# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

**Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD**

**Docket No. 52-046**

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| **RAI No.:** | **508-8592** |
| **SRP Section:** | **16 – Technical Specifications** |
| **Application Section:** | **16.3.1** |
| **Date of RAI Issue:** | **08/01/2016** |

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## Question No. 16-183

Paragraph (a)(11) of 10 CFR 52.47 states that a design certification (DC) applicant is to propose Technical Specifications (TS) prepared in accordance with 10 CFR 50.36 and 50.36a. NUREG-1432, “Standard Technical Specifications (STS)-Combustion Engineering Plants,” Rev. 4, provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements. Staff needs to evaluate all technical differences from standard TS (STS) NUREG-1432, STS Combustion Engineering Plants, Rev. 4, which is referenced by the DC applicant in DCD Tier 2 Section 16.1, and the docketed rationale for each difference because conformance to STS provisions is used in the safety review as the initial point of guidance for evaluating the adequacy of the generic TS to ensure adequate protection of public health and safety, and the completeness and accuracy of the generic TS Bases.

The Writer’s Guide for Plant-Specific Improved Technical Specifications (TSTF-GG-05-01) also provides guidance for the format and content of the TS. There are format and content differences between the DCD and the Writer’s Guide. These following corrections are necessary to ensure the completeness and accuracy of the TS and Bases.

Clarify a deviation from the STS in the Bases for Technical Specification (TS) 3.1.10 Special Test Exceptions (STE) – Shutdown Margin (SDM), TS 3.1.11 Special Test Exceptions (STE) – MODES 1 and 2, and TS 3.1.12 Special Test Exceptions (STE) – Reactivity Coefficient Testing.

In the APR1400 Bases, the first sentence in the final paragraph in the Applicable Safety Analysis section ends with the text “…and therefore no SECTION CRITERIA apply.” The same sentence in the STS ends with the following text “…and therefore no criteria of 10 CFR 50.36(c)(2)(ii) apply.” This appears to be a typographical error (only in TS 3.1.10) with the intended text being “SELECTION CRITERIA.”

In the APR1400 Bases, the final sentence in the same paragraph reads “A discussion of the SELECTION CRITERIA satisfied for the other LCOs are provided in their respective Bases.” The same sentence in the STS reads “A discussion of the criteria satisfied for the other LCOs is provided in their respective Bases.”

An RAI has been written to address the inclusion of SELECTION CRITERIA in the Definitions section of the TS, stating that SELECTION CRITERIA should not be in the Definitions. Therefore, if the term SELECTION CRITERIA is removed from the Definitions section, then the text in the 3.1.10 Bases will have to be altered.

This clarification is required to ensure the accuracy and completeness of the TS Bases.

## Response

In accordance with the response of Q. 16-26 for RAI 130-8065, the terminology of SELECTION CRITERIA will be deleted in the 3.1.10 Bases, 3.1.11 Bases and 3.1.12 Bases. Therefore those bases will be revised as indicated in the Attachment.

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**Impact on DCD**

Same as changes described in Impact on Technical Specifications section.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

The Bases for LCOs 3.1.10, 3.1.11, and 3.1.12 will be revised as indicated in the Attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

BASES

APPLICABLE SAFETY ANALYSES (continued)

PHYSICS TESTS include measurement of core parameters or exercise of control components that affect process variables. Among the process variables involved are total planar radial peaking factor, total integrated radial peaking factor, $T_q$, and ASI, which represent initial condition input (power peaking) to the accident analysis. Also involved are the shutdown and regulating CEAs, which affect power peaking and are required for shutdown of the reactor. The limits for these variables are specified in their respective LCOs.

criteria of 10 CFR 50.36(c)(2)(ii)

As described in LCO 3.0.7, compliance with Special Test Exception (STE) LCOs is optional, and therefore no ~~SECTION CRITERIA~~ apply. STE LCOs provide flexibility to perform certain operations by appropriately modifying requirements of other LCOs. A discussion of the ~~SELECTION CRITERIA~~ satisfied for the other LCOs are provided in their respective Bases.

the criteria

LCO

This LCO provides that a minimum amount of CEA worth is immediately available for reactivity control when CEA worth measurement tests are performed. This STE is required to permit the periodic verification of the actual versus predicted reactivity worth of the regulating CEA and shutdown CEA. The SDM requirements of LCO 3.1.1, the Shutdown CEA Insertion Limits of LCO 3.1.6, the Regulating CEA Insertion Limits of LCO 3.1.7, Trip Functions 2, 14 and 15 in Table 3.3.1-1 of LCO 3.3.1, and Trip Function 1 in Table 3.3.2-1 of LCO 3.3.2 may be suspended.

APPLICABILITY

This LCO is applicable in MODES 2 and 3. Although CEA worth testing is conducted in MODE 2, sufficient negative reactivity is inserted during the performance of these tests to result in temporary entry into MODE 3. Because the intent is to immediately return to MODE 2 to continue CEA worth measurements, the STE allows limited operation to 6 consecutive hours in MODE 3 as indicated by the Note, without having to borate to meet the SDM requirements of LCO 3.1.1.

