AREVAEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Friday, March 06, 2009 5:48 PM
To: Getachew Tesfaye
Cc: NOXON David B (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 142, Supplement 1
Attachments: RAI 142 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 5 of the 7 questions of RAI No. 142 on January 8, 2009. The attached file, "RAI 142 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to the two remaining questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 142 Question 19-269.

The following table indicates the respective pages in the response document, "RAI 142 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 142 — 19-262	2	5
RAI 142 — 19-269	6	8

This concludes the formal AREVA NP response to RAI 142, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Pederson Ronda M (AREVA NP INC)
Sent: Thursday, January 08, 2009 6:12 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); NOXON David B (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 142 (1623, 1630) ,FSAR Ch. 19

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 142 Response US EPR DC.pdf" provides technically correct and complete responses to 5 of the 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 142 Questions 19-266 and 19-267.

The following table indicates the respective pages in the response document, "RAI 142 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 142 — 19-262	2	2
RAI 142 — 19-264	3	5
RAI 142 — 19-265	6	6
RAI 142 — 19-266	7	7
RAI 142 — 19-267	8	10
RAI 142 — 19-268	11	11
RAI 142 — 19-269	12	12

A complete answer is not provided for 2 of the 7 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 142 — 19-262	March 6, 2009
RAI 142 — 19-269	March 6, 2009

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, November 26, 2008 12:34 PM
To: ZZ-DL-A-USEPR-DL
Cc: Hanh Phan; Theresa Clark; Edward Fuller; Lynn Mrowca; John Rycyna; Joseph Colaccino
Subject: U.S. EPR Design Certification Application RAI No. 142 (1623, 1630),FSAR Ch. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on November 14, 2008, and discussed with your staff on November 24 and 25, 2008. Draft RAI Questions 19-263 and 19-270 were deleted, and Draft RAI Questions 19-262 and 19-269 were modified as a result of those discussions. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs, excluding the time period of **December 20, 2008 thru January 1, 2009, to account for the holiday season** as discussed with AREVA NP Inc. For any

RAIs that cannot be answered **within 45 days**, it is expected that a date for receipt of this information will be provided to the staff within the 45-day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 298

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D31B89CCA)

Subject: Response to U.S. EPR Design Certification Application RAI No. 142, Supplement 1
Sent Date: 3/6/2009 5:47:53 PM
Received Date: 3/6/2009 5:47:56 PM
From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

Recipients:
"NOXON David B (AREVA NP INC)" <David.Noxon@areva.com>
Tracking Status: None
"BENNETT Kathy A (OFR) (AREVA NP INC)" <Kathy.Bennett@areva.com>
Tracking Status: None
"DELANO Karen V (AREVA NP INC)" <Karen.Delano@areva.com>
Tracking Status: None
"Getachew Tesfaye" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

Post Office: AUSLYNCMX02.adom.ad.corp

Files	**Size**	**Date & Time**
MESSAGE	4333	3/6/2009 5:47:56 PM
RAI 142 Supplement 1 Response US EPR DC.pdf		236747

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 142, Supplement 1

11/26/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application FSAR Sections: 19.1.5 & 19.1.6.1

QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1 (AP1000/EPR Projects) (SPLA)

Question 19-262:

Follow-up to Question 19-50. Please revise the estimated EPR flooding frequencies in accordance with the statement on Page 19.1-115 of the EPR FSAR by including the potential flooding sources of valves, pumps, tanks/pools, and heat exchangers. Also, describe the process and references used to assign the equipment rupture frequencies. Otherwise, justify why the exclusion of these potential flooding sources in the analysis is conservative.

Response to Question 19-262:

Internal flooding frequencies for the U.S. EPR probabilistic risk assessment (PRA) are estimated using the EPRI “Pipe Failure Study Update” (EPRI TR-102266, Reference 1). This reference does not explicitly state if pipe segment rupture frequencies include non-piping components, such as pumps, valves or heat exchangers. Because of this, a sensitivity study was performed to compare U.S. EPR internal flooding frequencies against frequencies obtained using a data source that explicitly includes non-piping components.

The selected data source is EPRI report 1013141 “Pipe Rupture Frequencies for Internal Flooding PRAs, Revision 1” (Reference 2) that presents rupture frequencies based on data from the extensive flooding database, PIPExp. As stated in the report, the presented rupture frequencies “account for all the components on the piping system pressure boundary whose failure could initiate an internal flooding initiating event including pipes, flanges, pump and valve bodies, fittings, vents, expansion joints, and relief valves” (page 1-1). Therefore, in Reference 2 system rupture frequencies, non-piping component failure rates are explicitly included even though they are not presented separately. This is why this data source was chosen to assign the new rupture frequencies in the sensitivity study presented below.

INEL Report EGG-SSRE-9639 (Reference 3) was also considered as a data source because it includes separate rupture frequencies for piping and non-piping components, but it was judged to be not applicable to a new plant internal flooding analysis because no updates of this work have been performed since 1990 and it does not account for new service experience data and the current state-of-knowledge with respect to piping reliability analysis.

Rupture rates in Reference 2 are given per linear foot of pipe. Therefore, the available piping information for the U.S. EPR (segments) was converted into length. Reference 2 states that a segment length usually ranges from 10 to 100 ft. Assuming that pipe segment failure rates are log-normally distributed, with 5^{th} percentile corresponding to 10 ft and 95^{th} percentile corresponding to 100 ft, results in a mean segment length of approximately 40 ft.

