

DAY 2 - Handouts

Day 2 - October 14, 2004 Topic: Post-Fire Safe-Shutdown Circuit Analysis

0800 - 0815 Registration

0815 - 0830 Welcome/Historical Perspectives (Klein)

0830 - 0900 Regulatory Background (Frumkin)

-GL 86-10

-10 CFR 50.48

Post Fire Safe Shutdown Circuit Analysis (Radlinski)

0900 - 0930 -Train Free of Fire Damage - Stakeholder Questions and Comments

0930 - 1000 -Spurious Actuations;

Any-And-All / One-At-A-Time - Stakeholder Questions and Comments

1000 - 1015 Break

1015 - 1045 -Associated Circuits - Stakeholder Questions and Comments

1045 - 1100 -Plant Specific Exemptions - Stakeholder Questions and Comments

1100 - 1115 -Emergency Control Stations - Stakeholder Questions and Comments

1115 - 1145 -Wrap-up and Review - Stakeholder Questions and Comments

1145 - 1300 Lunch

1300 - 1345 Inspection Procedures and the Reactor Oversight Process (Dreisbach/Frumkin)

-Revised Inspections Procedures

-Risk Screening and the Significance Determination Process

1345 - 1400 Related Public Questions

1400 - 1430 Enforcement Discretion (Klein)

1430 - 1445 Related Public Questions

1445 - 1500 Break

1500 - 1630 Practical Applications (Frumkin)

w/Related Public Questions

Adjourn



Post-Fire Safe-Shutdown Circuit Failure: Closure Path Appendix R and SRP Plants (Part 1)

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October 14, 2004



Introduction

- Purpose
 - Elements of the Overall Plan (a.m. session)
 - Discuss Acceptable Methods (p.m. session)
 - Discuss Acceptable Tools (p.m.)
 - Implications of Self-Assessments (p.m.)
 - Applicable Enforcement Discretion (p.m.)

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2



Elements of the Overall Closure Plan



- Issue revised RIS to risk-inform inspection of all circuits
- Endorse NEI-00-01 on circuit analysis
- Revised version of NEI-04-06 on self-assessments
- Revised version of NEI-02-03 on fire protection program change guide

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3



Elements of the Overall Closure Plan (Continued)



- Risk-informed NFPA 805 tools and methods to support Appendix R/SRP plants
- Provide enforcement discretion
- Establish HQ-office panel to assist regions
- Issue RIS providing final overall circuit closure path

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4




Post-Fire Safe-Shutdown Circuit Analysis Background

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Background

- In 1997, licensees submitted a number of licensee event reports (LERs) that document problems related fire-induced electrical circuit failures
- In response, the NRC issued Information Notice (IN) 99-17, "Problems Associated With Post-Fire Safe-Shutdown Circuit Analysis"



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Background

- On November 29, 2000, NRC temporarily suspended inspection of associated circuits (ML003773142).
- To support closure of the circuits issue Nuclear Energy Institute (NEI) developed NEI 00-01, "Guidance for Post-Fire Safe-shutdown Analysis" (ML031640322)



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Background Continued

- Brookhaven National Laboratory (BNL) developed a post-fire safe-shutdown analysis guidance letter report "Introduction to Post-Fire Safe-Shutdown Analyses" (ML023430533).
 - Currently NUREG-1778 "Knowledge Base for Post-Fire Safe-Shutdown Analysis" (Draft Report For Comment) (ML040210151)
- The Electric Power Research Institute (EPRI) issued "Spurious Actuation of Electrical Circuits Due to Cable Fires: Results of an Expert Elicitation" (Report No. 1006961, May 2002).



