May 30, 2012

MEMORANDUM TO: Alexander R. Klein, Chief
Fire Protection Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

FROM: Daniel M. Frumkin, Team Leader ***/RA/***
Fire Protection Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MAY 3, 2012, PUBLIC MEETING OF THE NUCLEAR REGULATORY COMMISSION TO DISCUSS FIRE PROTECTION CIRCUIT FAILURES AND OTHER CURRENT LICENSING BASIS ISSUES

On May 3, 2012, the U.S. Nuclear Regulatory Commission (NRC) staff held a Category 2 public meeting with industry stakeholders to discuss fire protection issues related to fire induced circuit failures. A list of participants is included in Enclosure 1. The main topics discussed were the status of industry activities relating to Revision 3 of Nuclear Energy Institute (NEI) 00-01, "Guidance for Post-Fire Safe Shutdown Circuit Analysis," submitted to the NRC on October 12, 2011 (see ADAMS Accession Number ML112910143), and licensing bases issues with regard to multiple spurious operations (MSOs). This meeting followed a similar meeting on January 31, 2012. The meeting minutes for the January 31, 2012, were published on March 5, 2012, as Agencywide Documents Access and Management System (ADAMS) Accession Number ML120481526.

Prior to the meeting, the NRC staff provided comments on sections of NEI 00-01, Revision 3, to industry stakeholders. These comments were distributed during the meeting and are included as Enclosure 2. During the meeting, industry stakeholders provided two presentations, one with responses to NRC comments on NEI 00-01, Revision 3, included as Enclosure 3; and one with a discussion of shorting switches, included as Enclosure 4.

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At the beginning of the meeting the NRC staff acknowledged that only one slide was provided as part of the NEI presentation (Slide 19 of Enclosure 3), on the topic of fire-induced circuit failure licensing basis. The slide indicated that industry stakeholders were concerned about establishing a stable technical resolution process. The staff indicated that licensing basis issues were a concern in the near term. The NRC staff informed the attendees that the discussion on this topic would be limited and that the NRC staff would consider next steps in resolving licensing basis issues, and will inform industry stakeholders when and if their involvement would be needed. The NRC staff will also consider 10 CFR 50, Appendix R, III.G.3 and III.L, Alternative and Dedicated Shutdown Capability when determining the next licensing basis steps.

The balance of the meeting followed the slides provided by NEI staff and industry stakeholders in Enclosures 3 and 4. The following points and actions items were discussed during the meeting beyond the information included on those slides.

The NRC staff had concerns with the characterization of pressurizer power operated relief valves (PORVs) at pressurized water reactors and safety relief valves (SRVs) at boiling water reactors. The staff was concerned that spurious opening of these valves represents a high consequence event and that rigorous analysis of defense-in-depth is needed. The NRC staff will work internally to characterize these concerns and will inform industry stakeholders of the specific concerns at the next public meeting on this topic.

Industry stakeholders had questions about the ongoing research. The NRC Office of Nuclear Regulatory Research had provided presentation on the status of this research in February 2012, the slides from that presentation are in the ADAMS document management system as Accession Number ML120340254. Discussion of research begins on page 23 of the presentation.

During the discussion of the white papers, Enclosure 3 – page 20, and Enclosure 4, the NRC staff indicated that clarification with regard to steam and water hammer would be helpful. In addition, the staff indicated that the failure to scram in Appendix E of NEI 00-01, Revision 3, which indicates that operator manual actions, ". . . are considered feasible and reliable for all fire conditions," needs more discussion. Lastly, the bounds of the shorting switch modifications should be discussed in NEI 00-01.

It is the NRC staff position that sufficient technical information is available in Regulatory Guide 1.189, Revision 2 for licensees to address circuit failure issues.

This meeting did not decide any Agency or staff positions, and it did not interpret regulations other than what is currently established by guidance or staff position.

There were no questions for the NRC staff from members of the public.

Enclosures:
As stated

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There were no questions for the NRC staff from members of the public.

Enclosures:
As stated

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NRC PUBLIC FIRE PROTECTION CIRCUIT FAILURES MEETING
LIST OF ATTENDEES

May 3, 2012

Name	Organization
Daniel Frumkin	NRR/DRA
Brian Metzger	NRR/DRA
Harry Barrett	NRR/DRA
Gary Cooper	NRR/DRA
Alex Klein	NRR/DRA
Bernard Litkett	NRR/DRA
Thinh Dinh	NRR/DRA
Brian Metzger	NRR/DRA
Gabriel Taylor	RES/DRA
Phil Qualls*	NRR/DRA
Michael King*	Region II
Robert Daley*	Region III
Gregory Pick*	Region IV
Stephanie Achen*	Region IV

Name	Organization
Greg Cameron	Arizona Public Service
Dan Mantefel	Nexus Engineering
Saeed Savar	UTR
Paul Bemis	PGE
Jim Gregorson	PG&E
Tony Maness	NEI
Tom Gorman	PPL
Chris Pragman	Exelon
Denis Henneke	GE Hitachi
Randy Jamison	Seabrook Station
Bob White	Erin Engineering
Steve Queen	Exelon
Glenn Stewart	Exelon
Mark Jeffers	Nexus
James Zimmerman	Xcel Energy
Mike Macfarlane	SNC
Brenda Simril	TVA
Greg Curtian*	Exelon
Jack Martin*	Dominion
Nancy Chapman*	Bechtel SERCH
Andy Ratchford*	RDS
Joe Loya*	STP
Harold Beck*	Areva
Fleur dePeralta*	Tri-En
Janet Ecker*	Morgan Lewis
Bob Kalantari*	EPM

* Participated via phone or video conference

NRC STAFF COMMENTS ON NEI 00-01, REVISION 3

Summary of NRC's comments on NEI's changes to Chapter 3 and Appendix G of NEI 00-01.

Note: Section 3 of NEI 00-01, Revision 2 was accepted with some modifications by the NRC as documented in Regulatory Guide 1.189, Revision 2.

Each change to Revision 3 of NEI 00-01, (Rev. 3) is followed by an NRC comment.

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3 DETERMINISTIC METHODOLOGY

The sections of this document accepted by the NRC are documented in Regulatory Guide 1.189 Revision 2.

C39. *Clarification* - This may not be a valid statement after NEI 00-01 Rev.3 is issued by NEI.

Section 3.1, continued:

The goal of post-fire safe shutdown is to assure that a one train of shutdown systems, structures, and components required to achieve hot shutdown remains free of fire damage for a single fire in any single plant fire area.

C42. *Clarification* – The regulatory requirement is to "… achieve and maintain hot shutdown…"

Section 3.1, continued:

In addition, flow diversions off of the main flow path for the systems performing the required for safe shutdown functions are initially classified as required for hot shutdown. This criterion is considered an exception since it involves consideration of fire-induced circuit damage in classifying components as required for hot shutdown. A subsequent evaluation using the criteria from Appendix H can be used to re-classify the flow diversion component as important to safe shutdown.

C45. *Clarification* – Clarify the following statement: "This criterion is considered an exception since it involves consideration of fire-induced circuit damage in classifying components as required for hot shutdown."

Section 3.1, continued:

The two cases described above are the only two cases where fire damage is considered.

C47. *Clarification* – Why are only two cases considered?

C48. *Clarification* - Further discussion required to show the value in the concept of fire damage being considered.

Section 3.1, continued:

The distinction between required for hot shutdown and important to safe shutdown, however, is a legal distinction related to the requirements in Appendix R Section III.G.1 and its legal relationship to Appendix R Section III.G.2. Required for hot shutdown components are not necessarily more critical to safe shutdown than important to safe shutdown components. Fire-induced damage to both required for hot shutdown and important to safe shutdown components must be appropriately addressed using a mitigating strategy appropriate to the significance of the fire-induced damage to post-fire safe shutdown.

C50. *Clarification* – Provide discussion of why reference to III.G.1 adds to this discussion. The rest of this paragraph makes sense without it.

Section 3.1, continued:

For important to SSD component failures, operator manual actions, fire modeling and/or a focused-scope fire PRA may be used to mitigate the impact. (If the issue under evaluation is a part of a Licensee's CLB and the use of a Focused-Scope Fire PRAs is not permitted in the Plants Current License Basis, then, a License Amendment Request (LAR) will be necessary to use the Focused-Scope Fire PRA).

C52. *No comments on this change.*

3.1.1 CRITERIA/ASSUMPTIONS

XXXXX

3.1.1.1 XXXXX

3.1.1.2 XXXXX

3.1.1.3 XXXXX

3.1.1.4 XXXXX

3.1.1.5 No Final Safety Analysis Report accidents or other design basis events (e.g. loss of coolant accident, earthquake, station blackout), single failures, severe natural phenomenon (e.g., severe ultimate heat sink temperature) or non-fire-induced transients need be considered in conjunction with the fire.

C54. *Clarification* – Why is "(e.g., severe ultimate heat sink temperature)" used as an example?

C55. The SSD/CA should address conditions under all normal environmental limits (temperature) without any natural phenomenon (calculations must demonstrate the ability to achieve shutdown limits with lowest and highest design basis temperatures, including ambient temperature and service water temperature.

3.1.1.6 XXXXX

3.1.1.7 XXXXX

3.1.1.8 Reasonable actions by the Nuclear Emergency Response Organization during the 72 hour coping period may be assumed to occur, if justifiable, e.g. actions to address room flooding.

C56. *Recommendation* – Remove the term "coping period". The term "coping period" has historically not been used to address Appendix R scenarios. This type of scope addition will require significant justification – plant staffing, procedures, equipment dedication, etc.