In this sensitivity study, the flooding frequencies presented in U.S. EPR FSAR Tier 2, Table 19.1-38, are re-evaluated using Reference 2 frequencies. The evaluation utilizes the segment count used to quantify the FSAR frequencies, with an assumed segment length of 40 ft. Systems included as flooding sources are binned with systems presented in Table ES-1 of Reference 2, as follows:

- Emergency feedwater system (EFWS) with “PWR FW – Stainless Steel Piping”.
- Essential service water system (ESWS) with “Service Water – River Water”. (This is conservative given the U.S. EPR ultimate heat sink design has cooling towers and associated water basins).

- Fire water distribution system with “Fire Protection”.
- Systems carrying demineralized water (demineralized water, component cooling water, seal water) with “CCW and CST”.
- Systems carrying borated water (safety injection, chemical and volume control, RBWMS) with “SIR outside of containment or drywell”.

The resulting flooding frequencies for each building considered in the internal flooding analysis are shown in Table 19-262-1. Flooding scenario frequencies are quantified and multiplied by each scenario’s conditional core damage probability (CCDP) to obtain the internal flooding core damage frequency (CDF), also shown in Table 19-262-1. Table 19-262-1 shows that the largest difference is in the essential service water (ESW) piping frequency, and in the CDF associated with the floods in the ESW Cooling Tower Structures. This difference is attributed to the conservatism associated with the selection of the “Service Water – River Water” data for the EPR ESW, whose ultimate heat sink design has dedicated water basins with separate cooling towers.

The resulting flooding CDF for this sensitivity study is 6.3E-08/yr. The base case CDF obtained by summing all flooding scenario CDFs is 6.4E-08/yr, as shown in U.S. EPR FSAR Tier 2, Table 19.1-40 (this is slightly higher than the U.S. EPR flooding CDF of 6.1E-08/yr due to the lower relative truncation for individual scenarios). Therefore, using Reference 2 flooding frequencies results in a small (1 percent) decrease in overall flooding CDF, and it does not affect the identification of the two important flooding scenarios (Annulus and Safeguard Building 1 or 4 with Fuel Building). It does not significantly affect the internal flooding insights discussed in U.S. EPR FSAR Tier 2, Section 19.1.5.2.2.8.

In conclusion, the sensitivity study that compares U.S. EPR internal flooding frequencies against frequencies obtained using a method that explicitly includes non-piping components shows that using rupture frequencies from Reference 1 is conservative, and that the choice of method does not significantly affect the U.S. EPR flooding PRA results and insights.

Table 19-262-1—Comparison of Flooding Frequencies for U.S. EPR Locations and Flooding Scenario CDFs between Reference 1 and Reference 2

U.S. EPR Location	Flooding Frequency Presented in the U.S. EPR FSAR Table 19.1.38 (based on Reference 1) (1/yr)	Sensitivity Case Flooding Frequency (based on Reference 2) (1/yr)	Corresponding Flood Scenario	CDF from the U.S. EPR FSAR Table 19.1.40 (1/yr)	Sensitivity Case CDF (1/yr)	Change Factor
Safeguard Building 1 or 4	1.4E-03	2.1E-03	FLD-SAB14 FB	2.1E-08	1.7E-08	0.81
Fuel Building	3.0E-03	6.5E-04				
Safeguard Building 2 or 3	9.4E-04	1.3E-03	FLD-SAB23	3.3E-11	4.6E-11	1.40
EFWS in Safeguard Building 1 or 4	3.3E-04	1.2E-04	FLD-EFW	7.2E-09	2.5E-09	0.35
EFWS in Safeguard Building 2 or 3	3.6E-04	1.2E-04				
Reactor Building Annulus	3.2E-04	4.0E-04	FLD-ANN SAB23	8.9E-13	1.1E-12	1.24
			FLD-ANN SAB2	1.3E-12	1.6E-12	1.24
			FLD-ANN ALL	3.2E-08	4.0E-08	1.24
ESW Cooling Tower Structures	1.8E-04	7.8E-04	FLD-ESW	4.0E-11	1.7E-10	4.30
Turbine Building	3.3E-02	3.3E-02	FLD-TB	4.0E-09	4.0E-09	1.00
			Total CDF	**6.4E-08**	**6.3E-08**	**0.99**

References for Question 19-262:

1. EPRI TR-102266, “Pipe Failure Study Update,” Electric Power Research Institute, 1993.
2. EPRI TR-1013141 “Pipe Rupture Frequencies for Internal Flooding PRAs, Revision 1”, Electric Power Research Institute, 2006.
3. EGG-SSRE-9639, “Component External Leakage and Rupture Frequency Estimates”, Idaho National Engineering Laboratory, 1991.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 19-269:

One of the acceptance criteria stated in Standard Review Plan (SRP) Section 19.0 is "that the applicant has used the PRA results and insights, including those from uncertainty analyses, importance analyses, and sensitivity studies, in an integrated fashion to identify and establish specifications and performance objectives (e.g., ITAAC [inspections, tests, analyses, and acceptance criteria], technical specifications [TS], RAP [reliability assurance program], RTNSS [regulatory treatment of non-safety systems], and COL [combined license] action items) for the design, construction, testing, inspection, and operation of the plant." Links between the PRA and the design process (FSAR Section 19.1.3.4), RAP (FSAR Section 19.1.7.4), development of PRA-based insights (FSAR Table 19.1-108), and development of COL items (FSAR Table 1.8-2) are specifically outlined. However, it is not clear how PRA results and insights were used to identify or establish any TS requirements. Therefore, the staff needs additional information to ensure the SRP acceptance criterion is met. Specifically:

a. Describe the process used to identify and establish TS requirements based on PRA results and insights (e.g., risk achievement worth (RAW) values), and revise the FSAR as appropriate to include this discussion. Include a discussion of how the process considers TS criterion 4, as presented in Title 10 of the Code of Federal Regulations (10 CFR) 50.36(c)(2)(ii)(D): "[a SSC] which operating experience or probabilistic risk assessment has shown to be significant to public health and safety."

b. In light of the response to part (a) above, justify the lack of TS requirements for the equipment for which sensitivity studies were performed in response to Question 19-176. This lack of TS requirements means that the shutdown risk profile of the U.S. EPR is largely dependent on voluntary actions (e.g., NUMARC 91-06 application) that could be withdrawn without NRC approval. If these design features were not available, the resulting risk profile is highly uncertain. Core damage frequency (CDF) and large release frequency (LRF) could increase by two or more orders of magnitude, and the impact on the significant initiating events, sequences, and SSCs is unclear. The justification should address the impact of equipment unavailability on the results and insights of the PRA.

Response to Question 19-269:

Response to Question 19-269a:

NUREG-1431, Rev. 3.1 (Reference 1) was used as the base document for the U.S. EPR Technical Specifications since it represents a four loop, active safety systems pressurized water reactor (PWR). As the U.S. EPR Technical Specifications were developed, other Improved Technical Specifications (ITS) (References 2, 3, and 4) were also used, as appropriate. The original development of these standardized technical specifications involved a process that utilized criterion 4-related reviews of operating experience and industry PRA-related results and insights to identify those structures, systems and components (SSC) which are important to risk, but may not already be included in the plant technical specifications by criteria 1 through 3.

For the U.S. EPR, the AREVA NP evaluation of criterion 4 and the process used to identify and establish technical specification requirements based on PRA results and insights was qualitative. Based on industry precedence as provided in the standardized technical specifications, and a review of industry operating experience and the U.S. EPR PRA results, and insights, the following technical specifications were included based on criterion 4:

- Remote Shutdown System (RSS).

- RCS Loops - MODE 4.
- RCS Loops - MODE 5, Loops Filled.
- EFW System operation in MODE 4.
- Residual Heat Removal (RHR) Loops - High Water Level.
- Residual Heat Removal (RHR) Loops - Low Water Level.

Included with this initial assessment was the guidance provided by NUMARC 91-06 to achieve risk minimization during shutdown not only by ensuring availability of design features (i.e., SSC) but also by limiting and strictly controlling higher risk plant evolutions through the use of administrative controls.

Response to Question 19-269b:

In light of the response to RAI 2, Question 19-27, and the associated sensitivity studies presented in the response to RAI 26, Question 19-176, AREVA NP has re-evaluated what is included in technical specifications for controlling risk during shutdown. Based on this re-evaluation, the following shutdown-related technical specifications are being added:

- Technical Specification 3.5.6 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 5

  This specification will provide a borated water source for the Medium Head Safety Injection (MHSI) pumps in MODE 5 for the loss of decay heat removal.

- Technical Specification 3.5.7 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 6

  This specification will provide a borated water source for the Medium Head Safety Injection (MHSI) pumps in MODE 6 for the loss of decay heat removal. The requirements include the contained water volume of the refueling cavity, refueling canal, and IRWST due to fuel handling requirements. The boron requirements are addressed in LCO 3.9.1.

- Technical Specification 3.5.8 ECCS - Shutdown, MODES 5 and 6

  This specification provides the availability of MHSI pumps for reactor coolant system (RCS) makeup from the IRWST in MODES 5 and 6 in the unlikely event of a loss of decay heat removal due to loss of inventory.

Related LCOs and Bases were modified editorially for the inclusion of the additional specifications

These additions to the technical specifications are made based on the AREVA NP qualitative process of reviewing PRA-related results and insights and establishing the appropriate measures to manage U.S. EPR risks. The other equipment identified in the response to Question 19-176, with a lesser impact on the total CDF (vs. shutdown CDF) is assumed to be managed by the implementation of NUMARC 91-06 guidance and other administrative controls, such as implementation of the maintenance rule program.

References for Question 10-269:

1. NUREG-1431, Rev. 3.1, "Standard Technical Specifications, Westinghouse Plants."
2. NUREG-1430, Rev. 3.1, "Standard Technical Specifications, Babcock & Wilcox Plants."
3. NUREG-1432, Rev. 3.1, "Standard Technical Specifications, Combustion Engineering Plants."
4. NUREG-1434, Rev. 3.1, "Standard Technical Specifications, General Electric Plants, BWR/6."

FSAR Impact:

U.S. EPR FSAR Tier 2, Chapter 16 Technical Specifications will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.3 ECCS - Shutdown, MODE 4

19-269

LCO 3.5.3 Two Medium Head Safety Injection (MHSI) trains shall be OPERABLE.

