National Nuclear Safety Administration (NNSA) Questions

and U.S. Nuclear Regulatory Commission (NRC) Responses

Regarding AP1000 Reactor Coolant System and Main Steam Line Leakage Detection

Question 1, Part (a)

> The Section of 2.1 in RG 1.45 (Revision 1) Part C requires that plant procedures should include the collection of leakage to the primary reactor containment from unidentified sources so that the total flow rate can be detected, monitored, and quantified for flow rates greater than or equal to 0.05 gal/min (0.19 L/min). As described in the Section of 23.F of NUREG-1793, the U.S. Nuclear Regulatory Commission requested the applicant to provide sufficient information to demonstrate that the newly proposed F-18 particulate radiation monitor (PSS-JE-RE027) sensitivity is capable of detecting the reactor coolant system (RCS) leak rate of 0.5 gal/min (1.9 L/min) according to the Technical Specification (TS), and the monitor sensitivity of detecting 0.5 gal/min (1.9 L/min) can satisfy the requirement of Regulatory Guide (RG)1.45 (Revision 1). National Nuclear Safety Administration (NNSA) find that the value difference is 10 times. Why is it?

Response:

The two different values (0.05 gpm and 0.5 gpm) meet two unrelated regulatory positions related to leakage detection capability. Therefore, it is reasonable to expect the values to be different, and the difference just happens to be 10 times for AP1000.

- The first value (0.05 gpm) corresponds to the reactor RCS leakage detection sensitivity established to meet RG 1.45 Revision 1 Part C Position 2.1. For this regulatory position, there is no response time limit. The sump level detection satisfies this regulatory position. One acceptable detection method is sufficient to satisfy this regulatory position. The F-18 particulate radiation monitor is not required to meet this 0.05 gpm sensitivity criterion.
  .
- The second value corresponds to the F-18 particulate monitor leakage detection capability to detect the RCS leakage of 0.5 gal/min within one hour to satisfy RG 1.45 Revision 1 Part C (Positions 2.2 and 2.3) and TS Limiting Conditions for Operation (LCO) 3.4.7 and 3.4.9. At least two detection methods should be provided to satisfy this capability and are included in the plant TSs. The F-18 particulate radiation monitor and sump level detector satisfy this detection capability and are included in the TSs.

  Regulatory Position 2.2 establishes a leakage detection criterion of 1 gpm with a response time of one hour. For the AP1000 and to support the leak-before-break (LBB) application, the acceptable criterion derived in Design Control Document Section 3.6.3 is 0.5 gpm. This value is specified in TS LCO 3.4.7. The 0.5 gpm criterion, which may not be applicable for other plants without applying LBB, is more stringent than the 1 gpm criterion specified in Position 2.2.

Question 1, Part (b)

> The detecting method of F-18 particulate radiation monitor only can be used above 20 percent FP of the reactor, so it cannot detect the leakage of RCS for all period of the reactor operation. And as described in the Section of 2.3 in RG 1.45 (Revision 1) Part C, plant TSs should identify at least two independent and diverse instruments and/or methods that have the detection and monitoring capabilities detailed above. So, does it meet the requirement?

Response:

Yes, it meets the regulatory positions. At least two detection methods (sump level detection and F-18 particulate radiation monitor) provide the capability to detect the RCS leakage of 0.5 gal/min within one hour, and these two detection methods are included in the plant TSs.

The regulatory positions do not ask for both methods to be operable all the time. The plant TSs specify how long one of the two may be inoperable, the compensatory measures, and the condition that the F-18 particulate radiation monitor is only required to be operable above 20 percent rated thermal power (RTP).

Additional discussion for operation below 20 percent RTP:

- The plant is not expected to operate below 20 percent RTP for significant periods of time that would impact the leakage detection capability. During this period, the method of sump level detection should be able to detect the leakage.

- RG 1.45 already contains provisions for considering low RCS activity associated with startup of the plant. However, reactor coolant activity should be low during initial reactor startup and for a few weeks thereafter until activated corrosion products have formed and fission products have potentially been released from fuel elements. During this period, radioactivity monitoring instruments may be of limited value in providing an early warning of very small leaks in the RCS.

Question 2

> The monitoring methods for reactor coolant leakage include containment sump level, inventory balance, and containment atmosphere radioactivity monitoring and so on. However, monitoring sump level is the only method for main steam pipe LBB technology. So, how can we confirm the leakage come from the reactor coolant system or main steam pipe by the containment sump level? How to confirm that the main steam pipe LBB technology meet the requirement?

Response:

Combining sump level detection and radiation monitoring is used to determine whether the leakage is from the RCS (high radiation level) or from main steam piping (low radiation level). TS LCO 3.7.8, “Main Steam Line Leakage” specifies that leakage must not exceed 0.5 gpm. TS B 3.7.8 Bases states that subtracting the RCS leakage and any other identified non-RCS

leakage into the containment area from the total plant leakage inside containment provides qualitative information to the operators regarding possible main steam line leakage.

Based on plant operating experiences, one can also use a comparison of RCS coolant activity to the activity contained in the sump fluids, as well as other chemical constituents, such as boron and lithium, to determine if leakage is from the main steam system or from the RCS. Leakage from the main steam system would not contain boron or lithium. When necessary, one could perform inspections inside of containment.