3.1.1.9 Spurious actuation of automatic systems (Safety Injection, Auxiliary Feedwater, High Pressure Coolant Injection, Reactor Core Isolation Cooling, etc.) due to fire damage, however, should be evaluated.

C57. *Recommendation* – Use "shall" vs. "should." "Should" implies that it is optional.

3.1.2 SHUTDOWN FUNCTIONS

XXXXX

3.1.2.1 Reactivity Control

[BWR] Control Rod Drive System

The primary means of accomplishing this post-fire safe shutdown function is either an automatic or manual scram from the control room. The inherent design of RPS generally provides a high degree of assurance of a reactor scram upon event initiation (GDC 23). In the unlikely event that a fire could adversely affect RPS prior to a scram,

C59. *Clarification* - Need to consider the Information Notice 2007-07.

Section 3.1.2.1, continued:

The presence of this action precludes the need to perform circuit analysis for the reactivity control function and is an acceptable way to accomplish this function. [Refer to BWROG Report No. BWROG-TP-11-011 Revision 0 June 2011 NEDO-33638, BWROG Assessments of Generic Multiple Spurious Operations (MSOs) in Post-Fire Safe Shutdown Circuit Analysis for Operating BWR Plants.] -Operators are trained extensively on the use of the emergency operating procedures and performance of this action in an ATWS condition is always treated as a very high priority action. Shift manning must be adequate at all times for implementing the emergency operating procedures. Therefore, procedures coupled with operator training and the necessary staffing are always available to address this condition with the appropriate priority. The use of this criterion must be reconciled with the plant's CLB.

~~If this action is a "time critical" action, the timing must be justified.~~

C60. *Clarification* – What is the intended use of BWROG Report?

C61. *Clarification* – Is shift manning adequate to fight the fire, implement these emergency operation procedures and perform other safe shutdown fire procedures and actions?

C62. The actions discussed here should be considered required to meet Defense-in-Depth for the reactivity control function.

3.1.2.2 Pressure Control Systems

XXXXX

[BWR] Safety Relief Valves (SRVs)

Automatic initiation of the ADS may be credited, if available. If automatic ADS is not available and use of ADS is desired, an alternative means of initiation of ADS separate from the automatic initiation logic for accomplishing the pressure control function should be provided. If a high pressure system is selected for post-fire safe shutdown and if pressure is being controlled by the SRVs lifting on their spring set point, then ADS and SRVs would be classified as important to safe shutdown and the pressure relief portion of the circuit would be required for safe shutdown.

C64. *Recommendation* – Use: "as justified through performing the appropriate analysis" vs. "if available".

C65. *Clarification* - Would the automatic initiation of the ADS require inclusion in the SSD analysis, (i.e.III.G.2 type protection/separation)?

C66. *Clarification* - If the SRVs lifting either mechanically or electrically are being credited for pressure control, it seems that they should be in the required path. This seems like a strange scenario to be a generic example.

C67. *Clarification* – This would seem to be required since failure to open would preclude SSD.

C68. SRV in pressure relief would be required for safe shutdown – mechanically (or electrically if that is how the valve functions in pressure relief mode).

Section 3.1.2.2, continued:

[PWR] Makeup/Charging

RCS pressure is controlled by controlling the rate of charging/makeup to the RCS. Although utilization of the pressurizer heaters and/or auxiliary spray reduces operator burden, neither component is required to provide adequate pressure control, but may be used. Pressure reductions are made by allowing the RCS to cool/shrink, thus reducing pressurizer level/pressure. Pressure increases are made by initiating charging/makeup to maintain pressurizer level/pressure or by using the pressurizer heaters. Manual initiation~~control~~ of the related pumps is acceptable.

C69. *Recommendation* – Add: "…but may be used if demonstrated to be free from fire damage."

C70. *Clarification* - This indicates generically that no plants credit, as required, the pressurizer heaters for any fire areas, but the next sentence states "or by using the pressurizer heaters."

C71. *Clarification* - This section depends upon the plant's CLB. If they include pressurizer heaters as required, they should be required.

C72. *Clarification* – "*Manual initiation of the related pumps is acceptable*." Is this to address all plants under all fire conditions or to be plant specific?

3.1.2.3 Inventory Control

[BWR] Systems selected for the inventory control function should be capable of supplying sufficient reactor coolant to achieve and maintain hot shutdown. Manual initiation of these systems is acceptable. Automatic initiation…

C73. *Clarification* - Is this manual initiation from the control room or emergency control stations? Why would it be generically acceptable? Use of examples should be justified.

C74. Manual initiation of injection systems is acceptable; however, undesired automatic initiation should be considered, evaluated and mitigated.

Section 3.1.2.3, continued:

For both BWRs and PWRs, the boundary of the system (train) used to meet the inventory control function includes the Reactor Coolant System. Leakage paths out of the RCS (PORVs, normal and excess letdown, head vents, RCS sample lines, etc.) are diversion paths from the injection system "train." These leakage pathways are initially treated as required for hot shutdown. The guidance in Appendix H can be used to determine these leakage paths can be classified as important to safe shutdown.

C76. *Recommendation* – Insert the above discussion.

3.1.2.4 Decay Heat Removal

XXXXX

3.1.2.5 Process Monitoring

XXXXX

3.1.2.6 Support Systems

3.1.2.6.1 Electrical Systems

AC Distribution System

XXXXX

DC Distribution System

XXXXX

3.1.2.6.2 Cooling Systems

XXXXX

3.1.2.6.3 HVAC Systems

Section 3.1.2.6.3, continued:

The action of opening doors or installing temporary fans is not considered to be either a manual operator action or a repair.

C81. *Clarification* – Provide basis for the action of opening doors or installing temporary fans not considered to be either a manual operator action or a repair. Installing fans could be as simple as plugging a cord into a receptacle or it could require connecting a fan to existing duct work for MCR cooling.

C82. Note that opening and/or closing a ventilation system damper may be either an operator manual action or a repair, depending upon the actions required to reposition the component.

3.1.3 METHODOLOGY FOR SHUTDOWN SYSTEM SELECTION

XXXXX

3.1.3.1 Identify safe shutdown functions

- Other NSSS Vendor Guidance

C84. *No comments on this change.*

3.1.3.2 Identify Combinations of Systems That Satisfy Each Safe Shutdown Function

The components in this latter set are classified as either required for hot shutdown or as important to SSD as explained in this section and in Appendix H.

C85. *Clarification* - Some licensees go directly to cold shutdown (BWR, via ADV and LPSI). Their licensed safe shutdown condition is cold shutdown. Consistency is needed in discussing plants that go to cold shutdown – see comment C13.

3.1.3.3 Define Combination of Systems for Each Safe Shutdown Path

XXXXX

3.1.3.4 Assign Shutdown Paths to Each Combination of Systems

XXXXX

3.2 SAFE SHUTDOWN EQUIPMENT SELECTION

3.2.1 CRITERIA/ASSUMPTIONS

Consider the following criteria and assumptions when identifying equipment necessary to perform the required safe shutdown functions:

3.2.1.1 Safe shutdown equipment can be divided into two categories. Equipment may be categorized as (1) primary components or (2) secondary components. Typically, the following types of equipment are considered to be primary components:

Those mechanical devices, such as pumps, fans, valves, dampers, process instruments providing an input to a system control function and instruments credited for satisfying the process monitoring safe shutdown function, are considered to be primary components for the purposes of this document.

C87. *Clarification* - Is "secondary" refers to sub-components? The primary component circuit contains several control panel switches, some fuses, some terminal blocks, some relays, the circuit contactors, the thermal overloads, etc. They are all part of the circuit, so they should be treated as part of the primary component.

C88. *Clarification* - If "mechanical" is deleted, the paragraph ~~can~~ also applies to instruments.

C89. *Clarification* - Valves can be subdivided into actuator and valve, positioner, E/P, solenoid, etc.

Section 3.2.1.1, continued:

The electrical components, such as generators, switchgear, load centers, motor control centers, batteries, inverters and distribution panels required to provide the motive or control power to mechanical components are defined as electrical distribution equipment and are also considered to be primary components for the purposes of this document.

C90. *Clarification* - The distinction between primary and secondary is not clear. The MCC is primary, yet the relays and switches are secondary. Isn't an MCC made up of relays and switches? How is it possible to make such a distinction? Perhaps a graphic of what NEI means to distinguish primary vs secondary would be helpful. Primary and secondary appear to be terms better suited for Chapter 4 of NEI 00-01.

C91. *Clarification* - Does this include process indication/instrumentation power and cabling?

Section 3.2.1.1, continued:

- ~~Pumps, motor operated valves, solenoid valves, fans, gas bottles, dampers, unit coolers, etc.~~

C92. *Clarification* - Why are Unit Coolers removed?

Section 3.2.1.1, continued:

Secondary components are typically items found within the circuitry for a primary component. These provide a supporting role to the overall circuit function. Some secondary components may provide an isolation function or a signal to a primary component via either an interlock or input signal processor. Devices, such as relays, switches and motors, necessary to support the functioning of the mechanical and electrical components are considered to be secondary components for the purposes of this document. Breakers and motor starters required for the operation of mechanical component are considered to be subcomponents of the mechanical component.

C94. *Clarification* - the pump is primary, but the motor is secondary? What is a pump without a motor? The distinction is not clear here.

C95. The pump and the motor have different Tag Numbers. Operations, P&IDs, and most plant documents use the pump number.

Section 3.2.1.1, continued:

The distinction provided between primary and secondary components is not a required distinction for the post-fire safe shutdown analysis, but may be a necessary distinction when determining whether or not a particular MSO is beyond that requiring consideration given the number of components required to spuriously operate. Refer to Section 3.5.

