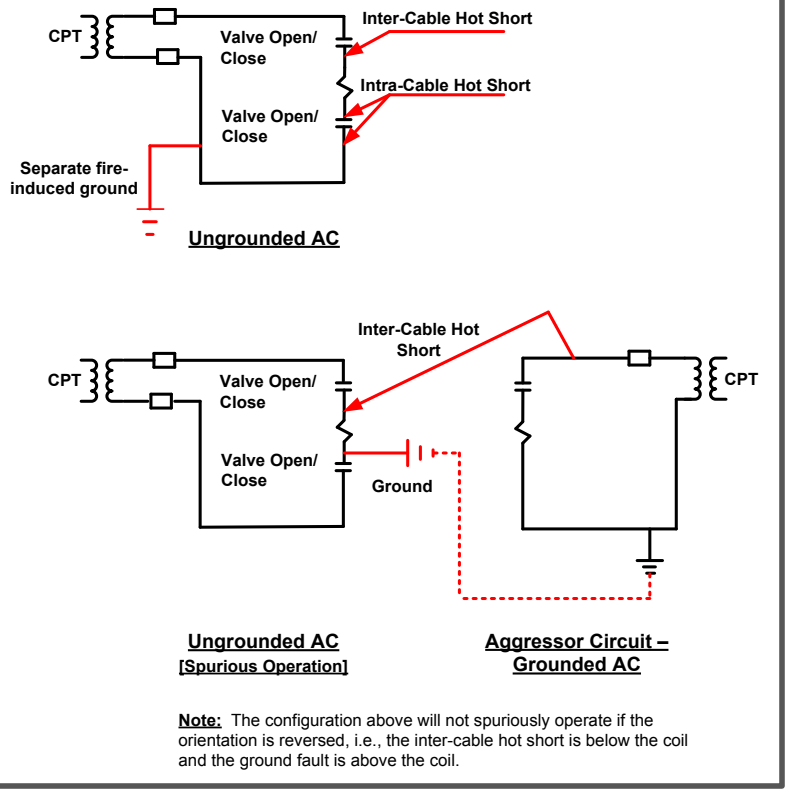
Single Break



Double Break



Note: The configuration above will not spuriously operate if the orientation is reversed, i.e., the inter-cable hot short is below the coil and the ground fault is above the coil.

Sample SOV Table

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Power Supply →		Grounded AC			Ungrounded AC (w/ Individual CPTs)			Ungrounded DC (or Distributed AC)			
Target Cable Configurations		Intra-Cable	Inter-Cable	Aggregate	Intra-Cable	Inter-Cable	Aggregate	Intra-Cable	Inter-Cable	Ground Fault Equivalent	Aggregate
		1	2	3	4	5	6	7	8	9	10
Thermoset-Insulated Conductor Cable	1	SB 01_01	SB 01_02	SB 01_01 + SB 01_02	SB 01_04	SB 01_05	SB 01_04 + SB 01_05	SB 01_07	SB 01_08	SB 01_09	SB 01_07 + SB 01_08 + SB 01_09
Thermoplastic-Insulated Conductor Cable	2	SB 02_01	SB 02_02	SB 02_01 + SB 02_02	SB 02_04	SB 02_05	SB 02_04 + SB 02_05	SB 02_07	SB 02_08	SB 02_09	SB 02_07 + SB 02_08 + SB 02_09
Metal Foil Shield Wrap Cable	3	SB 03_01	Incredible	SB 03_01	SB 03_04	Incredible	SB 03_04	SB 03_07	Incredible	SB 03_09	SB 03_07 + SB 03_09
Armored Cable	4	SB 04_01	Incredible	SB 04_01	SB 04_04	Incredible	SB 04_04	SB 04_07	Incredible	SB 04_09	SB 04_07 + SB 04_09

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MOV and double break

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- MOV estimates are based on SOV values and a multiplying factor distribution based on input from event trees developed by three proponents

- Double break estimates are developed based on SOV single break values and in some cases proponent, while MOV estimates are based on proponent input

NUREG/CR-6850 Task 10 Changes

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- NUREG/CR-6850, EPRI 1011989
  - Insulation Type
  - CPT
  - Raceway type
  - M/C vs. 1/C
- JACQUE-FIRE Volume 2
  - Circuit design (single break vs. double break)
  - Spurious Operation Device (SOV, MOV, Breaker)
  - Power supply/grounding configuration (Grounded AC, Ungrounded AC, Ungrounded DC)
  - Cable Configuration (Thermoset, Thermoplastic, Shield, Armor)
  - Use Aggregate unless only one failure mode possible

Table 10-1
Failure Mode Probability Estimates Given Cable Damage
Thermoset Cable with Control Power Transformer (CPT)

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable	0.30	0.10 – 0.50
	1/C Inter-cable	0.20	0.05 – 0.30
	M/C → 1/C Inter-cable	0.10	0.05 – 0.20
	M/C → M/C Inter-cable	0.01 – 0.05	
Conduit	M/C Intra-cable	0.075	0.025 – 0.125
	1/C Inter-cable	0.05	0.0125 – 0.075
	M/C → 1/C Inter-cable	0.025	0.0125 – 0.05
	M/C → M/C Inter-cable	0.005 – 0.01	

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Spurious Operation Duration

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- Based on data and expert judgment
- Data was pooled based on Kolmogorov-Smirnov (K-S)
- C-S model developed by NRC staff (M. Stutzke)
  - Model allows proponent experts to propose adjustments to data based curve.
  - “c” shifts curve and widens uncertainty
  - “s” adjusts uncertainty
- Floors added for AC and DC
  - Expert input combined using LOP method

Duration Curves

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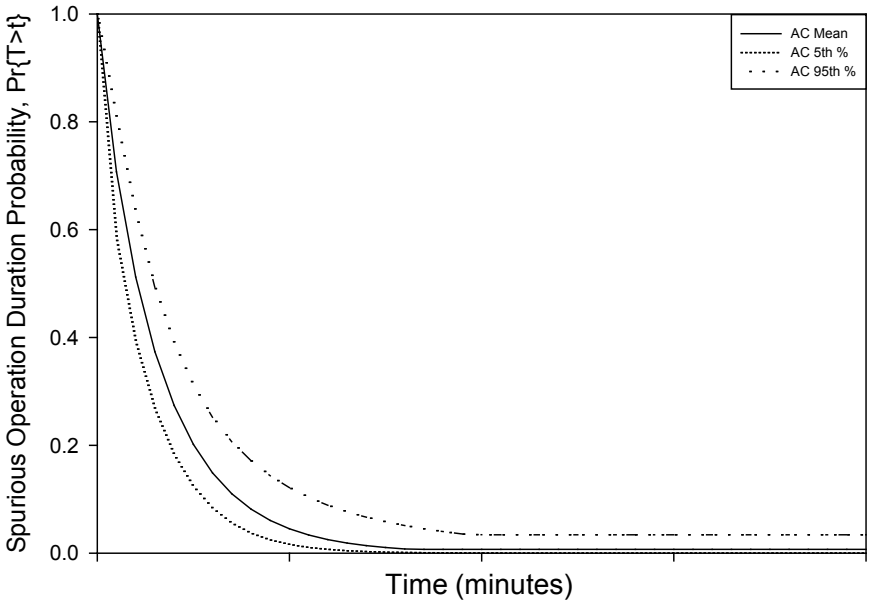

