ENHANCED BWR 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
SRV	Safety 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 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 SSW, vital AC and DC power.

Plant Operational State Definitions

Hot Shutdown - BWR 4 STS Definition with the RHR system in operation.

Shutdown, Head on - Shutdown operation with the RCS initially less than 200F and the reactor vessel head is on

Shutdown, head off - Shutdown operation with the RCS initially less than 200F, the reactor vessel head is off the vessel, and refueling cavity water level is less than 23 feet above the top of the reactor flange.

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).

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 BWR CHECK LISTS

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Analysis Section - BWR 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 the reactor vessel level instrumentation such that it is not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.

2. Does the finding involve the operability of the automatic isolation of the DHR system on low vessel level?

3. Does the finding involve the SRVs such that there are less than 2 available SRVs for RCS pressure control? 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- 5G 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 30 minutes?

5B. Are there trouble alarms present for finding such as CCW low flow alarms?

5C. Can the action to recover RHR be identified within ½ the time to RHR loss?

5D. Can the action to recover RHR be performed within ½ time to RHR loss?

5E. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.

5F. Does the licensee have at least two available SRVs for RCS pressure control?

5G. Does the licensee have an available train for suppression pool cooling OR containment venting and suppression pool makeup?

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

6A. Is the automatic isolation of the DHR system on low vessel level operable?
6B. Would the leak path been automatically isolated by the automatic isolation of RHR on low vessel level?
6C. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to low vessel level (the level at which DHR would automatically isolate) exceed one hour?
6D. Can the leak path be readily identified within ½ the time to drain to the low vessel level set point?
6E. Can the leak path be isolated by at least one functional valves such that a train of RHR can be re-started within ½ the time to reaching the low vessel level set point?
6F. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.
6G. Does the licensee have at least two available SRVs for RCS pressure control?
6H. Does the licensee have an available train for suppression pool cooling OR containment venting and suppression pool makeup?

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

8. 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.

9. Does the finding degrade the licensee's standby injection capability such that the licensee does not have at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load. 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 - BWR HOT SHUTDOWN OPERATION

Complete Check list only if finding needs 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 hi/low flow alarm.

_____ (2) Two Sources of vessel level instrumentation

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), initial magnitude of decay heat, time to boiling, time to core uncovery, initial RCS condition (NUMARC 91-06 guideline 4.1.1.1))

_____ (2) Procedures for DHR recovery if lost.

C. Equipment

_____ (1) Two RHR shutdown cooling subsystems shall be operable with one RHR system in operation (BWR/4 STS 3.4.8)

_____ (2) Available equipment to support an alternate core cooling path (Recirculation using SRVs and suppression pool) for at least 24 hours, includes:

_____ operable SRVs (BWR/4 STS 3.4.3)

_____ Each ECCS injection/spray subsystem shall be operable except HPCI and ADS (BWR/4 STS 3.5-1)

_____ Two operable RHR suppression pool cooling subsystems. (BWR/4 STS 3.6.2.3)

II. Inventory Control Guidelines

A. Instrumentation

_____ (1) The automatic isolation function of the DHR system (on low vessel level) is operable (BWR/4 STS 3.3.6.1 Primary Containment Isolation Instrumentation) (NUMARC 91-06 guideline 4.2.3.1)

_____ (2) Two sources of vessel level instrumentation.

B. Procedures/Administrative Controls/Training

_____ (1) Special administrative controls are used for valves which can cause rapid inventory loss (e.g. inventory losses to suppression pool) (NUMARC 91-06 guideline 4.2.3.2)

_____ (2) 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).

C. Equipment

_____ Equipment sufficient to keep the core covered given a loss of RCS inventory, includes:

_____ operable SRVs (BWR/4 STS 3.4.3)

_____ Each ECCS injection/spray subsystem shall be operable except HPCI and ADS (BWR/4 STS 3.5-1)

_____ Two operable RHR suppression pool cooling subsystems (BWR/4 STS 3.6.2.3)

III. Power Availability Guidelines

A. Procedures/Training

_____ (1) Control over switch yard and transformer yard activities (NUMARC 91-06 guidelines 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 (same as full power)

_____ (1) Two qualified circuit between the offsite transmission network and the onsite 1E AC electrical power distribution subsystems shall be operable(BWR/4 STS 3.8.1)

_____ (2) Necessary diesel generators and automatic sequencers to support Technical Specification (TS) compliance. (BWR/4 STS 3.8.1)

_____ (3) The necessary portions of the AC, DC, and vital AC bus electrical power distribution subsystems shall be operable to support equipment required to be operable.

