REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.:	**239-8076**
SRP Section:	**16 – Technical Specifications**
Application Section:	**16.3.3**
Date of RAI Issued:	**10/09/2015**

Question No. 16-92

Paragraph (a)(11) of 10 CFR 52.47 and paragraph (a)(30) of 10 CFR 52.79 state that a design certification (DC) applicant and a combined license (COL) applicant, respectively, are to propose TS prepared in accordance with 10 CFR 50.36 and 50.36a. 10 CFR 50.36 sets forth requirements for technical specifications to be included as part of the operating license for a nuclear power facility.

NUREG-1432, "Standard Technical Specifications-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.

Generic TS Table 3.3.1-1 Footnotes (a) and (c) differ from corresponding Footnotes (a) and (c) in STS Table 3.3.1-1 and Footnotes (a) and (e) in CE System 80+ generic TS Table 3.3.1-1 for the following RPS Functions with operating bypass features:

2. Logarithmic Power Level – High(a)
14. Local Power Density – High(c)
15. Departure from Nucleate Boiling Ration - Low(c)

Since the reasons for the differences with the STS footnotes are not clear to the NRC staff, the applicant is requested to discuss the differences with the STS footnotes and justify the proposed generic TS footnotes (a) and (c); including all related Bases discussions.

Response – (Rev. 1)

Regarding TS Table 3.3.1-1 Footnote (a), the operating bypass permissive and removal setpoints for Logarithmic Power Level – High function are for protection against a high reactivity insertion event during startup and low power condition. Since the trip setpoint is very low, this trip function should be bypassed to enter the power operation mode and the bypass

function is introduced to avoid an unwanted reactor trip. During the preliminary design of the Yonggwang 3 and 4 plant, the operating bypass setpoint was increased from 10^{-4}% to 10^{-3}% because CEA withdrawal event did not meet the acceptance criteria below the 10^{-3}% power initial condition. There was no specific need to change the operating bypass setpoint from 10^{-3}% to 10^{-4}%. The only inconvenience is that the operating bypass setpoint is temporarily changed to 10^{-4}% during low power physics test. Therefore, the operating bypass setpoint of 10^{-3}% power is applied in APR 1400.

The logarithmic power unit and the inequality, which are used for "Logarithmic Power Level - High," "Local Power Density - High," and "Departure from Nucleate Boiling Ratio - Low" functions will be revised to be consistent with STS.

In addition, LCO 3.1.10 states that trip function 2, "Logarithmic Power Level – High" in Table 3.3.1-1 is applied to the special test exception.

Regarding TS Table 3.3.1-1 Footnote (c), LCO 3.1.10 states that trip function 2, "Logarithmic Power Level – High" in Table 3.3.1-1 is applied to the special test exception.

Impact on DCD

DCD Tier 2 Table 7.2-1 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

Technical Specifications Section 3.3 and its Bases 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.

Table 7.2-1

Reactor Protection System Operating Bypass Permissive

Title	Operating Bypass Function	Operating Bypass Permissive	Removed By	Notes
DNBR and LPD	Disable low DNBR and high LPD trips by manual operation of bypass switch	If power is $\le 10^{-4}$ % $<$	Automatic if power is $> 10^{-4}$ % $\ge$	Allows low power testing and CEA withdrawal under non-critical state
Pressurizer pressure operating bypass permissive	Disables low pressurizer pressure trip, SIAS, and CIAS by manual operation of bypass switch	If pressure is ≤ 28.12 kg/cm^{2}A (400 psia)	Automatic if pressure is > 35.15 kg/cm^{2}A (500 psia)	-
High log power level operating bypass permissive	Disables high logarithmic power level trip by manual operation of bypass switch	If power is $\ge 10^{-3}$ % $>$	Automatic if power is $< 10^{-3}$ % $\le$	Bypassed during reactor startup
CPC CWP operating bypass permissive	Disables CPCS CWP signals by automatic operation of bypass	If power is $\le 10^{-4}$ %	Automatic if power is $> 10^{-4}$ %	CWP by high PZR pressure is not affected by bypass

SURVEILLANCE REQUIREMENTS

NOTE
Refer to Table 3.3.1-1 to determine which SR shall be performed for each RPS Function.

