# REVISED 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.:** | **295-8263** |
| **SRP Section:** | **16 – Technical Specifications** |
| **Application Section:** | **16.3.3 Instrumentation** |
| **Date of RAI Issue:** | **11/05/2015** |

## Question No. 16-113

Proposed generic TS Subsection 3.3.14, “Boron Dilution Alarms,” appears to reference generic TS 3.1.12 of CE System 80+ DCD Chapter 16 because the STS has no such LCO. In the following questions, the ‘reference TS’ means the generic TS in CE System 80+ DCD Chapter 16. The NRC staff noted the following deficiencies needing correction:

1. The LCO statement uses the name “startup channel high neutron flux alarms.” Though this is consistent with the reference TS, the broader term of “Boron Dilution Alarm System (BDAS)” is not used. For example, the LCO could be stated, “Two Boron Dilution Alarm System (BDAS) channels shall be OPERABLE.” Likewise, Condition A could be stated as “One BDAS channel inoperable.” And Condition B could be stated as “Two BDAS channels inoperable.” Also “BDAS channels” is used in the “Applicable Safety Analyses” section of the Bases for generic TS 3.3.14. The applicant is requested to consider using ‘BDAS channel’ instead of ‘startup channel high neutron flux alarm.’

   Related to this is the use of “startup range monitor (SRM)” as a synonym for “startup channel” in APR1400 generic TS 3.9.2. The applicant is requested to use the same title for the startup range neutron flux instrumentation channels across all of the generic TS. Following are examples of some of the various titles used:

   - startup range ..... Note to SR 3.3.14.1
   - startup range monitors (SRMs) ..... LCO 3.9.2 and the “Background” section of the Bases for generic TS 3.9.2, “Nuclear Instrumentation”
   - source range channels .....“SRs” section of Bases for generic TS 3.9.2, Bases for SR 3.9.2.1
   - excore startup channels ..... “Applicability” section of Bases for generic TS 3.3.14

- source range neutron flux monitoring ..... “Applicability” section of Bases for generic TS 3.3.14
- startup channel neutron flux indications ..... “Background” section of Bases for generic TS 3.3.14
- startup range neutron flux monitoring ..... “Applicability” section of Bases for generic TS 3.3.13, “Logarithmic Power Monitoring Channels”
- startup range nuclear monitoring channels... “Applicability” section of Bases for generic TS 3.3.13, “Logarithmic Power Monitoring Channels”

2. A part of the Applicability statement is presented in a Note. This is an inappropriate use of a Note. •The applicant is requested to revise the Applicability statement format and content to match the following:

APPLICABILITY: MODE 3 within 1 hour after the neutron flux is within the startup range following a reactor shutdown, *[note that there should be no blank line here, and the next line should be indented 1.5 inches - this is a limitation of the eRAI text formatting tools]*

MODES 4, and 5.

3. The Applicability also does not include Mode 6. The “Background” and “Applicability” sections of the Bases for generic TS 3.3.14 and the “Background” and “Applicability” sections of the Bases for generic TS 3.9.2 indicate that LCO 3.9.2 requires two BDAS channels to be operable in Mode 6, as well as the two associated “startup range monitor (SRM)” channels. The “Background” section of the Bases for generic TS 3.9.2 begins with the following sentence (*emphasis added*) (Staff suggests that the applicant insert “the” as indicated to correct the sentence’s grammar.):

> The installed startup range monitors (SRMs) *and boron dilution alarm system* are used during refueling operations to monitor **the** core reactivity condition.

However, LCO 3.9.2 just states “Two startup range monitors (SRMs) shall be OPERABLE.” If the intent of the generic TS is to also require two channels of the Boron Dilution Alarm System (BDAS) to be operable in Mode 6, then LCO 3.9.2 should explicitly say so. Otherwise, the Applicability of generic TS 3.3.14 should include Mode 6. The applicant is requested to revise LCO 3.9.2 to state (added text is in bold type, removed text is lined out):

LCO 3.9.2 Two startup range **neutron flux** monitors (SRMs) **channels and two Boron Dilution Alarm System high startup range neutron flux alarm (BDAS) channels** shall be OPERABLE.

