Response to Request for Additional Information 9846 (eRAI 9846)

NONE-2

Licensing Topical Report (LTR) HI-2201064, Revision 2, " Elimination of the Large Break Loss of Coolant Accident (LOCA) and Establishment of LOCA Acceptance Criteria," Section 7.1.1, references 10 CFR 50.34(f). The topical report states "10 CFR 50.34(f), "Additional TMI-related requirements" [5], requires that each applicant for a design certification, design approval, combined license, or manufacturing license under Part 52 of this chapter shall demonstrate compliance with the technically relevant portions of the requirements in paragraphs (f)(1) through (3) of this section, except for paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). The following requirements are evaluated as they are related to the LOCA and LOCA acceptance criteria."

The following questions are related to 10 CFR 50.34(f):

i. 10 CFR 50.34(f)(1)(iii) requires an evaluation of the potential for and impact of reactor coolant pump seal damage following small-break LOCA with loss of offsite power. If damage cannot be precluded, provide an analysis of the limiting small-break loss-of- coolant accident with subsequent reactor coolant pump seal damage.

Section 7.1.1 of the topical report states that "the SMR-160 does not include reactor coolant pumps for normal operation, as this plant relies on natural circulation. Therefore, this requirement is not technically relevant to the SMR-160."

The staff notes that SMR-160 contains reactor coolant startup pumps (RCSP). Additionally, the staff notes that all modes of normal operation should be considered including startup, run, and shutdown. How are the RCSP evaluated with respect to LOCA? How are the RCSP seals addressed with respect to this requirement? Provide the basis for why this requirement is not technically relevant considering that the SMR-160 contains RCSPs.

<u>RESPONSE:</u>

The RCSP used in the SMR-160 is a seal-less design that has all rotating components inside the pressure retaining housing. In the event of a small break LOCA coincident with a loss of offsite power, there is no potential for a RCSP seal failure since the RCSP does not contain a seal. In addition, there is no seal that can fail and initiate reactor coolant system leakage.

Statement of Compliance for 10 CFR 50.34(f)(1)(iii) in Section 7.1.1 of HI-2201064 will be updated as follows:

> "The RCSP used in the SMR-160 is a seal-less design that has all rotating components inside the pressure retaining housing. In the event of a small break LOCA coincident with a loss of offsite power, there is no potential for a RCSP seal failure since the RCSP does not contain a seal. Therefore, this requirement is not technically relevant since the RCSP used in the SMR-160 design does not contain a seal, so no seal damage can occur."

ii. 10 CFR 50.34(f)(1)(iv) requires an analysis of the probability of a small-break loss-of-coolant accident (LOCA) caused by a stuck-open power-operated relief valve (PORV). If this probability is a significant contributor to the probability of small-break LOCA's from all causes, provide a description and evaluation of the effect on small-break LOCA probability of an automatic PORV isolation system that would operate when the reactor coolant system pressure falls after the PORV has opened.

Section 7.1.1 of the topical report states that "The SMR-160 design does not include any PORVs on the pressurizer. The pressurizer is sufficiently sized such that the plant can accommodate normal power maneuvers without needing a PORV. The ADS Stage 1 valves are connected to the pressurizer, however each of the two ADS Stage 1 trains have two valves in series, so that a single failure of one of the valves would not result in inadvertent depressurization or a failure to isolate the pressurizer in the event that ADS is terminated. Therefore, this requirement is not technically relevant to the SMR-160."

Topical report section 4.1.1.1.3 states that "the ADS has two stages of depressurization with two trains in each stage. Only one train of each stage is needed to perform the depressurization function." And "[[ ]]

Provide the basis for why this requirement is not technically relevant considering that the SMR-160 contains ADS stage 1 and ADS stage 2 depressurization valves that can be opened and remain stuck open during an inadvertent actuation of the ADS system given all potential significant contributors to the probability of small-break LOCA's from all causes should be considered (i.e. common cause failures and inadvertent actuations).

<u>RESPONSE</u>:

The SMR-160 design does not include power-operated relief valves (PORVs) in the Reactor Coolant System (RCS). Overpressure protection is provided by two safety valves that actuate on high pressure. These valves are spring-loaded, self-actuated, and they are designed to meet the requirements of the ASME BPV Code, Section III. If the pressurizer pressure exceeds the set pressure, the safety valves start lifting. As discussed in HI-2201064, the pressurizer volume is sized to increase the margins for transient operation and prevent safety valve actuation. A temperature indicator in the discharge piping for each safety valve alarms on high temperature to alert the operator to the presence of high temperature fluid from leakage or when the valves open.