C96. *Clarification* - This section addresses generic SSD discussion. It isn't clear how MSO fits in here. See C90.

C97. *Clarification* - Discuss further. If NEI 00-01 is going to say that the hot short energized a relay that energized a solenoid that allowed air to open the valve is 3 components, it is a stretch of secondary components.

3.2.1.2 XXXXX

3.2.1.3

3.2.1.4 XXXXX

3.2.1.5 It is not necessary to consider the effects of fire-induced water hammer events affecting non-credited equipment. [Refer to BWROG Report No. BWROG-TP-11-011 Revsion 0 June 2011 NEDO-33638.] This assumption is based on the conclusions of the NEDO-33638 prepared by the BWROG on Fire-Induced Water Hammer which states that the likely failure mode for water hammer events in Nuclear Power Plants does not include major rupture of the piping pressure boundary. The failures experienced that did affect the piping system pressure boundary include failures of vents or small branch lines, pipe cracks and pipe weld cracks.

C100. *Clarification* – The application of the BWROG report to circuit failures should be explained here in this document so that the NRC staff can review to validate the generic position.

C101. *Clarification* - There are limits of applicability for this document. It addresses mechanically-induced water hammers only. It does not include thermally-induced water hammers (steam hammers). The hydraulic forces generated by a thermally induced water hammer can be many times higher than a mechanically induced one. Reference the severe Oconee water hammer in early 1990s.

Section 3.2.1.5, continued:

The primary concern for fire-induced water hammers in Nuclear Power Plants affecting non-credited equipment is the effects of subsequent flooding on the credited safe shutdown systems. Since this type of catastrophic failure was not evident in the water hammer studies perform in response to Unresolved Safety Issue (USI) A-1 and subsequent to that by EPRI in their Report on Water Hammer, the need to consider fire-induced water hammer in the post-fire safe shutdown analysis affecting non-credited equipment is neither required nor warranted. This section applies to both BWRs and PWRs.

C102**.** *Clarification* - This document should be reviewed to validate the generic position. If the fire has caused the water hammer event, then it should be analyzed. This is similar to a IN 92-18 scenario causing physical damage to a motor operated valve.

C103. *Clarification* - There are limits of applicability for this document. It addresses mechanically-induced water hammers only. It does not include thermally-induced water hammers (steam hammers). The hydraulic forces generated by a thermally induced water hammer can be many times higher than a mechanically induced one. Reference the severe Oconee water hammer in early 90s.

Section 3.2.1.6, continued:

An instrument circuit engineering failure modes and effects analysis (FMEA) could consider factors such as instrument loop bias, loop failure mode (i.e., fail high or low on short to ground, short conductor-to-conductor, or open circuit) and normal loop position (i.e., controller dialed to the closed position which corresponds to low signal), as well as, the specific circuit and cable design for the instrument. [Refer to NUREG/CR-6776 and NUREG/CR-5546.]

C105. *Clarification* – Applying the proper uses of data in these NUREGs to plant specific cable fire damage will be the responsibility of the licensee.

C106. *Clarification* - Are these really relevant to FMEA? They seem more to address cable failure modes – not instrument failure modes.

C107. *Clarification* - This can be simplified with the statement that any deviation from the typical assumptions of failing to the worst condition must be technically justified by the licensee on a case-by-case basis.

3.2.2 METHODOLOGY FOR EQUIPMENT SELECTION

XXXXX

3.2.2.1 Identify the System Flow Path for Each Shutdown Path

3.2.2.2 Identify the Equipment in Each Safe Shutdown System Flow Path Including Equipment That May Spuriously Operate and Affect System Operation

"…Criteria for making the determination as to which of these components are to be classified as required for hot shutdown or as important to SSD is contained in Section 3 and in Appendix H.

C110. *Recommendation* – Use “safe” vs. “hot” shutdown.

3.2.2.3 Develop a List of Safe Shutdown Equipment and Assign the Corresponding System and Safe Shutdown Path(s) Designation to Each.

XXXXX

“Identify instrument tubing that may cause subsequent effects on instrument readings or signals as a result of fire.”

C111. *Recommendation* – Use “undesired” vs. “subsequent”.

3.2.2.4 Identify Equipment Information Required for the Safe Shutdown Analysis

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3.2.2.5 Identify Dependencies Between Equipment, Supporting Equipment, Safe Shutdown Systems and Safe Shutdown Paths.

XXXXX

3.3 SAFE SHUTDOWN CABLE SELECTION AND LOCATION

XXXXX

3.3.1 CRITERIA/ASSUMPTIONS

XXXXX

3.3.1.1.1 XXXXX

3.3.1.1.1.1 “Electrical devices such as relays, switches and signal resistor units are considered to be acceptable isolation devices.”

C115. *Clarification* – Have signal resistor units been confirmed as isolation devices?

C116. Trying to list examples of these isolation devices may be more confusing than necessary. The paragraph works equally well without this first sentence. Recommend deleting.

3.3.1.1.2 XXXXX

3.3.1.1.2.1 The automatic initiation logics for the credited post-fire safe shutdown systems are generally not required to support safe shutdown, although exceptions may exist where logic must remain intact to support the availability of a permissive, i.e. reactor low pressure for LPCI injection, needed for component operation.

C118. *Clarification* - spurious actuation of automatic logic systems should be considered, evaluated and mitigated where fire-induced damage can cause it.

3.3.1.1.3 XXXXX

3.3.2 Associated Circuit of Concern Cables

XXXXX

Cables Whose Failure May Cause Spurious Operations

Safe shutdown system spurious operation concerns can result from fire damage to a cable whose failure could cause the spurious operation/mal-operation of equipment whose operation could affect safe shutdown. These cables are identified in Section 3.3.3 together with the remaining safe shutdown cables ~~requir~~needed to support control and operation of the equipment. As outlined in Appendix H, valves with the potential to cause flow diversions from the flow path credited to perform a hot shutdown function are classified as required for hot shutdown unless they meet the criteria outlined in Appendix H

C120. *Recommendation* – Revise to reads, "*...meet the Important SSD criteria outlined in Appendix H.*"

Common Power Source Cables

XXXXX

Common Enclosure Cables

XXXXX

3.3.3 Methodology for Cable Selection and Location

3.3.3.1 Identify Circuits Necessary for the Operation of the Safe Shutdown Equipment

XXXXX

3.3.3.2 Identify Interlocked Circuits and Cables Whose Spurious Operation or Mal-operation Could Affect Shutdown

---

3.3.3.3 Assign Cables to the Safe Shutdown Equipment

3.3.3.4 Identify Routing of Cables

XXXXX

3.3.3.5 Identify Location of Raceway and Cables by Fire Area

XXXXX

3.4 FIRE AREA ASSESSMENT AND COMPLIANCE STRATEGIES

3.4.1 Criteria/Assumptions

XXXXX

3.4.1.1 XXXXX

3.4.1.2 XXXXX

3.4.1.3 XXXXX

3.4.1.4

Step 8
Identify routing of cables.

Refer to Step 5 in Figure 3-3

Step 9
Identify location of cables by fire area.

(*) For electrical distribution equipment including power supplies, identify circuits whose failure may cause a coordination concern for the bus under evaluation.

3.4.1.5 XXXXX

3.4.1.6 XXXXX

3.4.1.9 XXXXX

3.4.2 Methodology for Fire Area Assessment

XXXXX

3.4.2.1 Identify the Affected Equipment by Fire Area

XXXXX

3.4.2.2 Determine the Shutdown Paths Least Impacted By a Fire in Each Fire Area

3.4.2.3 Determine Safe Shutdown Equipment Impacts

XXXXX

3.4.2.4 Develop a Compliance Strategy or Disposition to Mitigate the Effects Due to Fire Damage to Each Required Component or Cable

XXXXX

Important to Safe Shutdown Components:

- XXXXX
- Address using fire modeling or, if allowed under the CLB, a focused-scope fire PRA using the methods of Section 5 for MSO impacts. ~~[Note: The use of fire modeling will require a review by the Expert Panel and the use of a focused-scope fire PRA will require a LAR.]~~

C129. *Clarification* – The licensee should separate fire modeling from focused scope fire PRA.

C130. *Clarification* – No current CLBs (non-805) allow Fire PRA.

3.4.2.5 Document the Compliance Strategy or Disposition Determined to Mitigate the Effects Due to Fire Damage to Each Required Component or Cable

XXXXX

3.5 CIRCUIT ANALYSIS AND EVALUATION

XXXXX

3.5.1 CRITERIA/ASSUMPTIONS

XXXXX

3.5.1.1 **Circuit Failure Criteria**: The criteria provided below, when combined with the circuit failure criteria explained in Section 3.5.2, addresses the effects of multiple fire-induced circuit failures impacting circuits for components classified as either "required for hot shutdown" or "important to safe shutdown". Consider the following circuit failure types on each conductor of each unprotected cable, e.g. not a fire-rated cable, not wrapped with a qualified, protective fire wrap. These types of circuit failure types are to be applied to the circuit types shown depicted in Section 3.5.2 for components classified as either "required for hot shutdown" or "important to safe shutdown"

C132. *Clarification* - Does this mean IEEE-383 cable or cable with 3-hour shielding or cable types such as Rockbestos or Mineral Insulated?

C133. *Clarification* - Section 3.5.2 is not fully endorsed by the NRC.

Section 3.5.1.1, continued:

- A hot short in the control circuitry for an MOV can bypass the MOV protective devices, i.e. torque and limit switches. This is the condition described in NRC Information Notice 92-18. In this condition, the potential exists to damage the MOV motor and/or ~~valve~~operator.