Associated with this requested change, the applicant is requested to revise generic TS 3.9.2 Actions A and B to say:

A. One SRM channel inoperable. OR One BDAS channel inoperable. | A.1 Suspend positive reactivity additions. | Immediately AND A.2 Suspend operations that would cause introduction of coolant into the RCS with boron concentration less than required to meet the boron concentration of LCO 3.9.1. | Immediately

B. Two SRM channels inoperable. OR Two BDAS channels inoperable. | B.1 Initiate action to restore one SRM channel and one BDAS channel to OPERABLE status. | Immediately AND B.2 Perform SR 3.9.1.1. | Once per 12 hours.

In addition, the applicant is requested to make necessary and appropriate changes to the Bases for generic TS 3.9.2.n addition, the applicant is requested to make necessary and appropriate changes to the Bases for generic TS 3.9.2.

If the APR1400 design has more than two SRM channels or BDAS channels that could be used to satisfy LCO 3.3.14 and LCO 3.9.2, then the applicant is requested to insert the word “required” in the Conditions and Required Actions, as appropriate.

4. The “Applicable Safety Analyses” section of the Bases for generic TS 3.1.2, “SDM – $T_{cold}$ ≤ 99 °C (210 °F),” beginning with third paragraph, states (*emphasis added*):

   An inadvertent boron dilution is a moderate Frequency incident as defined in Reference 2. The core is initially subcritical with all CEAs inserted. A chemical and volume control system (CVCS) *malfunction occurs which causes unborated water to be pumped to the RCS via one charging pump.*

   The reactivity change rate associated with boron concentration changes due to inadvertent dilution is within the capabilities of operator recognition and control. *The high neutron flux alarm on the startup channel instrumentation will alert the operator of the boron dilution with a minimum of 30 minutes remaining before the core becomes critical.*

   APR1400 DCD Tier 2 Chapter 15, Rev. 0, Section 15.4.6.1, “Identification of Causes and Frequency Classification,” says:

   NUREG-0800, Subsection 15.4.6, states if operator action is required to terminate the transient, the following minimum time intervals must be available between the time an alarm announces an unplanned moderator dilution and the time shutdown margin is lost: (1) during refueling: 30 minutes, or (2) during startup, cold shutdown, hot shutdown, hot standby, and power operation: 15 minutes. However, in this analysis, the operator action time of 30 minutes is conservatively assumed for all operation modes (Modes 1 through 6).

   Analysis of the inadvertent decrease in reactor coolant boron concentration event initiated during each of the six operational modes defined in the Technical Specifications is performed. These analyses show that Mode 4 (hot shutdown) results

in the least time available for detection and termination of the event as shown in Table 15.4.6-1.

The applicant is requested to explain why assuming an operator has 30 minutes after receiving a BDAS alarm before a loss of SDM and criticality occurs is more conservative than assuming 15 minutes in Mode 4.

DCD Section 15.4.6.2, “Sequence of Events and Systems Operation,” paragraph e, describes indications and/or alarms available to alert the operators that the inadvertent decrease in reactor coolant boron concentration event is occurring in Mode 6 (emphasis added):

e. In Mode 6, with the reactor upper head removed and the CEAs fully withdrawn, the coolant is maintained at a boron concentration of at least 2,150 ppm before entering this mode. In this condition, deboration is prohibited. The neutron flux alarm on the startup flux channel or the reactor makeup water flow alarm (backup only) provides indication of any inadvertent decrease in reactor coolant boron concentration event. In Mode 6, this event is prevented by administrative controls that isolate the RCS from the potential source of unborated water. The associated valve in the CVCS is locked closed during Mode 6 to block the flow paths that could allow unborated makeup to reach the RCS.

DCD Section 15.4.6.2 goes on to say,

For Modes 3, 4, 5, and 6, operation time is calculated from event initiation to loss of shutdown margin. For these modes, 30 minutes is conservatively subtracted from this time to determine the latest allowable time for alarm actuation. In these modes, it is calculated that at 30 minutes prior to loss of shutdown [margin], the source range monitoring (SRM) ratio exceeds its setpoint. An operator response time of at least 30 minutes is demonstrated.

The operator can identify a boron dilution through a neutron flux alarm on the startup flux channel, reactor makeup flow rate, [reactor coolant] sampling, or boric acid flow rate. The operator turns off the charging pump in order to stop further boron dilution.