APPLICABILITY: MODE 4.

ACTIONS

---NOTE---
LCO 3.0.4.b is not applicable.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One required MHSI train inoperable.	A.1 Restore required MHSI train to OPERABLE status.	72 hours
B. Required Action and associated Completion Time of Condition A not met. OR Two required MHSI trains inoperable.	B.1 Be in ~~Mode~~ MODE 5.	12 hours

19-269

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.3.1	The following SRs are applicable for all required MHSI trains: SR 3.5.2.2, SR 3.5.2.3, SR 3.5.2.4, SR 3.5.2.5, and SR 3.5.2.6.	In accordance with applicable SRs

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.4 In-Containment Refueling Water Storage Tank (IRWST) - Operating

19-269

LCO 3.5.4 The IRWST shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. IRWST temperature, water volume, boron concentration, or enrichment not within limits.	A.1 Restore IRWST temperature, water volume, boron concentration, and enrichment to within limits.	8 hours
B. IRWST inoperable for reasons other than Condition A.	B.1 Restore IRWST to OPERABLE status.	1 hour
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 3. AND C.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.4.1	Verify IRWST borated water temperature is ≥ 59°F and ≤ 122°F.	24 hours

19-269

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.5.4.2	Verify IRWST borated water volume is ≥ 500,342 gallons and ≤ 523,703 gallons.	7 days
SR 3.5.4.3	Verify IRWST boron concentration is ≥ 1700 ppm and ≤ 1900 ppm enriched boron.	7 days
SR 3.5.4.4	Verify isotopic concentration of B~~10~~-10 in the IRWST is ≥ 37%.	24 months

19-269

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.6 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 5

LCO 3.5.6 The IRWST shall be OPERABLE.

APPLICABILITY: MODE 5.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. IRWST water volume, boron concentration, or enrichment not within limits.	A.1 Restore IRWST water volume, boron concentration, and enrichment to within limits.	8 hours
B. IRWST inoperable for reasons other than Condition A.	B.1 Restore IRWST to OPERABLE status.	1 hour
C. Required Action and associated Completion Time not met.	C.1 Initate action to restore IRWST to OPERABLE status. AND C.2 Suspend positive reactivity additions.	Immediately Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.5.6.1 SRs 3.5.4.2, 3.5.4.3, and 3.5.4.4 of Specification 3.5.4, “In-Containment Refueling Water Storage Tank (IRWST) – Operating” are applicable.	In accordance with applicable SRs.

19-269

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.7 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 6

LCO 3.5.7 The IRWST shall be OPERABLE.

APPLICABILITY: MODE 6.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. IRWST, refueling canal, and refueling cavity water volume not within limits.	A.1 Restore IRWST, refueling canal, and refueling cavity water volume to within limits.	8 hours
B. IRWST, refueling canal, and refueling cavity inoperable for reasons other than Condition A.	B.1 Restore IRWST, refueling canal, and refueling cavity to OPERABLE status.	1 hour
C. Required Action and associated Completion Time not met.	C.1 Initiate action to achieve refueling cavity water level ≥23 feet above the reactor vessel flange. AND C.2 Suspend positive reactivity additions.	Immediately Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.5.7.1 Verify IRWST, refueling canal, and refueling cavity borated water volume is ≥ 500,342 gallons.	24 hours

19-269

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.8 ECCS - Shutdown, MODES 5 and 6

LCO 3.5.8 Two Medium Head Safety Injection (MHSI) trains shall be OPERABLE.

APPLICABILITY: MODE 5 and 6.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One required MHSI train inoperable.	A.1 Restore required MHSI train to OPERABLE status.	72 hours
B. Required Action and associated Completion Time of Condition A not met. OR Two required MHSI trains inoperable.	B.1 Initiate action to restore at least one MHSI train to OPERABLE status.	Immediately

19-269

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.8.1	The following SRs are applicable for all required MHSI trains: SR 3.5.2.2, SR 3.5.2.3, SR 3.5.2.4, SR 3.5.2.5, and SR 3.5.2.6.	In accordance with applicable SRs

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.3 ECCS - Shutdown, MODE 4

19-269

BASES

BACKGROUND

The Background section for Bases 3.5.2, "ECCS - Operating," is applicable to these Bases, with the following modifications.

In MODE 4, a single ECCS train consisting of a Medium Head Safety Injection (MHSI) train is capable of providing the core cooling function. A second train is assumed to spill out of the break. Low head Safety Injection is not automatically actuated.

The ECCS flow paths consist of piping, valves, heat exchangers, and pumps such that water from the in-containment refueling water storage tank (IRWST) can be injected into the Reactor Coolant System (RCS) following the accidents described in Bases 3.5.2.

APPLICABLE SAFETY ANALYSES

The Applicable Safety Analyses section of Bases 3.5.2 also applies to this Bases section.

Due to the stable conditions associated with operation in MODE 4 and the reduced probability of occurrence of a Design Basis Accident (DBA), the ECCS operational requirements are reduced. Below P14 and RHR connected, LHSI is not automatically actuated by the Protection System (PS). However, MHSI is automatically actuated by the PS.

Two trains of ECCS are required for MODE 4. Protection against single failures is not relied on for this MODE of operation.

The ECCS trains satisfy Criterion 3 of 10 CFR 50.36(~~d~~c)(2)(ii).