ACTIONS

A.1

With any CEA not fully inserted and less than the minimum required reactivity equivalent available for insertion, or with all CEAs inserted and the reactor subcritical by less than the reactivity equivalent of the highest worth withdrawn CEA, restoration of the minimum SDM requirements must be accomplished by increasing the RCS boron concentration.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The safety analysis (Reference 6) places limits on allowable THERMAL POWER during PHYSICS TESTS and requires that the LHR and the DNBR be maintained within limits. The power plateau of less than 85 % RTP and the associated trip setpoints are required to ensure that LHR and DNBR are maintained within acceptable limits.

The individual LCOs governing CEA height, insertion and alignment, ASI, total planar radial peaking factor, total integrated radial peaking factor, and $T_q$, preserve the LHR limits. Additionally, the LCOs governing Reactor Coolant System (RCS) flow, reactor inlet temperature ($T_c$), and pressurizer pressure contribute to maintaining DNBR limits. The initial condition criteria for accidents sensitive to core power distribution are preserved by the LHR and DNBR limits. The criteria for the loss of coolant accident (LOCA) are specified in 10 CFR 50.46 (Reference 7). The criteria for the loss of forced reactor coolant flow accident are specified in Reference 8. Operation within the LHR limits preserves the LOCA criteria; operation within the DNBR limits preserves the loss of flow criteria. During PHYSICS TESTS, one or more of the LCOs that normally preserve the LHR and DNBR limits may be suspended. The results of the accident analysis are not adversely impacted, however, if LHR and DNBR are verified to be within their limits while the LCOs are suspended. Therefore, SRs are placed as necessary to ensure that LHR and DNBR remain within limits during PHYSICS TESTS. Performance of these Surveillances allows PHYSICS TESTS to be conducted without decreasing the margin of safety.

PHYSICS TESTS include measurement of core parameters or exercise of control components that affect process variables. Among the process variables involved are total planar radial peaking factor, total integrated radial peaking factor, $T_q$, and ASI, which represent initial condition input (power peaking) to the accident analysis. Also involved are the shutdown and regulating CEAs, which affect power peaking and are required for shutdown of the reactor. The limits for these variables are specified in their respective LCOs.

criteria of 10 CFR 50.36(c)(2)(ii)

As described in LCO 3.0.7, compliance with Special Test Exception (STE) LCOs is optional, and therefore no ~~SELECTION CRITERIA~~ apply. STE LCOs provide flexibility to perform certain operations by appropriately modifying requirements of other LCOs.

A discussion of the ~~SELECTION CRITERIA~~ satisfied for the other LCOs are provided in their respective Bases.

the criteria

BASES

APPLICABLE SAFETY ANALYSES (continued)

The individual LCOs governing CEA group height, insertion and alignment, ASI, total planar radial peaking factor, total integrated radial peaking factor, and $T_q$, preserve the LHR limits. Additionally, the LCOs governing Reactor Coolant System (RCS) flow, reactor inlet temperature (Tc), and pressurizer pressure contribute to maintaining DNBR limits. The initial condition criteria for accidents sensitive to core power distribution are preserved by the LHR and DNBR limits. The criteria for the loss of coolant accident (LOCA) are specified in 10 CFR 50.46 (Reference 7). The criteria for the loss of forced reactor coolant flow accident are specified in Reference 8. Operation within the LHR limit preserves the LOCA criteria. Operation within the DNBR limits preserves the loss of flow criteria.

During PHYSICS TESTS, one or more of the LCOs that normally preserve the LHR and DNBR limits may be suspended. The results of the accident analysis are not adversely impacted, however, if LHR and DNBR are verified to be within their limits while the LCOs are suspended. Therefore, SRs are placed as necessary to ensure that LHR and DNBR remain within limits during PHYSICS TESTS. Performance of these Surveillances allows PHYSICS TESTS to be conducted without decreasing the margin of safety.

PHYSICS TESTS include measurement of core parameters or exercise of control components that affect process variables. Among the process variables involved are total planar radial peaking factor, total integrated radial peaking factor, $T_q$, and ASI, which represent initial condition input (power peaking) to the accident analysis. Also involved are the shutdown and regulating CEAs, which affect power peaking and are required for shutdown of the reactor. The limits for these variables are specified in their respective LCOs.

criteria of 10 CFR 50.36(c)(2)(ii)

As described in LCO 3.0.7, compliance with Special Test Exception (STE) LCOs is optional, and therefore no ~~SELECTION CRITERIA~~ apply. STE LCOs provide flexibility to perform certain operations by appropriately modifying requirements of other LCOs. A discussion of the ~~SELECTION CRITERIA~~ satisfied for the other LCOs are provided in their respective Bases.

the criteria

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| **Application Section:** | **16.3.1** |
| **Date of RAI Issue:** | **08/01/2016** |

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## Question No. 16-184

Paragraph (a)(11) of 10 CFR 52.47 states that a design certification (DC) applicant is to propose Technical Specifications (TS) prepared in accordance with 10 CFR 50.36 and 50.36a. NUREG-1432, “Standard Technical Specifications (STS)-Combustion Engineering Plants,” Rev. 4, provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements. Staff needs to evaluate all technical differences from standard TS (STS) NUREG-1432, STS Combustion Engineering Plants, Rev. 4, which is referenced by the DC applicant in DCD Tier 2 Section 16.1, and the docketed rationale for each difference because conformance to STS provisions is used in the safety review as the initial point of guidance for evaluating the adequacy of the generic TS to ensure adequate protection of public health and safety, and the completeness and accuracy of the generic TS Bases.

