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MFN 09-074

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U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

Subject: **Submittal of a Portion of Response to NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application - Chapter 19 - PRA and Severe Accidents - RAI Number 19.2.4-1 S03, Supplemental Response**

The purpose of this letter is to submit a supplemental response to Nuclear Regulatory Commission (NRC) Request Additional Information (RAI) 19.2.4-1 S03 as committed the original response (Reference 1).

NRC requested 19.2.4-1 S03 in Reference 2. The response to RAI 19.2.4-1 S02 was provided in Reference 3 as requested by NRC in Reference 4. The response to RAI 19.2.4-1 S01 was provided in Reference 5 as requested by NRC in Reference 6. The original response to RAI 19.2.4-1 was provided via Reference 7 in response to NRC request (Reference 8).

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-892 - Submittal of a Portion of Response to NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application - Chapter 19 - PRA and Severe Accidents - RAI Number 19.2.4-1 S03, dated November 14, 2008

2. MFN 08-649 - Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 222 Related To ESBWR Design Certification Application*, dated August 15, 2008

3. MFN 05-169 S03 - Response to Portion of NRC Request for Additional Information Letter No. 121 Related to ESBWR Design Certification Application - PRA & Severe Accidents - RAI Number 19.2.4-1 Supplement 2, dated April 3, 2008

4. MFN 05-169 S02 - *Response to Portion of NRC Request for Additional Information Letter No. 3 Related to ESBWR Design Certification Application, RAI Number 19.2.4-1 S01*, dated October 5, 2007

5. MFN 07-658 - Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 121 Related To ESBWR Design Certification Application*, dated December 5, 2007

6. Emails from T. Kevern (NRC) To GEH, February 6, 2007

7. MFN 05-169 - *Response to NRC Request for Additional Information Letter No. 3 Related to ESBWR Design Certification Application – Chapter 19 – PRA & Severe Accident*, dated December 29, 2005

8. MFN 05-156 – Letter from U.S. Nuclear Regulatory Commission to David H. Hinds - *Request for Additional Information Letter No. 3 for the ESBWR Design Certification Application*, dated December 8, 2005

Enclosures:

1. MFN 09-074 – Response to Portion of NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application - Chapter 19 - PRA and Severe Accidents - RAI Number 19.2.4-1 S03 Supplemental Response

2. MFN 09-074 – Response to Portion of NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application - Chapter 19 - PRA and Severe Accidents - RAI Number 19.2.4-1 S03 Supplemental Response - Step-by-step Review of Containment Flood SAG

cc:	AE Cubbage	USNRC (with enclosure)
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Enclosure 1

MFN 09-074

Response to Portion of NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application

Chapter 19

PRA and Severe Accidents

RAI Number 19.2.4-1 S03

Supplemental Response

For historical purposes, the original text of RAI 19.2.4-1 and any previous supplemental text and GE/GEH responses are included preceding each supplemental response. Any original attachments or DCD mark-ups are not included to prevent confusion.

RAI 19.2.4-1

Provide a discussion or commitment (combined operating license action item) regarding the accident management program under which guidance and training would be provided on the use of such features as containment venting, drywell sprays, and AC-independent fire pumps for isolation condenser make-up.

GE Response

Revision 1 to the ESBWR DCD Chapter 19 will contain a list of COL Applicant commitments that include the following text:

"The COL Applicant referencing the ESBWR certified design will develop and implement severe accident management guidance, along with the required procedures and training, using the framework provided in DCD Chapter 18, Appendix A."

ESBWR DCD Revision 1 is to be submitted in accordance with the schedule provided in GE Letter, MFN 05-139, dated November 22, 2005.

Received by e-mail from Tom Kevern.

NRC RAI 19.2.4-1 S01

The response provided to RAI 19.1-18 discussed uncertainty and sensitivity analyses related to the EPRI BWR Applications Guidelines. This report only addressed thermalhydraulic phenomena that are important to predicting severe accident sequences. It did not address severe accident-related model parameters, nor did the response to the RAI.

Please document any analyses in which MAAP model parameters were varied, particularly those related to peak drywell pressure during a high-pressure scenario and to the potential for drywell liner failure in sequences where the BiMAC does not function.

GEH Response

See response to RAI 19.1-18 S01.

DCD/NEDO 33201 Impact

No DCD changes will be made in response to this RAI.

No changes to the subject NEDO-33201 will be made in response to this RAI.

NRC RAI 19.2.4-1 S02

The response to RAI 19.4.2-1 in MFN 05-169 indicated that Revision 1 to the DCD Chapter 19 would contain a list of COL Applicant commitments that would include text indicating that the COL applicant referencing the certified design will develop and implement severe accident management guidance, along with the required procedures and training, using the framework provided in DCD Chapter 18, Appendix A. In Revision 4 of the DCD, such text does not exist. Instead, Chapter 18, Revision 4, now has the following wording:

Technical bases for severe accident management (core damage prevention and mitigation strategies and actions to limit radionuclide releases with off-site dose limits) are documented in Item 7 of DCD Tier 1, Table 3.3-1 for HFE. Standard guidelines, procedures, and training modules are developed as described in Reference 18.1-1. The PRA and Human Reliability Assessment (HRA) confirm that the Emergency Procedure Guidelines (EPGs) and severe accident guidance effectively address:

- *o Preventing core damage,*
- *o Recovering from core damage*
- *o Maintaining containment integrity, and*
- *o Minimizing radionuclide releases*

The standard guidance and EPGs are used to develop and validate site-specific severe accident mitigation guidelines and procedures that satisfy Reference 18.1-2.

Reference 18.1-1, dated July 2007, is an ESBWR Licensing Topical Report that describes the Man-Machine Interface and Human Factors Engineering Implementation Plan. Reference 18.1-2 is an Industry document (NEI 91-04, Revision 1) on Severe Accident Closure Guidelines that provides an overview on how the existing plants should implement severe accident management guidelines. Section 3.2.4.5 of Reference 18.1-1 describes what GE calls its Emergency Management Program. This section lists GEH and applicant responsibilities in developing an emergency management program that would include procedures for preventing and mitigating the effects of severe accidents. The tone of the write up suggests that GEH may be considering the accident management program to be a COL information item. However, Section 19.3.6 of Revision 4 of the DCD omits any mention of it.

In light of the above, please answer the original RAI again, namely, provide a discussion or commitment (combined operating license information item) regarding the severe accident management program under which guidance and training would be provided on the use of such features as containment venting, drywell sprays, and AC-independent fire pumps for isolation condenser make-up.

GEH Response

Note that this response is substantially similar to the GEH response to NRC RAI 18.9-1 S02 (MFN 08-155, dated March 26, 2008) as the subject matter of the two RAIs is closely related.

The COL applicant commitments discussed in previous answers to this RAI will not be added to the DCD. As described below, ESBWR EPG/SAGs and the EOPs and SAMGs derived from them will be developed by the ESBWR design team.

The GEH top down HFE operational analysis and procedures development process will generate ESBWR EPGs/SAGs and the EOPS and SAMGs derived from them. Additionally, the HFE training development process will generate the training required to support performance of the ESBWR EOPs and SAMGs. Details regarding the documents that govern these processes are provided below.

DCD Reference 18.1-1, dated July 2007, is an ESBWR Licensing Topical Report (LTR) that describes the Man-Machine Interface and Human Factors Engineering. This reference was intended to provide insight into the integration and implementation of all DCD chapter 18 HFE activities with additional LTRs providing the details of how each HFE processes (such as training, procedures, etc) are to be implemented. In the case of EOPs/SAMGs, two HFE process area LTRs (NEDO-33274 ESBWR HFE Procedures Development Implementation Plan and NEDO-33275 ESBWR HFE Training Development Implementation Plan) provide detail and insight into the ESBWR severe accident management program development and the programs incorporation into the ESBWR training program.

ESBWR HFE Procedures Development Implementation Plan, NEDO-33274, Rev 2, March 2007 presents the procedure development processes and methodologies to be used in the development of procedures including ESBWR SAGs and the ESBWR SAMGs derived from them. Appendix A of NEDO-33274 "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" provides high-level summary insight into the severe accident management program.