The SMR-160 design includes an Automatic Depressurization System (ADS) as part of the Passive Core Cooling System (PCCS). The ADS consists of two stages of motor operated valves. ADS Stage 1 is connected to the top of the pressurizer. ADS Stage 2 is connected to the hot leg. Unlike PORVs, the ADS valves do not actuate on a RCS high-pressure signal.

A probabilistic safety assessment was used to evaluate the probability of inadvertent actuation and common cause failures which could lead to a stuck open valve. A single open valve will not result in a LOCA since all trains have two valves in series.

Design features to reduce the probability of inadvertent actuation and common cause failures which could lead to a stuck open valve of the ADS are: 1) appropriate interlocks for operation, 2) two-out-of-four instrument actuation, 3) fail as-is valves, 4) redundant and closed valves in series for both trains of both stages of ADS, and 5) the ability to remotely close the valves from the main control room. Barriers to address human error that could cause an inadvertent actuation of the system are also considered. These include the requirement for two push buttons to be pressed simultaneously to send a manual actuation signal and placing covers over the push buttons on the control panels to prevent inadvertent actuation of the ADS.

Based on the above, the probability of a small-break loss-of-coolant accident (LOCA) caused by stuck open ADS Stage 1 or Stage 2 valve is not expected to be a significant contributor to the probability of small-break loss of coolant accidents from all causes. This will be demonstrated in a future licensing application.

The Statement of Compliance for 10 CFR 50.34(f)(1)(iv) in Section 7.1.1 of HI-2201064 will be revised as follows:

> “The SMR-160 design does not include power-operated relief valves (PORVs) in the Reactor Coolant System (RCS). Overpressure protection is provided by two safety valves that actuate on high pressure. These valves are spring-loaded, self-actuated, and they are designed to meet the requirements of the ASME BPV Code, Section III. If the pressurizer pressure exceeds the set pressure, the safety valves start lifting. The pressurizer volume is sized to increase the margins for transient operation and prevent safety valve actuation. A temperature indicator in the discharge piping for each safety valve alarms on high temperature to alert the operator to the presence of high temperature fluid from leakage or when the valves open.
>
> The SMR-160 design includes an Automatic Depressurization System (ADS) as part of the Passive Core Cooling System (PCCS). The ADS consists of two stages of motor operated valves. ADS Stage 1 is connected to the top of the pressurizer. ADS Stage 2 is connected to the hot leg. Unlike PORVs, the ADS valves do not actuate on a RCS high-pressure signal.
>
> A probabilistic safety assessment was used to evaluate the probability of inadvertent actuation and common cause failures which could lead to a stuck open valve. A single open valve will not result in a LOCA since all trains have two valves in series.
>
> Design features to reduce the probability of inadvertent actuation and common cause failures which could lead to a stuck open valve of the ADS are: 1) appropriate interlocks for operation, 2) two-out-of-four instrument actuation, 3) fail as-is valves, 4) redundant and closed valves in series for both trains of both stages of ADS, and 5) the ability to remotely close the valves from the main control room. Barriers to address human error that could cause an inadvertent actuation of the system are also considered. These include the requirement for two push buttons to be pressed simultaneously to send a manual actuation signal and placing covers over the push buttons on the control panels to prevent inadvertent actuation of the ADS.

Based on the above, the probability of a small-break loss-of-coolant accident (LOCA) caused by stuck open ADS Stage 1 or Stage 2 valve is not expected to be a significant contributor to the probability of small-break loss of coolant accidents from all causes. This will be demonstrated in a future licensing application."

iii. 10 CFR50.34(f)(2)(vi) requires the provision of the capability of high point venting of non-condensable gases from the reactor coolant system, and other systems that may be required to maintain adequate core cooling. Systems to achieve this capability shall be capable of being operated from the control room and their operation shall not lead to an unacceptable increase in the probability of loss-of-coolant accident or an unacceptable challenge to containment integrity.

