# ENHANCED PWR Appendix G, PHASE 1
# TO BE USED BY INSPECTORS AND SRAS

## Shutdown Operations Significance Determination Process

## 1.0 Entry Conditions

Appendix G is used to assess performance deficiencies identified during shutdown operations when more than one fuel assembly is in the reactor vessel. Appendix G covers shutdown operations- initiating when the licensee has met the entry conditions for RHR and RHR cooling has been initiated and ending when the licensee is heating up and RHR has been secured.

NOTE: if the licensee is in a refueling outage or forced outage and the plant is above RHR entry conditions, then the full power SDP tools should be used acknowledging: (1) decay heat is less compared to full power, potentially allowing for more time for operator recovery, (2) some mitigating systems may require manual operation versus automatic operation, and (3) some containment systems may not be required to be operable potentially increasing the likelihood of containment failure.

## 2.0 OBJECTIVE

This tool is used to ensure that a licensee's shutdown mitigation capability (equipment, instrumentation, policies, procedures, and training) is consistent with the staff's estimate of industry shutdown risk presented to the Commission in SECY 97-168 (the proposed Shutdown Rule).

This tool is also used to assess shutdown conditions that represent a loss of control. These losses of control include (1) losses of reactor coolant system (RCS) level and (2) losses of thermal margin. These conditions are considered precursors to events that could result in actual loss of the decay heat removal (DHR) function. The staff is monitoring losses of control because the staff's risk estimate of generic PWR and BWR shutdown performance indicates that, based on experience, losses of DHR are relatively infrequent.

When a licensee has a performance deficiency associated with their shutdown mitigation capability or has a loss of control, this tool is used to screen those findings for potential risk significance.

## 3.0 Precautions

3.1 The inspector must understand the definitions of the shutdown initiating events . These definitions can be found in Chapter 4.

3.2 The inspector must understand the plant operational states (POS) definitions used for this tool. These definitions can be found in Chapter 4.

3.2 The availability of standby RCS injection along with operator error drives shutdown risk. As long as standby injection is available, in most cases, standby injection buys time for other operator recovery actions such as: leak path termination and RHR recovery. If there are factors that could render the standby RCS injection unavailable such as: gas intrusion or support system unavailability, then these factors (assumptions) become risk significant and should be assessed carefully.

# 4.0 Abbreviations and Definitions

## 4.1 Abbreviations

| | |
|---|---|
| CETs | Core Exit Thermocouples |
| CD | Core Damage |
| CCW | Component Cooling Water |
| DHR | Decay Heat Removal |
| ECCS | Emergency Core Cooling System |
| INDIC. | Indication |
| IMC | Inspection Manual Chapter |
| LOI | Loss of Reactor Inventory Initiating Event |
| LER | Licensee Event Report |
| LOOP | Loss of Offsite Power |
| LORHR | Loss of RHR Initiating Event |
| OP. | Operator |
| POS | Plant Operational State |
| PRA | Probabilistic Risk Assessment |
| RCS | Reactor Coolant System |
| RHR | Residual Heat Removal |
| ROP | Reactor Oversight Process |
| SDP | Significance Determination Process |
| SG | Steam Generator |
| SG PORV | Steam Generator Power Operated Relief Valve |
| SRW | Service Water |
| SSW | Standby Service Water |
| TBB | Time to Boiling |
| TW | Time Window |
| TW-E | Early Time Window, before refueling operation |
| TW-L | Late Time Window, after refueling operation |

## 4.2 Definitions

Phases of a Significance Determination

*Phase 1 -Characterization and Initial Screening of Findings:* Precise characterization of the finding and an initial screening of very low-significance findings for disposition by the licensee's corrective action program.

*Phase 3 - Risk Significance Finalization and Justification:* Assessment of the risk significance by the SRAs followed by concurrence by an NRR risk analyst.

Shutdown Initiating Events Definitions

Loss of Offsite Power (LOOP) - Includes losses of offsite power which cause a loss of the DHR function.

Loss of Reactor Inventory (LOI) - Includes losses of RCS inventory that lead to a loss of the DHR function due to loss of RHR pump suction.

Loss of Level Control (LOLC) - This initiating event category includes: (1) the operator overdrains the RCS to reach midloop conditions such that the DHR function is lost, and (2) the operator fails to maintain level control while in midloop such that the DHR function is lost.

Loss of the Operating Train of RHR (LORHR) - Failures in the operating train of RHR that cause loss of the RHR function (example the operating RHR pump fails, the RHR suction valve trips shut). This initiating event also includes failures of the RHR support systems such as CCW , SRW, vital AC and DC power.

Plant Operational State Definitions

Hot Shutdown - Average Reactor Coolant Temperature between 200 and 350 degrees F.