The Writer’s Guide for Plant-Specific Improved Technical Specifications (TSTF-GG-05-01) also provides guidance for the format and content of the TS. There are format and content differences between the DCD and the Writer’s Guide. These following corrections are necessary to ensure the completeness and accuracy of the TS and Bases.

Clarify a reference in the Bases for Technical Specification (TS) 3.1.11 Special Test Exceptions (STE) – MODES 1 and 2.

In the Background section, there is text that refers to “Reference 4”, which is DCD Tier 2, Chapter 14. This text is similar to text within the Bases for TS 3.1.10 and 3.1.12, both of which also refer to “Reference 4.” In those TS Bases, Reference 4 is ANSI/ANS-19.6.1-2005. In the STS for STE – MODES 1 and 2, Reference 4 also refers to ANSI/ANS-19.6.1-2005.

This clarification is required to ensure the text is referring to the correct Reference.

## Response

The reference 4 which is on page B 3.1.11-1 of the Technical Specification will be revised to reference 5 as indicated in the Attachment.

The numbering of the references in the Bases as called out in the text is being corrected as part of Technical Specification update to revision 1 and as such will not be corrected for this specific RAI.

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**Impact on DCD**

Same as changes described in Impact on Technical Specifications section.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

The Bases for LCOs 3.1.11 will be revised as indicated in the Attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

## B 3.1 REACTIVITY CONTROL SYSTEMS

## B 3.1.11 Special Test Exceptions (STE) – MODES 1 and 2

### BASES

**BACKGROUND**

The primary purpose of these MODES 1 and 2 STEs is to permit relaxation of existing LCOs to allow the performance of certain PHYSICS TESTS. These tests are conducted to determine specific reactor core characteristics.

10 CFR Part 50, Appendix B, Section XI (Reference 1) requires that a test program be established to ensure that structures, systems, and components will perform satisfactorily in service. All functions necessary to ensure that specified design conditions are not exceeded during normal operation and anticipated operational occurrences must be tested. Testing is required as an integral part of the design, fabrication, construction, and operation of the power plant. Requirements for notification of the NRC, for the purpose of conducting tests and experiments, are specified in 10 CFR 50.59, "Changes, Tests, and Experiments" (Reference 2).

The key objectives of a test program are to (Reference 3):

a. Ensure facility has been adequately designed.

b. Validate analytical models used in design and analysis.

c. Verify assumptions used for predicting plant response.

d. Ensure installation of equipment in the facility has been accomplished in accordance with design.

e. Verify operating and emergency procedures are adequate.

To accomplish these objectives, testing is required prior to initial criticality, after each refueling shutdown, and during startup, low power operation, power ascension, and at power operation. The PHYSICS TESTS requirements for the initial core and reload fuel cycles ensure that the operating characteristics of the core are consistent with the design predictions and that the core can be operated as designed (Reference 4). 5

PHYSICS TESTS procedures are written and approved in accordance with established formats. The procedures include all information necessary to permit a detailed execution of testing required to ensure that design intent is met.

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## Question No. 16-185

Paragraph (a)(11) of 10 CFR 52.47 states that a design certification (DC) applicant is to propose Technical Specifications (TS) prepared in accordance with 10 CFR 50.36 and 50.36a. NUREG-1432, "Standard Technical Specifications (STS)-Combustion Engineering Plants," Rev. 4, provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements. Staff needs to evaluate all technical differences from standard TS (STS) NUREG-1432, STS Combustion Engineering Plants, Rev. 4, which is referenced by the DC applicant in DCD Tier 2 Section 16.1, and the docketed rationale for each difference because conformance to STS provisions is used in the safety review as the initial point of guidance for evaluating the adequacy of the generic TS to ensure adequate protection of public health and safety, and the completeness and accuracy of the generic TS Bases.

The Writer's Guide for Plant-Specific Improved Technical Specifications (TSTF-GG-05-01) also provides guidance for the format and content of the TS. There are format and content differences between the DCD and the Writer's Guide. These following corrections are necessary to ensure the completeness and accuracy of the TS and Bases.

Justify a deviation for the STS in the Bases for Technical Specification (TS) 3.1.11 Special Test Exceptions (STE) – MODES 1 and 2 and TS 3.1.12 Special Test Exceptions (STE) – Reactivity Coefficient Testing.

The final sentence in the Actions B.1 section of the APR1400 Bases states "During suspending PHYSICS TEST STE, the corresponding LCOs shall be restored." The same sentence in the STS states "Suspension of PHYSICS TESTS exceptions requires restoration of each of the applicable LCOs to within specification." This is a clarity issue.