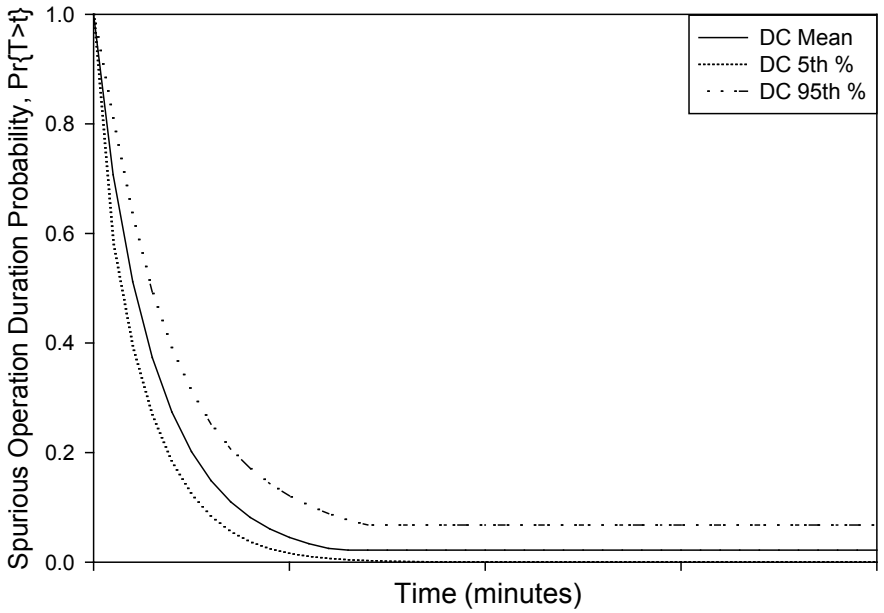

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Interim Guidance

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- Memo between RES and NRR to provide preliminary results to support NRR review of NFPA 805 applications
- ADAMS Accession No. ML13165A194
- Used SOV single break results to develop tables similar to NUREG/CR-6850 Task 10 tables
- Identified that Option 2 of NUREG/CR-6850 is not technically adequate
- Issuance of NUREG/CR-7150, Vol. 2 will supersede this guidance

Next Steps

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- Peer Review
- Publish
  - Joint NUREG/CR – EPRI Report
    - Late Spring/Early Summer 2014
- Evaluate potential research efforts related to Volume 1 future research recommendations
  - Instrumentation Circuits, Panel Wiring, Ground Fault Equivalent, Control circuit supplemental testing, Current Transformers, Trunk Cables
- HRR PIRT / Expert Elicitation?

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Thank You!

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NUCLEAR REGULATORY COMMISSION FIRE RESEARCH ACTIVITIES 2013

Mark Henry Salley P.E.
Branch Chief - Fire Research Branch
Division of Risk Analysis

NEI Fire Protection Information Forum
Philadelphia, PA Sheraton Downtown
September 15-18, 2013

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Current NRC Fire Research Activities

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- Gabriel Taylor
  - PRA Expert Elicitation Hot Shorts
  - Incipient Fire Detection
- Nicholas Melly
  - International High Energy Arc Fault (HEAF) Testing
  - Electrical Enclosure Heat Release Rate (HRR) Testing
- Provide High Level Discussion on Other Major Activities

NRC Fire Research Partners

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- National Institute of Standards and Technology (NIST)
- Department of Energy (DOE) National Laboratories
  - Sandia National Lab
  - Brookhaven National Lab
- Japan Nuclear Energy Safety Organization (JNES)
  - Memorandum of Understanding (MOU) Fire Research
  - High Energy Arc Testing (HEAF)
- Organization for Economic Co-operation and Development (OECD)
  - Fire Events Data Base
  - Joint Analysis of Arc Fault (Joan of Arc)
- Electric Power Research Institute (EPRI)
  - MOU and an Addendum for Fire Research
    - Rick Wachowiak
    - Ashley Lindeman

Fire Modeling

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- NUREG-1934 (EPRI 1023259) 'Nuclear Power Plant Fire Modeling Analysis Guidelines'
  - Published November, 2012
- NUREG-1805 'Fire Dynamic Tools Supplement 1'
  - Published July 2013
  - All Spreadsheets have been updated
  - SI Unit Sheets have been added
  - New Spreadsheet on Thermally-Induced Electrical Failure (THIEF)
- NUREG-1824 'Verification & Validation of Select Fire Models'
  - Update and Expand the Report
  - Include a Number of Additional Fire Experiments
  - Partnered with National Institute of Standards (NIST) and EPRI
  - Francisco Jogler provide details in another session
- For More Information: NRC PM David.Stroup@nrc.gov 301-251-7609

Fire Testing

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- NUREG/CR-7010 Vol.1"Cable Heat Release, Ignition, and Spread in Tray Installations During Fire (CHRISTIFIRE) Phase 1: Horizontal Trays
  - Published July, 2012
- NUREG/CR-7010 Vol.2 Vertical Shafts and Corridors
  - Testing Complete,
  - Currently in Publishing
- NUREG/CR-7010 Vol.3 Ignition, Cable Coatings, Solid Trays and Covers
  - Currently testing is underway
- All testing is being performed by NIST
- For More Information: NRC PM David.Stroup@nrc.gov 301-251-7609

Low Power Shutdown

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- NUREG/CR-7114 "A Framework for Low Power/Shutdown Fire PRA"
  - Extended Public Comment Period
  - Public Meeting (October 2012)
  - Two Table Top Exercises (March 2013)
    - Seabrook
    - Peach Bottom
  - Report being Finalized and sent to Publication
- For More Information: NRC PM Felix.Gonzalez@nrc.gov 301-251-7596

Compensatory Measures

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- Draft NUREG/CR-7135 "Compensatory and Alternative Regulatory Measures for Nuclear Power Plant Fire Protection (CARMEN-FIRE)
  - Safe and Effective Compensatory Measures will always be a part of a Robust Fire Protection Program
  - Over 40 years of Operating Experience; Can we do better?
  - New Technologies
- Public Comment Period extended to September 25, 2013.
- For More Information: NRC PM Felix.Gonzalez@nrc.gov 301-251-7596

Fire Human Reliability Analysis (HRA)

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- NUREG-1921 (EPRI 1023001) "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines" published July 2012
- Added Full Fire HRA Track to annual Fire PRA Training
- Additional work needs to be performed for Main Control Room Abandonment
- For More Information: NRC PM Susan.Cooper@nrc.gov 301-251-7604

Fire PRA Training

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- Continue Bi-Annual Fire PRA Training
  - Performing since 2005
  - Based on NUREG/CR-6850 (EPRI-1011989) "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities"
  - Five Unique Tracks
    - Fire PRA, Circuit Analysis, Fire Analysis, Fire HRA, Advanced Fire Modeling
  - 2013 EPRI's year to host
    - October 28 – Nov. 1, 2013, Charlotte NC.
  - 2014 NRC's year to host – Greater Washington DC area.

