

## SHUTDOWN OPERATIONS SIGNIFICANCE DETERMINATION PROCESS PHASE 1 INITIAL SCREENING AND CHARACTERIZATION OF FINDINGS

### 1.0 APPLICABILITY

This attachment and its exhibits are designed to provide U.S. Nuclear Regulatory Commission (NRC) inspectors and management with a framework for use in the initial screening and characterization of potentially risk-significant Shutdown (SD) issues within the Initiating Events, Mitigation Systems, and Barrier Integrity cornerstones for the Significance Determination Process (SDP). In addition, this process identifies findings of very low risk significance that do not warrant further NRC engagement. This appendix is intended to be used when the plant is shutdown with at least one fuel bundle in the reactor and temperature and pressure are within the normal Residual Heat Removal (RHR)/Decay Heat Removal (DHR) conditions, otherwise return to IMC 0609, Attachment 4, "Initial Characterization of Findings."

### 2.0 ENTRY CONDITIONS

Before entering an issue into the SDP, the inspector will screen the issue to determine its documentation threshold as described in IMC 0612, Appendix B, "Issue Screening. If an inspector screens a finding in accordance with Appendix B and is directed by Appendix B to determine its risk significance, and if that finding involves shutdown operations with fuel in the reactor, then the inspector will initially screen that finding using the SD Phase 1 screening questions found in Exhibits 2-5.

### 3.0 PHASE 1 SDP OVERVIEW

Appendix G of the SDP is a tool which uses a quantitative risk method to characterize the risk of events or conditions during SD. All issues, including those at SD, that screen more than minor in Appendix B of IMC 0612 are then characterized using IMC 0609, Attachment 4. If the finding impacts the Initiating Events, Mitigation Systems, or Barrier Integrity Cornerstone, then Table 3 in IMC 0609, Attachment 4 will refer the inspector to the appropriate SDP Appendix. In the case of a SD finding, it will refer them to this appendix. The inspector would utilize the information from their initial characterization of the finding in IMC 0609, Attachment 4, Tables 1 & 2, but would transfer to this Appendix in Step A of Table 3 when directed by IMC 0609, Attachment 4. The purpose of the screening questions in Exhibits 2-5 is to determine if the issue can be characterized as Green before entering into a more detailed analysis with IMC 0609, Appendix G Phase 2 or 3.

Phase 1 is intended to be accomplished by the inspection staff, with the assistance of a Senior Reactor Analyst (SRA), if needed. Inspectors should collect information needed for determining the significance of the finding, such as the structure, system, or component affected, the nature of the degradation, and the duration of the degraded condition. Inspectors should obtain licensee risk perspectives as early in the SDP process as a licensee is prepared to offer them, and use the SDP framework to the extent possible to evaluate the adequacy of the licensee's input and assumptions.

END

Exhibit 1 – User Guidance for Appendix G Phase 1: Initial Screening and Characterization of Findings

Exhibit 2 – Initiating Events Screening Questions

Exhibit 3 – Mitigating Systems Screening Questions

Exhibit 4 – Barrier Integrity Screening Questions

Exhibit 5 – External Events Screening Questions

## Exhibit 1 - User Guidance for Appendix G Phase 1: Initial Screening and Characterization of Findings

Step 1: Perform an initial screening of the inspection finding.

**CAUTION:** Most shutdown finding risk results are driven by the operator failure probabilities. When evaluating shutdown findings it is important to be aware of any conditions or events that may impact operator response.

- 1.1 It is important to note that current fleet Pressurized Water Reactor (PWR) designs do not have automatic safety actuation systems during shutdown. Also, in the current Boiling Water Reactor (BWR) designs there is no requirement to have the automatic low level injection initiation functional in cold shutdown and refueling. Therefore, the risk significance of many findings will rely on operator's ability to diagnose the problem and perform appropriate actions. Successful operator actions are dependent on plant procedures, available time, complexity of the mitigation response, training, ability to diagnose the problem, etc. Therefore, when evaluating the initial screening of a shutdown finding it is important to be aware of any conditions or events that may impact the operators' ability to diagnose and respond to a shutdown initiator. If you have any questions or are uncertain about an issue you are evaluating contact your Regional SRA.
- 1.2 Table G1 provides an overview of key safety functions and systems important to safety during shutdown, the inspector should use this table while completing the appropriate Exhibit 2-5. This table attempts to collect all potential influences on both the human actions and equipment that can affect the risk at shutdown. Inspectors should use the information in Table G1 to determine which, if any, categories of Exhibits 2-5 that are influenced by specific findings.
- 1.3 If the finding affects the safety of a reactor at shutdown, **THEN IDENTIFY** the affected cornerstone(s):
  - Initiating Event
  - Mitigation Systems
  - Reactor Coolant System (RCS) Barrier
  - Fuel Barrier
  - Containment Barriers