Cold Shutdown, RCS closed - Shutdown operation with the RCS initially less than 200F and the RCS is closed such that: (1) SG heat removal can be maintained OR (2) the RCS vent paths are not large enough to support feed and bleed.

Cold Shutdown and Refueling Operation, RCS Open - Shutdown operations with the RCS initially less than 200F and the RCS is vented such that (1) SG heat removal cannot be sustained AND (2) the vent path is large enough to support feed and bleed. Examples of vent paths include: open pressurizer manways, open PORVs, etc.

Refueling Cavity Flooded Operation - Shutdown Operations when the refueling cavity water level is greater than or equal to 23 feet above the top of the reactor vessel flange.

Other Key Shutdown Definitions

Available - A piece of equipment is considered available if it can be put into service quickly enough to meet its intended function and all necessary supporting systems are functional (such as AC power, cooling water, and DC control power).

Hot leg midplane - Midloop operations when water level reaches the middle of the hot leg pipe.

Mid-loop - The condition that exists whenever the RCS water level is lower than the top of the flow area at the junction of the hot legs with the reactor vessel.

Reduced Inventory Operations - Reduced inventory operation exists whenever the reactor vessel water level is lower than 3 feet below the reactor vessel flange.

Shutdown Operations - Shutdown Operation exists during hot shutdown, cold shutdown, and refueling when more than one fuel assembly is in the reactor vessel and the residual heat removal system is in operation.

## 5.0 PROCEDURE FOR SIGNIFICANCE DETERMINATION

**Step 5.1** Go to the Analysis Section for each POS that the finding occurred in.

**Step 5.2** Answer Each question in the Analysis section to determine if the finding needs phase 3 analysis.

**NOTE: IF FINDING OCCURS IN A POS, WHERE THE TIME TO RCS BOILING IS GREATER THAN 2 HOURS, USE THE REFUELING CAVITY ANALYSIS SECTION AND CHECKLIST**

**Step 5.3** Does the finding need phase 3 analysis?

**If YES, fill out the corresponding checklist for each POS that the finding occurred in. Then give the SRAs, (1) the completed Analysis section(s), (2) a description of the finding, and (3) the completed check list(s).**

**IF NO, the finding screens green and should be submitted to the licensee's corrective action program plan.**

## Section 6.0 PWR CHECK LISTS

## Analysis Section - HOT SHUTDOWN

**Directions: Evaluate each question in order. If finding requires phase 3 analysis, then fill out the corresponding checklist. When filling out the checklist, place a check if the statement is true.**

1. **Does the finding involve non-compliance with LTOP Tech. Specs? If yes, send to SRAs for phase 3 analysis.**

2. **Does the finding involve non-compliance with reactivity Tech Specs? If yes, send to SRAs for phase 3 analysis.**

3. **Does the finding involve the pressurizer level instrumentation or the core exit thermocouples such that they are not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

4. **Does the finding increase the likelihood of a loss of the operating train of RHR or has a loss of the operating train of RHR actually occurred? If yes, then answer all questions 4A-4F in this section. If no, then move on to question 5.**

   **4A. Is time to boiling greater than 20 minutes?**
   **4B. Can RHR be recovered within ½ time before boiling?**
   **4C. Does the licensee have at least one SG available for core cooling? Are there procedures for SG cooling? Does the licensee have the capability to add inventory to allow SG cooling for 24 hours? Does the licensee have the capability to vent steam from the SGs? Does the licensee have SG level indication?**
   **4D. Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
   **4E. Can the licensee establish a RCS bleed path large enough to support Feed and Bleed (example a open PORV)?**
   **4F. If the licensee cannot get RHR system back before boiling, does the licensee have the capability to recover the DHR function within ½ the time to RWST depletion (assuming sustained RCS injection to maintain core cooling)?**

**If the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**5. Did the finding cause a loss of RCS inventory such that :**

**There was an inadvertent loss of greater than 2 feet of RCS inventory when not in midloop?**

**OR**

**There was an inadvertent entry into midloop conditions?**

**If yes, then answer all the questions 5A-5G in this section. If no, then go to question 6.**

- **5A. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to hot leg midplane exceed one hour?**
- **5B. Is the RCS level indication a reasonable reflection of RCS level?**
- **5C. Can the leak path be readily identified within ½ the time to drain to hotleg midplane ?**
- **5D. Can the drain path be isolated by at least one functional valves such that a train of RHR can be re-started?**
- **5E. Does the licensee have at least one SG available for core cooling? Are there procedures for SG cooling? Does the licensee have the capability to add inventory to allow SG cooling for 24 hours? Does the licensee have the capability to vent steam from the SGs? Does the licensee have SG level indication?**
- **5F. Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
- **5G. Can the licensee establish a bleed path large enough to support Feed and Bleed (example, open a PORV)?**

**IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**6. Did this finding increase the likelihood of a LOOP? If yes, send the finding to the SRAs for phase 3 analysis.**

