November 22, 2024 Docket No. 52-050

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Responses to NRC Request for Additional Information No. 024 (RAI-10185 R1) on the NuScale Standard Design Approval Application

REFERENCE: NRC Letter to NuScale, “Request for Additional Information No. 024 (RAI-10185 R1),” dated May 10, 2024

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) responses to the referenced NRC Request for Additional Information (RAI).

The enclosures to this letter contain NuScale's responses to the following RAI questions from NRC RAI-10185 R1:

- 19.2-1
- 19.2-2
- 19.2-3
- 19.2-4

Enclosures 1, 3, 5, and 7 are the proprietary versions of the NuScale responses to NRC RAI No. 024 (RAI-10185 R1, Questions 19.2-1, 19.2-2, 19.2-3, and 19.2-4). 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 9) supports this request. Enclosures 1, 3, 5, and 7 have also been determined to contain Export Controlled Information. This information must be protected from disclosure per the requirement of 10 CFR § 810. Enclosures 2, 4, 6, and 8 are the nonproprietary versions of the NuScale responses.

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

If you have any questions, please contact Amanda Bode at 541-452-7971 or at abode@nuscalepower.com.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 22, 2024.

Sincerely,

Mark W. Shaver

Mark W. Shaver
Director, Regulatory Affairs
NuScale Power, LLC

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Enclosure 1: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-1, Proprietary
Enclosure 2: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-1, Nonproprietary
Enclosure 3: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-2, Proprietary
Enclosure 4: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-2, Nonproprietary
Enclosure 5: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-3, Proprietary
Enclosure 6: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-3, Nonproprietary
Enclosure 7: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-4, Proprietary
Enclosure 8: NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-4, Nonproprietary
Enclosure 9: Affidavit of Mark W. Shaver, AF-176034

Enclosure 1:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-1, Proprietary

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Enclosure 2:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-1, Nonproprietary

Response to Request for Additional Information
Docket: 052000050

RAI No.: 10185
Date of RAI Issue: 05/10/2024

NRC Question No.: 19.2-1

Regulatory Basis:

• 10 CFR 52.137(a)(2) requires a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification, upon which the requirements have been established, and the evaluations required to show that safety functions will be accomplished.

• 10 CFR 52.137(a)(4) requires analysis and evaluation of the design and performance of SSC with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.

• 10 CFR 52.137(a)(9) requires, for applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.

• 10 CFR 52.137(a)(12) requires an analysis and description of the equipment and systems for combustible gas control as required by § 50.44 of this chapter.

• 10 CFR 52.137(a)(23) a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass.

• 10 CFR 52.137(b) requires, in part, an application for approval of a standard design, which differs significantly from the light-water reactor designs of plants that have been licensed and in commercial operation before April 18, 1989, or uses simplified, inherent, passive, or other innovative means to accomplish its safety functions, must meet the requirements of 10 CFR 50.43(e), as identified below.

• 10 CFR 50.43, “Additional standards and provisions affecting class 103 licenses and certifications for commercial power,” states, in part, the following:

(e) Applications for a design certification, combined license, manufacturing license, or operating license that propose nuclear reactor designs which differ significantly from light- water reactor designs that were licensed before 1997, or use simplified, inherent, passive, or other innovative means to accomplish their safety functions, will be approved only if:

(1)(i) The performance of each safety feature of the design has been demonstrated through either analysis, appropriate test programs, experience, or a combination thereof;

(ii) Interdependent effects among the safety features of the design are acceptable, as demonstrated by analysis, appropriate test programs, experience, or a combination thereof; and

(iii) Sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions

• 10 CFR 50.44(c) Requirements for future water-cooled reactor applicants and licensees.The requirements in this paragraph apply to all water-cooled reactor construction permits or operating licenses under this part, and to all water-cooled reactor design approvals, design certifications, combined licenses or manufacturing licenses under part 52 of this chapter, any of which are issued after October 16, 2003.

(1) Mixed atmosphere. All containments must have a capability for ensuring a mixed atmosphere during design-basis and significant beyond design-basis accidents.

(2) Combustible gas control. All containments must have an inerted atmosphere, or must limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, uniformly distributed, to less than 10 percent (by volume) and maintain containment structural integrity and appropriate accident mitigating features.

(3) Equipment Survivability. Containments that do not rely upon an inerted atmosphere to control combustible gases must be able to establish and maintain safe shutdown and containment structural integrity with systems and components capable of performing their

functions during and after exposure to the environmental conditions created by the burning of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur. The amount of hydrogen to be considered must be equivalent to that generated from a fuel clad-coolant reaction involving 100 percent of the fuel cladding surrounding the active fuel region.

(4) Monitoring. (i) and (ii) Equipment must be provided for monitoring oxygen in containments that use an inerted atmosphere for combustible gas control. Equipment for monitoring oxygen and hydrogen must be functional, reliable, and capable of continuously measuring the concentration of oxygen in the containment atmosphere following a significant beyond design-basis accident for combustible gas control and accident management, including emergency planning.

(5) Structural analysis. An applicant must perform an analysis that demonstrates containment structural integrity. This demonstration must use an analytical technique that is accepted by the NRC and include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved. The analysis must address an accident that releases hydrogen generated from 100 percent fuel clad-coolant reaction accompanied by hydrogen burning. Systems necessary to ensure containment integrity must also be demonstrated to perform their function under these conditions.

• 10 CFR 50.12, “Specific exemptions,” Section (a). The Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of the regulations of this part, which are —

(1) Authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security.

(2) The Commission will not consider granting an exemption unless special circumstances are present

• 10 CFR Part 50, Appendix A, General Design Criteria

Criterion 1—Quality standards and records. Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

Criterion 4—Environmental and dynamic effects design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

Criterion 41—Containment atmosphere cleanup. Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure.

• Criterion 42—Inspection of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components,to assure the integrity and capability of the systems.

• Criterion 43—Testing of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural integrity of its components, (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation.

Issue:

A primary post-accident safety function is to protect the containment integrity. The passive autocatalytic recombiner (PAR) is a new design component that was not included in the US600 DCA design. The NuScale US460 SDAA design credits a single PAR for preventing a combustible mixture in the containment vessel (CNV) for design-basis events (DBEs), including anticipated operational occurrences (AOOs) that are expected to occur at least once in the lifetime of the plant, and during a severe accident (SA). The PAR is the basis for SDAA, Part 7, Section 2 (ML23304A389), which requests an exemption to 10 CFR 50.44(c)(4) for hydrogen and oxygen monitoring in the containment and is a new exemption request compared to the DCA. NuScale's analysis demonstrates that {{

}}[2(a),(c),ECI] Based on its analysis on the presence and treatment of combustible gas in the RCS in {{ }}[2(a),(c),ECI], which includes an evaluation of the scenario described above, NuScale concludes, {{

}}[2(a),(c),ECI] (emphasis added).

To perform its function unimpaired during DBEs, including AOOs, and SAs, the single PAR must be designed to withstand the normal operating environment of 60 years and the post-accident environment. The operational environment for the PAR in the US460 design during normal operations, and DBE and SA conditions is markedly different from that in operating reactors. As an example, for normal operation, the PAR needs to survive the high radiation environment of both neutrons and gammas to which it is exposed, which is different from operating reactors where PARs are usually located outside the bioshield and not exposed to neutron radiation. The main impacts of neutron irradiation would be PAR material embrittlement and activation. As such, qualification testing is needed to demonstrate the integrity of the PAR after 60 years of neutron and gamma irradiation or to inform an appropriate PAR life cycle management strategy. As another example, the PAR in the US460 design will be exposed to jet impingement forces as well as mechanical loads due to the mass and energy release to the CNV during the DBE and severe accidents, which is different from operating reactors. Qualification testing or a combination of testing and analysis would address these jet impingement loads. Post accident, the PAR must function during and after beta and gamma irradiation dose for 30 days.

NuScale has proposed to address the lack of the PAR design envelope, and qualification testing and analysis information in the FSAR by using the equipment survivability (ES) approach for the SDAA, including reliance on SDAA combined license (COL) Items 3.11-1 through 3.11-3, and COL Item 19.1-8. The ES approach addresses the SA dose only and does not address the unique PAR exposure to 60 years of neutron irradiation, dynamic effects such as jet impingement on the PAR, the effect of mechanical loads on the PAR during the mass and energy release phase, nor a post-accident environment of 30 days as stipulated for the harsh environment in the CNV. NuScale's ES approach as described in FSAR chapter 19.2.3 is to compare the equipment qualification (EQ) doses with the severe accident doses. Another consideration is the potential for boron deposition as the CNV is repeatedly filled with borated water during refueling. None of the existing COL Items in Section 3.11 of the FSAR reflect or include the PAR design specifications or necessary qualification testing and analysis. COL Item 19.1-8, which requires to confirm that the key assumptions used in the PRA are reflected in the as-built, as-operated PRA, does not apply to the PAR because the PAR is currently not modeled in the probabilistic risk assessment (PRA). NuScale also states that procured equipment must meet its internal design requirements, citing its Quality Assurance Program Description (QAPD). The NRC staff's review determined that the QAPD applies to safety-related structures, systems, and components (SSCs) and three specific non-safety-related SSCs. The scope of the QAPD does not include the PAR.

While NuScale cites Regulatory Guide 1.7, "Control of Combustible Gas in Containment," Revision 3, as providing the augmented quality requirements for the PAR, the RG does not include any specificity on these requirements (e.g., codes and standards, qualification testing, analysis, etc.). An example of the specificity needed can be found in Table B-2 of the Technical Report, "Treatment of DC Power in Safety Analyses," for the DC power system (EDAS).

The Statement of Considerations for 10 CFR Part 52 (72FR49352) state that the information for the SDA needs to be equivalent to that for a DCA and that the information for a DCA "…must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, and procurement specifications and construction and installation specifications by an applicant." The FSAR does not include information on the PAR consistent with the requirements in 10 CFR 52.137 (a)(2), (a)(4), and (a)(12). Specifically, the FSAR is lacking information about: (i) the design envelope for parameters that are key to achieving the functionality of the PAR during DBEs, including AOOs and SAs, including the 60-year neutron dose during normal operations, mechanical loads, dynamic effects from jet impingement, pressure, temperature, and humidity, and (ii) the qualification testing and analysis necessary to demonstrate that the key parameters, and consequently, PAR functionality are achieved. The current FSAR only points to the existence of a PAR, which is insufficient for the NRC staff to make a safety finding not only for the PAR in Sections 6.2.5, 19.2.3, and the exemption in SDAA, Part 7, Section 2, but also for other safety-related SSCs (e.g., CNV, emergency core cooling system (ECCS)). This is necessary because NuScale's analysis demonstrates that the PAR is needed to maintain the containment inert during DBEs, including AOOs. The current FSAR information is also insufficient for the staff to ensure that a COL applicant demonstrates that PAR functionality is achieved via qualification testing and analysis.

Information Requested:

NuScale is requested to provide SDA FSAR markups that provide:

1. The values or range of values for parameters that are key to assuring the functionality of the PAR during normal operations, DBEs, and SAs, including the 60-year neutron dose, temperature, pressure, humidity, mechanical loads, seismic categorization, and dynamic effects from jet impingement.

2. The technical basis for the selected values or range of values provided in item (1).

3. A new COL item or amendment to an existing COL item to demonstrate that the values or range of values for key parameters provided in item (1) are achieved through qualification testing and analysis.

4. Add the PAR to the scope of the QAPD, which is found in the topical report MN-122626, revision 1, “NuScale Power LLC, Quality Assurance Program Description.”

5. Confirm that the PAR is included in the FSAR Table 3.11-1, “List of EQ Equipment Located in Harsh Environments.” Justify any changes to the inclusion of the PAR in Table 3.11-1.

NuScale Response:

On September 12, 2024, NuScale and the Nuclear Regulatory Commission staff held a clarification call about NuScale’s response to Request for Additional Information 19.2-1. As a result, NuScale is including the remaining licensing basis changes to reflect conformance with 10 CFR 50.44(d), including a revision to Exemption 2. NuScale is also providing justification that 10 CFR 50.44(c) is not applicable to the US460 standard design. Additionally, NuScale is addressing conformance with Regulatory Guide 1.7, Control of Combustible Gas Concentrations in Containment. These items are addressed in the body of the response.

On September 20, 2024, the staff provided additional feedback to NuScale. In response, NuScale is providing a statement on the normal operating environment for the passive autocatalytic recombiner (PAR), providing additional justification of design consideration for jet impingement loads, providing a statement addressing the development of a design specification per the applicable requirements of American Society of Mechanical Engineers (ASME) AG-1, and revising Standard Design Approval Application Part 8 to include specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) to verify environmental qualification of the PAR. These items are addressed in the feedback portion of the response located at the end of this response.

Regulatory Basis

NuScale does not consider 10 CFR 50.43(e) relevant to the PAR. While the language of the rule broadly refers to "each safety feature" as requiring demonstration of performance, the Statements of Consideration adopting the rule make clear that the Commission was only referring to demonstrating "the performance of new or innovative safety features" (72 FR 49369). While the PAR is a safety feature in the US460 design, it is not new or innovative. Regulation 10 CFR 50.44, General Design Criterion 41, and other general design criteria are relevant to the PAR.

Items 1 and 2

The PAR is located in the upper containment vessel (CNV) (i.e., zone CNV-4 or CNV-5 as described in Final Safety Analysis Report (FSAR) Appendix 3C). The CNV operates at a partial vacuum during normal operation, maintained by the containment evacuation system. Final Safety Analysis Report Section 9.3.6 discusses the containment evacuation system, including that it maintains the CNV below the specified maximum operating pressure by removing water vapor and non-condensible gases. The partial vacuum limits potential convective heat transfer and relative humidity to the PAR. Appendix 3C Table 3C-6, Normal Operating Environmental Conditions, provides normal operating environmental conditions for these zones, including the 60-year integrated neutron dose, the 60-year integrated gamma dose, the temperature, the relative humidity, and the pressure. Appendix 3C Table 3C-7, Design Basis Event Environmental Conditions, provides environmental conditions for all design-basis events in Zones CNV-4 and CNV-5, including pressure (1015 psig) and relative humidity (100 percent). Appendix 3C Table 3C-8, Limiting Design Basis Accident EQ Radiation Dose, provides the integrated doses following a design-basis event for these zones. For Zones CNV-4 and CNV-5, the integrated doses 720 hours after a design-basis event are 3.4E+06 rads for integrated beta, and 4.2E+06 rads for integrated gamma.

The limiting pressure and temperature conditions applicable to the PAR are the peak containment pressure and temperature values of 937 psia and 533 degrees Fahrenheit, which are described in FSAR Table 6.2-3, Containment Response Analysis Results. Notwithstanding, the PAR is designed for CNV design pressure and design temperature, which are described in FSAR Table 6.2-1, Containment Design and Operating Parameters. Due to the nature of the

US460 design, the CNV will reach saturated conditions during design-basis events in which the emergency core cooling system is actuated. {{

}}2(a),(c),ECI The PAR is classified as a Seismic Category I component and thus maintains its function during a safe-shutdown earthquake event as described in FSAR Section 3.2.1.1.

The PAR is located in the upper CNV and is designed to withstand applicable dynamic loads from the reactor vent valves (RVVs) and the reactor safety valves (RSVs). The PAR design conforms with General Design Criterion 4, as described in FSAR Section 6.2.5, Combustible Gas Control in the Containment Vessel. {{

}}2(a),(c),ECI

As stated in FSAR Section 6.2.5.1, Design Bases, “The PAR is designed in accordance with the relevant requirements of ASME AG-1..., Section GE,” which includes analysis of dynamic loads such as jet impingement. Final placement of the PAR in the CNV will thus need to consider proximity to the RVVs and RSVs in this analysis of dynamic loads. Therefore, the PAR is protected from the dynamic effects of jet impingement. Conformance to ASME AG-1 Section GE also requires preparation of a design specification. Section GE-4110, Design Specification, states: “A design specification of the individual components shall be prepared, by the Owner or designee, in sufficient detail to provide a complete basis for equipment design in accordance with this Code.”

The NuScale Probabilistic Risk Assessment does not credit the PAR for mitigation of a severe accident. Notwithstanding, FSAR Section 19.2.3.3.8, Equipment Survivability, describes how equipment required to mitigate severe accidents is evaluated to perform its intended severe accident functions. Table 19.2-8, Equipment Survivability List, identifies the PAR for its function of combustible gas control.

Item 3

The PAR is in the scope of the Environmental Qualification Program, shown on the attached FSAR markups. Additionally, the PAR is being added to the scope of ITAAC. Specifically, the

PAR is within the scope of three ITAAC: the PAR is inspected to verify its physical arrangement and installation, the PAR is analyzed, tested, or a combination of analysis and testing is performed to verify it performs its function of recombining hydrogen and oxygen at the minimum recombination rate, and the PAR is included in the scope of equipment qualification ITAAC.

Because the ITAAC are sufficient to demonstrate equipment function and qualification for the PAR's operating environment, a new COL item is not being added to the Standard Design Approval Application.

Item 4

As a safety-related component, the PAR is within the scope of the Quality Assurance Program .

Item 5

Table 3.11-1 of the FSAR includes the PAR in the Environmental Qualification Program.

Based on the feedback from the staff described at the beginning of this response, NuScale is providing the following additional information:

Applicability of 10 CFR 50.44(c

The requirements of 10 CFR 50.44(c) are not applicable to the US460 standard design. Prior to the US600 design certification, the NRC staff concluded 50.44(c) was applicable to the NuScale small modular reactor design because, "the NuScale fuel design is expected to be a standard enriched uranium dioxide (UO2) fuel with zircaloy cladding at half the standard height which would have a potential for the production of combustible gases comparable to that of previously-licensed LWR [light water reactor] designs." This opinion refers to 10 CFR 50.44, Footnote 2, which states that "The requirements of [Paragraph (c)] apply only to water-cooled reactor designs with characteristics (e.g., type and quantity of cladding materials) such that the potential for production of combustible gases is comparable to light water reactor designs licensed as of October 16, 2003." In the sense that the NuScale Power Module (NPM) uses a zirconium alloy cladding, it is true that the NPM has the potential for producing amounts of hydrogen comparable to traditional LWRs. However, with respect to combustible gas control, the extent of similarity between the US460 standard design and traditional LWRs ends there.

The "potential for production of combustible gases" should consider other aspects of the design. The potential events, limiting events, and potential for accumulation of combustible gases is different than traditional light water reactors. Importantly, the NPM is an oxygen-limited design. Thus, while it has the potential of producing relatively large amounts of hydrogen in core damage events as noted by the staff's opinion, the NPM is not capable of producing the necessary amounts of oxygen early in those same severe accidents to yield a combustible containment atmosphere. As a result, non-core damage events, via the production of oxygen through radiolysis, are more limiting with respect to the potential for producing a combustible environment.

The following design features make the US460 standard design unique with respect to combustible gas control:

- A small containment volume that is significantly occupied by the reactor pressure vessel
- A normally evacuated containment with insignificant quantities of oxygen
- A fast-cooling emergency core cooling system that blows down steam into the containment vessel

Due to these design features, relatively cold and low pressure conditions are necessary to have an appreciable oxygen concentration in the containment atmosphere. The design maintains its oxygen-limiting condition, so the introduction of hydrogen and other gas species (e.g., steam) helps maintain an inert containment atmosphere during the course of an event. Due to the small containment size, oxygen production through radiolysis can lead to developing a combustible environment within the time period for design-basis events without the PAR. These characteristics highlight the unique attributes and potential for production of combustible gases in the US460 standard design.

Prior to the 2003 rulemaking, 10 CFR 50.44 provided requirements to control combustible gases during design-basis accidents. The design-basis loss-of-coolant accident (LOCA) was treated as the limiting event due to the potential for production of hydrogen from cladding oxidation. Light water reactors were required to provide safety-related means of controlling that hydrogen to prevent uncontrolled recombination (or demonstrate combustion could be withstood), which was generally in the form of safety-related hydrogen recombiners. Separate requirements in 10 CFR 50.34(f) addressed hydrogen control for severe accidents, which could be satisfied using nonsafety-related features such as igniters. The 2003 rulemaking was a risk-informed initiative that set out to, *inter alia*, "eliminate the requirements to control combustible gas concentration resulting from a postulated LOCA" because "this type of accident is not risk significant," and instead "specify in the regulation a specific combustible gas source term…for a severe accident"

(SECY-00-0198, page 7). As stated in the Federal Register Notice (68 FR 54123), revising 10 CFR 50.44:

> *The result of these studies has been an improved understanding of combustible gas behavior during severe accidents and confirmation that the hydrogen release postulated from a design-basis LOCA was not risk-significant because it was not large enough to lead to early containment failure, and that the risk associated with hydrogen combustion was from beyond design-basis (e.g., severe) accidents.*

Thus, when requirements similar to those in 50.44(b) are applied to future LWRs in 50.44(c), the "potential for production of combustible gases" must be viewed in light of the rulemaking's basis and purpose. That is, the potential for production of combustible gases in traditional LWRs is such that (1) combustible gas loads during design basis events (up to and including LOCA conditions) are not large enough to lead to early containment failure, and (2) combustible gas loads during severe accidents could potentially lead to early containment failure. The potential for production of combustible gases in the US460 NPM is different: design-basis events can produce enough oxygen to yield a combustible atmosphere while severe accidents produce too much hydrogen and steam to be combustible for a substantial length of time after the event.

Therefore, for the US460 standard plant design, it is appropriate to address combustible gas control under 10 CFR 50.44(d). That requirement ensures the safety impacts of combustible gases during both design-basis and severe accidents are considered and addressed.

Conformance with Regulatory Guide 1.7

Final Safety Analysis Report Table 1.9-2, Conformance with Regulatory Guides, describes the design's partial conformity with Regulatory Guide 1.7, including each of the regulatory positions. A detailed discussion on each regulatory position follows.

<u>Regulatory Position C.1, Combustible Gas Control Systems</u>

As stated in Table 1.9-2, "The design and quality standards applied to the PAR are commensurate with its safety-related, non-risk-significant function in the NuScale design, rather than the non-safety-related, risk-significant function underlying regulatory position C.1." As described in FSAR Section 19.2.3.3.8, Equipment Survivability, the PAR is evaluated for equipment survivability for the function of combustible gas control. This evaluation demonstrates the PAR is designed to provide reasonable assurance that it will operate in the severe accident environment for which it is intended, over the time span for which it is needed, consistent with SECY-93-087.

Regulatory Position C.2.1, Hydrogen Monitors, and Regulatory Position C.2.2, Oxygen Monitors

As stated in Table 1.9-2, “the design deviates from the positions on hydrogen and oxygen monitors. The design includes a passive autocatalytic recombiner (PAR) that is sized to limit oxygen concentrations to a level that does not support combustion (i.e., less than 4 percent), maintaining an inert containment atmosphere.” The US460 Standard Design Approval Application complies with 10 CFR 50.44(d), which does not prescribe the hydrogen and oxygen monitors addressed by these regulatory positions. However, the design supports an exemption to 10 CFR 50.34(f)(2)(xvii)(C), which requires the capability for monitoring combustible gases during an accident for the same underlying purpose.

Regulatory Position C.3, Atmosphere Mixing Systems

As described in FSAR Section 6.2.5.1, Design Bases, the design of the NPM ensures a mixed containment atmosphere through passive means:

- Temperature differences between the surfaces in the reactor pressure vessel and CNV create natural circulation mixing forces in containment.
- The CNV does not include sub-compartments where combustible gases could accumulate.
- The turbulent nature of events associated with reactor coolant system discharge to the CNV (e.g., a loss-of-coolant accident or inadvertent emergency core cooling system actuation) provides flow mixing effects.

Regulatory Position C.4, Hydrogen Gas Production

Materials of the CNV and structures, systems, and components within the CNV are selected to limit the production of hydrogen gas by corrosion, as stated in FSAR Section 6.1.1.2, Composition and Compatibility of Core Cooling Coolants: “No materials, paint, or coatings in the CNV contribute to corrosion-related hydrogen production...” Section 6.3, Emergency Core Cooling System, states that “[s]tainless steel fabricated or stainless steel clad form containment and components within containment, which precludes the production of corrosion components.”

Regulatory Position C.5, Containment Structural Integrity

As described in FSAR Section 6.2.1.1, Containment Structure, “The CNV is an American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Class MC (steel) containment whose design, analysis, fabrication, inspection, testing, and stamping conform to ASME BPVC Class 1 pressure vessel requirements in accordance with Section III, Subsection NB as permitted by NCA-2134(c).” As listed in FSAR Table 6.2-1, Containment Design and Operating Parameters, the internal design pressure of the CNV is 1200 psia, which exceeds the design-basis containment peak pressure by greater than 10 percent, as described in FSAR Section 6.2.1.1.3, Design Evaluation.

Combustible Gas Monitoring Exemption Request

NuScale has revised Standard Design Approval Application Part 7, Exemption 2, Combustible Gas Monitoring, to remove the request for an exemption to 10 CFR 50.44(c)(4). The request for an exemption to 10 CFR 50.34(f)(2)(xvii)(C) remains.

Additional Information:

The Standard Design Approval Application has been revised as described in the response above and as shown in the markup provided in this response.

Audit Question A-3.5.1.3-2, Audit Question A-3.7.3-3, Audit Question A-3.11.2.3-1, Audit Question A-5.2.3.4.2-1, Audit Question A-6.1.1-2, Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.1-4, Audit Question DWO-SC-26, Audit Question EDAS Deep Dive Action Item 1, Audit Question EDAS Deep Dive Action Item 3, Audit Question EDAS Deep Dive Action Item 4, Audit Question EDAS Deep Dive Action Item 5, Audit Question EDAS Deep Dive Action Item 6, Audit Question EDAS Deep Dive Action Item 9, Audit Question EDAS Deep Dive Action Item 11, Audit Question EDAS Deep Dive Action Item 14
RAI 5.4.1.6.1-1, RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-2: Conformance with Regulatory Guides

RG	Title	Rev.	Conformance Status	Comments	Section
1.6	Safety Guide 6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	0	Not Applicable	The onsite electrical AC power systems do not contain Class 1E distribution systems.	Not Applicable
1.7	Control of Combustible Gas Concentrations in Containment	3	Partially Conforms	The design complies with the intent of RG 1.7 regulatory positions that address atmosphere mixing, hydrogen gas production, and containment structural integrity. However, the design deviates from the positions on hydrogen and oxygen monitors. The design includes a passive autocatalytic recombiner (PAR) that is sized to limit oxygen concentrations to a level that does not support combustion (i.e., less than ~~four~~4 percent), ~~this results in~~maintaining an inert containment atmosphere. The design and quality standards applied to the PAR are commensurate with its safety-related, non-risk-significant function in the NuScale design, rather than the non-safety-related, risk-significant function underlying regulatory position C.1. The NuScale design does not include combustible gas monitoring~~supports an exemption to 10 CFR 50.44(c)(4)~~.	6.2.5
1.8	Qualification and Training of Personnel for Nuclear Power Plants	4	Not Applicable	This guidance governs site-specific programmatic and operational activities that are the responsibility of the applicant or licensee.	Not Applicable
1.9	Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants	4	Not Applicable	The NuScale design does not require or include safety-related emergency diesel generators.	Not Applicable
1.11	Instrument Lines Penetrating the Primary Reactor Containment	1	Not Applicable	No instrument lines penetrate the NuScale Power Module (NPM) containment.	Not Applicable

Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.2-2
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
SRP 1.0, Rev 2: Introduction and Interfaces	II.1	No Specific Acceptance Criteria	Not Applicable	No Specific Acceptance Criteria.	Not Applicable
SRP 1.0, Rev 2: Introduction and Interfaces	II.2	SRP Acceptance Criteria Associated with Each Referenced SRP section	Conforms	None.	Ch 1
SRP 1.0, Rev 2: Introduction and Interfaces	II.3	Performance of New Safety Features and Design Qualification Testing Requirements	Conforms	None.	Ch 1
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.1	Specific SRP Acceptance Criteria Contained in Related SRP Chapter 2 or Other Referenced SRP sections	Conforms	This acceptance criterion is a pointer to other SRP sections.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.2	COL Application Referencing an Early Site Permit but not a Certified Design	Not Applicable	This acceptance criterion is for COL applicants referencing an ESP.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.3	COL Application Referencing a Certified Design but not an Early Site Permit	Not Applicable	This acceptance criterion is for COL applicants that reference a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.4	COL Application Referencing an Early Site Permit and a Certified Design	Not Applicable	This acceptance criterion is for COL applicants that are referencing both an ESP and a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.5	COL Application Referencing Neither an Early Site Permit Nor a Certified Design	Not Applicable	This acceptance criterion is applicable to COL applicants that do not reference either an ESP or a certified design.	Not Applicable
SRP 2.1.1, Rev 3: Site Location and Description	All	Specification of Location and Site Area Map	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.2, Rev 3: Exclusion Area Authority and Control	All	Establishment of Authority, Exclusion or Removal of Personnel and Property, and Proposed and Permitted Activities	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.3, Rev 3: Population Distribution	All	Population Data, Exclusion Area, Low-Population Zone, Nearest Population Center Boundary, and Population Density	Not Applicable	Site-specific.	Not Applicable

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.4, Rev 0: Containment Isolation System	II.16	Specific Design Criteria for Containment Isolation Components	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.17	Provisions to Allow Control Room Operator Actions	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.18	Operability and Leakage Rate Testing	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.19	Reopening of Containment Isolation Valves	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.20	Station Blackout	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.21	Source Term in Radiological Calculations	Conforms	None.	6.2.4
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.1	Analysis of Hydrogen and Oxygen Concentration Control and Distribution in Containment	Partially Conforms	The containment atmosphere is maintained inert by the PAR, therefore the design safely accommodates hydrogen generated by an equivalent of a 100 percent~~%~~ fuel clad-coolant reaction without limiting containment hydrogen concentration to less than 10 percent~~%~~ by volume.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.2	Equipment Survivability and Containment Structural Integrity	Partially Conforms	The design satisfies 10 CFR 50.44(d)~~(c)(3)~~ by maintaining an inert atmosphere~~,~~ during design-basis and significant beyond design-basis accidents. T~~t~~herefore the environmental conditions created by hydrogen combustion are not considered.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.3	Ensuring a Mixed Atmosphere	Conforms	None.	6.2.5

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.4	Design Requirements of GDC 41	Partially Conforms	The design supports an exemption from the power provisions of GDC 41. As described in Section 3.1.4, the design complies with a NuScale-specific PDC in lieu of this GDC. Performance tests are performed on the PAR. The NuScale design does not include combustible gas monitors.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.5	Inspection and Test Requirements of GDC 41, GDC 42, and GDC 43	Partially Conforms	The design includes a PAR subject to inspection and testing. The test and inspection of containment components are addressed in FSAR Section 6.2.5. The design does not include combustible gas monitoring.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.6	Containment Structural Integrity Analysis	Partially Conforms	The design includes a PAR that maintains an inert containment atmosphere and precludes hydrogen combustion. A beyond-design-basis containment structural evaluation considers an amount of hydrogen exceeding that generated by 100 percent fuel clad-coolant reaction; the containment remains below design pressure.	6.2.5
DSRS 6.2.6, Rev 0: Containment Leakage Testing	All	Various	Partially Conforms	The design supports an exemption from the containment leakage rate testing at design pressure requirements of GDC 52 and Type A test requirements of 10 CFR 50 Appendix J.	6.2.6
SRP 6.2.7, Rev 1: Fracture Prevention of Containment Pressure Boundary	All	Various	Conforms	None.	6.2.7
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.1	ECCS Acceptance Criteria of 10 CFR 50.46	Conforms	None.	6.3.1 6.3.3
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.2	Single-Failure Consideration	Conforms	None.	6.3.1

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments

Description(4)(5)	Environmental Qualification Zone(1)	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category(3)	PAM Type(2)	Operating Time (Hrs)
Containment System (A013)						
I&C Division I Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
I&C Division II Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
PZR Heater Power Division I Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
PZR Heater Power Division II Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
I&C Channel A Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel C Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel B Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel D Instrument Seal Assembly (ISA)	CNV-6, RXBP-2	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
CRDM Power 1 Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #1 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #2 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments (Continued)

Description[4][5]	Environmental Qualification Zone[1]	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category[3]	PAM Type[2]	Operating Time (Hrs)
PZR Spray CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Injection Flow Check Valve~~	~~RXBP~~	~~Harsh~~	~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
CVC Injection CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
CVC Discharge CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Discharge Air Operated Valve~~	~~RXBP-1~~	~~Harsh~~	~~Electrical~~ ~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
Containment Flood and Drain CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Containment Evacuation CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Central Hydraulic Power Unit Skid A and Skid B	RXBG-8	Harsh	Electrical Mechanical	A B	N/A	1 720
Passive Autocatalytic Recombiner ~~(PAR)~~	CNV-4 or CNV-5	Harsh	Mechanical	A~~B~~	N/A	720
Containment Narrow Range Pressure Element A/B/C/D	CNV-6	Harsh	Electrical	A	N/A	720
Containment Wide Range Pressure Element A/B	CNV-6	Harsh	Electrical	A	B,C,D	720
Containment Level Indication A/B/C/D	RXBP-1, CNV-1 - CNV-6	Harsh	Electrical	A	N/A	720
SG #1 and SG #2 Main Steam Temperature Indication A/B/C/D	RXBP-1	Harsh	Electrical	A	N/A	720
FWIV #1 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720
FWIV #2 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720

6.2.5 Combustible Gas Control in the Containment Vessel

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The NPM design controls combustible gases to prevent hydrogen combustion inside containment following a severe accident. The combustible gas control requirements for future water-cooled reactor designs that have a potential for the production of combustible gases comparable to the light water reactor designs licensed as of October 16, 2003 are in 10 CFR 50.44(c).~~The US460 standard design includes a type and quantity of fuel cladding materials similar to that of a traditional light water reactor. However, due to unique attributes of the design (i.e., the small and normally-evacuated containment, fast-cooling ECCS that blows down into containment, and an oxygen-limiting design), the performance-based combustible gas control requirements of 10 CFR 50.44(d) are applied.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM includes a significantly smaller containment volume in relation to the RCS inventory compared to a traditional light water reactor. To preclude the formation of combustible gas mixtures in containment, the design passively limits the concentration of oxygen by volume in containment during both design-basis events and severe accidents. Due to the small and normally-evacuated containment volume (i.e., low initial oxygen concentration), as well as an ECCS design that blows down into containment, relatively cold and low pressure conditions are necessary to achieve appreciable oxygen concentrations. Because the design is oxygen-limiting, oxygen produced from radiolysis is the limiting consideration for combustible gas control. In severe accidents resulting in fuel damage, fuel cladding oxidation results in increased hydrogen gas inventory but does not increase the oxygen inventory, thereby lowering the oxygen concentration. Therefore, evaluation of non-core damage events for oxygen-based flammability addresses the bounding conditions of combustible gas generation. Discussion of severe accident combustible gas generation is in Section 19.2, Severe Accident Evaluation.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

During normal operation, the CNV is maintained at a partial vacuum (less than 1 psia), and dissolved hydrogen in the reactor coolant limits oxygen produced from radiolysis, as discussed in Section 5.2. In the early stages following an RCS blowdown event, steam, hydrogen from the RCS, and other noncondensable gases occupy the containment atmosphere. To address radiolytic oxygen production beyond the early stages of an event, the US460 standard design includes a passive autocatalytic recombiner (PAR) inside the CNV that is sized to maintain the containment atmosphere inert (i.e., less than 4 percent oxygen by volume) during design-basis events and significant beyond design-basis accidents.