**NOTE:** When assessing the significance of a finding affecting multiple cornerstones, the finding should be assigned to the cornerstone that best reflects the dominant risk of the finding.

**CONTINUE** to the appropriate Exhibit 2-5 to answer the screening questions.

- 1.4 Use the decision logic in the exhibits when answering the screening questions to determine if the issue can be characterized as Green. Note that the examples

provided in the exhibits are not all inclusive. If you have any questions or are uncertain about an issue you are evaluating contact your Regional SRA.

Step 2: If the finding screens as Green, then document in accordance with IMC 0612.

Step 3: If the finding screens as other than Green, perform an Appendix G Phase 2 or Phase 3 analysis as directed by the screening questions in Exhibits 2-5

<b>Table G1 Generic SD Key Safety Functions and System Dependencies<sup>1</sup></b>			
<b>Safety Function</b>	<b>Major Systems</b>	<b>Supporting Systems</b>	<b>Initiating Event Scenarios</b>
Decay Heat Removal	<ul style="list-style-type: none"> <li>• Residual Heat Removal</li> <li>• Decay Heat Removal</li> <li>• Shutdown Cooling</li> <li>• Steam Generators (PWR)</li> <li>• Feed and Bleed (Low Pressure Injection, High Pressure Injection, Charging System (PWR)</li> <li>• Control Rod Drive System (BWR)</li> <li>• Core Spray(BWR)</li> </ul>	<ul style="list-style-type: none"> <li>• AC Power</li> <li>• DC Power</li> <li>• RHR/DHR Heat Exchanger</li> <li>• Component Cooling Water (PWR)</li> <li>• Power Operated Relief Valves (PWR)</li> <li>• Instrumentation (i.e., RCS Level, RHR/DHR Heat Exchanger inlet/outlet Temperature and RHR/DHR Flow Indication, Core Exit Thermocouples (PWRs with reactor head installed only)</li> <li>• Residual Heat Removal Service Water (BWR)</li> <li>• Safety Relief Valves (BWR)</li> <li>• Training</li> <li>• Procedures</li> <li>• Time to Boil and Time to Core Uncovery</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of RHR (LORHR)</li> <li>• Loss of SDC (LOSDC)</li> <li>• Loss of Off-site Power (LOOP)</li> <li>• Loss of Inventory (LOI)</li> <li>• Overdrain (OD) (PWR)</li> <li>• Loss of Level Control<sup>2</sup> (LOLC) (PWR)</li> <li>• Loss of Component Cooling Water (CCW) (PWR)</li> <li>• Loss of Residual Heat Removal Service Water (RHRSW) (BWR)</li> </ul>

<sup>1</sup> This table is not intended to be all-inclusive. It is intended to give the inspector an overview of important systems and key safety functions to consider when characterizing the SD finding.