SURVEILLANCE		FREQUENCY
SR 3.3.1.1	Perform CHANNEL CHECK of each RPS instrument channel.	12 hours
SR 3.3.1.2	NOTE The performance shall be completed within 12 hours after THERMAL POWER ≥ ~~80 %~~ 80% RTP. Verify total reactor coolant system (RCS) flow rate indicated by each CPC is less than or equal to the RCS total flow rate. If necessary, adjust CPC addressable constant flow coefficients such that each CPC indicated flow is less than or equal to RCS flow rate.	12 hours
SR 3.3.1.3	Check CPC system event log.	12 hours
SR 3.3.1.4	NOTE 1. The performance shall be completed within 12 hours after THERMAL POWER ≥ ~~15 %~~ 15% RTP. 2. The daily calibration may be suspended during PHYSICS TESTS, provided calibration is performed upon reaching each major test power plateau and prior to proceeding to next major test power plateau. Perform calorimetric calculation and adjust linear power, CPC ΔT, and CPC neutron flux power to agree with calorimetric calculation if any of the linear power, CPC ΔT, and CPC neutron flux power is less than calorimetric calculation by more than ~~0.5 %~~ 0.5%.	24 hours

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SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.3.1.5	---------- NOTE ---------- The performance shall be completed within 12 hours after THERMAL POWER ≥ ~~80 %~~ 80% RTP. ------------------------------ Verify total RCS flow rate indicated by each CPC is less than or equal to RCS flow rate determined by secondary calorimetric calculations.	31 days
SR 3.3.1.6	---------- NOTE ---------- The performance shall be completed within 12 hours after THERMAL POWER ≥ ~~15 %~~ 15% RTP ------------------------------ Verify linear power subchannel gains of excore neutron detectors are consistent with values used to establish shape annealing matrix elements in the CPCs.	31 days
SR 3.3.1.7	---------- NOTE ---------- 1. The CPC CHANNEL FUNCTIONAL TEST includes verification that correct values of addressable constants are installed in each OPERABLE CPC. 2. Not required to be performed for Logarithmic Power Level – High until 2 hours after reducing THERMAL POWER below ~~10^{-3} % RTP~~ 10^{-3}% and only if reactor trip switchgears (RTSGs) are open. ------------------------------ Perform CHANNEL FUNCTIONAL TEST for each RPS instrumentation channel in accordance with Setpoint Control Program.	31 days

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.3.1.8	---------- NOTE ---------- Excore neutron detectors are excluded from CHANNEL CALIBRATION. -------------------- Perform CHANNEL CALIBRATION of linear power of excore neutron flux channel in accordance with Setpoint Control Program.	31 days
SR 3.3.1.9	---------- NOTE ---------- Excore neutron detectors are excluded from CHANNEL CALIBRATION. -------------------- Perform CHANNEL CALIBRATION on each trip channel, including operating bypass removal functions in accordance with Setpoint Control Program.	18 months
SR 3.3.1.10	Perform CHANNEL FUNCTIONAL TEST on each CPC channel in accordance with Setpoint Control Program.	18 months
SR 3.3.1.11	Using incore detectors, verify shape annealing matrix elements to be used by the CPCs in accordance with Setpoint Control Program.	Once after each refueling prior to exceeding ~~80 %~~ 80% RTP
SR 3.3.1.12	Perform CHANNEL FUNCTIONAL TEST on each automatic operating bypass removal channel.	Once within 31 days prior to each reactor startup
SR 3.3.1.13	---------- NOTE ---------- Excore neutron detectors are excluded. -------------------- Verify RPS RESPONSE TIME is within limits.	18 months on a STAGGERED TEST BASIS

Table 3.3.1-1 (Page 1 of 3)

Reactor Protection System Instrumentation – Operating

FUNCTION	APPLICABLE MODES or OTHER SPECIFIED CONDITION	SURVEILLANCE REQUIREMENTS
1. Variable Overpower	1, 2	SR 3.3.1.1 SR 3.3.1.4 SR 3.3.1.6 SR 3.3.1.7 SR 3.3.1.8 SR 3.3.1.9 SR 3.3.1.13
2. Logarithmic Power Level – High[(a)]	2	SR 3.3.1.1 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.12 SR 3.3.1.13
3. Pressurizer Pressure – High	1, 2	SR 3.3.1.1 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.13
4. Pressurizer Pressure – Low[(b)]	1, 2	SR 3.3.1.1 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.12 SR 3.3.1.13

(a) Trip may be bypassed when THERMAL POWER is ~~≥ 10^{-3} % RTP~~ $> 10^{-3}$%. Operating bypass shall be automatically removed when THERMAL POWER is ~~< 10^{-3} % RTP~~ $\leq 10^{-3}$%. Trip may be manually bypassed during PHYSICS TESTS pursuant to LCO 3.1.10, "Special Test Exception (STE) – SHUTDOWN MARGIN (SDM)."

(b) Pressurizer Pressure – Low trip setpoint may be decreased as pressurizer pressure is reduced to 7.0 kg/cm^{2}A (100 psia). The margin between pressurizer pressure and the setpoint shall be maintained at ≤ 28.1 kg/cm^{2}A (400 psia). The operating bypass shall be removed automatically at ≥ 35.2 kg/cm^{2}A (500 psia). The setpoint shall be increased automatically to normal setpoint as pressurizer pressure is increased.