C135. *Clarification* – Provide basis for removing discussion of damage to the valve.
An analysis should have normally been performed to show that valve damage can occur and it would not cause a breach of system boundary or that the breach is acceptable. (i.e. valve stem, yoke and seat damage could occur).
IN 92-18 discusses valve damage.

Section 3.5.1.1, continued:

- An open circuit may result from a fire-induced break in a conductor resulting in the loss of circuit continuity, or from a blown fuse or tripped breaker. An open circuit may prevent the ability to control or power the affected equipment. An open circuit may also result in a change of state for normally energized equipment. This is not considered to be a spurious operation. These types of failures are considered to be fire damage. (e.g. [for BWRs] loss of power to the Main Steam Isolation Valve (MSIV) solenoid valves due to an open circuit will result in the closure of the MSIVs).

C136. *Clarification* - The DC testing also showed that the energetic arcs generated in DC circuits could damage adjacent conductors as well as the conductor that shorts.

Section 3.5.1.1, continued:

[**Note**: Open circuits as a result of conductor melting have not occurred in any of the recent AC cable fire testing or in numerous actual plant fires and they are not considered to be a viable form of cable failure for AC control circuits.]

C137. *Clarification* – Provide basis for note.

C138. *Clarification* – Fort Calhoun power station experienced melted bus bars (an open circuit) due to a fire in ~~a~~ switchgear. Not a cable or control circuit per se, however they were conductors. Also they experienced cable failures internal to the switchgear due to the fire.

C139. Fires within major equipment (switchgear, MCCs, Load Centers, etc.) have experienced melting of bus bars and stabs. This discussion should probably be modified to be very clear that you are specifically talking about low voltage AC control cables in raceways and not medium voltage equipment.

Section 3.5.1.1, continued:

Note: Impacts to a component resulting from a set of shorts-to-ground equating to a ground fault equivalent hot short is considered to be similar to a hot short and is, therefore considered to be a spurious operation.]

C141. *Recommendation* – Add: "But cannot be used to limit the number of hot shorts."

Section 3.5.1.1, continued:

In general, components classified as "required for hot shutdown" are required to operate in support of post-fire safe shutdown. As such, open circuits and shorts-to-ground are critical circuit failure types in that they have the potential to cause a loss of circuit function that will prevent operation of the component. For components classified as "required for hot shutdown' because they represent potential flow diversions from the flow path being used for post-fire safe shutdown, hot shorts with the potential to cause a spurious opening of the flow diversion valve are the critical circuit failure type. The specific conductors required for the operation or that could cause the mal-operation of a "required for hot shutdown" component are determined based on a circuit analysis. The circuit failure criteria in Section 3.5.2 is to be used to determine which circuits are required for the operation of or that can cause the mal-operation of "required for hot shutdown" components.

C143. *Clarification* – The term "In general" does not address all. For a specific plant it may or may not be valid. This term is used throughout this document.

C144. *Clarification* – Provide basis for paragraph (Flow diversions make it confusing).

C145. *Clarification* – RG 1.189 "Chapter 3 of industry guidance document NEI 00-01(Ref. 25) provides an acceptable deterministic methodology for the analysis of post fire safe-shutdown circuits, when applied in conjunction with this regulatory guide."

Section 3.5.1.1, continued:

In general, the primary concern for components classified as "important to safe shutdown" is spurious operation. For "important to safe shutdown" components that are a concern for spurious operation, the critical circuit failure type is a hot short. If component operation is necessary, however, open circuits and shorts-to-ground may be the critical circuit failure types. The specific conductors required for the operation or that could cause the mal-operation of an important to safe shutdown component are determined based on a circuit analysis. The circuit failure criteria in Section 3.5.2 is to be used to determine which circuits are required for the operation of or that can cause the mal-operation of "important to safe shutdown" components.

C147. *Clarification* – The term "In general" does not address all. For a specific plant it may or may not be valid.

C148. What about HVAC systems? They may be active but we are classifying them as important rather than required. They are not spurious concerns.

3.5.1.2 **Duration of a Hot Short:** The duration of a hot short in an ac circuit may be assumed to be limited to 20 minutes. Once the evaluation of the dc cable fire testing is completed, a recommendation will be provided for the duration of hot shorts in dc circuits.

C149. *Clarification* – How are DC circuits analyzed prior to testing completion or if testing is not conclusive?

C150. This should be changed to state that DC hot shorts should be assumed to exist until action is taken to remove the hot short. Once the DC testing results have been evaluated and accepted by NRR, additional guidance may be provided.

3.5.1.3

Section 3.5.1.3, continued:

The list of MSO contained in Appendix G must be included in the analysis of MSOs. Additional MSO identified on a plant specific basis are to be included in the analysis of MSO, except as explained below.

- MSOs from the list of MSOs in Appendix G need to be combined, unless exempted as explained below~~except as explained in Section 4.4.3.4 of this document or unless exempted as explained below.~~:
  - Section 4.4.3.4 states that the expert panel should review the plant specific list of MSOs to determine whether any of the individual MSOs should be combined due to the combined MSO resulting in a condition significantly worse than either MSO individually.

C152. *Clarification* - The exception/exemption criteria are not described clearly.

C153. *Clarification* – The term "significantly worse than …" is too subjective.

Section 3.5.1.3, continued:

- When considering the need to combine MSOs, add a new MSO or in evaluating an existing MSO, the following criteria apply:

If the MSO involves more than a total of four (4) components requiring independent, (i.e. in separate cables,), hot shorts to cause each component to spuriously operate or if the MSO contains four (4) or fewer components, but requires -more than four (4) independent, (i.e. in separate cables,), hot shorts to cause all components in the MSO to spuriously operate, then these cases are considered to be beyond the required design basis for MSOs.

C154. *Clarification* - Provide basis for selecting "4" as the criteria.

Section 3.5.1.3, continued:

If the MSO involves assumptions related to selective timing of multiple fire-induced circuit failures with an assumed or fire-induced loss of offsite power where an adverse condition would not result if the postulated timing did not occur, this is considered to be beyond the required design basis for MSOs.

C155. *Clarification* - Is this scenario referring to failures that require a certain set of conditions that must occur in a defined time sequence? Is the assumption in relationship with or without offsite power?

C156. Sequential and/or concurrent hot shorts can NOT be categorically ruled out. The safe shutdown analysis must assume that they occur.

3.5.1.4 XXXX

3.5.2 Types of Circuit Failures

XXXXX

This section will discuss specific examples of each of the following types of circuit failures and how they need to be combined for these circuit types in order to address the issue of multiple hot shorts causing spurious operations. Within the limitations contained in Section 3.5.1.3 above, these individual spurious operations are then combined into multiple spurious operations (MSOs). Mitigating the potential affects of these multiple spurious operations using the mitigating strategies outlined in this document is one method for resolving the MSO Issue for a licensee. The types of circuit failures discussed in this section are defined in Section 3.5.1 and listed below:

C157. *Recommendation* – Add: "…outlined in this document when applied in conjunction with Regulatory Guide 1.189 is one method…"

3.5.2.1 Circuit Failures Due to an Open Circuit

Section 3.5.2.1, continued:

- Open circuit on a high voltage (e.g., 4.16 kV) ammeter current transformer (CT) circuit ~~may~~ has been hypothesized to result in secondary damage, possibly resulting in the occurrence of an additional fire in the location of the CT itself.

C160. *Clarification* - Although these scenarios may not have happened in the nuclear industry, they have been documented in other industries.

3.5.2.2 Circuit Failures Due to a Short-to-Ground

XXXXX

There is no limit to the number of shorts-to-ground that could be caused by the fire, except for cases involving ground equivalent hot short which are discussed in Section 3.5.2.3.

C162. *Clarification*: Although the argument that a ground fault equivalent hot short gives the same result as a normal hot short, we should not be limiting the number of ground fault equivalent hot shorts since a ground fault is the lowest energy state for an electrical circuit – they will all eventually go to ground.

Section 3.5.2.2, continued:

Note: The effect of a set of shorts-to-ground equating to a ground fault equivalent hot short is considered to be similar to a hot short. Circuit failures involving ground fault equivalent hot shorts are considered to be spurious operations. The effects of ground fault equivalent hot shorts causing a spurious operation is addressed under Section 3.5.2.3 on hot shorts. Spurious operations resulting from ground fault equivalent hot shorts would be included in the count of spurious operations discussed in Section 3.5.1.3.

C164. *Clarification*: Although the argument that a ground fault equivalent hot short gives the same result as a normal hot short, we should not be limiting the number of ground fault equivalent hot shorts since a ground fault is the lowest energy state for an electrical circuit – they will all eventually go to ground.

Section 3.5.2.2, continued:

This set of shorts-to-ground equating to a ground fault equivalent hot short is discussed in more detail in Section 3.5.2.3 on hot shorts. Spurious operations resulting from ground fault equivalent hot shorts would be included in the count of spurious operations discussed in Section 3.5.1.3.

C168. *Clarification*: Although the argument that a ground fault equivalent hot short gives the same result as a normal hot short, we should not be limiting the number of ground fault equivalent hot shorts since a ground fault is the lowest energy state for an electrical circuit – they will all eventually go to ground.

Section 3.5.2.3, continued:

- A hot short in the control circuitry for an MOV can bypass the MOV protective devices, i.e. torque and limit switches. This is the condition described in NRC Information Notice 92-18. In this condition, MOV actuator damage ~~can~~ could potentially occur. Damage to the MOV actuator could result in an inability to operate the MOV either remotely, using separate controls with separate control power, or manually using the MOV hand wheel.

C172. *Clarification* – Provide basis for damage to actuator only (What about valve stem, yoke, body?)

C173. *Recommendation* - MOV valve/actuator should be used – damage could be to actuator or valve.