  For More Information: NRC PM Kendra.Hill@nrc.gov 301-251-3300
- NUREG/CP-0194 (EPRI1020621) Methods for Applying Risk Analysis to Fire Scenarios (MARIAFIRES) 2008
  - Added New Volume on Fire HRA and Session Introduction Material
  - Currently in Publication
  - For More Information: NRC PM Kendra.Hill@nrc.gov 301-251-3300

Knowledge Management

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- New NUREG/KM Series "Knowledge Management"
  - NUREG/KM-0001 "Three Mile Island Accident of 1979 Knowledge Management Digest" published December 2012
  - NUREG/KM-0002 "The Browns Ferry Nuclear Plant Fire of 1975 Knowledge Management Digest" published May 2013
    - Supersedes NUREG/BR-0361
  - NUREG/KM-0003 "Fire Protection and Fire Research Knowledge Management Digest" (Under Development RIC 2014 Target Date)
    - Superseded NUREG/BR-0465 Rev.1
  - NUREG/KM-0004 "Fuel Behavior Under Abnormal Conditions" published January 2013
  - NUREG/KM-0005 "Davis Besse Reactor Pressure Vessel Head Degradation, Knowledge Management Digest" Currently Under Development
- For More Information: NRC PM Felix.Gonzalez@nrc.gov 301-251-7596

Current Challenges

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- Sequestration
  - So Far, So Good
  - More Creative ways to do work
    - Partnerships, (OECD, JNES, EPRI, etc)
- Quality of Work Published by NRC and Others
  - We have a Responsibility to Insure Material Published is; "Technically Adequate, Accurate and Complete."
  - "You can't believe everything you read on the Internet"
  - Must Embrace the Review Process and Welcome Constructive Comments
  - The State of Knowledge will continue to Advance
- For More Information: NRC BC Markhenry.Salley@nrc.gov 301-251-7613

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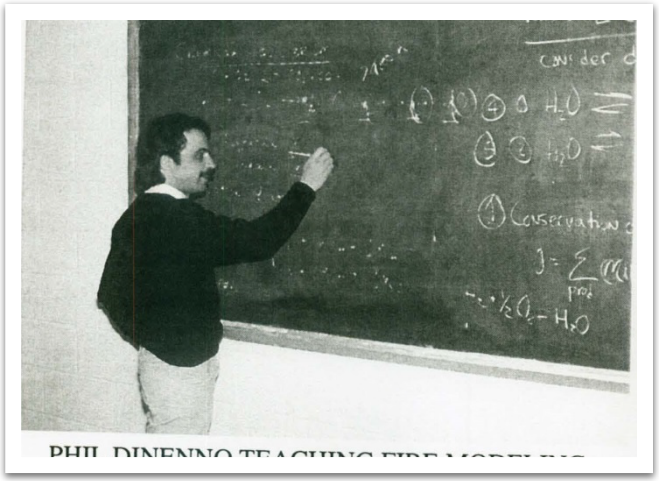
In Memory of Philip J. DiNenno P.E.

Born
July 23, 1953
Died
August 18, 2013



Phil was a leader to the Fire Protection Community. A 1977 Graduate of the Fire Protection Engineering Program at University of Maryland, Phil was the editor and driving force behind the creation *of The SFPE Handbook of Fire Protection Engineering*. Rest in Peace Phil, you will be greatly missed.

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INCIPIENT FIRE DETECTION SYSTEM CONFIRMATORY TESTING PROGRAM

Gabriel Taylor
Sr. Fire Protection Engineer

NEI Fire Protection Information Forum
Philadelphia, PA Sheraton Downtown
September 15-18, 2013

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Project Objective

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- Evaluate NFPA 805 FAQ 46
  - Effectiveness of area wide vs. in cabinet VEWFD applications
  - Comparison between traditional smoke detection and VEWFD
  - VEWFD system fire signature response
  - System response to common NPP products of combustion
  - Evaluate VEWFD system layout/design versus response
  - Human Reliability Analysis / Human Factors
  - Availability and reliability

Detection vs. Prevention

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- Defense-in-depth
  - Prevent fires from starting
  - Rapidly detect and control or suppress promptly fires that do occur
  - Design systems to ensure essential plant safety functions for fires not promptly suppressed
- Proposed application blurs line between detection and prevention
- Human response plays significant role in quantifing safety benefit of systems

Testing

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- National Institute of Standards and Technology (NIST)
- Scale of testing
  - laboratory, room (400ft^2), large room (~1,000ft^2)
- Materials
  - 10 types of wire and cable, terminal strip, PCB, resistor, capacitor, cellulosic material
- Detector types
  - 3 single zone ASD, 2 multi zone ADS, 3 spots (ion, photo, laser)
- Ventilation Rates
- Material Heating Profiles

Testing Variables

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Parameter	Laboratory Scale Variations
Material	11 plus resistors and capacitors
Heating rate	3
Cabinet ventilation scheme	Natural
Cabinet size	Single
Source location	Bottom of cabinet
Vent Location	Top and Side vented

Full-Scale Single-Zone ASDs		
Area monitored/ source location	Parameter	Variations
In-cabinet	Material	4
	Heating rate	3
	Cabinet ventilation scheme	2 (Natural, Forced)
	Cabinet size	3 (Single or multiple)
	Source location	2
	Room ventilation	2 (0,6-9 ACH)
Area-wide	Material	4
	Heating rate	3
	Source location	3
	Room ventilation	3 (0,6-9ACH)