Table 3.3.1-1 (Page 3 of 3)
Reactor Protection System Instrumentation – Operating

FUNCTION	APPLICABLE MODES or OTHER SPECIFIED CONDITION	SURVEILLANCE REQUIREMENTS
13. Reactor Coolant Flow, Steam Generator #2 Water Level – Low	1, 2	SR 3.3.1.1 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.13
14. Local Power Density – High[(c)]	1, 2	SR 3.3.1.1 SR 3.3.1.2 SR 3.3.1.3 SR 3.3.1.4 SR 3.3.1.5 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.10 SR 3.3.1.11 SR 3.3.1.12 SR 3.3.1.13
15. Departure From Nucleate Boiling Ratio (DNBR) – Low[(c)]	1, 2	SR 3.3.1.1 SR 3.3.1.2 SR 3.3.1.3 SR 3.3.1.4 SR 3.3.1.5 SR 3.3.1.7 SR 3.3.1.9 SR 3.3.1.10 SR 3.3.1.11 SR 3.3.1.12 SR 3.3.1.13

$< 10^{-4}\%$ $\geq 10^{-4}\%$

(c) Trip may be manually bypassed when THERMAL POWER is ~~$\leq 10^{-4}$ % RTP~~. Operating bypass shall be automatically removed when THERMAL POWER is ~~$\geq 10^{-4}$ % RTP~~. During testing pursuant to LCO 3.1.10, trip may be bypassed below ~~5 %~~ RTP. Operating bypass shall be automatically removed when THERMAL POWER is > ~~5 %~~ RTP.

5% 5%

Table 3.3.2-1 (Page 1 of 1)
Reactor Protection System Instrumentation – Shutdown

FUNCTION	APPLICABLE MODES or OTHER SPECIFIED CONDITION	SURVEILLANCE REQUIREMENTS
1. Logarithmic Power Level – High[(a)]	3[(b)], 4[(b)], 5[(b)]	SR 3.3.2.1 SR 3.3.2.2 SR 3.3.2.3 SR 3.3.2.4 SR 3.3.2.5
2. Steam Generator Pressure #1 – Low[(c)]	3[(b)], 4[(b)]	SR 3.3.2.1 SR 3.3.2.2 SR 3.3.2.4 SR 3.3.2.5
3. Steam Generator Pressurze #2 – Low[(c)]	3[(b)], 4[(b)]	SR 3.3.2.1 SR 3.3.2.2 SR 3.3.2.4 SR 3.3.2.5

(a) Trip may be bypassed when THERMAL POWER is ~~$\geq 10^{-3}$ % RTP~~ $> 10^{-3}$%. Operating bypass shall be automatically removed when THERMAL POWER is ~~$< 10^{-3}$ % RTP~~ $\leq 10^{-3}$%.

(b) With any reactor trip switchgears (RTSGs) closed, any control element assembly (CEA) capable of being withdrawn, and fuel loaded in reactor.

(c) Steam Generator Pressure – Low trip setpoint may be manually decreased as steam generator pressure is reduced in MODE 3 and 4, provided the margin between steam generator pressure and the setpoint is maintained at 14.1 kg/cm^{2}A (200 psia). The setpoint shall be increased automatically as steam generator pressure is increased.

APPLICABLE SAFETY ANALYSES (continued)

2. Logarithmic Power Level – High

The Logarithmic Power Level-High trip protects the integrity of the fuel cladding and helps protect the RCPB in the event of an unplanned criticality from a shutdown condition.

In MODES 2, 3, 4, and 5, with the RTSGs closed and the CEA drive system capable of CEA withdrawal, protection is required for CEA withdrawal events originating when THERMAL POWER is less than ~~10^{-3} % RTP~~ 10^{-3}% . For events originating above this power level, other trips provide adequate protection.

MODES 3, 4, and 5, with the RTSGs closed, are addressed in LCO 3.3.2, "Reactor Protection System (RPS) Instrumentation – Shutdown."

In MODES 3, 4, or 5, with the RTSGs open or the CEAs not capable of withdrawal, the Logarithmic Power Level – High trip does not have to be OPERABLE. The indication and alarm Functions are addressed in LCO 3.3.13, "Logarithmic Power Monitoring Channels."

