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May 20, 2020

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Changes to Final Safety Analysis Report, Section 6.2, “Containment Systems,” Section 6.3, “Emergency Core Cooling System,” and Technical Report TR-0516-49084, “Containment Response Analysis Methodology Technical Report”

REFERENCES:

1. Nuclear Regulatory Commission, “Request for Additional Information No. 466 (eRAI No. 9482),” dated May 4, 2018 (ML18125A003)
2. NuScale Response to NRC “Request for Additional Information No. 466 (eRAI No. 9482),” dated June 29, 2018 (ML18180A420)
3. NuScale Response to NRC “Request for Additional Information No. 466 (eRAI No. 9482),” dated October 26, 2018 (ML18304A128)
4. NuScale Supplemental Response to NRC “Request for Additional Information No. 466 (eRAI No. 9482),” dated January 28, 2019 (ML19028A413)
5. NuScale Supplemental Response to NRC “Request for Additional Information No. 466 (eRAI No. 9482),” dated May 22, 2019 (ML19143A26)
6. NuScale Supplemental Response to NRC “Request for Additional Information No. 466 (eRAI No. 9482),” dated October 31, 2019 (ML19304B471)

During an April 1, 2020 public teleconference including containment branch reviewers from the NRC Staff, NuScale Power, LLC (NuScale) discussed potential updates to Final Safety Analysis Report (FSAR), Section 6.2, “Containment Systems,” Section 6.3, “Emergency Core Cooling System,” and Technical Report TR-0516-49084, “Containment Response Analysis Methodology Technical Report.” As a result of this discussion, NuScale revised these documents. The Enclosures to this letter provide mark-ups of the pages incorporating revisions to FSAR Section 6.2, FSAR Section 6.3, and TR-0516-49084 in redline/strikeout format. These markups reflect the impacts to these documents as a result of adding a new module protection system (MPS) emergency core cooling system (ECCS) actuation on low reactor coolant system pressure, and of reducing the MPS ECCS actuation high containment level to a range of 240 inches to 264 inches. NuScale will include these changes as part of a future revision to the NuScale Design Certification Application.

Enclosure 1 is the proprietary version of the revised pages for Technical Report TR-0516-49084, Draft Revision 3. NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 contains the nonproprietary version of the revised pages for Technical Report TR-0516-49084, Draft Revision 3. Enclosure 2 also includes the revised pages for FSAR Sections 6.2 and 6.3, which are nonproprietary.

This letter makes no regulatory commitments or revisions to any existing regulatory commitments.

If you have any questions, please feel free to contact Matthew Presson at 451-452-7531 or at mpresson@nuscalepower.com.

Sincerely,

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Enclosure 1: Changes to NuScale Technical Report TR-0516-49084, Draft Revision 3, proprietary version
Enclosure 2: Changes to NuScale Technical Report TR-0516-49084, Draft Revision 3 and Final Safety Analysis Report Sections 6.2 and 6.3, nonproprietary version
Enclosure 3: Affidavit of Zackary W. Rad, AF-0520-70200

Enclosure 1:

Changes to NuScale Technical Report TR-0516-49084, Draft Revision 3, proprietary version

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Enclosure 2:

Changes to NuScale Technical Report TR-0516-49084, Draft Revision 3 and Final Safety Analysis Report Sections 6.2 and 6.3, nonproprietary version

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range of 950 psi +/- 50 psi. The CNV pressure for this limiting case is reduced to below 50 percent of the peak value in less than 2 hours, demonstrating adequate NPM containment heat removal.

The limiting CNV pressure and temperature cases were evaluated considering the low RCS pressure ECCS actuation and ECCS valve opening on low differential pressure between the RPV and CNV (approximately 15 psid). The limiting CNV temperature and maximum pressure remain bounding. Non-limiting cases were evaluated considering these ECCS actuations and were found to remain non-limiting, however, the results for these events were not updated in this report.

Section 5.4 discusses margin in the NPM design that is not included in the CNV design pressure rating or modeled in the containment response analyses. Design factors conservatively not credited include atmospheric pressure acting against the CNV exterior surface and the availability of the decay heat removal system (DHRS).