Full Scale Single Zone

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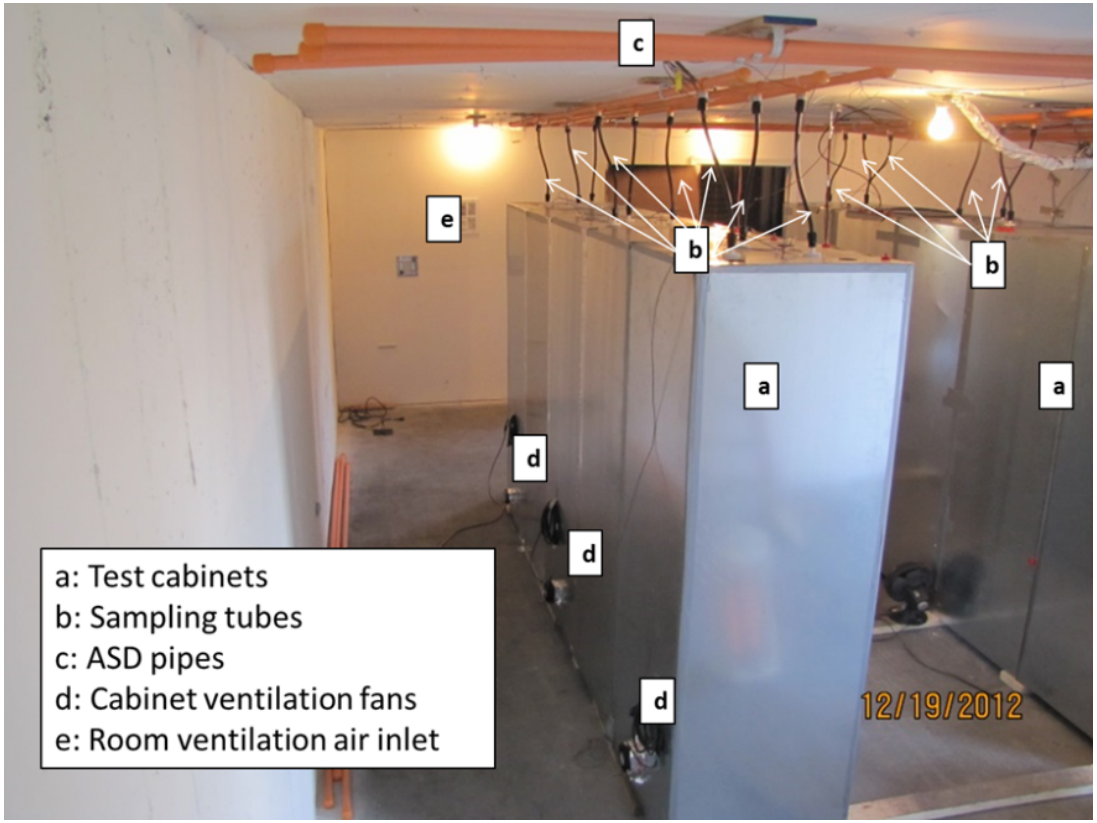

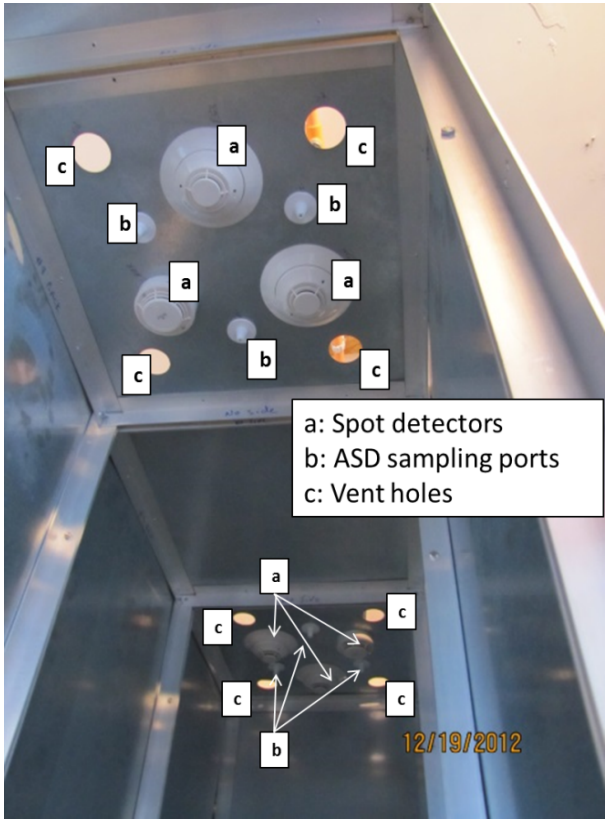

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Where WE ARE at

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- Project involvement
  - NRR, EPRI, Vendors of VEWFD system ASD
- Need support (information) in area of HRA/HF
- Testing
  - ~175 laboratory scale tests : Complete
  - ~100 full scale single zone tests : Complete
  - ~80 full scale multi-zone tests : Starting soon
- Draft report for public comment
  - Late CY2013 / Early CY2014

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Thank You!

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Joint Analysis of Arc Faults (Joan of ARC) OECD International Testing Program for High Energy Arc Faults (HEAF)

Nicholas Melly
U.S. Nuclear Regulatory Commission
RES/DRA/FRB

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Electrical Enclosures- Failure Modes

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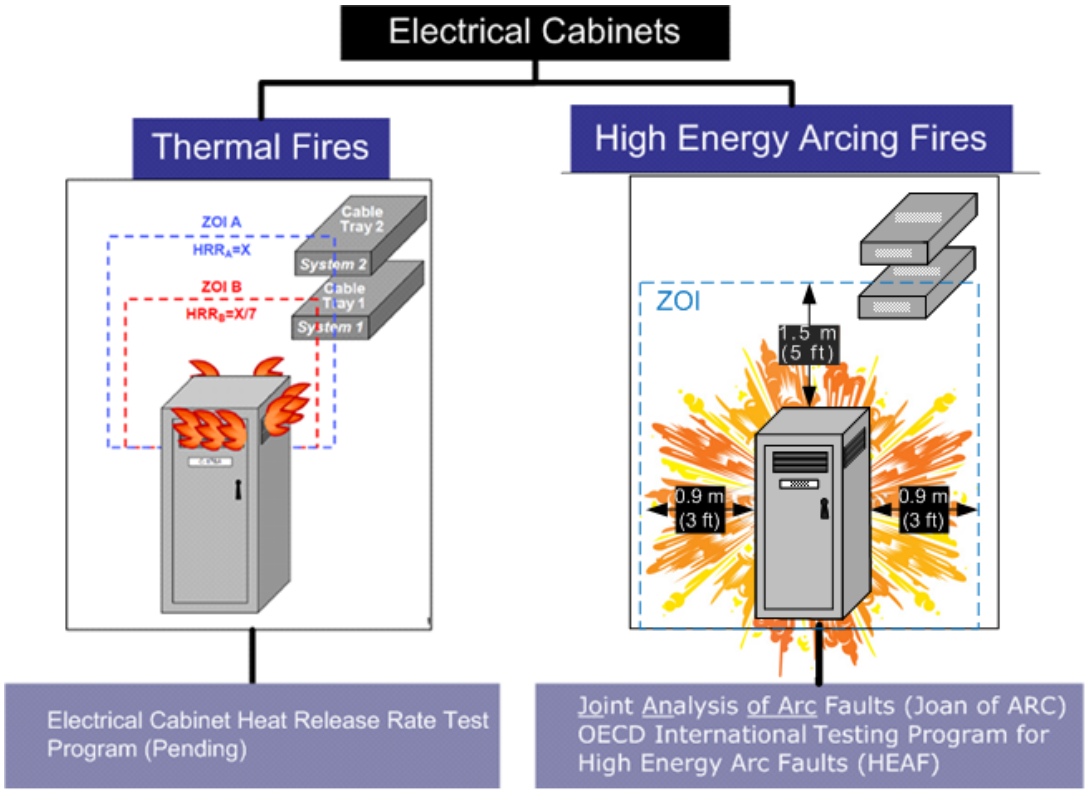

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Methodology Challenges
Risk driver for PRA analysis