3. Pressurizer Pressure – High

The Pressurizer Pressure – High trip provides protection for the high RCS pressure SL. In conjunction with the pressurizer safety valves and the main steam pilot operated safety relief valve (POSRV), it provides protection against overpressurization of the RCPB during the following events:

- Loss of electrical load without a reactor trip being generated by the turbine trip (AOO)
- Loss of condenser vacuum (AOO)
- CEA withdrawal from low power conditions (AOO)
- Chemical and volume control system malfunction (AOO)
- Main feedwater system pipe break (accident)

BASES

LCO (continued)

The Logarithmic Power Level – High trip may be bypassed manually when THERMAL POWER is greater than ~~or equal to~~ ~~10^{-3} % RTP~~ [10^{-3}%] to allow the reactor to be brought to power during a reactor startup. This bypass is automatically removed when THERMAL POWER is less than ~~10^{-3} % RTP~~ [or equal to 10^{-3}%]. Above ~~10^{-3} % RTP~~ [10^{-3}%], the Variable Overpower – High and Pressurizer Pressure – High trips provide protection for reactivity transients.

The trip may be manually bypassed during PHYSICS TEST pursuant to LCO 3.1.10, “Test Exceptions – SDM.” During this testing, the Variable Overpower – High trip and administrative controls provide the required protection.

3. Pressurizer Pressure – High

This LCO requires four channels of Pressurizer Pressure – High to be OPERABLE in MODES 1 and 2.

The Allowable Value is set below the nominal lift setting of the POSRVs, and its operation avoids the undesirable operation of these valves during normal plant operation. In the event of AOO and Accident causing overpressure, this setpoint ensures the reactor trip will take place, thereby assuring the integrity of the RCPB and preventing consequent pressure rise. The POSRVs can lift to prevent overpressurization of the RCS.

4. Pressurizer Pressure – Low

This LCO requires four channels of Pressurizer Pressure – Low to be OPERABLE in MODES 1 and 2.

The Allowable Value is set low enough to prevent a reactor trip during normal plant operation and pressurizer pressure transients. However, the setpoint is high enough that with a LOCA, the reactor trip will occur soon enough to allow the ESF systems to perform as expected in the analyses and mitigate the consequences of the accident.

BASES

LCO (continued)

3. CEAC1 processor module failure – this failure is addressed in LCO 3.3.3.

4. CEAC2 processor module failure – this failure is addressed in LCO 3.3.3.

5. CPP1 processor module failure – this failure is addressed in LCO 3.3.3.

6. CPP2 processor module failure – this failure is addressed in LCO 3.3.3.

The CPC channels may be manually bypassed below ~~10^{-4} % RTP~~ 10^{-4}% as sensed by the logarithmic nuclear instrumentation. This bypass is enabled manually in all four CPC channels when plant conditions do not warrant the trip protection. The bypass effectively removes the DNBR – Low and LPD – High trips from the RPS automatically removed when enabling bypass conditions are no longer satisfied.

This operating bypass is required to perform a plant startup, since both CPC generated trips will be in effect whenever shutdown CEAs are inserted. It also allows system tests at low power with pressurizer pressure – low or RCPs off.

During TESTS pursuant to LCO 3.1.10, the trip may be manually bypassed to make this test possible without reactor trip in condition less than or equal to 5% RTP.

15. Departure from Nucleate Boiling Ratio (DNBR) – Low

This LCO requires four channels of DNBR – Low to be OPERABLE. The LCO on the CPCs ensures that the SLs are maintained during all AOOs and the consequences of accidents are acceptable.

The CPC channel has many redundant features designed to improve channel reliability. A minimum subset of features must be functional in order for the CPC to be capable of performing its safety related trip function. Therefore, the channel can remain OPERABLE in the presence of a subset of channel failures, while maintaining the ability to provide the DNBR – Low trip function. On-line CPC channel diagnostics make use of redundant features to maintain channel OPERABILITY to the extent possible, and provide alarm and annunciation of detectable failures.

BASES

A CPC is not considered inoperable if CEAC inputs to the CPC are inoperable. The Required Actions required in the event of CEAC channel failures ensure the CPCs are capable of performing their safety function.

The CPC channels may be manually bypassed below ~~10^{-4} % RTP~~ 10^{-4}%, as sensed by the logarithmic nuclear instrumentation. This bypass is enabled manually in all four CPC channels when plant conditions do not warrant the trip protection. The bypass effectively removes the DNBR – Low and LPD – High trips from the RPS logic circuitry. The operating bypass is automatically removed when enabling bypass conditions are no longer satisfied.

- This operating bypass is required to perform a plant startup, since both CPC generated trips will be in effect whenever shutdown CEAs are inserted. It also allows system tests at lower power with Pressurizer Pressure – Low or RCPs off.

During TESTS pursuant to LCO 3.1.10, the trip may be manually bypassed to make this test possible without reactor trip in condition less than or equal to 5% RTP.