Section 7.1.1 of the topical report states that "for the SMR-160 the capability for remotely operated high point venting of the reactor coolant system is provided by [[

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According to NUREG-0737, Clarification of TMI Action Plan Requirements, the purpose of the system is to vent non-condensable gases from the RCS which may inhibit core cooling during natural circulation. Additionally, NUREG-0737 states (1) Each PWR licensee should provide the capability to vent the reactor vessel head (2) The reactor vessel head vent should be capable of venting non-condensable gas from the reactor vessel hot legs and cold legs (3) Additional venting capability is required for those portions of each hot leg that cannot be vented through the reactor vessel head vent or pressurizer.

Provide the information that shows that the ADS is able to vent all the high point locations including the vessel head, or provide the criteria or method that would be used in a bounding loss of coolant analysis that shows that the amount of venting provided by the ADS provides adequate core cooling.

<u>RESPONSE</u>:

As discussed in HI-2201064, the ADS valves would provide a pathway during a LOCA to vent non-condensable gases from the Reactor Coolant System to ensure core cooling. However, to meet provisions of 10 CFR 50.34(f)(2)(iv), the SMR-160 Reactor Coolant System has two locations for high point venting of non-condensable gases: one on top of the pressurizer and the other on top of the reactor pressure vessel head. The Primary Decay Heat Removal System also has a high point vent for non-condensable gases to ensure adequate core cooling during events which credit the use of the system.

All of the vent lines are manually operated from the main control room. The vents on the top of the pressurizer and in the Primary Decay Heat Removal System have two normally closed valves in series. The reactor pressure vessel head vent has two trains of valves, each with two normally closed valves in series. Downstream of the second valve on all vent lines is an orifice which limits the flow through the vent lines to within the normal Reactor Coolant System inventory makeup capability of the Chemical and

Volume Control System; therefore, their operation will not lead to an unacceptable increase in the probability of a loss-of-coolant accident.

The reactor vessel head vent and the Primary Decay Heat Removal System high-point vent both discharge to the passive core makeup water tanks. The vent on the top of the pressurizer vents to the radwaste systems. The operation of these vents does not pose an unacceptable challenge to containment.

The design and operation of the high point vents is not expected to be a significant contributor to the probability of small-break loss of coolant accidents from all causes or an unacceptable challenge to containment integrity. This will be demonstrated in a future licensing application.

The Statement of Compliance for 10 CFR 50.34(f)(2)(vi) in Section 7.1.1 of HI-2201064 will be revised as follows:

> “To meet provisions of 10 CFR 50.34(f)(2)(iv), the SMR-160 Reactor Coolant System has two locations for high point venting of non-condensable gases: one on top of the pressurizer and the other on top of the reactor pressure vessel head. The Primary Decay Heat Removal System also has a high point vent for non-condensable gases to ensure adequate core cooling during events which credit the use of the system.
>
> All of the vent lines are manually operated from the main control room. The vents on the top of the pressurizer and in the Primary Decay Heat Removal System have two normally closed valves in series. The reactor pressure vessel head vent has two trains of valves, each with two normally closed valves in series. Downstream of the second valve on all vent lines is an orifice which limits the flow through the vent lines to within the normal Reactor Coolant System inventory makeup capability of the Chemical and Volume Control System; therefore, their operation will not lead to an unacceptable increase in the probability of a loss-of-coolant accident.
>
> The reactor vessel head vent and the Primary Decay Heat Removal System high-point vent both discharge to the passive core makeup water tanks. The vent on the top of the pressurizer vents to the radwaste systems. The operation of these vents does not pose an unacceptable challenge to containment.
>
> The design and operation of the high point vents is not expected to be a significant contributor to the probability of small-break loss of coolant accidents from all causes or an unacceptable challenge to containment integrity. This will be demonstrated in a future licensing application.”

NONE-3

Licensing Topical Report (LTR) HI-2201064, " Elimination of the Large Break Loss of Coolant Accident (LOCA) and Establishment of LOCA Acceptance Criteria," states the objective of the topical report is to seek NRC approval that a postulated break in the Combined Vessel is not required as a design basis accident, thus eliminating a large break LOCA for the SMR-160.

LTR Section 7.1 identifies applicable regulations and general design criteria (GDC) for the SMR-160. The staff notes that the primary and secondary decay heat removal systems and passive containment heat removal system are described in the LTR to facilitate a basic understanding of the design. However, GDC 34 and GDC 38 are identified in Section 7.1 and are outside the scope and purpose of the LTR. Currently, the LTR does not contain sufficient information for the staff to fully evaluate whether the SRM-160 design can comply with GDC 34 and GDC 38.