6.2.5.1 Design Bases

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~In compliance with 10 CFR 50.44(c)(1), the CNV maintains a mixed containment atmosphere during design-basis and significant BDBE. Adequate mixing of the CNV occurs by virtue of temperature differences between the annular and head regions of the CNV and its partially immersed design with no sub-compartments that could facilitate separation, coupled with the dynamic nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS valve opening events).~~The NPM passively maintains the containment inert to preclude combustion. Specifically, the design includes a PAR in the upper CNV that recombines hydrogen and oxygen to limit oxygen concentration. The PAR is a self-actuating passive component with no moving parts. The PAR is safety-related, Seismic Category I, and included in the Environmental Qualification Program discussed in Section 3.11. The PAR is designed in accordance with the relevant requirements of ASME AG-1 (Reference 6.2-6), Section GE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM design ensures a mixed containment atmosphere during design-basis events and severe accidents due to:

- Temperature differences between the surfaces in the RPV and CNV create natural circulation ensuring mixing.
- The CNV does not include sub-compartments.
- The turbulent nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS actuation) provides flow mixing effects.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design includes a passive autocatalytic recombiner (PAR) that is non-safety related, seismic Class 2 with augmented requirements. The PAR is designed to survive severe accident conditions and the environment in which the PAR is relied upon to function. The PAR is sized to limit oxygen concentrations to a level that does not support combustion (less than four percent). This results in an inert containment atmosphere, thereby satisfying 10 CFR 50.44(c)(2) and 10 CFR 50.44(c)(3).~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design supports an exemption from the 10 CFR 50.44(c)(4) requirements for monitoring combustible gases during an accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The NPM relies on a PAR to maintain the containment atmosphere inert through the continuous consumption of oxygen generated post-accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Following a BDBA, the containment is oxygen-limited. The sources of oxygen are from the initial quantities in the reactor coolant system controlled by the Primary Coolant Chemistry Program and through radiolytic decomposition of water. Inerting is accomplished solely by the PAR recombining oxygen; no inert gas is added to the containment during operations or post-accident. The PAR has adequate capacity to maintain the containment oxygen concentration below four percent by volume.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design does not include continuous combustible gas monitoring. Each NPM includes a PAR to ensure an inert containment atmosphere through the continuous recombination of hydrogen and oxygen. The inert atmosphere precludes the loss of containment structural integrity, safe shutdown functions, or accident mitigation features by hydrogen combustion. The PAR is reliable, self-actuating, and passive, and the containment is not susceptible to de-inerting. The design also does not rely on hydrogen monitoring to assess core damage. The radiation monitors under the bioshield and core exit thermocouples provide the ability to assess core damage. Containment hydrogen and oxygen monitoring using the process sampling system during normal operations is discussed in Section 9.3.2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design relies on the PAR to maintain an inert containment atmosphere following a severe accident, therefore an analysis of the effects of combustion on containment integrity is not necessary. The PAR is a reliable passive device that self-actuates to recombine oxygen and hydrogen present in the surrounding environment. The NPM is not susceptible to de-inerting. The PAR is designed to function in the severe accident environment for which it is intended.~~The PAR maintains an inert atmosphere during design-basis events and significant beyond design-basis accidents; design basis events are limiting for PAR sizing. Notwithstanding, Section 19.2 evaluates a bounding BDBE case that produces more hydrogen than the 100 percent clad water reaction would and determines that the CNV does not exceed its design pressure assuming adiabatic combustion. ~~Therefore, the design conforms to the requirements of 10 CFR 50.44(c)(5).~~

The design does not require compliance with 10 CFR 50.34(f)(3)(v)(A)(1). 10 CFR 50.34 states that applicants for design approval under Part 52 need not demonstrate compliance with paragraph (f)(3)(v).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The PAR maintains the containment inert post-accident. The systems and components within the CNV that establish and maintain safe shutdown or support containment structural integrity remain capable of performing their required functions after BDBEs.~~

Section 6.3 addresses hydrogen generation criteria associated with the ECCS performance criteria requirements of 10 CFR 50.46.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs.~~Consistent with GDC 2, the PAR is designed to withstand the effects of natural phenomena. It is located in the CNV and is a Seismic Category I component. The PAR conforms with GDC 4 and withstands the environment conditions and dynamic effects inside the CNV. Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs. The PAR satisfies PDC 41 by maintaining the containment atmosphere inert following postulated accidents. The PAR is a passive component not susceptible to active single failure. Implementation of 10 CFR 50.44(d) meets PDC 41 by providing a system to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity. The PAR design permits appropriate periodic inspection and functional testing, thereby satisfying GDC 42 and GDC 43.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The PAR maintains the containment inert post-accident. Implementation of the requirements of 10 CFR 50.44, as modified by an exemption, meets the requirement of PDC 41 to provide systems to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity.~~

Section 1.9 addresses compliance with guidance in RG 1.7.

6.2.5.2 System Design

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV is a metal containment, Class MC pressure vessel that undergoes design, analysis, fabrication, inspection, testing, and stamping as an ASME BPVC Class 1 pressure vessel maintained partially immersed in a reactor pool common to other NPMs.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV meets 10 CFR 50.44(c) by safely accommodating the hydrogen generated by the equivalent of up to a 100 percent fuel-cladding metal water reaction. This type of accident is a BDBE in which hydrogen generation could exceed the flammability limits. The CNV is a passive design that relies on a PAR to maintain a containment atmosphere that does not support combustion following a significant BDBE for combustible gas control.~~Events involving combustible gas are discussed in Section 6.2.5. The CNV meets 10 CFR 50.44(d)(2) by safely maintaining a mixed atmosphere as well as maintaining an oxygen-limited environment during design-basis and significant beyond design-basis accidents.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV allows the PAR to perform its function by maintaining a mixed atmosphere. When blowdown occurs, the dynamic event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection. There are no partitions or sub-compartments to impede these natural mixing forces. Section 6.2.5.3, Design Evaluation, discusses the mixed containment atmosphere, including that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CES establishes a partial vacuum in the CNV before NPM startup that continues during reactor operation. The initial CNV pressure contributes to calculations that result in the initial combustible gas composition in the CNV based on the initial CNV pressure. Section 9.3.6 addresses the CES.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~When RCS discharge to the containment occurs, the dynamic nature of the event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection and molecular diffusion. There are no partitions or subcompartments to impede these natural mixing forces. Relevant events ensure convective mixing due to decay heat. Section 6.2.5.3 discusses turbulence in the CNV. The analysis shows that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV design utilizes a PAR to limit oxygen concentrations to a level that maintains an inerted containment atmosphere following a BDBE that releases an equivalent amount of hydrogen generated from a 100 percent fuel clad-coolant reaction, uniformly distributed. The configuration of the containment coupled with the dynamics of the LOCA and mitigating components ensures adequate mixing within the containment volume during and following events that generate and release combustible gases to containment. Section 6.2.5.3 discusses potential methods of gas accumulation. The limited-oxygen environment and mixed atmosphere maintains an inerted containment atmosphere, thereby precluding combustion that could challenge containment structural integrity.~~

As described in Section 6.2.5.3, there is margin to the containment pressure capacity limit such that there is no need for containment overpressure protection.

Section 6.2.5.5 addresses combustible gas monitoring.

6.2.5.3 Design Evaluation

Audit Question A-6.2.5-1

The partially immersed design with noThe CNV design ensures a mixed containment atmosphere for two reasons: (1) there are no sub-compartments that could facilitate separation, coupled withand (2) due to the turbulentdynamic nature of eventsthe CNV atmosphere associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS valve opening eventsconditions associated with ECCS operation). ensure adequate mixing of the CNV. To demonstrate compliance with the 10 CFR 50.44(c) requirement for a well mixed containment, CNV conditions at 72 hours are evaluated.

Audit Question A-6.2.5-1

An evaluation of the mixed containment atmosphere is performed at 72 hours after ECCS actuation. Turbulent flow forces decrease as decay heat decreases, therefore conditions at 72 hours are less turbulent, providing a bounding evaluationConditions earlier than 72 hours are generally more turbulent than conditions afterward. This evaluation considers two geometries: (1) the annular region between the RPV outer walls and the CNV inner walls (the annular region), and (2) the upper volume between the outer head of the RPV and the inner head of the CNV (the head space). The nondimensional Rayleigh (Ra) number, which represents whether the fluid heat transfer is primarily conductive or convective, evaluates mixing and establishes whether or not fluid flow is turbulent. A transition to bulk turbulent conditions occurs in a tall vertical cavity with a hot surface and a cool surface (in air) somewhere between Ra = 10,000 and Ra = 100,000Bulk turbulent flow conditions exist when the Rayleigh number exceeds the turbulence threshold for a specific enclosure. At 72 hours in the CNV, post-accident Raof ECCS operation, the containment atmosphere exceeds this transition regimeturbulence threshold by at least one order of magnitude, thereby demonstrating a well mixed volume.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Safety analyses show that the core does not uncover during a design-basis LOCA and as a result there is no fuel damage or fuel clad-coolant reaction that would result in an associated production and release of hydrogen or fission products. The risk-informed revision of 10 CFR 50.44 (68 FR 54125) eliminates the design-basis LOCA hydrogen release from the combustible gas control requirements of 10 CFR 50.44.The PAR is sized to ensure an inert atmosphere is maintained, irrespective of event type. Events with core damage result in increased zirconium cladding oxidation, thereby significantly increasing the production of hydrogen gas. Because the US460 standard design is oxygen-limiting, core damage events result in a lower oxygen concentration. Contrarily, events without core damage result in a higher oxygen concentration. Accordingly, the PAR is sized using bounding oxygen quantities for a non-core damage event. However, additional conservatism is added by considering the increased radiolysis associated with fuel damage energy deposition without taking credit for fuel damage cladding oxidation. Therefore, the PAR is conservatively sized to recombine a minimum of 15 moles of oxygen per hour at a partial

pressure of 1.69 kilopascals. This recombination rate establishes a PAR capacity that is sufficient for DBEs and BDBEs. Therefore the PAR maintains the CNV inert during a severe accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, as well as events with lesser or no clad-coolant reaction.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

An evaluation for the potential for combustible gas (hydrogen and oxygen) accumulation in the containment during and following postulated BDBEs was performed. The evaluation considered those BDBEs an intact containment boundary and resulting in varying degrees of core damage. One example of this type of BDBE is a LOCA inside containment with an ECCS failure that prevents the recirculation of coolant from the CNV back into the RPV. This scenario results in uncovering the reactor core with resulting fuel damage. Uncovering the reactor core can result in the production of a significant amount of hydrogen due to high temperature cladding-fuel interaction with additional amounts of hydrogen and oxygen produced from radiolytic decomposition of the reactor coolant that accumulates within the CNV. The sources of hydrogen in containment following a BDBE are limited to

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- oxidation of zirconium in the fuel cladding.
- radiolysis of water (reactor coolant).
- initial amount of dissolved hydrogen in the RCS.
- the amount of hydrogen accumulated in the upper region of the RPV (i.e., the pressurizer).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Within the CNV, the design restricts materials that have the potential to yield hydrogen gas because of contact with liquid contents in the CNV (upon ECCS actuation or other condition involving liquid in containment). Section 6.1 identifies any such materials.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Following a BDBE that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, the PAR is sized to maintain oxygen at a level (less than four percent) that does not support hydrogen combustion. Therefore, there is no hydrogen combustion, ensuring CNV integrity.

6.2.5.4 Inspection and Testing

RAI 19.2-1

Section 3.8.2.7, Section 6.2.1, Section 6.2.2, Section 6.2.4, Section 6.2.6, Section 6.2.7, Section 6.6, and Section 14.2 describes inspection and testing of the CNV and its components.The PAR is periodically tested and inspected in accordance with technical specifications.

Portions of the lower CNV have 60-year design fluence in excess of 1E+17 neutrons/cm^2, E > 1 MeV, with the peak fluence in the lower CNV not exceeding 2.5E+18 neutrons/cm^2, E > 1 MeV. The portions of the lower CNV with peak neutron fluence greater that 1E+17 neutrons/cm^2, E > 1 MeV, are composed of austenitic stainless steel. Austenitic stainless steels have superior ductility and are less susceptible to the effects of neutron embrittlement than ferritic materials. The peak neutron fluence for the ferritic portion of the CNV is less than the regulatory limit of 1E+17 neutrons/cm^2, E > 1 MeV. The material selection for the CNV pressure boundary ensures facture prevention.

6.2.8 References

6.2-1 NuScale Power, LLC, "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422-P, Revision 3.

6.2-2 NuScale Power, LLC, "Non-Loss-of-Coolant Accident Analysis Methodology Report," TR-0516-49416-P-A, Revision 3.

6.2-3 NuScale Power LLC, "Extended Passive Cooling and Reactivity Control Methodology Topical Report" TR-124587, Revision 0.

6.2-4 NuScale Power, LLC, "NuScale Containment Leakage Integrity Assurance," TR-123952-P, Rev. 0.

6.2-5 American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, 2017 edition, Section XI Division 1, "Rules for Inservice Inspection of Nuclear Components," New York, NY.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

6.2-6 American Society of Mechanical Engineers AG-1-2019, "Code on Nuclear Air and Gas Treatment," New York, NY.

Audit Question A-6.2.5-1, Audit Question A-19.1-53
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 6.2-8: Classification of Structures, Systems, and Components

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
CNTS, Containment System					
All components (except as listed below)-	RXB	A1	None	B	I
• CIVs (CVC PZR spray, RPV high point degasification, CVC injection & discharge) • CITFs (CVC PZR spray, RVP high point degasification, CVC injection & discharge)	RXB	A1	None	A	I
• CIV stored energy device pressure transmitters (MSIV, FWIV, RCCW CIVs, CVC high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVS) • Containment pressure instrumentation (narrow range) • Containment level instrumentation • MS temperature sensors • Closed and open position indicators for FWIVs • CHPU skid A & B • Supply/vent hydraulic lines from CHPU to CIVs • Hydraulic manifolds between CHPU and CIVs	RXB	A1	None	N/A	I
Feedwater isolation check valves	RXB	A2	None	B	I
• CNV-RPV support ledge • CNV CRDM support frame • Supply/vent hydraulic lines from CHPU to DHRS actuation valves	RXB	A2	None	N/A	I
• Containment top support structure	RXB	B1	• ASME-BTH-1-2017	N/A	I

Table 6.2-8: Classification of Structures, Systems, and Components (Continued)

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
• Containment pressure instrumentation (wide range) • Closed and open position indicators (MSIV, MSIBV, RCCWS CIVs, RPV high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVs)	RXB	B2	IEEE 497-2016 (Note 5)	N/A	I
PAR	RXB	~~B~~A2	None~~RG 1.7~~	N/A	I~~I~~
• Closed and open position indicators (RPV high point degasification solenoid valve, CVC discharge AOV) • Flushing hydraulic line from CHPU to inboard & outboard CIVs and DHR actuation valves	RXB	B2	None	N/A	II
Containment air temperature sensors	RXB	B2	None	N/A	III

Note 1: Acronyms used in this table are listed in Table 1.1-1

Note 2: Additional augmented design requirements, such as the application of a Quality Group, Radwaste safety, or seismic classification, to nonsafety-related SSC are reflected in the columns Quality Group / Safety Classification and Seismic Classification, where applicable. Environmental Qualifications for SSC are identified in Table 3.11-1.

Note 3: Section 3.2.2.1 through Section 3.2.2.4 provides the applicable codes and standards for each RG 1.26 Quality Group designation (A, B, C, and D). A Quality Group classification per RG 1.26 is not applicable to supports or instrumentation that do not serve a pressure boundary function. Section 3.2.1.4 provides a description of RG 1.143 classification for RW-IIa, RW-IIb, and RW-IIc.

Note 4: Where SSC (or portions thereof) as determined in the as-built plant that are identified as Seismic Category III in this table could, as the result of a seismic event, adversely affect Seismic Category I SSC or result in incapacitating injury to occupants of the control room, they are categorized as Seismic Category II consistent with Section 3.2.1.2 and analyzed as described in Section 3.7.3.8.

Note 5: IEEE Std 497-2016 as endorsed by RG 1.97 and implemented as described in Table 1.9-2

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS maintains an inert containment atmosphere following design-basis events.

The NPM performs the following nonsafety-related, risk-significant function that is verified by ITAAC. The CNTS supports the Reactor Building crane (RBC) by providing lifting attachment points that the RBC can connect to so that the NPM can be lifted.

The NPM performs the following nonsafety-related functions that are verified by ITAAC:

- The CNTS supports the SGS by providing structural support for the SGS piping.
- The CNTS supports the CRDS by providing structural support for the CRDS piping.
- The CNTS supports the RCS by providing structural support for the RCS piping.
- The CNTS supports the feedwater system by providing structural support for the feedwater system piping.

Design Commitments

- The NuScale Power Module ASME Code Class 1, 2, and 3 piping systems listed in Table 2.1-3 and NuScale Power Module ASME Code Class 1, 2, 3, and CS components listed in Table 2.1-4 comply with ASME Code Section III requirements.
- The NuScale Power Module ASME Code Class 1, 2, and 3 components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- The NuScale Power Module ASME Code Class CS components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- Safety-related SSC are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.

Audit Question A-6.3.2.2.1-1

- The ECCS supplemental boron componentsdissolvers and CNV lower mixing tubes are installed such that ECCS can perform the safety-related emergency supplemental boron function.
- Each CNTS containment electrical penetration assembly (EPA) listed in Table 2.1-5 is rated either (i) to withstand fault and overload currents for the time required to clear the fault from its power source, or (ii) to withstand the maximum fault and overload current for its circuits without a circuit interrupting device.
- The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.
- Closure times for CIVs listed in Table 2.1-5 limit potential releases of radioactivity.
- The length of piping listed in Table 2.1-3 shall be minimized between the containment penetration and the associated outboard CIVs.
- The CNTS containment electrical penetration assemblies listed in Table 2.1-5 are sized to power their design loads.

- The ECCS valves, CIVs, and DHRS actuation valves listed in Table 2.1-4, and their associated hydraulic lines, are installed such that each valve can perform its safety function.

Audit Question A-Part 8-2.1.2-1

- The remotely operated CNTS containment isolation valves listed in Table 2.1-4Table 2.1-5 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-Part 8-2.1.2-2

- The ECCS reactor recirculation valves and RVVsvalves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The DHRS valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The CNV top support structure (TSS) supports its rated load.
- The CNV top support structure is constructed to provide assurance that a single failure does not result in the uncontrolled movement of the lifted load.
- The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The ECCS reactor recirculation valves and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.
- The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner (PAR) is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.

Audit Question A-6.2-4

- The CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.

2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.1-1 contains the ITAAC for the NPM.

Table 2.1-1: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.01.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
18.	The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
19.	The ECCS RRVs and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the ECCS RRVs and RVVs listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each ECCS RRV and RVV listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of electrical power to its corresponding trip valve under preoperational temperature, differential pressure, and flow conditions.
20.	The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the DHRS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each DHRS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
21.	The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS check valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS check valve listed in Table 2.1-4 strokes fully open and closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions.
22.	The CNTS passive autocatalytic recombiner is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.	An inspection will be performed of the PAR.	A report exists and concludes that the PAR is installed in accordance with the associated installation specification.
23.	The as-built CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.	A reconciliation analysis will be performed of the as-built containment net free volume.	A report exists and concludes the as-built containment net free volume is greater than or equal to the free volume listed in FSAR Table 6.2-2.

Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Audit Question A-6.2-4

Table 2.1-2: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[1] (Continued)

ITAAC No.	Discussion
02.01.18	The CNTS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each CNTS safety-related hydraulic-operated valves listed in Table 2.1-4 repositions to or maintains its safety-related position on loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.19	The ECCS safety-related RRVs and RVVs are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of electrical power under preoperational temperature, differential pressure, and flow conditions. For the first NPM only, a test is conducted under preoperational test conditions that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations. The test is initiated with an initial RPV to CNV differential pressure greater than the inadvertent actuation block threshold pressure of 900 psid in accordance with FSAR Table 14.2-40 and demonstrates that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve. For subsequent NPMs a test is conducted at reduced pressure and temperature in accordance with FSAR Table 14.2-56 to demonstrate that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve.
02.01.20	The DHRS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each DHRS safety-related hydraulic-operated valves listed in Table 2.1-4 fails open loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.21	The CNTS safety-related check valves are tested to demonstrate the capability to perform their function to transfer open and transfer closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions. Check valves are tested in accordance with the requirements of the ASME OM Code, ISTC-5220, Check Valves. In accordance with FSAR Table 14.2-38, a preoperational test demonstrates that the CNTS check valves listed in Table 2.1-4 strokes fully open and closed under forward and reverse flow conditions, respectively. Preoperational test conditions are established that approximate design basis temperature, differential pressure and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.22	Quality Control inspection hold points are used to ensure the as-built CNTS passive autocatalytic recombiner is installed consistent with the associated installation specification, and therefore capable of performing its safety-related function. To demonstrate the acceptance criterion for ITAAC 02.01.22 is satisfied, and the associated design commitment fully met, a report will exist and conclude Quality Control inspection hold points exist and have been completed for the location and orientation of the PAR.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Audit Question A-6.2-4, Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.1-6: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.01.01	X					
02.01.02	X					
02.01.03	X					
02.01.04	X	X				
02.01.05	X					
02.01.06	X					
02.01.07	X					
02.01.08	X					
02.01.09	X					
02.01.10	X					
02.01.11	X					
02.01.12	X					
02.01.13	X					
02.01.14	X					
02.01.15	X					
02.01.16				X		
02.01.17				X		
02.01.18	X					
02.01.19	X					
02.01.20	X					
02.01.21	X					
02.01.22	X					
02.01.23	X					

- The safety-related relief valves listed in Table 2.4-3 provide overpressure protection.
- The DHRS condensers listed in Table 2.4-3 have the capacity to transfer their design heat load.
- The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions, and performs its function for the period of time required to complete the function.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.

RAI 19.2-1

- The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.

2.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4-1 contains the ITAAC for the equipment qualification - module-specific equipment.

Table 2.4-1: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.04.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
09.	The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the CNTS containment electrical penetration assemblies listed in Table 2.4-3 including associated connection assemblies. ii. An inspection will be performed of the containment CNTS electrical penetration assembles listed in Table 2.4-3, including associated connection assemblies.	i. An EQ record form exists and concludes that the CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, performs their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, are installed in their design location in a configuration bounded by the EQ record form.
10.	The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.	A type test, analysis, or a combination of type test and analysis will be performed of the CNTS passive autocatalytic recombiner.	A report exists and concludes that the PAR has sufficient capacity to meet or exceed the minimum required oxygen recombination rate.
11.	The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.	An analysis will be performed of the CNTS passive autocatalytic recombiner.	A qualification record form exists and concludes that the CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life under the design basis harsh environmental conditions specified in the qualification record form.

Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

RAI 19.2-1

Table 2.4-2: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[1] (Continued)

	ITAAC No.	Discussion
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4	02.04.10	FSAR Section 6.2.5, Combustible Gas Control in the Containment Vessel, discusses that the PAR provides the safety-related function of maintaining an inert atmosphere (i.e., less than 4 percent oxygen by volume) in the CNV, which is achieved by the continuous recombination of oxygen. FSAR Section 6.2.5 lists the minimum design oxygen recombination rate (in moles per hour) for the PAR to ensure the CNV atmosphere remains inert following design-basis events. This ITAAC verifies that the PAR oxygen recombination rate meets or exceeds the minimum required oxygen recombination rate specified in FSAR Section 6.2.5 to maintain the CNV atmosphere inert during design-basis events.
RAI 19.2-1	02.04.11	FSAR Section 3.11 presents information to demonstrate that the CNTS passive autocatalytic recombiner located in a harsh environment is qualified using an analysis to perform its function up to the end of its qualified life in design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions. Environmental conditions include both internal service conditions and external environmental conditions for the PAR. The qualification method employed for the equipment is the same as the qualification method described for that type of equipment in FSAR Section 3.11. The ITAAC verifies that: (1) an equipment qualification record form exists for the PAR, and (2) the qualification record form concludes that the PAR listed in Table 2.4-3 perform its intended function up to the end of its qualified life under the design basis environmental conditions (both internal service conditions and external environmental conditions) specified in the qualification record form.

