Response to SDAA Audit Question

Question Number: A-15.6.3-1

Receipt Date: 03/27/2023

Question:

The approved non-LOCA Topical Report contains a limitation and condition that requires an applicant or licensee using this methodology and seeking to credit the non-safety-related MSIVs in the analysis of a SGTF event to receive specific approval to credit the non-safety-related MSIVs through the design review. The SDAA Chapter 15 safety analysis credits the non-safety-related secondary MSIV for isolating the faulted steam generator and terminating mass release to the environment. The SDAA is missing an analysis demonstrating that a failure of the secondary MSIVs to close during a SG tube rupture event would not result in exceeding design basis dose release limits (10 CFR 52.137(a)(iv)).

Response:

As described in FSAR Section 10.3.2.1.2, the SDAA US460 design includes a nonsafety-related secondary main steam isolation valve (MSIV) downstream of each MSIV. The secondary MSIV, while nonsafety-related, has augmented quality requirements to ensure its capability to serve as a backup to the safety-related MSIV. Each secondary MSIV is also periodically tested as part of the Inservice Testing Program. In addition, the US460 Technical Specifications (Part 7 of the SDAA) require two MSIVs (and two MSIV bypass valves) per steam line to be operable in Limiting Condition for Operation (LCO) 3.7.1. The associated Technical Specification Bases identifies that the two MSIVs per steam line are the safety-related valve and the nonsafety-related valve. Operability of the nonsafety-related MSIVs is therefore required by the US460 Technical Specifications during all operational modes where a steam generator tube failure is postulated to occur. For these reasons, the secondary MSIV is ensured to reliably perform its function as backup isolation in the event of an assumed single failure of the MSIV in Chapter 15. The failure of both MSIVs is not assumed in Chapter 15.

The design certification application (DCA) for the US600 was submitted and accepted for NRC review with credit taken for the secondary (nonsafety-related) MSIV to close as a backup in the event of the assumed single failure of the primary (safety-related) MSIV for the FSAR Chapter

15 steam generator tube failure (SGTF) radiological consequence analysis. During the NRC review of the DCA, the NRC issued RAI 9420 Question 15-17 to request that an analysis be performed to demonstrate 10 CFR 52.47(a)(2)(iv) criteria were met assuming the failure of both the primary and secondary MSIVs. In response, NuScale described a sensitivity analysis that was performed that identified a potential increase in mass release of approximately 50% for the case where neither the primary nor secondary MSIVs close. A new dose analysis was not explicitly performed with this 50% increase in mass release, but the response concluded that the additional mass release would not challenge regulatory dose limits since there was significant margin (more than 100%) between the analysis of record in the DCA and the regulatory limit. The DCA FSAR Chapter 15 was not updated to include a discussion of the sensitivity analysis or results. The DCA was approved without incorporation of the sensitivity analysis in the FSAR.

Based on the precedent established from the DCA, the SDAA FSAR does not include an analysis that explicitly considers failure of both the primary and secondary MSIVs in Chapter 15. However, the SDAA does use a more conservative approach to the SGTF radiological consequence analysis than the DCA. For the SDAA, the SGTF radiological consequence analysis included in Section 15.0.3.7.2 of the SDAA FSAR uses a bounding mass release of 23,000 lbm associated with the tube failure. The method for determining this value, which is described in Section 15.0.3.7.2, is based on successful secondary system isolation (i.e., closure of either the primary or secondary MSIV). The assumption of successful secondary system isolation is consistent with the approved DCA. In addition, the assumed mass release of 23,000 lbm {{

}}$^{2(a),(c)}$ It is therefore reasonable to conclude that the mass release assumed in Section 15.0.3.7.2 of the SDAA FSAR is adequate to bound a potential failure of both the primary and secondary MSIVs. Consistent with the DCA, the SGTF radiological consequence results reported in Table 15.0-10 of the SDAA FSAR have significant margin (more than 100%) to the regulatory limit.