The applicant is requested to either remove the aforementioned regulatory requirements that are outside the scope of the LTR or expand the scope of the LTR to include consideration of non-LOCA events and containment performance. This would necessitate additional information related to design descriptions and requirements for the decay heat removal systems and containment systems.

RESPONSE:

Sections 7.1.12 and 7.1.14 will be removed from HI-2201064 in the next revision as requested.

NONE-4

Licensing Topical Report (LTR) HI-2201064, " Elimination of the Large Break Loss of Coolant Accident (LOCA) and Establishment of LOCA Acceptance Criteria," Section 4.1.1 states, "[t]he PCCS [passive core cooling system] is designed to provide emergency core heat removal and makeup water during postulated Design Basis Accidents (DBAs)." Further, it explains the PCCS consists of sub-systems including the primary decay heat removal system (PDHR) and secondary heat removal system (SDHR).

i. Sections 4.1.1.1.1 and 4.1.1.1.2 provide descriptions of the PDHR and SDHR, respectively. The primary function of both systems is identified as providing passive core cooling for non-LOCA events. Additionally, the LTR states the PDHR and SDHR are [[ ]]. Based on this statement it is unclear how these two systems will be credited within the LOCA analysis.

The staff requests the applicant to clarify in the LTR how the PDHR and SDHR will be considered within the LOCA analysis.

RESPONSE:

During a LOCA the Primary Decay Heat Removal System and Secondary Decay Heat Removal System will get a signal to actuate, and they will contribute to the overall reduction of RCS pressure and temperature. However, the need to credit these systems in the LOCA analysis has not been fully determined. This will be determined when all the LOCA analyses are completed as part of a future licensing application. For clarity, the sentences in Sections 4.1.1.1.1 and 4.1.1.1.2, respectively, will be updated as follows:

> "During a LOCA, the Primary Decay Heat Removal System will actuate and contribute to the reduction of RCS pressure and temperature. Credit for this reduction in RCS pressure and

temperature in the LOCA analysis will be determined later and provided in a future licensing application.”

“During a LOCA, the Secondary Decay Heat Removal System will actuate and contribute to the reduction of RCS pressure and temperature. Credit for this reduction in RCS pressure and temperature in the LOCA analysis will be determined later and provided in a future licensing application.”

ii. Based on their frequency, non-LOCA events tend to be classified as anticipated operational occurrences (AOOs). It is unclear to the staff whether this is consistent with Section 4.1.1 which seems to imply the PCCS is only designed to mitigate design basis accidents. The staff requests the applicant to revise Section 4.1.1 and clarify whether the PCCS is designed for both AOOs and accidents and evaluate whether a more inclusive term such as "design basis events" is appropriate.

RESPONSE:

For safety analysis, consistent with Chapter 15 events, PCCS will be credited for anticipated operational occurrences (AOOs) and design basis accidents (DBAs). The first sentence in Section 4.1.1 of HI-2201064 will be updated as follows:

“The PCCS is designed to provide emergency core heat removal and makeup water during postulated Anticipated Operational Occurrences (AOOs) and Design Basis Accidents (DBAs).”

NONE-5

Licensing Topical Report (LTR) HI-2201064, " Elimination of the Large Break Loss of Coolant Accident (LOCA) and Establishment of LOCA Acceptance Criteria,” Section 7.1.13 states, “[t]hese passive systems [[
]]. [[Class 1E dc power is an onsite power system]] and is subject to appropriate regulations, such as 10 CFR 50, Appendix A, General Design Criteria 17 and 18. The staff requests the applicant to correct this contradictory statement in the LTR and clarify in the LTR what is meant by no reliance on [[
”]].

RESPONSE:

The PCCS is designed such that no single failure prevents the system from performing its safety function including loss of onsite or offsite ac electrical power, initiation logic, and single active or passive component failure. The valves are the only active components in the PCCS and are designed to actuate using Class 1E dc power (batteries). After the actuation, the valves do not require a subsequent change of state or continuous availability of power to maintain their intended safety functions.

The last sentence of the first paragraph in Section 7.1.13 of HI-2201064 will be updated as follows to clarify that reliance on AC electric power is not required:

> "These passive systems [[ ]] and the safety function of the passive systems can be accomplished with an assumed single failure."