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Background Continued

- Staff conducted a facilitated public workshop on February 19, 2003, in Rockville, MD (ML030620006 - Transcript)
- Staff published a Regulatory Issue Summary (RIS) 2004-003



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Appendix R III.G Final Rule



- "The objective for the protection of safe shutdown capability is to ensure that at least one means of achieving and maintaining safe shutdown conditions will remain available during and after any postulated fire in the plant."
 - Federal Register, Vol. 45, No. 225, 11/19/1980

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- Paragraph A.
 - For any individual multiconductor cable (thermoset or thermoplastic), any and all potential spurious actuations that may result from intra-cable shorting, including any possible combination of conductors within the cable, may be postulated to occur concurrently regardless of number. However, as a practical matter, the number of combinations of potential hot shorts increases rapidly with the number of conductors within a given cable. . . . To facilitate an inspection that considers most of the risk presented by postulated hot shorts within a multiconductor cable, inspectors should consider only a few (three or four) of the most critical postulated combinations.
 - Note “combinations” not “spurious actuations”

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- Paragraph B.
 - For any thermoplastic cable, any and all potential spurious actuations that may result from intra-cable and inter-cable shorting with other thermoplastic cables, including any possible combination of conductors within or between the cables, may be postulated to occur concurrently regardless of number.
 - The maximum number of cables to be considered is limited by Paragraph C.

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- Paragraph C.
 - For cases involving the potential damage of more than one multiconductor cable, a maximum of two cables should be assumed to be damaged concurrently. The spurious actuations should be evaluated as previously described. The consideration of more than two cables being damaged (and subsequent spurious actuations) is deferred pending additional research.

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- Paragraph D.
 - For cases involving direct current (DC) circuits, the potential spurious operation due to failures of the associated control cables (even if the spurious operation requires two concurrent hot shorts of the proper polarity, e.g., plus-to-plus and minus-to-minus) should be considered when the required source and target conductors are each located within the same multiconductor cable.

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- Paragraph E.
 - Instrumentation Circuits. Required instrumentation circuits are beyond the scope of this associated circuit approach and must meet the same requirements as required power and control circuits. There is one case where an instrument circuit could potentially be considered an associated circuit. If fire-induced damage of an instrument circuit could prevent operation (e.g., lockout permissive signal) or cause maloperation (e.g., unwanted start/stop/reposition signal) of systems necessary to achieve and maintain hot shutdown, then the instrument circuit may be considered an associated circuit and handled accordingly.

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- High Consequence/Low Likelihood Item
 - Three-phase, proper-polarity hot short power cable failures (with one exception). In theory, such failures could cause a three-phase device to spuriously operate. However, such failures are considered of very low likelihood because the three distinct phases of power would have to align in the proper phased sequence to operate. (Note that three phase devices may still be subject to spurious operations due to faults in their related control and/or instrumentation circuits.) The one exception is the decay heat removal (DHR) system isolation valves. Spurious opening of these valves would result in the low-pressure portion of the DHR system piping located outside of containment being pressurized with the reactor coolant at or near normal reactor operating pressure.
 - From Bin 3, Item E

October 14, 2004 Post-Fire Safe-Shutdown Circuit Analysis Meeting 12

Post-Fire Safe-Shutdown Circuit Analysis

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Fire Protection Workshop
Atlanta, GA
October 14, 2004

United States Nuclear Regulatory Commission
Washington, DC 20555-0001



1

Purpose of Presentation

- Review the NRC's regulatory position on key issues related to post-fire safe-shutdown electrical circuit analysis
- Address aspects of these issues that are not specifically defined in regulatory documents
- Identify any additional issues that require clarification
- Obtain input from stakeholders on appropriate resolutions
- Provide foundation for final closure of circuit analysis issues in a new RIS



2

Issues That Will Be Addressed

- Train Free of Fire Damage
- Any-And-All, One-At-A-Time
- Associated Circuits
- Applicability of Plant-Specific Exemptions
- Emergency Control Stations



3

Train Free of Fire Damage

- "One train of equipment necessary to achieve hot shutdown from either the control room or emergency control station(s) must be maintained free of fire damage by a single fire, including an exposure fire." (10 CFR 50, Appendix R, Section 1, "Introduction and Scope")
- "The structure, system, or component under consideration is capable of performing its intended function during and after the postulated fire, as needed, without repair." (GL 86-10, Enclosure 1, Part 3, "Fire Damage")



4

Train Free of Fire Damage (Cont)

- "The term "damage by fire" also includes damage to equipment from the normal or inadvertent operation of fire suppression systems." (GL 86-10, Enclosure 1, Part 3, "Fire Damage")



5

Train Free of Fire Damage Need for Clarification

- Operator Manual Actions – Can a local manual action make a train "free of fire damage"? – This will be allowed for III.G.2 areas by OMA rulemaking.
- Superficial fire damage – not specifically excluded in regulations, but by corollary, any fire damage that does not affect safe shutdown does not need to be considered.



