RAIO-0817-55215

August 03, 2017

Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 54 (eRAI No. 8837) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 54 (eRAI No. 8837)," dated June 09, 2017

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

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 8837:

- 03.11-2
- 03.11-5
- 03.11-6
- 03.11-7
- 03.11-8
- 03.11-9
- 03.11-10
- 03.11-11

The responses to questions 03.11-1, 03.11-3, and 03.11-4 will be provided by December 29, 2017.

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
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Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 8837

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Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 8837

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Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 8837
Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-2

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Table 3C-8 provides accident EQ radiation dose information. Table 3C-8 indicates that it provides integrated beta and integrated gamma dose rates. The table indicates that integrated

gamma includes fission gamma, gammas from neutrons, and gammas from coolant. However, during design basis accidents it would appear that the reactors should be shut down. Therefore, there would not be expected to be significant amounts of fissions or neutrons. Please discuss how nuclear fission and neutrons contribute to the accident EQ radiation doses. Also, if Table 3C-8 is inaccurate, please update as appropriate.

NuScale Response:

Table 3C-8: "Accident EQ Radiation Dose" has the total integrated dose from the accident as well as the plant lifetime normal dose. This was done to bound the analysis so that it covers the dose the equipment would absorb if the accident were to happen at the end of the plant's 60 year lifetime of normal operation. The neutron and neutron-induced-gamma dose are from the normal operations of the plant for its lifetime.

Impact on DCA:
There are no impacts to the DCA as a result of this response.

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eRAI No.: 8837
Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-5

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

In DCD Section 3C.4.1, under "Harsh Environment" it states that, "The equipment requiring

qualification for a harsh environment, as identified in Section 3.11, includes the following." Then there are five bullets. The fifth bullet states, "equipment subject to environmental conditions that are more severe for other parameters (e.g., temperature, pressure, humidity, flood level, spray/wetting, radiation) such as those resulting from a fuel handling accident or moderate-energy line break." The basis, intent, and practical implementation of this bullet is not clear. Please clarify the intent of this bullet and its practical application for NuScale equipment design and update the DCD accordingly.

NuScale Response:

The intent of this specific bullet in FSAR Appendix 3C.4.1 is to clarify that the scope of the NuScale EQ Program includes events other than the spectrum of LOCA and HELBs. The purpose and intent of this criteria is to simply ensure that the mechanical and electrical equipment subject to harsh accident conditions are environmentally qualified to the most severe design basis accident conditions for which they could be exposed. This approach is consistent with the technical rationale in DSRS 3.11, 10 CFR 50.49, as well as Section B of Regulatory Guide1.89 Revision 1.

Table 3.11-1 was developed based on the following accident events having the potential to result in harsh environmental service conditions:

1. Spectrum of small break LOCAs (NuScale SMR does not have large break LOCA)
2. Spectrum of High Energy Line Breaks (HELBs) inside and outside of the RXM, including Main Steam Line Breaks, Feedwater Line Breaks, and Chemical Volume Control System Line Breaks.
3. Rod Ejection Accident
4. Spectrum of Moderate Energy Line Breaks (MELBs)
5. Fuel Handling Accidents

Impact on DCA:
There are no impacts to the DCA as a result of this response.

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Docket No. 52-048

eRAI No.: 8837
Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-6

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Section 3C.4.3, under “Radiation Dose Effects,” states, “In general, dose rate effects occur over long periods and, therefore, need only be addressed during the radiation conditions that occur during normal plant operation.”

a. This statement appears inconsistent with other information in the DCD which indicates that both normal operation and accident conditions are considered. For example, DCD Section 3C.5.4, under “Design Basis Event Radiation Doses” states, “The required dose used for environmental qualification considers the total integrated dose consisting of the normal dose plus the accident dose corresponding to the required post- accident operating time. The normal dose considers gamma and neutron effects, while the accident dose considers the gamma and beta dose that is expected at the equipment location.” Please explain how accident conditions have been considered and ensure that the DCD is consistent.

b. If accident conditions have been categorically excluded, please provide additional technical justification for excluding their consideration.

c. In addition, please describe any situations when the dose rate received during accident conditions has been or needs to be included.