Note:
1) References to Tables and Figures refer to ITAAC unless the reference specifically states FSAR Tables or Figures.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category[(1)]
Containment System						
CNV8	I&C Division I EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV9	I&C Division II EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV15	PZR heater power division I nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV16	PZR heater power division II nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV17	I&C Channel A instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV18	I&C Channel C instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV19	I&C Channel B instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV20	I&C Channel D instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV37	CRDM power 1 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV38	RPI group #1 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV39	RPI group #2 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV40	I&C separation group A EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV41	I&C separation group B EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV42	I&C separation group C EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV43	I&C separation group D EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV44	CRDM power 2 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
None	CNV CRDM Support Frame	N/A	N/A	Yes	N/A	N/A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
CNT-PE-1001A CNT-PE-1001B CNT-PE-1001C CNT-PE-1001D	Containment narrow range pressure elements	Harsh	Electrical	Yes	Yes	A
CNT-PE-1002A CNT-PE-1002B	Containment wide range pressure elements	Harsh	Electrical	Yes	No	A
CNT-LE-1003A CNT-LE-1003B CNT-LE-1003C CNT-LE-1003D	Containment level indication	Harsh	Electrical	Yes	Yes	A
CNT-PAR-0001	Passive autocatalytic recombiner	Harsh	Mechanical	Yes	N/A	A
MS-TE-1001A MS-TE-1001B MS-TE-1001C MS-TE-1001D	SG #1 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
MS-TE-2001A MS-TE-2001B MS-TE-2001C MS-TE-2001D	SG #2 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
CE-ZSC-0001	CES inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0001	CES inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0001	CES inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CE-ZSC-0002	CES outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0002	CES outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0002	CES outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0022	CFDS inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0022	CFDS inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0022	CFDS inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0021	CFDS outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0021	CFDS outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0021	CFDS outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CVC-ZSC-0334	CVCS discharge inboard CIV close position indicator	Harsh	Electrical	Yes	No	A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
ICI-TE-~~BA-~~0001F-B~~A / F~~ ICI-TE-~~BA-~~0002F-B~~A / F~~ ICI-TE-~~CA-~~0003F-C~~A / F~~ ICI-TE-~~CA-~~0004F-C~~A / F~~ ICI-TE-~~BA-~~0005F-B~~A / F~~ ICI-TE-~~BA-~~0006F-B~~A / F~~ ICI-TE-~~CA-~~0007F-C~~A / F~~ ICI-TE-~~CA-~~0008F-C~~A / F~~ ICI-TE-~~CA-~~0009F-C~~A / F~~ ICI-TE-~~BA-~~0010F-B~~A / F~~ ICI-TE-~~CA-~~0011F-C~~A / F~~ ICI-TE-~~BA-~~0012F-B~~A / F~~	Core ~~inlet /~~ exit thermocouples	Harsh	Electrical	Yes	No	A

Note:

1. EQ Categories:
   - A - Equipment that will experience the environmental conditions of DBAs for which it must function to mitigate said accidents, and that will be qualified to demonstrate operability in the accident environment for the time required for accident mitigation with safety margin to failure.
   - B - Equipment that will experience the environmental conditions of DBAs through which it need not function for mitigation of said accidents, but through which it must not fail in a manner detrimental to plant safety or accident mitigation, and that will be qualified to demonstrate the capability to withstand the accident environment for the time during which it must not fail with safety margin to failure.
   - E - Equipment that will not experience environmental conditions of DBAs and that will be qualified to demonstrate operability under the expected extremes of its nonaccident service environment.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-4: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.04.01	X					
02.04.02	X					
02.04.03	X					
02.04.04	X					
02.04.05	X					
02.04.06	X					
02.04.07	X					
02.04.08	X					
02.04.09	X					
02.04.10	X					
02.04.11	X					

RAI 19.2-1

Table 1.9-8: Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs"

Issue	Description	Conformance Status	Comments	Section
I.A	Use of a Physically-Based Source Term: Incorporation of engineering judgment and a more realistic source term in design that deviates from the siting requirements in 10 CFR 100.	Conforms	None.	15.0.3 15.10
I.B	Anticipated Transient without SCRAM (ATWS): Position on the current practices and design features to achieve a high degree of protection against an ATWS.	Partially Conforms	The design relies on diversity within the module protection system (MPS) to reduce the risk associated with ATWS events.	15.8
I.C	Mid-Loop Operation: Position on design features necessary to ensure a high degree of reliability of residual heat removal systems in PWR.	Not Applicable	Design does not use external loops and no drain down condition for refueling.	Not Applicable
I.D	Station Blackout: Position on methods to mitigate the effects of a loss of all AC power.	Not Applicable	The relevance of the SECY-90-016 SBO issue to passive ALWR designs was deferred to and addressed in Section F of SECY-94-084 and SECY-95-132. The NuScale design conforms to the passive plant guidance these documents.	Not Applicable
I.E	Fire Protection: Positions on design configuration and features the fire protection system and other management schemes to ensure safe shutdown of the reactor.	Conforms	None.	Appendix 9A
I.F	Intersystem LOCA: Position on acceptable design practices and preventative measures to minimize the probability of an interfacing systems loss-of-coolant accident.	Conforms	None.	9.3.4 19.2
I.G	Hydrogen Control: Position on acceptable requirements to measure and mitigate the effects of hydrogen produced due to a water reaction with zirconium fuel cladding.	Partially Conforms	The design includes a PAR that is sized to limit oxygen concentrations to a level that does not support combustion (less than four percent), this results in an inert containment atmosphere. The NuScale design supports an exemption to 10 CFR 50.34(f)(2)(xvii)(C)~~50.44(c)(4).~~	6.2.5
I.H	Core Debris Coolability: Acceptability criteria for cooling area and quenching ability regarding corium interaction with concrete.	Conforms	None.	19.2

CNV in conjunction with the containment isolation system is credited to mitigate the consequences of a design-basis accident.

Natural aerosol removal mechanisms inherent in the containment design deplete elemental iodine and particulates in the containment atmosphere. The limited containment leakage and natural fission product control mechanisms result in offsite doses that are less than regulatory limits.

RAI 19.2-1

~~P~~A passive autocatalytic recombiner~~s~~ is~~are~~ provided for each NPM to ~~control combustible gas concentrations~~address the safety impacts of combustible gases in accordance with 10 CFR 50.44(d).

The design supports an exemption from the electric power provisions of GDC 41.

Conformance or Exception

The design conforms to PDC 41, as follows:

> Systems to control fission products, hydrogen, oxygen, and other substances that may release into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to ensure that containment integrity is maintained.
>
> Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to ensure that its safety function can be accomplished, assuming a single failure.

Relevant FSAR Chapters and Sections

Section 6.2 Containment Systems

Section 6.5 Fission Product Removal and Control Systems

Section 8.2 Offsite Power System

Section 8.3 Onsite Power Systems

3.1.4.13 Criterion 42-Inspection of Containment Atmosphere Cleanup Systems

The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components, such as filter frames, ducts, and piping to assure the integrity and capability of the systems.

Implementation in the NuScale Power Plant Design

RAI 19.2-1

The passive autocatalytic recombiner design and location in the NPM permits appropriate periodic inspection.~~The design does not include containment atmosphere cleanup systems subject to GDC 42.~~

Conformance or Exception

RAI 19.2-1

The design conforms to GDC 42.~~GDC 42 is not applicable to the design.~~

Relevant FSAR Chapters and Sections

RAI 19.2-1

Section 6.2 Containment~~Fission Product Removal and Control~~ Systems

3.1.4.14 Criterion 43-Testing of Containment Atmosphere Cleanup Systems

The containment atmosphere cleanup system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves and (3) the operability of the systems as a whole and, under conditions as~~are~~ close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection systems, the transfer between normal and emergency power sources, and the operation of associated systems.

Implementation in the NuScale Power Plant Design

RAI 19.2-1

The passive autocatalytic recombiner design permits appropriate periodic functional testing to demonstrate operability via removal of catalytic plates for bench functional testing. Pressure testing and leaktight integrity are not relevant to passive autocatlytic recombiner operability; structural integrity is verified through inspection. There are no active components in the passive autocatalytic recombiner and there is no operational sequence to bring it into operation.~~The design does not include containment atmosphere cleanup systems subject to GDC 43.~~

Conformance or Exception

RAI 19.2-1

The design conforms to GDC 43.~~GDC 43 is not applicable to the design.~~

Relevant FSAR Chapters and Sections

RAI 19.2-1

Section 6.2 ContainmentFission Product Removal and Control Systems

3.1.4.15 Criterion 44-Cooling Water

A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

Implementation in the NuScale Power Plant Design

The UHS comprises the reactor pool, refueling pool, and spent fuel pool, and functions as a cooling water medium for the NPMs within the reactor pool and the stored spent fuel assemblies within the spent fuel pool. Because the NPMs are partially immersed in the UHS, no intermediate system is required to transfer heat from the NPMs to the UHS, which occurs either through the decay heat removal heat exchangers or through the containment vessel walls. Stored spent fuel assemblies are located in the UHS. To meet the intent of PDC 44, the requirements are applied to the UHS and the systems that ensure that the UHS is able to perform its safety function.

The Reactor Building provides a seismically-qualified enclosure that contains the water in the UHS. The pool leakage detection system provides indication of leakage from the pool walls and the pool liner on the floor of the UHS. Redundant level instrumentation provides another indication of leakage.

The pool cooling and cleanup system (PCWS) maintains UHS level and temperature during normal operation. The UHS maintains the core temperature at acceptably low levels following an accident, including a LOCA, that results in the initiation of ECCS. The passive cooling feature provided by the UHS does not include active components and does not rely on electrical power to perform its safety function.

The design supports an exemption from the electric power provisions of GDC 44.

Conformance or Exception

The design conforms to PDC 44, as follows:

> A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

~~adequate capacity to maintain the containment oxygen concentration below four percent by volume.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design does not include continuous combustible gas monitoring. Each NPM includes a PAR to ensure an inert containment atmosphere through the continuous recombination of hydrogen and oxygen. The inert atmosphere precludes the loss of containment structural integrity, safe shutdown functions, or accident mitigation features by hydrogen combustion. The PAR is reliable, self-actuating, and passive, and the containment is not susceptible to de-inerting. The design also does not rely on hydrogen monitoring to assess core damage. The radiation monitors under the bioshield and core exit thermocouples provide the ability to assess core damage. Containment hydrogen and oxygen monitoring using the process sampling system during normal operations is discussed in Section 9.3.2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design relies on the PAR to maintain an inert containment atmosphere following a severe accident, therefore an analysis of the effects of combustion on containment integrity is not necessary. The PAR is a reliable passive device that self-actuates to recombine oxygen and hydrogen present in the surrounding environment. The NPM is not susceptible to de-inerting. The PAR is designed to function in the severe accident environment for which it is intended.~~The PAR maintains an inert atmosphere during design-basis events and significant beyond design-basis accidents; design basis events are limiting for PAR sizing. Notwithstanding, Section 19.2 evaluates a bounding BDBE case that produces more hydrogen than the 100 percent clad water reaction would and determines that the CNV does not exceed its design pressure assuming adiabatic combustion. ~~Therefore, the design conforms to the requirements of 10 CFR 50.44(c)(5).~~

The design does not require compliance with 10 CFR 50.34(f)(3)(v)(A)(1). 10 CFR 50.34 states that applicants for design approval under Part 52 need not demonstrate compliance with paragraph (f)(3)(v).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The PAR maintains the containment inert post-accident. The systems and components within the CNV that establish and maintain safe shutdown or support containment structural integrity remain capable of performing their required functions after BDBEs.~~

Section 6.3 addresses hydrogen generation criteria associated with the ECCS performance criteria requirements of 10 CFR 50.46.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs.~~Consistent with GDC 2, the PAR is designed to withstand the effects of natural phenomena. It is located in the CNV and is a Seismic Category I component. The PAR conforms with GDC 4 and withstands the environment conditions and dynamic effects inside the CNV. Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs. The PAR satisfies PDC 41 by maintaining the containment atmosphere inert following postulated accidents. The PAR is a passive component not susceptible to active single failure. Implementation of 10 CFR 50.44(d) meets PDC 41 by providing a system to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity. The PAR design permits appropriate periodic inspection and functional testing, thereby satisfying GDC 42 and GDC 43.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The PAR maintains the containment inert post-accident. Implementation of the requirements of 10 CFR 50.44, as modified by an exemption, meets the requirement of PDC 41 to provide systems to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity.

Section 1.9 addresses compliance with guidance in RG 1.7.

6.2.5.2 System Design

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV is a metal containment, Class MC pressure vessel that undergoes design, analysis, fabrication, inspection, testing, and stamping as an ASME BPVC Class 1 pressure vessel maintained partially immersed in a reactor pool common to other NPMs.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV meets 10 CFR 50.44(c) by safely accommodating the hydrogen generated by the equivalent of up to a 100 percent fuel-cladding metal water reaction. This type of accident is a BDBE in which hydrogen generation could exceed the flammability limits. The CNV is a passive design that relies on a PAR to maintain a containment atmosphere that does not support combustion following a significant BDBE for combustible gas control.Events involving combustible gas are discussed in Section 6.2.5. The CNV meets 10 CFR 50.44(d)(2) by safely maintaining a mixed atmosphere as well as maintaining an oxygen-limited environment during design-basis and significant beyond design-basis accidents.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV allows the PAR to perform its function by maintaining a mixed atmosphere. When blowdown occurs, the dynamic event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection. There are no partitions or sub-compartments to impede these natural mixing forces. Section 6.2.5.3, Design Evaluation, discusses the mixed containment

~~the recirculation of coolant from the CNV back into the RPV. This scenario results in uncovering the reactor core with resulting fuel damage. Uncovering the reactor core can result in the production of a significant amount of hydrogen due to high temperature cladding-fuel interaction with additional amounts of hydrogen and oxygen produced from radiolytic decomposition of the reactor coolant that accumulates within the CNV. The sources of hydrogen in containment following a BDBE are limited to~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- ~~oxidation of zirconium in the fuel cladding.~~
- ~~radiolysis of water (reactor coolant).~~
- ~~initial amount of dissolved hydrogen in the RCS.~~
- ~~the amount of hydrogen accumulated in the upper region of the RPV (i.e., the pressurizer).~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Within the CNV, the design restricts materials that have the potential to yield hydrogen gas because of contact with liquid contents in the CNV (upon ECCS actuation or other condition involving liquid in containment). Section 6.1 identifies any such materials.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Following a BDBE that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, the PAR is sized to maintain oxygen at a level (less than four percent) that does not support hydrogen combustion. Therefore, there is no hydrogen combustion, ensuring CNV integrity.~~

6.2.5.4 Inspection and Testing

RAI 19.2-1

~~Section 3.8.2.7, Section 6.2.1, Section 6.2.2, Section 6.2.4, Section 6.2.6, Section 6.2.7, Section 6.6, and Section 14.2 describes inspection and testing of the CNV and its components.~~The PAR is periodically tested and inspected in accordance with technical specifications.

6.2.5.5 Instrumentation

Hydrogen and oxygen analyzers are within the containment sampling system portion of the process sampling system. During normal operation, the containment gas discharge from the CES vacuum pumps routes to the containment sampling system sample panel for online analysis of hydrogen and oxygen concentrations with indication in the main control room.

The CES isolates during DBAs and BDBEs. Because the design precludes a combustible atmosphere, monitoring of hydrogen concentration following a

The MCS provides a first-out alarm resolution capacity. In the case of an avalanche of alarms, the system is able to discriminate between them and date tag the alarms in order of their occurrence. Process alarms are logged with a time stamp that includes the year, month, day, hour, minutes, and second that provides the operator the ability to understand and diagnose major plant upsets.

7.2.13.6 Three Mile Island Action Items

The under-the-bioshield radiation monitor provides the primary means to satisfy the requirements of 10 CFR 50.34(f)(2)(xix) as well as the following variables used to identify inadequate core cooling to satisfy the requirements of 10 CFR 50.34(f)(2)(xviii):

- core exit temperatures
- wide range RCS pressure
- RCS hot temperature
- RPV riser level

The bypassed and operable status indication of safety interlocks is automatically provided in the control room as described in Section 7.2.13.4 and satisfies the requirements of 10 CFR 50.34(f)(2)(v) and RG 1.47.

The SDIS conforms to 10 CFR 50.34(f)(2)(iv) by providing the capability to display the Type B and Type C variables identified in Table 7.1-7 over anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions.

The reactor safety valve position indication is processed by the MPS and then sent to the SDIS and the MCS for display in the MCR. The reactor safety valve position indication is seismically qualified to Seismic Category I requirements and meets the requirements of 10 CFR 50.34(f)(2)(xi).

Consistent with 50.34(f)(2)(xvii) the SDI system provides the capability to monitor containment pressure, containment water level, and the reactor containment atmosphere for radioactivity released from postulated accidents. The MCS provides the recording function for the containment parameters.The PCS provides display and record capability for the noble gas effluent release points.

RAI 19.2-1

The design supports an exemption from the hydrogen monitoring requirement of 10 CFR 50.34(f)(2)(xvii)(C)~~ and the hydrogen and oxygen monitoring requirements of 10 CFR 50.44(c)(4)~~.

As described in Table 1.9-5, the design supports an exemption from the power supply requirements for pressurizer level indication included in 10 CFR 50.34(f)(2)(xx).

During normal operation, the CSS monitors gas discharged from the containment evacuation system for hydrogen and oxygen gas concentration.

Normal operation of the SSS includes continuous monitoring of the condensate pump discharge, condensate polisher effluents, feedwater, and main steam.

The frequency for sample collection and required analyses for local process sample points are addressed in the primary, secondary, and ancillary chemistry program and procedures.

Off-Normal Operations

RAI 19.2-1

The US460 standard plant design supports an exemption from 10 CFR 50.34(f)(2)(viii) that requires capability for obtaining and analyzing post-accident samples of reactor coolant and containment atmosphere for the purpose of assessing the presence and extent of core damage. The NuScale design also supports an exemption from 10 CFR 50.44(c)(4) and 10 CFR 50.34(f)(2)(xvii)(Cc).

9.3.2.3 Safety Evaluation

Consistent with GDC 1, PSS structures, systems, and components (SSC) are designed, fabricated, erected, and tested to appropriate quality standards such that their failure does not impact the function of safety-related or risk-significant systems. The SSC in the PSS are designed to Quality Group D standards, per Regulatory Guide 1.26. PSS piping conforms to American Society of Mechanical Engineers (ASME) B31.1 (Reference 9.3.2-2).

General Design Criterion 2 is considered in the design of the PSS. The primary sampling system and the CSS components are located inside the Reactor Building (RXB), and are protected from earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches to the extent that the RXB is protected from such events. The PSS does not connect to Seismic Category I piping. The SSC in the PSS are designated as Seismic Category III.

The PSS does not employ sample lines that penetrate the CNV and the reactor pressure vessel; therefore, there is no containment isolation function associated with the system. There is no physical interaction of process sampling system SSC with safety-related SSC. Process sampling system failure does not adversely affect the integrity of safety-related systems.

The PSS design supports conformance to GDC 13 in that sampling of reactor coolant enables the PSS to provide information on variables that can affect the fission process, the integrity of the reactor core, and the RCPB during normal modes of operation. The PSS collects water and gaseous samples from the RCS and associated auxiliary systems during normal modes of operation.

RAI 19.2-1

2. ~~10 CFR 50.44(c)(4) and~~ 10 CFR 50.34(f)(2)(xvii) Combustible Gas Monitoring

2.1 Introduction and Request

2.1.1 Summary

RAI 19.2-1

NuScale Power, LLC (NuScale) requests an exemption from ~~10 CFR 50.44(c)(4) and~~ 10 CFR 50.34(f)(2)(xvii)(C), which requires the capability for monitoring combustible gases during an accident. The underlying purpose of the rule~~s~~ is to support accident management and emergency planning for a significant beyond design-basis accident (BDBA) where hydrogen combustion could challenge containment integrity. The US460 standard design precludes combustion in containment during a significant BDBA by passively controlling the oxygen concentration to maintain an inert atmosphere. The capability to monitor hydrogen and oxygen concentrations is unnecessary to support mitigative actions or emergency planning. Moreover, the likelihood of a core damage event, where significant hydrogen could be generated, is very low. Therefore, the design meets the underlying purpose of the rules.

2.1.2 Regulatory Requirements

10 CFR 52.137(a) requires a standard design approval application final safety analysis report (FSAR) to include, in part:

> *(8) The information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v)…*

RAI 19.2-1

> ~~*(12) An analysis and description of the equipment and systems for combustible gas control as required by [10 CFR 50.44]*~~

10 CFR 50.34(f)(2)(xvii) states:

> *Provide instrumentation to measure, record and readout in the control room: (A) containment pressure, (B) containment water level, (C) containment hydrogen concentration, (D) containment radiation intensity (high level), and (E) noble gas effluents at all potential, accident release points. Provide for continuous sampling of radioactive iodines and particulates in gaseous effluents from all potential accident release points, and for onsite capability to analyze and measure these samples. (II.F.1)*

RAI 19.2-1

~~10 CFR 50.44(c)(4) states:~~

> ~~*Monitoring. (i) Equipment must be provided for monitoring oxygen in containments that use an inerted atmosphere for combustible gas control. Equipment for*~~

~~monitoring oxygen must be functional, reliable, and capable of continuously measuring the concentration of oxygen in the containment atmosphere following a significant beyond design-basis accident for combustible gas control and accident management, including emergency planning.~~

RAI 19.2-1

~~(ii) Equipment must be provided for monitoring hydrogen in the containment. Equipment for monitoring hydrogen must be functional, reliable, and capable of continuously measuring the concentration of hydrogen in the containment atmosphere following a significant beyond design-basis accident for accident management, including emergency planning.~~

2.1.3 Exemption Sought

RAI 19.2-1

Pursuant to 10 CFR 52.7, NuScale requests an exemption from ~~10 CFR 50.44(c)(4) and~~ 10 CFR 50.34(f)(2)(xvii)(C).

2.1.4 Effect on NuScale Regulatory Conformance

RAI 19.2-1

As a result of this exemption, the US460 standard design does not conform with ~~10 CFR 50.44(c)(4) and~~ 10 CFR 50.34(f)(2)(xvii)(C); post-accident hydrogen ~~and oxygen~~ monitoring to satisfy the rule~~s~~ is not included in the design.

2.2 Justification for Exemption

RAI 19.2-1

<u>10 CFR 50.34(f)(2)(xvii)(C) requires containment hydrogen monitoring capability. It is a Three Mile Island requirement that predates and has the same underlying purpose as 10 CFR 50.44(c)(4).</u> The underlying purpose of 10 CFR 50.44, overall, is to prevent a loss of containment structural integrity, safe shutdown functions, or accident mitigation features caused by the production and accumulation of combustible gases within containment following a BDBA. The rule's statements of consideration (at 68 FR 54130) explain that it addresses the risk from combustible gas generation during a BDBA:

> *Based upon the results of significant research into design-basis and beyond design-basis accidents, the NRC has determined that a design-basis combustible gas release is not risk-significant and certain beyond design-basis combustible gas releases are risk-significant. Therefore, the NRC is removing the requirements for combustible gas control systems that mitigate consequences of non-risk-significant design-basis accidents which are also not effective in reducing the risk from combustible gas releases in beyond-design-basis accidents.*

As discussed in FSAR Section 6.2.5, the NuScale Power Module (NPM) maintains an inert atmosphere in the containment during and following a BDBA. The design precludes the loss of containment structural integrity, safe shutdown functions, or accident mitigation features by hydrogen combustion.

10 CFR 50.44(c)(4), specifically, addresses the capability for containment hydrogen and oxygen monitoring for "water-cooled reactor designs with characteristics (e.g., type and quantity of cladding materials) such that the potential for production of combustible gases is comparable to" pre-existing light water reactors. Subparagraph (ii) requires hydrogen monitoring for all such containments. Subparagraph (i) requires oxygen monitoring for inert containments. Because the NPM is maintained inert, both provisions apply to the design.

As discussed in the rule's statements of consideration (68 FR 54136), the underlying purpose of combustible gas monitoring is to assess core damage and allow verification that combustible gas control systems perform their beyond design-basis functions, to support severe accident management and emergency planning:

> *Hydrogen monitors are required to assess the degree of core damage during beyond design-basis accidents. Hydrogen monitors are also used in conjunction with oxygen monitors to guide licensees in implementation of severe accident management strategies. Also, the NRC has decided to codify the existing regulatory practice of monitoring oxygen in containments that use an inerted atmosphere for combustible gas control. If an inerted containment became de-inerted during a beyond design-basis accident, other severe accident management strategies, such as purging and venting, would need to be considered. Monitoring of both hydrogen and oxygen is necessary to implement these strategies.*

The statements of consideration (at 68 FR 54131) further link the purpose of monitoring to the potential for failure of combustible gas control measures:

> *Because hydrogen monitors are not needed to initiate or activate any mitigative features during these accidents, they are not risk-significant for reducing the combustible gas threat as long as the hydrogen igniters are operable. If the igniters are not operating (such as during station blackout) hydrogen monitoring does not reduce risk since the containment cannot be purged or vented without electrical power. Nevertheless, the amended rule requires licensees to retain hydrogen monitors (and oxygen monitors in Mark I and Mark II BWRs) for their containments because they are useful in implementing emergency planning and severe accident management mitigative actions for beyond design basis accidents.*

Thus, the statements of consideration explain (68 FR 54126):

> *If an inerted containment was to become de-inerted during a significant beyond design-basis accident, then other severe accident management strategies, such as purging and venting, would need to be considered.…*
>
> *The hydrogen monitors are required to assess the degree of core damage during a beyond design-basis accident and confirm that random or deliberate ignition has taken place…. If an explosive mixture that could threaten containment integrity exists, then other severe accident management strategies, such as purging and/or venting, would need to be considered.*

RAI 19.2-1

As discussed in FSAR Section 6.2.5, the NPM relies on a safety-related passive autocatalytic recombiner to maintain the containment inert through the continuous recombination of oxygen and hydrogen that may initially be in the NPM at the beginning of BDBAs and any generated post accident. In the NuScale design oxygen is the limiting reactant for the PAR function. The NPM is not susceptible to de-inerting. The design utilizes radiation monitors under the bioshield and core exit thermocouples to assess core damage. As such, combustible gas monitoring is not necessary for the NPM to guide implementation of the emergency plan and severe accident management mitigative actions. Therefore, the design meets the underlying purpose of 10 CFR 50.44(c)(4).

RAI 19.2-1

10 CFR 50.34(f)(2)(xvii)(C) also requires containment hydrogen monitoring capability. It is a Three Mile Island requirement that predates and has the same underlying purpose as 10 CFR 50.44(c)(4). Therefore, the design also meets the underlying purpose of 10 CFR 50.34(f)(2)(xvii)(C).

2.2.1 Technical Basis

The underlying purpose of the combustible gas monitoring requirements is to enable the assessment of core damage and verification that combustible gas control systems perform their beyond design-basis functions, to support severe accident management and emergency planning.

RAI 19.2-1

As discussed in FSAR Section 6.2.5, the NPM relies on a passive autocalytic recombiner (PAR) to maintain the containment inert through the continuous recombination of oxygen and hydrogen that may initially be in the NPM at the beginning of BDBAs and any generated post accident. The PAR is designed to maintain the containment inert following both design basis and beyond design basis events, but design basis events are limiting. In the NuScale design oxygen is the limiting reactant for the PAR function. Unlike hydrogen igniters and similar mitigation features, the PAR does not rely on electric power or moving parts to function. The PAR is a highly reliablesafety-related passive device that self-actuates to recombine oxygen and hydrogen present in the surrounding environment. The PAR is designed to function in the severe accident environments for which it is intended.

RAI 19.2-1

The NPM is not susceptible to de-inerting. Following a BDBA the containment will be oxygen-limited; the hydrogen generated in a clad-coolant reaction would only further reduce the relative oxygen concentration. The only sources of oxygen are from the initial quantities in the reactor coolant system controlled by the primary chemistry control program and through radiolytic decomposition of water. Inerting is accomplished solely by the PAR recombining oxygen; no inert gas is added to the containment during operations or post-accident. The PAR has adequate capacity to maintain the containment oxygen concentration below four percent by volume.

The design does not rely on hydrogen monitoring to assess core damage. As described in FSAR Section 7.1, the radiation monitors under the bioshield and the core exit thermocouples provide the ability to detect and assess core damage.

The requested exemption is authorized by law (10 CFR 50.12(a)(1)). This exemption is not inconsistent with the Atomic Energy Act of 1954, as amended. The NRC has authority under 10 CFR 52.7 and 10 CFR 50.12 to grant exemptions from the requirements of this regulation. Therefore, the proposed exemption is authorized by law.

The requested exemption will not present an undue risk to the public health and safety (10 CFR 50.12(a)(1)). This exemption does not affect the performance or reliability of power operations, does not impact the consequences of any design-basis event, and does not create new accident precursors. This exemption concerns only the capability to monitor combustible gases during a BDBA; the design precludes combustion. Therefore, the exemption does not present an undue risk to the public health and safety.

The requested exemption is consistent with the common defense and security (10 CFR 50.12(a)(1)). The exemption does not affect the design, function, or operation of structures or plant equipment necessary to maintain the secure status of the plant. The proposed exemption has no impact on plant security or safeguards procedures. Therefore, the requested exemption is consistent with the common defense and security.

Special circumstances are present (10 CFR 50.12(a)(2)(ii)) in that application of the regulation in the particular circumstances is not necessary to achieve the underlying purpose of the rule. The design precludes combustion that could challenge containment structural integrity, safe shutdown functions, or accident mitigation features. Combustible gas monitoring is not necessary to support severe accident management and emergency planning.

Special circumstances are present (10 CFR 50.12(a)(2)(vi)) in that there is present a material circumstance not considered when the regulation was adopted for which it would be in the public interest to grant an exemption. The design has a very low likelihood of core damage that would lead to significant amounts of combustible gases within containment, and the design passively controls oxygen levels to preclude combustion. Combustible gas monitoring would require unisolating the containment during the response to an accident, where containment isolation is essential to both severe accident prevention and mitigation. Therefore, the difference in "risk tradeoff" is a material circumstance not considered when the regulation was adopted; the exemption avoids unnecessary containment unisolation, which is in the public interest.

2.4 Conclusion

RAI 19.2-1

On the basis of the information presented, NuScale requests that the NRC grant an exemption from ~~10 CFR 50.44(c)(4) and~~ 10 CFR 50.34(f)(2)(xvii)(C) for the US460 standard design approval.

NRC staff concluded that the topical reports provided adequate basis to eliminate the PASS as a required system for post-accident sampling. As discussed in the safety evaluation for CE NPSD-1157, the NRC based its decision "on the acceptability of the proposal to eliminate PASS on the benefit that the information obtained from PASS would provide in accident management and emergency response. If this information was considered to be necessary, and therefore, planned to be obtained shortly after a severe accident, then a PASS would be prudent to ensure that samples could be taken promptly and exposure minimized. However … the information is not considered to be beneficial for accident management or emergency response. Therefore, there is considered to be sufficient time to establish an alternate sampling capability if samples were considered to be beneficial in the longer term."

As addressed below, in the US460 design the information that could be obtained from post-accident sampling is not necessary for accident management and emergency response, because the design allows for sufficient information collection through other means.

16.2.2 Technical Basis

The underlying purpose of 10 CFR 50.34(f)(2)(viii) is to ensure the capability for plant operators to assess the presence and extent of core damage following an accident. In the US460 design, this capability is provided by radiation monitors under the bioshield and by core exit thermocouples. The design is capable of classifying a fuel damage event at the alert level threshold utilizing the radiation monitors under the bioshield and the core exit thermocouples.

In major accident scenarios, including core damage events, the NuScale Power Module (NPM) is designed to preserve primary coolant inventory and contain the potential post-accident source term by isolating containment. The process of taking a sample from the primary coolant or containment would require unisolating containment and extracting potentially radioactive post-accident material to the outside of containment. In lieu of such a process, the design relies upon other means to indicate the presence of core damage, namely radiation monitors under the bioshield and core exit thermocouples. This design philosophy results in a lower potential for facility contamination and personnel radiation exposure. The specific sampling capabilities required by 10 CFR 50.34(f)(2)(viii) are addressed below.

Primary Coolant Dissolved Gases (Including Hydrogen):

The NPM is insusceptible to an accumulation of noncondensable gases interfering with post-accident natural circulation (Part 7, Section 1, and FSAR Section 5.4.4). Therefore, grab sampling of reactor coolant for dissolved gas analysis is unnecessary to ensure post-accident natural circulation capability.

Containment Hydrogen and Oxygen:

RAI 19.2-1

The NPM has features that support containment hydrogen and oxygen monitoring using the process sampling system (PSS) during normal operations (FSAR

Section 9.3.2). The design precludes a combustible atmosphere following a beyond design basis event by using a passive autocatalytic recombiners to limit oxygen concentration. Therefore, sampling of containment hydrogen and oxygen is unnecessary to ensure containment integrity. FSAR Section 6.2.5 contains additional information on combustible gas control capability ~~and exemption from the monitoring requirements of 10 CFR 50.44(c)(4)~~.