Section 3.5.2.3, continued:

- This condition could be a concern in two instances: (1) For fires requiring Control Room evacuation and remote operation from the Remote Shutdown Panel; (2) For fires where the selected means of addressing the effects of fire induced damage is the use of an operator manual action. In this latter case, analysis must be performed to demonstrate that the MOV thrust at motor failure does not exceed the capacity of the MOV hand wheel. ~~For either case, analysis must demonstrate the MOV thrust at actuator failure does not damage the MOV pressure boundary.~~

C174. *Clarification* – Provide basis for no damage to valve stem, yoke, body.

C175. *Clarification* - Either the valve or actuator can be damaged, depending upon the weak link analysis.

Section 3.5.2.3, continued:

- A short-to-ground in one conductor traveling through the ground plane affecting a separate short-to-ground in another conductor acting like a ground fault equivalent hot short. This type of failure only needs to be considered when both cables/conductors are within the same raceway. This type of circuit failure is considered to be bounded by the consideration of an inter-cable hot short. If both cables required for a ground fault equivalent hot short are located in separate raceway, then it does not need to be considered under the circuit failure criteria for Appendix R post-fire safe shutdown.

C176. *Clarification* – Provide basis for above statement.

C177. *Clarification* - Not true - DESIREE-Fire testing demonstrated that ground fault equivalent hot shorts could travel between raceways (either conduits or metal cable trays).

C178. *Clarification* - Not true - . The probability of a ground fault equivalent hot short is higher than a cable-to-cable hot short.

Section 3.5.2.3, continued:

A Hot Short on Ungrounded Circuits

In the case of an ungrounded circuit, a single hot short may be sufficient to cause a spurious operation. A single hot short can cause a spurious operation if the hot short comes from a circuit from the positive leg of the same ungrounded source as the affected circuit. For ungrounded circuits, the hot short should be assumed to come from the same source unless it can be demonstrated that this cannot happen. If this latter condition is used to demonstrate that the component will not spuriously operate, then provisions must be included in the design and configuration control process to prevent the occurrence from happening by a future plant circuit change.

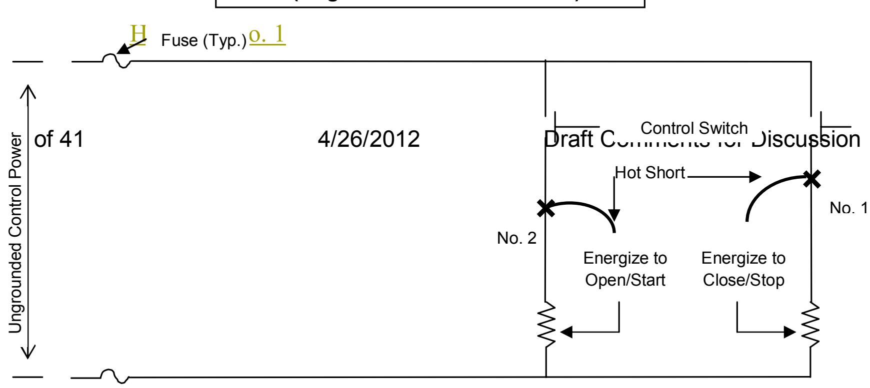
C180. *Clarification* – Justify the applicability of this statement for ungrounded AC.

C181. *Clarification* - It is understandable that it would be very unlikely if not impossible to cause a spurious actuation of an MOV circuit with an ungrounded CPT if the hot short was assumed to occur from the same source since the circuits are so simple. But for DC circuits, the hot short could be from any component supplied from the same battery, which would not be low likelihood.

Section 3.5.2.3, continued:

In the discussion provided below, it is assumed that a single fire in a given fire area could cause any one of the hot shorts depicted. The discussion provided below describes the impact of these cable faults on the operation of the equipment controlled by this circuit.

Figure 3.5.2-5
Hot Short
(Ungrounded Control Circuit)



A hot short at this location from the same control power source would energize the close relay and result in the undesired closure of a motor operated valve.

Hot short No. 2

A hot short at this location from the same control power source would energize the open relay and result in the undesired opening of a motor operated valve.

C182. *No comments on this change.*

Section 3.5.2.3, continued:

Hot Shorts affecting Solenoid Valves:

The following cases address the criteria to be applied to double break solenoid valves.

Field Code Changed

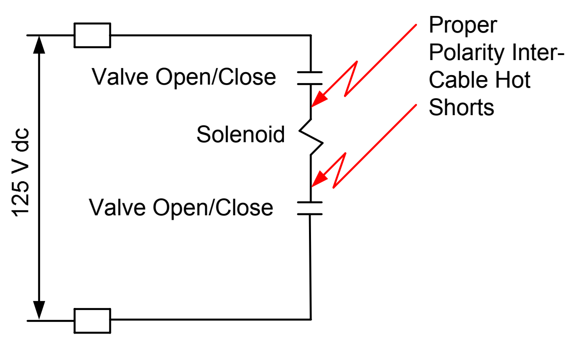


Figure 3.5.2-6 - Two Inter Cable Hot Shorts of Proper Polarity

Two inter-cable hot shorts of the proper polarity on an ungrounded DC Circuit as shown above are not required to be considered except in the case of hi/lo pressure interface components. Refer to Appendix C for additional information on hi/lo pressure interface components.

C183. *No comments on this change.*

Section 3.5.2.3, continued:

[**Note**: This configuration also bounds the condition of a hot short of the proper polarity coupled with ground fault equivalent hot shorts in the same raceways on an ungrounded DC Circuit.]

C184. *Clarification* - Do not limit this to the same raceway.

Section 3.5.2.3, continued:

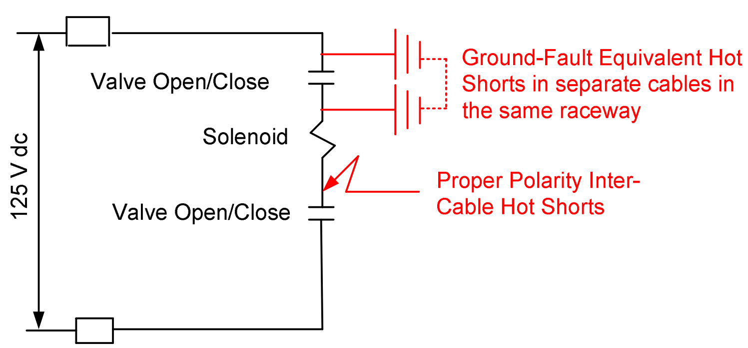


Figure 3.5.2-7 - Inter-Cable with Ground Plane [Same Raceway]

Field Code Changed

An inter-cable hot short of the proper polarity coupled with ground fault equivalent hot shorts in the same raceway on an ungrounded DC Circuit as shown above needs to be considered only for the case of hi/lo pressure interface components. Refer to Appendix C for additional information on hi/lo pressure interface components.

C185. *Clarification* - The probability of a ground-fault equivalent hot short is high enough that this combination should be considered for all components, not just Hi-Lo interface.

Section 3.5.2.3, continued:

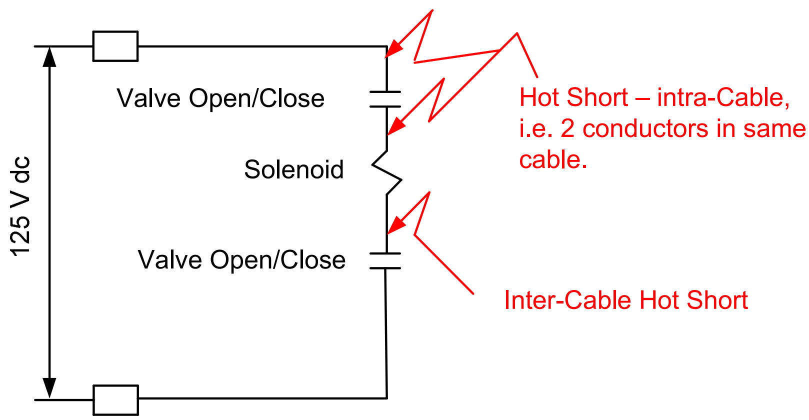


Figure 3.5.2-8 – Inter & Intra-Cable Hot Shorts

An inter-cable hot short of the proper polarity coupled with an intra-cable hot short in an ungrounded DC Circuit as shown above needs to be considered for all cases.

C186. *No comments on this change.*

Section 3.5.2.3, continued:

Field Code Changed

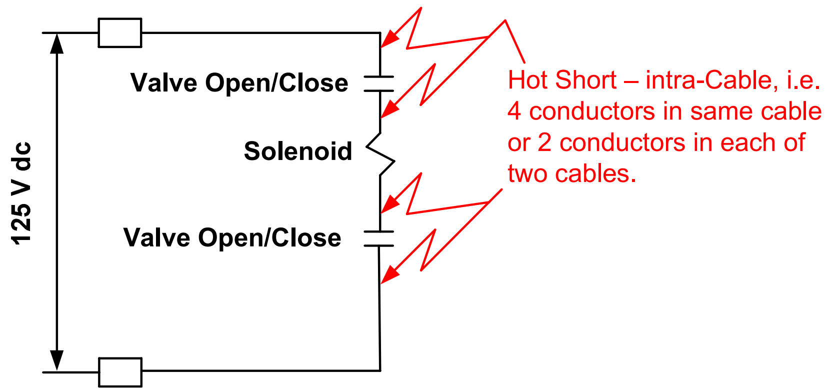


Figure 3.5.2-9 - Double Intra-Cable Hot Shorts

Field Code Changed

Two intra-cable hot shorts of the proper polarity on an ungrounded DC Circuit as shown above are to be considered for all components.