NuScale Response:

The discussion in FSAR Appendix 3C.4.3, under Radiation Dose Effects, is specifically dealing with synergistic effects related to radiation dose rate effects. This section of the FSAR is intended to describe how the NuScale EQ program addresses, or otherwise accounts for known synergistic effects, as required by 10 CFR 50.49 and RG 1.89, Revision 1. The statement that “In general, dose rate effects occur over long periods and, therefore, need only be addressed during the radiation conditions that occur during normal plant operation.” reflects the need to consider the potential for lower dose rates during normal operation to produce more severe degradation for certain materials compared to higher dose rates used to accelerate the radiation exposure time during a qualification test program. This should not be considered to be inconsistent or in conflict with other sections of the FSAR which describe how qualification to the total integrated (normal + accident) dose will be conducted.

FSAR Appendix 3C.5.4, “Design Basis Event Radiation Doses” clearly specifies that the required dose used for environmental qualification considers the total integrated dose consisting of the normal dose plus the accident dose corresponding to the required post-accident operating time. The normal dose considers gamma and neutron effects, while the accident dose considers

the gamma and beta doses that are postulated at the equipment's location.

The qualification to the postulated radiation environment is based on the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during for which the equipment is required to function and is consistent with 10 CFR 50.49 e(4). The only consideration of dose rate effects involves dose rate synergistic effects under normal operating conditions as described in FSAR Appendix 3C.4.3.

Impact on DCA:
There are no impacts to the DCA as a result of this response.

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Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-7

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Section 3C.4.4 states, "Equipment required to be environmentally qualified has one or more of the following design functions related to safety: reactor trip, engineered safeguards

actuation, post-accident monitoring, or containment isolation." It is not clear to the staff how this list was developed. 10 CFR 50.49, specifies that equipment required to maintain safe shutdown and non-safety related equipment whose failure could prevent satisfactorily accomplishing a safety-function, must also be qualified. Please explain how this list comprehensively meets the requirements of 10 CFR 50.49. Please update the DCD accordingly and ensure that additional equipment does not need to be added to DCD Table 3.11-1, as a result.

NuScale Response:

The identification of the electrical equipment important to safety that is subject to 10 CFR 50.49 has been developed in a manner that considers the criteria in paragraphs b(1), b(2), and b(3).

The following summary is intended to clarify and reaffirm that the equipment identified in Table 3.11-1 of the DCD is comprehensive and complete with respect to the requirements of 10 CFR 50.49.

10 CFR 50.49 b(1): Safety-Related Electric Equipment

The following system-level functions are associated with establishing the environmentally qualified path, to achieve and maintain safe shutdown, following a design basis accident that results in a significant change in environmental service conditions. These functions are representative of system level functions associated with control, cooling, contain, monitoring and support functions and represent the functional objectives of the environmentally qualified line of defense for the NPM:

- Reactivity control
- Decay heat removal
- Containment isolation
- Maintain RCS pressure boundary integrity
- Mitigate the severity of the event
- Control Room habitability
- Post-Accident Monitoring (PAM)
- System support function(s)

These system level functions were developed using the guidance from Appendix A of RG 1.89 Revision 1 and were applied for each DBA that has the potential to produce a harsh environment. Therefore, the qualified line of defense, provided in Table 3.11-1, includes all the safety related equipment that is governed by 10 CFR 50.49 b(1).

10 CFR 50.49 b(2): Nonsafety-Related Electric Equipment

The potential for failure of nonsafety-related electrical equipment impacting or preventing the accomplishment of a function covered under 10 CFR 50.49 b(1) or b(3) has been considered. Due to the passive nature of the NPM, electrical power is not needed to mitigate design basis accidents. The lack of a safety related electrical power system eliminates many of the electrical interactions related to failure of nonsafety-related electrical equipment causing a loss of

electrical power to an electrical component that is performing a safety-related function during or following a DBA. The design of the EDSS and EDN electrical systems does provide electrical separation between the EDSS which provides electrical power to electrical equipment subject to EQ requirements. The electrical isolation between the EDSS and EDN has been credited in preventing an electrical fault in the EDN from affecting the equipment powered by EDSS.

As a result, there are currently no 10 CFR 50.49 b(2) items that require qualification to harsh environmental conditions.

10 CFR 50.49 b(3): Certain Post Accident Monitoring Equipment

Instrumentation associated with RG 1.97, Revision 4, Category B, C, and D variables have been included within the scope of the EQ program. It should be noted that the NPM has no Type A variables. Table 3.11-1 of the DCD includes the Type B, C, and D variables that are located in a harsh environment area following a design basis accident as requiring environmental qualification. In addition to RG 1.97 variables, the identification of 10 CFR 50.49 b(3) indication also includes the position indication for reactor safety valve in accordance with NUREG-0737 II.D.3. As a result, the applicable post-accident monitoring instrumentation required by 10 CFR 50.49 b(3) has been included within the scope of environmental qualification program.