Revision 2 of NEDO-33274 provides a high level presentation of how ESBWR EPGs and SAMGs are to be generated. The NEDO commits to deriving ESBWR EPGs/SAGs from BWROG EPG/SAG Rev 2. Additionally, the NEDO commits to implementing the HFE top-down operational analysis process contained in NUREG-0711, Rev 2 to develop the ESBWR EPGs/SAGs and the EOPs and SAMGs developed from their requirements. Using the processes described in NEDO-33274, Rev 2 and the requirements and regulations noted in it, the following EOP development actions will be performed:

- ESBWR specific Appendix C calculations will be developed from the BWROG EPG/SAG, Rev 2 Appendix C adapted using ESBWR plant specific design input, analyses, instrument set points, vendor input, and other system data.

- ESBWR specific EPG/SAGs will be developed from the BWROG EPG/SAG, Rev 2 using the ESBWR specific Appendix C calculations, ESBWR plant specific Design input, PRA input, ESBWR philosophy of operation, and HFE operational analysis.

- ESBWR specific EOP writer's guide will be developed using EPG/SAG Rev 2 guidance, industry examples, HFE design team input, and ESBWR HSI design inputs. The ESBWR EOP writer's guide will provide details of the specific methods for translating and transcribing the ESBWR specific EPG/SAGs into EOPs and SAMGs.

- ESBWR EOP and SAMG flow charts and supporting emergency procedures will be generated using the ESBWR specific writer's guide, EPG/SAGs, and Appendix C calculations discussed above.

Because they are written using, and benefit from, the top-down design process outlined in NUREG-0711, Rev 2, the ESBWR specific EPG/SAGs and the EOPS and SAMGs developed from them will not be available for submittal to the NRC prior to design certification. The ESBWR HFE operational analysis process will be completed in three phases (design, detailed, and economic). The design analysis is currently in progress and analyzes the operation of the ESBWR and its systems with everything functioning as designed. The detailed analysis phase takes place following the completion of design phase analysis and analyzes the operation of the ESBWR and its systems during alarm, abnormal, and emergency conditions. ESBWR SAGs will be developed during the detailed phase of operational analysis. ESBWR SAGs and the SAMGs derived from them will be complete and available for NRC review.

As ESBWR SAGs are integral to the development of ESBWR SAMGs they will be complete and available for NRC review no later than the completion date for DCD Tier 1 Table 3.3-1 ITAAC 7. ESBWR Training Development implementation Plan, NEDO-33275, Rev 1, February 2007 presents the training development processes and methodologies to be used in the development and delivery of training including the ESBWR SAMGs.

Using the HFE top-down analysis process presented in NEDO-33275, Rev 1, each plant function will be analyzed and broken down into tasks with associated procedures. These tasks are also analyzed in accordance with the ESBWR systematic approach to training process to ultimately determine:

- Knowledge and ability requirements,
- Needed training,
- Training objectives,
- Training frequency,
- Training materials needed,
- Training venue,

- Needed scenarios (if simulator or mockup training is determined to be appropriate),
- Examination methodology,
- Failure criteria, and
- Any other training program attributes that need to be associated with the tasks.

In the case EOP/SAMG training, analysis will determine and establish requirements for initial and requalification training on all tasks contained in the ESBWR EOPs/SAMGs.

Though the training analysis is not yet complete, it is expected that both classroom and simulator training will be required for EOP/SAMG procedures that provide guidance for addressing such things as:

- Preventing core damage
- Recovering from core damage
- Maintaining containment integrity, and
- Minimizing radionuclide releases

DCD Impact

No DCD changes will be made in response to this RAI.

No changes to the subject LTRs (NEDO-33274 ESBWR HFE Procedures Development Implementation Plan and NEDO-33275 ESBWR HFE Training Development Implementation Plan) will be made in response to this RAI.

NRC RAI 19.2.4-1 S03

Question Summary: Technical basis for severe accident management

Full Text:
In response to RAI 19.2.4-1 S02 in MFN 05-169, Supplement 3, GEH described how the technical basis for severe accident management would be developed for the ESBWR plants. Specifically, GEH states that it will perform four ESBWR-specific EOP development actions: Appendix C calculations, EPG/SAGs, EOP writer's guide, and EOP and SAMG flow charts. GEH also stated that these products would not be available to the NRC prior to design certification.
Since the NRC would need to review the severe accident management technical basis before a COL is issued, please provide documentation of the ESBWR-specific Appendix C calculations and EPG/SAGs for NRC Staff review. Also, either provide the writer's guide and EOP SAMG flow charts, or identify the development of these products as COL action items.

GEH Response

This response is based on reviews of previous responses to this RAI; resolved response to RAI 19.2-37; NUREG-0800 Chapters 13, 18, and 19; 10CFR52 - Licenses, Certifications, And Approvals For Nuclear Power Plants; NRC Inspection Manual 2504, Construction Inspection Program - Non-ITAAC Inspections; and Regulatory Guide 1.206 C.I.13.5.2.1 - Operating and Emergency Operating Procedures; and a teleconference held October 29, 2008 among NRC, GEH and utility personnel.

As a result of an improved understanding of deliverables required to satisfy NRC review of severe accident technical basis, GEH will provide an assessment of the impact of ESBWR PRA insights on ESBWR Severe Accident Management. This assessment will take the form of modifications to Section 4.0 of the BWR Owners' Group Accident Management Guidelines Overview Document capturing the ESBWR PRA as an input to severe accident insights and evaluating the PRA insights for impact on severe accident principles. Changes to the principles and new insights will then be used to recommend changes to BWROG generic severe accident strategies. This assessment will include particular emphasis and more detailed evaluation of the GDCS and BIMAC system impacts on severe accident strategies.

The output of this assessment will provide the supplement to this RAI response no later than January 31, 2009.

The supplement to this response is included as follows below.

RAI 19.2.4-1 S03 – Supplement

Assessment of the impact of ESBWR PRA insights on ESBWR Severe Accident Management

Supplemental Response Summary
The central deliverable in this supplement as committed in response to RAI 19.2.4-1 S03 is an assessment that proposes modifications to Section 4.0 of the BWR Owners' Group Accident Management Guidelines Overview Document capturing the ESBWR PRA as an input to severe accident insights and evaluating the PRA insights for impact on severe accident principles.

Changes to the principles and new insights will then be used to recommend changes to BWROG generic severe accident strategies.

This assessment will include particular emphasis and more detailed evaluation of the GDCS and BIMAC system impact on severe accident strategies.

Summary:
The review focused on changes to the BWROG SAG strategies resulting from ESBWR PRA insights and design changes particularly GDCS and BiMAC. This high level assessment concludes that there are conditions for which containment flooding prescribed in the BWROG EPG/SAG Revision 2 is counter to successful mitigation of event progressions that lead to vessel breach for the ESBWR. As discussed in references 6 and 7, BiMAC was invented to provide ex-vessel debris cooling without risk of energetic steam explosions caused by water below the vessel. The fundamental objective of the BWROG SAG to submerge core debris through intelligent containment flooding from external injection sources will be modified to account for the BiMAC design.

GDCS contributes little to the changes in strategy as successful GDCS avoids core damage and entry to SAG is unnecessary.

Other insights include:
- limitations on use of drywell sprays
  (to limit impact on PCCS/GDCS operation and lower drywell level)
- simplified RPV venting through use of DPVs
- impact of DPV failure
- flooding for lower DW level above EVE containment failure elevation

Process
ESBWR documents, ESBWR Severe Accident Phenomenology, NEDO-33255 and PRA Insights Affecting ESBWR Design, NEDO-33201 Chapters 18 and 21, were reviewed for insights that might affect the principles identified in the BWROG Overview Document or strategies in the BWROG EPG/SAG Revision 2. A high level step-by-step review of the BWROG SAG was conducted to determine impact on individual SAG steps focusing on the Containment Flooding section.

Resulting changes and comments on the BWROG AMG Overview Document are highlighted by revision bars and colored text.