DCD Section 15.4.6.3.3, “Results” (limiting dilution event in Mode 4) says:

Using the above conservative parameters in Equation (15.4-3), the minimum possible time interval to dilute from 6.5 %Δρ subcritical to criticality is 72.8 minutes. Utilizing only the redundant, qualified neutron flux alarm, this time period will provide reasonable assurance of detection of an inadvertent decrease in reactor coolant boron concentration event at least 30 minutes prior to criticality.

The applicant is requested to explain why in Mode 6, the generic TS do not include an LCO that requires the isolation (e.g., locked closed CVCS makeup valve) of the RCS from unborated water sources, which is described as an “administrative control” in the above DCD passages, to preclude an RCS boron dilution event in Mode 6. Such an LCO is included in TS for other PWR designs.

5. In the Required Action column of the Actions table of generic TS 3.3.14, the applicant is requested to place the Note inline with associated Required Action A.1, not above it, and inline with associated Required Action B.1, not above it.

   In addition, the applicant is requested to correct the vertical spacing of logical connectors in the required action column compared to the completion times in the adjacent column in generic TS 3.3.14 Actions A and B – that is, ensure the logical connector occurs after one blank line below the end of the completion time of the preceding Required Action.

   The applicant is requested to provide the time intervals referred to by the Completion time for Required Actions A.1 and B.1 (“At the monitoring Frequency specified in the COLR”).

6. The title of the SRs table should be vertically separated three blank lines below the end of the Actions table, in generic TS 3.3.14.

7. The applicant is requested to explain why SR 3.3.14.2 (Channel Functional Test) with a Frequency of “Total shutdown period 31 days” and SR 3.3.14.3 (Channel Calibration) with an 18 month Frequency are proposed, while the CE System 80+ DCD generic TS 3.1.12 specifies no Channel Functional Test, but does specify SR 3.1.12.2 (Channel Calibration) with a Frequency of “Every 31 days of cumulative operation during shutdown”; staff notes that the Bases for SR 3.3.14.2 quotes the Frequency as “31 days of cumulative operation during shutdown.”

8. The applicant is requested to explain why generic TS SR 3.3.14.1 (Channel Check) includes a surveillance column Note, which says “Not required to be performed until 1 hour after neutron flux is within the startup range” instead of the additional Frequency of CE System 80+ DCD generic TS SR 3.1.12.1 (Channel Check), which states:

   When initially setting setpoints at the following times:

   a. One hour after a reactor trip
   b. After a controlled reactor shutdown: Within 1 hour after the neutron flux is within the startup range in MODE 3.

The Bases for SR 3.3.14.1 second and third sentences say **(emphasis added)**

> ... A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to **a similar parameter** on other channels. It is based upon the assumption that instrument channels monitoring **the same parameter** should read approximately the same value. ...

The applicant is requested to replace the phrase ‘a similar parameter’ with the phrase ‘the same parameter.’

The applicant is requested to revise the second sentence of the fourth paragraph of the Bases for SR 3.3.14.1, as indicated:

Since the probability of two random failures in redundant channels in

any 12 hour period is extremely low, CHANNEL CHECK minimizes the chance of **a** loss of **a** protective **alarm** function due to **a** failure of redundant channels.

The applicant is requested to revise the first paragraph of Bases for SR 3.3.14.3, as indicated:

SR 3.3.14.3 is the performance of a CHANNEL CALIBRATION. A CHANNEL CALIBRATION is performed every 18 months. The Surveillance is a complete check and ~~re~~adjustment of the excore startup channel from the **neutron flux detector** input through to the BDAS **alarm in the MCR**. The Surveillance verifies that the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channel adjusted to account for instrument drift between successive calibrations to ensure that the channel remains **OPERABLE**. This SR is an extension of the SR 3.9.2.2 for the **startup range neutron flux monitor (SRM)** nuclear instrumentation CHANNEL CALIBRATION listed here because of its Applicability in MODES 3, 4 and 5.

## Response – (Rev.1)

1. The use of the term “startup channel high neutron flux alarm” will be replaced with “Boron Dilution Alarm System (BDAS)” in TS 3.3.14. In addition, the various terms used related to startup channels in TS B 3.3.13, TS B 3.3.14, and TS 3.9.2 and its associated Bases will be revised to “startup channel of the ENFMS” for consistency. TS 3.9.2 defines ENFMS as the ex-core neutron flux monitoring system.