The containment response analysis methodology demonstrates that the NPM design has adequate margin to design limits and that it satisfies the requirements of General Design Criteria (GDC) 16, 50, and Principal Design Criterion (PDC) 38.

- reactor protection system
- engineered safety feature controls

The NRELAP5 NuScale Power Module model from which LOCA runs are initiated is described in the LOCA Evaluation Model in detail (Reference 7.2.1, Section 5.3) and is summarized in this report. The objectives of the NRELAP5 loss-of-coolant accident model are to analyze the LOCA break spectrum for the NPM and to demonstrate compliance with 10 CFR 50 Appendix K.

Figure 3-1 is a simplified diagram of the nodalization selected to enable modeling of the phenomena that were determined to be important for the spectrum of LOCA scenarios. The LOCA primary system release scenarios start with the blowdown of the primary inventory through the pipe break into the CNV. The reactor trips on high CNV pressure, which causes a turbine trip along with main steam isolation and feedwater isolation. The primary system depressurizes as the CNV pressurizes, and the coolant inventory accumulates in the CNV. Steam released into the CNV condenses on the CNV inner surface that is cooled by conduction and convection to the reactor pool. When the ECCS actuation setpoint on high CNV level or low RCS pressure is reached,~~CNV level reaches the high level setpoint,~~ and the pressure drop across the ECCS valves is less than the inadvertent actuation block (IAB) release pressure, the ECCS valves open. Opening of the reactor vent valves (RVVs) increases the primary depressurization rate and completes equalization of primary and secondary pressures. Opening of the RRVs establishes a flowpath for the inventory in the CNV to flow by gravity into the RPV for core cooling. The flowpaths through the break plus the RVV, and the flowpath through the RRV provide abundant core cooling that is sufficient to keep the core covered by a two-phase mixture that prevents any heatup of the fuel rod cladding.

The NRELAP5 loss-of-coolant accident model includes the following additions to obtain a conservative LOCA analysis that meets the Appendix K requirements:

- conservative initial conditions at 102 percent of rated power level
- with or without loss of normal alternating current (AC) power
- high core power peaking factors
- break junction modeling for the various break locations
- Moody critical flow option
- ANS 1973 decay heat standard with 1.2 factor and actinides
- limiting single failure assumption

- ECCS actuation with conservative performance[1]
- conservative CNV modeling
- conservative reactor pool modeling
- conservative setpoints and actuation delays

The LOCA evaluation model nodalization and each of these conservative LOCA modeling elements are evaluated in Section 3.2.4.1 for use in the primary system release event containment response analysis methodology. The adequacy of the NRELAP5 code and the LOCA model for modeling the primary system M&E scenarios is addressed in Sections 4.1 and 4.2.

[1] ECCS actuates on high CNV level or loss of DC power to the valve actuators. ECCS also actuates on low RCS pressure with elevated containment pressure and sufficiently high RCS temperature conditions. The ECCS actuation on low RCS pressure was not addressed in the calculations in this report. However, the limiting cases were evaluated and determined not to be affected and nonlimiting cases were verified to remain nonlimiting.

The results of the LOCA scenario PIRT are directly applicable to the primary system M&E release and resultant CNV pressure and temperature response that are the focus of the containment response methodology. The basis for this statement is that “CNV pressure and temperature” is a figure-of-merit in the LOCA phenomena identification and ranking table. Therefore, the LOCA scenario PIRT is also considered to be the LOCA containment response analysis methodology PIRT.

3.3.1.2 Module Response

The typical response of the NPM to a primary system M&E release is characterized by a simultaneous depressurization of the primary system and pressurization of the CNV. The module response depends on the size of the break or valve opening, the location of the release as that determines if the release is steam or liquid or two-phase, and the timing of the M&E releases. The resulting high containment pressure signal causes an immediate actuation of the following safety features:

- containment isolation, including
  - closure of MSIVs
  - closure of FWIVs
  - closure of backup MSIVs (non-safety)
  - closure of FWRVs (non-safety)
- reactor trip
- turbine trip

Any steam that is released through the break or valve condenses on the cold inner surface of the CNV. Condensate and any unflashed break liquid accumulates into a pool on the bottom of the CNV. The primary system level decreases due to the break or valve flow. The ECCS actuates on the following conditions:

- high CNV level
- loss of normal AC power and the highly reliable DC power system
- low RCS pressure concurrent with an increase in containment pressure and sufficiently high RCS temperature (results for this signal not presented in this report but were determined not to impact limiting analyses)

The following design criteria govern RVVs and RRVs opening:

- If the pressure differential across the valves is greater than the IAB threshold when the ECCS signal actuates, then the valves stay closed until the pressure differential decreases to below the IAB release pressure
- If the pressure differential across the valves has decreased to below the IAB threshold pressure when the ECCS signal actuates, then the valves open and the IAB release pressure is not used. As discussed in FSAR Section 6.3.2.2, the threshold pressure for IAB operation to prevent spurious opening of the main ECCS valve is 1300 psid.

Parameter	Boundary Condition Assumption	Rationale
{{		
		}}2(a),(c)

Parameter	Boundary Condition Assumption	Rationale
{{		}}2(a),(c)

Note 1: ECCS also actuates on low RCS pressure with elevated containment pressure and sufficiently high RCS temperature conditions. This actuation was not addressed in the calculations in this report. However, the limiting cases were evaluated and determined not to be affected and nonlimiting cases were verified to remain nonlimiting.

3.5.3 Main Steam Line Break Initial Conditions

Initial conditions for the MSLB containment response analyses are selected to ensure a conservative CNV peak pressure and peak temperature result. The process of selecting the initial conditions is consistent with the guidance in DSRS Section 6.2.1.4. The selection process ensures that energy sources are maximized and energy sinks are minimized. Table 3-4 presents the primary system initial conditions used for primary system release containment response analyses. {{

}}2(a),(c) Table 3-5 presents the CNV and reactor pool initial conditions used by the LOCA containment response analyses that are also used by the MSLB containment response analyses. Table 3-7 presents the secondary system initial conditions used by the MSLB containment response analyses.

Parameter	Boundary Condition Assumption	Rationale
{{		
		}}2(a),(c)

Note 1: ECCS also actuates on low RCS pressure with elevated containment pressure and sufficiently high RCS temperature conditions. This actuation was not addressed in the calculations in this report. However, the limiting cases were evaluated and determined not to be affected and nonlimiting cases were verified to remain nonlimiting.

3.5.5 Feedwater Line Break Initial Conditions

Initial conditions for the FWLB mass and energy release analyses are selected to ensure a conservative CNV peak pressure and peak temperature result. The process of selecting the initial conditions is consistent with the guidance in DSRS Section 6.2, and DSRS Section 6.2.1.4 specifically. The selection process ensures that energy sources are maximized and energy sinks are minimized. Table 3-4 presents the primary system initial conditions used by the LOCA containment response analyses. {{

}}2(a),(c) Table 3-5 presents the CNV and reactor pool initial conditions used by the LOCA containment response analyses, and these initial conditions are also used by the FWLB containment response analyses. Table 3-7 presents the secondary system initial conditions used by the MSLB containment response analyses, and these initial conditions are also used by the FWLB containment response analyses.

3.5.6 Feedwater Line Break Boundary Conditions

Boundary conditions for the FWLB mass and energy release analyses are selected to ensure a conservative CNV peak pressure and peak temperature result. The process of selecting the boundary conditions is consistent with the guidance in DSRS Section 6.2, and specifically DSRS Section 6.2.1.4. The selection process ensures that energy sources are maximized and energy sinks are minimized. Section 3.4.4 and Table 3-8 presented the boundary conditions used by the MSLB containment response analyses, these boundary conditions are also used by the FWLB containment response analyses, with the exception of the single failure evaluation that is discussed below.

The largest break size is assumed to maximize the initial M&E release into the CNV. However, it is the subsequent second M&E release following ECCS actuation and opening of the three RVVs that results in the peak CNV pressure and temperature response. Also, opening of the RVVs depends on the pressure differential decreasing to below the IAB release pressure, and that may not occur until DHRS has been operating for some period

5.0 Results

5.1 Primary System Release Scenario Containment Response Analysis

This section presents the results of the NRELAP5 limiting analyses of the spectrum of primary system M&E release scenarios for the NPM, listed in Table 3-3, and secondary system break scenarios that are determined using the containment response analysis methodology presented earlier in this report. The case labels from Table 3-3 are used in the following discussion.