LCO

In MODE 4, two of the four independent (and redundant) ECCS MHSI trains are required to be OPERABLE to ensure that sufficient ECCS flow is available to the core following a DBA. One train is required to accomplish the safety function and one train is assumed to feed the break. The ECCS cross-connects are not needed for events postulated in MODE 4.

In MODE 4, an ECCS train consists of an MHSI subsystem. Each train includes the piping, instruments, and controls to ensure an OPERABLE flow path capable of taking suction from the IRWST.

BASES

LCO (continued)

During an event requiring ECCS MHSI actuation, a flow path is required to provide an abundant supply of water from the IRWST to the RCS via the ECCS pumps and to its associated four cold leg injection nozzles. In the long term, this flow path may be switched to deliver its flow to the RCS hot and cold legs.

APPLICABILITY

In MODES 1, 2, and 3 ~~and 4~~, the OPERABILITY requirements for ECCS are covered by LCO 3.5.2.

In MODE 4, two OPERABLE ECCS MHSI trains are acceptable without single failure consideration on the basis of the stable reactivity of the reactor and the limited core cooling requirements.

In MODES 5 and 6, the OPERABILITY requirements for ECCS are covered by LCO 3.5.8 ~~plant conditions are such that the probability of an event requiring ECCS injection is extremely low.~~ Core cooling requirements in MODE 5 are addressed by LCO 3.4.7, "RCS Loops - MODE 5, Loops Filled," and LCO 3.4.8, "RCS Loops - MODE 5, Loops Not Filled." MODE 6 core cooling requirements are addressed by LCO 3.9.4, "LHSI/RHR and Coolant Circulation - High Water Level," and LCO 3.9.5, "LHSI/RHR and Coolant Circulation - Low Water Level."

19-269

ACTIONS

A Note prohibits the application of LCO 3.0.4.b to an inoperable ECCS MHSI train. There is an increased risk associated with entering MODE 4 from MODE 5 with an inoperable ECCS MHSI train and the provisions of LCO 3.0.4.b, which allow entry into a MODE or other specified condition in the Applicability with the LCO not met after performance of a risk assessment addressing inoperable systems and components, should not be applied in this circumstance.

A.1

With one required MHSI train inoperable, the inoperable train must be returned to OPERABLE status within 72 hours. The 72 hour Completion Time is based on an NRC reliability evaluation (Ref. 5) and is a reasonable time for repair of many ECCS components.

An ECCS train is inoperable if it is not capable of delivering design flow to the RCS. Individual components are inoperable if they are not capable of performing their design function or supporting systems are not available.

19-269

BASES

ACTIONS (continued)

B.1

When Required Action A.1 cannot be completed within the required Completion Time; or if two required ECCS MHSI trains are inoperable, the unit must be placed in a MODE in which the LCO does not apply. To achieve this status, the unit must be placed in MODE 5 within 12 hours.

The allowed Completion Time is reasonable, based on operating experience, to reach the required unit conditions from MODE 4 in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.5.3.1

The applicable Surveillance descriptions from Bases 3.5.2 apply.

REFERENCES

The applicable references from Bases 3.5.2 apply.

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.4 In-Containment Refueling Water Storage Tank (IRWST) - Operating

19-269

BASES

BACKGROUND

The IRWST supplies borated water to the refueling pool during refueling, and to the ECCS during accident conditions.

The IRWST supplies all four trains of the ECCS through separate, independent supply headers during the injection phase of a loss of coolant accident (LOCA) recovery.

During normal operation in MODES 1, 2, and 3, Medium Head Safety Injection (MHSI) and Low Head Safety Injection (LHSI) pumps are aligned to take suction from the IRWST.

The ECCS pumps are provided with recirculation lines that ensure each pump can maintain minimum flow requirements when operating at or near shutoff head conditions.

This LCO ensures that:

a. The IRWST contains sufficient borated water to support the ECCS accident mitigation function; and

b. The reactor remains subcritical following a LOCA.

Insufficient water in the IRWST could result in insufficient cooling capacity and suction head for ECCS operation. Improper boron concentrations or enrichment could result in a reduction of SDM or excessive boric acid precipitation in the core following the LOCA, as well as excessive caustic stress corrosion of mechanical components and systems inside the containment.

APPLICABLE SAFETY ANALYSES

During accident conditions, the IRWST provides a source of borated water to the ECCS pumps. As such, it provides containment energy removal, core cooling, and replacement inventory and is a source of negative reactivity for reactor shutdown (Ref. 1). The design basis transients and applicable safety analyses concerning the ECCS~~each of these~~ system~~s~~ ~~are~~ is discussed in the Applicable Safety Analyses section of B 3.5.2, "ECCS - Operating," and B 3.5.3, "ECCS – Shutdown MODE 4." These analyses are used to assess changes to the IRWST in order to evaluate their effects in relation to the acceptance limits in the analyses.

19-269

The IRWST must also meet volume, boron concentration, boron isotopic inventory (i.e., enrichment), and temperature requirements for non-LOCA

19-269

BASES

APPLICABLE SAFETY ANALYSES (continued)

events. The volume is not an explicit assumption in non-LOCA events since the required volume is a small fraction of the available volume. The deliverable volume limit is set by the required volumes for an outage and is therefore not limiting. The minimum IRWST volume is determined by ECCS pump NPSH requirements. The minimum boron concentration and isotopic inventory are explicit assumptions in the main steam line break (MSLB) analysis to ensure the required shutdown capability. The importance of its value is small due to the Extra Borati~~on~~ng System (EBS) with its high boron concentration.