4.0 EPG CHANGES

As discussed in Section 1 of this document, the original BWROG AMG approach was to use the EPGs to implement severe accident mitigation strategies. All BWROG AMG changes were initially developed as EPG changes to support that approach. Section 9 of this document contains a partial listing of industry accident management related documents. Severe accident insights from these documents were reviewed during the development of the EPG and SAG strategy changes. The principal sources and documents used to generate the insights include:

1. Individual Plant Examinations (IPEs): The BWROG Severe Accident Evaluation Committee (SAEC) met to identify and discuss potential insights from IPEs performed by various utilities. **Reference:** Transcript of BWROG SAEC meeting on September 2, 1991, regarding IPE insights, forwarded under GE Letter OG91-988-58 dated December 2, 1991.

2. NRC "A" Strategies: The NRC collection of candidate accident management strategies from various NRC and industry reports. **Reference:** Assessment of Candidate Accident Management Strategies, NUREG/CR-5474.

3. Severe Accident Applicability Review of the EPGs: This document was prepared for the BWROG by a contractor team. **Reference:** "Categorization of Observations from Severe Accident Applicability Review of EPG Rev. 4 Report," attachment to a letter from P.S. Smith to B. Berg and B. Williamson dated July 13, 1990.

4. UCLA BWR Accident Management Workshop: This is summary of discussion at the workshop. **Reference:** Summary of a Workshop on Severe Accident Management for BWRs, NUREG/CR-5780.

5. Severe Accident Management Guidance Technical Basis Report: This report provides a technical basis for the development of AMGs. **Reference:** Severe Accident Management Guidance Technical Basis Report, EPRI TR-101869, Vol 1 & 2.

6. ESBWR Severe Accident Phenomenology: This report provides description of severe accident for ESBWR including detailed description of BIMAC. **Reference**: ESBWR Severe Accident Phenomenology, NEDO-33255.

7. PRA Insights Affecting ESBWR Design: Summarizes design impact of the ESBWR risk profile including uncertainty, and assumptions., **Reference**: PRA Insights Affecting ESBWR Design, NEDO-33201 Chapter 18

Information from the various sources was assigned to one of several categories (or bins) to facilitate the development of BWR principles. Only information which was substantive and substantiated and which was not previously considered in the development of generic accident management guidance (e.g., EPGs and SAG) was assigned to bins. The following BWR principles were developed as a result of the binning process.

1. Steam Explosion
   a. An in-vessel steam explosion in a BWR is very unlikely due to the lower plenum internals configuration.
   b. The MK I/II/III containments cannot survive a large ex-vessel steam explosion with or without effective pressure suppression.
   c. A large ex-vessel steam explosion is unlikely.

[For ESBWR] The CF EVE outcome (containment failure by ex-vessel steam explosion) is assumed in light of the large uncertainties that would have to be addressed if a claim was to be made to otherwise. (from NEDO-33201 Rev. 3, Chapter 21.6 Conclusions Summarized in the Form of CPETS)

2. High Pressure Melt Ejection (HPME) / Direct Containment Heating (DCH)
   a. HPME and DCH are precluded if the RPV is depressurized when it is breached.
   b. HPME and DCH alone will probably not fail the containment if the containment is not pressurized and pressure suppression is available when the RPV is breached.

3. Core-Concrete Interaction (CCI)
   a. CCI can generate four to five times as much gas as is normally present in the containment.
   b. CCI can generate gas at temperatures as high as 3000°F.
   c. CCI can generate combustible concentrations of carbon monoxide (CO).
   d. CCI will continue until ex-vessel core debris is flooded and quenched.

   BiMAC operation makes CCI physically unreasonable [Figures 21.6-1 & 2]

4. Recriticality
   a. Control material will melt before fuel rods melt.
   b. Recriticality as a result of flooding a core in which control blades have melted but fuel rods have not is very unlikely.
   c. A debris bed in-vessel or ex-vessel will not become critical if submerged with water.

5. In-Vessel Debris Cooling
   a. Submerging core debris will retain it in the RPV.
   b. Flooding core debris which is above the core support plate provides more effective cooling than spraying the debris.
   c. Unless core debris in the RPV can be cooled or the drywell can be cooled and depressurized, high drywell temperature and pressure will fail the drywell head seals and, eventually, the drywell.

6. External Vessel Cooling
   a. If the RPV skirt is vented, flooding the containment to above TAF will retain all

core debris in the RPV.

b. If the RPV skirt is not vented, flooding the containment to above the top of the in-vessel core debris can delay RPV failure by several hours.

c. Flooding the containment to above the RPV lower head before lower plenum dryout will preclude subsequent in-core instrument thimble failures.

We concluded that this could be a highly effective approach for the ESBWR as well, however, only if all equipment found hanging from the lower head penetrations were to be supported from the outside so as to maintain the melt containing capacity of the lower head. This proved unworkable from the operational perspective, and the option was rejected by the design managers. On the other hand, we determined that the coolability question could be addressed ex-vessel and with a high degree of certainty. (From Chapter 21.1)

7. <u>Ex-Vessel Debris Cooling</u>
   a. Submerging all core debris in the MK I drywell will preclude drywell failure due to creep rupture or melt-through of the liner at the core debris/liner interface.
   b. Unless core debris in the drywell can be cooled, the drywell will fail.

8. <u>Pressure Suppression</u>
   a. Pressure suppression in most MK II containments will be lost shortly after the discharge of core debris from the RPV begins.

9. <u>Determination of Accident Progression</u>
   a. It is not reasonable to expect that the onset of core melting will be identified by the control room or TSC staff when it occurs.
   b. It is not reasonable to expect that the relocation of core debris to the lower plenum will be identified by the control room or TSC staff when it occurs.
   c. It is reasonable to expect that RPV breach by core debris will be identified by the control room and TSC staff when it occurs.

10. <u>Control and Termination of the Accident</u>
   a. Any plant state in which fuel or core debris is not cooled is not a stable state.
   b. A severe accident will not be controlled and terminated until all fuel and core debris is quenched and submerged.
   c. An accident in which the RCS is breached below TAF is not controlled and terminated until the containment is flooded to above TAF.

The above BWR principles, along with other EPG issues, were used to recommend changes to the EPGs. EPG changes were incorporated in the following areas:

	ESBWR design/PRA impacts
o Power control by water level reduction	not impacted
o Recriticality control by soluble boron	not impacted
o Steam cooling without injection	not impacted
o Prevention of RPV repressurization	use DPV

o	RCS cooling by core spray	no core spray
o	Integrated Containment Flooding (ICF)	
	- RCS cooling by ex-vessel flooding	BIMAC first
	- In-vessel cooling by spray	no core spray
	- In-vessel cooling by submergence	GDCS function
	- In-vessel cooling by ex-vessel flooding	BIMAC first
	- Pool cooling by mass addition	not impacted
	- Steam condensation by spray	no core spray
	- Ex-vessel cooling by RPV injection	not impacted
	- Ex-vessel cooling by drywell spray	avoid water in lower DW & PCCS impact
	- Ex-vessel cooling by flooding	if DW level > 1.5 m
	- RCS scrubbing by core spray	no core spray
	- RCS scrubbing by submergence	not impacted
	- PC scrubbing by submergence	not impacted
	- Venting	use DPV
o	Venting Strategy	
	- Pressure control	not impacted*
	- PC radionuclide release control	not impacted
o	RPV pressure control by injection termination	not impacted
o	N_2 inertion	not impacted
o	Primary containment scrubbing by spray	not impacted
o	Debris cooling by BiMAC	new

Because the BWROG AMG strategies will be issued as two discrete products (EPGs and SAG) in one document, the developed changes span both products. The bulk of the recommended changes will appear in the SAG but changes to the EPGs are still required for the following reasons:

- o Remove actions beyond the scope of the EPGs
- o Modify the EPGs to provide a seamless transition into the SAG
- o Incorporate actions that remain within the EPG scope, identified during development of the BWROG AMG strategies.

The RPV and Containment Flooding strategy is beyond the scope of the EPGs. This strategy is contained entirely in the SAG and therefore changes are provided to remove the Primary Containment Flooding strategy from the EPGs.