5.1.1 Analysis Approach

The approach to determine the limiting peak CNV pressure event from the the spectrum of primary mass and energy release scenarios for the NPM, listed in Table 3-3, and the limiting peak CNV temperature for each primary release event was as follows:

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}}2(a),(c)

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}}2(a),(c)

The threshold pressure for IAB operation to prevent spurious opening of the main ECCS valve is 1300 psid. Therefore, the IAB prevents the main valve from opening for all reactor pressures 1300 psid and greater, with respect to containment. Given an initial IAB block, the IAB releases at 950 psid +/- 50 psi once reactor pressure is reduced. The IAB does not prevent the main valve from opening for initial pressures of 900 psid and below.

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}}2(a),(c)

5.1.2 Base Case Analysis and Sensitivity Results

The following insights were obtained from the results of the NRELAP5 analyses of the five primary system M&E release cases and associated sensitivity studies.

- The peak CNV pressure scenario is the RRV release (Case 5). The RRV mass and energy release causes an initial heatup and pressurization of the CNV, and then ECCS actuation results in a second M&E release with all three RVVs and second RRV opening that pressurizes the CNV to the highest peak pressure.
- The peak CNV wall temperature scenario is the CVCS injection line LOCA (Case 2). The break in this location combines a high temperature liquid initial M&E release followed by a high temperature M&E release through all three RVVs following an ECCS actuation signal.
- The sensitivity parameters have only a small effect on the peak CNV pressure and temperature results of the limiting cases. No single failures had a significant impact on the results for the limiting cases. The loss of power sensitivity that results in early ECCS actuation, and the IAB release pressure sensitivity that affects the timing of the opening of the ECCS valves, were the more important sensitivity parameters.
- The value of the CNV level ECCS actuation setpoint did not impact limiting CNV pressure or temperature. The CNV level setpoint did have a minor impact on some non-limiting cases. The results for these non-limiting cases are representative of the CNV methodology but do not reflect final design values.

- The limiting pressure and temperature cases were evaluated considering the addition of ECCS actuation on low RCS pressure and the addition of riser holes. It was determined that the limiting peak CNV temperature and pressure remain bounding.
- The non-limiting cases were also re-evaluated with all ECCS actuation signals and addition of riser holes. There were no significant changes in the peak containment pressure and temperature results in the re-evaluated non-limiting cases.
- {{

}}2(a),(c)

5.1.3 Primary Release Scenario Pressure and Temperature Results

The initial conditions used by NRELAP5 analyses for each of the five cases in Table 3-4 are shown in Table 5-1. The initial condition values in the second column of Table 5-1 are the nominal values plus the uncertainty or conservative allowance in parentheses. The assumed parameter values are consistent with the methodology as discussed by Section 3.5.1 and maximize heat sources while minimizing heat sinks. The decay heat conservatively used by these analyses is 120 percent of the 1979 ANS standard rather than the methodology assumption (1979 ANS standard plus 2-sigma uncertainty). The 120 percent assumption bounds the required 2-sigma uncertainty required by the containment response analysis methodology (See Table 3-6).

Table 5-1 Initial conditions for primary system release event analyses

Parameter	**Conservative Containment Response Analysis Methodology Initial Condition**
{{	
	}}2(a),(c)

temperature case. Figure 5-16 shows the CNV pressure response for the RCS injection line LOCA peak wall temperature case. Figure 5-17 shows the CNV wall temperature response for the RCS injection line LOCA peak CNV wall temperature case and the overall limiting value of 526 degrees F. This limiting NRELAP5 is less than the CNV design temperature of 550 degrees F. This is a key result of this limiting containment wall temperature response analysis case.