**Table G1 Generic SD Key Safety Functions and System Dependencies<sup>1</sup>**

Safety Function	Major Systems	Supporting Systems	Initiating Event Scenarios
Inventory Control	<ul style="list-style-type: none"> <li>• Low Pressure Injection</li> <li>• High Pressure Injection</li> <li>• Charging System (PWR)</li> <li>• Control Rod Drive System (BWR)</li> <li>• Core Spray (BWR)</li> </ul>	<ul style="list-style-type: none"> <li>• Drain Down Isolation Valve(s)</li> <li>• AC Power</li> <li>• DC Power</li> <li>• RHR/DHR Heat Exchanger</li> <li>• RHR/DHR Relief Valves</li> <li>• Power Operated Relief Valves (PWR)</li> <li>• Instrumentation (i.e., RCS Level, RHR/DHR Heat Exchanger inlet/outlet Temperature and RHR/DHR Flow Indication, Core Exit Thermocouples (PWRs with reactor head installed only))</li> <li>• Safety Relief Valves (BWR)</li> <li>• Training</li> <li>• Procedures</li> <li>• Time to Boil and Time to Core Uncovery</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of Inventory (LOI)</li> <li>• Overdrain (OD) (PWR)</li> <li>• Loss of Level Control<sup>2</sup> (LOLC) (PWR)</li> </ul>
Electric Power Availability	<ul style="list-style-type: none"> <li>• Emergency Diesel Generators</li> <li>• Offsite Power Feeds</li> <li>• Offsite Transformers</li> <li>• Offsite Inverters</li> </ul>	<ul style="list-style-type: none"> <li>• AC and DC Busses</li> <li>• Batteries and Battery Charges</li> <li>• Motor Generators</li> <li>• Inverters</li> <li>• Training</li> <li>• Procedures</li> <li>• Time to Boil and Time to Core Uncovery</li> </ul>	<ul style="list-style-type: none"> <li>• All Initiators</li> </ul>

<sup>2</sup> Loss of level control requires a Phase 2 or Phase 3 if

**Loss of Level for PWRs:** inadvertent loss of 2 feet of RCS inventory when not in mid-loop OR inadvertent entry into reduced inventory OR mid-loop conditions OR

inadvertent loss of 2 inches of RCS inventory when in mid-loop conditions.

**Loss of Level for BWRs:** inadvertent loss of 2 feet of RCS inventory OR inadvertent RCS pressurization.

**Table G1 Generic SD Key Safety Functions and System Dependencies<sup>1</sup>**

<b>Safety Function</b>	<b>Major Systems</b>	<b>Supporting Systems</b>	<b>Initiating Event Scenarios</b>
Reactivity Control	<ul style="list-style-type: none"> <li>• RPS</li> <li>• Control rod and associated drive mechanisms</li> <li>• Chemical and Volume Control System (PWR)</li> <li>• Standby Liquid Control (BWR)</li> </ul>	<ul style="list-style-type: none"> <li>• AC Power</li> <li>• DC Power</li> <li>• Nuclear Instrumentation</li> <li>• Training</li> <li>• Procedures</li> <li>• Time to Boil and Time to Core Uncovery</li> </ul>	<ul style="list-style-type: none"> <li>• Reactivity (inadvertent criticality)</li> </ul>
Containment	<ul style="list-style-type: none"> <li>• Hydrogen Control</li> <li>• Containment Closure Capability</li> <li>• Penetrations</li> </ul>	<ul style="list-style-type: none"> <li>• AC Power</li> <li>• DC Power</li> <li>• Motive Power to close Hatches (assuming loss of AC power)</li> <li>• Temporary closures/penetrations</li> <li>• Training</li> <li>• Procedures</li> <li>• Time to Boil and Time to Core Uncovery</li> </ul>	<ul style="list-style-type: none"> <li>• All Initiators</li> </ul>

## Exhibit 2 - Initiating Events Screening Questions

### A. SD Initiators

1. Does the finding increase the likelihood of a SD initiating event?

- If YES → Stop. Go to Appendix G Phase 2.**
- If NO, continue.

### B. Loss of Coolant Accident - Loss of Inventory (LOI) Initiators

2. Did a LOI event result in a leakage such that if the leakage were undetected and/or unmitigated in 24 hours or less it would cause the currently operating decay heat removal method to fail (e.g., level would drop to below the hotleg suction of the operating decay heat removal pump (PWR), or to the shutdown cooling isolation Level 3 setpoint (BWR))?

- If YES → Stop. Go to Appendix G Phase 2.**
- If NO, continue.

3. Is the LOI event self-limiting such that leakage will stop before impacting the operating method of decay heat removal?

- If YES, continue.
- If NO → Stop. Go to Appendix G Phase 2.**

### C. Transient Initiators

4. LOOP - Did the initiator occur when refuel canal/cavity was flooded?

- If YES, continue.
- If NO → Stop. Go to Appendix G Phase 2.**

5. LOOP - Did the initiator occur when the time to boil off RCS inventory to the top of active fuel (TAF) was shorter than the time to recover offsite power?

- If YES → Stop. Go to Appendix G Phase 2.**
- If NO, continue.