This justification is required to ensure the clarity of the TS Bases.

## Response

The 3.1.11 Bases and 3.1.12 Bases will be revised as indicated in the Attachment.

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**Impact on DCD**

Same as changes described in Impact on Technical Specifications section.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

The Bases for LCOs 3.1.11, 3.1.12 will be revised as indicated in the Attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical, or Environmental Report.

BASES

ACTIONS (continued)

B.1

If Required Action A.1 cannot be completed within the required Completion Time, PHYSICS TESTS must be suspended within 1 hour. Allowing 1 hour for suspending PHYSICS TESTS allows the operator sufficient time to change any abnormal CEA configuration back to within the limits of LCO 3.1.5, 3.1.6, and 3.1.7. ~~During suspending PHYSICS TEST STE, the corresponding LCOs shall be restored.~~

Suspension of PHYSICS TESTS exceptions requires restoration of each of the applicable LCOs to within specification.

SURVEILLANCE REQUIREMENTS

SR 3.1.11.1

Verifying that THERMAL POWER is equal to or less than that allowed by the test power plateau, as specified in the PHYSICS TEST procedure and required by the safety analysis, ensures that adequate LHR and DNBR margins are maintained while LCOs are suspended. The 1-hour Frequency is sufficient, based upon the slow rate of power change and increased operational controls in place during PHYSICS TESTS. Monitoring LHR ensures that the limits are not exceeded.

REFERENCES

1. 10 CFR Part 50, Appendix B, Section XI.
2. 10 CFR 50.59
3. NRC RG 1.68, Revision 4, June 2013.
4. DCD Tier 2, Chapter 14.
5. ANSI/ANS-19.6.1-2005.
6. DCD Tier 2, Chapter 15.
7. 10 CFR 50.46.
8. DCD Tier 2, Subsection 15.3.1.

BASES

**LCO**

This LCO permits Part Strength CEAs and Regulating CEAs to be positioned outside of their normal group heights and insertion limits, and RCS cold leg temperature to be outside its limits during the performance of PHYSICS TESTS. These PHYSICS TESTS are required to determine the isothermal temperature coefficient (ITC), MTC, and power coefficient.

The requirements of LCOs 3.1.7, 3.1.8 and 3.4.1 (for RCS cold leg temperature only) may be suspended during the performance of PHYSICS TESTS provided COLSS is in service.

**APPLICABILITY**

This LCO is applicable in MODE 1 with THERMAL POWER greater than 20 % RTP because the reactor must be critical at THERMAL POWER levels greater than 20 % RTP to perform the PHYSICS TESTS described in the LCO section.

**ACTIONS**

A.1

With the LHR or DNBR outside the limits specified in their LCOs, adequate safety margin is not assured and power must be reduced to restore LHR and DNBR to within limits. The required Completion Time of 15 minutes ensures prompt action is taken to restore LHR or DNBR to within limits.

B.1

When the Required Action cannot be met or completed within the required Completion Time, PHYSICS TESTS must be suspended within 1 hour. Allowing 1 hour for suspending PHYSICS TESTS allows the operator sufficient time to change any abnormal conditions back to within the limits of LCOs 3.1.7, 3.1.8, and 3.4.1 (for RCS cold leg temperature only). During suspending PHYSICS TEST STE, the corresponding LCOs shall be restored.

Suspension of PHYSICS TESTS exceptions requires restoration of each of the applicable LCOs to within specification.

**SURVEILLANCE REQUIREMENTS**

With THERMAL POWER greater than or equal to 20 % RTP, LHR and DNBR can be continuously monitored using the COLSS since the COLSS is available with THERMAL POWER above 20 % RTP. If COLSS is not available, LHR and DNBR can be continuously monitored using any OPERABLE CPC channel. Continuous monitoring is required to ensure that the LHR and DNBR limits are satisfied at all times. SRs 3.2.1.1 and 3.2.4.1 provide the specific requirements for performing this SR.

# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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**Docket No. 52-046**

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| **RAI No.:** | **508-8592** |
| **Review Section:** | **16 – Technical Specifications** |
| **Application Section:** | **16.3.4, 16.3.5, 16.3.6, 16.3.7, 16.3.9** |
| **Date of RAI Issue:** | **08/01/2016** |

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## Question No. 16-191

Paragraph (a)(11) of 10 CFR 52.47 states that a design certification (DC) applicant is to propose Technical Specifications (TS) prepared in accordance with 10 CFR 50.36 and 50.36a. NUREG-1432, “Standard Technical Specifications (STS)-Combustion Engineering Plants,” Rev. 4, provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements. Staff needs to evaluate all technical differences from standard TS (STS) NUREG-1432, STS Combustion Engineering Plants, Rev. 4, which is referenced by the DC applicant in DCD Tier 2 Section 16.1, and the docketed rationale for each difference because conformance to STS provisions is used in the safety review as the initial point of guidance for evaluating the adequacy of the generic TS to ensure adequate protection of public health and safety, and the completeness and accuracy of the generic TS Bases.