Table 5-3 Case 2 sequence of events for limiting containment vessel temperature event - reactor coolant system injection line break loss-of-coolant accident

Peak CNV Pressure Case Time (sec)	**Event**	**Peak CNV Temperature Case Time (sec)**
0	LOCA in RCS injection line For peak pressure case: • Loss of normal AC power • FW/MS isolation • Reactor trip For peak temperature case: • Loss of normal AC power • FW/MS isolation	0
3	High CNV pressure resulting in For peak pressure case: • Containment isolation For peak temperature case: • Containment isolation • Reactor trip	3
364	ECCS actuation on For peak pressure case: • IAB release pressure For peak ~~pressure~~ temperature case: • high CNV level	952
367	ECCS valve opening	955
385	Peak CNV pressure reached: For peak pressure case: 959 psia For peak temperature case: 939 psia	967
384	Peak CNV temperature reached: For peak pressure case: 509 °F For peak temperature case: 526 °F	978
2200	CNV pressure decreases to <50% of peak pressure	~2500

- For the limiting cases the results of the sensitivity studies, including postulated single failures, showed only a limited impact (<1 percent) on the key figures-of-merit. The loss of normal AC and DC power and the timing of ECCS valve opening were the most important sensitivity parameters.

The limiting LOCA peak pressure and CNV wall temperature are a result of the reactor coolant system (RCS) injection line break. The LOCA limiting peak CNV wall temperature is approximately 526 degrees F and it results from a reactor coolant system injection line break case, with a loss of normal alternating current (AC) power. The LOCA limiting peak pressure is approximately 959 psia, which results from a reactor coolant system injection line break case, with a loss of normal AC and DC power. The LOCA event peak CNV pressure is below the CNV design pressure of 1050 psia. The LOCA peak CNV pressure and wall temperature bound the main steamline break (MSLB) and feedwater lind break (FWLB) results.

The overall limiting event for peak CNV pressure is approximately 994 psia, which is approximately 5 percent below the containment design pressure of 1050 psia. It results from an inadvertent reactor recirculation valve opening anticipated operational occurrence with a loss of normal AC and DC power considering an IAB release pressure range of 950 +/- 50 psia. The CNV pressure for this limiting case is reduced to below 50 percent of the peak value in less than 2 hours, demonstrating adequate NPM containment heat removal.

The limiting CNV pressure and temperature cases were evaluated considering the low RCS pressure ECCS actuation and ECCS valve opening on low differential pressure between the RPV and CNV (approximately 15 psid). The limiting CNV temperature and maximum pressure remain bounding. Non-limiting cases were evaluated considering these ECCS actuations and were found to remain non-limiting, however, the results for these events were not updated in this report.

Section 5.4 discussed margin in the NPM design that is not included in the CNV design pressure rating or modeled in the containment response analyses. Design factors conservatively not credited include static water pressure and the availability of the DHRS.

The containment response analysis demonstrates that the NPM design has adequate margin to design limits and that it satisfies the requriements of GDC 16 and 50 and PDC 38.

mass and energy releases are provided in Section 6.2.1.3, and secondary system mass and energy releases are provided in Section 6.2.1.4. Graphical results for the limiting CNV pressure, temperature, and mass and energy release rates are shown in Figure 6.2-9 through Figure 6.2-14. Table 6.2-7 and Table 6.2-8 provide the sequence of events for the CNV peak pressure and peak temperature cases, respectively.

In the event of a mass and energy release into CNV, a process of condensation and retention within the CNV facilitates the transfer of the energy to the UHS.

Reactor coolant released from the RPV or main steam or feedwater released from the secondary system condenses on the relatively cool inner surface of the CNV wall. The resulting condensate flows down the inner CNV wall and collects in the bottom of the CNV shell. The vapor condensation and heat removal from containment is accomplished passively by transferring the energy through the CNV wall to the reactor pool.

RAI 06.02.01.01.A-18, RAI 06.02.01.01.A-19

For releases from the RPV, the reactor coolant is condensed and collected until the condensate level within the CNV has increased to the ECCS actuation setpoint or when RCS pressure falls to the ECCS actuation setpoint. Actuation of the safety system opens the RVVs and RRVs, further depressurizing the RPV and increasing the discharge of RPV inventory to the CNV. When RPV and CNV pressures approach equilibrium and the accumulated level in the CNV shell reaches a level where sufficient driving head is available, coolant flow from the CNV is returned to the RPV through the ECCS recirculation valves for core cooling. Opening of the RVVs and RRVs establishes the CNV shell as the outer boundary of the coolant circulation flow path. This method of passive coolant circulation and heat removal is further described in Section 6.2.2.