To ensure that the EPGs and the SAG continue to function as an integrated set of instructions, necessary changes to the EPGs were developed to ensure a seamless transition from the EPGs into the SAG. In addition to RPV and Containment Flooding, portions of all EPG strategies remain applicable in the SAG. These strategies include guidance for

- o Reactor Power Control
- o RPV Pressure Control
- o RPV Level Control (part of RPV and Containment Flooding)

- o Suppression Pool Water Level Control (part of RPV and Containment Flooding)
- o Suppression Pool Temperature Control
- o Drywell Temperature Control
- o Containment Temperature Control
- o Combustible Gas Control
- o Secondary Containment Area Temperature Control
- o Secondary Containment Area Radiation Control
- o Secondary Containment Area Water Level Control
- o Offsite Radioactivity Release Control.

EPG changes are provided to ensure a smooth coordinated transition into the SAG for each of these areas.

* Containment venting strategies to facilitate flooding will be impacted by ESBWR design if injection sources used are part of the design. Adequate discharge pressure is provided for makeup pumps to assure that core cooling flow will be available at containment failure pressure. Prior designs may need to maintain containment pressure below the failure pressure to support injection from alternate injection systems (service water and fire water) to facilitate flooding. NOTE that SAG containment flooding does not assume anything about the injection source (allows for use of off site equipment which may not be capable of the same flow rates and discharge pressures).

End of BWROG Accident Management Guideline Overview Document Section 4.0

PRA INSIGHTS

NEDO-33201 Revision 3, Section 18.4 describes the process used to identify key assumptions and insights. The key insights are identified in Table 18.1-1, Risk Insights and Assumptions. A review of the table for impact on the SAG is provided below.

Additional insights have been isolated from Chapter 21 of NEDO-33201 Revision 3 to support evaluation of external vessel steam explosions and ex-vessel cooling.

These insights provide the basis for exceptions taken to the BWROG EPG/SAG principles and changes in Section 4.0 of the BWROG Accident Management Guideline Overview Document.

Table 18.1-1 Risk Insight and Assumption Evaluation

Insight or Assumption	Disposition	Potential Impact on SAG
Dominant initiating events for internal events: %T-IORV, %T-GEN, %TFDW, and %T-LOPP are applied using operating experience data. LOCA frequencies (%LL-S-FDWB) are also applied using operating experience data. Overall, none of the dominant initiating events are considered to have unique risk insights.	Insight	Insight does not impact SAG
The most important Level 2 initiating events are %T-IORV, %T-GEN, and %T-FDW; however, they result in controlled releases. The most important large release initiating event is %LL-S-FDWB, which represents a Large LOCA in Feedwater Line B.	Insight	Insight does not impact SAG
The containment provides a highly reliable barrier to the release of fission products after a severe accident, with the dominant release category being that defined by Technical Specification leakage (TSL).	Insight	Insight does not impact SAG
The Level 3 results indicate that the offsite consequences due to internal at-power events are negligible. The results, including sensitivity studies, demonstrate that the estimated offsite consequences are less than the defined individual, societal, and radiation dose limits by several orders of magnitude.	Insight	Insight does not impact SAG
The ESBWR front-line safety functions are passive and, therefore, have significantly less reliance on the performance of supporting systems or operator actions. In fact, ESBWR does not require operator actions for successful event mitigation until 72 hours after the onset of an accident.	Insight	Insight does not impact SAG
The ESBWR design reduces the reliance on AC power by using 72-hour batteries for several components. Diesel-driven pumping has been added as a diverse makeup system. The core can be kept covered without any AC sources for the first 72 hours following an initiating fault. This ability significantly reduces the consequences of a loss of preferred (offsite) power initiating fault.	Insight	Insight does not impact SAG
Anticipated Transients Without Scram (ATWS) events are low contributors to plant core damage frequency (CDF) because of the improved scram function and passive boron injection.	Insight	Insight does not impact SAG
The ESBWR design reduces the frequency and consequences of loss of coolant accidents (LOCA) due to large diameter piping by removing the recirculation system altogether.	Insight	Insight does not impact SAG

Insight or Assumption	Disposition	Potential Impact on SAG
The design of the ESBWR reduces the possibility of a LOCA outside the containment by designing to the extent practical all piping systems, major system components (pumps and valves), and subsystems connected to the reactor coolant pressure boundary (RCPB) to an ultimate rupture strength at least equal to the full RCPB pressure.	Insight	Insight does not impact SAG
The probability of a loss of containment heat removal is significantly reduced because the Passive Containment Cooling System is highly reliable due to redundant heat exchangers and totally passive component design.	Insight	Insight does not impact SAG
The ESBWR is designed to minimize the effects of direct containment heat, ex-vessel steam explosions, and core-concrete interaction The ESBWR containment is designed to a higher ultimate pressure than conventional BWRs.	Insight	The higher containment ultimate pressure will increase the Primary Containment Pressure Limit (PCPL-C) and containment venting pressure. Limited impact on action step. See review of BiMAC for additional insights.
Dominant sequences typically do not contain independent component failures. Instead, they consist of common cause failures that disable entire mitigating functions. And, it is important to note that multiple mitigating functions must fail in the dominant sequences, so a single common cause event is insufficient to directly result in core damage.	Insight	Insight does not impact SAG
The most significant seismic margins contributor is seismic-induced loss of DC power, and ATWS due to seismic-induced failure of the fuel channels and seismic-induced failure of the SLC tank.	Insight	Insight does not impact SAG
LOCA frequencies. For each pipe group, the number of lines, the number of sections (assessed on the basis of layout drawings), the frequency apportionments, and the final averaged frequencies. These data are binned into the LOCA initiator classes, as summarized in Section 2, Table 2.3-2. Sensitivity study results indicate that changes in the LOCA frequencies have the potential to impact CDF.	Insight	Insight does not impact SAG
Sensitivity study results indicate that changes in the human error failure probabilities, particularly pre-initiators, have the potential to impact CDF.	Insight	Insight does not impact SAG
Sensitivity study results indicate that squib valve failure rate estimates have the potential to impact CDF	Insight	Insight does not impact SAG
Sensitivity study results indicate that changes in test and maintenance unavailability do not significantly impact the CDF or insights.	Insight	Insight does not impact SAG

Insight or Assumption	Disposition	Potential Impact on SAG
Accident sequences in which DPVs are challenged contribute to approximately 61% of the CDF. In two-thirds of the cases the DPVs are demanded and are successful, and in one-third of the cases the DPVs are demanded and have failed.	Insight	DPVs are the obvious RPV vent path. Failure probability suggests ensuring that alternates are available. [MSL drain, RPV head vent, SRVs] Limited impact on action steps.
Core damage sequences involving failure of ICS are Class I or III sequences where high pressure makeup has failed and either failure to depressurize occurs or low pressure injection is not available. Given that ICS is failed, the failure of PCCS, or failure to provide make-up to the pools are not significant contributors to core damage frequency.	Insight	Insight does not impact SAG
FAPCS and FPS injection capability provide adequate core cooling for transients given successful DPV or ADS valve operation, even if containment pressure is at the ultimate containment pressure.	Design Requirement	Venting to "facilitate containment flooding" would be limited to non-design pumping capability [offsite resources - fire trucks]. Limited impact on action steps.
CRD injection is unaffected by containment overpressurization failure. This is an important assumption, based on the containment failure analysis, that supports the use of CRD in these sequences.	Design Requirement	Insight does not impact SAG
The DPS cabinet is assumed to be located in a separate fire area in the control building. A preliminary fire PRA analysis model with DPS cabinet located inside room 3301 shows that the fire risk in fire area F3301 would be the dominant contributor to all fire risks due to the high failure probability of common cause failure of software for the safety system, the failure of DPS, and multiple nonsafety-related systems impacted by a fire in room 3301. With a separate fire area for the proposed DPS cabinet in the detailed design, the fire risk can be significantly reduced.	Design Requirement	Insight does not impact SAG