The Writer’s Guide for Plant-Specific Improved Technical Specifications (TSTF-GG-05-01) also provides guidance for the format and content of the TS. There are format and content differences between the DCD and the Writer’s Guide. These following corrections are necessary to ensure the completeness and accuracy of the TS and Bases.

Correct the formatting of the titles in the upper right hand corner in the Bases for Technical Specifications (TS) 3.4.7 and 3.4.8.

The title for TS 3.4.7 in the upper right hand corner reads “RCS Loops – MODES 5(Loops Filled)” and the title for TS 3.4.8 in the upper right hand corner reads “RCS Loops – MODES 5(Loops Not Filled).” The following 2 corrections need to be made. The ”MODES” should read “MODE” and a space needs to be added between the “5” and the “(“. These corrections need to be made on pages B3.4.7-1 through B3.4.7-7 and B3.4.8-1 through B3.4.8-6.

These corrections are required to ensure the accuracy of the TS Bases.

## Response

The Bases for TS 3.4.7 and 3.4.8 will be revised as indicated in the Attachment.

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**Impact on DCD**

Same as changes described in Impact on Technical Specifications section.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

The Bases for TS 3.4.7 and 3.4.8 will be revised as indicated in the Attachment.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical or Environmental Report.

B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.7 RCS Loops – MODE 5 (Loops Filled)

BASES

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BACKGROUND

In MODE 5 with the RCS loops filled, the primary function of the reactor coolant is the removal of decay heat and the transfer of this heat either to the steam generators (SGs) secondary side coolant or the component cooling water via shutdown cooling (SC) heat exchangers. While the principal means for decay heat removal is via the SC system, the SGs are specified as a backup means for redundancy. Even though the SGs cannot produce steam in this MODE, they are capable of being a heat sink due to their large contained volume of secondary side water. As long as the SG secondary side water is at a lower temperature than the reactor coolant, heat transfer will occur. The rate of heat transfer is directly proportional to the temperature difference. The secondary function of the reactor coolant is to act as a carrier for soluble neutron poison, boric acid.

In MODE 5 with RCS loops filled, the SC trains are the principal means for decay heat removal. The number of trains in operation can vary to suit the operational needs. The intent of this LCO is to provide forced flow from at least one SC train for decay heat removal and transport. The flow provided by one SC train is adequate for decay heat removal. The other intent of this LCO is to require that a second path be available to provide redundancy for decay heat removal.

The LCO provides for redundant paths of decay heat removal capability. The first path can be an SC train that must be OPERABLE and in operation. The second path can be another OPERABLE SC train, or through the SGs, having an adequate water level.

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APPLICABLE SAFETY ANALYSES

In MODE 5, RCS circulation is considered in the determination of the time available for mitigation of the accidental boron dilution event. The SC trains provide this circulation.

RCS loops – MODE 5 (loops filled) have been included in Specification as important contributors to risk reduction according to LCO SELECTION CRITERION 4.

BASES

LCO

The purpose of this LCO is to require at least one of the SC trains be OPERABLE and in operation with an additional SC train OPERABLE or secondary side water level of each SG shall be greater than or equal to 25 % wide range. One SC train provides sufficient forced circulation to perform the safety functions of the reactor coolant under these conditions. The second SC train is normally maintained OPERABLE as a backup to the operating SC train to provide redundant paths for decay heat removal. However, if the standby SC train is not OPERABLE, a sufficient alternate method to provide redundant paths for decay heat removal is two SGs with their secondary side water levels greater than or equal to 25 % wide range. Should the operating SC train fail, the SGs could be used to remove the decay heat.

Note 1 permits all SC pumps to be de-energized less than or equal to 1 hour per 8-hour period. The circumstances for stopping both SC trains are to be limited to situations where pressure and temperature increases can be maintained well within the allowable pressure (pressure and temperature (P/T) limits or low temperature overpressure protection (LTOP) limits) and 5.6 °C (10 °F) subcooling limits, or an alternate heat removal path through the SG(s) is in operation.

This LCO is modified by a Note that prohibits boron dilution when SC forced flow is stopped because an even concentration distribution cannot be ensured. Core outlet temperature is to be maintained at least 5.6 °C (10 °F) below saturation temperature, so that no vapor bubble would form and possibly cause a natural circulation flow obstruction.

In this MODE, the SG(s) can be used as the backup for SC heat removal. To ensure their availability, the RCS loop flow path is to be maintained with subcooled liquid.

In MODE 5, it is sometimes necessary to stop all RCPs or SC forced circulation. This is permitted to change operation from one SC train to the other, perform surveillance or startup testing, perform the transition to and from the SC system, or to avoid operation below the RCP minimum net positive suction head limit. The time period is acceptable because natural circulation is acceptable for decay heat removal, the reactor coolant temperature can be maintained subcooled, and boron stratification affecting reactivity control is not expected.

BASES

LCO (continued)

Note 2 allows one SC train to be inoperable for a period of up to 2 hours provided that the other SC train is OPERABLE and in operation. This permits periodic surveillance tests to be performed on the inoperable train during the only time when such testing is safe and possible.