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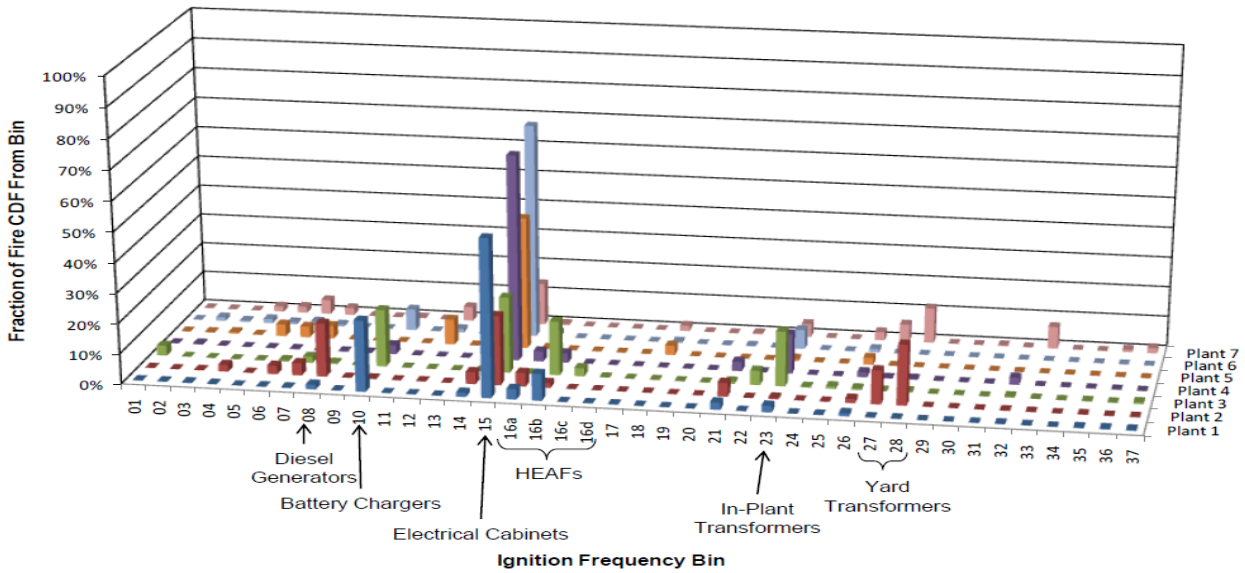
- Presentation by EPRI for the ACRS December 13th 2010

Fire CDF Contribution by Ignition Source



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EPRI ELECTRIC POWER RESEARCH INSTITUTE

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Current State-of-the-Art Equipment

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- Same treatment for all enclosures 480V to 4160V
- Initial arcing fault can cause destructive unrecoverable damage to the faulting device
- Copper ejecta and plasma and/or mechanical shock will cause adjoining/adjacent equipment to trip open
- Assumes next upstream over-current protection device will trip open
  - Robinson event illustrated the potential for failure of the upstream breaker and extended consequence

Current State-of-the-Art

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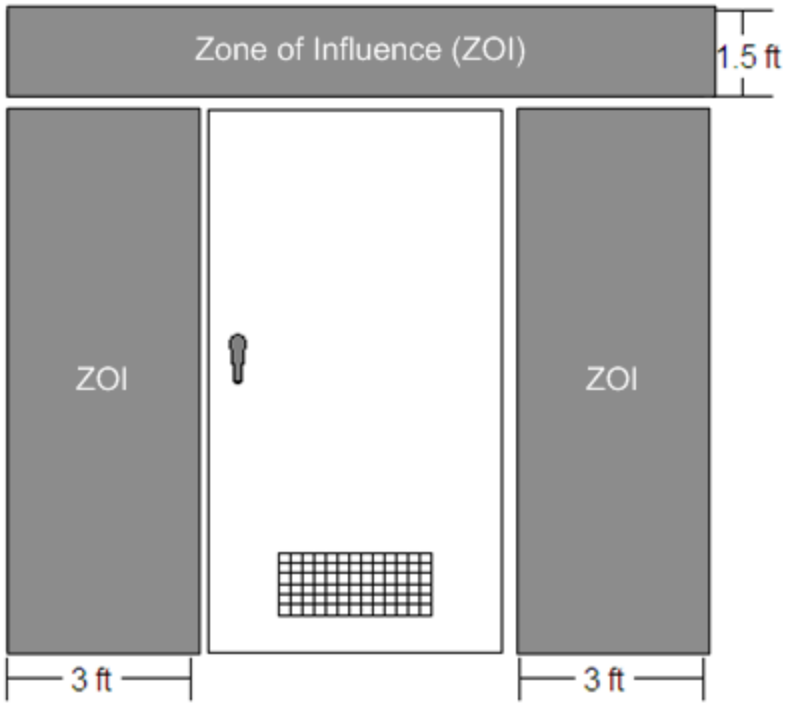
- NUREG/CR-6850, Appendix M (2005)
- Method based on **one** well documented fire event at San Onofre in 2001 to define zone of influence (ZOI)
- Components within ZOI are assumed to instantly fail or ignite
- This becomes the input to fire PRA model
- How well do the Robinson and Onagawa events fit this model?



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Recent HEAF Events in US NPPs

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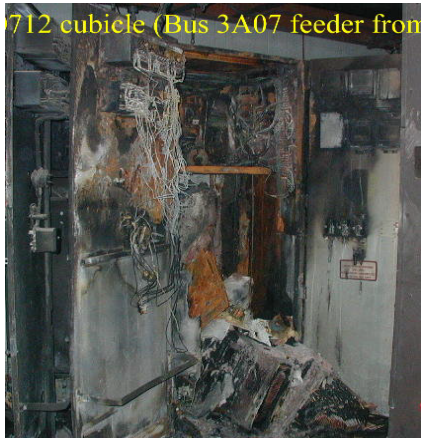
Waterford 1995

Diablo Canyon 2000

Prairie Island 2001



SONGS 2001

Columbia 2009

Robinson 2010

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San Onofre Fire

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- Faulted 4160 V Switchgear (non-class 1E) breaker.
  - Ionized gases and smoke diffused through cable passages between adjacent cubicles
- Five cabinets in the bus were damaged with evidence of sustained burning of the internal combustibles and cable trays above the fire
  - Fire lasted for over 2 hours
- Damage/ignition to a front cabinet 1.4m (4.5ft) away
  - No direct observation of how the cabinet was damaged/ignited
- Ignition of trays 0.6m (2ft), 1.8m (6ft) , 2.3m (7.5ft), above the cabinet
  - No direct observation of ignition times

Robinson

- March 28, 2010
- 2 events
  - 4.16 kV bus cable – arc flash – Bus 5
    - No control power to upstream breaker
    - Trip on overpressure of UAT (UAT damaged)
  - Med. voltage breaker – arc flash – Bus 4
    - Reset of generator lockout relay
    - Fast transfer UAT to SUT
    - Local equipment to breaker damaged

Robinson (cont.)