Insight or Assumption	Disposition	Potential Impact on SAG
The ESBWR design features as described in DCD Tier 2 Section 7.1.3 help minimize the adverse affect on safe shutdown due to fire-induced spurious actuations. First of all, the ESBWR instrumentation and control system is digital. A spurious signal cannot be induced by the fire damages in a fiber optic cable. The hard wires are minimized to limit the consequences of a postulated fire. Typically the main control room (MCR) communicates with the safety-related and nonsafety-related DCIS rooms with fiber optics. From the DCIS rooms to the components, fiber optics will also be used up to the Remote Multiplexing Units (RMUs) in the plant. Hard wires then are used to control the subject components. Typically two load drivers are actuated simultaneously in order to actuate the component. To eliminate spurious actuations, these two load drivers are located in different fire areas. Therefore, a fire in a single fire area cannot cause spurious actuation.	Design Requirement	Insight does not impact SAG
Since the main control room communicates with the DCIS rooms via fiber-optic cables, no spurious actuations due to electrical shorting will be originated from a MCR fire.	Design Requirement	Insight does not impact SAG
It is assumed that the doors that connect the Control and Reactor Buildings with the Electrical Building galleries are watertight, for flooding of the galleries up to the ground level elevation.	Design Requirement	Insight does not impact SAG
The Class IV (ATWS) sequences experience core damage at high pressure because ADS is inhibited as part of the core damage mitigation effort. <u>However, it is assumed that Emergency Operating Procedures (EOPs) will instruct the operator to depressurize after core damage has occurred in an attempt to preserve containment</u>. It is shown in Appendix 8A that the frequency of ATWS sequences experiencing RPV rupture at high pressure is negligible, so only failures at low pressure were analyzed.	Operational Program	Depressurization in the EPG takes place prior to core damage. Since the EPG depressurization would occur early, this timing does not have a significant impact.
Venting is assumed to occur when the containment pressure reaches 90% of the ultimate containment strength.	Operational Program	Insight may impact the value of the PCPL.
During shutdown conditions, a fire barrier may not be intact due to maintenance activities. However, an added fire watch would not only increase the success probability of fire detection and suppression, but also help restore the fire barrier in time to prevent fire propagation. Shutdown fire risks related to the fire barriers are evaluated and managed in accordance with the outage risk management program of 10CFR50.65(a)(4).	Operational Program	Shutdown conditions are not specifically addressed by SAG.

Insight or Assumption	Disposition	Potential Impact on SAG
All LOCAs below TAF during shutdown require closure of lower drywell hatch. The hatch can be opened during shutdown. If a break occurs in the lower drywell and the hatch is not closed, core damage is assumed to occur (once the water level reaches the bottom of the hatch, it is assumed that the door can not be closed and the leak not isolated).	Operational Program	Shutdown conditions are not specifically addressed by SAG.
An important recovery action during shutdown is to recover at least one train after loss of both operating RWCU/SDCS trains.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
An important recovery action during shutdown is to recover Service Water function after loss of PSW.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
The plant should not be in a Mode 6 Unflooded condition when a hurricane strike occurs. This is because in Mode 6 unflooded the containment is open, the reactor vessel is open and the water above the core will not keep the core cool for an extended period of time.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
The greatest contribution to shutdown risk comes from breaks in lines connected to the vessel below TAF. In these cases, the lower drywell equipment hatch or personnel hatch is likely to be open to facilitate work in the lower drywell. Although the frequency of these events is very low, there is only one method for mitigation – manual closure of the hatch(es).	Operational Program	Shutdown conditions are not specifically addressed by SAG.
The dominant risk contributor with respect to shutdown modes is "Mode 6 Unflooded." This is consistent with the baseline shutdown CDF results since the isolation condenser system is not credited in the Mode 6 Unflooded event trees. Therefore, it is necessary to ensure the operability of the systems critical to decay heat removal function during this mode.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
It is assumed that the watertight doors are normally closed at power. Opening of the doors would generate an alarm in the Control Room, and procedures direct their immediate closure upon receipt of an alarm.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
It is assumed that, during shutdown, manual and automatic depressurization (ADS) of the vessel are available while the vessel head is in place.	Operational Program	Shutdown conditions are not specifically addressed by SAG.
It is assumed that the actuation of the GDCS due to an RPV Level 1 water level signal is available during the entire shutdown period.	Operational Program	Shutdown conditions are not specifically addressed by SAG.

Chapter 21 insights

The following have been extracted from Chapter 21 discussion and applies to comments on the BWROG Accident Management Guideline Overview Document and the discussion of impact of BiMAC that follows.

21.1 Overview of ESBWR Design Features to Eliminate Hypothetical Severe Accident Threats to Containment Integrity – paragraph 4
As one potential option we examined the applicability and effectiveness of In-Vessel Retention (IVR)—an internationally pursued severe accident management approach, already developed and utilized for the passive PWR designs in the USA (Theofanous et al, 1996). We concluded that this could be a highly effective approach for the ESBWR as well, however, only if all equipment found hanging from the lower head penetrations were to be supported from the outside so as to maintain the melt containing capacity of the lower head. This proved unworkable from the operational perspective, and the option was rejected by the design managers. On the other hand, we determined that the coolability question could be addressed ex-vessel and with a high degree of certainty.

Provides basis for design and use of BiMAC vice external vessel cooling.

21.4.4.5 Prediction of Failure Probability
The results of the previous two sections on pedestal loads and fragility are juxtaposed in Figure 21.4.4.5-1. The loads from 1 and 2 m (3 and 6.5 ft) deep, highly sub-cooled pools are taken to bound loads from shallow, saturated pools. There is a huge margin in this bound, and as the figure shows there an extra huge margin to failure even given this bounding of loads. Thus we conclude that in 99% [88%] of the Class I severe accidents in ESBWR, pedestal failure by an EVE are physically unreasonable. This covers ~99% [~41%] of the CDF.

The remaining 1% refers to Class I with deep (H >> 1.5 m (4.9 ft)) [10% of Class I], sub-cooled water pools. For such pools, although not considered in any detail here, an appropriately conservative position would be that "integrity of both the liner and the concrete structure could be possibly compromised".

Provides basis for use of LDW level qualifier for successful BiMAC operation without risk from EVE.

21.4.5 Summary and Conclusions for EVE
The above results show that for all but 1% [6%] of the CDF, that is accidents involving deep, subcooled water pools, violation of the ESBWR containment leak-tightness, and of the BiMAC function, due to ex-vessel steam explosions are physically unreasonable.

Principal ingredients to such a conclusion can be recapitulated as follows:
(1) An accident management strategy, and related hardware features that prohibit large amounts of cold water from entering the LDW prior to RPV breach,
(2) The physical fact that premixtures in saturated water pools become highly voided and thus unable to support the escalation of natural triggers to thermal detonations,

(3) Reactor pedestal and BiMAC structural designs that are capable of resisting explosion load impulses of over ~500 kPa s (73 psi.s) and ~100 kPa s (14.5 psi.s) respectively.

Provides the basis for limiting containment injection (primarily DW sprays) when conditions for successful BiMAC operation are present.

21.6 Conclusions Summarized in the Form of CPETS - paragraph 4

The CF EVE outcome (containment failure by ex-vessel steam explosion) is assumed in light of the large uncertainties that would have to be addressed if a claim was to be made to otherwise. While we feel that in the frame of ROAAM this could not be effectively accomplished, it may be worth pointing out that other levels of treatment have been proposed and accepted by the US NRC (i.e. the ABWR SSAR) argued that such a failure was not risk-significant. This line of argumentation and related parametric/sensitivity studies can be found in Section 9 of NEDC-33201P. As indicated this outcome pertains to a deeply flooded LDW and reflects less than 1% of the CDF [approximately 5% in PRA Revision 2]. It is important to recall that this low incidence rate of such scenarios was engineered as part of the ESBWR SAM precisely for this reason.

Although there is uncertainty in the merits of external vessel cooling (EVE in deep pools), this statement provides the basis for flooding the LDW when LDW level is already high enough to cause containment failure (DW hatch elevation)

DISCUSSION OF GDCS AND BIMAC DESIGN ON BWROG EPG/SAG REV 2 STRATEGIES

This assessment focuses on the impact of GDCS and BIMAC on severe accident strategies. The strategies being used for comparison are those found in BWROG Emergency Procedure Guideline/Severe Accident Guideline, Revision 2.