**7. Did this finding degrade the availability of the licensee's emergency AC capability? If yes, send the finding to the SRAs for phase 3 analysis.**

**8. Does the finding degrade the licensee's ability to use the steam generators as a decay heat removal path?. If yes, send the finding to the SRAs for phase 3 analysis.**

**9. Does the finding degrade the licensee's standby injection capability such that the licensee does not have at least two available standby injection trains? (Each train should be able to keep the core covered, and one injection train should be an ECCS injection train.) If yes, send the finding to the SRAs for phase 3 analysis.**

**10. Does the finding degrade the ability of containment to remain closed following a severe accident at shutdown? If yes, send the finding to the SRAs for phase 3 analysis.**

**You have completed the analysis section, if the finding did not require phase 3 analysis , then the finding may be screened green.**

## Check List - HOT SHUTDOWN OPERATION

# Complete Checklist ONLY if finding requires phase 3 analysis.

**I. Core Heat Removal Guidelines**

**A.Instrumentation**

**____(1)DHR heat exchanger inlet/outlet temperature and DHR flow indication in the control room with flow hi/low alarm**

**_____(2)2 core exit thermocouples with readout and hi alarm in the control room.**

**B.Training/Procedures**

**____ (1)Training and Procedures for normal and abnormal DHR operation. Procedure for loss of normal DHR include: prioritized alternate core cooling paths (e.g steam generator cooling, low pressure pump feed and bleed, etc.) , initial magnitude of decay heat, versus time to boiling, time to core uncovery, (NUMARC 91-06 guideline 4.1.1 1) ).**

**____(2)Training and Procedures for DHR recovery.**

**C.Equipment**

**_____(1)Two heat removal paths consisting of any combination of RCS loops and RHR systems and necessary support systems. (WOG STS 3.4-11)**

**_____(2)Available equipment to support two alternate core cooling paths for at least 24 hours, steam generator cooling and feed and bleed. Minimum equipment needs include:**

- **_____Steam generator inventory, auxiliary feed water (if needed), secondary steam relief**
- **_____one available high pressure injection train (one operable ECCS train WOG STS 3.5-7)**
- **_____RWST operable (WOG STS 3.5.4),**
- **_____An RCS vent path of sufficient size to support feed and bleed (e.g. a PORV) (WOG LTOP TS 3.4.12)**

**_____Recirculation capability or if needed**

**II. Inventory Control Guidelines**

**A.Instrumentation**

**_____2 independent pressurizer level instruments with a Hi/Lo alarm or level deviation annunciator.**

**B.Training/Procedures**

**_____(1)Loss of Inventory procedures which address: source and magnitude of loss, providing sufficient makeup capability, coping with high radiation levels in containment. (NUMARC 91-06 guidelines 4.2.2.1)**

**_____(2)No plant configurations where a single active failure or personnel error can result in a rapid loss of RCS inventory (includes overlapping activities, e.g. Wolf Creek drain down in 1994) (NUMARC 91-06 guideline 4.2.2 2))**

**C.Equipment**

**_____Available equipment sufficient to keep the core covered given a loss of RCS inventory. Minimum equipment needs include:**

**_____one available high pressure injection train (one ECCS train operable by WOG STS 3.5-7)**

**_____RWST operable (WOG STS 3.5.4).**

**III.Power Availability Guidelines**

**C.Equipment**

**_____(1)Two qualified circuits between the offsite transmission network and the onsite class 1E AC Electrical Power Distribution Systems (WOG STS 3.8.1).**

**_____(2)Two sources of onsite AC power sources (WOG STS 3.8.1)**

**_____(3)Two trains of DC electrical power subsystems (WOG STS 3.8.4)**

**IV.Containment Control Guidelines**

**A.Equipment**

**_____(1)Containment operable (WOG STS 3.6.1)**

**_____(2)Containment isolation valves operable (WOG STS 3.6.3)**

**_____(3)Containment Spray and Containment cooling operable (WOG STS 3.6.6)**

**_____(4)Containment ice beds, ice condenser doors, divider barrier integrity, containment Recirculation drains, and shield buildings operable if applicable (WOG STS 3.6.15 -19)**

**V.Reactivity Guidelines**

**_____assumes compliance with Technical Specifications**

## Analysis Section - COLD SHUTDOWN RCS CLOSED

**Directions: Evaluate each question in order. If finding requires phase 3 analysis, then fill out the corresponding checklist. When filling out the checklist, place a check if the statement is true:**

**1.** **Does the finding involve in non-compliance with LTOP Tech. Specs? If yes, send to SRAs for phase 3 analysis.**

**2.** **Does the finding involve non-compliance with reactivity Tech Specs? If yes, send to SRAs for phase 3 analysis.**