Interlocks/Bypasses

The LCO on operating bypass permissive removal channels requires that the automatic operating bypass removal feature of all four operating bypass channels be OPERABLE for each RPS function with an operating bypass in the MODES addressed in the specific LCO for each Function. All four operating bypass removal channels must be OPERABLE to ensure that none of the four RPS channels are inadvertently bypassed.

This LCO applies to the operating bypass removal feature only. If the bypass enable Function is failed so as to prevent entering a bypass condition, operation may continue. In the case of the Logarithmic Power Level – High trip (Function 2), the absence of a bypass will limit maximum power to below the trip setpoint.

The interlock function Allowable Values are based upon analysis of functional requirements for the bypassed Functions. These are discussed above as part of the LCO discussion for the affected Functions.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.1.6

The three vertically mounted excore nuclear instrumentation detectors in each channel are used to determine axial power distribution (APD) for use in the DNBR and LPD calculations. Because the detectors are mounted outside the reactor vessel, a portion of the signal from each detector is from core sections not adjacent to the detector. This is termed shape annealing and is compensated for after every refueling by performing SR 3.3.1.11, which adjusts the gains of the three detector amplifiers for shape annealing. SR 3.3.1.6 ensures that the pre-assigned gains are still proper. Power must be greater than or equal to 15% RTP because the CPCs do not use the excore generated signals for axial flux shape information at low power levels.

The Note allowing 12 hours after reaching 15% RTP is required for plant stabilization and testing.

The 31-day Frequency is adequate because the demonstrated long term drift of the instrument channels is minimal.

SR 3.3.1.7

A CHANNEL FUNCTIONAL TEST on each channel is performed every 31 days to ensure the entire channels will perform its intended function when needed. The SR is modified by a Note. The Note allows the CHANNEL FUNCTIONAL TEST for the Logarithmic Power Level – High channels to be performed 2 hours after logarithmic power drops below ~~10- 3 %~~ $10^{-3}\%$ and is required to be performed only RTSGs are closed.

The RPS CHANNEL FUNCTIONAL TEST consists of overlapping tests as described in DCD TIER 2, Section 7.2 (Reference 6). These tests verify that the RPS is capable of performing its intended function from bistable input through the RTSGs. They include:

Bistable Logic Tests

Bistable logic tests are performed to confirm that bistable logics are properly operating.

BASES

LCO (continued)

Bypassing the same parameter in more than one channel is restricted by the administrative procedure. The coincidence logic becomes 2-out-of-3 coincidence logic. All-bypass function for bypassing all parameters in the channel is interlocked in LCL algorithm to prevent simultaneous bypass of more than one channel. The all-bypass interlock is implemented based on analog circuit through hardwired cable between LCLs in all channels. The purpose of all-bypass function is to support testing and maintenance of BP whereas the trip channel bypass is used against sensor failure. With one channel in each Function trip channel bypassed, this effectively places the plant in a two- out-of-three logic configuration in those Functions. Plants are restricted to 48 hours in a trip channel bypass condition before either restoring the function to four channel operation (two-out-of-four logic) or placing the channel in trip (one-out-of-three logic).

This LCO requires all four channels of the Logarithmic Power Level – High to be OPERABLE in MODE 2, and in MODE 3, 4, or 5 when the RTSGs are closed and the CEA drive system is capable of CEA withdrawal.

The Allowable Value specified in the Setpoint Control Program (SCP) is high enough to provide an operating envelope that prevents unnecessary Logarithmic Power Level – High reactor trips during normal plant operations. The Allowable Value is low enough for the system to maintain a safety margin for unacceptable fuel cladding damage should a CEA withdrawal event occur.

The Logarithmic Power Level – High trip may be bypassed when logarithmic power is above ~~10^{-3} %~~ 10^{-3}% to allow the reactor to be brought to power during a reactor startup. This bypass is automatically removed when logarithmic power decreases below ~~10^{-3} %.~~ 10^{-3}%. Above ~~10^{-3} %,~~ 10^{-3}%, the Linear Power Level – High and Pressurizer Pressure – High trips provide protection for reactivity transients.

The trip may be manually bypassed during physics testing pursuant to LCO 3.1.10, “Special Test Exception (STE) – Shutdown Margin (SDM).” During this testing, the Linear Power Level – High trip and administrative controls provide the required protection.

BASES

APPLICABILITY

Most RPS trips are required to be OPERABLE in MODES 1 and 2 because the reactor is critical in these MODES. The trips are designed to take the reactor subcritical, which maintains the SLs during AOOs and assists the engineered safety features actuation system (ESFAS) in providing acceptable consequences during accidents.