BWROG SAG is composed of six separate containment flooding paths that describe the relative priority of containment injection, RPV injection, containment venting, RPV venting and use of sprays. The SAG also provides control paths for radiological release, containment control including combustible gas and secondary containment control. This assessment focuses on the impact of containment flooding.

The containment flooding sections of the SAG were reviewed and a summary of the step-by-step review is reported in Enclosure 2.

GDCS

First, if the GDCS function is successful as described in the design basis DCD Chapter 6.2, the spectrum of Loss of Coolant (LOCA) and loss of RPV injection events result in GDCS actuation with a final reactor vessel level at least 1 meter above TAF. No fuel failure is postulated for this class of event.

Should GDCS fail, assuming no other injection systems are available, core uncovery and severe accident progression begins and SAG applies.

The assumption in this assessment, is that GDCS has failed to actuate long enough for an event to progress to core uncovery. Generic severe accident strategies will attempt to initiate GDCS and other injection systems until the deluge function of the BiMAC is initiated. If the operator is successful in initiating GDCS before vessel failure, there is a possibility that the core debris will be cooled in vessel.

BiMAC

Until the vessel is breached, the SAG attempts to line up injection systems to provide debris cooling such that vessel lower head failure is avoided. In Figure 1 this translates to movement from Steps RC/F-3, 4, 5 and 6 back to the Step RC/F-2 condition of core submergence. The SAG provides a preference for use of external injection.

The primary method of limiting inventory addition to the lower DW would be met through cautions on the use of DW sprays, and adding lower DW level to the conditions in RC/F-5 that wait for vessel breach to occur.

For RPV breaks below TAF, adding water to the RPV to resubmerge the core will add inventory to the lower DW and as long as those actions are effective, either in restoring core cooling or maintaining conditions that make vessel breach unlikely, they would continue.

Has it been determined that core debris has breached the RPV?

Yes → [Step RC/F-1]

No ↓

Can it be determined that RPV water level can be restored and maintained above [-164 in. (top of active fuel)]?

Yes → [Step RC/F-2]

No ↓

Can it be determined that RPV water level can be restored and maintained above [-314 in. (bottom of active fuel)]?

Yes → [Step RC/F-3]

No ↓

Can it be determined that injection into the RPV can be restored and maintained greater than the Minimum Debris Retention Injection Rate?

Yes → [Step RC/F-4]

No ↓

Are suppression chamber pressure and primary containment water level within the Pressure Suppression Pressure?

Yes → [Step RC/F-5]

No ↓

[Step RC/F-6]

Figure 1

Step RC/F-1 – core breach results in initiation of BiMAC. BiMAC cools external debris and limits impact of ex-vessel steam explosion.

Step RC/F-2 – no impact/change as the event has been effectively terminated

Step RC/F-3 – assumption is that if RPV water level can be maintained above BAF, vessel failure is unlikely. BIMAC not implicated unless conditions worsen. SAG continues attempts to restore RPV level > TAF.

Step RC/F-4 - assumption is that if RPV injection rate can be maintained above MDRIR, vessel failure is unlikely. BIMAC not implicated unless conditions worsen. Operators continue attempts to restore RPV level > TAF.

Step RC/F-5 – vessel failure is likely and containment conditions are such that core debris ex-vessel will not cause containment failure. EPG assumes that containment conditions within Pressure Suppression Pressure assures no containment failure should vessel breach occur. Based on PRA insights, lower DW water level < 1 meter would be added to ensure limited impact on containment from ex-vessel steam explosion.

Step RC/F-6 – vessel failure is likely and containment conditions will not support core debris ex-vessel without challenging containment. Currently considering lower DW flooding to provide ex-vessel cooling as a last resort for prevention of vessel failure and ultimately containment failure.

Summary of ESBWR SAG Strategy Impacts

Based on the insights from PRA including the description of severe accident mitigation in Chapter 21 of the PRA, the following BWROG EPG/SAG Revision 2 strategy changes are recommended:

1) Provide a caution on the use of DW sprays and preclude their use in step RC/F-5 where vessel failure is likely and DW level is below 1.5 meters.

2) Add lower DW level (1.5 meters) to the existing Pressure Suppression Pressure condition in RC/F-5 as an indicator of the containment's ability to handle vessel breach.

3) Do not preclude flooding of the lower DW to provide ex-vessel cooling in RC/F-6 as an alternative non-preferred method to avoid ex-vessel steam explosions by retaining core debris within the RPV.

Additional Insights

RC/F-5
If RPV injection rate is insufficient to maintain BAF or MDRIR AND lower DW level approaches the elevation associated with containment failure, RPV injection should be secured.

Review of injection systems/locations that can impact lower DW level

RPV Injection
HP CRD
Feedwater/Condensate
Fire Water

RPV injection that could impact lower DW level involves a break somewhere below TAF. Reason: If the break is above TAF and lower DW level is increasing, the core is adequately cooled and use of the BiMAC is not needed.

RPV injection with a break below TAF, could result in lower DW level above 1.5 meters and assumptions on use of BiMAC without containment failure due to ex-vessel steam explosion are not satisfied. If injection rate is adequate to maintain Minimum Debris Retention Injection Rate or RPV level above BAF, injection would continue.

Containment injection
DW Spray (from SP to DW atmosphere)
Suppression Pool cooling return (does not communicate with lower DW until spillover hole is covered)
GDCS pool (overflow returns to the SP)

DW Sprays are the focus of efforts to maintain lower DW level below 1.5 meters.

Enclosure 2

MFN 09-074

Response to Portion of NRC Request for Additional Information (RAI) Letter 222 - Related to ESBWR Design Certification Application

Chapter 19

PRA and Severe Accidents

RAI Number 19.2.4-1 S03

Supplemental Response

Step-by-step Review of Containment Flood SAG

Step-by-step Review of Containment Flood SAG

This review focuses on the strategy impact from PRA Insights and BiMAC design. The strategy impacts have been identified below the respective step.

The existing BWROG SAG steps have not been modified.

RPV AND PRIMARY CONTAINMENT FLOODING SEVERE ACCIDENT GUIDELINE

PURPOSE

The purpose of this guideline is to:

- Submerge the core and core debris,
- Shut down the reactor, and
- Depressurize the RPV and prevent it from repressurizing.

ENTRY CONDITIONS

This guideline is entered whenever Primary Containment Flooding is required.

OPERATOR ACTIONS

Execute [Steps RC/F, RC/P, and RC/Q] concurrently.

RC/F Monitor and control RPV and primary containment water levels. ∂ •

If while executing the following steps: ...

- Drywell sprays have been initiated, terminate drywell sprays before drywell pressure drops to 0 psig.
- Suppression pool sprays have been initiated, terminate suppression pool sprays before suppression chamber pressure drops to 0 psig.

Flood the primary containment as follows:

Has it been determined that core debris has breached the RPV?

No ↓ | Yes → [Step RC/F-1]

Can it be determined that RPV water level can be restored and maintained above [-164 in. (top of active fuel)]?

No ↓ | Yes → [Step RC/F-2]

Can it be determined that RPV water level can be restored and maintained above [-314 in. (bottom of active fuel)]?

No ↓ | Yes → [Step RC/F-3]

Can it be determined that injection into the RPV can be restored and maintained greater than the Minimum Debris Retention Injection Rate?

No ↓ | Yes → [Step RC/F-4]

Are suppression chamber pressure and primary containment water level within the Pressure Suppression Pressure?

No ↓ | Yes → [Step RC/F-5]

[Step RC/F-6]

Lower drywell level below 1 meter will be added to this question. Limiting lower DW level minimizes probability of containment failure due to ex-vessel steam explosion following vessel breach.

RC/F-1 IT HAS BEEN DETERMINED THAT CORE DEBRIS HAS BREACHED THE RPV

RC/F-1.1 Secure RPV venting.