Table 3.11-1 does not need additional updates since it includes the complete list of components required to be environmentally qualified is consistent with the requirements of 10 CFR 50.49 b(1), b(2) and b(3). The list of design functions related to safety in Appendix 3C.4.4 has been revised to consistent with the above list of system level functions associated with equipment requiring qualification per 10 CFR 50.49 b(1).

Impact on DCA:

Appendix 3C.4 has been revised as described in the response above and as shown in the markup provided in this response.

interaction effects are minute by comparison to the primary effects, and thus require significantly more experimental evidence to identify. Current research, as referenced below, indicates that synergistic effects can typically be categorized under two main headings:

- Test sequence effects - The sequence in which radiation and thermal aging exposures occur is an important consideration. Radiation combined with elevated temperatures or radiation followed by elevated temperatures may produce more material degradation than when thermal aging precedes radiation exposure (NUREG/CR-3629 (Reference 3C-14)).
- Radiation dose rate effects - For many materials, it has been observed that lower dose rates produce more degradation than a higher dose rate for the same total applied dose (NUREG/CR-2157 (Reference 3C-15)).

Test Sequence Effects

An important aging consideration is the possible existence of synergistic effects when multiple stress environments such as radiation and elevated temperatures, are applied simultaneously. Currently, sequential exposure is the only commercially available means of testing; no commercial facility offers simultaneous steam and radiation exposure. Although sequential and simultaneous tests can produce variances in degradation, the differences tend to be minor compared to total degradation. The possibility that significant synergistic effects may exist is addressed by the using the "worst-case" aging sequence, conservative accelerated aging parameters and conservative, DBE test levels to provide confidence that any synergistic effects are enveloped.

Radiation Dose Effects

The need for qualification due to radiation exposure is evaluated for each piece of equipment. The radiation environment is based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional.

In general, dose rate effects occur over long periods and, therefore, need only be addressed during the radiation conditions that occur during normal plant operation.

3C.4.4 Operating Time

RAI 03.11-7

Equipment required to be environmentally qualified has one or more of the following design functions related to safety: ~~reactor trip~~reactivity control, ~~engineered safeguards actuation~~decay heat removal, post-accident monitoring, ~~or~~ containment isolation, maintenance of RCS pressure boundary integrity, control room habitability, event severity mitigation or system support functions. For each function, a period of operability is assigned that ranges from less than 1 hour to a maximum of 2400 hours. The assignment of these post accident operating times is separated into the five

different time frames that are related to plant status or system functional requirements. These operating time designations and durations are summarized in Table 3C-4.

Equipment that performs its design function related to safety prior to significant changes in its environment may be qualified for shorter durations. In accordance with Regulatory Guide 1.89, justification for shorter duration includes:

- the consideration of a spectrum of pipe break sizes
- the potential need for the equipment later in an event or during recovery operations
- Subsequent failure of the equipment is shown to not be detrimental to plant safety or to mislead the operator

Post-accident operating times for equipment to be qualified shall be specified in the EQ Master List and as shown in Table 3.11-1.

3C.4.5 Performance Criterion

The qualification test program demonstrates the capability of the equipment to meet the design function related to safety performance requirements defined in the EQRF (Section 3C.8). As stated previously, the primary objective of qualification is to demonstrate that equipment, for which a qualified life or condition has been established, can perform its design functions related to safety without experiencing common-cause failures before, during, and after applicable DBEs. The continued capability for this equipment and its interfaces (Reference 3C-16) to meet or exceed its specification requirements is provided through an operational program that includes, but is not limited to, design control, quality control, qualification, installation, maintenance, periodic testing, and surveillance.

3C.4.6 Margin

The purpose of using margin in the qualification program is to account for commercial production variability, errors in establishing satisfactory performance, and errors in experimental measurements, thereby providing greater assurance that the equipment can perform under the specified service conditions. Table 3C-5 presents the margins for various environmental parameters. The margins shown in the table are those recommended in IEEE Std. 323 (Reference 3C-1).

3C.4.7 Treatment of Failures

Any failure to meet the acceptance criteria is analyzed to determine the cause. Equipment modifications, equipment retesting, or equipment use limitations are imposed as necessary to address the failure.

