RISK-INFORMING POST-FIRE SAFE-SHUTDOWN ASSOCIATED CIRCUIT INSPECTIONS

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BACKGROUND

- 10 CFR Part 50, Appendix R/NUREG 0800 SRP.
  - Licensees are required to provide reasonable assurance that **Fire-Induced Circuit Failures** that could adversely affect the ability to achieve and maintain post-fire safe shutdown will not occur
- Information Notice 99-17, Problem Associated with Post-Fire Safe Shutdown Circuit Analyses.
  - Recent problems with associated circuits at a number of licensees
- November 2000, NRC suspends associated circuit inspection.
  - Determines the issue is generic
  - Work with stakeholders to solve the issue in a **Risk-Informed** manner

BACKGROUND (cont'd)

- NEI Fire Testing.
  - 18 full-scale fire tests
  - May 2002, EPRI published, "Spurious Actuation of Electrical Cables to Cables Fire: Results of Expert Elicitation."
- February 2003, Facilitated Public Workshop.
  - Consensus on the Most Risk Significant Associated Circuit Scenarios
  - Identify Most Risk Significant Cable Configurations and Attributes
- August 2003, Draft Regulatory Issue Summary (RIS).
  - Technical input for Risk-Informing Associated Circuit Inspections
  - Issued for public comment
- January 2004, Draft NUREG-1778
  - Knowledge Base Post-Fire Safe-Shutdown Analysis
  - Issued for public comments

ASSOCIATED CIRCUIT RISK

- Risk = (Fire Frequency) x (Likelihood of fire effects & cable attributes that contribute to failure) x (Likelihood of undesired consequences).
  - Fire Frequency established in other programs
  - Creditable Fire Threat
    - Fire Dynamics Analysis
  - Cable Attributes
    - Thermal Failure Mechanism
  - Severity of Consequence

CABLE ATTRIBUTES

- Fire Testing
  - Review Past Research Work
    - (Sandia National Laboratory, Factory Mutual, etc.)
  - NEI 00-01 Fire Testing Program
    - Designed to Quantify Spurious Actuations
- Results
  - Thermoplastic vs. Thermoset Jacket/Insulation Materials
  - Intra- vs. Inter- Cable Failure

SEVERITY OF SPURIOUS OPERATION

- Most Risk Significant Consequences
  - Failures that Impede Hot Shutdown within the First Hour of the Event
    - Flow Diversion
    - Loss of Coolant
    - Other Scenarios

NUMBER OF CABLE FAILURE TO CONSIDER

- Two “cable” Failures Evaluated per Scenario.
  - Intra – cables failure for Thermoset and Thermoplastic
  - Any number of conductors/combinations are possible within the cable
  - Inter – cable failures possible between Thermoplastic cables

ISSUES REQUIREING FURTHER RESEARCH – MODERATE RISK

- Moderate Risk – Requires Additional Research to Better Understand
  - Inter – cable shorting of Thermoset cables
    - Thermoset to Thermoplastic
    - Thermoset to Thermoset
  - Need to Evaluate Three or More Cables for Each Scenario
    - How many are creditable
  - Effects of Control Power Transformers (CPT)
  - Duration of Hot Shorts
  - - How long do they remain energized

ISSURES REQUIREING FURTHER RESEARCH – LOW RISK

- Low Risk
  - Open Circuits
    - Loss of Continuity
  - Inter – cable Shorting involving Conduits and Armored Cable
  - Multiple High – Impedance Faults on a Common Power Supply
  - Three-Phase Power Failures Occurring with Proper Polarity
  - Reversible DC–Motor Power Cable
    - Requires Proper Combination & Polarity of 5 Circuit Failures

REMAINING ACTIVITY

- Issue Final RIS (February/March 2004)
- Issue Final NUREG-1778 (May/June 2004)
- Conduct Public Workshop (Spring/Summer 2004)
- Issues Requiring Further Research (FY 05/06)

CONCLUSION

- Inspections will Focus on Most **Risk Significant Cases.**
- Most Effective Use of Inspection and Licensee Resources.
- Promote Safety Culture in this Risk-Sensitive Area.