Note 3 requires that before an RCP may be started with any RCS cold leg temperature less than or equal to less than or equal to the LTOP enable temperature specified in the PTLR, that secondary side water temperature in each SG is less than 55.6 °C (100 °F) above each of the RCS cold leg temperatures.

Satisfying the above conditions will preclude a low temperature overpressure event due to a thermal transient when the RCP is started.

Note 4 provides for an orderly transition from MODE 5 to MODE 4 during a planned heatup by permitting removal of SC trains from operation when at least one RCP is in operation. This Note provides for the transition to MODE 4 where an RCP is permitted to be in operation and replaces the RCS circulation function provided by the SC trains.

An OPERABLE SC train is composed of an OPERABLE SC pump and an OPERABLE SC heat exchanger. Management of gas voids is important to SCS OPERABILTY.

SC pumps are OPERABLE if they are capable of being powered and are able to provide flow if required. An OPERABLE SG can perform as a heat sink when it has an adequate secondary water level and is OPERABLE in accordance with the In-service Inspection Program.

Note 5 permits the alignment of a containment spray pump if a SC pump is not available or becomes inoperable. These pumps are designed to be interchangeable for operational flexibility.

APPLICABILITY

In MODE 5 with RCS loops filled, this LCO requires forced circulation to remove decay heat from the core and to provide proper boron mixing. One SC train provides sufficient circulation for these purposes.

BASES

APPLICABILITY (continued)

Operation in other MODES is covered by:

LCO 3.4.4, “RCS Loops – MODES 1 and 2”

LCO 3.4.5, “RCS Loops – MODE 3”

LCO 3.4.6, “RCS Loops – MODE 4”

LCO 3.4.8, “RCS Loops – MODE 5 (Loops Not Filled)”

LCO 3.9.4, “Shutdown Cooling System (SCS) and Coolant Circulation – High Water Level”, and

LCO 3.9.5, “Shutdown Cooling System (SCS) and Coolant Circulation – Low Water Level"

ACTIONS

A.1, A.2, B.1 and B.2

If the required SC train is inoperable and any SGs have secondary side water levels less than 25 % wide range, redundancy for heat removal is lost. Action must be initiated immediately to restore a second SC train to OPERABLE status or to restore the water level in the required SGs. Either Required Action A.1 or Required Action A.1 and A.2 will restore redundant decay heat removal paths. The immediate Completion Times reflect the importance of maintaining the availability of two paths for decay heat removal.

C.1 and C.2

If both SC trains are inoperable or no SC train is in operation, except as permitted in Note 1, all operations involving the reduction of RCS boron concentration must be suspended. Action to restore one SC train to OPERABLE status and operation must be initiated immediately. Boron dilution requires forced circulation for proper mixing and margin to criticality must not be reduced in this type of operation. The immediate Completion Times reflect the importance of maintaining operation for decay heat removal.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.4.7.1

This SR requires verification every 12 hours that one SC train is in operation. Verification includes flow rate, temperature, or pump status monitoring, which help ensure that forced flow is providing decay heat removal. The 12-hour Frequency has been shown by operating practice to be sufficient to regularly assess degradation and verify operation is within safety analyses assumptions. In addition, MCR indication and alarms will normally indicate loop status.

The SC flow is established to ensure that core outlet temperature is maintained sufficiently below saturation to allow time for swap over to the standby SC train should the operating train be lost.

SR 3.4.7.2

Verifying the SGs are OPERABLE by ensuring their secondary side water levels are greater than or equal to 25 % wide range ensures that redundant heat removal paths are available if the second SC train is inoperable.

The Surveillance is required to be performed when the LCO requirement is being met by use of the SGs. If both SC trains are OPERABLE, this SR is not needed. The 12-hour Frequency has been shown by operating practice to be sufficient to regularly assess degradation and verify operation within safety analyses assumptions.

SR 3.4.7.3

Verification that the second SC train is OPERABLE ensures that redundant paths for decay heat removal are available. The requirement also ensures that the additional train can be placed in operation, if needed, to maintain decay heat removal and reactor coolant circulation. Verification is performed by verifying proper breaker alignment and power available to the required pump. The Surveillance is required to be performed when the LCO requirement is being met by one of two SC trains (e.g., SGs have less than 25 % wide range water level). The 7-day Frequency is considered reasonable in view of other administrative controls available and has been shown to be acceptable by operating experience.

This SR is modified by a Note that states the SR is not required to be performed until 24 hours after a required pump is not in operation.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.7.4

SCS piping and components have the potential to develop voids and pockets of entrained gases. Preventing and managing gas intrusion and accumulation is necessary for proper operation of the required SCS train(s) and may also prevent water hammer, pump cavitation, and pumping of noncondensible gas into the reactor vessel.

Selection of SCS locations susceptible to gas accumulation is based on a review of system design information, including piping and instrumentation drawings, isometric drawings, plan and elevation drawings, and calculations. The design review is supplemented by system walk downs to validate the system high points and to confirm the location and orientation of important components that can become sources of gas or could otherwise cause gas to be trapped or difficult to remove during system maintenance or restoration. Susceptible locations depend on plant and system configuration, such as stand-by versus operating conditions.