Most trips are not required to be OPERABLE in MODES 3, 4, and 5. In MODES 3, 4, and 5, the emphasis is placed on return to power events. The reactor is protected in these MODES by ensuring adequate SDM. Exceptions to this are:

a. The Logarithmic Power Level – High trip, RPS Logic RTSGs, and Manual Trip are required in MODES 3, 4, and 5, with the RTSGs closed, to provide protection for boron dilution and CEA withdrawal events. The Logarithmic Power Level – High trip in these lower MODES is addressed in this LCO. The RPS Logic in MODES 1, 2, 3, 4, and 5 is addressed in LCO 3.3.4, "Reactor Protection System (RPS) Logic and Trip Initiation."

b. The Steam Generator #1 Pressure – Low trip, Steam Generator #2 Pressure – Low trip, RPS Logic, RTSGs and manual trip are required in MODES 3 and 4, with the RTSGs closed, to provide protection for MSLB. The Steam Generator Pressure – Low trip in shutdown MODE is described in LCO.

c. The Applicability is modified by a Note that allows the trip to be bypassed when logarithmic power is greater than or equal to 1 x ~~10^{-3} %~~ 10^{-3}% , and the bypass is automatically removed when logarithmic power is less than 1 x ~~10^{-3} %~~ 10^{-3}%.

The most common causes of channel inoperability are outright failure or drift of the bistable or process module sufficient to exceed the tolerance allowed by the plant specific setpoint analysis. Typically, the drift is found to be small and results in a delay of actuation rather than a total loss of function. This determination is generally made during the performance of a CHANNEL FUNCTIONAL TEST when the process instrument is set up for adjustment to bring it to within specification. If the trip setpoint is less conservative than the Allowable Value stated in the SCP, the channel is declared inoperable immediately, and the appropriate Condition(s) must be entered immediately.

In the event a channel's trip setpoint is found nonconservative with respect to the Allowable Value, or the excore logarithmic power channel or RPS bistable trip unit is found inoperable, then all affected Functions provided by that channel must be declared inoperable and the unit must enter the Condition for the particular protection Function affected.

ACTIONS (continued)

a. Required Action B.1 immediately renders the affected CPCS channels inoperable, thus requiring entry into the Required Actions associated with LCO 3.3.1.

b. Required Action B.2.1 through B.2.5 disable the DRCS, while providing increased assurance that CEA deviations are not occurring and informing all OPERABLE CPCS channels, via a software flag, that both CEACs are failed. This will ensure that the large penalty factor associated with two CEAC failures will be applied to the CPC calculations. The penalty factor for two failed CEACs is sufficiently lower than ~~100 %~~ 100% RTP if CPC generated reactor trips are to be avoided. The Completion Time of 4 hours is adequate to accomplish these actions while minimizing risks.

The Required Actions are as follows.

B.1

Required Action B.1 provides for declaration of affected CPC channel inoperability within 1 hour, and entry into Required Actions associated with LCO 3.3.1 for the DNBR – Low and LPD – High trip function. This Required Action treats failure of both CEACs in one or more channels in a manner consistent with other RPS failures in one or more channels. Similarly, this Required Action permits immediate declaration of channel inoperability and entry in the Required Action of LCO 3.3.1 if the Required Actions and associated Completion Times of Condition A are not met. Required Action B.1 may be the preferred action if only one CPCS channel is affected. If the failure affects more than two CPCS channels, Required Action B.2.1 through B.2.5 would be preferable.

B.2.1

Meeting the margin requirements of DNBR in LCO 3.2.4 ensures that power level is within a conservative region of operation based on actual core conditions. In addition to the above actions, RPCS must be disabled. This ensures that CEA positions will not be affected by RPCS operation.

B 3.3 INSTRUMENTATION

B 3.3.7 Emergency Diesel Generator (EDG) – Loss of Voltage Start (LOVS)

BASES

BACKGROUND

The EDGs provide a source of emergency power when offsite power is either unavailable or insufficiently stable to allow safe plant operation. Undervoltage protection will generate a LOVS in the event a Loss of Voltage or Degraded Voltage condition occurs. There are two LOVS Functions for each 4.16 kV vital bus.

Four undervoltage relays with inverse time characteristics are provided on each 4.16 kV Class 1E instrument bus for the purpose of detecting a sustained undervoltage condition or a loss of bus voltage. The relays are combined in a two-out-of-four logic to generate a LOVS if the voltage is below 75 % for a short time or below ~~90 %~~ 90% for a long time. The LOVS initiated actions are described in "Onsite Power Systems" (Reference 1).