For a secondary system mass and energy release into containment, the released steam or feedwater is captured within the CNV by closure of the CIVs. The collected inventory is condensed and retained with the heat energy transferred to the reactor pool.

The design of the CNV is consistent with the functional requirements of the ECCS and its associated acceptance criteria. Acceptable models for evaluating emergency core cooling during the postulated mass and energy releases are defined in 10 CFR 50 Appendix K.

The CNTS design provides for the isolation of process systems that penetrate the CNV. The design allows for the normal or emergency passage of fluids, vapor or gasses through the containment boundary while preserving the ability of the boundary to prevent or limit the escape of fission products in the event of postulated events. The containment isolation valves are described in Section 6.2.4.

The CNV components and appurtenances are designed to ensure pressure boundary integrity for the life of the plant when considering fatigue, corrosion and wear. The CNV components and penetrations (piping, electrical and

  - RCS injection line
  - RPV high point vent degasification line
- inadvertent RVV opening
- inadvertent RRV opening

The NuScale LOCA evaluation model divided the NPM LOCA scenarios into two phases for phenomena identification:

- LOCA blowdown phase (Phase 1a)
- ECCS recirculation (Phase 1b)

For primary system mass release events, the blowdown phase begins at break initiation or valve opening. Reactor coolant released into the containment volume pressurizes the containment volume and depressurizes the RPV. Pressurization of the containment and the decreased inventory within the RPV results in reactor trip and closure of the CIVs. The blowdown phase ends when the ECCS actuates the RVVs and the RRVs.

The ECCS actuation occurs as a result of any of the following conditions:

- high CNV level
- loss of normal AC power and the EDSS
- low RCS pressure

The RVVs and RRVs open under the following conditions:

- If the pressure differential across the valves is greater than the IAB threshold when the ECCS signal actuates, then the valves stay closed until the pressure differential decreases to below the IAB release pressure.
- If the pressure differential across the valves has decreased to below the IAB threshold pressure when the ECCS signal actuates, then the valves open at that time.
- If the pressure differential across the valves is less than the valve opening spring force (approximately 15 psid), the valves open even without an ECCS actuation signal.

Opening of the RVVs increases the depressurization rate, and the primary system and CNV pressures approach equalization. As the pressures equalize, the break and valve flow decreases. With pressure equalization and the increase in the CNV pool level, flow through the RRVs into the reactor vessel starts to provide long-term cooling (LTC) via recirculation. This terminates the reactor vessel level decrease prior to core uncovery. Heat transfer to the CNV wall and to the reactor pool eventually exceeds the energy addition from the break flow and the RVV flow. When this occurs, the period of peak containment pressure and temperature have been completed, and a gradual depressurization and cooling phase begins.

Sensitivity cases are performed to determine the effect of loss of power (AC or DC) scenarios, as well as postulated single failures, on the primary system mass and energy

During normal power operation (normal AC and DC power available), the primary system release scenarios start with the blowdown of the primary inventory through the pipe break or valve opening into the CNV. The reactor trips on high CNV pressure, and that causes a turbine trip along with main steam isolation and feedwater isolation. The primary system depressurizes as the CNV pressurizes, and the coolant inventory accumulates in the CNV. Steam released into the CNV condenses on the CNV inner surface that is cooled by conduction and convection to the reactor pool. When the CNV level reaches the high level setpoint or when RCS pressure falls to the ECCS actuation setpoint, the ECCS actuates. The ECCS valves subsequently open as described in Section 6.2.1.3.

The NRELAP5 primary release event model is developed from engineering information, drawings and associated reference documents to develop a thermal-hydraulic simulation model that calculates the mass and energy released from the RCS during blowdown.

The containment response analysis methodology assumes an initial power level of 1.02 times the licensed power level. The initial RCS volume and mass are consistent with that power level.

The mass and energy release determined by the containment response analysis methodology is based on the NRELAP5 computer code, and the modeling approach is very similar to the NuScale LOCA Evaluation Model that complies with the applicable portions of 10 CFR 50 Appendix K. Specific changes to the LOCA Evaluation Model required to model primary system mass release events are described by Reference 6.2-1. A discharge coefficient of 1.0 is applied to the applicable critical flow correlation. Reference 6.2-2 demonstrates the adequacy of the LOCA Evaluation Model two-phase and single phase choked and unchoked flow models for predictions of mass and energy release based on assessments of comparisons of NRELAP5 mass flow predictions to experimental data.