Primary Coolant Chlorides:

The purpose of sampling the reactor coolant for chlorides is to ensure that chloride-induced stress corrosion cracking of stainless steel components will not occur post-accident in the long term. As opposed to typical light water reactors, the NPM design does not employ automatic safety injection or other coolant makeup, and does not utilize large quantities of chlorinated cable insulation inside containment. Therefore, the amount of reactor coolant chlorides during ECCS recirculation remains unchanged and post-accident reactor coolant sampling for chlorides is unnecessary.

Primary Coolant Boron Concentration:

The purpose of sampling the reactor coolant for boron is to ensure that there is adequate shutdown margin to maintain safe shutdown during long term emergency cooling. The capability to ascertain the RCS boron concentration is important where makeup water, other than the original reactor coolant inventory, is used to refill the reactor vessel or to flood the containment during an accident. Because the NPM design does not employ automatic safety injection or other coolant makeup, the total boron concentration in the primary coolant does not decrease. FSAR Section 15.0.5 addresses long-term boron concentration and reactor shutdown capability. Therefore, post-accident boron sampling is not necessary.

Primary Coolant and Containment Radionuclide Concentration:

The purpose of sampling the post-accident reactor coolant for radionuclide content is to verify that the integrity of the fuel rod cladding is not breached during an accident, or to assess the degree of core damage if cladding is breached. The capability to measure reactor coolant radionuclides also supports the Emergency Action Level (EAL) classification in the Site Emergency Plan. The design utilizes radiation monitors under the bioshield and core exit thermocouples to assess core damage. Therefore, post-accident radionuclide content sampling is not necessary.

16.3 Regulatory Basis

16.3.1 Criteria of 10 CFR 50.12, Specific Exemptions

Pursuant to 10 CFR 52.7, "consideration of requests for exemptions from requirements of the regulations of other parts in this chapter, which are applicable by virtue of this part, shall be governed by the exemption requirements of those parts." The exemption requirements for 10 CFR Part 50 regulations are found in 10 CFR 50.12, and are addressed as follows:

- The safety-related relief valves listed in Table 2.4-3 provide overpressure protection.
- The DHRS condensers listed in Table 2.4-3 have the capacity to transfer their design heat load.
- The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions, and performs its function for the period of time required to complete the function.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.

RAI 19.2-1

- The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.

2.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4-1 contains the ITAAC for the equipment qualification - module-specific equipment.

Table 2.4-1: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.04.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
09.	The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the CNTS containment electrical penetration assemblies listed in Table 2.4-3 including associated connection assemblies. ii. An inspection will be performed of the containment CNTS electrical penetration assembles listed in Table 2.4-3, including associated connection assemblies.	i. An EQ record form exists and concludes that the CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, performs their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, are installed in their design location in a configuration bounded by the EQ record form.
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4 10.	The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.	A type test, analysis, or a combination of type test and analysis will be performed of the CNTS passive autocatalytic recombiner.	A report exists and concludes that the PAR has sufficient capacity to meet or exceed the minimum required oxygen recombination rate.
RAI 19.2-1 11.	The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.	An analysis will be performed of the CNTS passive autocatalytic recombiner.	A qualification record form exists and concludes that the CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life under the design basis harsh environmental conditions specified in the qualification record form.

Table 2.4-2: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[1] (Continued)

	ITAAC No.	Discussion
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4	02.04.10	FSAR Section 6.2.5, Combustible Gas Control in the Containment Vessel, discusses that the PAR provides the safety-related function of maintaining an inert atmosphere (i.e., less than 4 percent oxygen by volume) in the CNV, which is achieved by the continuous recombination of oxygen. FSAR Section 6.2.5 lists the minimum design oxygen recombination rate (in moles per hour) for the PAR to ensure the CNV atmosphere remains inert following design-basis events. This ITAAC verifies that the PAR oxygen recombination rate meets or exceeds the minimum required oxygen recombination rate specified in FSAR Section 6.2.5 to maintain the CNV atmosphere inert during design-basis events.
RAI 19.2-1	02.04.11	FSAR Section 3.11 presents information to demonstrate that the CNTS passive autocatalytic recombiner located in a harsh environment is qualified using an analysis to perform its function up to the end of its qualified life in design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions. Environmental conditions include both internal service conditions and external environmental conditions for the PAR. The qualification method employed for the equipment is the same as the qualification method described for that type of equipment in FSAR Section 3.11. The ITAAC verifies that: (1) an equipment qualification record form exists for the PAR, and (2) the qualification record form concludes that the PAR listed in Table 2.4-3 perform its intended function up to the end of its qualified life under the design basis environmental conditions (both internal service conditions and external environmental conditions) specified in the qualification record form.

Note:
1) References to Tables and Figures refer to ITAAC unless the reference specifically states FSAR Tables or Figures.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-4: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.04.01	X					
02.04.02	X					
02.04.03	X					
02.04.04	X					
02.04.05	X					
02.04.06	X					
02.04.07	X					
02.04.08	X					
02.04.09	X					
02.04.10	X					
02.04.11	X					

Enclosure 3:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-2, Proprietary

NuScale Power, LLC
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Enclosure 4:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-2, Nonproprietary

Response to Request for Additional Information
Docket: 052000050

RAI No.: 10185
Date of RAI Issue: 05/10/2024

NRC Question No.: 19.2-2

Regulatory Basis:

• 10 CFR 52.137(a)(2) requires a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification, upon which the requirements have been established, and the evaluations required to show that safety functions will be accomplished.

• 10 CFR 52.137(a)(4) requires an analysis and evaluation of the design and performance of SSC with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.

• 10 CFR 52.137(a)(9) requires, for applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.

• 10 CFR 52.137(a)(12) requires an analysis and description of the equipment and systems for combustible gas control as required by § 50.44 of this chapter.

• 10 CFR 52.137(a)(23) requires a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass.

• 10 CFR 52.137(a)(25) requires that the application must contain a final safety analysis report that describes … the design-specific probabilistic risk assessment and its results.

• 10 CFR 52.137(b) requires, in part, an application for approval of a standard design, which differs significantly from the light-water reactor designs of plants that have been licensed and in commercial operation before April 18, 1989, or uses simplified, inherent, passive, or other innovative means to accomplish its safety functions, must meet the requirements of 10 CFR 50.43(e), as identified below.

• 10 CFR 50.43, “Additional standards and provisions affecting class 103 licenses and certifications for commercial power,” states, in part, the following:

(e) Applications for a design certification, combined license, manufacturing license, or operating license that propose nuclear reactor designs which differ significantly from light- water reactor designs that were licensed before 1997, or use simplified, inherent, passive, or other innovative means to accomplish their safety functions, will be approved only if:

(1)(i) The performance of each safety feature of the design has been demonstrated through either analysis, appropriate test programs, experience, or a combination thereof;

(ii) Interdependent effects among the safety features of the design are acceptable, as demonstrated by analysis, appropriate test programs, experience, or a combination thereof; and

(iii) Sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions

• 10 CFR 50.44(c) Requirements for future water-cooled reactor applicants and licensees. The requirements in this paragraph apply to all water-cooled reactor construction permits or operating licenses under this part, and to all water-cooled reactor design approvals, design certifications, combined licenses or manufacturing licenses under part 52 of this chapter, any of which are issued after October 16, 2003.

(1) Mixed atmosphere. All containments must have a capability for ensuring a mixed atmosphere during design-basis and significant beyond design-basis accidents.

(2) Combustible gas control. All containments must have an inerted atmosphere, or must limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, uniformly distributed, to less than 10 percent (by volume) and maintain containment structural integrity and appropriate accident mitigating features.

(3) Equipment Survivability. Containments that do not rely upon an inerted atmosphere to control combustible gases must be able to establish and maintain safe shutdown and containment structural integrity with systems and components capable of performing their functions during and after exposure to the environmental conditions created by the burning of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur. The amount of hydrogen to be considered must be equivalent to that generated from a fuel clad-coolant reaction involving 100 percent of the fuel cladding surrounding the active fuel region.

(4) Monitoring. (i) and (ii) Equipment must be provided for monitoring oxygen in containments that use an inerted atmosphere for combustible gas control. Equipment for monitoring oxygen and hydrogen must be functional, reliable, and capable of continuously measuring the concentration of oxygen in the containment atmosphere following a significant beyond design-basis accident for combustible gas control and accident management, including emergency planning.

(5) Structural analysis. An applicant must perform an analysis that demonstrates containment structural integrity. This demonstration must use an analytical technique that is accepted by the NRC and include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved. The analysis must address an accident that releases hydrogen generated from 100 percent fuel clad-coolant reaction accompanied by hydrogen burning. Systems necessary to ensure containment integrity must also be demonstrated to perform their function under these conditions.

• 10 CFR 50.12, “Specific exemptions,” Section (a). The Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of the regulations of this part, which are--

(1) Authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security.

(2) The Commission will not consider granting an exemption unless special circumstances are present

• 10 CFR Part 50, Appendix A, General Design Criteria

Criterion 1—Quality standards and records. Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

Criterion 4—Environmental and dynamic effects design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

Criterion 41—Containment atmosphere cleanup. Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure.

Criterion 42—Inspection of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components, to assure the integrity and capability of the systems.

Criterion 43—Testing of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural integrity of its components, (3) the operability of the systems as a whole and, under conditions as close to design as practical.

Issue:

To address the issue of combustible mixture within the reactor coolant system (RCS), NuScale has identified the ECCS valves (reactor vent valves) opening automatically at 8 hours after design basis events to prevent a combustible gas mixture in the RCS. These valves vent H2 and O2 into the CNV, promptly creating a combustible gas mixture in the CNV. NuScale then relies on the PAR with preventing combustion in the CNV, thereby protecting the CNV integrity and avoiding a direct path of radioactive release to the environment. NuScale's supporting analysis for AOOs, events which are expected to occur at least once in the life of the plant, demonstrates release of a combustible mixture in the CNV within 24 hours and reliance on the PAR to maintain containment integrity. Based on its analysis on the presence and treatment of combustible gas in the RCS in EC-121960, NPM-20, Combustible Gas Management, Revision 2, which includes an evaluation of the scenario described above, NuScale concludes, "The results found that {{

}}[2(a),(c)]" (emphasis added).

The PAR is currently not modeled in the NuScale SDAA PRA based on the results of SA sequence simulations that demonstrate that a combustible mixture is not present in the containment for 72 hours for those sequences. These are the so-called failure sequences in the PRA which lead to core damage. However, NuScale's analyses demonstrate that the PAR is necessary for containment integrity during DBE scenarios. The DBE sequences represent the so-called success sequences in the PRA which do not lead to core damage. Therefore, failure of the PAR during success sequences would result in a direct release of radioactivity (i.e., the radioactive steam transferred from the RCS to the containment via the ECCS) to the environment. NuScale has not provided any quantitative evaluation that demonstrates a different conclusion. Consequently, the current PRA does not reflect the US460 design, and the PAR needs to be included in the SDAA PRA for the success sequences which do not go to core damage but can result in large release due to loss of containment integrity.

Information Requested:

To support the staff's finding against 10 CFR 52.137(a)(25) that the PRA represents the as-designed plant:

1. Include the PAR in the PRA for the NuScale SDAA and provide (i) FSAR markups with corresponding event trees, risk insights, dominant large release frequency sequences, and risk quantification results, and (ii) a discussion of the modeling of the PAR in the PRA, including the sequences that are impacted, the basis for the selected reliability, and any sensitivities performed.

2. Demonstrate that the human reliability analysis (HRA) and resulting human error probability (HEP) for the manual bypass of the 8-hour ECCS timer includes consideration of the need to confirm the critical hydrogen concentration in the RCS by the operators in addition to

subcriticality at cold conditions. Include discussion of how the operators will make this determination identifying the instrumentation that will be used by the operators for confirmation and its reliability. If the HRA or the HEP needs to be changed, justify the new value, and provide FSAR markups resulting from HEP change.

3. Provide FSAR markups in Chapter 6 to include details related to when and how the manual bypass of the 8-hour ECCS timer will be performed by the operators to confirm critical hydrogen concentration in the RCS.

4. Provide a summary of NuScale report ER-126742, Revision 1, Severe Accident Selection Methodology and Results, on the docket that describes (i) the representative SA scenarios selected for evaluation, (ii) the modeling of H2 from clad oxidation and O2 from radiolysis, and (iii) the results that demonstrate that for 72 hours, a combustible mixture in the CNV is not produced, including Table O-2, and Figures O-1 through O-13 from Appendix O of the report.

NuScale Response:

The staff's issue statement for Request for Additional Information Question 19.2-2 suggests that in a non-core damage event, a release of reactor coolant to the environment can represent a large release. As discussed in Final Safety Analysis Report (FSAR) Section 19.1.4.2.1.4, Release Categories, NuScale's definition of a large release is based on a threshold radionuclide dose of 200 rem acute whole body dose. This dose requires a source term that is orders of magnitude greater than a release of all primary coolant in a NuScale Power Module (NPM) directly to the environment, bypassing containment. NuScale's Probabilistic Risk Assessment (PRA) considers sequences that bypass containment with a substantial release of primary coolant to the environment without core damage (e.g., unisolated chemical and volume control system [CVCS] breaks outside of containment), and these scenarios are not large releases. In order to generate a radionuclide dose large enough to meet the definition of a large release, an event must include core damage, although not all events that include core damage lead to a large release.

The staff further asserts that "NuScale's analyses demonstrate that the PAR is necessary for containment integrity during DBE scenarios." NuScale analyses do not demonstrate the passive autocatalytic recombiner (PAR) is necessary for containment integrity. NuScale analyses show that a combustible atmosphere could develop without the PAR. NuScale elected to demonstrate containment vessel integrity under combustion conditions for the US600 design. For the US460 design, NuScale has elected to preclude combustion via the PAR, despite a similar containment vessel design with a higher design pressure.

1. Analyses performed to support the US460 Standard Design Approval Application show the structural integrity of the reactor pressure vessel and the containment vessel are not threatened by the energy produced in a postulated hydrogen combustion. Additionally, NuScale performed analyses postulating a hypothetical failure of the containment pressure boundary occurring after a combustible environment forms in the NPM. Those analyses demonstrate that core damage does not result. Therefore, the PAR does not impact PRA success criteria and is not included in the PRA.

2. The expected operational requirements for the manual bypass of the 8-hour emergency core cooling system (ECCS) timer (i.e., block the ECCS actuation due to the 8-hour timer) include confirming subcriticality at cold conditions and a critical hydrogen concentration. The detailed steps are expected to include confirmation of control rod insertion and verification of sufficient reactor coolant system (RCS) hydrogen concentration. Operators can confirm sufficient hydrogen concentration by an RCS dissolved hydrogen sample, which requires operation of the CVCS, or if the pressurizer gas space has not been vented since the last successful hydrogen sample. Operators perform this action routinely following every automatic or manual reactor trip.

There are only two scenarios that can vent the pressurizer gas space of enough hydrogen to jeopardize radiolytic suppression: intentional venting of the pressurizer to remove noncondensible gas and improve spray response, and events initiated by a pressurizer spray line break outside of containment. These scenarios are rare and easily identifiable, meaning that operators will reliably confirm sufficient hydrogen concentration and bypass the 8-hour timer after reactor trips, even if CVCS is not available to produce a dissolved hydrogen sample. The quantification of human error probability has sufficient margin to accommodate these actions.

3. NuScale added information about the RCS hydrogen concentration criterion to bypass the 8-hour ECCS timer to FSAR Section 6.3, Emergency Core Cooling System, in response to Audit Issue A-6.3-10. The FSAR pages with this added information are attached to this Request for Additional Information response.

4.

(i) Final Safety Analysis Report Section 19.2.3, Severe Accident Mitigation, includes a discussion on the selection of severe accident sequences and descriptions of the most relevant cases. Table 1, Severe Accident Cases, provides the severe accident cases NuScale analyzes and a description of each case.

(ii) MELCOR severe accident simulations supporting the NuScale PRA do not directly account for the generation of gases from radiolysis. However, the generation of oxygen gas from radiolysis is relevant to the formation of a combustible mixture in the NPM during a severe accident because oxygen is the limiting reactant in a potential combustible mixture. To address this limitation, NuScale evaluates the potential for a combustible mixture to form in the NPM during a severe accident when the effects of radiolysis are considered.

The evaluation, without consideration of the PAR, superimposes the generation of oxygen gas from radiolysis onto the MELCOR results from representative severe accident sequences to determine if a combustible environment forms. Five representative sequences are selected from the list of severe accident sequences in FSAR Section 19.2.3. The selected sequences are intact containment severe accident sequences that consider a range of system failures and result in diverse severe accident progressions. Unisolated breaks outside of containment are not considered because these cases already involve containment failure and the potential challenge to containment integrity from combustion is not relevant. The sequences selected for evaluation are:

- LCC-05T-01
- LCC-05T-02
- LEC-06T-00
- LEC-05T-00
- TRN-07T-01

The MELCOR simulation results provide time-history partial pressures of steam and hydrogen in the containment. The partial pressure of steam is related to the temperature of coolant in the NPM, which is generally decreasing from the start of the transient. Hydrogen is produced by cladding oxidation, which occurs following core uncovery. The partial pressure of oxygen is calculated from the ideal gas law based on a conservative estimate of the radiolysis rate (moles of oxygen as a function of time) and the temperature and volume of the gas space in containment. The evaluation considers two initial containment atmospheres for each sequence: no air or oxygen (the “base case”), and 0.21 psia of oxygen (the “sensitivity case”), which is equivalent to 1 psia of air. Figure 1, Total Moles of Oxygen, presents the time-history number of moles of oxygen in containment for the base case and sensitivity case.

The containment oxygen gas fraction is calculated as the oxygen partial pressure divided by the total pressure, which is the sum of the steam, hydrogen, and oxygen partial pressures. The evaluation considers a combustibility criterion of 4 percent oxygen.

(iii) Figures 2 and 3 present the oxygen fractions for each 72-hour severe accident sequence for the base case and sensitivity case, respectively. Table 2 presents the peak oxygen fractions for each case. Even in the conservative sensitivity case, the oxygen fractions do not exceed the 4 percent combustibility criterion; accordingly, the containment remains inert, even without the PAR.

Figures 4 through 13 present the containment atmosphere composition (hydrogen, oxygen, and steam fractions) for each sequence and case (base case and sensitivity case). TRN-07T-01 (Figures 12 and 13), which is a slow vapor space break, contains the highest oxygen fraction. This sequence produces {{

}}2(a),(c)

Table 1: Severe Accident Scenarios

Case	Description
LCC-05T-01	CVCS injection line LOCA inside containment with reactor vent valves (RVVs) opening on demand. No other systems functioning.
LCC-05T-02	CVCS injection line LOCA inside containment with all ECCS valves failing to open. No other systems functioning.
LEC-06T-00	Spurious actuation of a single RVV with the other RVV opening on demand. No other systems functioning.
TRN-07T-01	One reactor safety valve sticking open upon first demand without any other systems functioning (no ECCS valves open)
{{	
	}}2(a),(c)
LEC-05T-00	Similar to LEC-06T-00, in that it is a spurious LOCA with incomplete ECCS actuation, but with a spurious single reactor recirculation valve opening with the other reactor recirculation valve opening on demand (as opposed to a spurious single RVV opening as in LEC-06T-00). No other systems functioning.
LCU-03T-01	Unisolated CVCS injection line pipe break outside containment with no other systems functioning and ECCS completely failed. Despite the prescribed failure of containment isolation, this case provides insight into the containment vessel performance when subject to thermal attack from core debris.
{{	}}2(a),(c)

Table 2: Peak Oxygen Fractions

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}}2(a),(c)

Figure 1: Total Moles of Oxygen

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}}2(a),(c), ECI

Figure 2: Oxygen Fractions, Base Cases

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}}2(a),(c), ECI

Figure 3: Oxygen Fractions, Sensitivity Cases

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}}2(a),(c), ECI

Figure 4: Containment Atmosphere Composition – LCC-05T-01, Base Case

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}}2(a),(c), ECI

Figure 5: Containment Atmosphere Composition – LCC-05T-01, Sensitivity Case

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}}2(a),(c), ECI

Figure 6: Containment Atmosphere Composition – LCC-05T-02, Base Case

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}}2(a),(c), ECI

Figure 7: Containment Atmosphere Composition – LCC-05T-02, Sensitivity Case

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}}2(a),(c), ECI

Figure 8: Containment Atmosphere Composition – LEC-06T-00, Base Case

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}}2(a),(c), ECI

Figure 9: Containment Atmosphere Composition – LEC-06T-00, Sensitivity Case

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}}2(a),(c), ECI

Figure 10: Containment Atmosphere Composition – LEC-05T-00, Base Case

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}}2(a),(c), ECI

Figure 11: Containment Atmosphere Composition – LEC-05T-00, Sensitivity Case

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}}2(a),(c), ECI

Figure 12: Containment Atmosphere Composition – TRN-07T-01, Base Case

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}}2(a),(c), ECI

Figure 13: Containment Atmosphere Composition – TRN-07T-01, Sensitivity Case

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}}2(a),(c), ECI

Service Level B Transient 7 - Inadvertent Operation of the Decay Heat Removal System

Audit Question A-3.9.1-1

Inadvertent operation of the DHRS could occur in two ways. The first is inadvertent opening of one or more of the DHRS actuation valves from a single DHRS train. Opening an actuation valve allows flow between the DHRS condenser and the steam line as steam and feedwater pressures equalize. Initial pressure equalization in the secondary side disrupts the primary temperature. Inadvertent opening of the single DHRS valve wouldmay result in a reactor trip and eventual actuation of the second DHRS train. The second way to cause inadvertent DHRS actuation is by the MPS sending a signal to actuate the DHRS by closing the MSIVs and feedwater isolation valves (FWIVs) and opening the DHRS actuation valves on one train, which results in the full-power operation of botha single trains of the DHRS. The DHRS actuation signal causes a reactor trip. The reactor safety valves (RSVs) do not lift for either occurrence.

Service Level B Transient 8 - Reactor Trip from Full Power

Audit Question A-6.3-10

A reactor trip from full power could be caused by multiple spurious sensor signals to the MPS, or a spurious trip signal from the MPS, or miscellaneous failures that cause a reactor trip setpoint to be reached, and are not already included in other transients. Once the trip begins, control rods drop into the core to take the core subcritical, reducing core thermal power to decay heat and causing hot and cold RCS temperatures to converge close to the average RCS temperature. Cooling is then initiated by one of two methods: either normal feedwater, or actuating the DHRS. If the DHRS is actuated, then a containment isolation signal may also be generated. When circulating feedwater through the SGs, the steam produced is directed through the turbine bypass valve to the condenser. Steam and feedwater flow rates are controlled to keep the cooling rate below allowable cooldown rates for the RCS and pressurizer regions. This transient ends once the reactor reaches the minimum hot shutdown temperature. Cooldown is accounted for in the cycles of the cooldown from hot shutdown transient. If the DHRS is actuated for a more severe failure, heat is removed through the DHRS condenser to the pool. An eight-hour ECCS actuation timer starts at an automatic or manual reactor trip and may be blocked if plant conditions allow, as described in Section 7.0.~~may be bypassed after completing a calculation demonstrating margin to subcriticality at cold temperature (e.g., pool temperature).~~

Service Level B Transient 9 - Control Rod Misoperation

This transient includes misoperations of the control rod assemblies (CRAs), such as the drop of a single CRA, the drop of a bank of CRAs, withdrawal of a single CRA, or withdrawal of a CRA bank. The CRA adds negative reactivity to the core that quickly reduces reactor power. Such a reduction in power leads to a decrease in RCS temperature and pressure. The decreasing temperature

The design supports an exemption from GDC 33 and Section 3.1.4 addresses this exemption.

The module protection system (MPS) and containment system isolates postulated leaks that occur outside the containment, thereby preserving the remaining inventory in the containment. This inventory maintains the coolant level above the top of active fuel and establishes cooling using the ECCS. The reactor coolant system or the ECCS supplemental boron function assure that reactivity control is maintained prior to and after ECCS actuation.

Audit Question A-6.3-10

The ECCS setpoints ensure ECCS valves automatically actuate for any of the following conditions:

Audit Question A-6.3-10

- in response to design-basis LOCA events
- 24 hours after a loss of AC power
- to perform an LTOP function
- if needed to maintain subcriticality during extended passive cooling
- if needed to maintain the RCS inert during extended passive cooling

Audit Question A-6.3-10

~~The ECCS setpoints ensure automatic actuation of ECCS valves in response to design-basis LOCA events or 24 hours after a loss of AC power, LTOP function, or if needed to maintain subcriticality during extended passive cooling.~~ ECCS valves also automatically actuate at a RCS pressure or RCS temperature conditions that could occur during beyond-design-basis event conditions, to provide defense in depth RPV and CNV over-pressure protection. Table 7.1-4 provides analytical limits used in analyses for ECCS actuation. The RPV and CNV design, in conjunction with the passive design and operation of ECCS and containment isolation, ensure that the core remains covered and ensures maintenance of adequate core cooling if a break occurs in the RCPB.

There is no safety-related coolant makeup system for coolant for protection against small breaks in the RCPB. The CVCS provides reactor coolant makeup during normal operation for small leaks in the RCPB, but is not relied upon during a design-basis event. The RPV and CNV design retain sufficient coolant inventory that, in conjunction with safety actuation setpoints to isolate CVCS from the RCS and operation of ECCS, adequate cooling is maintained and the SAFDLs are not exceeded in the event of a small break in the RCPB.Therefore, the ECCS design does not require a reactor makeup system and satisfies the underlying purpose of GDC 33.

Facility design meets the regulatory requirements of principal design criterion 35, and GDC 36 and GDC 37 as they relate to the ECCS providing sufficient core cooling to transfer heat from the core at a rate such that fuel and cladding damage does not interfere with or prevent long-term core cooling, permit appropriate periodic inspection of important components, and provide for appropriate periodic testing. Redundancy of

Stainless steel bolt-on flow diffusers are mounted on the discharge of the RVVs to diffuse the high pressure steam and water flow discharged to the CNV. RRVs do not require diffusers because they are smaller and more distant from equipment requiring protection. The RVV and diffuser, as a combined unit, have a minimum flow coefficient of 375 and minimum terminal pressure drop ratio (Xt) of 0.62. For ECCS demands, the RVVs fully open within 10 seconds after trip valve solenoid power removal.

Audit Question A-6.3-12

A venturi is in the inlet of each RVV and RRV between the RPV and the RRV and the RVV and is inserted internal to the main valve body. Each venturi throat diameter is sufficiently small to limit (choked) blowdown flow during postulated inadvertent reactor valve actuation events when there is a high differential pressure between the RPV and CNV to slow the depressurization rate. The RVV venturi throat diameter is 3.5 inches. The RRV venturi throat diameter is one inch. The venturi orientation minimizes unrecoverable pressure losses during long-term recirculation flow. With the venturis installed, the RVVs and RRVs maintain sufficient flow capacity to maintain long-term cooling when there is lower differential pressure. The key design parameter to ensure adequate flow capacity is the valve flow coefficient discussed above. Section 6.3.2.4 addresses flow blockage due to debris. ~~The venturi size and orientation maintains sufficient flow capacity through the RVV and RRV when there is lower differential pressure for recirculation conditions (unchoked flow) and long-term cooling and maintains margins for precluding the potential for flow blockage due to debris.~~

The containment shell provides passive heat removal by transferring decay and sensible heat to the reactor pool. The accumulated discharge of coolant into the CNV provides conductive and convective heat transfer to the reactor pool. Section 6.2 describes the CNV with additional information on the heat removal function in Section 6.2.2.

The capability for containment heat removal through ECCS operation occurs without operator action for at least 7 days. Section 9.2.5 describes the reactor pool (ultimate heat sink).

Audit Question A-6.3-10

Upon a sensed loss of AC power to the EDAS power system battery chargers, the MPS initiates reactor trip, decay heat removal actuation, demineralized water system isolation, and containment isolation to reduce battery load. In addition, three 24-hour digital timers in each division of the MPS start. If AC power cannot be restored within 24 hours, the timers initiate the ECCS by de-energizing the engineered safety features actuation system (ESFAS) MPS divisions. This ECCS hold mode maintains energized ECCS trip valve solenoids without an actuation signal, but sheds the load at 24 hours, ensuring sufficient battery power for post-accident monitoring for at least 72 hours. The ECCS immediately initiates upon receipt of an ECCS actuation signal as listed in Table 6.3-1 during the 24-hour timing period.

Audit Question A-6.3-10

~~This ECCS hold mode maintains energized ECCS trip valve solenoids without an actuation signal, but sheds the load at 24 hours ensuring sufficient battery power for post-accident monitoring for at least 72 hours. The ECCS immediately initiates upon receipt of an ECCS actuation signal as listed in Table 6.3-1 during the 24-hour timing period.~~ An timer automatically actuates ECCS eight hoursactuation after an automatic or manual reactor trip to allows the ECCS supplemental boron to recirculate into the reactor core region before xenon decays from the core, to passively ensuringe subcriticality without requiring operator actions. The RCS is also maintained inert by the actuation of the eight hour ECCS timer. Section 6.2.5 describes operation of the passive autocatalytic recombiner to maintain containment inert. Operators may manually blockbypass the actuation if subcriticality at cold conditions is confirmed and if it is confirmed that sufficient hydrogen concentration will be maintained in the RCS throughout DHRS cooldown to preclude radiolytic generation of combustible gases.~~upon confirmation of subcriticality at cold conditions.~~

6.3.2.2.1 ECCS Core Cooling System Supplemental Boron

Audit Question A-6.3-6

Upon actuation of ECCS, an ECCS supplemental boron (ESB) feature provides additional boron concentration to ensure that the reactor remains subcritical for at least 72 hours following an design-basis event. ~~Thus for DBEs, t~~The combined reactivity of the control rod assemblies and ESB ensures reactivity is controlled in accordance with GDC 27, as demonstrated in Section 15.0.5. Section 19.3.2, Structures, Systems, and Components Identification and Designation within Regulatory Treatment of Nonsafety Systems Program Scope, discusses subcriticality in the period beginning 72 hours after a design-basis event and lasting the following 4 days. The ESB provides sufficient boron to ensure core subcriticality and that the reactor core boron concentration remains below precipitation limits. The ESB and its components are not part of the RCPB and accordingly are not required to be designed to Quality Group A requirements. They are designed to remain operable following a design basis seismic event.

The two ESB dissolvers add boron to the ECCS recirculating coolant for reactivity control to maintain subcriticality following some design basis events (Figure 6.3-2). The dissolvers maintain subcriticality when the highest-worth control rod is stuck in a fully withdrawn position during long term cooling to prevent an overcooling return to power. Although the boron added by the dissolvers is not necessary during all design basis events to maintain subcriticality, the dissolvers are passive and respond to design basis accidents and transients that result in ECCS actuation where condensate forms on the inner containment surfaces. The dissolvers are fed by hoppers during the startup process and do not require personnel in the area to perform dissolver loading. This activity is performed remotely.

as a master on the MPS gateway backplane and then transmits the consolidated data through a qualified, isolated, one-way communication path to the MWS and the SDIS hubs as shown in Figure 7.0-8. There is one MPS gateway for each division.