The maximum boron concentration is an explicit assumption in the inadvertent ECCS actuation analysis, although it is typically a nonlimiting event and the results are very insensitive to boron concentrations. The maximum temperature ensures that the amount of cooling provided from the IRWST during the heatup phase of a feedline break is consistent with safety analysis assumptions; the minimum is an assumption in both the MSLB and inadvertent ECCS actuation analyses, although the inadvertent ECCS actuation event is typically nonlimiting.

For a large break LOCA analysis, the minimum water volume of 500,342 gallons and the lower boron concentration limit of 1700 ppm of ≥~~>~~ 37% enriched boron are used to compute the post LOCA sump boron concentration necessary to assure subcriticality. The large break LOCA is the limiting case since the safety analysis assumes that all control rods are out of the core. This minimum volume bounds the ECCS pump NPSH requirements.

The maximum water volume of 523,703 gallons and the upper limit on boron concentration of 1900 ppm are used to determine the maximum allowable time to switch to hot leg recirculation following a LOCA. The purpose of switching from cold leg to hot leg injection is to avoid boron precipitation in the core following the accident.

The upper temperature limit of 122°F is used in the small break LOCA analysis and containment OPERABILITY analysis. Exceeding this temperature will result in a higher peak clad temperature, because there is less heat transfer from the core to the injected water for the small break LOCA. For the containment response following an MSLB, the lower limit on boron concentration and the upper limit on IRWST water temperature are used to maximize the total energy release to containment.

The minimum temperature ~~valve~~ value of 59°F is consistent with mechanical requirements, particularly reactor pressure vessel brittle fracture risk.

The IRWST satisfies Criterion 3 of 10 CFR 50.36(~~d~~c)(2)(ii).

19-269

BASES

LCO

The IRWST ensures that an adequate supply of borated water is available to cool and depressurize the containment in the event of a Design Basis Accident (DBA), to cool and cover the core in the event of a LOCA, to maintain the reactor subcritical following a DBA, and to ensure adequate level in the containment sump to support ECCS pump operation.

To be considered OPERABLE, the IRWST must meet the temperature, water volume, and boron concentration and enrichment limits established in the SRs.

APPLICABILITY

In MODES 1, 2, 3, and 4, IRWST OPERABILITY requirements are dictated by ECCS OPERABILITY requirements. Since the ECCS must be OPERABLE in MODES 1, 2, 3, and 4, the IRWST must also be OPERABLE to support its operation. ~~In MODES 5 and 6, the IRWST is in standby.~~ Core cooling requirements in MODE 5 are addressed by LCO 3.4.7, "RCS Loops - MODE 5, Loops Filled," and LCO 3.4.8, "RCS Loops - MODE 5, Loops Not Filled." MODE 6 core cooling requirements are addressed by LCO 3.9.4, "LHSI/RHR and Coolant Circulation - High Water Level," and LCO 3.9.5, "LHSI/RHR and Coolant Circulation - Low Water Level."

19-269

ACTIONS

A.1

With IRWST temperature, water volume, boron concentration, or enrichment not within limits, it must be returned to within limits within 8 hours. Under these conditions the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE condition. The 8 hour limit ~~limit to restore the IRWST boron concentration or enrichment to within limits was developed considering the time required to change the boron concentration/isotopic inventory and the fact that the contents of the tank are still available for injection~~ is acceptable considering that the IRWST will be fully capable of performing its assumed safety function in response to DBAs with slight deviations in these parameters.

B.1

With the IRWST inoperable for reasons other than Condition A ~~(e.g., water volume)~~, it must be restored to OPERABLE status within 1 hour.

In this Condition, the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE status or to place the plant in a MODE in which the IRWST is not required. The short time limit of 1 hour to restore the IRWST to OPERABLE status is based on this condition simultaneously affecting redundant trains.

19-269

BASES

ACTIONS (continued)

C.1 and C.2

If the IRWST cannot be returned to OPERABLE status within the associated Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.5.4.1

The IRWST borated water temperature should be verified every 24 hours to be within the limits assumed in the accident analyses band. This Frequency is sufficient to identify a temperature change that would approach either limit and has been shown to be acceptable through operating experience.

SR 3.5.4.2

The IRWST water volume should be verified every 7 days to be within limits. The required minimum volume is verified in order to ensure that a sufficient NPSH is available for injection and to support continued ECCS pump operation. The maximum volume is verified in order to ensure the value assumed in the post-LOCA boron precipitation evaluation is not exceeded. Since the IRWST volume is normally stable and is protected by an alarm, a 7 day Frequency is appropriate and has been shown to be acceptable through operating experience.

SR 3.5.4.3

The boron concentration of the IRWST should be verified every 7 days to be within the required limits. This SR ensures that the reactor will remain subcritical following a LOCA. Further, it assures that the resulting sump pH will be maintained in an acceptable range so that boron precipitation in the core will not occur and the effect of chloride and caustic stress corrosion on mechanical systems and components will be minimized.

Since the IRWST inventory is normally stable, a 7 day sampling Frequency to verify boron concentration is appropriate and has been shown to be acceptable through operating experience.