IV. Containment Guidelines

A. Equipment

_____ Primary Containment and Secondary Containment are required to be operable. Most containment systems are required to be operable, exceptions include: primary oxygen concentration and hydrogen re-combiners (if permanently installed)

Analysis Section - BWR Shutdown, Head On

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 the reactor vessel level instrumentation such it is not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

2. **Does the finding involve the operability of the automatic isolation of the DHR system on low vessel level?**

3. **Does the finding involve the SRVs such that there are less than 2 available SRVs for RCS pressure control? 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- 5G in this section. If no, then move on to question 5.**

    - **5A. Is the time to loss of the operating train of RHR greater than 30 minutes assuming no successful operation action?**
    - **5B. Are there trouble alarms present for finding such as CCW low flow alarms?**
    - **5C. Can the action to recover RHR be identified within ½ the time to RHR loss?**
    - **5D. Can the action to recover RHR be performed within ½ time to RHR loss?**
    - **5E. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.**
    - **5F. Does the licensee have at least two available SRVs for RCS pressure control?**

5G. Does the licensee have an available train for suppression pool cooling OR containment venting and suppression pool makeup?

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

6A. Is the automatic isolation of the DHR system on low vessel level operable?

6B. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to low vessel level (the level at which DHR would automatically isolate) exceed one hour?

6C. Can the leak path be readily identified within ½ the time to drain to the low vessel level set point?

6D. Can the leak path be isolated by at least one functional valves such that a train of RHR can be re-started within ½ the time to reaching the low vessel level set point?

6E. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.

6F. Does the licensee have an available train for suppression pool cooling OR containment venting and suppression pool makeup?

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

8. 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.

9. Does the finding degrade the licensee's standby injection capability such that the licensee does not have at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR

Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load. If yes, send the finding to the SRAs for phase 3 analysis.

10. Did the finding increase the failure probability of a freeze seal whose failure can impact RCS inventory? If yes, send the finding to the SRAs for phase 3 analysis.

11. 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 - BWR SHUTDOWN, Head On

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 hi/low flow alarm.

_____ (2) Two sources of vessel level instrumentation

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), initial magnitude of decay heat, time to boiling, time to core uncovery, initial RCS condition (NUMARC 91-06 guideline 4.1.1.1))

_____ (2) Procedures for DHR recovery if lost.

C. Equipment

_____ (1) Two RHR shutdown cooling subsystems shall be operable with one RHR system in operation (BWR/4 STS 3.4.9, BWR/4 STS 3.9.9)

_____ (2) Available equipment to support an alternate core cooling path (Recirculation using SRVs and suppression pool) for at least 24 hours, includes:

_____ (3) two available SRVs for RCS pressure control

_____ (4) two operable low pressure ECCS injection/spray subsystems (BWR/4 STS 3.5-7)

II. Inventory Control Guidelines

A. Instrumentation

_____ (1) The automatic isolation function of the DHR system (on low vessel level) is operable (BWR/4 STS 3.3.6.1 Primary Containment Isolation Instrumentation) (NUMARC 91-06 guideline 4.2.3.1)

_____ (2) Two sources of level instrumentation with low level set point alarm.

B. Procedures/Administrative Controls/Training

_____ (1) Special administrative controls used for valves which can cause rapid inventory loss (e.g. inventory losses to suppression pool) (NUMARC 91-06 guideline 4.2.3.2)

_____ (2) 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).

_____ (3) Freeze seals used in locations than can impact RCS inventory are continuously monitored. Procedures and contingency plans are established if freeze seal fails. (NUMARC guideline 4.2.2.6).

C. Equipment

_____ Equipment sufficient to keep the core covered given a loss of RCS inventory, includes two operable low pressure ECCS injection/spray subsystems (BWR/4 STS 3.5-7).