For further verification, a new sensitivity analysis was performed for the SDAA similar to the one previously described in the response to DCA RAI 9420 Question 15-17. The limiting mass release case from the analyses performed in support of Section 15.6.3 of the SDAA FSAR was modified to not credit closing of either the primary or secondary MSIV. The sensitivity analysis is described below.

A reactor trip results in a turbine trip. As described in SDAA FSAR Section 10.2.3, a turbine trip signal closes the nonsafety-related turbine stop and control valves. The closure of these turbine stop and control valves isolates the steam lines. The turbine bypass valve (TBV), which is

closed during normal operations as described in Section 10.4.4.2, would normally open following a turbine trip to allow steam dump to the condenser. Two scenarios are considered for the TBV and discussed further below.

In the first scenario, the TBV is assumed to open as designed. As described in Section 10.4.4.2, the TBV is capable of throttling the full bypass flow without requiring actuation of the main steam safety valve (MSSV). As the primary system depressurizes through the SGTF, the TBV will throttle to maintain a constant secondary pressure {{ }}$^{2(a),(c)}$ Eventually, as the pressure between the primary and secondary systems decreases and equalizes, the TBV will close. At this point, the flow of primary coolant into the secondary system will stop. In this scenario, the sensitivity analysis shows that the mass release is increased compared to the case where at least one of the MSIVs closes as expected as shown in Table 1.

In the second scenario, the TBV is assumed to remain closed or is immediately reclosed after opening. As a result, the MSSVs located downstream of the MSIVs and upstream of the turbine stop and control valves (as shown in Figure 10.1-1) may open to relieve steam line pressure as necessary during the transient and then close when steam line pressure decreases. The intermittent opening of the MSSVs allows for additional mass release. The sensitivity analysis considered two different closure times for the turbine stop and control valves; {{ }}$^{2(a),(c)}$ Although the MSSVs release steam directly to the environment rather than into a building, the radiological consequence analyses also model the release of primary coolant as direct to the environment as described in Section 15.0.3.7.2. Once secondary system pressure has decreased to the point where MSSVs no longer open and primary and secondary system pressures have equalized, the mass release is terminated. In this scenario, the sensitivity analysis shows that the mass release is increased compared to the case where at least one of the MSIVs closes as expected as shown in Table 1.

In both scenarios, the additional loss of primary coolant to the secondary side results in reactor pressure vessel level decreasing to the point where ECCS actuates. The actuation of ECCS further depressurizes the primary side and reduces the primary-to-secondary flow through the SG tube. {{ }}$^{2(a),(c)}$

Despite the increases relative to the limiting mass release case from the analyses performed in support of Section 15.6.3, the total mass release in either sensitivity scenario still remains less than the bounding mass release of 23,000 lbm assumed in Section 15.0.3.7.2 as shown in Table 1.

Based on the above considerations, it is not necessary to explicitly include an SGTF radiological consequence analysis considering failure of both the primary and secondary MSIVs in the SDAA. The combination of the bounding mass release assumption already included in the SDAA and the significant available margin to the regulatory limit in Table 15.0-10 provides reasonable assurance that 10 CFR 52.137(a)(iv) is met even if the nonsafety-related MSIV is not credited to close as a backup following an assumed single failure of the safety-related MSIV to close. No changes to the SDAA are required.

Table 1:
Steam Generator Tube Failure Main Steam Isolation Valve Failure Sensitivity Study

Case	Primary Coolant Mass Release from Tube (lbm)
Event-Specific Result from 15.6.3	{{ }}[2(a),(c)]
Sensitivity Scenario 1 (TBV open)	{{ }}[2(a),(c)]
Sensitivity Scenario 2 (TBV closed)	{{ }}[2(a),(c)]
Bounding Assumption in 15.0.3.7.2	23,000

No changes to the SDAA are necessary.