RIC 2014
The Promise and Perils of Risk-Informed Decisionmaking
"State of the Art Fire Research at the U.S. NRC"

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Why we do research

- Conduct confirmatory experiments and analysis
- Develop methods, tools and data
- Identify and resolve safety issues
- Develop technical bases to support regulatory decisions and guidance development

Fire Research

- Supports NRC's regulatory licensing and oversight programs
- Fire research focused on:
  - Fire analysis methods
  - Fire damage and assessment tools
  - Fire phenomena and events/operating experience
  - Experimental data
- Specialized training for fire practitioners

Fire Research Collaboration

- Electric Power and Research Institute (EPRI)
  - Memorandum of Understanding (MOU) for Joint Fire Research
- Department of Energy (DOE) Laboratories,
  - Sandia National Laboratories
  - Brookhaven Laboratories
- National Institute Standards and Technology (NIST)
  - Specialized skills/test facilities/expertise
- Academia
  - University of Maryland
- International
  - Organization for Economic Co-operation and Development (OECD)

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Fire Probabilistic Risk Assessment (PRA)

- EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities NUREG/CR-6850 (EPRI TR-1011989)
- Provide Support for NFPA 805 Frequently Asked Questions (FAQ)
  - Issued Supplement 1 to NUREG/CR-6850 in 2010
  - Continuing to work with EPRI on future Updates
- Developed Detailed Fire Human Reliability Analysis (HRA) Methods
  - Published NUREG-1921 (EPRI 1023001) in 2012
  - Developed Specialized Training
- Conduct specialized training
  - Annual Fire PRA Workshops
  - Video training, NUREG/CP-0194 MARIAFIRES (EPRI 3002000267)
  - Risk Analysis for Fire Scenarios

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Fire Modeling

- Developed fire modeling tools to support licensing, NFPA-805, and Reactor Oversight Program
  - Supplement 1 to NUREG -1805, "Fire Dynamics Tools"
  - Enhanced model for electrical cables (Thermally Induced Electrical Failure (THIEF))
  - Enhanced model for cable trays(Flame Spread over Horizontal Cable Trays (FLASHCAT))
  - Phenomena Identification and Ranking Table (PIRT) expert elicitation activities
  - Extensive fire model verification and validation project
  - Specialized fire modeling application guide for nuclear power plants.
- These research activities improve model quality and facilitate the use of modeling to evaluate nuclear power plant applications

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Fire Induced Effects on Electrical Circuits

- Conducted 3 major test series:
  - Cable Response To Live Fire (CAROLFIRE) NUREG/CR-6931, 2008
  - Kerite Analysis in Thermal Environment of Fire (KATE-FIRE) NUREG/CR-7102, 2011
  - Direct Current Electrical Shorting in Response to Exposure Fire (DESIREE-FIRE) NUREG/CR-7100, 2012
- Phenomena Identification and Ranking Table (PIRT) Expert Elicitation NUREG/CR-7150 Vol.1 (EPRI 1026424) 2012
- Fire Effects on Circuits PRA Expert Elicitation 2013
- Results of these projects improve knowledge, understanding and provides data on how electrical circuits perform under fire conditions

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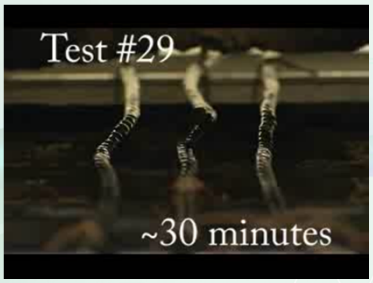
NUREG/CR-7100 DC Hot Shorting



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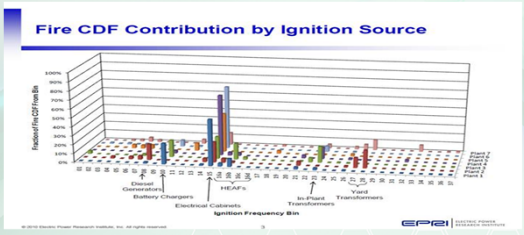
Fire Testing – Electrical Enclosures

- Early Fire PRA insights indicate electrical enclosure fires (cabinets) can be a significant risk driver:



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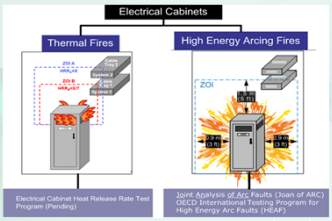
Fire Testing – Electrical Equipment Failure

- Two basic failure mechanisms for enclosed electrical equipment (cabinets):



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Electrical Enclosure – Heat Release Rate (HRR) Testing

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Recent Operating Experience High Energy Arc Faults (HEAF)

Waterford 1995

Diablo Canyon 2000

Prairie Island 2001

Robinson 2010

Columbia 2009

SONGS 2001

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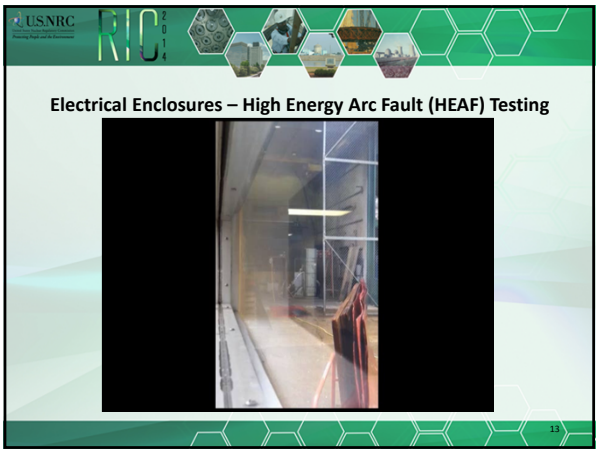
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Electrical Enclosures – High Energy Arc Fault (HEAF) Testing
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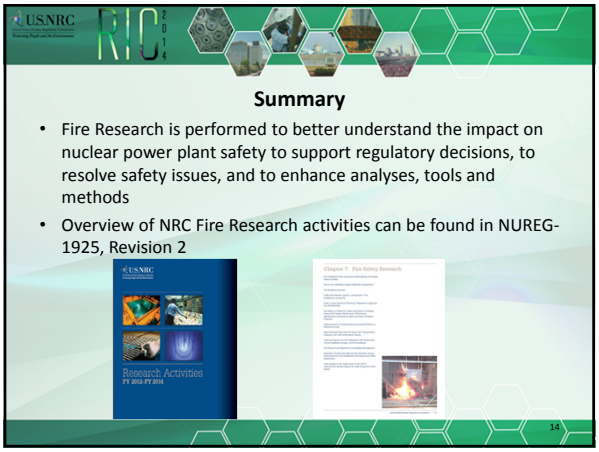
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Summary
• Fire Research is performed to better understand the impact on nuclear power plant safety to support regulatory decisions, to resolve safety issues, and to enhance analyses, tools and methods
• Overview of NRC Fire Research activities can be found in NUREG-1925, Revision 2
Research Activities
FY 2012-FY 2016
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U.S.NRC
Office of Nuclear Regulatory Research
Fire Research: Advancing the State-of-the-Art in Nuclear Fire Safety
Fire Testing
PRA
TESTING
MODELING
Fire Probabilistic Risk Assessment (PRA)
Training
Fire Research Knowledge Management
Other Research Activities
Fire and Electrical Systems Circuit Analysis
Fire Modeling
Collaborative External Partners