III. Power Availability Guidelines

A. Procedures/Training

_____ (1) Control over switch yard and transformer yard activities (NUMARC 91-06 guidelines 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) One qualified circuit between the offsite transmission network and the onsite 1E AC electrical power distribution subsystems shall be operable(BWR/4 STS 3.8.2)

_____ (2) One diesel generator capable of supplying one division of the onsite class 1E electrical power distribution subsystems shall be operable (BWR/4 STS 3.8.2)

_____ (3) The necessary portions of the AC, DC, and vital AC bus electrical power distribution subsystems shall be operable to support equipment required to be operable. (BWR/ STS 3.8.10)

IV. Containment Guidelines

A. Procedures/Training

_____ Secondary containment closure can be accomplished in sufficient time before the release of fission products. Procedure includes the unavailability of AC power and expected environmental condition in containment. (NUMARC Guideline 4.5-1)

Analysis Section- BWR SHUTDOWN, Head off (RCS level < 23 feet above the reactor 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 the reactor vessel level instrumentation such it is not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

2. **Does the finding involve the operability of the automatic isolation of the DHR system on low vessel level?**

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

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

   4A. Is the time to loss of the operating train of RHR assuming no successful operation action greater than 30 minutes?
   4B. Are there trouble alarms present for finding such as CCW low flow alarms?
   4C. Can the action to recover RHR be identified within ½ the time to RHR loss?
   4D. Can the action to recover RHR be performed within ½ time to RHR loss?
   4E. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.

   OR

   Does the licensee have an additional train for removing decay heat which diverse from the two LPCI trains used to satisfy the RHR Technical Specifications? This could include using the Control Rod

Drive pumps for RCS injection and the Reactor Water Cleanup system for enerey removal.

4F. Does the licensee have an available source of water should extended RCS injection be required (such as fire water)?

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

5A. Is the automatic isolation of the DHR system on low vessel level operable?

5B. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to low vessel level (the level at which DHR would automatically isolate) exceed one hour?

5C. Can the leak path be readily identified within ½ the time to drain to the low vessel level set point?

5D. Can the leak path be isolated by at least one functional valves such that a train of RHR can be re-started within ½ the time to reaching the low vessel level set point?

5E. Does the licensee has at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load.

5F. Does the licensee have an available source of water should extended RCS injection be required (such as fire water)?

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 standby injection capability such that the licensee does not have at least one available RCS injection train which is *in addition* to the two LPCI trains being used to satisfy the RHR Technical Specifications? This injection train could include a LPCS train or a non-ECCS injection train that is capable of keeping the core covered given the decay heat load. If yes, send the finding to the SRAs for phase 3 analysis.

9. Did the finding increase the failure probability of a freeze seal whose failure can impact RCS inventory? 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 - BWR SHUTDOWN, Head off

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 hi/low flow alarm.

_____ (2) Two sources of vessel level instrumentation

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), initial magnitude of decay heat, time to boiling, time to core uncovery, initial RCS condition (NUMARC 91-06 guideline 4.1.1.1))

_____ (2) Procedures for DHR recovery if lost.

C. Equipment

_____ (1) Two RHR shutdown cooling subsystems shall be operable with one RHR system in operation (BWR/4 STS 3.4.9, BWR/4 STS 3.9.9)

_____ (2) Available equipment to support an alternate core cooling path (Recirculation using SRVs and suppression pool) for at least 24 hours, includes:

_____ (3) two available SRVs, if vessel head is on

_____ (4) two operable low pressure ECCS injection/spray subsystems (BWR/4 STS 3.5-7)

II. Inventory Control Guidelines

A. Instrumentation

_____ (1) The automatic isolation function of the DHR system (on low vessel level) is operable (BWR/4 STS 3.3.6.1 Primary Containment Isolation Instrumentation) (NUMARC 91-06 guideline 4.2.3.1)

_____ (2) Two sources of level instrumentation with low level set point alarm.

B. Procedures/Administrative Controls/Training

_____ (1) Special administrative controls used for valves which can cause rapid inventory loss (e.g. inventory losses to suppression pool) (NUMARC 91-06 guideline 4.2.3.2)

_____ (2) 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).

_____ (3) Freeze seals used in locations than can impact RCS inventory are continuously monitored. Procedures and contingency plans are established if freeze seal fails. (NUMARC guideline 4.2.2.6).