6. LORHR - Did the initiator occur when refuel canal/cavity was flooded?

- If YES, continue.
- If NO → Stop. Go to Appendix G Phase 2.**

7. Loss of Level Control (LOLC) or Over Drain (OD) - For PWRs, did the initiator occur when reactor level was in reduced inventory?

- If YES → Stop. Go to Appendix G Phase 2.**
- If NO, continue.

D. External Event Initiators

8. Does the finding increase the likelihood of a fire or internal/external flood that could cause an SD initiating event?

- If YES → Stop. Go to Phase 3.**
- If NO, screen as Green.



### Exhibit 3 – Mitigating Systems Screening Questions

#### A. Mitigating Structure System Component (SSC) and Functionality

1. If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?
  - If YES, screen as Green.**
  - If NO, continue.
2. Does the finding represent a loss of system safety function?
  - If YES → Stop. Go to Appendix G Phase 2.**
  - If NO, continue.
3. Does the finding represent an actual loss of safety function of at least a single Train for greater than its Tech Spec Allowed Outage Time, OR two separate safety systems out-of-service for greater than its Tech Spec Allowed Outage Time?
  - If YES → Stop. Go to Appendix G Phase 2.**
  - If NO, continue.
- 4.a) If the cavity is flooded, does the finding represent an actual loss of safety function of one or more non-Tech Spec Trains of equipment during SD designated as risk-significant (e.g. 10CFR50.65), for greater than 24 hrs?
  - If YES → Stop. Go to Appendix G Phase 2.**
  - If NO, continue.
- 4.b) If the cavity is not flooded, does the finding represent an actual loss of safety function of one or more non-Tech Spec Trains of equipment during SD designated as risk-significant (e.g. 10CFR50.65), for greater than 4 hrs?
  - If YES → Stop. Go to Appendix G Phase 2.**
  - If NO, continue.
- 5.a) For PWRs, does the finding degrade RCS level indication and/or core exit thermal couples (CETs) when the cavity is not flooded?
  - If YES → Stop. Go to Appendix G Phase 2.**
  - If NO, continue.

5.b) For BWRs, does the finding degrade a functional auto-isolation, regardless of whether it is required to be operable or not, of RHR on low reactor vessel level?

- If YES → Stop. Go to Appendix G Phase 2.**
- If NO, continue.

B. External Event Mitigation Systems (Seismic/Fire/Flood/Severe Weather Protection Degraded)

6. Does the finding screen as potentially risk significant due to a seismic, flooding, or severe weather initiating event, using the criteria in Exhibit 5?

- If YES → Stop. Go to Phase 3.**
- If NO, continue.

C. Fire Brigade

7. Does the finding involve Fire Brigade training and qualification requirements, or brigade staffing?

- If YES → check if one or more of the following apply:**
  - The fire brigade demonstrated the ability to meet the required times for fire extinguishment for the fire drill scenarios, and the finding did not significantly affect the ability of the fire brigades to respond to a fire.
  - The overall time duration (exposure time) that the Fire Brigade was understaffed was short (< 2 hours).
- If none of the above apply → Stop. Go to IMC 0609, Appendix M.**
- If at least one of the above is applicable, continue.**
- If NO, continue.

8. Does the finding involve the response time of the Fire Brigade to a fire?
- If YES → check if one or more of the following apply:**
    - The fire brigade's response time was mitigated by other defense-in-depth elements, such as area combustible loading limits were not exceeded, installed fire detection systems were functional, and alternate means of safe shutdown were not impacted.
    - The finding involved risk-significant fire areas that had automatic suppression systems.
    - The licensee had adequate fire protection compensatory actions in place.
  - If none of the above apply → Stop. Go to IMC 0609, Appendix M.**
  - If at least one of the above is applicable, continue.**
  - If NO, continue.
9. Does the finding involve fire extinguishers, fire hoses, or fire hose stations?
- If YES → check if one or more of the following apply:**
    - There was no degraded fire barrier and the fire scenario did not require the use of water to extinguish the fire.
    - The missing fire extinguisher or fire hose was missing for a short time and other extinguishers or hose stations were in the vicinity.
  - If none of the above apply → Stop. Go to IMC 0609, Appendix M.**
  - If at least one of the above is applicable, screen as Green.**
  - If NO, screen as Green.**