C187. *Recommendation* – Use "cases" vs." components" for consistency.

3.5.2.4 Circuit Failures affecting Power Cables

The following criteria apply to circuit failures involving power cables.

Power Cables for AC Motors:

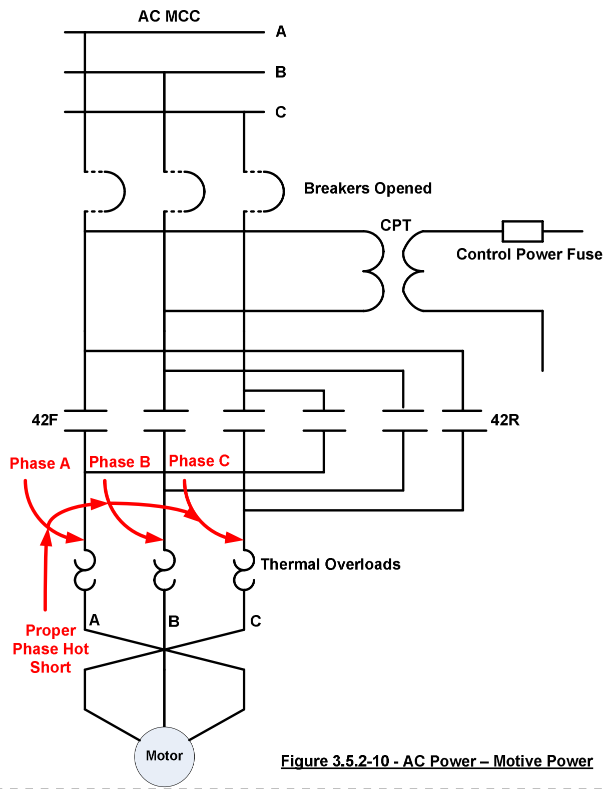


Figure 3.5.2-10 - AC Power – Motive Power

Field Code Changed

Three phase hot shorts on the AC Power - motive power cables should ~~are required to~~ be considered for the case of hi/lo pressure interface components only.

C188. *Clarification* - RG 1.189 states, "For three-phase ac circuits, the probability of getting a hot short on all three phases in the proper sequence to cause spurious actuation of a motor is considered sufficiently low that an evaluation is **not required**, **except for** cases involving high- and low-pressure interfaces."

Section 3.5.2.4, continued:

Refer to Appendix C for additional information on hi/lo pressure interface components. In general, for two series valves opening of the feeder breaker to the motor for each valve has been viewed by the NRC as an acceptable mitigating action, since this prevents circuit failures in the control circuit from causing a spurious operation.

C189. *Clarification* - Normally cables (outside MCR/CSR) for 1 of 2 valves are not in the same fire area and are free of fire damage.

C190. The term **in general** is used throughout this document with no definition.

Section 3.5.2.4, continued:

Power Cables for Ungrounded DC Motors:

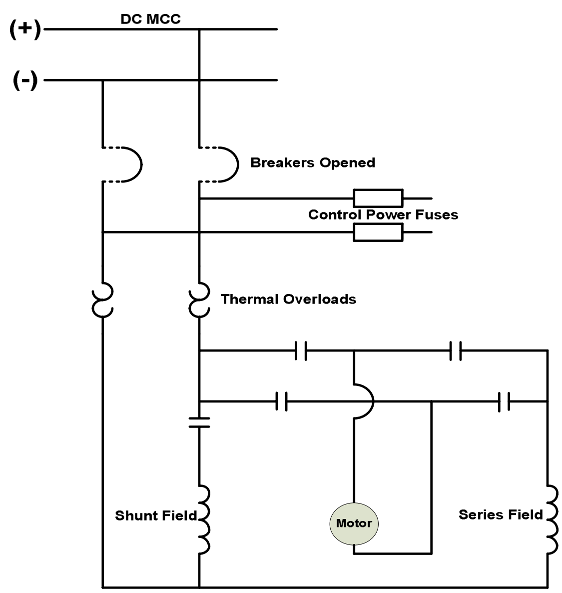


Figure 3.5.2-11 - DC Motor – Motive power

Field Code Changed

Two hot shorts of the proper polarity for ungrounded DC Power - motive power cables shouldareshouldare required to be considered for the case of hi/lo pressure interface components only. Refer to Appendix C for additional information on hi/lo pressure interface components.

C192. *Clarification* - RG 1.189 states, "For ungrounded dc circuits, if the licensee can show that at least two hot shorts of the proper polarity without grounding are required to cause spurious actuation, no further evaluation is necessary, except for any cases involving high- and low-pressure interfaces."

Same as 3 Phase comment on previous page remove required and add should be.

Section 3.5.2.4, continued:

In general, for two series valves, opening ~~of~~ the feeder breaker to the motor for each valve has been viewed by the NRC as an acceptable mitigating action, since this prevents circuit failures in the control circuit from causing a spurious operation. A number of different approaches have been accepted by the NRC for addressing hi/lo pressure interface components. Each licensee should check their licensing basis for the approach accepted for their facility.

C193. *Clarification* - Normally cables (outside MCR/CSR) for 1 of 2 valves are not in the same fire area and are free of fire damage.

C194. The term **in general** is used throughout this document with no definition

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APPENDIX G - GENERIC LIST OF MSOs

XXXXX

"….MSOs listed in this appendix that apply to III.G.3 areas only, with the exception listed below, need not be included in the analysis of impacts to the III.G.3,"

C275. *Recommendation* – Use "…fire areas meeting the requirements of Appendix R Section III.G.3" instead of "…the III.G.3".

Appendix G, continued:

"The licensing basis for NRC approved III.G.3 areas is as outlined in Appendix D or in a licensee's current licensing basis. The MSOs with applicability to III.G.3 areas for these licensees are intended, at most, for use in a voluntary effort performed by a licensee to assess fire risk in III.G.3 areas."

C276. *Clarification* - This statement is not correct. MSO combinations that occur after transfer to the ASD equipment must be considered, evaluated and mitigated.

TABLE G-1 – BWR Generic MSO List

**MPL – B21 (2a) - (Main Steam) Head vent valves (2) Spuriously Open.*

C277. *Clarification* - The last columns should be "Yes" since failure to isolate the main steam lines can cause failure to meet the inventory control function.

Table G-1, continued:

**MPL – B21 (2b) - (Main Steam) MSIV's hot short results in MSIVs failing to close or re-opening.*

C278. *Clarification* - The last columns should be "Yes" since failure to isolate the main steam lines can cause failure to meet the inventory control function.

Table G-1, continued:

**MPL – B21 (2c) - (Main Steam), Main Steam Line Drain Shutoffs spuriously open. Flow diversions may exist at Leakage Control System Valves MSLC-V-3A and -2A, MSIV V 3B and -2B, MSLC-V-3C and MSLC-V-2C, and MSLC-V-3D and MSLC-V-2D if inboard MSIVs MS-V-22A, MS-V 22B, MS-V 22C and MS-V-22D are open.*

C279. *Clarification* - The last columns should be "Yes" since failure to isolate the main steam lines can cause failure to meet the inventory control function.

Table G-1, continued:

**MPL – E12 (2f) – "*RHR-V-8, RHR-V-9 (F008, F009) or similar. Removal of DC Control Power Fuses may resolve (may not resolve 3-phase proper rotation hot shorts). This is the traditional Hi/Lo pressure interface."

C280. *Clarification* - Since this is the classical Hi/Lo interface, proper polarity hot shorts must be considered. If RCS boundary is included in injection train boundary, these valves would be required.

Table G-1, continued:

**MPL – E12 (2g)- Inventory control valve spurious operation - (Residual Heat Removal) Discharge to Recirc Loop Isolation Valves*

C281. *Clarification* – The last column should be “Yes” if SRV/LPCI is credited to meet hot shutdown. This is a required RCS boundary.

Table G-1, continued:

**MPL – E12 (2i.2)- Spurious Operations that creates RHR Pump Flow Diversion from LPCI.*

C282. *Clarification* – The last column should be “Yes” if SRV/LPCI is credited for hot shutdown.

Table G-1, continued:

**MPL – G31 (2ad) - RPV bottom drain isolations to reactor building equipment drain tank spuriously opening*

C283. *Clarification* – The last column should be “Yes” if RCS boundary is included in injection train – required for inventory control.

Table G-1, continued:

**MPL – G33 (2ae) - Spurious operation of RX Water Clean Up valves (RWCU drain to condenser and/or radwaste collection tanks, drain via the filter/demin. flush lines).*

C284. *Clarification* – The last column should be “Yes” if RCS boundary is included in injection train – required for inventory control.

Table G-1, continued:

**MPL – B21 (3c) - Spurious ADS: Safety Relief Valve-Failure of ADS Initiation Logic, opening SRVs simultaneously due to energization of relays*

C285. Add new scenario – excessive cooldown as a result of uncontrolled Isolation Condenser operation.

Table G-1, continued:

**MPL – E12 (4b) –* "May not fail pool cooling function, since heat is removed from the pool either way. Small amount of water may be held up on drywell floor, slightly lowering pool level. However, may need to look at suppression pool volume and NPSH due to slightly lower suppression pool level."

C286. *Clarification* – Possible challenge to containment integrity/pressure suppression design due to rapid evaporative cooling in hot dry drywell that could exceed ability of containment vacuum breakers to prevent damage.

Table G-1, continued:

**MPL – E15 (4e) – "Dedicated Shut Down Cooling System - "Spurious closure of Pump discharge to drywell valves (IV-80-15, 16, 35 and 36)"*

C287. *Clarification* – This scenario is characterized wrong – these valves must be closed to perform torus cooling. The adverse scenario is if they open while cooling the torus – resulting in unwanted drywell sprays – challenge containment integrity.

