



**U.S.NRC**  
UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# Fire Research Activities at the Nuclear Regulatory Commission

NEI Fire Protection Information Forum

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**Office of Nuclear  
Regulatory Research**



***Mark Henry Salley P.E.***  
***Fire Research Branch***  
***Markhenry.Salley@nrc.gov***  
***301-251-7613***



## Major Program Areas

- Fire Modeling for NPP Applications
- Fire Probabilistic Risk Assessment (PRA)
- Fire Human Reliability Assessment (HRA)
- Direct Current (DC) Circuit Testing & Follow-on Circuit Analysis Work
- Electrical Cable Combustibility Properties
- Fire Research Knowledge Management
- Non-Reactor Projects





# A Word on Collaboration

- Takes place in a number of different forms/venues
  - Memorandum of Understanding (MOU)
  - Electric Power Research Institute (EPRI)
  - International Agreements
    - Organization for the Economic Co-Operation and Development (OECD) Nuclear Energy Agency (NEA)
    - Developing a Working Agreement with Japan (JNES)
- National Laboratories
  - National Institute Standards and Technology (NIST)
  - Sandia, Idaho & Brookhaven DOE National Laboratories
- Collaboration with Other Federal Agencies & Universities
  - NASA, Navy, ATF, University Maryland
- Peer-Reviews, ACRS and Public Comment Periods





# Fire Modeling Program Overview

- Four step process:
  - NUREG-1805 Introduction to Fire Dynamics in NPP applications (December 2004)
  - NUREG-1824 Fire Model Verification & Validation (V&V) (May 2007)
  - NUREG/CR-6978 Fire Model Phenomena Identification Ranking Table (PIRT) (November 2008)
  - Fire Model Users Guide for NPP applications
    - About to be released for Public Comment
- Future Improvements & Revisions





# Fire PRA: Implementation of NUREG/CR-6850

- NUREG/CR-6850 (EPRI 1011989) being used extensively in NFPA 805 NPP transitions
- RES/EPRI worked fire PRA FAQs related to implementation of Fire PRA
- NUREG/CR-6850 remains best available overall fire PRA methodology
  - Fire PRA continues to evolve
  - Supplement current revision
  - When has the State-of-the-Art advanced to point where a full Revision is warranted?





# Fire PRA Training

- RES/EPRI conducted two detailed fire PRA training courses in June and October of 2009 in Palo Alto, CA and Richmond VA.
  - Averaging 100+ attendees; Modules conducted in:
    - Fire – frequency, suppression, and elements supporting fire damage assessment
    - Electrical circuits – Circuits and spurious operations, including probabilities
    - PRA – modification of internal events model for fire
    - HRA – will be expanded based on the Fire HRA project
  - RES/EPRI will conduct fire PRA training next year (2010) in Bethesda, MD Area





## Quantitative HRA Guidance

- Detailed quantitative methodology tailored to the performance of post-fire HRA at power operations
  - Scoping and detailed approaches
  - Extension of the work done in NUREG/CR-6850
- Enhance reproducibility and defensibility of analyses
- Peer reviewed in June 2008 by a panel of experts from industry and NRC
- Testing of guidance performed at two NPPs
- Joint RES/EPRI document to be issued for public comment before the end of 2009
- Inclusion in the RES/EPRI Fire PRA Training Program



# Direct Current (DC) Circuit Testing & Circuit Analysis Programs

- DC testing is in process
  - Expanded Program to include EPRI
    - Modified existing MOU
- After Completion of DC testing, NRC will be performing:
  - Expert Elicitation
  - PIRT







## Cable Combustibility Testing

- Assembled large stock of representative cable at NIST
- Collect data on Ignition, HRR, flame spread for different cable types/ different configuration
- Phase I ongoing at NIST in 2009
- Phase II will start in 2010
- Phase III & IV under development





# Fire Research/Regulation Knowledge Management

- Three Main Parts:
  - Browns Ferry Fire NUREG/BR-0361 (February 2009)
  - Short History NRC Fire Research NUREG/BR-0364 (June 2009)
  - Fire Regulations and Research NUREG/BR-XXXX (Winter 2009) (Currently known as RIC CD)
    - Over 30 years of information assembled in two main areas:
      - Regulations
      - Research
      - Older reports were difficult to recover
        - Adding to Electronic Data Base
      - Plan to Update & Expand annually for RIC





## International Projects

- OECD Fire Events Data Base
- Fire Modeling
  - OECD PRISME
  - Collaborative Fire Modeling
- Exploring High Energy Arcing Faults



## New Project Starts/ Other Projects Under Consideration

- Compensatory Measures
- Additional Fire Model Validation Data
- Fire Events Data Base
- Low Power Shutdown Fire PRA
- Documentation of ERFBS Issue
- Incipient Detection Systems



# New Project Starts/ Other Projects Under Consideration

- Electrical Cabinet Heat Release Rates
- Gaseous Fire Suppression Agents
- Smoke Effects on Electronics
- Fire Effects on Fiber Optics Cable and Digital I&C





## “Back-Burner” Projects

- Supplement 1 NUREG-1805
  - Add THIEF Spreadsheet
  - Upgrade all Existing Spreadsheets
- Methods for Applying Risk Analysis to Fire Scenarios (MARIA FIRES)
  - On Line Learning Program based on the 2008 NRC RES-EPRI Fire PRA Training





## Non-Reactor Projects

- Red Oil
- LWT Shipping Cask Fire Testing beyond Design Basis
- Development of an SDP type tool for Fuel Fabrication Facility Inspections



## Conclusion

- NRC/RES actively engaged in Fire Research Activities
  - Research Products often support the broader Fire Protection Engineering Community
- NRC/RES always willing to partner with other Agencies/Organizations to support similar safety missions.