**3.** **Does the finding involve the pressurizer level instrumentation (the RCS level instrumentation while in reduced inventory operation) OR the core exit thermocouples such that they are not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

**4.** **Does the finding increase the likelihood of a loss of the operating train of RHR or has a loss of the operating train of RHR actually occurred? If yes, then answer all questions 4A- 4F in this section. If no, then move on to question 5.**

**4A.** **Is time to boiling greater than 20 minutes?**
**4B.** **Can RHR be recovered within ½ time before boiling?**
**4C.** **Does the licensee have at least one SG available for core cooling? Are there procedures for SG cooling? Does the licensee have the capability to add inventory to allow SG cooling for 24 hours? Does the licensee have the capability to vent steam from the SGs? Does the licensee have SG level indication?**
**4D.** **Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
**4E.** **Can the licensee establish a RCS bleed path large enough to support Feed and Bleed (example a open PORV)?**
**4F.** **If the licensee cannot get RHR system back before boiling, does the licensee have the capability to recover the DHR function within ½ the time to RWST depletion (assuming sustained RCS injection to maintain core cooling)?**

**IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**5. Did the finding cause a loss of RCS inventory such that :**

**There was an inadvertent loss of greater than 2 feet of RCS inventory when not in midloop?**
**OR**
**There was an inadvertent entry into midloop conditions?**
**OR**
**There was an inadvertent loss of 2 inches of RCS inventory when in midloop conditions?**

**If yes, then answer all the questions 5A-5G in this section. If no, the go to question 6.**

- **5A. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to hot leg midplane exceed one hour?**
- **5B. If the RCS level indication a reasonable reflection of RCS level?**
- **5C. Can the leak path be readily identified within ½ the time to drain to hotleg midplane?**
- **5D. Can the drain path be isolated by at least one functional valves such that a train of RHR can be re-started?**
- **5E. Does the licensee have at least one SG available for core cooling? Are there procedures for SG cooling? Does the licensee have the capability to add inventory to allow SG cooling for 24 hours? Does the licensee have the capability to vent steam from the SGs? Does the licensee have SG level indication?**
- **5F. Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
- **5G. Can the licensee establish a bleed path large enough to support Feed and Bleed?**

**IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**6. Did this finding increase the likelihood of a LOOP? If yes, send the finding to the SRAs for phase 3 analysis.**

**7. Did this finding degrade the availability of the licensee's emergency AC capability? If yes, send the finding to the SRAs for phase 3 analysis.**

**8. Does the finding degrade the licensee's ability to use the steam generators as a decay heat removal path? If yes, send the finding to the SRAs for phase 3 analysis.**

**9. Does the finding degrade the licensee's standby injection capability such that the licensee does not have at least two available standby injection trains? (Each train should be able to keep the core covered, and one injection train should be an ECCS injection train.) If yes, send the finding to the SRAs for phase 3 analysis.**

**10. Does the finding degrade the ability of containment to remain intact following a severe accident at shutdown? If yes, send the finding to the SRAs for phase 3 analysis.**

**You have completed the analysis section, if the finding did not require phase 3 analysis , then the finding may be screened green.**

# Check List - COLD SHUTDOWN, RCS CLOSED

## Complete Checklist ONLY if finding requires phase 3 analysis.

**I.Core Heat Removal Guidelines**

**A.Instrumentation**

**_____ (1)DHR heat exchanger inlet/outlet temperature and DHR flow indication in the control room with flow hi/low alarm.**

**______(2)Two core exit thermocouples with control room readout and hi alarm.**

**B.Training/Procedures**

**_____(1)Procedures for normal and abnormal DHR operation. Procedure for loss of normal DHR include: prioritized alternate core cooling paths (e.g steam generator cooling, low pressure pump feed and bleed, etc.) , initial magnitude of decay heat, versus time to boiling, time to core uncovery, (NUMARC 91-06 guideline 4.1.1 1))**

**_____(2)Training and Procedures for DHR recovery.**

**C.Equipment**

**_____(1)one RHR loop operable and one additional RHR loop operable or the secondary side water level of at least two steam generators sufficient for DHR (includes necessary support systems (WOG STS 3.4.7)**

**_____(2)Available equipment to support two alternate core cooling paths for at least 24 hours, steam generator cooling and feed and bleed. Minimum equipment needs include:**

**____ steam generator inventory, secondary steam relief , and auxiliary feed water (if needed)**

**____one available high pressure injection pump train AND one other pump train capable of keeping the core covered in addition to the pumps that are part of the normal DHR system.**

**____ An adequate vent path to support feed and bleed (e.g. a PORV) (WOG LTOP STS 3.4.12),**

**____available RWST.**

**_____ Recirculation from emergency sump (if needed).**

**II.Inventory Control Guidelines**

**A.Instrumentation**

**_____2 pressurizer level instruments with hi/low alarm or level deviation in control room or 2 RCS level instruments while in reduced inventory operation (GL 88-17)**