C. Equipment

_____ Equipment sufficient to keep the core covered given a loss of RCS inventory, includes two operable low pressure ECCS injection/spray subsystems (BWR/4 STS 3.5-7).

III. Power Availability Guidelines

A. Procedures/Training

_____ (1) Control over switch yard and transformer yard activities (NUMARC 91-06 guidelines 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) One qualified circuit between the offsite transmission network and the onsite 1E AC electrical power distribution subsystems shall be operable(BWR/4 STS 3.8.2)

_____ (2) One diesel generator capable of supplying one division of the onsite class 1E electrical power distribution subsystems shall be operable (BWR/4 STS 3.8.2)

_____ (3) The necessary portions of the AC, DC, and vital AC bus electrical power distribution subsystems shall be operable to support equipment required to be operable. (BWR/ STS 3.8.10)

IV. Containment Guidelines

A. Procedures/Training

_____ Secondary containment closure can be accomplished in sufficient time before the release of fission products. Procedure includes the unavailability of AC power and expected environmental condition in containment. (NUMARC Guideline 4.5-1)

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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 involve the reactor vessel level instrumentation such it is not reflective of RCS conditions? If yes, send the finding to the SRAs for phase 3 analysis.**

2. **Does the finding involve the operability of the automatic isolation of the DHR system on low vessel level?**

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

   - **3A. Is the automatic isolation of the DHR system on low vessel level operable?**
   - **3B. Given the event, assuming the drain path could not be isolated, does the time to drain the RCS to low vessel level (the level at which DHR would automatically isolate) exceed one hour?**
   - **3C. Can the leak path be readily identified within ½ the time to drain to the low vessel level set point?**
   - **3D. Can the leak path be isolated by at least one functional valves such that a train of RHR can be re-started within ½ the time to reaching the low vessel level set point?**
   - **3E. Does the licensee has at least one available ECCS injection train for RCS injection?**

4. **Did the finding increase the failure probability of a freeze seal whose failure can impact RCS inventory? OR Did the finding increase the likelihood of 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 hi/low flow alarm.

_____(2)Two sources of vessel level instrumentation

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), initial magnitude of decay heat, time to boiling, time to core uncovery, initial RCS condition (NUMARC 91-06 guideline 4.1.1.1)

__

C.Equipment

_____At least one RHR loop shall be operable and in operation with necessary support systems (BWR/4 STS 3.9.8)

II.Inventory Control Guidelines

A.Instrumentation

_____(1)Two sources of level instrumentation system with low level setpoint alarm.

_____(2)The automatic isolation function of the DHR system (on low vessel level) is operable (BWR/STS 3.3.6.1 Primary Containment Isolation Instrumentation) (NUMARC 91-06 guideline 4.2.3.1)

B.Procedures

_____(1)Preventive maintenance/inspection or post-installation testing is 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)Freeze seals used in locations than can impact RCS inventory are continuously monitored. Procedures and contingency's are established in the event of freeze seal failure. (NUMARC guideline 4.2.2.6).

_____(3)Verify procedures for reactor cavity seal failure or loss of cavity inventory (NUMARC 91-06 guideline 4.2.5.2)

_____(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 4.2.2.1).

C.Equipment

_____Two low pressure ECCS injection/spray subsystems shall be operable (BWR STS 3.5-7 except when the spent fuel storage pool gates are removed).

III.AC Power Guidelines

_____(1)One qualified circuit between the offsite transmission network and the onsite 1E AC electrical power distribution subsystems shall be operable(BWR/4 STS 3.8.2)

_____(2)One diesel generator capable of supplying one division of the onsite class 1E electrical power distribution subsystems shall be operable (BWR/4 STS 3.8.2)

_____(3)The necessary portions of the AC, DC, and vital AC bus electrical power distribution subsystems shall be operable to support equipment required to be operable. (BWR/ STS 3.8.10)

IV.Containment Control Guidelines

_____Secondary Containment shall be operable during fuel movement, core alterations, and during operations with a potential for draining the reactor vessel. (BWR STS 3.6.4.1)

VI.Reactivity Guidelines

_____assumes existing core alteration 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."