The EDAS is the power source for the MPS as described in Section 8.3. The DC-to-DC voltage converters are used for Class 1E isolation and protection of the MPS equipment. Division I MPS power is generated from power channels A and C through a DC-DC converter for Class 1E isolation, and then distributed to the loads by sharing or auctioneering. Division II power is generated from power channels B and D, similar to Division I. Each of the separation groups is redundantly supplied from a single EDAS channel, and then distributed to the loads by sharing or auctioneering. Configuration of the EDAS channels and DC-to-DC voltage converters for MPS Division I and separation groups A and C are shown in Figure 7.0-9. The MPS Division II and separation groups B and D are similar. The EDAS power channels A and C that supply power to MPS Division I are completely independent from EDAS power channels B and D that supply power to MPS Division II and are shown in Figure 8.3-4a and Figure 8.3-4b.

To ensure EDAS batteries supply power for their mission time, only loads associated with maintaining the ECCS valves closed and PAM instrumentation remain energized during ECCS-hold mode. These loads include the MPS and NMS cabinets, including power to sensors, ECCS valve solenoids, RMS bioshield radiation monitors, and the EDAS battery monitors. If two out of four sensors detect a loss of voltage on both B and C battery charger switchgears, the MPS automatically generates a reactor trip, decay heat removal system (DHRS) actuation, pressurizer heater trip, demineralized water supply isolation, secondary system isolation, chemical and volume control system isolation, containment isolation, and starts the three 24-hour timers per division. For the first 24 hours following a loss of voltage, the four separation groups of MPS equipment and both divisions of ESFAS and RTS remain energized. If an ECCS actuation is not required due to plant conditions, then ECCS is not actuated (ECCS trip solenoid valves remain energized), which is defined as the ECCS-hold mode, to allow time to restore AC power and prevent actuation of ECCS. The ECCS still actuates if the associated ESFAS signal is generated during this 24-hour period.

If AC power is not restored within 24 hours, the 24-hour timers time out (PAM only mode), the RTS chassis, ESFAS chassis, MWS for both MPS divisions, and Separation Groups A and D are de-energized, and the rest of the ESFAS actuations initiate (e.g., ECCS), reducing the load on batteries for buses B and C to support the availability of PAM indications for a minimum of 72 hours.

Audit Question A-6.3-10

The MPS actuates ECCS automatically after a specified period of time following an automatic or manual reactor trip. This actuation allows the ECCS supplemental boron to recirculate into the reactor core region before xenon decays from the core, to assure subcriticality without requiring operator actions. The RCS is maintained inert by the actuation of the eight hour ECCS timer. This actuation may be manually blocked by operatorsOperators may manually block the actuation if subcriticality at cold conditions is confirmed and if it is confirmed that sufficient hydrogen concentration will be maintained in the RCS throughout DHRS cooldown to preclude radiolytic generation of combustible gases.

7.0.4.2 Neutron Monitoring System

The neutron monitoring system (NMS) performs the following functions:

- provides neutron flux data to the MPS for various reactor trips
- provides information signals to the MPS for post-accident monitoring
- provides neutron flux signals to the PCS during refueling operations

When the NPM is in transit to or from the refueling bay of the plant, neutron monitoring is not required. Equipment with the potential to cause core alterations, such as control rod drive mechanisms, is disconnected or disabled prior to NPM movement. The NMS consists of NMS-excore, NMS-refuel, NMS-flood, and positioning equipment.

The neutron monitoring system PAM function meets augmented quality and regulatory requirements described in Regulatory Guide 1.97, including Seismic categorization.

The NMS operating bay positioning equipment is safety-related. The nonsafety-related hydraulic power unit and control skid are classified as Seismic Category II, augmented quality.

7.0.4.2.1 Neutron Monitoring System-Excore

Neutron flux level signals generated by the safety-related NMS-excore equipment are used by the MPS to generate appropriate reactor protection trips, operating permissives, indication, and alarms for various modes of reactor operation, including shutdown conditions. The MPS sends neutron flux signals to other systems in order to provide non-protective controls and indication.

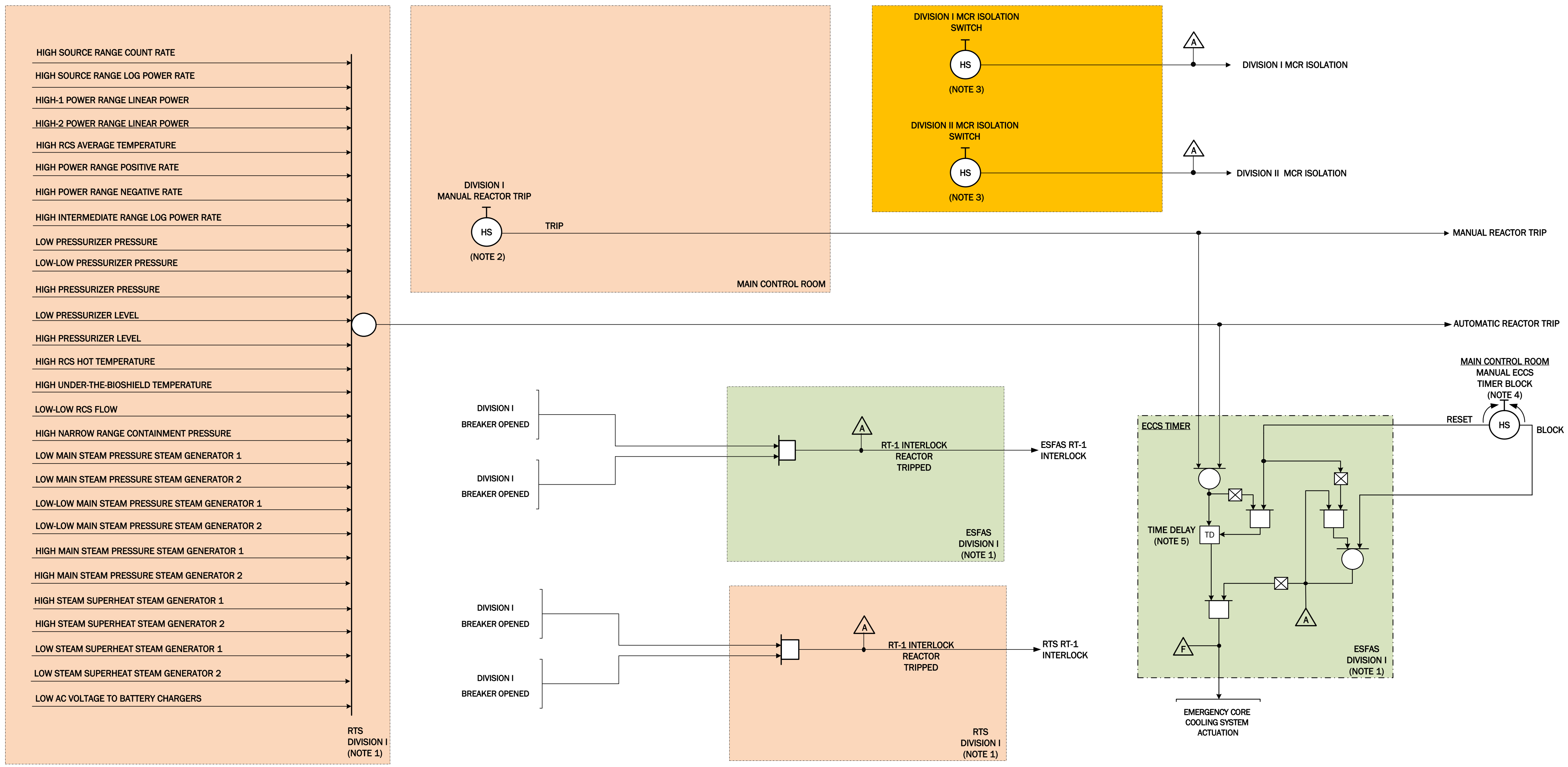
The NMS-excore sub-system monitors neutron flux during normal operations, off-normal conditions, design basis events, and the subsequent long-term stable shutdown phase. The NMS-excore sub-system continuously monitors the reactor neutron flux from shutdown to full rated power with wide range detectors for the source range, intermediate range, and power range.

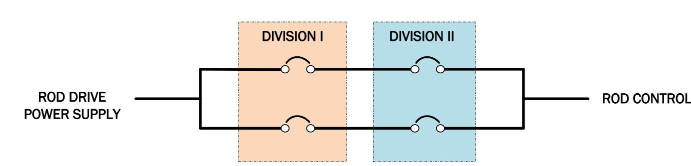
An NMS-excore sub-system includes the following components for each NPM:

- four wide-range excore detectors functioning over the source, intermediate, and power ranges distinguished by processing electronics
- moderator assemblies

Audit Question A-6.3-10

Figure 7.1-1j: Reactor Trip and Reactor Tripped Interlock RT-1





REACTOR TRIP BREAKER ARRANGEMENT

NOTE 1: LOGIC IS SHOWN FOR DIVISION I ONLY. LOGIC FOR DIVISION II IS THE SAME AS DIVISION I.

NOTE 2: TWO MANUAL REDUNDANT SWITCHES, ONE PER RTS DIVISION.

NOTE 3: TWO MANUAL ACTUATION ISOLATION REDUNDANT SWITCHES LOCATED OUTSIDE OF THE CONTROL ROOM, ONE PER ESFAS DIVISION.

NOTE 4: ECCS ACTUATION 8HRS AFTER REACTOR TRIP MAY BE MANUALLY BLOCKED BY OPERATORS IF SUBCRITICALITY AT COLD CONDITIONS IS CONFIRMED AND IF IT IS CONFIRMED THAT THE RPV CONTAINS SUFFICIENT HYDROGEN TO MAINTAIN A CRITICAL HYDROGEN CONCENTRATION IN THE RCS THROUGHOUT DHRS COOLDOWN.

NOTE 5: A CHANGE IN LOGIC STATE (FROM TRUE TO FALSE) RESETS THE TIMER. TIMER IS INSTANTIATED IN THE ESFAS SVM(S).

4) ECCS actuation following a LOCA, inadvertent ECCS operation, or DBE with loss of normal AC and EDAS power

Significant boron redistribution before ECCS actuation and unacceptable positive reactivity insertion is precluded as shown by analyses performed in accordance with Reference 15.0-8 and discussed below.

Scenario 1 - Decay and Residual Heat Removal using DHRS

Audit Question A-6.3-10

Non-LOCA events progress from event initiation to the point at which DHRS actuation valves open and MSIVs and FWIVs close to allow DHRS operation. This scenario assumes AC power is available and the post-trip reactivity balance for cold conditions is acceptable. Once reactivity and RCS hydrogen conditions are verified by the operators, the 8-hour ECCS timer is blocked. DHRS cools the NPM and provides long-term removal of decay heat while the RRVs and RVVs remain closed. Section 5.4.3 describes operation of DHRS, including actuation, cooling to the safe, stabilized condition, and long-term residual and decay heat removal.

In some scenarios, DHRS can cool the RCS such that the level drops below the top of the riser. Condensation of steam on the outside of the steam generator tubes could reduce the downcomer boron concentration. Diverse flow paths in the riser allow continued primary coolant flow and promote mixing to preclude unacceptable positive reactivity insertion in the event that ECCS actuates.

Scenario 2 - Decay and Residual Heat Removal using DHRS followed by Natural Circulation through the RVVs and RRVs after 24 hours

Audit Question A-6.3-10

For non-LOCA events that result in reactor trip and DHRS actuation, the ECCS actuates 8 hours after reactor trip unless the operators block the ECCS timer. Operators block the ECCS timer if RCS hydrogen conditions are met and if reactivity conditions indicate the additional negative reactivity provided by ESB is not needed to maintain subcriticality under cold conditions (Scenario 3 addresses the case where the 8-hour timer is not blocked by operators). If onsite AC power is lost for an extended time and the 8-hour timer actuation is blocked, EDAS power to the RVVs and RRVs is automatically removed after 24 hours and the valves go to a fail-safe open position. The RVVs open, steam condenses in the CNV, and natural circulation is established through the RRVs.

Opening the RVVs and RRVs to continue to depressurize the RCS and establish extended passive cooling with the ECCS is not considered an event escalation because the functions of the RCS barrier are not lost. Progression of the cooling function from DHRS to natural circulation using the RVVs and RRVs is an inherent function in the passive design of the NPM. The RCS barrier continues to provide a confined volume for reactor coolant, which allows a flow path for cooling the core and thus, confining fission products to the fuel and preventing an escalation of a DBE, including an AOO.

In some scenarios, DHRS can cool the RCS such that the level drops below the top of the riser. Condensation of steam on the outside of the steam generator tubes could reduce the downcomer boron concentration. Diverse flow paths located in the riser allow continued primary coolant flow and promote mixing to preclude unacceptable positive reactivity insertion when ECCS is actuated.

Scenario 3 - Decay and Residual Heat Removal using DHRS followed by Natural Circulation through the RVVs and RRVs after 8 hours

Audit Question A-6.3-10

For non-LOCA events that result in reactor trip and DHRS actuation, the ECCS actuates in 8 hours after a reactor trip. If reactivity conditions indicate that negative reactivity from ESB is needed to maintain subcriticality under cold conditions or if RCS hydrogen conditions are not met, operators do not block the ECCS 8-hour timer. In this scenario ECCS actuates after 8 hours, the RVVs open immediately and RRVs open when the IAB release differential pressure is reached, typically at the same time as the RVVs as DHRS cooldown depressurizes the RCS. Natural circulation is established through the RRVs.

In some scenarios, DHRS can cool the RCS such that the level drops below the top of the riser and the natural circulation loop is interrupted. Without natural circulation flow, condensation of steam on the outside of the steam generator tubes could reduce the downcomer boron concentration. Diverse flow paths through four holes located in the riser allow continued primary coolant flow and promote mixing to preclude unacceptable positive reactivity insertion when ECCS is actuated.

Scenario 4: Decay and Residual Heat Removal using ECCS following an Inadvertent ECCS Operation or LOCA

The system response in terms of potential challenge to the fuel from inadvertent ECCS operation, as described in Section 15.6.6, bounds other RPV valve opening events. After the RVVs and RRVs open following a LOCA or inadvertent ECCS operation, RCS inventory is redistributed between the RPV and CNV, and the NPM enters the same cooling configuration, irrespective of the initiating event. The results of the extended passive cooling analysis are summarized in Section 15.0.5.3.

Loss-of-coolant accidents or inadvertent ECCS operation events can result in condensation of unborated water in the RPV downcomer once level drops below the riser and the SG tubes become uncovered. The diverse flow paths in the upper riser promote mixing to preclude unacceptable positive reactivity insertion when ECCS is actuated, and ECCS actuation signals are designed to occur before the upper riser flow paths uncover. The lower riser holes provide a flow path for boron mixing for all extended ECCS cooling events.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The ACTUATION RESPONSE TIME of valves actuated by the ESFAS are verified in accordance with the IST program, and LCO 3.4.6, "Chemical and Volume Control System Isolation Valves," LCO 3.4.10, "LTOP Valves," LCO 3.5.1, "ECCS," LCO 3.5.2, "DHRS," LCO 3.6.2, "Containment Isolation Valves," LCO 3.7.1, "MSIVs," and LCO 3.7.2, "Feedwater Isolation."

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

SR 3.3.3.3

This SR measures the ECCS supplemental boron actuation time delay. A delayed ECCS actuation is initiated by any Reactor Trip Signal ensuring automatic ECCS actuation thereby causing supplemental boron to dissolve and recirculate into the RCS. The boron dissolves into RCS condensate from the open ECCS reactor vent valve flow. The dissolved boron then flows into the reactor vessel through the reactor recirculation valves. OPERABILITY requirements for the ECCS supplemental boron function are specified in LCO 3.5.4, “Emergency Core Cooling System Supplemental Boron (ESB).”

The ECCS supplemental boron actuation time delay is established to ensure boron automatically reaches the reactor core to mitigate the reactivity effects of the reduction of reactor power, xenon decay and RCS cooldown as assumed in the safety analyses. The delay provides an opportunity for the operating staff to block the actuation if conditions are evaluated and it is determined that~~determine the~~ supplemental boron is not required to mitigate the reactivity effects and that sufficient hydrogen concentration will be maintained in the RCS throughout DHRS cooldown to preclude radiolytic generation of combustible gases.

The acceptable ECCS actuation delay limits are specified in the COLR. Actual setpoints are established in accordance with the Setpoint Program.

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

Enclosure 5:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-3, Proprietary

Enclosure 6:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-3, Nonproprietary

Response to Request for Additional Information
Docket: 052000050

RAI No.: 10185
Date of RAI Issue: 05/10/2024

NRC Question No.: 19.2-3

Regulatory Basis:

• 10 CFR 52.137(a)(2) requires a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification, upon which the requirements have been established, and the evaluations required to show that safety functions will be accomplished.

• 10 CFR 52.137(a)(4) An analysis and evaluation of the design and performance of SSC with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.

• 10 CFR 52.137(a)(9) For applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.

• 10 CFR 52.137(a)(12) An analysis and description of the equipment and systems for combustible gas control as required by § 50.44 of this chapter.

• 10 CFR 52.137(a)(23) a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass.

• 10 CFR 50.44(c) Requirements for future water-cooled reactor applicants and licensees. The requirements in this paragraph apply to all water-cooled reactor construction permits or operating licenses under this part, and to all water-cooled reactor design approvals, design certifications, combined licenses or manufacturing licenses under part 52 of this chapter, any of which are issued after October 16, 2003.

(1) Mixed atmosphere. All containments must have a capability for ensuring a mixed atmosphere during design-basis and significant beyond design-basis accidents.

(2) Combustible gas control. All containments must have an inerted atmosphere, or must limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, uniformly distributed, to less than 10 percent (by volume) and maintain containment structural integrity and appropriate accident mitigating features.

(3) Equipment Survivability. Containments that do not rely upon an inerted atmosphere to control combustible gases must be able to establish and maintain safe shutdown and containment structural integrity with systems and components capable of performing their functions during and after exposure to the environmental conditions created by the burning of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur. The amount of hydrogen to be considered must be equivalent to that generated from a fuel clad-coolant reaction involving 100 percent of the fuel cladding surrounding the active fuel region.

(4) Monitoring. (i) and (ii) Equipment must be provided for monitoring oxygen in containments that use an inerted atmosphere for combustible gas control. Equipment for monitoring oxygen and hydrogen must be functional, reliable, and capable of continuously measuring the concentration of oxygen in the containment atmosphere following a significant beyond design-basis accident for combustible gas control and accident management, including emergency planning.

(5) Structural analysis. An applicant must perform an analysis that demonstrates containment structural integrity. This demonstration must use an analytical technique that is accepted by the NRC and include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved. The analysis must address an accident that releases hydrogen generated from 100 percent fuel clad-coolant reaction accompanied by hydrogen burning. Systems necessary to ensure containment integrity must also be demonstrated to perform their function under these conditions.

• 10 CFR 50.12, "Specific exemptions," Section (a) The Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of the regulations of this part, which are--

(1) Authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security.

(2) The Commission will not consider granting an exemption unless special circumstances are present

• 10 CFR Part 50, Appendix A, General Design Criteria

Criterion 1—Quality standards and records. Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

Criterion 4—Environmental and dynamic effects design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

Criterion 41—Containment atmosphere cleanup. Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure.

Criterion 42—Inspection of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components, to assure the integrity and capability of the systems.

Criterion 43—Testing of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural integrity of its components, (3) the operability of the systems as a whole and, under conditions as close to design as practical.

Issue:

Based on its analysis on the presence and treatment of combustible gas in the RCS in {{ }}[2(a),(c),ECI], which includes an evaluation of an AOO, NuScale concludes, "The results found that {{ }}[2(a),(c),ECI] (emphasis added). Therefore, the PAR is necessary to prevent a combustible mixture in the CNV and maintain CNV integrity for DBEs, including AOOs. The CNV is a safety-related SSC, which is a key fission product barrier and reactor coolant pressure boundary, especially after ECCS activation for DBEs. The integrity of the CNV is essential for both preventing the release of radioactive material and for effective core cooling. Therefore, the staff believes that the current categorization of the PAR's function as non-risk significant does not reflect its risk significance demonstrated by NuScale's analyses.

The PAR is currently designated as nonsafety-related. NuScale evaluated the PAR against the regulatory treatment of nonsafety systems (RTNSS) and determined that the PAR did not meet any of the five RTNSS criteria (A – E). Per the Design Reliability Assurance Program (D-RAP), an expert panel evaluated the PAR for risk significance and determined that the PAR did not perform any risk-significant functions, other than providing defense in depth for maintaining containment integrity following a SA. Consequently, the PAR is currently designated as non-risk significant. The SDAA FSAR, Revision 1, cites Regulatory Guide (RG) 1.7 for the augmented quality requirements for the PAR.

Per SRP Chapter 17.4, Revision 1, "Reliability Assurance Program," the Reliability Assurance Program (RAP) provides reasonable assurance of the following:

• The RAP SSCs do not degrade to an unacceptable level of reliability, availability, or condition during plant operations;

• These SSCs will function reliably when challenged;

• Quality assurance (QA) programs related to design and construction activities (e.g., design, procurement, fabrication, construction, inspection, and testing activities) to provide control over activities affecting the quality of the RAP SSCs.

Chapter 17.4 of the NuScale SDAA states that the implementation of the RAP provides reasonable assurance that, among other things, the "plant is designed, constructed, and operated in a manner that is consistent with the risk insights and key assumptions (e.g., SSC design, reliability, and availability) from the probabilistic, deterministic, and other methods of analysis used to identify and quantify risk" (emphasis added). Because the PAR is currently not identified as a risk significant SSC, it is not currently part of the SDAA's D-RAP.

In accordance with the Staff Requirements Memorandum to the SECY-95-132, the staff verifies the future implementation of the D-RAP using the inspections, tests, analyses, and acceptance criteria (ITAAC) process. The ITAAC ensures that the design bases and other requirements have been correctly translated into the detailed design documents used for procurement and construction of every RAP SSC. The D-RAP ITAAC provides assurance to the staff that appropriate controls were imposed during the development of design products for RAP SSCs. SRP 14.3.11, Containment Systems ITAAC, contains the guidance for the ITAAC relevant to the CNV, including hydrogen generation and control. Currently, there is no ITAAC for the PAR.

NuScale's analyses performed in response to RAI-10081 6.3-1 demonstrates that the PAR is necessary to prevent a combustible mixture in the CNV and maintain CNV integrity for DBEs, including AOOs. The CNV is a safety-related fission product barrier and reactor coolant pressure boundary, especially after ECCS activation. The integrity of the CNV is essential for both preventing the release of radioactive material and for effective core cooling. Therefore, the PAR meets Criterion 3 of 10 CFR 50.36(c)(2)(ii)(c) because it is part of the primary success path and functions to mitigate a DBA or transient that presents a challenge to the integrity of a fission product barrier. A technical specification limiting condition for operation should be established for the PAR.

The 2003 rulemaking for 10 CFR 50.44 was undertaken based on evaluations that demonstrated that combustible gases were not risk-significant for design basis events for large light-water reactors (LWRs). In contrast, as discussed above, NuScale's analysis demonstrates that combustible gas mixture is risk significant for the US460 design. NuScale has not provided any quantitative evaluation that demonstrates a different conclusion.

Based on the above, the PAR in Sections 6.2.5, 19.2.3, the exemption in SDAA, Part 7, Section 2, and for safety-related SSCs, such as the CNV, the staff believes that the PAR in the US460 design should be designated as a risk significant SSC and that regulatory controls are necessary to ensure that the PAR's risk significant function is achieved through design, procurement, qualification testing and analyses, and during plant operations.

Information Requested:

To support the staff's safety findings on the PAR and safety-related SSCs, such as the CNV, against the regulatory bases identified above, NuScale is requested to provide following FSAR markups to reflect the PAR's risk significant function demonstrated by NuScale's analyses:

1. Identify the PAR as a risk significant SSC and add it to the SDAA D-RAP program.

2. Provide the specific augmented quality requirements for the PAR.

3. Provide ITAAC(s) for the PAR.

4. Provide a Technical Specification for the PAR with justification for the corresponding action statement(s) and their completion time(s), and surveillance requirement(s).

NuScale Response:

In the issue portion of the Request for Additional Information (RAI), the staff refers to EC-121960. The request states:

> *Based on its analysis on the presence and treatment of combustible gas in the RCS in* {{ }}2(a),(c),ECI*, which includes an evaluation of an AOO, NuScale concludes, "The results found that* {{ }}2(a),(c),ECI *(emphasis added). Therefore, the PAR is necessary to prevent a combustible mixture in the CNV and maintain CNV integrity for DBEs, including AOOs.*

This calculation is not performing Chapter 15 analyses or evaluating Chapter 15 design-basis events, nor is this calculation evaluating a specific type of event. {{ }}2(a),(c),ECI

{{

}}2(a),(c),ECI

Furthermore, the Staff's assertion that preventing a combustible atmosphere is necessary to maintain CNV integrity is an unsupported assumption. NuScale elected to demonstrate CNV integrity under combustion conditions for the US600 design. For the US460 design, NuScale has elected to preclude combustion via the PAR, despite a similar CNV design with a higher design pressure.

Item 1

As discussed in the response to RAI 19.2-1, NuScale has reclassified the PAR as safety-related. By classifying the PAR as a safety-related component, additional controls (e.g., 10 CFR 50 Appendix B design control measures), programs (e.g., Environmental Qualification, technical specifications), and requirements (e.g., Inspections, Tests, Analyses, and Acceptance Criteria) provide additional assurance the PAR will perform its function in maintaining the containment atmosphere inert.

The PAR is not identified as risk-significant. NuScale's Design Reliability Assurance Program process has determined that the PAR is not risk-significant. Hydrogen combustion is not a safety concern in the context of the Probabilistic Risk Assessment. Specifically, the operation (or failure) of the PAR has no impact on the likelihood of core damage. As discussed in the response to RAI 19.2-1, the PAR is not credited in NuScale's Probabilistic Risk Assessment. Final Safety Analysis Report Section 19.2, Severe Accident Evaluation, discusses the adiabatic isochoric complete combustion analysis that uses the maximum hydrogen production from the severe accident simulations. It states:

> *Oxygen and hydrogen are produced by radiolysis until oxygen exceeds a 5 percent concentration, which is the MELCOR default lower limit and is challenging as it increases the total available moles of oxygen for combustion. It is estimated that radiolysis would have to proceed uninhibited for 37 days to produce such an oxygen concentration. The adiabatic isochoric complete combustion calculation results show that the post-deflagration pressure remains below the CNV design pressure. Therefore, the conservative adiabatic isochoric complete combustion analysis with several weeks of oxygen production demonstrates that hydrogen combustion does not pose a credible risk to the CNV.*

As stated above, this analysis is performed without credit for the PAR. Additionally, the response to RAI 19.2-2 includes other considerations. {{

}}2(a),(c),ECI

Item 2

As the PAR is now a safety-related component, it does not include augmented design requirements. The PAR includes the following design requirements:

- The PAR conforms with General Design Criterion 4.
- The PAR is designed in accordance with the relevant requirements of American Society of Mechanical Engineers (ASME) AG-1-2019, which includes analysis of prescribed load conditions including dynamic loads such as jet impingement.
- The PAR is a Seismic Category I component.
- The PAR is included in the Environmental Qualification Program.

Item 3

As a safety-related component located within the NuScale Power Module, Part 8 is revised to include the PAR within the scope of Inspections, Tests, Analyses, and Acceptance Criteria.

Item 4

The NuScale Generic Technical Specifications (TSs) are revised to include a TS Limiting Condition for Operation for the PAR. The associated TS and TS Bases are provided in the attached markups. Justification for the corresponding action statements and their completion times, and surveillance requirements is provided in the TS Bases.

Additional Information:

The Standard Design Approval Application has been revised as described in the response above and as shown in the markup provided in this response.