**B.Training/Procedures**

**____(1)Loss of Inventory procedures address: source and magnitude of loss, providing sufficient makeup capability, coping with high radiation levels in containment. (NUMARC 91-06, guideline 4.2.2.1)**
**____(2)No plant configurations where a single active failure or personnel error can result in a rapid loss of RCS inventory, includes overlapping activities. (NUMARC 91-06, guideline 4.2.2. 2.)**

**C. Equipment**
**Available equipment sufficient to keep the core covered given a loss of RCS inventory. Minimum equipment needs include:**
**____one available high pressure injection pump train AND one other pump train capable of keeping the core covered in addition to the pumps that are part of the normal DHR system.**

**III.Power Availability Guidelines**

**A.Procedures/Training**
**_____(1)Control over switch yard and transformer yard activities. (NUMARC 91-06 guideline 4.3.2.1)**
**_____(2)Work activities do not have significant potential to affect existing operable power supplies (NUMARC 91-06 guidelines 4.3.1.2)**

**B.Equipment**
**_____(1)3 sources of AC power including: 1 offsite and 1 onsite source.**
**_____(2)Necessary DC and AC vital bus electrical power distribution subsystems to support the equipment needed to meet the core heat removal and inventory control safety function guidelines.**

**IV.Containment Control Guidelines**

**A.Procedures/Training**
**_____Procedures and training to close containment before core uncovery commensurate with plant conditions (should consider unavailability of AC power and environmental conditions in containment) following a loss of RHR AND a loss of RCS inventory. (NUMARC 91-06 guideline 4.5.1))**

**B.Equipment**
**_____Containment penetrations (including temporary) have a differential pressure equal to the ultimate pressure capability of containment or would be expected to remain intact following a severe accident .**

**V.Reactivity Guidelines**
**_____assumes compliance with Technical Specifications Reactivity Guidelines**

## Analysis Section- COLD SHUTDOWN & REFUELING, RCS OPEN (RCS level < 23' above vessel flange)

## Directions: Evaluate each question in order. If finding requires phase 3 analysis, then fill out the corresponding checklist. When filling out the checklist, place a check if the statement is true.

**1. Does the finding involve in non-compliance with LTOP Tech. Specs, if yes, send to SRAs for phase 3 analysis?**

**2. Does the finding involve non-compliance with reactivity Tech Specs, if yes, send to SRAs for phase 3 analysis?**

**3. Does the finding involve the RCS level instrumentation or the core exit thermocouples such that they are not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

**4. Did the finding cause a loss of the operating train of RHR? If yes, send the finding to the SRAs for phase 3 analysis.**

**5. Did the finding increase the likelihood of a loss of the operating train of RHR? If yes, then answer all questions 5A- 5F in this section. If no, then move on to question 6.**

- **5A.** **Is the time to loss of the operating train of RHR assuming no successful operation action greater than one hour?**
- **5B.** **Are there trouble alarms present for finding such as CCW low flow alarms?**
- **5C.** **Is time to boiling greater than 60 minutes?**
- **5D.** **Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
- **5E.** **If the licensee cannot get RHR system back before boiling, does the licensee have the capability to recover the DHR function within ½ the time to RWST depletion (assuming sustained RCS injection to maintain core cooling)?**
- **5F.** **Does the licensee have procedures and equipment necessary to provide makeup to the RWST before RWST depletion (assuming sustained RCS injection)?**

**I IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**6. Did the finding cause a loss of RCS inventory such that :**

**There was an inadvertent loss of greater than 2 feet of RCS inventory when not in midloop?**
**OR**
**There was an inadvertent entry into midloop conditions?**
**OR**
**There was an inadvertent loss of 2 inches of RCS inventory when in midloop conditions**

**If yes, then answer all the questions 6A-6F in this section. If no, the go to question 7.**

**6A. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS such that RHR would be lost exceed one hour?**
**6B. If the RCS level indication a reasonable reflection of RCS level?**
**6C. Can the leak path be readily identified within ½ the time to drain to hotleg midplane?**
**6D. Can the drain path be isolated by at least one functional valves such that a train of RHR can be re-started?**
**6E. Does the licensee has at least two available standby injection trains such that (1) each train is not impacted by the finding and (2) each train is able to keep the core covered? (One injection train should be an ECCS injection train.)**
**6F. Does the licensee have procedures and equipment necessary to provide makeup to the RWST?**

**IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**7. If nozzle dams are installed, is there an adequate vent path such that loss of a nozzle dam following a postulated RCS re-pressurization is prevented?**

**8. Did this finding increase the likelihood of a LOOP? If yes, send the finding to the SRAs for phase 3 analysis.**

**9. Did this finding degrade the availability of the licensee's emergency AC capability? If yes, send the finding to the SRAs for phase 3 analysis.**