2. The Applicability statement format and content of the TS 3.3.14 will be revised to delete the note and to add the pertinent information appropriately.

3. The “Background” section of the Bases for TS 3.9.2 indicates that the installed startup range monitor (SRMs) and the boron dilution alarm system are used during refueling operations to monitor the core reactivity condition. However, as stated in the ″Applicability” section of B 3.9.2, only two operable SRMs are required to alert operators to unexpected changes in the core reactivity; the boron dilution alarm system is not required in Mode 6 and is not credited in any refueling event analyses. Operators can be alerted by visual indication and an audible alarm coming from two operable SRMs of any unexpected changes in the core reactivity such as a boron dilution event or an improperly loaded fuel assembly. Therefore, neither TS 3.3.14 nor TS 3.9.2 need to be revised to include the operability of BDAS or any other instruments for Mode 6.

   The word “the” will be added in front of “core reactivity condition” in the “Background” section of B 3.9.2. To be consistent with the changes made in response to item 1 above, “SRM” will be changed to “startup channel of the ENFMS.”

4. Total dilution time from the initiation of boron dilution to criticality is the same whether assuming 15 minutes for operator action or 30 minutes for operator action. To enable a longer operator action time, the BDAS alarm is set to alert earlier (i.e., alarm setpoint at a lower value) than in the case that assumes 15 minutes for operator action. Due to a lower alarm setpoint, an operator will receive an early BDAS alarm and allow the operator to respond longer than the 15 minutes stated for Mode 4.

   KHNP is developing a proposed new LCO 3.9.7 and associated Bases to prohibit dilution during Mode 6 in response to RAI 216-8221 Question 15.04.06-7.

5. The location of the note in TS 3.3.14 and the vertical spacing of the logical connectors will be appropriately revised as shown in the attached markup page 2.

   The Completion time for Required Actions A.1 and B.1 (“At the monitoring Frequency specified in the COLR”) is like below,

TS

TS

6. The title of the SRs table in TS 3.3.14 will be vertically separated with three blank lines below the end of the Actions table as shown in the attached markup page 3.

7. The surveillance requirements of the Channel Functional Test were completed based on NUREG-1432, “Standard Technical Specifications – Combustion Engineering Plants.” The frequency stated of “Total shutdown period 31 days” was meant as “every 31 days of cumulative operation during shutdown.” To make it clear, the frequency for the Channel Functional Test will be revised from “Total shutdown period 31 days” to “every 31 days of cumulative operation during shutdown” as shown in the attached markup page 3.

   According to NUREG-1432, SR 3.3.13.2 (Channel Functional Test) has a frequency stated of “Total shutdown period 92 days” and for SR 3.3.14.3 (Channel Calibration), an 18 month frequency is proposed. In the case of the APR1400, the Channel Functional Test with a frequency of “every 31 days of cumulative operation during shutdown” is considered more conservative and the Channel Calibration with an 18 month frequency is in alignment with the proposed NUREG-1432 SR frequency.

8. The surveillance column Note in SR 3.3.14.1 will be revised based on the APPLICABILITY of LCO 3.3.14 which does not specify separate reactor conditions, whether a reactor trip or a controlled shutdown.

   The Bases for SR 3.3.14.1 will be revised to replace the phrase ‘a similar parameter’ with ‘the same parameter’ and to incorporate the recommended changes to the frequency justification of the Channel Check. The Bases for SR 3.3.14.3 will also be appropriately revised to incorporate the changes to the frequency justification for the Channel Calibration as shown in the attached markup pages 6 and 7.

The response has been revised as shown in the Attachment to address the NRC comments including the editorial comments raised at the meeting on Technical Specification on February 24 and 25, 2016.

**Impact on DCD**

Same as the changes described in Impact on Technical Specifications.

**Impact on PRA**

There is no impact on PRA.

**Impact on Technical Specifications**

TS 3.3.14 and TS 3.9.2 and Bases B 3.3.13, B 3.3.14, and B 3.9.2 will be revised as shown in the attached markup.

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

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

BASES

APPLICABLE SAFETY ANALYSES (continued)

The OPERABILITY of logarithmic power monitoring channels is necessary to meet the assumption of the safety analyses and to provide for the mitigation of accident and transient conditions.