If while executing the following step primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit C, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rates if necessary, to maintain suppression chamber pressure below Primary Containment Pressure Limit C. If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit C, but only if total injection into the RPV and drywell can be maintained greater than the Minimum Debris Retention Injection Rate, terminate injection into the RPV and primary containment from sources external to the primary containment except drywell sprays.

If while executing the following step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)], RPV injection will not be reduced, and, if drywell spray can be operated, only if drywell spray flowrate will not be reduced below [3840 gpm (Minimum Drywell Spray Flow)], initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary, using sources external to the primary containment if possible but only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit C.

If DPVs are open, this step cannot be implemented.
ESBWR does not have suppression pool sprays.
Drywell sprays will have additional limitations places upon their use as sprays (1) adds inventory to the lower DW which increases the likelihood of ex-vessel steam explosions energetic enough to fail containment and (2) condenses steam which reduces the effectiveness of PCCS.

If while executing the following step:

- Drywell sprays are not operating, initiate drywell sprays, defeating drywell spray interlocks if necessary and irrespective of the Drywell Spray Initiation Limit or whether RPV or primary containment injection will be reduced. Use sources external to the primary containment if possible.

- Drywell sprays are operating, maintain drywell spray flowrate greater than [3840 gpm (Minimum Drywell Spray Flow)], defeating drywell spray interlocks if necessary and irrespective of whether RPV or primary containment injection will be reduced. Use sources external to the primary containment if possible.

RC/F-1.2 Flood the primary containment as follows:

Initiate SPMS.

Maximize injection into the RPV from sources external to the primary containment using the following systems, defeating interlocks if necessary: ÷≠≡

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- HPCS, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS
- LPCI, with injection through the heat exchangers as soon as possible.
- [RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.]

[
- RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems
]

If injection into the RPV from sources external to the primary containment will not be reduced, maximize injection into the primary containment from sources external to the primary containment.

If injection into neither the RPV nor the primary containment from sources external to the primary containment will be reduced, maximize injection into the RPV from the suppression pool.

If venting the primary containment will facilitate primary containment flooding, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

If while executing the following step primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit C, restore and maintain primary containment water level and suppression chamber pressure below Primary Containment Pressure Limit C by one or both of the following methods:

- Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.
- Terminate injection into the RPV and primary containment from sources external to the primary containment except drywell sprays.

If while executing the following step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)], initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit C .

If while executing the following step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit, initiate drywell sprays, defeating drywell spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit C.

- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit C.

RC/F-1.3 When primary containment water level reaches [25 ft. (Minimum Debris Submergence Level)]:

Operate HPCS and LPCS, defeating interlocks if necessary.

Maintain primary containment water level between [25 ft. (Minimum Debris Submergence Level)] and [103 ft. 6 in. (elevation of primary containment vent)] using the following systems, defeating interlocks if necessary:

- Condensate/Feedwater
- CRD
- LPCI, with injection through the heat exchangers as soon as possible.
- [RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.]
- [RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems]

If necessary to maintain primary containment water level above [25 ft. (Minimum Debris Submergence Level)], vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

This strategy simplifies to verification of the BIMAC function followed by re-submergence of all debris (including what may be left in the RPV).

RC/F-2 RPV WATER LEVEL CAN BE RESTORED AND MAINTAINED ABOVE [-164 IN. (TOP OF ACTIVE FUEL)]

> If while executing this step primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit A:
>
> (1) Terminate direct injection into the primary containment from sources external to the primary containment.
>
> (2) If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit A:
>
> - Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to restore and maintain suppression chamber pressure below Primary Containment Pressure Limit A.
> - If primary containment water level and suppression chamber pressure reach Primary Containment Pressure Limit A, but only if RPV water level can be maintained above [-164 in. (top of active fuel)], terminate injection into the RPV from sources external to the primary containment, except boron injection from SLC.

If while executing this step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)] and RPV water level can be maintained above [-164 in. (top of active fuel)], initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

If while executing this step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit and RPV water level can be maintained above [-164 in. (top of active fuel)], initiate drywell sprays, defeating drywell spray interlocks if necessary. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary, but only if RPV water level can be maintained above [-164 in. (top of active fuel)]. Sources external to the primary containment may be used only if primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

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Restore and maintain RPV water level between [-164 in. (top of active fuel)] and [+58 in. (high level trip setpoint)] using the following systems, taking suction from sources external to the primary containment only when required, defeating interlocks if necessary:

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- LPCI, with injection through the heat exchangers as soon as possible.
- RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.

If required to restore and maintain RPV water level above [-164 in. (top of active fuel)], use the following systems, taking suction from sources external to the primary containment only when required, defeating interlocks if necessary:

- LPCI, with injection through the heat exchangers as soon as possible.
- HPCS, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS
- RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems

If necessary to restore and maintain RPV water level above [-164 in. (top of active fuel)]:

- Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.
- Vent the RPV with one or more of the following, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary:
  [
  - Flood vent valves
  - MSIVs
  - MSL drains
  - HPCI steam line
  - RCIC steam line
  - IC tube side vents
  - RHR
  ]

The intent of this flow path remains the same – attempt to re-submerge the reactor core inside the RPV prior to vessel failure.

RC/F-3 RPV WATER LEVEL CAN BE RESTORED AND MAINTAINED ABOVE [-314 IN. (BOTTOM OF ACTIVE FUEL)]

If while executing this step primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit A:

(1) Terminate direct injection into the primary containment from sources external to the primary containment except drywell sprays.

(2) If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit A:

- Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to restore and maintain suppression chamber pressure below Primary Containment Pressure Limit A.
- If primary containment water level and suppression chamber pressure reach Primary Containment Pressure Limit A, but only if RPV water level can be maintained above [-314 in. (bottom of active fuel)], terminate injection into the RPV from sources external to the primary containment, except boron injection from SLC.

If while executing this step RPV pressure is more than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, terminate direct injection into the primary containment from sources external to the primary containment.

If while executing this step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)] and RPV water level can be maintained above [-314 in. (bottom of active fuel)], initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary, using sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

If while executing this step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit and RPV water level can be maintained above [-314 in. (bottom of active fuel)], initiate drywell sprays, defeating drywell spray interlocks if necessary. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary, but only if RPV water level can be maintained above [-314 in. (bottom of active fuel)]. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

Initiate SPMS.

Operate the following systems, defeating interlocks if necessary: ÷

- HPCS, with suction from the CST if available, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS; operate one LPCS with suction from the suppression pool if possible; supply other LPCS from sources external to the primary containment if possible.

Restore and maintain RPV water level above [-314 in. (bottom of active fuel)] using the following systems, defeating interlocks if necessary, maximizing injection into the RPV and primary containment from sources external to the primary containment: ÷ ≠ ≡

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- LPCI, with injection through the heat exchangers as soon as possible.
- [RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.]
- [RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems]

If venting the primary containment will facilitate primary containment flooding or RPV injection, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

When primary containment water level exceeds RPV water level, vent the RPV with one or more of the following, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary:

[
- Flood vent valves
- MSIVs
- MSL drains
- HPCI steam line
- RCIC steam line
- IC tube side vents
- RHR
]

The intent of this flow path remains the same – maintain RPV level above BAF and continue attempts to re-submerge the reactor core inside the RPV prior to vessel failure (which would result in transition to RC/F-2).

RC/F-4 RPV WATER LEVEL CANNOT BE RESTORED AND MAINTAINED ABOVE [-314 in. (BOTTOM OF ACTIVE FUEL)], RPV INJECTION CAN BE RESTORED AND MAINTAINED GREATER THAN THE MINIMUM DEBRIS RETENTION INJECTION RATE

If while executing this step RPV water level can be determined and primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit B:

(1) Terminate direct injection into the primary containment from sources external to the primary containment except drywell sprays.

(2) If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit B:

- Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to restore and maintain suppression chamber pressure below Primary Containment Pressure Limit B.
- If primary containment water level and suppression chamber pressure reach Primary Containment Pressure Limit B, but only if injection into the RPV can be maintained greater than the Minimum Debris Retention Injection Rate, terminate injection into the RPV from sources external to the primary containment, except boron injection from SLC.