**10. Does the finding degrade the licensee's standby injection capability such that the licensee does not have at least two available standby injection trains? (Each train should be able to keep the core covered, and one injection train should be an ECCS injection train.) If yes, send the finding to the SRAs for phase 3 analysis.**

**10. Does the finding degrade the ability of containment to remain intact following a severe accident at shutdown? If yes, send the finding to the SRAs for phase 3 analysis.**

**You have completed the analysis section, if the finding did not require phase 3 analysis , then the finding may be screened green.**

# Check List - COLD SHUTDOWN & REFUELING, RCS OPEN (RCS level < 23' above flange)

## Complete Checklist ONLY if finding requires phase 3 analysis.

**I.Core Heat Removal Guidelines**

**A.Instrumentation**

**_____(1)DHR heat exchanger inlet/outlet temperature, DHR flow indication with hi/low flow alarm, and DHR pump motor current with alarm. (GL 88-17)**

**_____(2)At least two core exit thermocouples with control room readout and hi alarm until must be removed for preparations for vessel head removal (GL 88-17).**

**B.Training/Procedures**

**_____(1)Procedures for normal and abnormal DHR operation. Procedure for loss of normal DHR include: alternate core cooling paths (e.g feed and bleed), initial magnitude of decay heat, versus time to boiling, time to core uncovery, initial RCS condition (e.g. filled, mid-loop, etc.), RCS configuration (open/closed, nozzle dams installed or loop isolation valves closed, etc.) (NUMARC 91-06 guideline 4.1.1.1)**

**_____(2)Training and Procedures for DHR recovery.**

**C.Equipment**

**_____(1)Both trains of DHR operable with necessary support systems. (STS)**

**_____(2)Available equipment to support feed and bleed for at least 24 hours. Minimum equipment needs include:**

**____One high pressure injection pump train AND one other pump train capable of keeping the core covered in addition to the pumps that are part of the normal DHR system (GL 88-17)**

**_____An adequate vent path that can (1) support feed and bleed and (2) prevent loss of a nozzle dam during RCS re-pressurization following a postulated loss of DHR (e.g. pressurizer manway). (GL 88-17),**

**_____Available RWST (GL 88-17)**

**_____Recirculation capability from sump (if needed).**

**II. Inventory Control Guidelines**

**A.Instrumentation**

**_____(1)2 sources of pressurizer level instrumentation with hi/low alarm or level deviation in control room when inventory in pressurizer.**

**_____(2)Two sources of level continuous level instrumentation with pressurizer empty. Monitoring performed by an operator in the control room or from a location other than the control room with a provision for providing immediate water level values to an operator in the control room if significant changes occur. (GL 88-17)**

B.Procedures/Training

_____(1)Outage schedule minimizes the overall time that the plant is in a reduced inventory condition (NUMARC 91-06 guideline 4.2.1.3)

_____(2)Outage schedule delays to the extent practical going to reduced inventory conditions when decay heat load is high. (NUMARC 91-06 guideline 4.2.1.2)

_____(3)Training, procedures and administrative controls implemented to avoid operations that could lead to perturbations in RCS level control or DHR flow (GL 88-17, NUMARC 91-06 guideline 4.2.1.4)

_____(4)Loss of Inventory procedures address: source and magnitude of loss, providing sufficient makeup capability, coping with high radiation levels in containment. (NUMARC 91-06 guideline 4.2.2.1)

_____(5)Drain down is controlled; inventory balances performed and appropriate action taken on level deviation.

C.Equipment

_____(1)At least, one large hot leg vent established and maintained prior to opening an RCS cold leg penetration. (GL 88-17)

_____(2)Equipment sufficient to keep the core covered given a loss of RCS inventory. Minimum equipment needs include: one high pressure injection pump train (after breaker racked -in) AND one other pump capable of keeping the core covered in addition to the pumps that are part of the normal DHR system. (GL 88-17).

III.Power Availability Guidelines

A.Procedures/Training/Administrative Controls

_____(1)Work activities do not have significant potential to affect existing operable power supplies (NUMARC 91-06 guidelines 4.3.1.2)

_____(2)Control over switch yard and transformer yard activities. (NUMARC 91-06 guideline 4.3.2.1)

B.Equipment

_____(1)3 sources of AC power including: 1 offsite and 1 onsite source.

_____(2)Necessary DC and AC vital bus electrical power distribution subsystems to support the equipment needed to meet the core heat removal and inventory control safety function guidelines.