The logarithmic power monitoring channels satisfy LCO SELECTION CRITERION 3.

LCO

The LCO on the logarithmic power monitoring channels ensures that adequate information is available to verify core reactivity conditions while shut down.

A minimum of two logarithmic power monitoring channels are required to be OPERABLE.

APPLICABILITY

In MODES 3, 4, and 5, with RTSGs open or the control element assembly (CEA) drive system not capable of CEA withdrawal, logarithmic power monitoring channels must be OPERABLE to monitor core power for reactivity changes. In MODES 1 and 2, and in MODES 3, 4, and 5, with the RTSGs shut and the CEAs capable of withdrawal, the logarithmic power monitoring channels are addressed as part of the RPS in LCO 3.3.1, “Reactor Protection System Instrumentation – Operating,” and LCO 3.3.2, “Reactor Protection System Instrumentation – Shutdown.”

startup channels of the ENFMS

The requirements for ~~startup range neutron flux monitoring~~ in MODE 6 are addressed in LCO 3.9.2, "Nuclear Instrumentaion" ~~The startup range nuclear monitoring channels~~ provide neutron flux coverage extending an additional one to two decades below the logarithmic channels for use during refueling, when neutron flux could be extremely low.

ACTIONS

A channel is inoperable when it does not satisfy the OPERABILITY criteria for the channel's function. These criteria are outlined in the LCO section of the Bases.

A.1 and A.2

With one required channel inoperable, it may not be possible to perform a CHANNEL CHECK to verify that the other required channel is OPERABLE.

Boron Dilution Alarms 3.14

APPLICABILITY: MODE 3 within 1 hour after the neutron flux is within the startup range following a reactor shutdown,

MODES 4, and 5.

3.3 INSTR

3.3.14 Boron Dilution Alarms

~~Boron Dilution Alarm Systems (BDAS)~~

Boron Dilution Alarm System (BDAS) channels

LCO 3.3.14 Two ~~startup channel high neutron flux alarms~~ shall be OPERABLE.

~~APPLICABILITY: MODES 3, 4, and 5.~~

~~NOTE~~

~~MODE 3, within 1 hour after the neutron flux is within the startup range following a reactor shutdown.~~

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. One ~~startup channel high neutron flux alarm~~ inoperable. | A.1 NOTE Turn on auxiliary charging pump if necessary. | |
| | ~~A.1~~ Turn off charging pump and determine the RCS boron concentration. | Immediately AND At the monitoring Frequency specified in the COLR |
| | AND move to correct the vertical spacing | |
| | A.2 Suspend all operations involving positive reactivity additions. | Immediately |
| B. Two ~~startup channel high neutron flux alarms~~ inoperable. | B.1 NOTE Turn on auxiliary charging pump if necessary. | |
| | ~~B.1~~ Turn off charging pump and determine the RCS boron concentration by redundant methods. | Immediately AND At the monitoring Frequency specified in the COLR |
| | AND move to correct the vertical spacing | |

~~BDAS~~

BDAS channel

~~BDAS~~

BDAS channels

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| B. (continued) | B.2 Suspend all operations involving positive reactivity additions. | Immediately |

Insert three blank lines

SURVEILLANCE REQUIREMENTS

This SR is applicable ~~within 1 hour after the~~

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.3.14.1 | NOTE<br>~~Not required to be performed until 1 hour after~~ neutron flux is within the startup range.<br>Perform CHANNEL CHECK. | Not required to be performed until 1 hour after<br>12 hours |
| SR 3.3.14.2 | NOTE<br>Neutron flux detector is excluded from CHANNEL FUNCTIONAL TEST.<br>Perform CHANNEL FUNCTIONAL TEST. | 31 days of cumulative operation during shutdown<br>~~Total shutdown period 31 days~~ |
| SR 3.3.14.3 | NOTE<br>Neutron flux detector is excluded from CHANNEL CALIBRATION.<br>Perform CHANNEL CALIBRATION. | 18 months |

B 3.3 INSTRUMENTATION

B 3.3.14 Boron Dilution Alarms

BASES

BACKGROUND

The boron dilution alarm system (BDAS) alerts the operator of a boron dilution event in MODES 3, 4 and 5. The boron dilution alarm is received at least 30 minutes prior to criticality in MODES 3, 4, and 5 to allow the operator to terminate the boron dilution.