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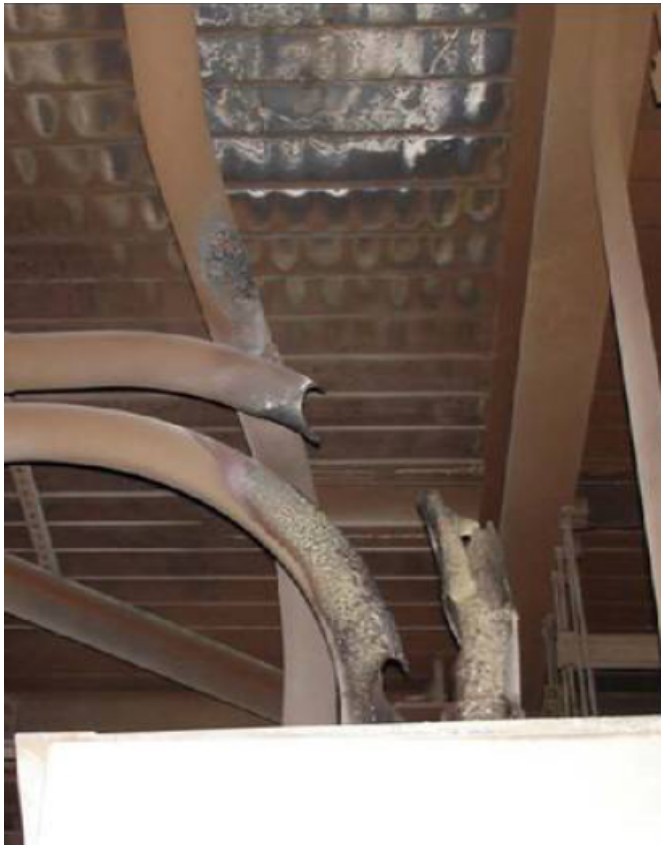
Bus 5



Bus 4

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Palo Verde

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- July 3, 2013
- Phase to ground short caused by broken tie wraps
- The damage was contained within the load center
- The force of the explosion caused the back panel to blow off, the frame to warp, and the front window to crack
- No ensuing fire

Onagawa, Japan Event March 2011

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- Onagawa Event (March 11, 2011)
- 2 HEAFs
  - Seismic Induced HEAF
  - Possibly combustion products
- Multiple sections of Medium Voltage switchgear damaged
- Fire could not be suppressed and was allowed to burn out (~7hrs)

JNES/SAIC Phase 1 Testing

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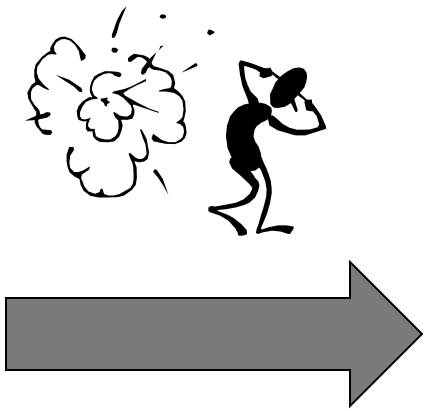

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JNES Test 1 480V

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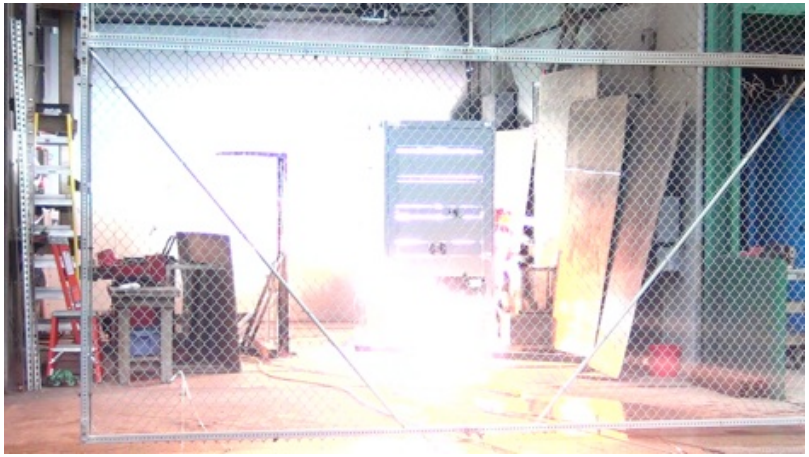

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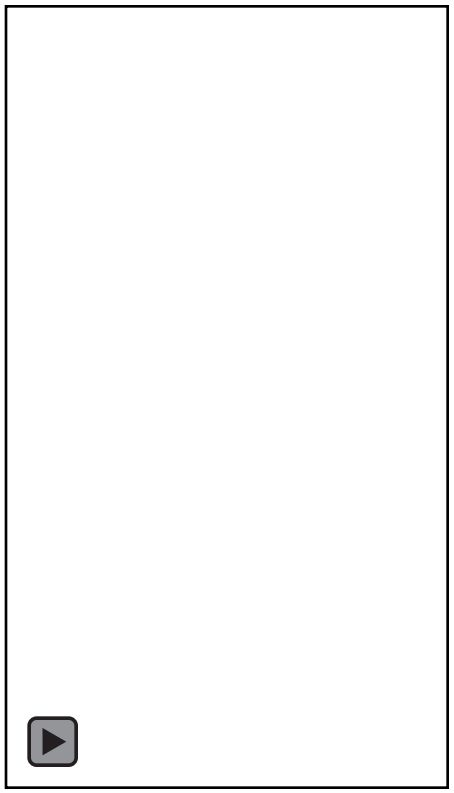
JNES Test 2 480V- Plasma Effect



JNES Test 2 480V

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Testing in Cooperation with the OECD

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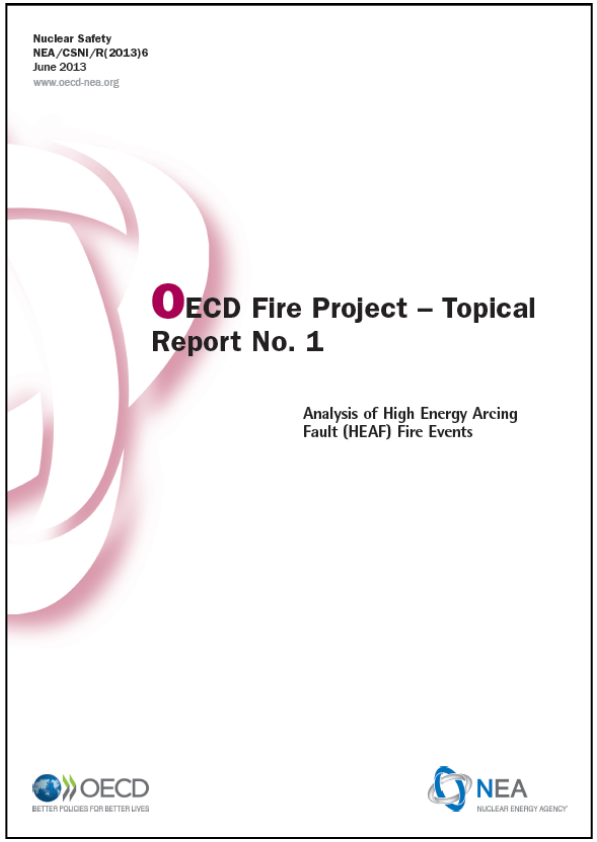
- OECD FIRE Project - TOPICAL REPORT No. 1
  - Analysis of High Energy Arcing Faults, HEAF
  - NEA/CSNI/R(2013)6
- Non-negligible contribution
  - 48 out of the in total 415 fire events collected in the International NPP database up to mid-2012 represent HEAF induced fire events (over 10%)
- Each country is providing a detailed analysis of past events in an effort to classify the ZOI