Table G-1, continued:

**MPL – E15 (4i) – "Dedicated Containment Spray System - Spurious opening of normally closed Containment spray venting valves (MOVs IV-80-114 and 115)*

C288. *Clarification* – These valves control flow to the Radwaste System. They are not system vents.

Table G-1, continued:

**MPL – E15 (4i) – "…*May not fail spray function, since heat is removed from the pool either way.

C289. *Clarification* – Not true – if there is an open flow path, these valves would divert cooled torus water to the Radwaste system where it would be unavailable for inventory in the torus.

Table G-1, continued:

**MPL – E52 (4n) – "*Small diversion of steam, and may not result in any RPV inventory loss, if returned to main steam system inside containment.

C290. *Clarification* – No, Isolation Condenser vents and drains connect to main steam outside primary containment.

Table G-1, continued:

**MPL – E52 (4o) –* "Small diversion of steam, and may not result in any RPV inventory loss, if returned to main steam system inside containment.

C291. *Clarification* – No, Isolation Condenser vents and drains connect to main steam outside primary containment.

Table G-1, continued:

**MPL – T23 (4r) – Spurious initiation of containment sprays.*

C292. *Clarification* – Page G-2 states: "Changed scenario descriptions to indicate spurious containment sprays may be applicable to plants not crediting COP. Modified notes to clarify non-COP scenario." Needs further discussion.

Table G-1, continued:

**MPL – R43 (5i) –* " For III.G.3, this MSO is likely beyond the required design basis for control room fire."

C293. *Clarification* – Disagreed since many of the conditions that could cause this are not spurious actuations, but are the result of fire damage.

TABLE G-2 – PWR Generic MSO List

ID #6 – "IMPORTANT". Letdown is not part of the "required" SSD path. Consequence is RCS flow diversion.

C294. *Clarification* - If injection train boundary includes RCS boundary, these valves would be required unless Appendix H indicates that they can be open for 1 hour.

Table G-2, continued:

ID #7 - "IMPORTANT". Letdown is not part of the "required" SSD path. Consequence is RCS flow diversion.

C295. *Clarification* - If injection train boundary includes RCS boundary, these valves would be required unless Appendix H indicates that they can be open for 1 hour.

Table G-2, continued:

ID #8 - "IMPORTANT". Letdown is not part of the "required" SSD path. Consequence is RCS flow diversion.

C296. *Clarification* - If injection train boundary includes RCS boundary, these valves would be required unless Appendix H indicates that they can be open for 1 hour.

Table G-2, continued:

ID #10 - Plant-specific classification required and depends if RWST is included in the credited flow path. "REQUIRED" if VCT flowpath is credited for post-fire SSD analysis ***OR*** "IMPORTANT" if RWST flowpath is credited for post-fire SSD analysis.

C297. *Recommendation* - Revise this to say that for the required train, the path is required – VCT is required until the RWST valve is open; once RWST valve is open, VCT valve is important.

Table G-2, continued:

ID #11 - Plant-specific classification required and depends if RWST is included in the credited flow path. "REQUIRED" if RWST flowpath is credited for post-fire SSD analysis ***OR*** "IMPORTANT" if VCT flowpath is credited for post-fire SSD analysis.

C298. *Recommendation* - Revise this to say that for the required train, the path is required – VCT is required until the RWST valve is open; once RWST valve is open, VCT valve is important.

Table G-2, continued:

ID #12 - "IMPORTANT" if VCT flowpath is not credited for post-fire SSD analysis. Note: Damage scenarios that involve non-credited equipment (i.e. non-credited pumps, inadvertent ESFAS signals are also IMPORTANT.

C299. *Clarification* - For credited train, this would be required to protect the required pump.

Table G-2, continued:

ID #13 - "IMPORTANT". Letdown and CCW cooling of letdown are not part of the "required" SSD path.

C300. *Clarification* - Required since this scenario can damage credited train.

Table G-2, continued:

ID #14 - "IMPORTANT". Based on the fact that associated circuit failures (e.g., spurious PORV opening) would have to be affected for the pump to reach runout conditions.

C301. *Clarification* - The PORV will cause the depressurization, but the credited pump is damaged.

Table G-2, continued:

ID #16 - Note that the spurious pump starting can occur for several reasons, including fire damage to control circuitry or inadvertent ESFAS signal.

C302. *Clarification* - Plants must evaluate the consequences of inadvertent containment sprays. Some containments do not have vacuum breakers and may be damaged (failed) by negative pressure.

Table G-2, continued:

ID #17 - "IMPORTANT". Isolation of the RHR pump suction valves from the RCS is not part of the "required" SSD path. Consequence is RCS flow diversion.

C303. *Clarification* - If RCS boundary is included in boundary of injection train, these would be required.

Table G-2, continued:

ID #17 – "From a PFSS analysis perspective, this is classified as a high/low pressure interface and maintaining the valves de-energized generally complies with fire protection regulatory requirements."

C304. *Clarification* – Does high/low circuit analysis repower the valves in the same fire area/zone?

Table G-2, continued:

ID #18 – "IMPORTANT". Isolation of the pressurizer PORV(s) is not part of the "required" SSD path. Consequence is RCS flow diversion.

C305. *Clarification* – This, and all related "IMPORTANT" flow diversion classifications, fail to take into account if flow diversion affects SSD if unmitigated for an hour. This is part of RG 1.189.

Table G-2, continued:

ID #18 - "IMPORTANT". Isolation of the pressurizer PORV(s) is not part of the "required" SSD path. Consequence is RCS flow diversion.

C306. *Clarification* - If RCS boundary is included in boundary of injection train, these would be required.

Table G-2, continued:

ID #22 - "IMPORTANT" Primary sample system is not part of the "required" SSD path. Consequence is RCS flow diversion."

C307. *Clarification* - If RCS boundary is included in boundary of injection train, these would be required.

Table G-2, continued:

ID #47 – "Simultaneous loading for credited equipment is a "REQUIRED" scenario unless plant specific analysis shows failure of credited diesel will not result. Non-credited loads are "IMPORTANT"

C308. *Clarification* - The circuit breakers for non-credited loads are required in order to fulfill their function for common power supply associated circuits. Cables downstream of the breaker are important

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Table G-2, continued:

ID #50 – "REQUIRED" if the pump is "required" and the spurious operation occurs on a "required" flowpath

C309. *Clarification* – If the valve closure can damage the credited pump, it is required.

Table G-2, continued:

ID #56a – "IMPORTANT" See Scenario 56.

C310. *Clarification* – Important so long as none of these pumps are credited pump.

Table G-2, continued:

ID #56d – Scenario causes a pumped RWST drain down via the containment spray pumps and containment spray ring.

C311. *Clarification* – Inadvertent sprays must be evaluated. Many PWR containments do not have vacuum breakers and will fail when exposed to negative pressure.

Table G-2, continued:

ID #56e - "IMPORTANT" See Scenario 56.

C312. *Clarification* – If RCS boundary is included in boundary of injection train, these would be required.

Table G-2, continued:

ID #56f – "IMPORTANT" See Scenario 56.

C313. *Clarification* – Required if this scenario causes the loss of the credited makeup pump.

------ END -----

Public Meeting
NEI 00-01 Revision 3
&
MSO Licensing Basis

NEI Circuit Failures ITF

May 3, 2012

Agenda

- **NEI 00-01 Revision 3 Review**
  - General Review of NRC Comments
    - Section 3 & Appendix G
- **Licensing Basis for MSO**
  - Problem Statement
- **Specific Review of NRC Comments on NEI 00-01 Revision 3, Section 3 and Appendix G.**
  - Discussion of Generic Papers

NRC Comments on Revision 3

- **General Discussion Points**
  - Section 3
    - Component Classification
    - Circuit Failure Criteria – (Use of PIRT Data)
  - Appendix G – General
    - III.G.3 (Licensing Basis Question)
  - Appendix G – BWR List
    - Component Classification (7/17 = 42%)
  - Appendix G – PWR List
    - Component Classification (17/20 = 85%)

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NRC Comments on Revision 3

- The majority of the NRC Comments are related to component classification, circuit failure analysis & the use of III.G.3.
- Agreement on these three issues is critical to the Licensee Efforts to Resolve MSOs.
  - The Resolution of MSO's is tied to the end of enforcement discretion under EGM 09-002, i.e. November 2, 2012.
  - The Resolution of MSO's is also tied to the question of future licensing basis changes.
  - Each of these issues is tied to regulatory stability in the area of Fire Protection, specifically post-fire safe shutdown circuit analysis.