startup channels of the ex-core neutron flux monitoring system (ENFMS)

In MODES 1 and 2, protection for a boron dilution event is presented in LCO 3.3.1, "Reactor Protection System (RPS) Instrumentation – Operating." In MODES 3 and 4 with the CEAs withdrawn, LCO 3.3.2, "Reactor Protection System (RPS) Instrumentation – Shutdown," provides protection. In MODE 6, protection for a boron dilution event is presented in LCO 3.9.2, "Nuclear Instrumentation."

startup channels of the ENFMS

The ~~boron dilution alarm system (~~BDAS~~)~~ uses two ~~channels~~ that monitor the ~~startup channel~~ neutron flux ~~indications~~. If the neutron flux signals increase to the calculated alarm setpoint an MCR annunciation is received. The setpoint is automatically lowered to a fixed amount above the current flux level signal. The alarm setpoint will only follow decreasing or constant flux levels, not increasing levels. Two channels of BDAS must be OPERABLE to provide single failure protection and to facilitate detection of channel failure by providing CHANNEL CHECK capability.

APPLICABLE SAFETY ANALYSES

The BDAS channels are necessary to monitor core reactivity changes. They are the primary means for detecting and triggering operator ACTIONS to respond to boron dilution events initiated from conditions in which the RPS is not required to be OPERABLE.

The OPERABILITY of BDAS channels is necessary to meet the assumptions of the safety analyses to mitigate the consequences of an inadvertent boron dilution event as described in the APR1400 DCD Tier 2, Chapter 15.

The BDAS channels satisfy LCO SELECTION CRITERION 3.

startup channels of the ENFMS

startup channels of the ENFMS

BASES

LCO

The LCO on the BDAS channels ensures that adequate information is available to mitigate the consequences of a boron dilution event.

At least two BDAS channels are required to be OPERABLE. Because the BDAS uses the ~~excore startup channel instrumentation~~ as its detection system, the OPERABILITY of the ~~excore startup channel~~ is also part of the OPERABILITY of the BDAS.

~~startup channel of the ENFMS~~

APPLICABILITY

The BDAS must be OPERABLE in MODES 3, 4, and 5 because the safety analysis assumes this alarm will be available in these MODES to alert the operator to take action to terminate the boron dilution. In MODES 1 and 2 and in MODES 3, 4 and 5, with the RTCBs shut and the CEAs capable of withdrawal, the logarithmic power monitoring channels are addressed as part of the RPS in LCO 3.3.1, “Reactor Protection System (RPS) Instrumentation – Operating,” and LCO 3.3.2, “Reactor Protection System (RPS) Instrumentation – Shutdown.”

startup channels of the ENFMS

The requirements for ~~source range neutron flux monitoring~~ in MODE 6 are addressed in LCO 3.9.2, “Nuclear Instrumentation.” The ~~excore startup channels~~ provide neutron flux coverage extending an additional one to two decades below the logarithmic channels for use during shutdown and refueling when neutron flux could be extremely low.

specifies that

The Applicability ~~is modified by a Note that the~~ BDAS is required in MODE 3 within 1 hour after the neutron flux is within the startup range following a reactor shutdown. This allows the neutron flux level to decay to a level within the range of the ~~excore startup channels~~ and for the operator to initialize the BDAS

startup channels of the ENFMS

ACTIONS

A channel is inoperable when it does not satisfy the OPERABILITY criteria for the channel's function. These criteria are outlined in the LCO section of the Bases.

prohibit

Turn off charging pump immediately to ~~prohibit~~ a possible excessive positive reactivity addition if LCO 3.3.14 is not met. But, an auxiliary charging pump, which supplies a restricted charging flow, may be turned on if necessary.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.14.1

SR 3.3.14.1 is the performance of a CHANNEL CHECK on each required channel every 12 hours. A CHANNEL CHECK is normally a comparison of the parameter indicated on one channel to ~~a similar parameter~~ on other channels. It is based upon the assumption that instrument channels monitoring the same parameter should read approximately the same value. Significant deviations between instrument channels could be an indication of excessive instrument drift in one of the channels or of something even more serious.

CHANNEL CHECK will detect gross channel failure. Thus, it is a key to verifying that the instrumentation continues to operate properly between each CHANNEL CALIBRATION.