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NRC/OECD Test Plan

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- The Organization for Economic Co-operation and Development (OECD)
- Testing will be performed at the KEMA test facility in Chalfont, PA
- Evaluate conditions that may influence failure characteristics
- Advance the understanding of physical dynamics of HEAFs and update NUREG/CR-6850, Appendix M (2005)
- Focus on obtaining data and information to improve zone of influence (ZOI) model

Test Parameters

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- Relevant Information
  - Voltage
  - Power Level
  - Damage Zone
    - Blast Damage vs. Enduring Fire Damage
  - Event Duration
  - Furthest extent of damage
    - Thermal (i.e. ensuing fire damage / smoke damage)
    - Physical (i.e. thrown cabinet door, shrapnel)

OECD Member Equipment Donation

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- Equipment donation both internationally and domestically will be the key to the success of this effort
- More Equipment →More tests
- More tests → More Realistic Results
- More Realistic Results →Less uncertainty & Better Understanding of HEAF Phenomena

Possible US NPP involvement

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- Any US utility interested in participating by providing equipment or valuable expertise is welcome to contact EPRI (Ashley Lindeman)
- HEAF Shields Contribution
  - Donation of HEAF shields or,
  - Specifications of shielding used to protect from HEAF effects

Proposed HEAF Testing Schedule

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- HEAF events have occurred and are expected to continue in the future
- Data from experimental testing will assist in developing more realistic tools to model the risk in fire PRAs
- Motive for experimental program is supported internationally by CSNI/IAGE HEAF TG work

Timeline		
2012- 2013	2013-2014	2014-2016
•Equipment Collection •Finalize Test Plan •Establish Lab Contracts •Establish OECD Contracts	•Perform actual Testing at KEMA ○ March 2014	•Document and Analyze Test Program

Summary/Conclusions

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- HEAF events continue to occur domestically and internationally
- HEAF events pose a significant fire risk
- Testing will advance the understanding of physical dynamics of HEAFs and update NUREG/CR-6850, Appendix M (2005)
- NPP Equipment donation will ensure realism
- Testing expected to begin Spring 2014

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FIRE HAZARD ASSESSMENT OF ELECTRICAL ENCLOSURE HEAT RELEASE RATE TESTING

Nicholas Melly
U.S. Nuclear Regulatory Commission
RES/DRA/FRB

NEI Fire Protection Information Forum
Philadelphia, PA Sheraton Downtown
September 15-18, 2013

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NRC HRR Testing Program

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- EPRI 1022993 “Evaluation of Peak Heat Release Rates in Electrical Cabinet Fires Reanalysis of Table G-1 of NUREG/CR-6850 and Table G-1 of EPRI 1011989”

- NRC Review of this report [ADAMS ML121510213] and summarized in [ADAMS ML121510213] states:
  - “Some of the report’s basic premises are well accepted within the fire protection community. However, the limited amount of fire test data and unsubstantiated assumptions, such as the inappropriate use of “combustion efficiency,” does not support the broad applications proposed in the report”

Current Method

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- Table G-1 in NUREG/CR-6850
- HRR for five different categories of electrical enclosures
- Based on selected values of the 75th and 98th percentile fires
- Developed in early 2000's by a panel of experts who considered actual fire events in NPPs and other industrial facilities, along with limited experimental data

Ignition Source	HRR kW		Gamma Distribution	
	75th	98th	α	β (kW)
Vertical cabinets with qualified cable, fire limited to one cable bundle	69	211	0.84	59.3
Vertical cabinets with qualified cable, fire in more than one cable bundle	211	702	0.7	216
Vertical cabinets with unqualified cable, fire limited to one cable bundle	90	211	1.6	41.5
Vertical cabinets with unqualified cable, fire in more than one cable bundle closed doors	232	464	2.6	67.8
Vertical cabinets with unqualified cable, fire in more than one cable bundle open doors	232	1002	0.46	386

Current Method Cont.

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- Considers five different categories of electrical enclosures
  - combustible load (one vs. multiple cable bundles)
  - flame spread of materials (qualified vs. unqualified cable)
  - ventilation (door open vs. door closed)
- The “bundle” concept was an attempt to simplify the assessment, but much of the combustible load within an enclosure falls outside of the cable bundles that typically are located at the side walls
- Limited fire test data was obtained by testing only Control Cabinets in 1978
  - NUREG/CR-4527 “An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets

Electrical Enclosure Testing Objectives

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- Testing will be performed with the National Institute of Standards and Technology (NIST) at the Naval Research Laboratory Chesapeake Bay Detachment
- Investigate unsubstantiated assumptions
- Create enhanced categories based on more refined information
  - Combustible Loading
  - Predominant Fuel Type (Control Cabinet Cards, Thermoplastic Cable, etc.)
  - Ventilation Configuration (Forced Ventilation, Natural Ventilation etc.)

- Power
  - Medium voltage switchgear
  - Load centers
  - Motor control centers
  - Power distribution panels
  - Battery chargers
  - Inverters etc.

- Control
  - relay racks
  - reactor protection systems
  - auxiliary control panels
  - instrumentation racks
  - control room bench board panels
  - control room back panels

Cabinet Disparity

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Protection System Aux Cabinet 1

Front Back

Protection System Aux Cabinet 2

Front Back

Currently Investigating Ignition Mechanisms

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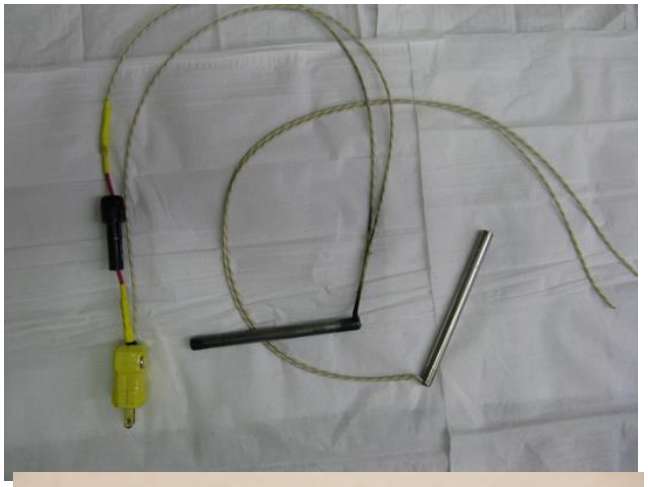
- Ignition feasibility testing being performed at NIST
- Ignition scenario where a localized failure causes a relatively small fire to ignite
- Cabinets will be preheated to an initial internal cabinet temperature of roughly 35°C (95°F)
- The intent of the ignition method is to achieve full burnout, while varying the parameters in question



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Possible Expert Elicitation or PIRT at end of project