The containment response analysis methodology uses the heat transfer correlation package in the NRELAP5 computer code. The LOCA Evaluation Model report demonstrates these correlations are applicable to the NPM design (Reference 6.2-2).

6.2.1.3.4 Description of the Emergency Core Cooling System Recirculation Model

The containment response analysis methodology models the applicable phenomena that contribute to maximizing the mass and energy release into containment and the resulting pressure and temperature during the ECCS recirculation phase.

The methodology applied during the ECCS recirculation phase is the same as previously described for the blowdown phase.

Operation of the ECCS is further discussed in Section 6.3.

RAI 06.02.01.01.A-18, RAI 06.02.01.01.A-18S3, RAI 06.02.01.01.A-19

Table 6.2-2: Containment Response Analysis Results[3, 4]

Event Description	Case Description	CNV Pressure (psia)	CNV Wall Temperature (°F)
RCS Discharge Break	Base Case	705	492
RCS Discharge Break	Limiting Sensitivity Case Results	946~~3~~	521~~0~~
RCS Injection Line Break	Base Case	894	514
RCS Injection Line Break	Limiting Sensitivity Case Results	959	526[2]
RPV High Point Vent Degasification Line Break	Base Case	554	471
RPV High Point Vent Degasification Line Break	Limiting Sensitivity Case Results	901	492~~89~~
Inadvertent RVV Actuation	Base Case	856	483
Inadvertent RVV Actuation	Limiting Sensitivity Case Results	911	486
Inadvertent RRV Actuation	Base Case	941	492
Inadvertent RRV Actuation	Limiting Sensitivity Case Results	994[1]	515~~2~~
Main Steam Line Break	Limiting Results	449	433
Feedwater Line Break	Limiting Results	416	408

[1] Limiting NPM primary/secondary release event peak pressure, includes IAB operating range sensitivity.

[2] Limiting NPM primary/secondary release event peak temperature.

[3] Results reflected in this Table do not consider the impact of sensitivity studies performed to address a revised IAB operating range as discussed by Reference 6.2-1, Section 5.1.1, except as stated in Note 1 and Note 4.

[4] Limiting LOCA and inadvertent valve opening cases consider ECCS actuation on CNV level, RCS pressure or IAB release, accounting for staggered ECCS valve opening.

6.3 Emergency Core Cooling System

The emergency core cooling system (ECCS) provides core cooling during and after anticipated operational occurrences (AOOs) and postulated accidents, including loss-of-coolant accidents (LOCAs). The ECCS is an important NuScale Power Plant safety system in its safety-related response to LOCAs and as a component of both the reactor coolant and containment vessel (CNV) pressure boundaries. In conjunction with the containment heat removal function of containment, the ECCS provides core decay heat removal in the event of a loss of coolant that exceeds makeup capability.

The ECCS consists of three reactor vent valves (RVVs) mounted on the upper head of the reactor pressure vessel (RPV), two reactor recirculation valves (RRVs) mounted on the side of the RPV, and associated actuators located on the upper CNV as shown in Figure 6.3-1. All five valves are closed during normal plant operation and open to actuate the system during applicable accident conditions. The RVVs vent steam from the RPV into the CNV, where the steam condenses and liquid condensate collects in the bottom of the containment. The RRVs allow the accumulated coolant to reenter the RPV for recirculation and cooling of the reactor core. Placement of the RRV penetrations on the side of the RPV is such that when the system is actuated, the coolant level in the RPV is maintained above the core and the fuel remains covered. The cooling function of the ECCS is entirely passive, with heat conducted through the CNV wall to the reactor pool.

After actuation, the ECCS is a passive system that does not include long lengths of piping or holding tanks. The system is made up of the valves described above, which allow recirculation of the reactor coolant between the RPV and the CNV. The valves are maintained in the closed position during normal plant operation and receive an actuation signal upon predetermined event conditions (initiated by high containment level or low RCS pressure) to depressurize the RPV and allow flow of reactor coolant between the CNV and the RPV. In events that result in rapid equalization of pressure between the RCS and the CNV, such as an inadvertent RVV opening, the ECCS valves can open on low differential pressure without an ECCS actuation signal.

