# 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.:** | **439-8524** |
| **SRP Section:** | **16 – Technical Specifications** |
| **Application Section:** | **16.3.1** |
| **Date of RAI Issue:** | **03/11/2016** |

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## Question No. 16-129

The (Dec 2015) Deviation report justifies including LCO 3.4.1.b in the LCO 3.1.~~12~~11 exception list by stating: “The LCO for cold leg temperature is narrow for the APR1400, so the LCO 3.4.1.b may be suspended.” LCO 3.4.1.b states

> RCS departure from nucleate boiling (DNB) parameters for pressurizer pressure, cold leg temperature, and RCS total flow rate shall be within the limits specified below:
>
> b. RCS cold leg temperature ($T_{cold}$):
> ≥ 286.7 °C (548 °F) and ≤ 293.3 °C (560 °F) for < 90 % RTP
> ≥ 289.4 °C (553 °F) and ≤ 293.3 °C (560 °F) for ≥ 90 % RTP

This means that below 90 % RTP there is a 12 degree F band, and at or above 90 % RTP there is a 7 degree F band. The applicant is requested to discuss how these temperature bands compare with the CE plant design assumed in CE STS 3.4.1.

In addition, the Applicable Safety Analyses section of the Bases for Rev. 0 of generic TS 3.1.~~12~~11 refers to "cold leg temperature ($T_{cold}$)" as "reactor inlet temperature ($T_c$)," which is inconsistent. The applicant is requested to use the former terminology, despite the latter being used in this location in the Bases for STS.

## Response

The CE STS Rev. 3, LCO 3.4.1 states the cold leg temperature as follows (Note that Rev. 3 is used for comparison since Rev. 4 removed the specific temperature values and simply references the COLR):

- RCS cold leg temperature: [535]°F ≤ (Tc) ≤ [558]°F for < [70]% RTP
  [544]°F ≤ (Tc) ≤ [588]°F for ≥ [70]% RTP

The APR1400 has a narrower band of 7°F above 90% RTP compared to the CE STS Rev. 3. Therefore, the special test exception of LCO 3.4.1.b is needed in order to successfully perform physics testing. For example, the variable $T_{avg}$ test described in DCD section 14.2.12.4.1 includes a measurement of moderator temperature coefficient with a planned variation of cold leg temperature at the minimum band of 6°F based on ANSI/ANS-19.6.1.

The ranges of the cold leg temperatures specified in LCO 3.4.1.b were determined based on a safety analysis that used the cold leg temperatures specified in the DCD Table 15.0-3 as an initial condition. The lower value was selected based on the minimum temperature for criticality and to ensure acceptable consequences for a loss of condenser vacuum (LOCV) event. The upper bound of this range was selected to: (1) limit the core reactivity addition rate and amount during a steam line break (SLB) event, and (2) maintain sufficient sub-cooling at the core exit during normal operations.

The current terminology "reactor inlet temperature ($T_c$)" will be revised to "cold leg temperature ($T_{cold}$)" in the Applicable Safety Analyses section of the Bases for TS 3.1.12(Special Test Exceptions (STE) – Reactivity Coefficient Testing) and other similar LCO Bases.

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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 Reports.

BASES

APPLICABLE SAFETY ANALYSES (continued)

Therefore, this LCO places limits on the minimum amount of CEA worth required to be available for reactivity control when CEA worth measurements are performed.

cold leg temperature ($T_{cold}$)

The individual LCOs cited above govern SDM, CEA group height, insertion, and alignment. 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 6). The criteria for the loss of forced reactor coolant flow accidents are specified in Reference 7. Operation within the LHR limit preserves the LOCA criteria. Operation within the DNBR limits preserves the loss of flow criteria.

SRs are conducted as necessary to ensure that LHR and DNBR remain within limits during PHYSICS TESTS. Performance of these SRs allows PHYSICS TESTS to be conducted without decreasing the margin of safety.

Requiring that shutdown reactivity equivalent to at least the highest estimated CEA worth (of those CEAs actually withdrawn) be available for trip insertion from the OPERABLE CEAs, provides a high degree of assurance that shutdown capability is maintained for the most challenging postulated accident, a stuck CEA. Since LCO 3.1.1 is suspended, however, there is not the same degree of assurance during this test that the reactor would always be shut down if the highest worth CEA was stuck out and calculational uncertainties or the estimated highest CEA worth was not as expected (the single failure criterion is not met). This situation is judged acceptable, however, because specified acceptable fuel damage limits are still met.

The risk of experiencing a stuck CEA and subsequent criticality is reduced during this PHYSICS TEST exception by the requirements to determine CEA positions every 2 hours, the trip of each CEA to be withdrawn within 24 hours prior to suspending the SDM requirements, and ensuring that shutdown reactivity is available equivalent to the reactivity worth of the estimated highest worth withdrawn CEA (Reference 5).

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.

cold leg temperature ($T_{cold}$)

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.

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.

BASES

APPLICABLE SAFETY ANALYSES (continued)

cold leg temperature ($T_{cold}$)

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.

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