Audit Question A-3.5.1.3-2, Audit Question A-3.7.3-3, Audit Question A-3.11.2.3-1, Audit Question A-5.2.3.4.2-1, Audit Question A-6.1.1-2, Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.1-4, Audit Question DWO-SC-26, Audit Question EDAS Deep Dive Action Item 1, Audit Question EDAS Deep Dive Action Item 3, Audit Question EDAS Deep Dive Action Item 4, Audit Question EDAS Deep Dive Action Item 5, Audit Question EDAS Deep Dive Action Item 6, Audit Question EDAS Deep Dive Action Item 9, Audit Question EDAS Deep Dive Action Item 11, Audit Question EDAS Deep Dive Action Item 14
RAI 5.4.1.6.1-1, RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-2: Conformance with Regulatory Guides

RG	Title	Rev.	Conformance Status	Comments	Section
1.6	Safety Guide 6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	0	Not Applicable	The onsite electrical AC power systems do not contain Class 1E distribution systems.	Not Applicable
1.7	Control of Combustible Gas Concentrations in Containment	3	Partially Conforms	The design complies with the intent of RG 1.7 regulatory positions that address atmosphere mixing, hydrogen gas production, and containment structural integrity. However, the design deviates from the positions on hydrogen and oxygen monitors. The design includes a passive autocatalytic recombiner (PAR) that is sized to limit oxygen concentrations to a level that does not support combustion (i.e., less than four4 percent), this results inmaintaining an inert containment atmosphere. The design and quality standards applied to the PAR are commensurate with its safety-related, non-risk-significant function in the NuScale design, rather than the non-safety-related, risk-significant function underlying regulatory position C.1. The NuScale design does not include combustible gas monitoringsupports an exemption to 10 CFR 50.44(c)(4).	6.2.5
1.8	Qualification and Training of Personnel for Nuclear Power Plants	4	Not Applicable	This guidance governs site-specific programmatic and operational activities that are the responsibility of the applicant or licensee.	Not Applicable
1.9	Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants	4	Not Applicable	The NuScale design does not require or include safety-related emergency diesel generators.	Not Applicable
1.11	Instrument Lines Penetrating the Primary Reactor Containment	1	Not Applicable	No instrument lines penetrate the NuScale Power Module (NPM) containment.	Not Applicable

Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.2-2
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
SRP 1.0, Rev 2: Introduction and Interfaces	II.1	No Specific Acceptance Criteria	Not Applicable	No Specific Acceptance Criteria.	Not Applicable
SRP 1.0, Rev 2: Introduction and Interfaces	II.2	SRP Acceptance Criteria Associated with Each Referenced SRP section	Conforms	None.	Ch 1
SRP 1.0, Rev 2: Introduction and Interfaces	II.3	Performance of New Safety Features and Design Qualification Testing Requirements	Conforms	None.	Ch 1
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.1	Specific SRP Acceptance Criteria Contained in Related SRP Chapter 2 or Other Referenced SRP sections	Conforms	This acceptance criterion is a pointer to other SRP sections.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.2	COL Application Referencing an Early Site Permit but not a Certified Design	Not Applicable	This acceptance criterion is for COL applicants referencing an ESP.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.3	COL Application Referencing a Certified Design but not an Early Site Permit	Not Applicable	This acceptance criterion is for COL applicants that reference a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.4	COL Application Referencing an Early Site Permit and a Certified Design	Not Applicable	This acceptance criterion is for COL applicants that are referencing both an ESP and a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.5	COL Application Referencing Neither an Early Site Permit Nor a Certified Design	Not Applicable	This acceptance criterion is applicable to COL applicants that do not reference either an ESP or a certified design.	Not Applicable
SRP 2.1.1, Rev 3: Site Location and Description	All	Specification of Location and Site Area Map	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.2, Rev 3: Exclusion Area Authority and Control	All	Establishment of Authority, Exclusion or Removal of Personnel and Property, and Proposed and Permitted Activities	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.3, Rev 3: Population Distribution	All	Population Data, Exclusion Area, Low-Population Zone, Nearest Population Center Boundary, and Population Density	Not Applicable	Site-specific.	Not Applicable

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.4, Rev 0: Containment Isolation System	II.16	Specific Design Criteria for Containment Isolation Components	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.17	Provisions to Allow Control Room Operator Actions	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.18	Operability and Leakage Rate Testing	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.19	Reopening of Containment Isolation Valves	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.20	Station Blackout	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.21	Source Term in Radiological Calculations	Conforms	None.	6.2.4
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.1	Analysis of Hydrogen and Oxygen Concentration Control and Distribution in Containment	Partially Conforms	The containment atmosphere is maintained inert by the PAR, therefore the design safely accommodates hydrogen generated by an equivalent of a 100 percent~~%~~ fuel clad-coolant reaction without limiting containment hydrogen concentration to less than 10 percent~~%~~ by volume.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.2	Equipment Survivability and Containment Structural Integrity	Partially Conforms	The design satisfies 10 CFR 50.44(d)~~(c)(3)~~ by maintaining an inert atmosphere~~,~~ during design-basis and significant beyond design-basis accidents. T~~t~~herefore the environmental conditions created by hydrogen combustion are not considered.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.3	Ensuring a Mixed Atmosphere	Conforms	None.	6.2.5

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.4	Design Requirements of GDC 41	Partially Conforms	The design supports an exemption from the power provisions of GDC 41. As described in Section 3.1.4, the design complies with a NuScale-specific PDC in lieu of this GDC. Performance tests are performed on the PAR. The NuScale design does not include combustible gas monitors.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.5	Inspection and Test Requirements of GDC 41, GDC 42, and GDC 43	Partially Conforms	The design includes a PAR subject to inspection and testing. The test and inspection of containment components are addressed in FSAR Section 6.2.5. The design does not include combustible gas monitoring.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.6	Containment Structural Integrity Analysis	Partially Conforms	The design includes a PAR that maintains an inert containment atmosphere and precludes hydrogen combustion. A beyond-design-basis containment structural evaluation considers an amount of hydrogen exceeding that generated by 100 percent fuel clad-coolant reaction; the containment remains below design pressure.	6.2.5
DSRS 6.2.6, Rev 0: Containment Leakage Testing	All	Various	Partially Conforms	The design supports an exemption from the containment leakage rate testing at design pressure requirements of GDC 52 and Type A test requirements of 10 CFR 50 Appendix J.	6.2.6
SRP 6.2.7, Rev 1: Fracture Prevention of Containment Pressure Boundary	All	Various	Conforms	None.	6.2.7
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.1	ECCS Acceptance Criteria of 10 CFR 50.46	Conforms	None.	6.3.1 6.3.3
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.2	Single-Failure Consideration	Conforms	None.	6.3.1

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments

Description(4)(5)	Environmental Qualification Zone(1)	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category(3)	PAM Type(2)	Operating Time (Hrs)
Containment System (A013)						
I&C Division I Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
I&C Division II Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
PZR Heater Power Division I Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
PZR Heater Power Division II Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
I&C Channel A Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel C Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel B Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel D Instrument Seal Assembly (ISA)	CNV-6, RXBP-2	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
CRDM Power 1 Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #1 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #2 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments (Continued)

Description(4)(5)	Environmental Qualification Zone(1)	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category(3)	PAM Type(2)	Operating Time (Hrs)
PZR Spray CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Injection Flow Check Valve~~	~~RXBP~~	~~Harsh~~	~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
CVC Injection CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
CVC Discharge CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Discharge Air Operated Valve~~	~~RXBP-1~~	~~Harsh~~	~~Electrical~~ ~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
Containment Flood and Drain CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Containment Evacuation CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Central Hydraulic Power Unit Skid A and Skid B	RXBG-8	Harsh	Electrical Mechanical	A B	N/A	1 720
Passive Autocatalytic Recombiner ~~(PAR)~~	CNV-4 or CNV-5	Harsh	Mechanical	A~~B~~	N/A	720
Containment Narrow Range Pressure Element A/B/C/D	CNV-6	Harsh	Electrical	A	N/A	720
Containment Wide Range Pressure Element A/B	CNV-6	Harsh	Electrical	A	B,C,D	720
Containment Level Indication A/B/C/D	RXBP-1, CNV-1 - CNV-6	Harsh	Electrical	A	N/A	720
SG #1 and SG #2 Main Steam Temperature Indication A/B/C/D	RXBP-1	Harsh	Electrical	A	N/A	720
FWIV #1 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720
FWIV #2 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720

6.2.5 Combustible Gas Control in the Containment Vessel

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The NPM design controls combustible gases to prevent hydrogen combustion inside containment following a severe accident. The combustible gas control requirements for future water-cooled reactor designs that have a potential for the production of combustible gases comparable to the light water reactor designs licensed as of October 16, 2003 are in 10 CFR 50.44(c).~~The US460 standard design includes a type and quantity of fuel cladding materials similar to that of a traditional light water reactor. However, due to unique attributes of the design (i.e., the small and normally-evacuated containment, fast-cooling ECCS that blows down into containment, and an oxygen-limiting design), the performance-based combustible gas control requirements of 10 CFR 50.44(d) are applied.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM includes a significantly smaller containment volume in relation to the RCS inventory compared to a traditional light water reactor. To preclude the formation of combustible gas mixtures in containment, the design passively limits the concentration of oxygen by volume in containment during both design-basis events and severe accidents. Due to the small and normally-evacuated containment volume (i.e., low initial oxygen concentration), as well as an ECCS design that blows down into containment, relatively cold and low pressure conditions are necessary to achieve appreciable oxygen concentrations. Because the design is oxygen-limiting, oxygen produced from radiolysis is the limiting consideration for combustible gas control. In severe accidents resulting in fuel damage, fuel cladding oxidation results in increased hydrogen gas inventory but does not increase the oxygen inventory, thereby lowering the oxygen concentration. Therefore, evaluation of non-core damage events for oxygen-based flammability addresses the bounding conditions of combustible gas generation. Discussion of severe accident combustible gas generation is in Section 19.2, Severe Accident Evaluation.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

During normal operation, the CNV is maintained at a partial vacuum (less than 1 psia), and dissolved hydrogen in the reactor coolant limits oxygen produced from radiolysis, as discussed in Section 5.2. In the early stages following an RCS blowdown event, steam, hydrogen from the RCS, and other noncondensable gases occupy the containment atmosphere. To address radiolytic oxygen production beyond the early stages of an event, the US460 standard design includes a passive autocatalytic recombiner (PAR) inside the CNV that is sized to maintain the containment atmosphere inert (i.e., less than 4 percent oxygen by volume) during design-basis events and significant beyond design-basis accidents.

6.2.5.1 Design Bases

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~In compliance with 10 CFR 50.44(c)(1), the CNV maintains a mixed containment atmosphere during design-basis and significant BDBE. Adequate mixing of the CNV occurs by virtue of temperature differences between the annular and head regions of the CNV and its partially immersed design with no sub-compartments that could facilitate separation, coupled with the dynamic nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS valve opening events).~~The NPM passively maintains the containment inert to preclude combustion. Specifically, the design includes a PAR in the upper CNV that recombines hydrogen and oxygen to limit oxygen concentration. The PAR is a self-actuating passive component with no moving parts. The PAR is safety-related, Seismic Category I, and included in the Environmental Qualification Program discussed in Section 3.11. The PAR is designed in accordance with the relevant requirements of ASME AG-1 (Reference 6.2-6), Section GE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM design ensures a mixed containment atmosphere during design-basis events and severe accidents due to:

- Temperature differences between the surfaces in the RPV and CNV create natural circulation ensuring mixing.
- The CNV does not include sub-compartments.
- The turbulent nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS actuation) provides flow mixing effects.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design includes a passive autocatalytic recombiner (PAR) that is non-safety related, seismic Class 2 with augmented requirements. The PAR is designed to survive severe accident conditions and the environment in which the PAR is relied upon to function. The PAR is sized to limit oxygen concentrations to a level that does not support combustion (less than four percent). This results in an inert containment atmosphere, thereby satisfying 10 CFR 50.44(c)(2) and 10 CFR 50.44(c)(3).~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design supports an exemption from the 10 CFR 50.44(c)(4) requirements for monitoring combustible gases during an accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The NPM relies on a PAR to maintain the containment atmosphere inert through the continuous consumption of oxygen generated post-accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Following a BDBA, the containment is oxygen-limited. The sources of oxygen are from the initial quantities in the reactor coolant system controlled by the Primary Coolant Chemistry Program and through radiolytic decomposition of water. Inerting is accomplished solely by the PAR recombining oxygen; no inert gas is added to the containment during operations or post-accident. The PAR has adequate capacity to maintain the containment oxygen concentration below four percent by volume.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design does not include continuous combustible gas monitoring. Each NPM includes a PAR to ensure an inert containment atmosphere through the continuous recombination of hydrogen and oxygen. The inert atmosphere precludes the loss of containment structural integrity, safe shutdown functions, or accident mitigation features by hydrogen combustion. The PAR is reliable, self-actuating, and passive, and the containment is not susceptible to de-inerting. The design also does not rely on hydrogen monitoring to assess core damage. The radiation monitors under the bioshield and core exit thermocouples provide the ability to assess core damage. Containment hydrogen and oxygen monitoring using the process sampling system during normal operations is discussed in Section 9.3.2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design relies on the PAR to maintain an inert containment atmosphere following a severe accident, therefore an analysis of the effects of combustion on containment integrity is not necessary. The PAR is a reliable passive device that self-actuates to recombine oxygen and hydrogen present in the surrounding environment. The NPM is not susceptible to de-inerting. The PAR is designed to function in the severe accident environment for which it is intended.The PAR maintains an inert atmosphere during design-basis events and significant beyond design-basis accidents; design basis events are limiting for PAR sizing. Notwithstanding, Section 19.2 evaluates a bounding BDBE case that produces more hydrogen than the 100 percent clad water reaction would and determines that the CNV does not exceed its design pressure assuming adiabatic combustion. Therefore, the design conforms to the requirements of 10 CFR 50.44(c)(5).

The design does not require compliance with 10 CFR 50.34(f)(3)(v)(A)(1). 10 CFR 50.34 states that applicants for design approval under Part 52 need not demonstrate compliance with paragraph (f)(3)(v).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The PAR maintains the containment inert post-accident. The systems and components within the CNV that establish and maintain safe shutdown or support containment structural integrity remain capable of performing their required functions after BDBEs.

Section 6.3 addresses hydrogen generation criteria associated with the ECCS performance criteria requirements of 10 CFR 50.46.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs.~~Consistent with GDC 2, the PAR is designed to withstand the effects of natural phenomena. It is located in the CNV and is a Seismic Category I component. The PAR conforms with GDC 4 and withstands the environment conditions and dynamic effects inside the CNV. Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs. The PAR satisfies PDC 41 by maintaining the containment atmosphere inert following postulated accidents. The PAR is a passive component not susceptible to active single failure. Implementation of 10 CFR 50.44(d) meets PDC 41 by providing a system to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity. The PAR design permits appropriate periodic inspection and functional testing, thereby satisfying GDC 42 and GDC 43.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The PAR maintains the containment inert post-accident. Implementation of the requirements of 10 CFR 50.44, as modified by an exemption, meets the requirement of PDC 41 to provide systems to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity.~~

Section 1.9 addresses compliance with guidance in RG 1.7.

6.2.5.2 System Design

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV is a metal containment, Class MC pressure vessel that undergoes design, analysis, fabrication, inspection, testing, and stamping as an ASME BPVC Class 1 pressure vessel maintained partially immersed in a reactor pool common to other NPMs.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV meets 10 CFR 50.44(c) by safely accommodating the hydrogen generated by the equivalent of up to a 100 percent fuel-cladding metal water reaction. This type of accident is a BDBE in which hydrogen generation could exceed the flammability limits. The CNV is a passive design that relies on a PAR to maintain a containment atmosphere that does not support combustion following a significant BDBE for combustible gas control.~~Events involving combustible gas are discussed in Section 6.2.5. The CNV meets 10 CFR 50.44(d)(2) by safely maintaining a mixed atmosphere as well as maintaining an oxygen-limited environment during design-basis and significant beyond design-basis accidents.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV allows the PAR to perform its function by maintaining a mixed atmosphere. When blowdown occurs, the dynamic event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection. There are no partitions or sub-compartments to impede these natural mixing forces. Section 6.2.5.3, Design Evaluation, discusses the mixed containment atmosphere, including that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CES establishes a partial vacuum in the CNV before NPM startup that continues during reactor operation. The initial CNV pressure contributes to calculations that result in the initial combustible gas composition in the CNV based on the initial CNV pressure. Section 9.3.6 addresses the CES.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~When RCS discharge to the containment occurs, the dynamic nature of the event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection and molecular diffusion. There are no partitions or subcompartments to impede these natural mixing forces. Relevant events ensure convective mixing due to decay heat. Section 6.2.5.3 discusses turbulence in the CNV. The analysis shows that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV design utilizes a PAR to limit oxygen concentrations to a level that maintains an inerted containment atmosphere following a BDBE that releases an equivalent amount of hydrogen generated from a 100 percent fuel clad-coolant reaction, uniformly distributed. The configuration of the containment coupled with the dynamics of the LOCA and mitigating components ensures adequate mixing within the containment volume during and following events that generate and release combustible gases to containment. Section 6.2.5.3 discusses potential methods of gas accumulation. The limited-oxygen environment and mixed atmosphere maintains an inerted containment atmosphere, thereby precluding combustion that could challenge containment structural integrity.~~

As described in Section 6.2.5.3, there is margin to the containment pressure capacity limit such that there is no need for containment overpressure protection.

Section 6.2.5.5 addresses combustible gas monitoring.

6.2.5.3 Design Evaluation

Audit Question A-6.2.5-1

~~The partially immersed design with no~~The CNV design ensures a mixed containment atmosphere for two reasons: (1) there are no sub-compartments that could facilitate separation, ~~coupled with~~and (2) due to the turbulent~~dynamic~~ nature of ~~events~~the CNV atmosphere associated with RCS discharge to the CNV (e.g., ~~LOCA or inadvertent ECCS valve opening events~~conditions associated with ECCS operation). ~~ensure adequate mixing of the CNV~~. ~~To demonstrate compliance with the 10 CFR 50.44(c) requirement for a well mixed containment, CNV conditions at 72 hours are evaluated.~~

Audit Question A-6.2.5-1

An evaluation of the mixed containment atmosphere is performed at 72 hours after ECCS actuation. Turbulent flow forces decrease as decay heat decreases, therefore conditions at 72 hours are less turbulent, providing a bounding evaluation~~Conditions earlier than 72 hours are generally more turbulent than conditions afterward~~. This evaluation considers two geometries: (1) the annular region between the RPV outer walls and the CNV inner walls (the annular region), and (2) the upper volume between the outer head of the RPV and the inner head of the CNV (the head space). The nondimensional Rayleigh (Ra) number, which represents whether the fluid heat transfer is primarily conductive or convective, evaluates mixing and establishes whether or not fluid flow is turbulent. ~~A transition to bulk turbulent conditions occurs in a tall vertical cavity with a hot surface and a cool surface (in air) somewhere between Ra = 10,000 and Ra = 100,000~~Bulk turbulent flow conditions exist when the Rayleigh number exceeds the turbulence threshold for a specific enclosure. At 72 hours ~~in the CNV, post-accident Ra~~of ECCS operation, the containment atmosphere exceeds this ~~transition regime~~turbulence threshold by at least one order of magnitude, thereby demonstrating a well mixed volume.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Safety analyses show that the core does not uncover during a design-basis LOCA and as a result there is no fuel damage or fuel clad-coolant reaction that would result in an associated production and release of hydrogen or fission products. The risk-informed revision of 10 CFR 50.44 (68 FR 54125) eliminates the design-basis LOCA hydrogen release from the combustible gas control requirements of 10 CFR 50.44.~~The PAR is sized to ensure an inert atmosphere is maintained, irrespective of event type. Events with core damage result in increased zirconium cladding oxidation, thereby significantly increasing the production of hydrogen gas. Because the US460 standard design is oxygen-limiting, core damage events result in a lower oxygen concentration. Contrarily, events without core damage result in a higher oxygen concentration. Accordingly, the PAR is sized using bounding oxygen quantities for a non-core damage event. However, additional conservatism is added by considering the increased radiolysis associated with fuel damage energy deposition without taking credit for fuel damage cladding oxidation. Therefore, the PAR is conservatively sized to recombine a minimum of 15 moles of oxygen per hour at a partial

pressure of 1.69 kilopascals. This recombination rate establishes a PAR capacity that is sufficient for DBEs and BDBEs. Therefore the PAR maintains the CNV inert during a severe accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, as well as events with lesser or no clad-coolant reaction.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~An evaluation for the potential for combustible gas (hydrogen and oxygen) accumulation in the containment during and following postulated BDBEs was performed. The evaluation considered those BDBEs an intact containment boundary and resulting in varying degrees of core damage. One example of this type of BDBE is a LOCA inside containment with an ECCS failure that prevents the recirculation of coolant from the CNV back into the RPV. This scenario results in uncovering the reactor core with resulting fuel damage. Uncovering the reactor core can result in the production of a significant amount of hydrogen due to high temperature cladding-fuel interaction with additional amounts of hydrogen and oxygen produced from radiolytic decomposition of the reactor coolant that accumulates within the CNV. The sources of hydrogen in containment following a BDBE are limited to~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- ~~oxidation of zirconium in the fuel cladding.~~
- ~~radiolysis of water (reactor coolant).~~
- ~~initial amount of dissolved hydrogen in the RCS.~~
- ~~the amount of hydrogen accumulated in the upper region of the RPV (i.e., the pressurizer).~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Within the CNV, the design restricts materials that have the potential to yield hydrogen gas because of contact with liquid contents in the CNV (upon ECCS actuation or other condition involving liquid in containment). Section 6.1 identifies any such materials.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Following a BDBE that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, the PAR is sized to maintain oxygen at a level (less than four percent) that does not support hydrogen combustion. Therefore, there is no hydrogen combustion, ensuring CNV integrity.~~

6.2.5.4 Inspection and Testing

RAI 19.2-1

~~Section 3.8.2.7, Section 6.2.1, Section 6.2.2, Section 6.2.4, Section 6.2.6, Section 6.2.7, Section 6.6, and Section 14.2 describes inspection and testing of the CNV and its components.~~The PAR is periodically tested and inspected in accordance with technical specifications.

Portions of the lower CNV have 60-year design fluence in excess of 1E+17 neutrons/cm^2, E > 1 MeV, with the peak fluence in the lower CNV not exceeding 2.5E+18 neutrons/cm^2, E > 1 MeV. The portions of the lower CNV with peak neutron fluence greater that 1E+17 neutrons/cm^2, E > 1 MeV, are composed of austenitic stainless steel. Austenitic stainless steels have superior ductility and are less susceptible to the effects of neutron embrittlement than ferritic materials. The peak neutron fluence for the ferritic portion of the CNV is less than the regulatory limit of 1E+17 neutrons/cm^2, E > 1 MeV. The material selection for the CNV pressure boundary ensures facture prevention.

6.2.8 References

6.2-1 NuScale Power, LLC, “Loss-of-Coolant Accident Evaluation Model,” TR-0516-49422-P, Revision 3.

6.2-2 NuScale Power, LLC, “Non-Loss-of-Coolant Accident Analysis Methodology Report,” TR-0516-49416-P-A, Revision 3.

6.2-3 NuScale Power LLC, “Extended Passive Cooling and Reactivity Control Methodology Topical Report” TR-124587, Revision 0.

6.2-4 NuScale Power, LLC, “NuScale Containment Leakage Integrity Assurance,” TR-123952-P, Rev. 0.

6.2-5 American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, 2017 edition, Section XI Division 1, “Rules for Inservice Inspection of Nuclear Components,” New York, NY.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

6.2-6 American Society of Mechanical Engineers AG-1-2019, “Code on Nuclear Air and Gas Treatment,” New York, NY.

Audit Question A-6.2.5-1, Audit Question A-19.1-53
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 6.2-8: Classification of Structures, Systems, and Components

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
CNTS, Containment System					
All components (except as listed below)-	RXB	A1	None	B	I
• CIVs (CVC PZR spray, RPV high point degasification, CVC injection & discharge) • CITFs (CVC PZR spray, RVP high point degasification, CVC injection & discharge)	RXB	A1	None	A	I
• CIV stored energy device pressure transmitters (MSIV, FWIV, RCCW CIVs, CVC high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVS) • Containment pressure instrumentation (narrow range) • Containment level instrumentation • MS temperature sensors • Closed and open position indicators for FWIVs • CHPU skid A & B • Supply/vent hydraulic lines from CHPU to CIVs • Hydraulic manifolds between CHPU and CIVs	RXB	A1	None	N/A	I
Feedwater isolation check valves	RXB	A2	None	B	I
• CNV-RPV support ledge • CNV CRDM support frame • Supply/vent hydraulic lines from CHPU to DHRS actuation valves	RXB	A2	None	N/A	I
• Containment top support structure	RXB	B1	• ASME-BTH-1-2017	N/A	I

Table 6.2-8: Classification of Structures, Systems, and Components (Continued)

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
• Containment pressure instrumentation (wide range) • Closed and open position indicators (MSIV, MSIBV, RCCWS CIVs, RPV high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVs)	RXB	B2	IEEE 497-2016 (Note 5)	N/A	I
PAR	RXB	~~B~~A2	None~~RG 1.7~~	N/A	I~~I~~
• Closed and open position indicators (RPV high point degasification solenoid valve, CVC discharge AOV) • Flushing hydraulic line from CHPU to inboard & outboard CIVs and DHR actuation valves	RXB	B2	None	N/A	II
Containment air temperature sensors	RXB	B2	None	N/A	III

Note 1: Acronyms used in this table are listed in Table 1.1-1

Note 2: Additional augmented design requirements, such as the application of a Quality Group, Radwaste safety, or seismic classification, to nonsafety-related SSC are reflected in the columns Quality Group / Safety Classification and Seismic Classification, where applicable. Environmental Qualifications for SSC are identified in Table 3.11-1.

Note 3: Section 3.2.2.1 through Section 3.2.2.4 provides the applicable codes and standards for each RG 1.26 Quality Group designation (A, B, C, and D). A Quality Group classification per RG 1.26 is not applicable to supports or instrumentation that do not serve a pressure boundary function. Section 3.2.1.4 provides a description of RG 1.143 classification for RW-IIa, RW-IIb, and RW-IIc.

Note 4: Where SSC (or portions thereof) as determined in the as-built plant that are identified as Seismic Category III in this table could, as the result of a seismic event, adversely affect Seismic Category I SSC or result in incapacitating injury to occupants of the control room, they are categorized as Seismic Category II consistent with Section 3.2.1.2 and analyzed as described in Section 3.7.3.8.

Note 5: IEEE Std 497-2016 as endorsed by RG 1.97 and implemented as described in Table 1.9-2

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS maintains an inert containment atmosphere following design-basis events.

The NPM performs the following nonsafety-related, risk-significant function that is verified by ITAAC. The CNTS supports the Reactor Building crane (RBC) by providing lifting attachment points that the RBC can connect to so that the NPM can be lifted.

The NPM performs the following nonsafety-related functions that are verified by ITAAC:

- The CNTS supports the SGS by providing structural support for the SGS piping.
- The CNTS supports the CRDS by providing structural support for the CRDS piping.
- The CNTS supports the RCS by providing structural support for the RCS piping.
- The CNTS supports the feedwater system by providing structural support for the feedwater system piping.

Design Commitments

- The NuScale Power Module ASME Code Class 1, 2, and 3 piping systems listed in Table 2.1-3 and NuScale Power Module ASME Code Class 1, 2, 3, and CS components listed in Table 2.1-4 comply with ASME Code Section III requirements.
- The NuScale Power Module ASME Code Class 1, 2, and 3 components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- The NuScale Power Module ASME Code Class CS components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- Safety-related SSC are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.

Audit Question A-6.3.2.2.1-1

- The ECCS supplemental boron ~~dissolvers and CNV lower mixing tubes~~ components are installed such that ECCS can perform the safety-related emergency supplemental boron function.
- Each CNTS containment electrical penetration assembly (EPA) listed in Table 2.1-5 is rated either (i) to withstand fault and overload currents for the time required to clear the fault from its power source, or (ii) to withstand the maximum fault and overload current for its circuits without a circuit interrupting device.
- The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.
- Closure times for CIVs listed in Table 2.1-5 limit potential releases of radioactivity.
- The length of piping listed in Table 2.1-3 shall be minimized between the containment penetration and the associated outboard CIVs.
- The CNTS containment electrical penetration assemblies listed in Table 2.1-5 are sized to power their design loads.

- The ECCS valves, CIVs, and DHRS actuation valves listed in Table 2.1-4, and their associated hydraulic lines, are installed such that each valve can perform its safety function.

Audit Question A-Part 8-2.1.2-1

- The remotely operated CNTS containment isolation valves listed in Table 2.1-4Table 2.1-5 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-Part 8-2.1.2-2

- The ECCS reactor recirculation valves and RVVsvalves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The DHRS valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The CNV top support structure (TSS) supports its rated load.
- The CNV top support structure is constructed to provide assurance that a single failure does not result in the uncontrolled movement of the lifted load.
- The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The ECCS reactor recirculation valves and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.
- The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner (PAR) is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.

Audit Question A-6.2-4

- The CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.

2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.1-1 contains the ITAAC for the NPM.

Table 2.1-1: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.01.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
18.	The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
19.	The ECCS RRVs and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the ECCS RRVs and RVVs listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each ECCS RRV and RVV listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of electrical power to its corresponding trip valve under preoperational temperature, differential pressure, and flow conditions.
20.	The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the DHRS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each DHRS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
21.	The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS check valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS check valve listed in Table 2.1-4 strokes fully open and closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions.
22.	The CNTS passive autocatalytic recombiner is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.	An inspection will be performed of the PAR.	A report exists and concludes that the PAR is installed in accordance with the associated installation specification.
23.	The as-built CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.	A reconciliation analysis will be performed of the as-built containment net free volume.	A report exists and concludes the as-built containment net free volume is greater than or equal to the free volume listed in FSAR Table 6.2-2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Audit Question A-6.2-4

Table 2.1-2: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[(1)] (Continued)

ITAAC No.	Discussion
02.01.18	The CNTS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each CNTS safety-related hydraulic-operated valves listed in Table 2.1-4 repositions to or maintains its safety-related position on loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.19	The ECCS safety-related RRVs and RVVs are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of electrical power under preoperational temperature, differential pressure, and flow conditions. For the first NPM only, a test is conducted under preoperational test conditions that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations. The test is initiated with an initial RPV to CNV differential pressure greater than the inadvertent actuation block threshold pressure of 900 psid in accordance with FSAR Table 14.2-40 and demonstrates that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve. For subsequent NPMs a test is conducted at reduced pressure and temperature in accordance with FSAR Table 14.2-56 to demonstrate that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve.
02.01.20	The DHRS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each DHRS safety-related hydraulic-operated valves listed in Table 2.1-4 fails open loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.21	The CNTS safety-related check valves are tested to demonstrate the capability to perform their function to transfer open and transfer closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions. Check valves are tested in accordance with the requirements of the ASME OM Code, ISTC-5220, Check Valves. In accordance with FSAR Table 14.2-38, a preoperational test demonstrates that the CNTS check valves listed in Table 2.1-4 strokes fully open and closed under forward and reverse flow conditions, respectively. Preoperational test conditions are established that approximate design basis temperature, differential pressure and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.22	Quality Control inspection hold points are used to ensure the as-built CNTS passive autocatalytic recombiner is installed consistent with the associated installation specification, and therefore capable of performing its safety-related function. To demonstrate the acceptance criterion for ITAAC 02.01.22 is satisfied, and the associated design commitment fully met, a report will exist and conclude Quality Control inspection hold points exist and have been completed for the location and orientation of the PAR.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Audit Question A-6.2-4, Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.1-6: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.01.01	X					
02.01.02	X					
02.01.03	X					
02.01.04	X	X				
02.01.05	X					
02.01.06	X					
02.01.07	X					
02.01.08	X					
02.01.09	X					
02.01.10	X					
02.01.11	X					
02.01.12	X					
02.01.13	X					
02.01.14	X					
02.01.15	X					
02.01.16				X		
02.01.17				X		
02.01.18	X					
02.01.19	X					
02.01.20	X					
02.01.21	X					
02.01.22	X					
02.01.23	X					

- The safety-related relief valves listed in Table 2.4-3 provide overpressure protection.
- The DHRS condensers listed in Table 2.4-3 have the capacity to transfer their design heat load.
- The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions, and performs its function for the period of time required to complete the function.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.

RAI 19.2-1

- The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.

2.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4-1 contains the ITAAC for the equipment qualification - module-specific equipment.

Table 2.4-1: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.04.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
09.	The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the CNTS containment electrical penetration assemblies listed in Table 2.4-3 including associated connection assemblies. ii. An inspection will be performed of the containment CNTS electrical penetration assembles listed in Table 2.4-3, including associated connection assemblies.	i. An EQ record form exists and concludes that the CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, performs their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, are installed in their design location in a configuration bounded by the EQ record form.
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4 — 10.	The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.	A type test, analysis, or a combination of type test and analysis will be performed of the CNTS passive autocatalytic recombiner.	A report exists and concludes that the PAR has sufficient capacity to meet or exceed the minimum required oxygen recombination rate.
RAI 19.2-1 — 11.	The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.	An analysis will be performed of the CNTS passive autocatalytic recombiner.	A qualification record form exists and concludes that the CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life under the design basis harsh environmental conditions specified in the qualification record form.

Table 2.4-2: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[(1)] (Continued)

	ITAAC No.	Discussion
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4	02.04.10	FSAR Section 6.2.5, Combustible Gas Control in the Containment Vessel, discusses that the PAR provides the safety-related function of maintaining an inert atmosphere (i.e., less than 4 percent oxygen by volume) in the CNV, which is achieved by the continuous recombination of oxygen. FSAR Section 6.2.5 lists the minimum design oxygen recombination rate (in moles per hour) for the PAR to ensure the CNV atmosphere remains inert following design-basis events. This ITAAC verifies that the PAR oxygen recombination rate meets or exceeds the minimum required oxygen recombination rate specified in FSAR Section 6.2.5 to maintain the CNV atmosphere inert during design-basis events.
RAI 19.2-1	02.04.11	FSAR Section 3.11 presents information to demonstrate that the CNTS passive autocatalytic recombiner located in a harsh environment is qualified using an analysis to perform its function up to the end of its qualified life in design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions. Environmental conditions include both internal service conditions and external environmental conditions for the PAR. The qualification method employed for the equipment is the same as the qualification method described for that type of equipment in FSAR Section 3.11. The ITAAC verifies that: (1) an equipment qualification record form exists for the PAR, and (2) the qualification record form concludes that the PAR listed in Table 2.4-3 perform its intended function up to the end of its qualified life under the design basis environmental conditions (both internal service conditions and external environmental conditions) specified in the qualification record form.