19-269

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.5.4.4

The boron used in the IRWST is enriched to ≥~~>~~ 37% in the B-10 isotope. Verification every 24 months that the B-10 enrichment is ≥~~>~~ 37% ensures that the B-10 concentration assumed in the accident analysis is available. Since B-10 in the IRWST is not exposed to a significant neutron field, 24 months is considered conservative.

REFERENCES

1. FSAR Chapter 6 and Chapter 15.

19-269

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.6 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 5

BASES

BACKGROUND	A description of the IRWST is provided in LCO 3.5.4, “In-containment Refueling Water Storage Tank - Operating.”
APPLICABLE SAFETY ANALYSES	For postulated shutdown events in MODE 5 with the Reactor Coolant System (RCS) pressure boundary intact, the primary protection is the Medium Head Safety Injection (MHSI) trains, where the IRWST serves as the source of borated water. For events in MODE 5 with the RCS pressure boundary open, RCS heat removal is provided by MHSI injection of borated water from the IRWST. No loss of coolant accidents (LOCAs) are postulated during plant operation in MODE 5. However, the IRWST is available to minimize the probablity and consequence of an event to the extent possible. The IRWST in MODE 5 is included pursuant to 10 CFR 50.36 (b).
LCO	The IRWST requirements ensure that an adequate supply of borated water is available to supply the required volume of borated water as safety injection for cool cooling and reactivity control. To be considered OPERABLE, the IRWST must meet the water volume, boron concentration and boron enrichment limits defined in the Surveillance Requirements.
APPLICABILITY	In MODE 5 with the RCS pressure boundary intact or with the RCS open, the IRWST is an RCS injection source of borated water for core cooling and reactivity control. The requirements for the IRWST in MODES 1, 2, 3 and 4 are specified in LCO 3.5.4, In-containment Refueling Water Storage Tank (IRWST) - Operating. The requirements for the IRWST in MODE 6 are specified in LCO 3.5.7, In-containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 6.

19-269

BASES

ACTIONS

A.1

With IRWST water volume, boron concentration, or enrichment not within limits, it must be returned to within limits within 8 hours. Under these conditions the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE condition. The 8 hour limit is acceptable considering that the IRWST will be fully capable of performing it's assumed safety function in response to DBAs with slight deviations in these parameters.

B.1

With the IRWST inoperable for reasons other than Condition A, it must be restored to OPERABLE status within 1 hour.

In this Condition, the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE status or to place the plant in a condition in which the probability and consequences of an event are minimized to the extent possible. The short time limit of 1 hour to restore the IRWST to OPERABLE status is based on this condition simultaneously affecting redundant trains.

C.1 and C.2

If the IRWST cannot be returned to OPERABLE status within the associated Completion Time, the plant must be placed in a condition in which the probability and consequences of an event are minimized to the extent possible. This is done by immediately initiating action to restore the IRWST to OPERABLE status. Additionally, action to suspend positive reactivity additions is required to ensure that the SDM is maintained. Sources of positive reactivity addition include boron dilution, withdrawal of rod control cluster assemblies, and excessive cooling of the RCS.

SURVEILLANCE REQUIREMENTS

SR 3.5.7.1

The LCO 3.5.4 Surviellance Requirements and Frequencies (SR 3.5.4.2 through 3.5.4.4) are applicable to the IRWST in MODE 5. Refer to the corresponding Bases for LCO 3.5.4 for a discussion of each SR.

REFERENCES

None

19-269

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.7 In-Containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 6

BASES

BACKGROUND	A description of the IRWST is provided in LCO 3.5.4, “In-containment Refueling Water Storage Tank - Operating.”
APPLICABLE SAFETY ANALYSES	For MODE 6, heat removal is provided by injection of borated water from the IRWST by Medium Head Safety Injection (MHSI). The IRWST in MODE 6 is included pursuant to CFR 50.36 (b).
LCO	The IRWST requirements ensure that an adequate supply of borated water is available to supply the required volume of borated water as safety injection for cool cooling. To be considered OPERABLE, the IRWST in combination with the refueling canal must meet the water volume limits defined in the Surveillance Requirement. Any canal leakage should be estimated and made up with borated water such that the volume in the IRWST plus the refueling canal and refueling cavity will meet the IRWST volume requirement. Boron concentration requirements are addressed by LCO 3.9.1
APPLICABILITY	In MODE 6, the IRWST is the MHSI injection source of borated water for core coolling. The requirements for the IRWST in MODES 1, 2, 3, and 4 are specified in LCO 3.5.4, In-containment Refueling Water Storage Tank (IRWST) - Operating. The requirements for the IRWST in MODE 5 are specified in LCO 3.5.6, In-containment Refueling Water Storage Tank (IRWST) - Shutdown, MODE 5.
ACTIONS	A.1 With IRWST, refueling canal, and refueling cavity water volume not within limit, it must be returned to within limit within 8 hours. Under these conditions the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE condition. The 8 hour limit is acceptable considering that the IRWST will be fully capable of performing its assumed safety function in response to DBAs with slight deviations in these parameters.

19-269

BASES

ACTIONS (continued)

B.1

With the IRWST inoperable for reasons other than Condition A, it must be restored to OPERABLE status within 1 hour.