6

Train Free of Fire Damage Need for Clarification (Cont)

- Appendix R, III.G.1 applicability – For Appendix R plants, can a manual operation mitigate a spurious actuation? – Per Appendix R, Section III.G.2: "... where cables or equipment, including associated non-safety circuits that could prevent operation or cause maloperation...of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located in the same fire area...one of the following means..."



7

Train Free of Fire Damage Need for Clarification (Cont)

- Appendix R, III.G.1 applicability (Cont) – A circuit whose fire-induced failure could cause a maloperation of a train is considered a part of the affected train.
- If the circuit is routed through the fire area of the redundant train, it should be protected in accordance with III.G.2 since redundant train cables are located in the same fire area (III.G.1 is not applicable).
- III.G.3 and GL 81-12 allow other protection options for "associated circuits of concern" in alternative or dedicated shutdown systems.



8

Train Free of Fire Damage Need for Clarification (Cont)

- Appendix R, III.G.1 applicability (Cont) – Can a fire damaged component be locally operated as an "emergency control station" for III.G.1 compliance? If operation of a component is needed for safe shutdown using Train A and it's circuitry is damaged in the Train B fire area, III.G.1 protection has not been provided and is not applicable.



9

Spurious Actuations Any-And-All

- "For consideration of spurious actuations, all possible functional failure states must be evaluated, that is, the component could be energized or de-energized by one or more of the above failure modes." (GL 86-10, Response to Question 5.3.1)
- Specific exceptions (same reference):
 - Three phase hot shorts in proper sequence to cause spurious motor operation, except high/low pressure interfaces
 - Ungrounded DC circuits, if it can be shown that only two hot shorts of the proper polarity without grounding could cause spurious operation, except high/low pressure interfaces



10

Spurious Actuations Any-And-All (Cont)

- "...the staff reiterated the regulatory requirement that multiple spurious actuations caused by fire-induced hot shorts, shorts to ground, or open circuits must be considered and evaluated" (S.J. Collins letter to NEI, March 11, 1997)
- "The staff concluded that its position (that the technical issue addressed in IN 92-18 is within the scope of the existing fire protection regulation) is justified." (S.J. Collins letter to NEI, March 11, 1997)



11

Spurious Actuations One-At-A-Time

- Not defined in regulatory documents
- EPRI fire tests demonstrated that multiple spurious actuations can occur in rapid succession (within seconds)



12

Any-And-All, One-At-A-Time Need for Clarification

- How many spurious actuations must be postulated? – Regulations do not limit the number.
- Cumulative effect of multiple spurious actuations – Regulations are silent on this issue
- Mitigation between faults – will be addressed by operator manual actions rulemaking for III.G.2 areas.
- Any others?/Comments?

13



Associated Circuits

- "Associated Circuits of Concern are defined as those cables (safety related, non-safety related, Class 1E, and non-Class 1E) that:"
 - Have a physical separation less than that required by Section III.G.2 of Appendix R, and have one of the following:
 - A common power source with redundant or alternative shutdown equipment and not electrically protected, or
 - A connection to circuits of equipment whose spurious operation would adversely affect the shutdown capability, or
 - Common enclosure with the shutdown cables (redundant and alternative) and not electrically protected or will allow fire propagation into the common enclosure
- Reference: NRC GL 81-12 clarification letter to licensees dated April 7, 1982

14



Associated Circuits (Cont)

- "Associated Circuits – Circuits that do not meet the separation requirements for safe shutdown systems and components and are associated with safe shutdown systems and components by common power supply, common enclosure, or the potential to cause spurious operations that could prevent or adversely affect the capability to safely shut down the reactor as a result of fire-induced failures (hot shorts, open circuits, and short to ground)." (Regulatory Guide 1.189)

15



Associated Circuits Need for Clarification

- Applicability beyond alternative shutdown:
 - 81-12 clarification letter specifically mentions both alternative and redundant shutdown cables for common enclosure and common power supply
 - Clarification letter does not mention redundant systems with respect to spurious operations
 - Regulatory Guide 1.189 addresses associated circuits and alternative shutdown separately
 - Is the protection required for the associated circuits in III.G.2 areas different from that of other SSD circuits?