Note:

1) References to Tables and Figures refer to ITAAC unless the reference specifically states FSAR Tables or Figures.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
Containment System						
CNV8	I&C Division I EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV9	I&C Division II EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV15	PZR heater power division I nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV16	PZR heater power division II nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV17	I&C Channel A instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV18	I&C Channel C instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV19	I&C Channel B instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV20	I&C Channel D instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV37	CRDM power 1 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV38	RPI group #1 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV39	RPI group #2 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV40	I&C separation group A EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV41	I&C separation group B EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV42	I&C separation group C EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV43	I&C separation group D EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV44	CRDM power 2 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
None	CNV CRDM Support Frame	N/A	N/A	Yes	N/A	N/A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category[1]
CNT-PE-1001A CNT-PE-1001B CNT-PE-1001C CNT-PE-1001D	Containment narrow range pressure elements	Harsh	Electrical	Yes	Yes	A
CNT-PE-1002A CNT-PE-1002B	Containment wide range pressure elements	Harsh	Electrical	Yes	No	A
CNT-LE-1003A CNT-LE-1003B CNT-LE-1003C CNT-LE-1003D	Containment level indication	Harsh	Electrical	Yes	Yes	A
CNT-PAR-0001	Passive autocatalytic recombiner	Harsh	Mechanical	Yes	N/A	A
MS-TE-1001A MS-TE-1001B MS-TE-1001C MS-TE-1001D	SG #1 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
MS-TE-2001A MS-TE-2001B MS-TE-2001C MS-TE-2001D	SG #2 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
CE-ZSC-0001	CES inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0001	CES inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0001	CES inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CE-ZSC-0002	CES outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0002	CES outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0002	CES outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0022	CFDS inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0022	CFDS inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0022	CFDS inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0021	CFDS outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0021	CFDS outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0021	CFDS outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CVC-ZSC-0334	CVCS discharge inboard CIV close position indicator	Harsh	Electrical	Yes	No	A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
ICI-TE-~~BA-~~0001F-BA~~ / F~~ ICI-TE-~~BA-~~0002F-BA~~ / F~~ ICI-TE-~~CA-~~0003F-CA~~ / F~~ ICI-TE-~~CA-~~0004F-CA~~ / F~~ ICI-TE-~~BA-~~0005F-BA~~ / F~~ ICI-TE-~~BA-~~0006F-BA~~ / F~~ ICI-TE-~~CA-~~0007F-CA~~ / F~~ ICI-TE-~~CA-~~0008F-CA~~ / F~~ ICI-TE-~~CA-~~0009F-CA~~ / F~~ ICI-TE-~~BA-~~0010F-BA~~ / F~~ ICI-TE-~~CA-~~0011F-CA~~ / F~~ ICI-TE-~~BA-~~0012F-BA~~ / F~~	Core ~~inlet /~~ exit thermocouples	Harsh	Electrical	Yes	No	A

Note:

1. EQ Categories:
   - A - Equipment that will experience the environmental conditions of DBAs for which it must function to mitigate said accidents, and that will be qualified to demonstrate operability in the accident environment for the time required for accident mitigation with safety margin to failure.
   - B - Equipment that will experience the environmental conditions of DBAs through which it need not function for mitigation of said accidents, but through which it must not fail in a manner detrimental to plant safety or accident mitigation, and that will be qualified to demonstrate the capability to withstand the accident environment for the time during which it must not fail with safety margin to failure.
   - E - Equipment that will not experience environmental conditions of DBAs and that will be qualified to demonstrate operability under the expected extremes of its nonaccident service environment.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-4: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.04.01	X					
02.04.02	X					
02.04.03	X					
02.04.04	X					
02.04.05	X					
02.04.06	X					
02.04.07	X					
02.04.08	X					
02.04.09	X					
02.04.10	X					
02.04.11	X					

PASSIVELY COOLED, and MODE 4 with the upper module assembly seated on the lower containment vessel flange, require module liquid inventory to maintain core coverage and transfer decay heat from the reactor fuel to the ultimate heat sink. Containment closure ensures the inventory will remain available to perform this function during an extended loss of alternating current power or during delays in the transfer of the module between the operating location and the containment closure tool. Containment closure must be maintained until the containment is disassembled and the reactor vessel is thermally connected to~~, or when the containment is disassembled from~~ the UHS via the de-energized ECCS valves. Limiting Condition ~~of~~for Operation 3.6.3 satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

RAI 19.2-3

3.3.18 Addition of Limiting Condition for Operation 3.6.4, Passive Autocatalytic Recombiner

RAI 19.2-3

Limiting Condition for Operation 3.6.4 is added to ensure the passive autocatalytic recombiner is available to preclude formation of a combustible atmosphere during either design-basis accidents and significant beyond design-basis accidents by passively limiting oxygen concentration in the containment. Limiting Condition for Operation 3.6.4 satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

Audit Question A-16-5

3.3.19 Removal of Limiting Condition ~~of~~for Operation 3.7.3, In-Containment Secondary Piping Leakage

Audit Question A-16-5

Limiting Condition ~~of~~for Operation 3.7.3 is deleted as no longer necessary because the break exclusion design criteria is applied to the secondary system piping within the containment. The DCA design for secondary system piping met the leak-before-break design criteria of General Design Criteria 4.

US460 Standard Design Approval FSAR Section 3.6 describes the application of design measures to prevent or mitigate postulated dynamic effects associated with postulated rupture of US460 piping. The US460 SDA design of secondary piping inside the containment meets the criteria for exclusion from postulated breaks and cracks provided in NRC Branch Technical Position (BTP) 3-4. Based on this change the US600 Design Certification Application LCO is no longer needed because the piping is excluded from consideration of postulated breaks and cracks.

3.3.20 Other Bases Changes

In addition to the specific changes described above, Applicable Safety Analyses sections are modified to reflect changes to the safety analyses, primarily as a result of the increased reactor power. Other changes are made in response to operational analysis feedback to clarify and ease understanding of the requirements.

3.6 CONTAINMENT SYSTEMS

3.6.4 Passive Autocatalytic Recombiner (PAR)

LCO 3.6.4 Passive Autocatalytic Recombiner shall be OPERABLE.

APPLICABILITY: MODES 1 and 2,
MODE 3 not PASSIVELY COOLED.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. PAR inoperable.	A.1 Restore PAR to OPERABLE status.	72 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 2. AND B.2 Be in MODE 3 and PASSIVELY COOLED.	6 hours 48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.4.1	Visually examine PAR enclosure and ensure there is no obstruction or blockage of the inlets or outlets.	During each refueling
SR 3.6.4.2	Test a sample of PAR catalytic plates to confirm catalyst performance.	During each refueling

B 3.0 LIMITING CONDITION FOR OPERATION AND SURVEILLANCE REQUIREMENTS (continued)

B 3.6 CONTAINMENT SYSTEMS

B 3.6.4 Passive Autocatalytic Recombiner

BASES

BACKGROUND

During normal operation, the CNV is maintained at a partial vacuum, and dissolved hydrogen in the reactor coolant system (RCS) limits oxygen produced from radiolysis. In the early stages following an event involving the blowdown of the RCS inventory into the CNV, steam, hydrogen from the RCS, and other non-condensable gases occupy the containment atmosphere. To address radiolytic oxygen production, beyond the early stages of an event, the US460 standard design includes a passive autocatalytic recombiner (PAR) inside the CNV that is sized to maintain the containment atmosphere less than four percent oxygen by volume.

The PAR is a self-actuating passive device without moving parts and does not require electrical power or any other support system. The PAR precludes the formation of combustible gas mixtures during either design-basis accidents or significant beyond design-basis accidents, by passively limiting the oxygen concentration in containment. Due to the small and normally evacuated containment volume (i.e., low initial oxygen concentration), as well as an ECCS design that blows down into the CNV, the design is oxygen-limited. Oxygen produced from radiolysis is the limiting consideration for combustible gas control.

In severe accidents resulting in fuel damage, fuel cladding oxidation results in increased hydrogen gas concentration but does not increase the oxygen concentration, thereby leading to reduced oxygen concentration by volume. Therefore, events that do not account for fuel cladding oxidation are more limiting with respect to combustible gas control.

Due to the unique attributes of the NuScale Power Module (NPM) design with respect to combustible gas control, the performance-based combustible gas control requirements of 10 CFR 50.44(d) are applied.

BASES

APPLICABLE SAFETY ANALYSES

The NPM passively limits oxygen concentration to maintain an inert environment and preclude the formation of combustible gas mixtures. The NPM design includes a PAR in the upper CNV that recombines hydrogen and oxygen to maintain the containment atmosphere at less than four percent oxygen by volume for design basis accidents and significant beyond design-basis accidents.

The NPM design ensures a mixed containment atmosphere for the PAR to perform its function. Mixing is ensured by the turbulent nature of events associated with RCS discharge to the CNV (e.g., conditions associated with ECCS operation) and natural circulation created by temperature differences between the surfaces in the RPV and CNV. There are no containment partitions or sub-compartments to impede these mixing forces.

To preclude the formation of combustible gas mixtures in containment, the PAR passively limits oxygen concentration in containment during both design-basis accidents and significant beyond design-basis accidents. Because the design is oxygen-limiting, oxygen produced from radiolysis is the limiting consideration for combustible gas control.

The combustible gas control design of the NPM is described in FSAR Section 6.2.5 (Ref. 1). Discussion of severe accident combustible gas generation is in FSAR Section 19.2 (Ref. 2).

The NPM design meets 10 CFR 50.44(d) by safely maintaining a mixed atmosphere in containment as well as maintaining an inert environment in containment during design-basis accidents and significant beyond-design-basis accidents.

The PAR is sized to ensure an inert containment atmosphere is maintained, irrespective of event type. Maintaining an inert containment atmosphere supports maintaining containment functionality and functionality of other safety-related SSC inside containment which are relied upon for accident mitigation or safe shutdown by ensuring that they are not subject to loads beyond their design bases.

BASES

LCO	This LCO ensures the PAR is available to preclude formation of a combustible atmosphere during either design-basis accidents or significant beyond design-basis accidents, by passively limiting oxygen concentration in the containment.
APPLICABILITY	In MODES 1 and 2, and MODE 3 not PASSIVELY COOLED, the PAR is relied upon to passively limit the oxygen concentration within the containment atmosphere below its flammability limit. The PAR is not required to be OPERABLE in MODE 3 when PASSIVELY COOLED and in MODES 4 and 5 because containment is not required to be OPERABLE in those MODES.
ACTIONS	A.1 A Completion Time of 72 hours is reasonable based on the low likelihood of an event requiring the PAR during that time frame. The 72 hour Completion Time also provides time for resolution of concerns with the operability of the PAR before taking actions that would impact plant operation. B.1 and B.2, and B.3 If the PAR cannot be restored to OPERABLE status within the required Completion Time, the unit must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours and to MODE 3 and PASSIVELY COOLED within 48 hours. The allowed Completion Times are reasonable, to reach the required unit conditions from full power conditions in an orderly manner.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.6.4.1

Visual examination of the PAR enclosure will ensure there is no obstruction or blockage that could negatively impact the flow of gas through the device.

SR 3.6.4.2

Passive Autocatalytic Recombiner performance is verified through testing performed in accordance with manufacturer recommendations and the guidance of ASME AG-1 (Ref. 3), Article GE-5000.

REFERENCES

1. FSAR Section 6.2.5.

2. FSAR Section 19.2.

3. ASME AG-1-[2019], “Code on Nuclear Air and Gas Treatment.”

Enclosure 7:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-4, Proprietary

Enclosure 8:

NuScale Response to NRC Request for Additional Information RAI-10185 R1, Question 19.2-4, Nonproprietary

Response to Request for Additional Information
Docket: 052000050

RAI No.: 10185
Date of RAI Issue: 05/10/2024

NRC Question No.: 19.2-4

Regulatory Basis:

• 10 CFR 50.2, Definition, Safety-related structures, systems and components means those structures, systems and components that are relied upon to remain functional during and following design basis events to assure:

(1) The integrity of the reactor coolant pressure boundary, (2) The capability to shut down the reactor and maintain it in a safe shutdown condition; or (3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in § 50.34(a)(1) or § 100.11 of this chapter, as applicable.

• 10 CFR 52.137(a)(2) requires a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification, upon which the requirements have been established, and the evaluations required to show that safety functions will be accomplished.

• 10 CFR 52.137(a)(4) An analysis and evaluation of the design and performance of SSC with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.

• 10 CFR 52.137(a)(9) For applications for light-water cooled nuclear power plants, an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.

• 10 CFR 52.137(a)(12) An analysis and description of the equipment and systems for combustible gas control as required by § 50.44 of this chapter.

• 10 CFR 52.137(a)(23) a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass.

Issue:

10 CFR 50.2 defines safety-related SSCs as those that are relied upon to remain functional during and following DBEs to assure: “(1) The integrity of the reactor coolant pressure boundary, (2) The capability to shut down the reactor and maintain it in a safe shutdown condition; or (3)The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in § 50.34(a)(1) or § 100.11 of this chapter, as applicable.”

Based on its analysis on the presence and treatment of combustible gas in the RCS in {{ }}$^{2(a),(c),ECI}$, which includes an evaluation of an AOO, NuScale concludes, {{ }}$^{2(a),(c),ECI}$ (emphasis added). Therefore, the PAR is necessary to maintain the reactor in a safe shutdown condition following a DBE. Further, safety-related SSCs in the US460 design are not designed to withstand the dynamic effects and loading from a combustion event. Consequently, without the PAR, the containment integrity is not maintained and a direct path of radioactive release to the environment is available during DBEs. Due to ECCS operation during such events and the release of radioactive steam from the RCS to the CNV, loss of containment integrity will result in a radioactive release to the environment.

The 2003 rulemaking for 10 CFR 50.44 was undertaken based on evaluations that demonstrated that combustible gas releases were not risk-significant for design basis events for large light-water reactors (LWRs). In contrast, as discussed above, NuScale’s analysis demonstrates that combustible gas mixture is risk significant for the US460 design. NuScale has not provided any quantitative evaluation that demonstrates a different conclusion.

Therefore, the PAR is relied upon to remain functional during DBEs to maintain the US460 design in safe shut down condition and to prevent the consequences of accidents which could result in potential offsite exposures exceeding applicable regulatory limits.

Information Requested:

NuScale is requested to identify the PAR as a safety-related SSC or justify why the PAR can remain classified as non-safety related. If justification is provided, it should address: (1) the necessity of the PAR's function to maintain containment integrity and safe shutdown conditions during DBEs, (2) the ability of safety-related SSCs to continue to perform their function under dynamic effects and loading from a combustion event with the frequency of an AOO, and (3) the difference in the quality and performance of a PAR that is designated as safety-related and one that is not (see Information Requested on risk significance of the PAR).

NuScale Response:

As discussed in previous responses, the staff assertion that "without the PAR, the containment integrity is not maintained" is an unsupported assumption. NuScale has elected to preclude a combustible atmosphere with a passive autocatalytic recombiner (PAR) in the US460 design, instead of analyzing SSC to withstand a combustion event as was done for the US600 design.

NuScale reconsidered the PAR design function to maintain an inert containment atmosphere in certain shutdown conditions identified as design-basis events. The PAR sizing accounts for possible hydrogen generation during a design-basis event and precludes a combustible environment. The minimum required PAR consumption rate to prevent the containment atmosphere from reaching a flammable concentration is based on bounding assumptions that consider the oxygen and hydrogen created by radiolysis in core damage and non-core damage conditions, thus ensuring the containment atmosphere remains inert throughout the duration of a severe accident. Although the 10 CFR 50.44 rulemaking generically reclassified combustible gas control as a nonsafety-related function, based upon design-specific considerations not accounted for in 10 CFR 50.44(c), NuScale has reclassified the PAR as a safety-related component, with no risk significance in accordance with the processes described in Final Safety Analysis Report Section 17.4.

Additional Information:

The Standard Design Approval Application has been revised as described in the response above and as shown in the markup provided in this response.

Audit Question A-3.5.1.3-2, Audit Question A-3.7.3-3, Audit Question A-3.11.2.3-1, Audit Question A-5.2.3.4.2-1, Audit Question A-6.1.1-2, Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.1-4, Audit Question DWO-SC-26, Audit Question EDAS Deep Dive Action Item 1, Audit Question EDAS Deep Dive Action Item 3, Audit Question EDAS Deep Dive Action Item 4, Audit Question EDAS Deep Dive Action Item 5, Audit Question EDAS Deep Dive Action Item 6, Audit Question EDAS Deep Dive Action Item 9, Audit Question EDAS Deep Dive Action Item 11, Audit Question EDAS Deep Dive Action Item 14
RAI 5.4.1.6.1-1, RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-2: Conformance with Regulatory Guides

RG	Title	Rev.	Conformance Status	Comments	Section
1.6	Safety Guide 6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems	0	Not Applicable	The onsite electrical AC power systems do not contain Class 1E distribution systems.	Not Applicable
1.7	Control of Combustible Gas Concentrations in Containment	3	Partially Conforms	The design complies with the intent of RG 1.7 regulatory positions that address atmosphere mixing, hydrogen gas production, and containment structural integrity. However, the design deviates from the positions on hydrogen and oxygen monitors. The design includes a passive autocatalytic recombiner (PAR) that is sized to limit oxygen concentrations to a level that does not support combustion (i.e., less than ~~four~~4 percent), ~~this results in~~maintaining an inert containment atmosphere. The design and quality standards applied to the PAR are commensurate with its safety-related, non-risk-significant function in the NuScale design, rather than the non-safety-related, risk-significant function underlying regulatory position C.1. The NuScale design does not include combustible gas monitoring~~supports an exemption to 10 CFR 50.44(c)(4)~~.	6.2.5
1.8	Qualification and Training of Personnel for Nuclear Power Plants	4	Not Applicable	This guidance governs site-specific programmatic and operational activities that are the responsibility of the applicant or licensee.	Not Applicable
1.9	Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants	4	Not Applicable	The NuScale design does not require or include safety-related emergency diesel generators.	Not Applicable
1.11	Instrument Lines Penetrating the Primary Reactor Containment	1	Not Applicable	No instrument lines penetrate the NuScale Power Module (NPM) containment.	Not Applicable

Audit Question A-6.1.1-8, Audit Question A-6.2.5-1, Audit Question A-8.2-2
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
SRP 1.0, Rev 2: Introduction and Interfaces	II.1	No Specific Acceptance Criteria	Not Applicable	No Specific Acceptance Criteria.	Not Applicable
SRP 1.0, Rev 2: Introduction and Interfaces	II.2	SRP Acceptance Criteria Associated with Each Referenced SRP section	Conforms	None.	Ch 1
SRP 1.0, Rev 2: Introduction and Interfaces	II.3	Performance of New Safety Features and Design Qualification Testing Requirements	Conforms	None.	Ch 1
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.1	Specific SRP Acceptance Criteria Contained in Related SRP Chapter 2 or Other Referenced SRP sections	Conforms	This acceptance criterion is a pointer to other SRP sections.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.2	COL Application Referencing an Early Site Permit but not a Certified Design	Not Applicable	This acceptance criterion is for COL applicants referencing an ESP.	2.0
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.3	COL Application Referencing a Certified Design but not an Early Site Permit	Not Applicable	This acceptance criterion is for COL applicants that reference a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.4	COL Application Referencing an Early Site Permit and a Certified Design	Not Applicable	This acceptance criterion is for COL applicants that are referencing both an ESP and a certified design.	Not Applicable
SRP 2.0, Rev 1: Site Characteristics and Site Parameters	II.5	COL Application Referencing Neither an Early Site Permit Nor a Certified Design	Not Applicable	This acceptance criterion is applicable to COL applicants that do not reference either an ESP or a certified design.	Not Applicable
SRP 2.1.1, Rev 3: Site Location and Description	All	Specification of Location and Site Area Map	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.2, Rev 3: Exclusion Area Authority and Control	All	Establishment of Authority, Exclusion or Removal of Personnel and Property, and Proposed and Permitted Activities	Not Applicable	Site-specific.	Not Applicable
SRP 2.1.3, Rev 3: Population Distribution	All	Population Data, Exclusion Area, Low-Population Zone, Nearest Population Center Boundary, and Population Density	Not Applicable	Site-specific.	Not Applicable

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.4, Rev 0: Containment Isolation System	II.16	Specific Design Criteria for Containment Isolation Components	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.17	Provisions to Allow Control Room Operator Actions	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.18	Operability and Leakage Rate Testing	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.19	Reopening of Containment Isolation Valves	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.20	Station Blackout	Conforms	None.	6.2.4
DSRS 6.2.4, Rev 0: Containment Isolation System	II.21	Source Term in Radiological Calculations	Conforms	None.	6.2.4
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.1	Analysis of Hydrogen and Oxygen Concentration Control and Distribution in Containment	Partially Conforms	The containment atmosphere is maintained inert by the PAR, therefore the design safely accommodates hydrogen generated by an equivalent of a 100 percent~~%~~ fuel clad-coolant reaction without limiting containment hydrogen concentration to less than 10 percent~~%~~ by volume.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.2	Equipment Survivability and Containment Structural Integrity	Partially Conforms	The design satisfies 10 CFR 50.44(d)~~(c)(3)~~ by maintaining an inert atmosphere~~,~~ during design-basis and significant beyond design-basis accidents. T~~t~~herefore the environmental conditions created by hydrogen combustion are not considered.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.3	Ensuring a Mixed Atmosphere	Conforms	None.	6.2.5

Table 1.9-3: Conformance with NUREG-0800, Standard Review Plan and Design Specific Review Standard (Continued)

SRP or DSRS Section, Rev: Title	AC	AC Title/Description	Conformance Status	Comments	Section
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.4	Design Requirements of GDC 41	Partially Conforms	The design supports an exemption from the power provisions of GDC 41. As described in Section 3.1.4, the design complies with a NuScale-specific PDC in lieu of this GDC. Performance tests are performed on the PAR. The NuScale design does not include combustible gas monitors.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.5	Inspection and Test Requirements of GDC 41, GDC 42, and GDC 43	Partially Conforms	The design includes a PAR subject to inspection and testing. The test and inspection of containment components are addressed in FSAR Section 6.2.5. The design does not include combustible gas monitoring.	6.2.5
DSRS 6.2.5, Rev 0: Combustible Gas Control in Containment	II.6	Containment Structural Integrity Analysis	Partially Conforms	The design includes a PAR that maintains an inert containment atmosphere and precludes hydrogen combustion. A beyond-design-basis containment structural evaluation considers an amount of hydrogen exceeding that generated by 100 percent fuel clad-coolant reaction; the containment remains below design pressure.	6.2.5
DSRS 6.2.6, Rev 0: Containment Leakage Testing	All	Various	Partially Conforms	The design supports an exemption from the containment leakage rate testing at design pressure requirements of GDC 52 and Type A test requirements of 10 CFR 50 Appendix J.	6.2.6
SRP 6.2.7, Rev 1: Fracture Prevention of Containment Pressure Boundary	All	Various	Conforms	None.	6.2.7
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.1	ECCS Acceptance Criteria of 10 CFR 50.46	Conforms	None.	6.3.1 6.3.3
DSRS 6.3, Rev 0: Emergency Core Cooling System	II.2	Single-Failure Consideration	Conforms	None.	6.3.1

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments

Description(4)(5)	Environmental Qualification Zone(1)	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category(3)	PAM Type(2)	Operating Time (Hrs)
Containment System (A013)						
I&C Division I Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
I&C Division II Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	A	~~B,C,~~D	720
PZR Heater Power Division I Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
PZR Heater Power Division II Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
I&C Channel A Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel C Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel B Instrument Seal Assembly (ISA)	CNV-6, RXBP-1	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
I&C Channel D Instrument Seal Assembly (ISA)	CNV-6, RXBP-2	Harsh	~~Electrical~~ Mechanical	~~A~~B	~~C~~N/A	720
CRDM Power 1 Nozzle Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #1 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720
RPI Group #2 Electrical Penetration Assembly (EPA)	CNV-5, RXBP-1	Harsh	Electrical Mechanical	~~A~~B	N/A	1 720

Table 3.11-1: List of Environmentally Qualified Equipment Located in Harsh Environments (Continued)

Description(4)(5)	Environmental Qualification Zone(1)	Environmental Qualification Environment	Qualification Program	Environmental Qualification Category(3)	PAM Type(2)	Operating Time (Hrs)
PZR Spray CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Injection Flow Check Valve~~	~~RXBP~~	~~Harsh~~	~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
CVC Injection CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
CVC Discharge CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
~~CVC Discharge Air Operated Valve~~	~~RXBP-1~~	~~Harsh~~	~~Electrical~~ ~~Mechanical~~	~~A~~ ~~B~~	~~N/A~~	~~1~~ ~~720~~
Containment Flood and Drain CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Containment Evacuation CIV, Inboard and Outboard	RXBP-1	Harsh	~~Electrical~~ Mechanical	A B	N/A	1 720
Central Hydraulic Power Unit Skid A and Skid B	RXBG-8	Harsh	Electrical Mechanical	A B	N/A	1 720
Passive Autocatalytic Recombiner ~~(PAR)~~	CNV-4 or CNV-5	Harsh	Mechanical	A~~B~~	N/A	720
Containment Narrow Range Pressure Element A/B/C/D	CNV-6	Harsh	Electrical	A	N/A	720
Containment Wide Range Pressure Element A/B	CNV-6	Harsh	Electrical	A	B,C,D	720
Containment Level Indication A/B/C/D	RXBP-1, CNV-1 - CNV-6	Harsh	Electrical	A	N/A	720
SG #1 and SG #2 Main Steam Temperature Indication A/B/C/D	RXBP-1	Harsh	Electrical	A	N/A	720
FWIV #1 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720
FWIV #2 Position Indication A / B	RXBP-1	Harsh	Electrical	A	B,C,D	720

6.2.5 Combustible Gas Control in the Containment Vessel

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM design controls combustible gases to prevent hydrogen combustion inside containment following a severe accident. The combustible gas control requirements for future water-cooled reactor designs that have a potential for the production of combustible gases comparable to the light water reactor designs licensed as of October 16, 2003 are in 10 CFR 50.44(c).The US460 standard design includes a type and quantity of fuel cladding materials similar to that of a traditional light water reactor. However, due to unique attributes of the design (i.e., the small and normally-evacuated containment, fast-cooling ECCS that blows down into containment, and an oxygen-limiting design), the performance-based combustible gas control requirements of 10 CFR 50.44(d) are applied.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM includes a significantly smaller containment volume in relation to the RCS inventory compared to a traditional light water reactor. To preclude the formation of combustible gas mixtures in containment, the design passively limits the concentration of oxygen by volume in containment during both design-basis events and severe accidents. Due to the small and normally-evacuated containment volume (i.e., low initial oxygen concentration), as well as an ECCS design that blows down into containment, relatively cold and low pressure conditions are necessary to achieve appreciable oxygen concentrations. Because the design is oxygen-limiting, oxygen produced from radiolysis is the limiting consideration for combustible gas control. In severe accidents resulting in fuel damage, fuel cladding oxidation results in increased hydrogen gas inventory but does not increase the oxygen inventory, thereby lowering the oxygen concentration. Therefore, evaluation of non-core damage events for oxygen-based flammability addresses the bounding conditions of combustible gas generation. Discussion of severe accident combustible gas generation is in Section 19.2, Severe Accident Evaluation.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

During normal operation, the CNV is maintained at a partial vacuum (less than 1 psia), and dissolved hydrogen in the reactor coolant limits oxygen produced from radiolysis, as discussed in Section 5.2. In the early stages following an RCS blowdown event, steam, hydrogen from the RCS, and other noncondensable gases occupy the containment atmosphere. To address radiolytic oxygen production beyond the early stages of an event, the US460 standard design includes a passive autocatalytic recombiner (PAR) inside the CNV that is sized to maintain the containment atmosphere inert (i.e., less than 4 percent oxygen by volume) during design-basis events and significant beyond design-basis accidents.

6.2.5.1 Design Bases

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~In compliance with 10 CFR 50.44(c)(1), the CNV maintains a mixed containment atmosphere during design-basis and significant BDBE. Adequate mixing of the CNV occurs by virtue of temperature differences between the annular and head regions of the CNV and its partially immersed design with no sub-compartments that could facilitate separation, coupled with the dynamic nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS valve opening events).~~The NPM passively maintains the containment inert to preclude combustion. Specifically, the design includes a PAR in the upper CNV that recombines hydrogen and oxygen to limit oxygen concentration. The PAR is a self-actuating passive component with no moving parts. The PAR is safety-related, Seismic Category I, and included in the Environmental Qualification Program discussed in Section 3.11. The PAR is designed in accordance with the relevant requirements of ASME AG-1 (Reference 6.2-6), Section GE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The NPM design ensures a mixed containment atmosphere during design-basis events and severe accidents due to:

- Temperature differences between the surfaces in the RPV and CNV create natural circulation ensuring mixing.
- The CNV does not include sub-compartments.
- The turbulent nature of events associated with RCS discharge to the CNV (e.g., LOCA or inadvertent ECCS actuation) provides flow mixing effects.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design includes a passive autocatalytic recombiner (PAR) that is non-safety related, seismic Class 2 with augmented requirements. The PAR is designed to survive severe accident conditions and the environment in which the PAR is relied upon to function. The PAR is sized to limit oxygen concentrations to a level that does not support combustion (less than four percent). This results in an inert containment atmosphere, thereby satisfying 10 CFR 50.44(c)(2) and 10 CFR 50.44(c)(3).~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The design supports an exemption from the 10 CFR 50.44(c)(4) requirements for monitoring combustible gases during an accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The NPM relies on a PAR to maintain the containment atmosphere inert through the continuous consumption of oxygen generated post-accident.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Following a BDBA, the containment is oxygen-limited. The sources of oxygen are from the initial quantities in the reactor coolant system controlled by the Primary Coolant Chemistry Program and through radiolytic decomposition of water. Inerting is accomplished solely by the PAR recombining oxygen; no inert gas is added to the containment during operations or post-accident. The PAR has adequate capacity to maintain the containment oxygen concentration below four percent by volume.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design does not include continuous combustible gas monitoring. Each NPM includes a PAR to ensure an inert containment atmosphere through the continuous recombination of hydrogen and oxygen. The inert atmosphere precludes the loss of containment structural integrity, safe shutdown functions, or accident mitigation features by hydrogen combustion. The PAR is reliable, self-actuating, and passive, and the containment is not susceptible to de-inerting. The design also does not rely on hydrogen monitoring to assess core damage. The radiation monitors under the bioshield and core exit thermocouples provide the ability to assess core damage. Containment hydrogen and oxygen monitoring using the process sampling system during normal operations is discussed in Section 9.3.2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The design relies on the PAR to maintain an inert containment atmosphere following a severe accident, therefore an analysis of the effects of combustion on containment integrity is not necessary. The PAR is a reliable passive device that self-actuates to recombine oxygen and hydrogen present in the surrounding environment. The NPM is not susceptible to de-inerting. The PAR is designed to function in the severe accident environment for which it is intended.The PAR maintains an inert atmosphere during design-basis events and significant beyond design-basis accidents; design basis events are limiting for PAR sizing. Notwithstanding, Section 19.2 evaluates a bounding BDBE case that produces more hydrogen than the 100 percent clad water reaction would and determines that the CNV does not exceed its design pressure assuming adiabatic combustion. Therefore, the design conforms to the requirements of 10 CFR 50.44(c)(5).