IV.Containment Control Guidelines

A.Procedures/Training

_____(1)Procedures and training to close containment prior to core boiling if the RCS is open. (NUMARC 91-06 guideline 4.2.5 and GL 88-17

_____(2)Procedures and training to close containment before core uncovery commensurate with plant conditions if the RCS is closed (should consider unavailability of AC power and environmental conditions in containment) following a loss of RHR AND a loss of RCS inventory. (NUMARC 91-06 guideline 4.5.1))

**B.Equipment**

**_____Containment penetrations (including temporary) have a differential pressure equal to the ultimate pressure or would be expected to remain intact following a severe accident. (GL 88-17)**

**V.Reactivity Guidelines**

**_____(assumes compliance with Technical Specifications)**

## Analysis Section - REFUELING CAVITY FLOODED

**Directions: Evaluate each question in order. If finding requires phase 3 analysis, then fill out the corresponding checklist. When filling out the checklist, place a check if the statement is true.**

**1. Does the finding increase the likelihood of a LOOP AND failure of the refueling cavity seal following a loss of offsite power? If yes, send to SRAs for phase 3 analysis.**

**2. Does the finding increase the likelihood of EDG failure AND failure of the refueling cavity seal given a loss of emergency AC power? If yes, then send the finding to the SRAs for phase 3 analysis.**

**3. Did the finding cause a loss of RCS inventory such that greater than 2 feet of RCS inventory was lost? If yes, then answer all the questions 3A-3D, in this section. If the answer is no, then go to question 4.**

- **3A. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to hot leg midplane exceed one hour?**
- **3B. If the RCS level indication a reasonable reflection of RCS level?**
- **3C. Can the leak path be readily identified within ½ the time to drain to hotleg midplane?**
- **3D. Can the drain path be isolated by at least one functional valves such that a train of RHR can be re-started?**

**IF the answers to ALL of these questions are yes, then the finding may be screened green. If the finding can't be screened green, then send the finding to the SRAs for phase 3 analysis.**

**4. Did the finding increase the likelihood of freeze seal or refueling cavity seal failure? If yes, then send the finding to the SRAs for phase 3 analysis.**

**You have completed the analysis section, if the finding did not require phase 3 analysis , then the finding may be screened green.**

# Check List - REFUELING CAVITY FLOODED

## Complete Checklist ONLY if finding requires phase 3 analysis.

**I.Core Heat Removal Guidelines**

**A.Instrumentation**

**_____(1)DHR heat exchanger inlet/outlet temperature and DHR flow indication in the control room with flow hi/low alarm.**

**_____(2)Two sources of vessel temperature instrumentation (as soon as practical during vessel head re-installation).**

**B.Procedures/Training**

**_____(1)Procedures for normal and abnormal DHR operation. Procedure for loss of normal DHR include: alternate core cooling paths (e.g feed and bleed, use of fuel storage pool cooling), initial magnitude of decay heat, versus time to boiling, time to core uncovery, initial RCS condition (NUMARC 91-06 guideline 4.1.1.1))**

**_____(2)Procedures for RHR recovery.**

**C.Equipment**

**_____(1)At least one RHR loop shall be operable and in operation with support systems (WOG STS 3.9.8.1 or applicable RHR TS )**

**II.Inventory Control Guidelines**

**A.Instrumentation**

**_____Two sources of level instrumentation system with low level setpoint alarm with level < 23 ' above reactor vessel flange. One source of level instrumentation with refueling cavity flooded.**

**B.Procedures/Training/Administrative Controls**

**_____(1)Preventive maintenance/inspection or post-installation testing performed on reactor cavity seals prior to filling the reactor cavity to preclude potential seal failure. (NUMARC 91-06 guideline 4.2.5.1)**

**_____(2)Verify procedures for reactor cavity seal failure or loss of cavity inventory (NUMARC 91-06 guideline 4.2.5.2)**

**_____(3)Loss of Inventory procedures address: source and magnitude of loss, providing sufficient makeup capability, coping with high radiation levels in containment. (NUMARC 91-06 4.2.2.1).**

**_____(4)Freeze seals used in locations that can impact RCS inventory are continuously monitored. Procedures and contingency plans are established in the event of freeze seal failure. (NUMARC 4.2.2.6)**

**C.Equipment**

**_____Equipment necessary for makeup to the refueling cavity**

**III.Power Availability Guidelines**

**_____TS for AC and DC power are being met.**

**IV.Containment Control Guidelines**

**_____TS for core alterations are being met, if applicable. Containment closure should be addressed in contingency plans and/or in procedures.**

**V.Reactivity Guidelines**

**_____TS are being met.**

## 7.0 BASIS

This tool is used to ensure that a licensee’s shutdown mitigation capability (equipment, instrumentation, policies, procedures, and training) is consistent with the staff's estimate of industry shutdown risk presented to the Commission in SECY 97-168 (the proposed Shutdown Rule).