Agreement criteria are determined by the plant staff and should be based on a combination of the channel instrument uncertainties. If a channel is outside of the criteria, it could be an indication that the transmitter or the signal processing equipment has drifted outside of its limits. If the channels are within the criteria, it is an indication that the channels are OPERABLE.

The Frequency, about once every shift, is based on operating experience that demonstrates the rarity of channel failure. Since the probability of two random failures in redundant channels in any 12-hour period is extremely low, CHANNEL CHECK minimizes the chance of loss of protective function due to failure of redundant channels. CHANNEL CHECK supplements less formal, but more frequent, checks of channel OPERABILITY during normal operational use of displays associated with the LCO required channels.

This SR is modified by a Note that states the CHANNEL CHECK is not required to be performed until 1 hour after neutron flux is within the startup range.

SR 3.3.14.2

A CHANNEL FUNCTIONAL TEST is performed every 31 days of cumulative operation during shutdown to ensure that the BDAS is capable of properly alerting the operator to a boron dilution event.

BASES

SURVEILLANCE REQUIREMENTS (continued)

startup channel of the ENFMS

Internal ~~excore startup channel~~ test circuitry is used to feed pre-adjusted test signals into the ~~excore startup channel~~ to verify the proper neutron flux indication is received at the BDAS.

This SR is modified by a Note to indicate that it is not necessary to test the detector, because generating a meaningful test signal is difficult; the detectors are of simple construction, and any failures in the detectors will be apparent as a change in channel output.

A CHANNEL FUNCTIONAL TEST of the BDAS consists of online tests including verification of the alarm in the MCR.

neutron flux detector

SR 3.3.14.3

startup channel of the ENFMS

BDAS alarm in the MCR.

SR 3.3.14.3 is the performance of a CHANNEL CALIBRATION. A CHANNEL CALIBRATION is performed every 18 months. The Surveillance is a complete check and ~~re~~adjustment of the ~~excore startup channel~~ from the input through to the BDAS. The Surveillance verifies that the channel responds to a measured parameter within the necessary range and accuracy. CHANNEL CALIBRATION leaves the channel adjusted to account for instrument drift between successive calibrations to ensure that the channel remains ~~operational~~. This SR is an extension of the SR 3.9.2.2 for the nuclear instrumentation CHANNEL CALIBRATION listed here because of its Applicability in MODES 3, 4 and 5.

OPERABLE.

startup channel of the ENFMS

This SR is modified by a Note to indicate that it is not necessary to test the detector, because generating a meaningful test signal is difficult; the detectors are of simple construction, and any failures in the detectors will be apparent as a change in channel output.

REFERENCES

1. DCD Tier 2, Chapter 7.
2. DCD Tier 2, Chapter 15.

3.9 REFUELING OPERATIONS

3.9.2 Nuclear Instrumentation

startup channels of the ex-core neutron flux monitoring system (ENFMS)

LCO 3.9.2 Two ~~startup range monitors (SRMs)~~ shall be OPERABLE.

APPLICABILITY: MODE 6.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. One ~~SRM~~ inoperable. | A.1 Suspend positive reactivity additions.<br><br>AND<br><br>A.2 Suspend operations that would cause introduction of coolant into the RCS with boron concentration less than required to meet the boron concentration of LCO 3.9.1. | Immediately<br><br><br><br>Immediately |
| B. Two ~~SRMs~~ inoperable. | B.1 Initiate action to restore one ~~SRM~~ to OPERABLE status.<br><br>AND<br><br>B.2 Perform SR 3.9.1.1. | Immediately<br><br><br><br>Once per 12 hours |

startup channel of the ENFMS

startup channels of the ENFMS

main control room (MCR) and startup range neutron flux information to the BDAS for an audible alarm to alert operators to a possible dilution accident.

the boron dilution alarm system (BDAS)

B 3.9.2 Nuclear Instrumentati

startup channels of the ex-core neutron flux monitoring system (ENFMS)

the

The neutron flux

BASES

BACKGROUND

The installed startup range monitors (SRMs) and boron dilution alarm system are used during refueling operations to monitor core reactivity condition. The SRMs are a part of the ex-core neutron flux monitoring system (ENFMS) and related indicators and recorders. These detectors are located external to the reactor vessel and detect neutrons leaking from the core.

startup channels of the ENFMS

startup channels

startup channel of the ENFMS

of these startup channels

The SRMs monitor the neutron flux in counts per second (cps) and cover neutron flux up to $10^5$ cps with a 5 % instrument accuracy. Each SRM provides visual indication in the MCR and an audible alarm to alert operators to a possible dilution accident. The ENFMS is designed in accordance with the criteria presented in Reference 1.