The design does not require compliance with 10 CFR 50.34(f)(3)(v)(A)(1). 10 CFR 50.34 states that applicants for design approval under Part 52 need not demonstrate compliance with paragraph (f)(3)(v).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The PAR maintains the containment inert post-accident. The systems and components within the CNV that establish and maintain safe shutdown or support containment structural integrity remain capable of performing their required functions after BDBEs.

Section 6.3 addresses hydrogen generation criteria associated with the ECCS performance criteria requirements of 10 CFR 50.46.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs.~~Consistent with GDC 2, the PAR is designed to withstand the effects of natural phenomena. It is located in the CNV and is a Seismic Category I component. The PAR conforms with GDC 4 and withstands the environment conditions and dynamic effects inside the CNV. Consistent with GDC 5, the design relies on passive control of combustible gases that does not involve sharing between NPMs. The PAR satisfies PDC 41 by maintaining the containment atmosphere inert following postulated accidents. The PAR is a passive component not susceptible to active single failure. Implementation of 10 CFR 50.44(d) meets PDC 41 by providing a system to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity. The PAR design permits appropriate periodic inspection and functional testing, thereby satisfying GDC 42 and GDC 43.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The PAR maintains the containment inert post-accident. Implementation of the requirements of 10 CFR 50.44, as modified by an exemption, meets the requirement of PDC 41 to provide systems to control, as necessary, the concentration of hydrogen and oxygen to ensure containment integrity.~~

Section 1.9 addresses compliance with guidance in RG 1.7.

6.2.5.2 System Design

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV is a metal containment, Class MC pressure vessel that undergoes design, analysis, fabrication, inspection, testing, and stamping as an ASME BPVC Class 1 pressure vessel maintained partially immersed in a reactor pool common to other NPMs.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV meets 10 CFR 50.44(c) by safely accommodating the hydrogen generated by the equivalent of up to a 100 percent fuel-cladding metal water reaction. This type of accident is a BDBE in which hydrogen generation could exceed the flammability limits. The CNV is a passive design that relies on a PAR to maintain a containment atmosphere that does not support combustion following a significant BDBE for combustible gas control.~~Events involving combustible gas are discussed in Section 6.2.5. The CNV meets 10 CFR 50.44(d)(2) by safely maintaining a mixed atmosphere as well as maintaining an oxygen-limited environment during design-basis and significant beyond design-basis accidents.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

The CNV allows the PAR to perform its function by maintaining a mixed atmosphere. When blowdown occurs, the dynamic event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection. There are no partitions or sub-compartments to impede these natural mixing forces. Section 6.2.5.3, Design Evaluation, discusses the mixed containment atmosphere, including that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CES establishes a partial vacuum in the CNV before NPM startup that continues during reactor operation. The initial CNV pressure contributes to calculations that result in the initial combustible gas composition in the CNV based on the initial CNV pressure. Section 9.3.6 addresses the CES.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~When RCS discharge to the containment occurs, the dynamic nature of the event creates a mixed atmosphere because of the induced high turbulent condition. As turbulence subsides later in the event, continued mixing occurs through convection and molecular diffusion. There are no partitions or subcompartments to impede these natural mixing forces. Relevant events ensure convective mixing due to decay heat. Section 6.2.5.3 discusses turbulence in the CNV. The analysis shows that turbulent convective mixing exists in the CNV throughout the first 72 hours of a DBE or BDBE.~~

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~The CNV design utilizes a PAR to limit oxygen concentrations to a level that maintains an inerted containment atmosphere following a BDBE that releases an equivalent amount of hydrogen generated from a 100 percent fuel clad-coolant reaction, uniformly distributed. The configuration of the containment coupled with the dynamics of the LOCA and mitigating components ensures adequate mixing within the containment volume during and following events that generate and release combustible gases to containment. Section 6.2.5.3 discusses potential methods of gas accumulation. The limited-oxygen environment and mixed atmosphere maintains an inerted containment atmosphere, thereby precluding combustion that could challenge containment structural integrity.~~

As described in Section 6.2.5.3, there is margin to the containment pressure capacity limit such that there is no need for containment overpressure protection.

Section 6.2.5.5 addresses combustible gas monitoring.

6.2.5.3 Design Evaluation

Audit Question A-6.2.5-1

~~The partially immersed design with no~~The CNV design ensures a mixed containment atmosphere for two reasons: (1) there are no sub-compartments that could facilitate separation, ~~coupled with~~and (2) due to the turbulent~~dynamic~~ nature of ~~events~~the CNV atmosphere associated with RCS discharge to the CNV (e.g., ~~LOCA or inadvertent ECCS valve opening events~~conditions associated with ECCS operation). ~~ensure adequate mixing of the CNV~~. ~~To demonstrate compliance with the 10 CFR 50.44(c) requirement for a well mixed containment, CNV conditions at 72 hours are evaluated.~~

Audit Question A-6.2.5-1

An evaluation of the mixed containment atmosphere is performed at 72 hours after ECCS actuation. Turbulent flow forces decrease as decay heat decreases, therefore conditions at 72 hours are less turbulent, providing a bounding evaluation~~Conditions earlier than 72 hours are generally more turbulent than conditions afterward~~. This evaluation considers two geometries: (1) the annular region between the RPV outer walls and the CNV inner walls (the annular region), and (2) the upper volume between the outer head of the RPV and the inner head of the CNV (the head space). The nondimensional Rayleigh (Ra) number, which represents whether the fluid heat transfer is primarily conductive or convective, evaluates mixing and establishes whether or not fluid flow is turbulent. ~~A transition to bulk turbulent conditions occurs in a tall vertical cavity with a hot surface and a cool surface (in air) somewhere between Ra = 10,000 and Ra = 100,000~~Bulk turbulent flow conditions exist when the Rayleigh number exceeds the turbulence threshold for a specific enclosure. At 72 hours ~~in the CNV, post-accident Ra~~of ECCS operation, the containment atmosphere exceeds this ~~transition regime~~turbulence threshold by at least one order of magnitude, thereby demonstrating a well mixed volume.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

~~Safety analyses show that the core does not uncover during a design-basis LOCA and as a result there is no fuel damage or fuel clad-coolant reaction that would result in an associated production and release of hydrogen or fission products. The risk-informed revision of 10 CFR 50.44 (68 FR 54125) eliminates the design-basis LOCA hydrogen release from the combustible gas control requirements of 10 CFR 50.44.~~The PAR is sized to ensure an inert atmosphere is maintained, irrespective of event type. Events with core damage result in increased zirconium cladding oxidation, thereby significantly increasing the production of hydrogen gas. Because the US460 standard design is oxygen-limiting, core damage events result in a lower oxygen concentration. Contrarily, events without core damage result in a higher oxygen concentration. Accordingly, the PAR is sized using bounding oxygen quantities for a non-core damage event. However, additional conservatism is added by considering the increased radiolysis associated with fuel damage energy deposition without taking credit for fuel damage cladding oxidation. Therefore, the PAR is conservatively sized to recombine a minimum of 15 moles of oxygen per hour at a partial

pressure of 1.69 kilopascals. This recombination rate establishes a PAR capacity that is sufficient for DBEs and BDBEs. Therefore the PAR maintains the CNV inert during a severe accident that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, as well as events with lesser or no clad-coolant reaction.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

An evaluation for the potential for combustible gas (hydrogen and oxygen) accumulation in the containment during and following postulated BDBEs was performed. The evaluation considered those BDBEs an intact containment boundary and resulting in varying degrees of core damage. One example of this type of BDBE is a LOCA inside containment with an ECCS failure that prevents the recirculation of coolant from the CNV back into the RPV. This scenario results in uncovering the reactor core with resulting fuel damage. Uncovering the reactor core can result in the production of a significant amount of hydrogen due to high temperature cladding-fuel interaction with additional amounts of hydrogen and oxygen produced from radiolytic decomposition of the reactor coolant that accumulates within the CNV. The sources of hydrogen in containment following a BDBE are limited to

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- oxidation of zirconium in the fuel cladding.
- radiolysis of water (reactor coolant).
- initial amount of dissolved hydrogen in the RCS.
- the amount of hydrogen accumulated in the upper region of the RPV (i.e., the pressurizer).

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Within the CNV, the design restricts materials that have the potential to yield hydrogen gas because of contact with liquid contents in the CNV (upon ECCS actuation or other condition involving liquid in containment). Section 6.1 identifies any such materials.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Following a BDBE that releases an equivalent amount of hydrogen as would be generated from a 100 percent fuel clad-coolant reaction, the PAR is sized to maintain oxygen at a level (less than four percent) that does not support hydrogen combustion. Therefore, there is no hydrogen combustion, ensuring CNV integrity.

6.2.5.4 Inspection and Testing

RAI 19.2-1

Section 3.8.2.7, Section 6.2.1, Section 6.2.2, Section 6.2.4, Section 6.2.6, Section 6.2.7, Section 6.6, and Section 14.2 describes inspection and testing of the CNV and its components.The PAR is periodically tested and inspected in accordance with technical specifications.

Portions of the lower CNV have 60-year design fluence in excess of 1E+17 neutrons/cm^2, E > 1 MeV, with the peak fluence in the lower CNV not exceeding 2.5E+18 neutrons/cm^2, E > 1 MeV. The portions of the lower CNV with peak neutron fluence greater that 1E+17 neutrons/cm^2, E > 1 MeV, are composed of austenitic stainless steel. Austenitic stainless steels have superior ductility and are less susceptible to the effects of neutron embrittlement than ferritic materials. The peak neutron fluence for the ferritic portion of the CNV is less than the regulatory limit of 1E+17 neutrons/cm^2, E > 1 MeV. The material selection for the CNV pressure boundary ensures facture prevention.

6.2.8 References

6.2-1 NuScale Power, LLC, "Loss-of-Coolant Accident Evaluation Model," TR-0516-49422-P, Revision 3.

6.2-2 NuScale Power, LLC, "Non-Loss-of-Coolant Accident Analysis Methodology Report," TR-0516-49416-P-A, Revision 3.

6.2-3 NuScale Power LLC, "Extended Passive Cooling and Reactivity Control Methodology Topical Report" TR-124587, Revision 0.

6.2-4 NuScale Power, LLC, "NuScale Containment Leakage Integrity Assurance," TR-123952-P, Rev. 0.

6.2-5 American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, 2017 edition, Section XI Division 1, "Rules for Inservice Inspection of Nuclear Components," New York, NY.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

6.2-6 American Society of Mechanical Engineers AG-1-2019, "Code on Nuclear Air and Gas Treatment," New York, NY.

Audit Question A-6.2.5-1, Audit Question A-19.1-53
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 6.2-8: Classification of Structures, Systems, and Components

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
CNTS, Containment System					
All components (except as listed below)-	RXB	A1	None	B	I
• CIVs (CVC PZR spray, RPV high point degasification, CVC injection & discharge) • CITFs (CVC PZR spray, RVP high point degasification, CVC injection & discharge)	RXB	A1	None	A	I
• CIV stored energy device pressure transmitters (MSIV, FWIV, RCCW CIVs, CVC high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVS) • Containment pressure instrumentation (narrow range) • Containment level instrumentation • MS temperature sensors • Closed and open position indicators for FWIVs • CHPU skid A & B • Supply/vent hydraulic lines from CHPU to CIVs • Hydraulic manifolds between CHPU and CIVs	RXB	A1	None	N/A	I
Feedwater isolation check valves	RXB	A2	None	B	I
• CNV-RPV support ledge • CNV CRDM support frame • Supply/vent hydraulic lines from CHPU to DHRS actuation valves	RXB	A2	None	N/A	I
• Containment top support structure	RXB	B1	• ASME-BTH-1-2017	N/A	I

Table 6.2-8: Classification of Structures, Systems, and Components (Continued)

SSC (Note 1)	Location	SSC Classification (A1, A2, B1, B2)	Augmented Design Requirements (Note 2)	Quality Group/Safety Classification (Ref RG 1.26 or RG 1.143) (Note 3)	Seismic Classification (Ref. RG 1.29 or RG 1.143) (Note 4)
• Containment pressure instrumentation (wide range) • Closed and open position indicators (MSIV, MSIBV, RCCWS CIVs, RPV high point degasification CIVs, PZR spray CIVs, CVC injection & discharge CIVs, CFD CIVs, CE CIVs)	RXB	B2	IEEE 497-2016 (Note 5)	N/A	I
PAR	RXB	~~B~~A2	None~~RG 1.7~~	N/A	I~~I~~
• Closed and open position indicators (RPV high point degasification solenoid valve, CVC discharge AOV) • Flushing hydraulic line from CHPU to inboard & outboard CIVs and DHR actuation valves	RXB	B2	None	N/A	II
Containment air temperature sensors	RXB	B2	None	N/A	III

Note 1: Acronyms used in this table are listed in Table 1.1-1

Note 2: Additional augmented design requirements, such as the application of a Quality Group, Radwaste safety, or seismic classification, to nonsafety-related SSC are reflected in the columns Quality Group / Safety Classification and Seismic Classification, where applicable. Environmental Qualifications for SSC are identified in Table 3.11-1.

Note 3: Section 3.2.2.1 through Section 3.2.2.4 provides the applicable codes and standards for each RG 1.26 Quality Group designation (A, B, C, and D). A Quality Group classification per RG 1.26 is not applicable to supports or instrumentation that do not serve a pressure boundary function. Section 3.2.1.4 provides a description of RG 1.143 classification for RW-IIa, RW-IIb, and RW-IIc.

Note 4: Where SSC (or portions thereof) as determined in the as-built plant that are identified as Seismic Category III in this table could, as the result of a seismic event, adversely affect Seismic Category I SSC or result in incapacitating injury to occupants of the control room, they are categorized as Seismic Category II consistent with Section 3.2.1.2 and analyzed as described in Section 3.7.3.8.

Note 5: IEEE Std 497-2016 as endorsed by RG 1.97 and implemented as described in Table 1.9-2

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS maintains an inert containment atmosphere following design-basis events.

The NPM performs the following nonsafety-related, risk-significant function that is verified by ITAAC. The CNTS supports the Reactor Building crane (RBC) by providing lifting attachment points that the RBC can connect to so that the NPM can be lifted.

The NPM performs the following nonsafety-related functions that are verified by ITAAC:

- The CNTS supports the SGS by providing structural support for the SGS piping.
- The CNTS supports the CRDS by providing structural support for the CRDS piping.
- The CNTS supports the RCS by providing structural support for the RCS piping.
- The CNTS supports the feedwater system by providing structural support for the feedwater system piping.

Design Commitments

- The NuScale Power Module ASME Code Class 1, 2, and 3 piping systems listed in Table 2.1-3 and NuScale Power Module ASME Code Class 1, 2, 3, and CS components listed in Table 2.1-4 comply with ASME Code Section III requirements.
- The NuScale Power Module ASME Code Class 1, 2, and 3 components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- The NuScale Power Module ASME Code Class CS components listed in Table 2.1-4 conform to the rules of construction of ASME Code Section III.
- Safety-related SSC are protected against the dynamic and environmental effects associated with postulated failures in high- and moderate-energy piping systems.

Audit Question A-6.3.2.2.1-1

- The ECCS supplemental boron components~~dissolvers and CNV lower mixing tubes~~ are installed such that ECCS can perform the safety-related emergency supplemental boron function.
- Each CNTS containment electrical penetration assembly (EPA) listed in Table 2.1-5 is rated either (i) to withstand fault and overload currents for the time required to clear the fault from its power source, or (ii) to withstand the maximum fault and overload current for its circuits without a circuit interrupting device.
- The CNV serves as an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.
- Closure times for CIVs listed in Table 2.1-5 limit potential releases of radioactivity.
- The length of piping listed in Table 2.1-3 shall be minimized between the containment penetration and the associated outboard CIVs.
- The CNTS containment electrical penetration assemblies listed in Table 2.1-5 are sized to power their design loads.

- The ECCS valves, CIVs, and DHRS actuation valves listed in Table 2.1-4, and their associated hydraulic lines, are installed such that each valve can perform its safety function.

Audit Question A-Part 8-2.1.2-1

- The remotely operated CNTS containment isolation valves listed in ~~Table 2.1-4~~Table 2.1-5 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-Part 8-2.1.2-2

- The ECCS reactor recirculation valves and RVVs~~valves~~ listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The DHRS valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.
- The CNV top support structure (TSS) supports its rated load.
- The CNV top support structure is constructed to provide assurance that a single failure does not result in the uncontrolled movement of the lifted load.
- The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The ECCS reactor recirculation valves and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.
- The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.
- The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner (PAR) is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.

Audit Question A-6.2-4

- The CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.

2.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.1-1 contains the ITAAC for the NPM.

Table 2.1-1: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.01.xx) (Continued)

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
18.	The CNTS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
19.	The ECCS RRVs and RVVs listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power to their corresponding trip valves under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the ECCS RRVs and RVVs listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each ECCS RRV and RVV listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of electrical power to its corresponding trip valve under preoperational temperature, differential pressure, and flow conditions.
20.	The DHRS hydraulic-operated valves listed in Table 2.1-4 fail to (or maintain) their safety-related position on loss of electrical power under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the DHRS hydraulic-operated valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each DHRS hydraulic-operated valve listed in Table 2.1-4 fails to (or maintains) its safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions.
21.	The CNTS check valves listed in Table 2.1-4 change position under design-basis temperature, differential pressure, and flow conditions.	A test will be performed of the CNTS check valves listed in Table 2.1-4 under preoperational temperature, differential pressure, and flow conditions.	Each CNTS check valve listed in Table 2.1-4 strokes fully open and closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions.
22.	The CNTS passive autocatalytic recombiner is installed such that it can perform its safety-related function to maintain an inert containment atmosphere.	An inspection will be performed of the PAR.	A report exists and concludes that the PAR is installed in accordance with the associated installation specification.
23.	The as-built CNV has sufficient net free volume to maintain peak containment pressure below containment design pressure during design-basis events.	A reconciliation analysis will be performed of the as-built containment net free volume.	A report exists and concludes the as-built containment net free volume is greater than or equal to the free volume listed in FSAR Table 6.2-2.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Audit Question A-6.2-4

Table 2.1-2: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Additional Information[(1)] (Continued)

ITAAC No.	Discussion
02.01.18	The CNTS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each CNTS safety-related hydraulic-operated valves listed in Table 2.1-4 repositions to or maintains its safety-related position on loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.19	The ECCS safety-related RRVs and RVVs are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of electrical power under preoperational temperature, differential pressure, and flow conditions. For the first NPM only, a test is conducted under preoperational test conditions that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations. The test is initiated with an initial RPV to CNV differential pressure greater than the inadvertent actuation block threshold pressure of 900 psid in accordance with FSAR Table 14.2-40 and demonstrates that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve. For subsequent NPMs a test is conducted at reduced pressure and temperature in accordance with FSAR Table 14.2-56 to demonstrate that each ECCS safety-related valve listed in Table 2.1-4 fails open on loss of electrical power to its corresponding trip valve.
02.01.20	The DHRS safety-related hydraulic-operated valves are tested to demonstrate the capability to perform their function to fail to or maintain their safety-related position on loss of motive power under preoperational temperature, differential pressure, and flow conditions. In accordance with FSAR Table 14.2-56, a preoperational test demonstrates that each DHRS safety-related hydraulic-operated valves listed in Table 2.1-4 fails open loss of motive power (electric power to the valve actuating solenoid(s) is lost, or hydraulic pressure to the valve(s) is lost). Preoperational test conditions are established that approximate design basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.
02.01.21	The CNTS safety-related check valves are tested to demonstrate the capability to perform their function to transfer open and transfer closed (under forward and reverse flow conditions, respectively) under preoperational temperature, differential pressure, and flow conditions. Check valves are tested in accordance with the requirements of the ASME OM Code, ISTC-5220, Check Valves. In accordance with FSAR Table 14.2-38, a preoperational test demonstrates that the CNTS check valves listed in Table 2.1-4 strokes fully open and closed under forward and reverse flow conditions, respectively. Preoperational test conditions are established that approximate design basis temperature, differential pressure and flow conditions to the extent practicable, consistent with preoperational test limitations.
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4 02.01.22	Quality Control inspection hold points are used to ensure the as-built CNTS passive autocatalytic recombiner is installed consistent with the associated installation specification, and therefore capable of performing its safety-related function. To demonstrate the acceptance criterion for ITAAC 02.01.22 is satisfied, and the associated design commitment fully met, a report will exist and conclude Quality Control inspection hold points exist and have been completed for the location and orientation of the PAR.

Audit Question A-6.2-4, Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.1-6: NuScale Power Module Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.01.01	X					
02.01.02	X					
02.01.03	X					
02.01.04	X	X				
02.01.05	X					
02.01.06	X					
02.01.07	X					
02.01.08	X					
02.01.09	X					
02.01.10	X					
02.01.11	X					
02.01.12	X					
02.01.13	X					
02.01.14	X					
02.01.15	X					
02.01.16				X		
02.01.17				X		
02.01.18	X					
02.01.19	X					
02.01.20	X					
02.01.21	X					
02.01.22	X					
02.01.23	X					

- The safety-related relief valves listed in Table 2.4-3 provide overpressure protection.
- The DHRS condensers listed in Table 2.4-3 have the capacity to transfer their design heat load.
- The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions, and performs its function for the period of time required to complete the function.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

- The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.

RAI 19.2-1

- The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.

2.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4-1 contains the ITAAC for the equipment qualification - module-specific equipment.

Table 2.4-1: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC 02.04.xx) (Continued)

	No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	09.	The CNTS containment electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, withstand the design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions and performs its function for the period of time required to complete the function.	i. A type test or a combination of type test and analysis will be performed of the CNTS containment electrical penetration assemblies listed in Table 2.4-3 including associated connection assemblies. ii. An inspection will be performed of the containment CNTS electrical penetration assembles listed in Table 2.4-3, including associated connection assemblies.	i. An EQ record form exists and concludes that the CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, performs their function under the environmental conditions specified in the EQ record form for the period of time required to complete the function. ii. The CNTS electrical penetration assemblies listed in Table 2.4-3, including associated connection assemblies, are installed in their design location in a configuration bounded by the EQ record form.
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4	10.	The CNTS passive autocatalytic recombiner provides the safety-related function to control combustible gas within the CNV for design-basis events.	A type test, analysis, or a combination of type test and analysis will be performed of the CNTS passive autocatalytic recombiner.	A report exists and concludes that the PAR has sufficient capacity to meet or exceed the minimum required oxygen recombination rate.
RAI 19.2-1	11.	The CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life in the design basis harsh environmental conditions (both internal service conditions and external environmental conditions) experienced during normal operations, AOOs, DBAs, and post-accident conditions.	An analysis will be performed of the CNTS passive autocatalytic recombiner.	A qualification record form exists and concludes that the CNTS passive autocatalytic recombiner performs its function up to the end of its qualified life under the design basis harsh environmental conditions specified in the qualification record form.

Table 2.4-2: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Additional Information(1) (Continued)

	ITAAC No.	Discussion
Audit Question A-6.2.5-1 RAI 19.2-1, RAI 19.2-3, RAI 19.2-4	02.04.10	FSAR Section 6.2.5, Combustible Gas Control in the Containment Vessel, discusses that the PAR provides the safety-related function of maintaining an inert atmosphere (i.e., less than 4 percent oxygen by volume) in the CNV, which is achieved by the continuous recombination of oxygen. FSAR Section 6.2.5 lists the minimum design oxygen recombination rate (in moles per hour) for the PAR to ensure the CNV atmosphere remains inert following design-basis events. This ITAAC verifies that the PAR oxygen recombination rate meets or exceeds the minimum required oxygen recombination rate specified in FSAR Section 6.2.5 to maintain the CNV atmosphere inert during design-basis events.
RAI 19.2-1	02.04.11	FSAR Section 3.11 presents information to demonstrate that the CNTS passive autocatalytic recombiner located in a harsh environment is qualified using an analysis to perform its function up to the end of its qualified life in design basis harsh environmental conditions experienced during normal operations, AOOs, DBAs, and post-accident conditions. Environmental conditions include both internal service conditions and external environmental conditions for the PAR. The qualification method employed for the equipment is the same as the qualification method described for that type of equipment in FSAR Section 3.11. The ITAAC verifies that: (1) an equipment qualification record form exists for the PAR, and (2) the qualification record form concludes that the PAR listed in Table 2.4-3 perform its intended function up to the end of its qualified life under the design basis environmental conditions (both internal service conditions and external environmental conditions) specified in the qualification record form.

Note:
1) References to Tables and Figures refer to ITAAC unless the reference specifically states FSAR Tables or Figures.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category[(1)]
Containment System						
CNV8	I&C Division I EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV9	I&C Division II EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV15	PZR heater power division I nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV16	PZR heater power division II nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV17	I&C Channel A instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV18	I&C Channel C instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV19	I&C Channel B instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV20	I&C Channel D instrument seal assembly	Harsh	~~Electrical~~ Mechanical	Yes	No	~~A~~B
CNV37	CRDM power 1 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV38	RPI group #1 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV39	RPI group #2 EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
CNV40	I&C separation group A EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV41	I&C separation group B EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV42	I&C separation group C EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV43	I&C separation group D EPA	Harsh	Electrical Mechanical	Yes	Yes	A
CNV44	CRDM power 2 nozzle EPA	Harsh	Electrical Mechanical	Yes	No	~~A~~B
None	CNV CRDM Support Frame	N/A	N/A	Yes	N/A	N/A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
CNT-PE-1001A CNT-PE-1001B CNT-PE-1001C CNT-PE-1001D	Containment narrow range pressure elements	Harsh	Electrical	Yes	Yes	A
CNT-PE-1002A CNT-PE-1002B	Containment wide range pressure elements	Harsh	Electrical	Yes	No	A
CNT-LE-1003A CNT-LE-1003B CNT-LE-1003C CNT-LE-1003D	Containment level indication	Harsh	Electrical	Yes	Yes	A
CNT-PAR-0001	Passive autocatalytic recombiner	Harsh	Mechanical	Yes	N/A	A
MS-TE-1001A MS-TE-1001B MS-TE-1001C MS-TE-1001D	SG #1 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
MS-TE-2001A MS-TE-2001B MS-TE-2001C MS-TE-2001D	SG #2 main steam temperature indication	Harsh	Electrical	Yes	Yes	A
CE-ZSC-0001	CES inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0001	CES inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0001	CES inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CE-ZSC-0002	CES outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CE-ZSO-0002	CES outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CE-PT-0002	CES outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0022	CFDS inboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0022	CFDS inboard CIV open position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0022	CFDS inboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CFD-ZSC-0021	CFDS outboard CIV close position indicator	Harsh	Electrical	Yes	No	A
CFD-ZSO-0021	CFDS outboard CIV open Position indicator	Harsh	Electrical	Yes	No	A
CFD-PT-0021	CFDS outboard CIV nitrogen accumulator pressure transmitter	Harsh	Mechanical	Yes	No	B
CVC-ZSC-0334	CVCS discharge inboard CIV close position indicator	Harsh	Electrical	Yes	No	A

Table 2.4-3: Module-Specific Mechanical and Electrical/Instrumentation and Controls Equipment (Continued)

Equipment Identifier	Description	EQ Environment	Qualification Program	Seismic Category I	Class 1E	EQ Category(1)
ICI-TE-~~BA-~~0001F-B~~A / F~~ ICI-TE-~~BA-~~0002F-B~~A / F~~ ICI-TE-~~CA-~~0003F-C~~A / F~~ ICI-TE-~~CA-~~0004F-C~~A / F~~ ICI-TE-~~BA-~~0005F-B~~A / F~~ ICI-TE-~~BA-~~0006F-B~~A / F~~ ICI-TE-~~CA-~~0007F-C~~A / F~~ ICI-TE-~~CA-~~0008F-C~~A / F~~ ICI-TE-~~CA-~~0009F-C~~A / F~~ ICI-TE-~~BA-~~0010F-B~~A / F~~ ICI-TE-~~CA-~~0011F-C~~A / F~~ ICI-TE-~~BA-~~0012F-B~~A / F~~	Core ~~inlet /~~ exit thermocouples	Harsh	Electrical	Yes	No	A

Note:

1. EQ Categories:
   - A - Equipment that will experience the environmental conditions of DBAs for which it must function to mitigate said accidents, and that will be qualified to demonstrate operability in the accident environment for the time required for accident mitigation with safety margin to failure.
   - B - Equipment that will experience the environmental conditions of DBAs through which it need not function for mitigation of said accidents, but through which it must not fail in a manner detrimental to plant safety or accident mitigation, and that will be qualified to demonstrate the capability to withstand the accident environment for the time during which it must not fail with safety margin to failure.
   - E - Equipment that will not experience environmental conditions of DBAs and that will be qualified to demonstrate operability under the expected extremes of its nonaccident service environment.

Audit Question A-6.2.5-1
RAI 19.2-1, RAI 19.2-3, RAI 19.2-4

Table 2.4-4: Equipment Qualification - Module-Specific Inspections, Tests, Analyses, and Acceptance Criteria Top-Level Design Feature Categories

ITAAC No.	Design Basis Accident	Internal / External Hazard	Radiological	PRA & Severe Accident	Fire Protection	Physical Security
02.04.01	X					
02.04.02	X					
02.04.03	X					
02.04.04	X					
02.04.05	X					
02.04.06	X					
02.04.07	X					
02.04.08	X					
02.04.09	X					
02.04.10	X					
02.04.11	X					

Enclosure 9:

Affidavit of Mark W. Shaver, AF-176034

NuScale Power, LLC

AFFIDAVIT of Mark W. Shaver

I, Mark W. Shaver, 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 response by which NuScale develops its NuScale Power, LLC Response to NRC Request for Additional Information (RAI No. 10185 R1, Questions 19.2-1, 19.2-2, 19.2-3, and 19.2-4) on the NuScale Standard Design Approval Application.

NuScale has performed significant research and evaluation to develop a basis for this response 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 RAI 10185 R1, Questions 19.2-1, 19.2-2, 19.2-3, and 19.2-4. The enclosures contain 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 November 22, 2024.

Mark W. Shaver

Mark W. Shaver