In this Condition, the ECCS cannot perform its design function. Therefore, prompt action must be taken to restore the tank to OPERABLE status or to place the plant in a condition in which the probability and consequences of an event are minimized to the extent possible. The short time limit of 1 hour to restore the IRWST to OPERABLE status is based on this condition simultaneously affecting redundant trains.

C.1 and C.2

If the IRWST cannot be returned to OPERABLE status within the associated Completion Times, the plant must be placed in a condition in which the probability and consequences of an event are minimized to the extent possible. In MODE 6, action must be immediately initiated to be in MODE 6 with the water level ≥23 feet above the top of the reactor vessel flange.

The time to RCS boiling is maximized by maximizing the RCS inventory and maintaining RCS temperatures as low as practical. Additionally, action to suspend positive reactivity additions is required to ensure that the SDM is maintained. Sources of posititve reactivity addtion include boron dilution, withdrawal of rod control cluster assemblies, and excessive cooling of the RCS. These actions place the plant in a condition which maximized the time to IRWST injection, thus providing time for repairs or application of alternative cooling capabilities.

SURVEILLANCE REQUIREMENTS

SR 3.5.7.1

The IRWST, refueling canal, and refueling cavity should be verified every 24 hours to be within limits. The required minimum volume is verified in order to ensure that a sufficient NPSH is available for injection and to support continued ECCS pump operation. Since the IRWST volume is normally stable and is protected by an alarm, a 24 hour frequency is appropriate and has been shown to be acceptable through operating experience

REFERENCES None

19-269

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.8 ECCS - Shutdown, MODE 5 and 6

BASES

BACKGROUND

The Background section for Bases 3.5.2, "ECCS - Operating," is applicable to these Bases, with the following modifications.

In MODES 5 and 6, a single ECCS train consisting of a Medium Head Safety Injection (MHSI) train is capable of providing the core cooling function. Low head Safety Injection is not automatically actuated.

The ECCS flow paths consist of piping, valves, heat exchangers, and pumps such that water from the in-containment refueling water storage tank (IRWST) can be injected into the Reactor Coolant System (RCS) following loss of shutdown cooling event.

APPLICABLE SAFETY ANALYSES

The Applicable Safety Analyses section of Bases 3.5.2 also applies to this Bases section.

Due to the stable conditions and low RCS pressure associated with operation in MODES 5 and 6 and the reduced probability of occurrence of a shutdown event, the ECCS operational requirements are reduced. Below P14 and RHR connected, LHSI is not automatically actuated by the Protection System (PS). However, MHSI is automatically actuated by the PS.

Two trains of ECCS are required for MODES 5 and 6. Protection against single failures is provided for this MODE of operation.

The ECCS trains in MODES 5 and 6 are included pursuant to 10 CFR 50.36(b).

LCO

In MODES 5 and 6, two of the four independent (and redundant) ECCS MHSI trains are required to be OPERABLE to ensure that sufficient ECCS flow is available to the core following shutdown events. One train is required to accomplish the safety function and one train is assumed lost to a single failure. The ECCS cross-connects are not needed for events postulated in MODES 5 and 6.

In MODES 5 and 6, an ECCS train consists of an MHSI subsystem. Each train includes the piping, instruments, and controls to ensure an OPERABLE flow path capable of taking suction from the IRWST.

19-269

BASES

LCO (continued)

During an event requiring ECCS MHSI actuation, a flow path is required to provide an abundant supply of water from the IRWST to the RCS via the ECCS pumps and to its associated four cold leg injection nozzles. In the long term, this flow path may be switched to deliver its flow to the RCS hot and cold legs.

APPLICABILITY

In MODES 1, 2, and 3, the OPERABILITY requirements for ECCS are covered by LCO 3.5.2. MODE 4 OPERABILITY is covered by LCO 3.5.3.

In MODES 5 and 6, two OPERABLE ECCS MHSI trains are acceptable and provide for single failure consideration on the basis of the stable reactivity of the reactor and the limited core cooling requirements.

In MODES 5 and 6, plant conditions are such that the probability of an event requiring ECCS injection is extremely low. Core cooling requirements in MODE 5 are addressed by LCO 3.4.7, "RCS Loops - MODE 5, Loops Filled," and LCO 3.4.8, "RCS Loops - MODE 5, Loops Not Filled." MODE 6 core cooling requirements are addressed by LCO 3.9.4, "LHSI/RHR and Coolant Circulation - High Water Level," and LCO 3.9.5, "LHSI/RHR and Coolant Circulation - Low Water Level."

ACTIONS

A.1

With one required MHSI train inoperable, the inoperable train must be returned to OPERABLE status within 72 hours. The 72 hour Completion Time is based on an NRC reliability evaluation (Ref. 5) and is a reasonable time for repair of many ECCS components.

An ECCS train is inoperable if it is not capable of delivering design flow to the RCS. Individual components are inoperable if they are not capable of performing their design function or supporting systems are not available.

B.1

When Required Action A.1 cannot be completed within the required Completion Time; or if two required ECCS MHSI trains are inoperable, immediate action must be taken to restore at least one MHSI train to OPERABLE status.

SURVEILLANCE REQUIREMENTS

SR 3.5.8.1

The applicable Surveillance descriptions from Bases 3.5.2 apply.

REFERENCES

The applicable references from Bases 3.5.2 apply.