Reactor coolant inventory released during a LOCA event is collected and retained within the CNV which precludes the requirement to provide the makeup capacity necessary to replace coolant inventory lost to the core cooling function. The ECCS does not provide replacement or addition of inventory from an external source and does not provide a reactivity control function.

Facility design relies on passive design provisions that ensure sufficient coolant inventory is retained in the module to maintain the core covered and cooled. Makeup (addition) of reactor coolant inventory is not necessary or relied upon to protect against breaks. Reactor coolant inventory released from the reactor vessel during an in-containment unisolatable LOCA is collected and maintained within the CNV. After the ECCS valves open, the collected RCS inventory is returned to the reactor vessel by natural circulation. This return path to the vessel ensures that the core remains covered. The ECCS passively transfers water from containment to the RPV. It also transfers heat from the RCS to the reactor pool passively though the CNV wall. Actuating the ECCS ensures that the core remains covered and that RCS temperature and pressure are reduced for all design-basis losses of coolant.

Automatic actuation signals for the ECCS are provided from independent and redundant sensors. The ECCS is automatically actuated and requires no operator action during the first 72 hours following event initiation. ~~Applicable parameters with analytical limits~~ECCS actuation values are listed in Table 6.3-1.

The ESFAS uses four redundant sensors (channels) to monitor ECCS-associated actuation parameters (high CNV water level) processed through MPS separation groups. The separation groups supply signals to two independent divisions of ESFAS that use two-out-of-four voting so that a single failure of an initiation signal cannot prevent a valid actuation or initiate an invalid actuation.

The actuators for the ECCS solenoid valves and ECCS valve position indications are supplied with power by the highly reliable DC power system. This power may not necessarily be available during an accident, and valve closure is not required during an accident. Position indication cabling is qualified in accordance with IEEE 323-1974 for the design conditions (temperature, humidity, submergence, pressure, radiation) of containment.

The ECCS performance monitoring is accomplished with instrumentation provided by the MPS for RPV riser and CNV water level, temperature and pressure; reactor pool temperature and level; and, valve positions for the ECCS valves, actuators, and containment isolation valves.

The MPS monitors-wide range RCS cold temperature and wide range RCS pressure parameters that provide the signal to initiate LTOP (opening of the RVVs).

6.3.6 References

6.3-1 NuScale Power, LLC, "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422-P, Revision 1.

6.3-2 NuScale Power, LLC, "Long-Term Cooling Methodology," TR-0916-51299-P-A, Revision 2.

Table 6.3-1: Emergency Core Cooling System ~~Alarms and~~ Actuation Values

Parameter	~~Analytical Limit~~Value[1]
~~High CNV level alarm~~	~~N/A~~
High CNV level actuation	~~282~~252 inches above reactor pool floor
~~RPV low temperature & high pressure warning (LTOP) alarm~~	~~N/A~~
Low RCS pressure	800 psia
RPV low temperature & high pressure (LTOP) actuation	The LTOP pressure setpoint is a function of the RCS cold temperature (Refer to Table 5.2-10 and Figure 5.2-4).

Note 1: Additional information for ECCS actuation values is provided in Table 7.1-4.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0520-70200

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

(1) I am the Director of Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale

(2) I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:

(a) The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.

(b) The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.

(c) Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.

(e) The information requested to be withheld consists of patentable ideas.

(3) Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying Request for Additional Information response reveals distinguishing aspects about the method by which NuScale develops its containment response analysis.

NuScale has performed significant research and evaluation to develop a basis for this method and has invested significant resources, including the expenditure of a considerable sum of money.

The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

(4) The information sought to be withheld is in the enclosed response to NRC Request for Additional Information No. 466, eRAI 9482. The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.

(5) The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).

(6) Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:

(a) The information sought to be withheld is owned and has been held in confidence by NuScale.

(b) The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.

(c) The information is being transmitted to and received by the NRC in confidence.

(d) No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.

(e) Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 20, 2020.

Zackary W. Rad