Trip Setpoints and Allowable Values

The trip setpoints and Allowable Values are based on the analytical limits presented in "Accident Analysis," Reference 2. The selection of these trip setpoints is such that adequate protection is provided when all sensor and processing time delays are taken into account. To allow for calibration tolerances, instrumentation uncertainties, and instrument drift, Allowable Values specified in Setpoint Control Program (SCP) are conservatively adjusted with respect to the analytical limits. A detailed description of the methodology used to calculate the trip setpoints, including their explicit uncertainties, is provided in the SCP. The actual nominal trip setpoint is normally still more conservative than that required by the plant specific setpoint calculations. If the measured trip setpoint does not exceed the documented Surveillance acceptance criteria, the undervoltage relay is considered OPERABLE.

Setpoints in accordance with the Allowable Values will ensure that the consequences of accidents will be acceptable, providing the plant is operated from within the LCOs at the onset of the accident and the equipment functions as designed.

BASES

LCO (continued)

Listed below are discussions of the specified instrument functions listed in Table 3.3.11-1. The following instruments are displayed on QIAS-P, QIAS-N, and IPS.

1. Logarithmic Reactor Power

Logarithmic Reactor Power indication is provided to verify reactor shutdown.

Inputs are provided by two safety CHANNELS with a minimum sensor and indicated range of 2×10^{-8} to ~~200 %~~ 200% power.

2, 3. Reactor Coolant Hot Leg Temperature (wide range) and Cold Leg Temperature (wide range)

Reactor coolant hot leg and cold leg temperatures are variables provided for verification of core cooling and long term surveillance. They are also inputs to the reactor coolant system subcooled margin monitor.

Reactor coolant outlet and inlet temperature inputs to the AMI are provided by two fast response resistance elements and associated transmitters in each loop. The CHANNELS provide indication over a minimum sensor and indicated range of 0 to 400°C (32 to 752 °F).

4. Reactor Coolant System Pressure (wide range)

RCS pressure (wide range) is a variable, provided for verification of core cooling and RCS integrity long term surveillance. Wide range RCS loop pressure is measured by pressure transmitters with a minimum sensor and indicated range of 0 to 281.2 kg/cm^2G (4,000 psig). The pressure transmitters are located inside the containment. Redundant monitoring capability is provided by two trains of instrumentation.

BASES

LCO (continued)

5. Reactor Vessel Coolant Level

Reactor vessel coolant level is provided for verification and long term surveillance of core cooling.

The reactor vessel coolant level monitors provide a direct measurement of the collapsed liquid level above the fuel alignment plate surface. The collapsed liquid represents the amount of liquid mass that is in the reactor vessel above the core. Measurement of the collapsed coolant level is selected because it is a direct indication of the coolant inventory. The collapsed level is obtained over the same temperature and pressure range as the saturation measurements, thereby encompassing all operating and accident conditions where it must function. Also, it functions during the recovery interval. Therefore, it is designed to survive the high steam temperature that can occur during the preceding core recovery interval.

The level range extends from the top of the vessel down to the top of the fuel alignment plate surface. The response time is short enough to track the level during small break LOCA events. The resolution is sufficient to show the initial level drop, the key locations near the hot leg elevation, and the lowest levels just above the fuel alignment plate surface. This provides the operator with adequate indication to track the progression of the accident and to detect the consequences of its mitigating actions or the functionality of automatic equipment.

Two CHANNELS with minimum sensor range of 0 ~ 673.5 cm (0 ~ 265.16 in) above the fuel alignment plate surface is provided. The minimum indicated range for these two CHANNELS is 0 to ~~100 %~~ 100%.

6. Reactor Cavity Level

Reactor cavity level is provided for verification and long term surveillance of the RCS integrity and vessel integrity.

Reactor cavity level is measured by four instruments with a minimum sensor and indicated range of 0 to ~~100 %~~ 100%.

BASES

LCO (continued)

10. Containment Upper operating Area Radiation

The Containment Upper operating Area Radiation monitor is provided to monitor for the potential of significant radiation releases and to provide release assessment for use by operators in determining the need to invoke site emergency plans. Two sensors with a minimum sensor and indicated range of 10^1 to 10^8 mSv/hr provide input to the monitor.

11. Pressurizer Level

The Pressurizer Level is used to determine whether to terminate safety injection (SI), if still in progress, or to reinitiate SI if it has been stopped. Knowledge of pressurizer level is also used to verify the plant conditions necessary to establish natural circulation in the RCS and to verify that the plant is maintained in a safe shutdown condition.

Two pressurizer level sensors are provided. They have a minimum indicated and sensor range of 0 to ~~100 %~~ 100%.

12. Steam Generator Level (wide range)

The Steam Generator Level (wide range) monitor is provided to monitor operation of decay heat removal via the steam generators. The measured differential pressure is displayed as 0 to ~~100 %~~ 100% at the reference leg temperature of 20 °C (68 °F). Temperature compensation of this indication is performed manually by the operator. Redundant monitoring capability is provided by two trains of instrumentation.