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Component Classification

- Component Classification in NEI 00-01 Revision 2 & 3 is based on NRC Guidance, including Regulatory Guide 1.189 Revision 2.
  - Review of NRC Guidance
  - Review of NEI 00-01 Guidance

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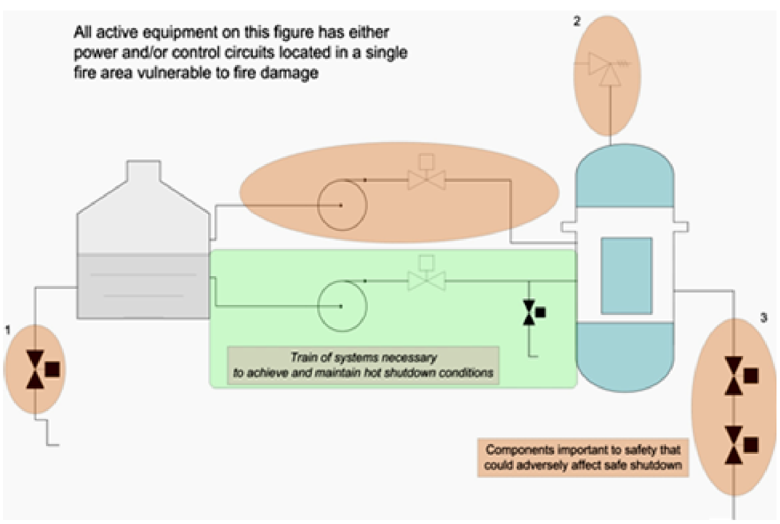

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From Regulatory Guide 1.189 Revision 2:

Examples of Safe-Shutdown Success Path SSCs
- **Reactivity control** SSCs that are required to achieve and maintain cold-shutdown reactivity conditions
- **Reactor coolant makeup** SSCs that are required to maintain the reactor coolant level above the top of the core for BWRs and within the level indication in the pressurizer for PWRs
- **Reactor heat removal** SSCs that are required to achieve and maintain decay heat removal
- **Process monitoring** SSCs that are required to provide direct readings of the process variables necessary to achieve and maintain safe shutdown
- **Supporting** SSCs that are required to provide the process cooling, lubrication, etc., necessary to permit the operation of the equipment used to achieve and maintain safe shutdown
- **Significant diversion paths** from flow path that would lead to core damage or cause reactor coolant loss if diverted for 1 hour or less
- **Power supplies** for safe-shutdown success path components

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From Regulatory Guide 1.189 Revision 2:

Examples of SSCs Important to Safe Shutdown
- Success path **supply tank** spurious drain or bypass
- Decay heat removal system valves, when not part of safe-shutdown success path
- **HVAC systems** and components required to provide cooling to success path components to the extent that cooling is required for post-fire safe shutdown
- **Power-operated relief valves and safety relief valves** not part of safe-shutdown success path
- Spurious start of equipment not relied on for a safe-shutdown success path, which could cause overfill conditions
- **Small diversion paths** from success path flow path—smaller than the significant diversion paths described above
- Multiple separate small diversion paths that, when combined, would lead to core damage, rupture of the primary coolant boundary, or rupture of primary containment
- A connection to circuits of equipment where spurious operation would adversely affect the SSC's important to safe shutdown (e.g., residual heat removal/reactor coolant system isolation valves)

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NEI 00-01 Classification

- **Required for Hot Shutdown**
  - – Determine Systems used for each of the Post-Fire Safe Shutdown Functions; reactivity control, pressure control, inventory control, process monitoring, support systems
    - Flow Diversions from any of the selected system flow paths
    - Power supplies to the required equipment.
  - – Determine by reviewing P&IDs for selected systems in the absence of fire damage, except for flow diversions.

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NEI 00-01 Classification

- **Important to Safe Shutdown**
  - – Other selected components with the potential to impact post-fire safe shutdown, i.e., Spurious Operation Components

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NEI 00-01 Classification

- **Changes to Revision 3 are intended to:**
  - Provide clarity that classification of "**Required**" is not a function of the significance of the consequences
  - Assure consistency throughout the industry
  - Clarify that classification is used to distinguish the set of components for which the use of fire modeling and/or operator manual actions is available
    - The resolution approach regardless of classification needs to be technically appropriate

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Circuit Failure Criteria

- Changes to NEI 00-01 Revision 3 were required to address the criteria for circuits not adequately covered in Revision 2.
  - Exceptions taken by NRC in Regulatory Guide 1.189 Revision 2 to NEI 00-01 Revision 2.
  - Double Break Solenoid design not addressed in NEI 00-01 Revision 2.

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Circuit Failure Criteria

- Changes to NEI 00-01 Revision 3 are intended to be consistent with the current regulatory guidance and its implementation.
  - i.e., ground fault equivalent hot shorts are only addressed for their similarity to inter-cable hot shorts for cables within the same raceway.
- Changes did not incorporate any of the preliminary information from the Electrical PIRT Panel.
- Once the Electrical PIRT Panel Report is published, changes addressed by the NRC following the normal regulatory process will be addressed in a future revision to NEI 00-01.

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III.G.3

- NRC has approved each Licensee's III.G.3 Compliance Approach
  - 10CFR50.48 Paragraph (c)(5)
  - Generic Letter 81-12
- NRC Regulatory Guide 1.189 Revision 2
  - Section 5.4.1 defers to the Plant's Approved Fire Protection Program.
  - Section 5.4.1 also endorses Appendix D & G to NEI 00-01 Revision 2.

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III.G.3

- Appendix D to NEI 00-01 Revision 2 states regarding the criteria in NRC Generic letter 86-10 question 5.3.10:
  - "The response to question 5.3.10 provides a bounding plant transient which describes the expected worse case conditions for such an event."
  - Questions 5.3.10 requires:
    - "*The safe shutdown capability should not be adversely affected by any **one** spurious actuation or signal resulting from a fire in any plant area.*"

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III.G.3

- Appendix G states [Continued]:
  - "The licensing basis for NRC approved III.G.3 areas is as outlined in Appendix D or in a licensee's current licensing basis. The MSOs with applicability to III.G.3 areas for these licensees are intended, at most, for use in a voluntary effort performed by a licensee to assess fire risk in III.G.3 areas."

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III.G.3

- Appendix G states [Continued]:
  - "Since this type of a review is a voluntary review, any Licensee's electing to assess risk in these previously approved III.G.3 areas may use any of the available tools to disposition the MSO, including Focused-scope Fire PRA or qualitative assessments of risk without prior NRC approval."

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Licensing Basis for MSOs

Problem Statement:

There is not a clear Regulatory footprint for the process applied to the resolution of MSOs.

- **Industry Concerns:**
  - Clarity of the CLB related to whether or not MSOs are included
  - Establishing a stable resolution process is seen as a necessary precursor to establishing a regulatory foot print

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NRC Comment on NEI 00-01

- **Specific NRC Comments on NEI 00-01 Revision 3; Section 3 and Appendix G**
  - Discussion of specific comments
    - Section 3
    - Appendix G – III.G.3
    - Appendix G-1 – BWR MSO List
    - Appendix G-2 – PWR MSO List
  - Discussion of Generic papers
    - GE NEDO 33638
    - Shorting Switches

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Shorting Switch

Current status

- Exelon technical evaluation and guidance doc approved and issued for use in Dec 2011.
- Stand-alone topical report. Not currently included in NEI 00-01.
- Provides technical limitations and considerations that must be addressed. Not a cookie-cutter design.
- Doc provided to NRR/RES in Jan 2012.
- Site-specific confirmation that the guidance is met - to be completed by Nov 2012.

2

Known Precedents

- Nine-Mile 1 (NRC SER 03/03/1983)
  - ADS System
  - Rx Head Vents
- TMI 1
  - RCS head vents and high-point vents
  - Sump recirc valves - RWST draindown
- Oyster Creek
  - Rx Head Vents
- Monticello

3

Boundary Conditions for Shorting Switch Application

- Post-Modification Testing and Periodic Testing
  - **PMT:** Inject voltage and show no spurious actuation
  - **Periodic:** Address aspects not covered by existing test program
- Licensing Aspects
  - Orange-Box scenarios – no restrictions on use
  - III.G.3 scenarios – performance-based approach permitted (ex., realistic cabinet fires).
  - For other scenarios, careful understanding of CLB needed to determine if prior NRC review required

4

Boundary Conditions for Shorting Switch Application

- Justification that target coil will not pick up
  - Minimum pickup voltage of target coil becomes a critical design attribute
  - Characterization of potential aggressor sources needed
  - Computation of voltage on target coil
- Justification that open circuits will not occur
  - Fire testing and real events provide this data
- Equipment capable of withstanding scenario
  - Momentary fault/clearing current thru devices
  - Switch will withstand credible fire exposure (if credited for MCR fires). Exelon sponsored testing of several switch models.

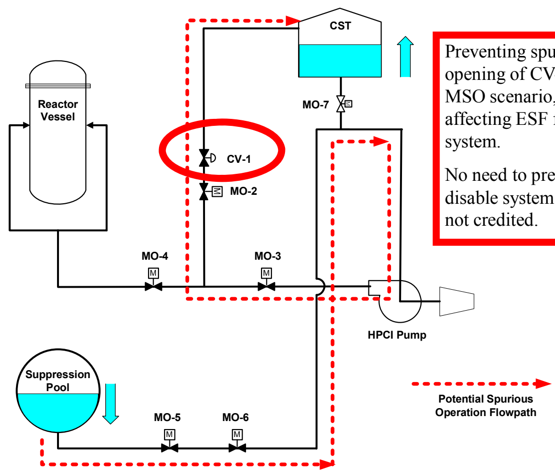
5

Key technical support for shorting switch

- Cable fire tests. AC control wire does not melt open. DC control wire may melt (or not), depending on fuse sizes and faults.
  - Discussed in NEI 00-01 and endorsed in RG 1.189
  - Test results agree with industry fire event experience
- Switch, terminal block, relay contacts, etc. must maintain continuity to keep short in place.
  - Switch fire testing completed by Exelon in 2011. Bounds NUREG/CR-4527 testing for comparable cabinets and contents.
  - Relay and terminal blocks already fire tested by SANDIA NUREG/CR-4527 and historical Exelon testing.
  - Panel testing based on “credible fires”. Each application must confirm that plant aligns with testing literature.
  - Short circuit ratings provided by mfg. Higher ratings have been justified by testing for some equipment.

6

Example Application



Preventing spurious opening of CV-1 prevents MSO scenario, without affecting ESF functions of system.

No need to preemptively disable system when it is not credited.