If while executing this step RPV water level cannot be determined and primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit A:

(1) Terminate direct injection into the primary containment from sources external to the primary containment except drywell sprays.

(2) If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit A:

- Vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to restore and maintain suppression chamber pressure below Primary Containment Pressure Limit A.

- If primary containment water level and suppression chamber pressure reach Primary Containment Pressure Limit A, but only if injection into the RPV can be maintained greater than the Minimum Debris Retention Injection Rate, terminate injection into the RPV from sources external to the primary containment, except boron injection from SLC.

If while executing this step RPV pressure is more than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, terminate direct injection into the primary containment from sources external to the primary containment.

If while executing this step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)] and injection into the RPV can be maintained greater than the Minimum Debris Retention Injection Rate, initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary, using sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

If while executing this step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit and injection into the RPV can be maintained greater than the Minimum Debris Retention Injection Rate, initiate drywell sprays, defeating drywell spray interlocks if necessary. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.
- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary, but only if injection into the RPV can be maintained greater than the Minimum Debris Retention Injection Rate. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

Initiate SPMS.

Operate the following systems, defeating interlocks if necessary: ÷

- HPCS, with suction from the CST if available, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS; operate one LPCS with suction from the suppression pool if possible; supply other LPCS from sources external to the primary containment if possible.

Restore and maintain injection into the RPV greater than the Minimum Debris Retention Injection Rate using the following systems, defeating interlocks if necessary, maximizing injection into the RPV and primary containment from sources external to the primary containment: ÷≠≡

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- LPCI, with injection through the heat exchangers as soon as possible.
- [RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.]
- [RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems]

If venting the primary containment will facilitate primary containment flooding or RPV injection, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

When primary containment water level reaches [53 ft. 7 in. (elevation of the bottom of the RPV lower head], vent the RPV with one or more of the following, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary:

[
- Flood vent valves
- MSIVs
- MSL drains
- HPCI steam line
- RCIC steam line
- IC tube side vents
- RHR
]

The intent of this flow path remains the same – maintain flow to the RPV above MDRIR and continue attempts to re-submerge the reactor core inside the RPV prior to vessel failure (which would result in transition to RC/F-2).

RC/F-5 RPV INJECTION CANNOT BE RESTORED AND MAINTAINED GREATER THAN THE MINIMUM DEBRIS RETENTION INJECTION RATE, SUPPRESSION CHAMBER PRESSURE AND PRIMARY CONTAINMENT WATER LEVEL ARE WITHIN THE PRESSURE SUPPRESSION PRESSURE

If while executing this step:

- Suppression chamber pressure cannot be maintained below the Pressure Suppression Pressure, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to control suppression chamber pressure below the Pressure Suppression Pressure.

- Primary containment water level cannot be maintained below [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])], terminate direct injection into the primary containment from sources external to the primary containment.

- Primary containment water level approaches [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])], terminate injection into the RPV from sources external to the primary containment, except boron injection from SLC.

If while executing this step RPV pressure is more than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, terminate direct injection into the primary containment from sources external to the primary containment.

If while executing this step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)] initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and suppression pool water level can be maintained below [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])].

If while executing this step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit, initiate drywell sprays, defeating drywell spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and suppression pool water level can be maintained below [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])].

- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary and irrespective of whether injection into the RPV will be reduced. Sources external to the primary containment may be used only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and suppression pool water level can be maintained below [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])].

Initiate SPMS.

Maximize injection into the RPV using the following systems, defeating interlocks if necessary: ÷≠≡

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- HPCS, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS
- LPCI, with injection through the heat exchangers as soon as possible.
- [RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.]
- [RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems]

If injection into the RPV will not be reduced and primary containment water level can be maintained below [16 ft. 1 in. (Maximum Pressure Suppression Primary Containment Water Level [or elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water], whichever is lower])], inject into the primary containment from sources external to the primary containment.

If venting the primary containment will facilitate primary containment flooding or RPV injection, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

This step identifies the containment conditions for which containment failure is unlikely should vessel breach occur. Lower drywell level above which ex-vessel steam explosions fail containment becomes significant and will be added to the PSP. If RPV injection is contributing to increasing lower DW level, RPV injection must be secured.

RC/F-6 RPV INJECTION CANNOT BE RESTORED AND MAINTAINED GREATER THAN THE MINIMUM DEBRIS RETENTION INJECTION RATE, SUPPRESSION CHAMBER PRESSURE AND PRIMARY CONTAINMENT WATER LEVEL ARE NOT WITHIN THE PRESSURE SUPPRESSION PRESSURE

If while executing this step, primary containment water level and suppression chamber pressure approach or exceed Primary Containment Pressure Limit A, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary, to maintain suppression chamber pressure below Primary Containment Pressure Limit A. If primary containment water level and suppression chamber pressure cannot be maintained below Primary Containment Pressure Limit A, terminate direct injection into the primary containment from sources external to the primary containment except drywell sprays.

If while executing this step RPV pressure is more than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, terminate direct injection into the primary containment from sources external to the primary containment.

If while executing this step Suppression Pool Spray is required, but only if [suppression chamber pressure is above the Mark III Containment Spray Initiation Pressure Limit] [suppression pool water level is below 24 ft. 6 in. (elevation of suppression pool spray nozzles)] and either injection into the RPV will not be reduced, RPV pressure is at least [50 psig (Decay Heat Removal Pressure) above suppression chamber pressure, or suppression chamber pressure can be restored and maintained below the Pressure Suppression Pressure, initiate suppression pool sprays, defeating suppression pool spray interlocks if necessary, using sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

If while executing this step Drywell Spray is required and:

- Drywell sprays are not operating and [suppression pool water level is below [17 ft. 2 in. (elevation of bottom of suppression chamber to drywell vacuum breaker openings [less vacuum breaker opening pressure in feet of water])] and] drywell temperature is below the Drywell Spray Initiation Limit and either injection into the RPV will not be reduced, RPV pressure is at least [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, or suppression chamber pressure can be restored and maintained below the Pressure Suppression Pressure, initiate drywell sprays, defeating drywell spray interlocks if necessary. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

- Drywell sprays are operating, continue to operate drywell sprays, defeating drywell spray interlocks if necessary, but only if either injection into the RPV will not be reduced, RPV pressure is at least [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure, or suppression chamber pressure can be restored and maintained below the Pressure Suppression Pressure. Use sources external to the primary containment if possible but only if RPV pressure is less than [50 psig (Decay Heat Removal Pressure)] above suppression chamber pressure and primary containment water level and suppression chamber pressure can be restored and maintained below Primary Containment Pressure Limit A.

Initiate SPMS.

Maximize injection into the RPV using the following systems, defeating interlocks if necessary: ÷≠≡

- Condensate/Feedwater
- CRD
- RCIC, defeating high suppression pool water level suction transfer logic if necessary.
- HPCS, defeating high suppression pool water level suction transfer logic if necessary.
- LPCS
- LPCI, with injection through the heat exchangers as soon as possible.
- RHR through the shutdown cooling return, with injection through the heat exchangers as soon as possible.
- RHR Service Water crosstie
- Fire System
- Interconnections with other units
- ECCS Keep-Full
- SLC
- Other primary containment fill systems

If injection into the RPV will not be reduced, maximize injection into the primary containment from sources external to the primary containment.

If venting the primary containment will facilitate primary containment flooding or RPV injection, vent the primary containment, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary.

When primary containment water level reaches [53 ft. 7 in. (elevation of the bottom of the RPV lower head)], vent the RPV with one or more of the following, defeating isolation interlocks and exceeding offsite radioactivity release rate limits if necessary:

- Flood vent valves
- MSIVs
- MSL drains
- HPCI steam line
- RCIC steam line
- IC tube side vents
- RHR

In step RC/F-5 the combination of conditions for which vessel breach would not compromise containment integrity were used to limit containment flooding. In this step, either one of the conditions NOT satisfied would lead to containment failure upon breach of the RPV by core debris. In this case, containment flooding is not precluded.