## Exhibit 4 – Barrier Integrity Screening Questions

### A. RCS or Fuel Barrier

Note: If the finding involves fuel bundle misplacement or misorientation in the reactor core, **screen as Green.**

1. Low Temperature Over Pressurization (LTOP) – For PWRs, does the finding involve an inadvertent Safety Injection Actuation, the unavailability of a PORV or LTOP relief valve or their associated setpoints during LTOP operations or when it is required?
  - If YES → Stop. Go to Phase 3.**
  - If NO, continue.
2. Freeze Seal – Does the finding increase the potential for failure of the freeze seal or if unmitigated have the potential to cause a disruption in RHR/DHR or a LOI event?
  - If YES → Stop. Go to Phase 3.**
  - If NO, continue.
3. Steam Generator (SG) Nozzles Dams – Does the finding involve improper SG nozzle dam installation (e.g. hot leg manway must be opened first, hotleg SG nozzle dam installed last), inadequate SG nozzle dam RCS vent path, deficiencies of the SG nozzle dams (Ref GL 88-17 and IN 88-36) or SG nozzle dam functionality?
  - If YES → Stop. Go to Phase 3.**
  - If NO, continue.
- 4.a) Criticality – For PWRs, does the finding involve the potential for, or an actual, RCS boron dilution event?
  - If YES → Stop. Go to IMC 0609, Appendix M.**
  - If NO, continue.
- 4.b) Criticality – For BWRs, does the finding involve 2 or more adjacent control rods with the potential to, or actually, add positive reactivity?
  - If YES → Stop. Go to IMC 0609, Appendix M.**
  - If NO, continue.

5. Drain Down Path or Leakage Path - Does the finding degrade the ability to isolate a drain down or leakage path?

**If YES → Stop. Go to Phase 3.**

If NO, continue.

B. Containment Barrier

6. Does the finding degrade the ability to close or isolate the containment (this includes but is not limited to equipment and personnel hatches and permanent and temporary penetrations)?

**If YES → Stop. Go to IMC 0609, Appendix H.**

If NO, continue.

7. Does the finding degrade the physical integrity of reactor containment (valves, penetrations, containment isolation components)?

**If YES → Stop. Go to IMC 0609, Appendix H.**

If NO, continue.

8. Does the finding involve an actual reduction in function of hydrogen control for BWR Mark III and PWR ice condenser containments?

**If YES → Stop. Go to IMC 0609, Appendix H.**

If NO, screen as Green.

## Exhibit 5 – External Events Screening Questions

1. If the equipment or safety function is assumed to be completely failed or unavailable, are ANY of the following three statements TRUE? The loss of this equipment or function by itself, during the external initiating event it was intended to mitigate:
  - would cause any of the Initiating Events used by Table G1 for the plant in question;
  - would degrade **two or more** trains of a multi-train safety system or function, or would degrade the only available train, which would defeat the entire safety function;
  - would degrade one or more trains of a system that supports a safety system or function.

**If YES** → the finding is potentially risk significant due to external initiating event core damage sequences return to screening questions in Exhibits 2-5.

If NO, continue.
2. Does the finding involve the total loss of any safety function, identified by the licensee through a Probabilistic Risk Assessment, Individual Plant Examination External Events, or similar analysis, that contributes to external event initiated core damage accident sequences (i.e., initiated by a seismic, flooding, or severe weather event)?

**If YES** → the finding is potentially risk significant due to external initiating event core damage sequences return to screening questions in Exhibits 2-5.

If NO, screen as Green.

Attachment 1  
Revision History Page

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description Training Required And Completion Date	Comment Feedback Resolution Accession Number
N/A	05/25/04 CN 04-015	Initial issuance	N/A	N/A
	ML13050A934 05/09/14 CN 14-011	IMC 0609 App G, Att. 1 is revised to enhance the usability of this appendix, based on feedback received from the SRA. The formatting was updated to be consistent with IMC 0609 Appendix A. The checklists from the previous revision, for PWRs and BWRs, were combined into one list in the various Exhibits in the attachment using screening questions and decision logic. The content was updated and reworked to be more user-friendly for inspectors to screen findings to determine if they are Green or a more detailed analysis is needed. Incorporated feedback from ROPFF 0609G1-1911 and 0609G-1323. This is a complete reissue no red line.	N/A	ML13162A640  0609G-1323 ML14120A177  0609G1-1911 ML1412A166