BASES

LCO (continued)

13. Holdup Volume Tank (HVT) Level

The HVT performs water collection and storage functions during accident conditions. Level indication is provided in the MCR to allow the operator to monitor HVT level after an accident. HVT level is measured by five instruments with a minimum sensor and indicated range of 0 to ~~100 %~~ 100%.

14, 15, 16, 17. Core Exit Temperature

Core exit temperature is provided for verification and long term surveillance of core cooling.

An evaluation is made of the minimum number of valid core exit thermocouples necessary for inadequate core cooling detection. The evaluation determines the reduced complement of core exit thermocouples necessary to detect initial core recovery and trend the ensuing core heatup. The evaluations account for core nonuniformities including incore effects of the radial decay power distribution and excore effects of condensate runback in the hot legs and nonuniform inlet temperatures. Based on these evaluations, adequate or inadequate core cooling detection is ensured with two valid core exit thermocouples per quadrant.

The design of the Incore Instrumentation System includes a Type K (chromel alumel) thermocouple within each of the incore instrument detector assemblies. The junction of each thermocouple is located a few inches (cm) above the fuel assembly, inside a structure that supports and shields the incore instrument detector assembly string from flow forces in the outlet plenum region. These core exit thermocouples monitor the temperature of the reactor coolant as it exits the fuel assemblies.

The core exit thermocouples have a usable sensor and indicated temperature range from 0 to 1,260.0 °C (32 to 2,300 °F), although accuracy is reduced at temperatures above 982.2°C (1,800 °F).

BASES

LCO (continued)

21. IRWST Level

The IRWST Level monitor is provided to sure water supply for Emergency Core Cooling and Containment Spray. The IRWST consists of one torus-type tank inside containment. There are four 0 to ~~100 %~~ 100% sensors and indicated range level CHANNELS.

22. IRWST Temperature

IRWST temperature is provided for verification of long term decay heat removal operation. There are four 50 to 350 °F sensors with an indicated range temperature CHANNELS.

23. Containment Level

The containment level monitor is provided for verification and long term surveillance of Emergency Core Cooling and the Containment Level is measured by two instruments with a minimum sensor and indicated range of 0 to ~~100 %~~ 100%.

24. Control Rod Position

To verify whether the Control Rods are full in or not full in, Control Rod Positions are calculated in CPCS with a range of 0 to 381 cm.

25. Containment Operating Area Radiation

A containment operating area radiation monitor is provided to monitor the potential of significant radiation releases from an event occurring in the containment (e.g., fuel handling accident) and to provide a release assessment for use by operators in determining the need to invoke the site emergency plans. In addition, this area monitoring initiates containment purge isolation actuation signal (CPIAS) to prevent radioactive release through containment purge system.
Two containment operating radiation monitors are available and two sensors with a minimum sensor indicated range of 10^{-3} mSv/hr to 10^{2} mSv/hr provide input

B 3.3 INSTRUMENTATION

B 3.3.13 Logarithmic Power Monitoring Channels

BASES

BACKGROUND

The logarithmic power monitoring channels provide neutron flux power indication from less than ~~10^{-7} %~~ 10^{-7}% RTP to greater than ~~100 %~~ 100% RTP. They also provide reactor protection when the reactor trip switchgears (RTSGs) are shut, in the form of a Logarithmic Power Level – High trip.

This LCO addresses MODES 3, 4, and 5 with the RTSGs open. When the RTSGs are shut, the logarithmic power monitoring channels are addressed by LCO 3.3.2, "Reactor Protection System (RPS) Instrumentation – Shutdown."

When the RTSGs are open, two of the four logarithmic power monitoring channels must be available to monitor neutron flux power. In this application, the RPS channels need not be OPERABLE since the reactor trip Function is not required. By monitoring neutron flux (logarithmic) power when the RTSGs are open, loss of SDM caused by boron dilution can be detected as an increase in flux. Alarms are also provided when power increases above the fixed bistable setpoints. Two channels must be OPERABLE to provide single failure protection and to facilitate detection of channel failure by providing CHANNEL CHECK capability.

APPLICABLE SAFETY ANALYSES

The logarithmic power monitoring channels are necessary to monitor core reactivity changes. They are one of the primary means for detecting and triggering operator actions to respond to reactivity transients initiated from conditions in which the RPS is not required to be OPERABLE. The logarithmic power monitoring channels also trigger operator actions to anticipate RPS actuation in the event of reactivity transients starting from shutdown or low power conditions. The logarithmic power monitoring channel's LCO requirements support compliance with Reference 1. Reference 2 describes the specific logarithmic power monitoring channel features that are critical to comply with the GDC.