16



Associated Circuits Closure

- The revision to RIS 2004-03 will eliminate any distinction between associated circuits and other SSD circuits for inspection focus.
- Operator manual actions rulemaking will remove any distinction with respect to the protection against spurious operations for III.G.2 areas.
- Approach is consistent with NFPA 805 – any circuit whose function or absence of malfunction is required for safe shutdown is "required" and should be protected.
- "Associated Circuits of Concern" definition and protection for common enclosure and common power supply situations will not change.

17



Applicability of Plant-Specific Exemptions

- Plant-specific exemptions granted in accordance with 10 CFR 50.48 and 10 CFR 50.12 are only applicable to the specific plant and situation for which they were granted. They do not constitute a new regulatory position generically applicable to other licensees.

18



Emergency Control Stations

- **"Emergency Control Station —** Location outside the main control room where actions are taken by operations personnel to manipulate plant systems and controls to achieve safe shutdown of the reactor." (Regulatory Guide 1.189)

19



Emergency Control Stations Need for Clarification

- Applicability to a single component – does regulation consider a single valve, etc., to be an emergency control station? Operator manual actions rulemaking will resolve for III.G.2 areas.
- Appendix R, III.G.1 applicability – Can an undamaged component be locally operated as an "emergency control station" for III.G.1 compliance? No guidance in regulations.
- Any others?/Comments?

20



Summary – Path to Closure

- Develop clarification of any outstanding issues
- Additional stakeholder comments submitted within 30 days will be considered
- The information provided in this meeting and other circuit-related clarifications will be published in a new Regulatory Issue Summary (April 2005)

21



COMPENSATORY MEASURES TALKING POINTS

- REGULATORY ISSUE SUMMARY (RIS) IS IN PREPARATION AND WE HOPE TO ISSUE IT WITHIN THE NEXT TWO MONTHS OR SO
- COMPENSATORY MEASURE FOR MISSING OR DEGRADED FIRE BARRIER IS TYPICALLY AN HOURLY FIRE WATCH TOUR
- MANUAL ACTIONS IN LIEU OF A III.G.2 FIRE BARRIER IS RESULTING IN NUMEROUS INSPECTION FINDINGS, MANY OF LOW RISK
- STANDARD LICENSE CONDITION ALLOWS CHANGE OF FPP WITHOUT PRIOR APPROVAL WITH NO ADVERSE AFFECT ON SSD
- A LICENSEE MAY PREFER TO USE PROPERLY ANALYZED MANUAL ACTIONS AS THE COMPENSATORY MEASURE FOR THE MISSING FIRE BARRIER RATHER THAN A FIRE WATCH.
- TO DO THIS
 - Assume that the degraded condition is a missing or derated fire barrier.
 - Do a fire protection program change IAW the operating license condition to allow the manual action in lieu of the hourly fire watch tour

- Licensee evaluation must demonstrate that the manual actions would not result in an adverse affect when compared to an hourly fire watch tour.
- **DEPENDING UPON CIRCUMSTANCE, THE USE OF MANUAL ACTIONS AS A COMPENSATORY MEASURE MAY RESULT IN NO INSPECTION FINDING**
 - Currently if a fire barrier is degraded or taken out of service and the licensee institutes compensatory measures in accordance with the approved FPP LCO (usually within one hour) then no violation has occurred.
 - If manual actions are an acceptable compensatory measure in the approved fire protection program, then no violation would occur in a similar circumstance

Risk-informed Inspection

- Inspections are risk-informed
 1. Areas that are risk-important in terms of cornerstones
 2. Frequency and sample size based on risk-insights
 3. Sample selection based on risk-significant equipment, activities, and zones.