The SCS is OPERABLE when it is sufficiently filled with water. Acceptance criteria are established for the volume of accumulated gas at susceptible locations. If accumulated gas is discovered that exceeds the acceptance criteria for the susceptible location (or the volume of accumulated gas at one or more susceptible locations exceeds an acceptance criteria for gas volume at the suction or discharge of a pump), the Surveillance is not met. If it is determined by subsequent evaluation that the SCS is not rendered inoperable by the accumulated gas (i.e., the system is sufficiently filled with water), the Surveillance may be declared met. Accumulated gas should be eliminated or brought within the acceptance criteria limits.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SCS locations susceptible to gas accumulation are monitored and, if gas is found, the gas volume is compared to the acceptance criteria for the location. Susceptible locations in the same system flow path which are subject to the same gas intrusion mechanisms may be verified by monitoring a representative sub-set of susceptible locations. Monitoring may not be practical for locations that are inaccessible due to radiological or environmental conditions, the plant configuration, or personnel safety. For these locations alternative methods (e.g., operating parameters, remote monitoring) may be used to monitor the susceptible location. Monitoring is not required for susceptible locations where the maximum potential accumulated gas void volume has been evaluated and determined to not challenge system OPERABILITY. The accuracy of the method used for monitoring the susceptible locations and trending of the results should be sufficient to assure system OPERABILITY during the Surveillance interval.

This SR is modified by a Note that states the SR is not required to be performed until 12 hours after entering MODE 4. In a rapid shutdown, there may be insufficient time to verify all susceptible locations prior to entering MODE 4.

The 31 day Frequency takes into consideration the gradual nature of gas accumulation in the SCS piping and the procedural controls governing system operation.

REFERENCES None

MODE 5 (Loops Not Filled)

B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.8 RCS Loops – MODE 5 (Loops Not Filled)

BASES

BACKGROUND

In MODE 5 with the reactor coolant system (RCS) loops not filled, the primary function of the reactor coolant is the removal of decay heat and transfer of this heat to the shutdown cooling (SC) heat exchangers. The steam generators are not available as a heat sink when the loops are not filled. The secondary function of the reactor coolant is to act as a carrier for soluble neutron poison, boric acid.

In MODE 5 with loops not filled, only the SC system can be used for coolant circulation. The number of trains in operation can vary to suit the operational needs. The intent of this LCO is to provide forced flow from at least one SC train for decay heat removal and transport. The other intent of this LCO is to require that two paths be available to provide redundancy for heat removal.

This LCO permits limited periods without forced circulation. When the SC trains are not in operation, no alternate heat removal path exists. The response of the RCS without the SC system depends on the decay heat load and the length of time that the SC pumps are stopped. As decay heat diminishes, the effects on RCS temperature diminish. Without cooling by SC system, higher heat loads will cause the reactor coolant temperature to increase at a rate proportional to the decay heat load. Because pressure can increase, applicable system pressure limits (pressure and temperature limits or low temperature overpressurization limits) must be observed and forced SC system flow must be reestablished prior to reaching the pressure limit. Entry into a condition with no SC system train in operation stops heat removal and should only be considered for limited circumstances such as when switching from one SC system train to the other. With the SC pumps stopped, pressure and temperature could increase and pumps must be restored prior to exceeding pressure and subcooling limits.

The SC system removes decay heat from the RCS and transfers the heat to the component cooling water (CCW) system. During “Loops Not Filled” operations the interruption or loss of SCS flow, decay heat removal (DHR) capability, can lead to bulk boiling quite rapidly.

BASES

BACKGROUND (continued)

In some cases, this can occur in 15 to 20 minutes. During "Loops Not Filled" operations, the SC system is the primary means of decay heat removal.

APPLICABLE SAFETY ANALYSES

In MODE 5, RCS circulation is considered in determining the time available for mitigation of the accidental boron dilution event. The SC trains provide this circulation. The flow provided by one SC train is adequate for decay heat removal and for boron mixing.

RCS loops – MODE 5 (loops not filled) has been included in specification as important contributors to risk reduction according to LCO SELECTION CRITERION 4.

LCO

The purpose of this LCO is to require a minimum of two SC trains be OPERABLE and one of these trains be in operation. An OPERABLE train is one that has the capability of transferring heat from the reactor coolant at a controlled rate.

Heat removal cannot occur via the SC system unless forced flow is used. A minimum of one running SC pump meets the LCO requirement for one train in operation. An additional SC train is required to be OPERABLE to meet the single failure criterion.

During Loops Not Filled operations, the containment spray pump in the OPERABLE SC train shall be OPERABLE.

Note 1 permits the SC pumps to be de-energized for less than or equal to 15 minutes when switching from one train to another. The circumstances for stopping both SC pumps are to be limited to situations when the outage time is short and the core outlet temperature is maintained at least 5.6 °C (10 °F) below saturation temperature. The Note prohibits boron dilution and draining operations when SC forced flow is stopped.

Note 2 allows one SC train to be inoperable for a period of 2 hours provided that the other train is OPERABLE and in operation. This permits periodic surveillance tests to be performed on the inoperable train during the only time when these tests are safe and possible.