- Data obtained from this test series could be provided to an expert panel
- Possible EPRI participate under the NRC-RES/ EPRI Memorandum of Understanding (MOU) collaborative research agreement
- Test results, along with expert judgment and operating experience could be used to develop new electrical enclosure fire heat release rate distributions

Utility involvement

- Test plan currently under industry review, all comments should be provided to EPRI
- Any US utility interested in participating by providing equipment or valuable expertise is welcome to contact EPRI (Ashley Lindeman)
- Equipment Contribution
  - power distribution
    - medium voltage switchgear enclosure
    - low voltage motor control center.
- Technical Expertise

Current Testing Schedule

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Task Name	Start Date	Completion Date
Test Plan Development	07/15/2013	08/26/2013
Peer Review	08/26/2013	09/06/2013
Comment Resolution	09/06/2013	09/16/2013
Sample Preparation	09/16/2013	9/30/2013
Cabinet Testing*	9/30/2013	12/15/2013
Data Collection & Analysis*	12/15/2013	02/09/2014
Report Test Results*	02/15/2014	03/14/2014
Expert Elicitation or PIRT Analysis*	03/17/2014	01/13/2015
Document Preparation*	01/13/2015	01/16/2015
Report Review & Publishing*	01/16/2015	06/1/2015

* based on estimated testing start date of 9/30/2013

Summary

- Electrical Enclosure HRR is a driving factor in many PRA assessments
- Limited amount of fire test data to support unsubstantiated assumptions
- Project Plan was volunteered for industry comments and project support through the MOU with EPRI
- Testing set to begin later this month

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Fire Protection Licensing Basis for Fire Induced Circuit Failures

Daniel Frumkin, Team Leader, NRC/NRR/DRA

2013 NEI Fire Protection Information Forum
Plenary 8, Breakout Session D

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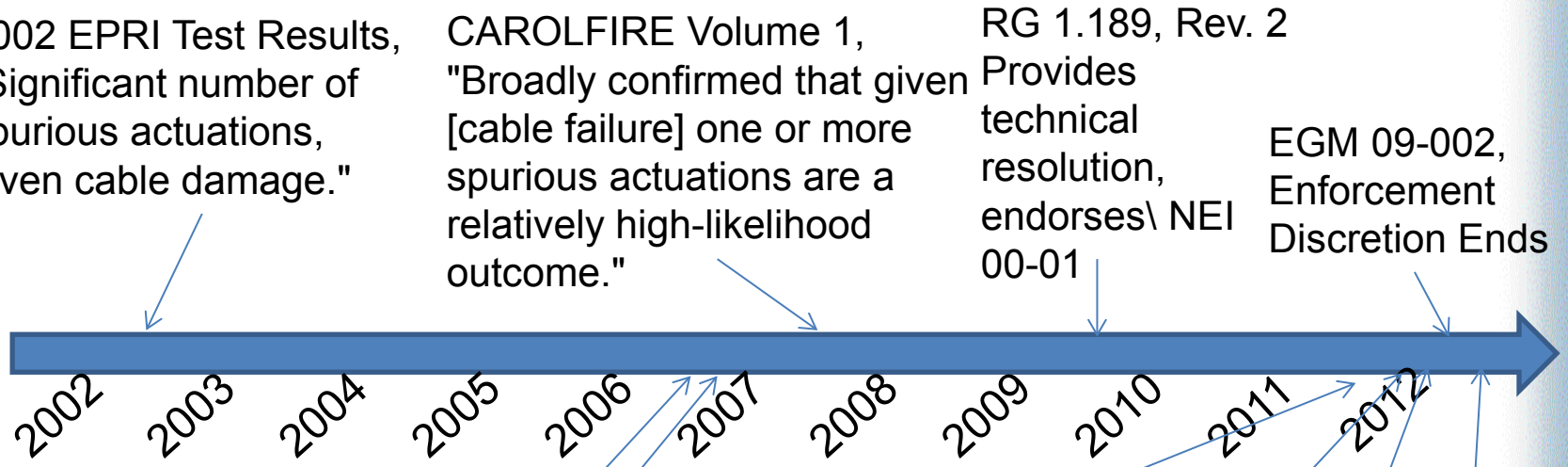
Circuits History



SECY-06-0196, Proposed a generic letter regarding circuit failures

SRM-SECY-06196, Commission directed staff to work with industry to develop technical resolution

Meeting with industry on licensing basis (LB) #1

Meeting with industry on LB #2

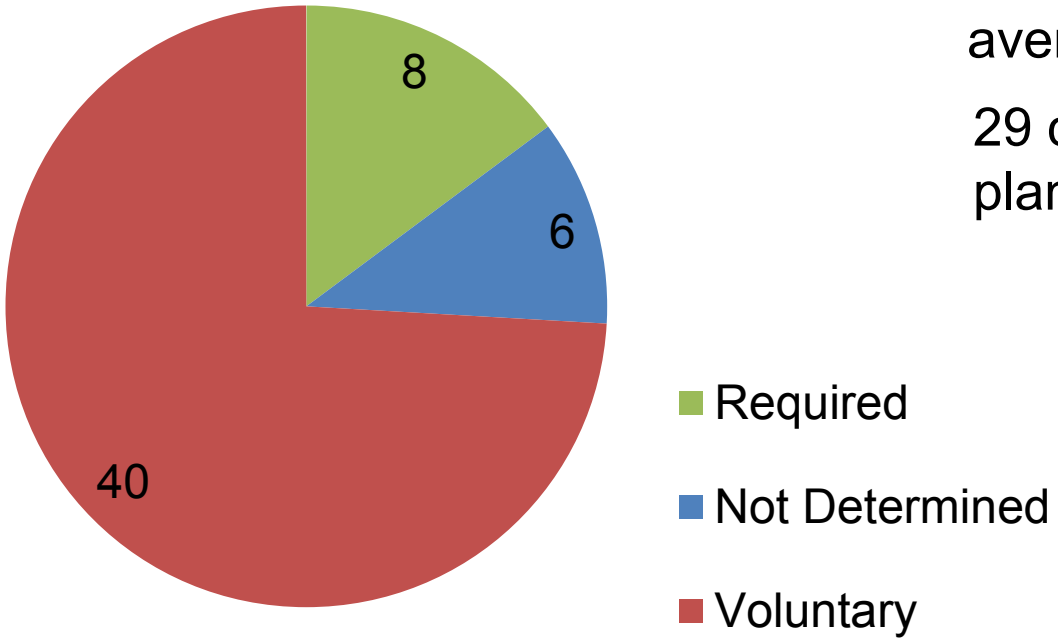
Meeting with industry on LB #3

Meeting with industry on LB #4

Industry Status

Based on September 2012 NEI FPIF Slides - ML12297A441

Plant Treatment of Multiple Spurious Within Licensing Basis



$5.5 million spent per unit on average

29 circuit modifications planned pre unit on average

* Numbers don't include recent decommissioning announcements

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Path Forward

- Generic resolution under internal NRC staff consideration
- Regulatory treatment of voluntary initiatives?

- Questions?