Risk-informed FP Inspection

- FP Procedure is risk-informed from #2 and #3.
- Revised FP IP to further risk-inform
 - Adds risk-information to use when selecting sample
 - Adds risk-information to use when assessing issues
 - Brings more risk-awareness to inspectors
- Revised FP IP incorporates insights from the RIS



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Post-Fire Safe-Shutdown Circuit Failure: Closure Path Appendix R and SRP Plants (Part 2)

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October 14, 2004



Introduction

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- Purpose
 - Elements of the Overall Plan (a.m. session)
 - Discuss Acceptable Methods
 - Discuss Acceptable Tools
 - Implications of Self-Assessments
 - Applicable Enforcement Discretions

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2



RIS to Risk-Inform Inspection of All Circuits

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- Resumption of inspection focused on high probability configurations (Bin 1 of RIS 2004-03)
- Perform confirmatory research on Bin 2 (uncertain configurations) by the Office of Research
- Note: Even though inspections are risk-informed, licensees must come into compliance on findings in each Bin. The methods available to come into compliance depends on the licensing basis of the plant.

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3



NEI-00-01

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- Provided detailed staff comments (September 2004)
- Received revised version (10/8/04)
- Undergoing staff review
- Will endorse and/or take exceptions

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NEI 04-06

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- NEI is updating NEI 04-06 based on the NEI pilot results
- Staff will review and provide comments on the revised NEI 04-06, when available

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5



NEI-02-03

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- NEI is currently updating NEI 02-03
- NEI has expressed an interest in getting staff acceptance of NEI 02-03
- Staff will review and provide comments on revised NEI 02-03, when available and if requested
- Note: Appendix R plants and SRP plants may apply NEI 02-03 differently

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6



NFPA Tools & Methods NRR

- Risk-Informed tools and methods in NFPA 805 are available for non-NFPA 805 plants as well.
- However, changes may require prior NRC approval.

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7



Enforcement Discretion Plans NRR

- Discretion from action matrix and enforcement.
- Current enforcement manual allows discretion
- Changes to ROP and inspection strategy to continue discretion for self-assessment findings

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8



Establish HQ Office Panel NRR

- Recognize challenges in licensing basis in spite of ongoing efforts to clarify expectation
- Assist regions (if assistance is requested)

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9



RIS on Closure Path NRR

- Document key issues
- Use stakeholder feedback for final overall circuit closure path
- Issue generic communication

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10



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Practical Applications Post-Fire Safe-Shutdown Circuit Analysis

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Risk Assessment and Circuit Analysis Tools

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- Circuit Analysis Tools
 - Current NRC Guidance
 - NEI 00-01, Chapter 3
- Risk Assessment Tools
 - Fire Protection SDP (IMC 0609, Appendix F)
 - NEI 00-01, Chapter 4
 - Fire Protection Requantification (EPRI and Office of Research) – Comprehensive

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2



NEI Pilot Questions

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- How many cables will be considered to have independent intracable interactions?
 - Two cables will be considered to intracable interactions.
- How many thermoplastic cables will be considered for intercable interactions.
 - Two cables will be considered. This includes intercable interactions and intracable interactions within each cable, if applicable

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3



NEI Pilot Questions

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- Will the inspection focus on only intracable interactions for DC circuits in thermoplastic cable?
 - For thermoset cables intracable failures will be considered. For thermoplastic, both intercable and intracable failures will be considered.
- Considering the above response, will inspectors focus on intracable interactions for ungrounded AC circuits in thermoplastic cable?
 - For thermoset cables intracable failures will be considered. For thermoplastic, both intercable and intracable failures will be considered.

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4



NEI Pilot Questions



- Will the inspection focus on damage to only two cables regardless of whether they are thermoset or thermoplastic cables and regardless of whether they are "source" or "target" cables? Or, should one assume that two "target" cables can interact with two "source" cables?
 - Damage is assumed to occur to all affected cables. Cable interactions (other than short to ground) are expected to occur in only two cables, one "target," and one "source."

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5



NEI Pilot Questions



- Does the CPT (control power transformer) restriction apply to the source circuit or the target circuit?
 - Source circuit, since this is where the power limitation will occur.
- If the target circuit, how does the 150% limitation keep the current flow to the target from causing the spurious actuation if only 100% of the nominal current is needed to actuate the circuit?
 - Not applicable (since the target circuit CPT may be bypassed).

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6



NEI Pilot Questions



- To facilitate an inspection that considers most of the risk presented by postulated hot shorts within a multiconductor cable, inspectors should consider only a few (three or four) of the most critical postulated combinations. [RIS 2004-003, Bin 1, Item A]
 - Note that this refers to combinations, not spurious actuations. A single combination may cause multiple spurious actuations.

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7