LCO (continued)

An OPERABLE SC train is composed of an OPERABLE SC pump capable of providing forced flow to an OPERABLE SC heat exchanger, along with the appropriate flow and temperature instrumentation for control, protection, and indication. SC pumps are OPERABLE if they are capable of being powered and are able to provide flow if required. Management of gas voids is important to SCS OPERABILITY.

Note 3 permits the alignment of a containment spray pump if an SC pump is not available or becomes inoperable. These pumps are designed to be interchangeable for operational flexibility.

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APPLICABILITY

In MODE 5 with loops not filled, this LCO requires core heat removal and coolant circulation by the SCS.

Operation in other MODES is covered by:

LCO 3.4.4, “RCS Loops – MODES 1 and 2”

LCO 3.4.5, “RCS Loops – MODE 3”

LCO 3.4.6, “RCS Loops – MODE 4”

LCO 3.4.7, “RCS Loops – MODE 5 (Loops Filled)”

LCO 3.9.4, “Shutdown Cooling System (SCS) and Coolant Circulation – High Water Level”, and

LCO 3.9.5, “Shutdown Cooling System (SCS) and Coolant Circulation – Low Water Level”

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ACTIONS

A.1

If one required SC train is inoperable, redundancy for heat removal is lost. Action must be initiated immediately to restore a second train to OPERABLE status. The immediate Completion Time reflects the importance of maintaining the availability of two paths for heat removal.

ACTIONS (continued)

B.1, B.2 and B.3

If required SC trains are inoperable or no train is in operation, the action requires immediate suspension of any operation for boron concentration reduction, initiating action to raise RCS level to greater than EL 38.72 m (127 ft 1/4 in) and requires action to immediately start restoration of one SC train to OPERABLE status. Boron dilution requires forced circulation for proper mixing and margin to criticality must not be reduced in this type of operation. The immediate Completion Time reflects the importance of maintaining operation for decay heat removal.

SURVEILLANCE REQUIREMENTS

SR 3.4.8.1

This SR requires verification of the required SC train is in operation every 12 hours.

Verification includes flow rate, temperature, or pump status monitoring, which help ensure forced flow is providing decay heat removal.

The 12-hour Frequency has been shown by operating practice to be sufficient to regularly assess degradation and verify operation within safety analyses assumptions.

SR 3.4.8.2

Verification that the required number of trains are OPERABLE ensures that redundant paths for heat removal are available and additional trains can be placed in operation, if needed, to maintain decay heat removal and reactor coolant circulation. Verification is performed by verifying proper breaker alignment and indicated power available to the required pumps.

The 7-day Frequency is considered reasonable in view of other administrative controls available and has been shown to be acceptable by operating experience.

This SR is modified by a Note that states the SR is not required to be performed until 24 hours after a required pump is not in operation.

MODE 5 (Loops Not Filled)



SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.8.3

SCS piping and components have the potential to develop voids and pockets of entrained gases. Preventing and managing gas intrusion and accumulation is necessary for proper operation of the SC trains and may also prevent water hammer, pump cavitation, and pumping of noncondensible gas into the reactor vessel.

Selection of SCS locations susceptible to gas accumulation is based on a review of system design information, including piping and instrumentation drawings, isometric drawings, plan and elevation drawings, and calculations. The design review is supplemented by system walk downs to validate the system high points and to confirm the location and orientation of important components that can become sources of gas or could otherwise cause gas to be trapped or difficult to remove during system maintenance or restoration. Susceptible locations depend on plant and system configuration, such as stand-by versus operating conditions.

The SCS is OPERABLE when it is sufficiently filled with water. Acceptance criteria are established for the volume of accumulated gas at susceptible locations. If accumulated gas is discovered that exceeds the acceptance criteria for the susceptible location (or the volume of accumulated gas at one or more susceptible locations exceeds an acceptance criteria for gas volume at the suction or discharge of a pump), the Surveillance is not met. If it is determined by subsequent evaluation that the SCS is not rendered inoperable by the accumulated gas (i.e., the system is sufficiently filled with water), the Surveillance may be declared met. Accumulated gas should be eliminated or brought within the acceptance criteria limits.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SCS locations susceptible to gas accumulation are monitored and, if gas is found, the gas volume is compared to the acceptance criteria for the location. Susceptible locations in the same system flow path which are subject to the same gas intrusion mechanisms may be verified by monitoring a representative sub-set of susceptible locations. Monitoring may not be practical for locations that are inaccessible due to radiological or environmental conditions, the plant configuration, or personnel safety. For these locations alternative methods (e.g., operating parameters, remote monitoring) may be used to monitor the susceptible location. Monitoring is not required for susceptible locations where the maximum potential accumulated gas void volume has been evaluated and determined to not challenge system OPERABILITY. The accuracy of the method used for monitoring the susceptible locations and trending of the results should be sufficient to assure system OPERABILITY during the Surveillance interval.

The 31 day Frequency takes into consideration the gradual nature of gas accumulation in the SCS piping and the procedural controls governing system operation.

REFERENCES None