This tool is also used to assess shutdown conditions that represent a loss of control. These losses of control include (1) losses of reactor coolant system (RCS) level and (2) losses of thermal margin. These conditions are considered precursors to events that could result in actual loss of the decay heat removal (DHR) function. The staff is monitoring losses of control because the staff's risk estimate of generic PWR and BWR shutdown performance indicates that, based on experience, losses of DHR are relatively infrequent.

For this screening tool, PWR shutdown operation has been partitioned into four plant operational states (POSs): hot shutdown, cold shutdown operation with a closed RCS, cold shutdown with an open RCS, and refueling cavity flooded operation. When an inspector has identified a shutdown performance deficiency, the inspector chooses the Analysis section for each POS that the finding occurred in. The Analysis section requires the inspector to answer yes/no type questions to see if the finding needs quantitative analysis (phase 3 analysis) or can be screened green. These questions were developed based on results of the phase 3 Shutdown SDP templates.

Should a finding require quantitative assessment, the analyst needs to fill in the corresponding Checklist for each POS. The Checklist defines a set of equipment, instrumentation, policies, and procedures that the staff expects the licensee to maintain during shutdown. This Checklist is grouped by the five shutdown safety functions identified by NUMARC 91-06: decay heat removal, inventory control, power availability, reactivity control, and containment.

The Analysis section and the Checklist for each POS recognize that certain plant configurations have inherently higher risks than others. The Analysis section and the Checklists for higher risk POSs have more questions and guidelines for each safety function.

Findings that need quantitative assessment should be forwarded to the Region SRA. To start the assessment, the SRA needs: (1) a description of the finding, (2) the completed Analysis section for each POS the finding occurred in, and (3) the completed Checklist for each finding that the POS occurred in.

Background

In SECY 97-168, the staff requested the Commission to approve the publication of a proposed rule for comment that would cover shutdown and low power operation at nuclear power plants. The proposed rule was applicable during cold shutdown and refueling operation as defined in Technical Specifications. This rule would have required licensees to establish and implement procedures for training, quality assurance, and corrective actions to ensure that the safety functions of: decay heat removal, inventory control, and pressure control are maintained and monitored. The proposed rule also required the licensees to provide a mitigation capability. The mitigation capability would include the necessary equipment to maintain the reactor in a safe condition in the event of the loss of the operating decay heat removal system. A quantitative regulatory analysis using PRA techniques was performed for SECY 97-168 to evaluate the benefit of the proposed rule. Core damage frequencies were developed for three cases of shutdown operation at PWRs and BWRs: the base case, the voluntary case, and the rule case.

The base case represented the level of protection provided strictly by legally enforceable requirements, i.e., current regulations, technical specifications, licensee conditions and orders. It did not credit any measure that was voluntary or that could be unilaterally changed by the licensee, such as licensee commitments made in response to generic letters and bulletins. The base case was used to assess the benefit of the proposed new rule.

The voluntary case represented the level of protection for plants operated with a reasonable implementation of voluntary measures, based on guidance from NUMARC 91-06 and GL 88-17. (NUMARC 91-06 provides guidance on improving outage management and GL 88-17 provides recommendations concerning the ability of a licensee to mitigate a potential loss of DHR during reduced inventory operations at PWRs). The voluntary action case also credited equipment assumed operable according to Technical Specifications. The rule case represents the level of protection provided by all plants complying with the requirements of the proposed rule. For both PWRs and BWRs, two voluntary action cases were performed using different interpretation of NUMARC 91-06 and GL 88-17. The higher CDF voluntary case represents a minimal implementation of both guidance documents. The lower CDF voluntary case represents an in-depth implementation of both guidance documents. The Regulatory analysis reported core damage frequencies (per reactor year) on the order of E-2 per year and E-3 per year for PWRs and BWRs respectively for the base case. The core damage frequencies (per reactor year) estimated for the voluntary action cases ranged from 8E-5 to 2E-6 per year for PWRs and from 1E-5 to 6E-7 for BWRS.

Based on staff review of the base case, voluntary action cases, and the rule case, the staff reported in SECY 97-168 that: (1) the existing level of safety at shutdown is largely dependent upon measures that are not traceable to specific underlying regulations, and that could, therefore, be withdrawn by licensees without prior staff approval (2) little reduction of risk is achieved by the rule for the licensee who has adopted effective voluntary practices that reduce risk for shutdown operation.

In response to SECY 97-168, the Staff Requirements Memorandum (SRM) did not authorize the staff to issue the rule. As documented in the Federal Register (dated February 4, 1999, vol. 64, no. 23), the Commission did not believe that the proposed shutdown rule was needed given the staff's estimate of current industry performance. However, as directed in the SRM, the Commission "expects the staff to continue to monitor licensee performance, through inspections and other means, in the area of shutdown operations to ensure that the current level of safety is maintained." In addition, in the Federal Register (dated February 4, 1999, vol. 64, no. 23), it states, "the Commission will continue to monitor industry performance and may take further action if any adverse trends are identified."