APPLICABLE SAFETY ANALYSES

Two OPERABLE SRMs are required to provide a signal to alert the operator to unexpected changes in core reactivity such as a boron dilution accident or an improperly loaded fuel assembly. The safety analysis of the uncontrolled boron dilution accident is described in Reference 2. This analysis shows that the normally available SHUTDOWN MARGIN would be reduced, but that there is sufficient time available for the operator to detect and to terminate the event should it occur.

The SRMs satisfy LCO SELECTION CRITERION 3.

LCO

This LCO requires two OPERABLE SRMs to ensure that redundant monitoring capability is available to detect changes in core reactivity.

APPLICABILITY

In MODE 6 two SRMs must be OPERABLE to determine changes in core reactivity. No other direct means are available to check core reactivity levels.

In MODES 3, 4, and 5, the installed SRMs are required to be OPERABLE by LCO 3.3.14, "Boron Dilution Alarms."

startup channels of the ENFMS

The BDAS is not required to be OPERABLE in MODE 6 because such an event is precluded by LCO 3.9.7, "Unborated Water Source Isolation Valves" which requires the flow paths for unborated makeup water sources to be secured in MODE 6.

BASES

ACTIONS

A.1 and A.2

With only one ~~SRM~~ OPERABLE, redundancy has been lost. Since these instruments are the only direct means of monitoring core reactivity conditions, positive reactivity additions and introduction of coolant into the RCS with boron concentration less than required to meet the minimum boron concentration of LCO 3.9.1 must be suspended immediately. Suspending positive reactivity additions that could result in failure to meet the minimum boron concentration limit is required to assure continued safe operation. Introduction of coolant inventory must be from sources that have a boron concentration greater than that what would be required in the RCS for minimum refueling boron concentration. This could result in an overall reduction in RCS boron concentration, but provides acceptable margin to maintaining subcritical operation. Performance of Required Action A.1 shall not preclude completion of movement of a component to a safe position.

B.1

startup channel of the ENFMS

With no ~~SRM~~ OPERABLE, ACTION to restore a monitor to OPERABLE status shall be initiated immediately. Once initiated, ACTIONS shall be continued until a ~~SRM~~ is restored to OPERABLE status.

B.2

startup channels of the ENFMS

With no ~~SRM~~ OPERABLE, there is no direct means of detecting changes in core reactivity. However, since positive reactivity additions are not to be made, the core reactivity condition is stabilized until the ~~SRMs~~ are OPERABLE. This stabilized condition is determined by performing SR 3.9.1.1 to verify that the required boron concentration exists.

The Completion Time of once per 12 hours is sufficient to obtain and analyze a reactor coolant sample for boron concentration and ensures that unplanned changes in boron concentration would be identified. The 12-hour Frequency is reasonable, considering the low probability of a change in core reactivity during this period.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.9.2.1

SR 3.9.2.1 is the performance of a CHANNEL CHECK, which is the comparison between channels of the indicated parameter values for each of the functions. It is based on the assumption that the two indication channels should be consistent with core conditions. Changes in fuel loading and core geometry can result in significant differences between ~~source range channels~~ but each channel should be consistent with its local conditions. The 12-hour Frequency is consistent with the CHANNEL CHECK Frequency specified similarly for LCO 3.3.1, “Reactor Protection System (RPS) Instrumentation – Operating.”

startup channels of the ENFMS

SR 3.9.2.2

SR 3.9.2.2 is the performance of a CHANNEL CALIBRATION every 18 months. The CHANNEL CALIBRATION for the ~~SRMs~~ consists of obtaining the voltage plateau curves or preamp discriminator curves, evaluating those curves, and comparing the curves to the manufacturer's data. The 18-month Frequency is based on the need to perform this Surveillance under the conditions that apply during a plant outage.

REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 13, 26, 28, and 29.

2. DCD Tier 2, Subsection 15.4.6.