3C.5 Design Specifications

The equipment design specification identifies the applicable codes and standards, required operating times, performance requirements, design functions related to safety, operational service conditions, environmental service conditions, accepted methods of qualification,

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NRC Question No.: 03.11-8

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Section 3.11.5.2 specifies that "the radiation doses are continuously monitored during

plant life and compared to the calculated doses. If the measured doses are higher than the calculated doses, the EQ Master List will be revised if an affected mild environment becomes harsh." This description does not explain how equipment located in harsh conditions will be monitored and managed throughout plant life. As discussed in numerous places in the DCD, equipment located in harsh environmental zones is designed to perform under all appropriate environmental conditions. So if the dose in a harsh environment is higher than the calculated dose, it could possibly result in a TID (including consideration for postulated accidents) which exceeds the TID for which the equipment in that area was designed to withstand. Therefore, please discuss in the DCD any necessary actions that may be necessary if the measured dose is higher than the calculated dose for equipment located in harsh environments.

NuScale Response:

COL Item 3.11-4 has been added to FSAR Section 3.11.5.2:

COL Item 3.11-4:

A COL applicant that references the NuScale Power Plant design certification will ensure the Environmental Qualification Program cited in COL Item 3.11-1 includes a description of how equipment located in harsh conditions will be monitored and managed throughout plant life. This description will include methodology to ensure equipment located in harsh environments will remain qualified if the measured dose is higher than the calculated dose.

Impact on DCA:

FSAR Section 3.11.5 has been revised as described in the response above and as shown in the markup provided in this response.

The normal and abnormal environmental conditions shown on Appendix 3.C, Table 3.C-6 and Table 3.C-7, reflect anticipated normal and maximum conditions. The HVAC systems in the standard design are non-safety related and are assumed to not be functional during design basis events (except in cases where operation may result in more severe environmental conditions for equipment).

3.11.5 Estimated Chemical and Radiation Environment

3.11.5.1 Chemical Environments

Applicable chemical environments are defined in Appendix 3.C for normal and abnormal operating conditions. The chemical environments from the most limiting design basis event is also considered in the qualification of the equipment and presented in Appendix 3.C.

Chemicals that are used for water chemistry and pH control have been considered as well as the borated water environment that will be present inside containment and outside containment. Water chemistry is discussed in Section 5.2.3.2.1 for primary side water chemistry, Section 6.1.1.2 for the reactor pool and spent fuel pool chemistry, and Section 10.3.5 for the secondary side water chemistry.

3.11.5.2 Radiation Environments

Radiation environments are defined in Appendix 3.C for normal and accident conditions.

RAI 03.11-8

Normal operation radiation doses are calculated for initial plant start-up conditions using the source terms and analysis. The radiation doses are ~~continuously~~ monitored during plant life and compared to the calculated doses. If the measured doses are higher than the calculated doses, the EQ Master List will be revised if an affected mild environment becomes harsh. Section 12.3 discusses the assumptions associated with the normal operations dose rates.

The normal operations dose rates for equipment qualification are derived from direct gamma emitted by radioactive fluids. Beta radiation and Bremsstrahlung radiation during normal operations are considered negligible contributors to doses in comparison to the gamma radiation and therefore are omitted. Normal doses within the CNV and other areas also account for neutron fluence, when applicable, by equating the neutron fluence to an equivalent dose in Rad. The loss-of-coolant accident dose rates include a submersion dose and a direct dose contribution. The submersion dose is derived from both the gamma and beta radiation. The beta radiation may be attenuated by low-density equipment enclosures. Alpha radiation is neglected from both the normal and accident equipment qualification dose rates because the alpha particle is easily attenuated by air.

In the event doses are determined to exceed the qualified dose for a specific piece of equipment, a component specific dose calculation may be performed to determine the component specific dose at the specific equipment location. The accident dose rates

were calculated based on the methodology presented in Topical Report TR-0915-17565-P and Section 12.2.1.13. The assumptions associated with the accident dose rates are discussed in Section 15.0.3. See also the discussion in Appendix 3.C for additional information on normal and accident dose rates used for environmental qualification.

RAI 03.11-8

COL Item 3.11-4: A COL applicant that references the NuScale Power Plant design certification will ensure the Environmental Qualification Program cited in COL Item 3.11-1 includes a description of how equipment located in harsh conditions will be monitored and managed throughout plant life. This description will include methodology to ensure equipment located in harsh environments will remain qualified if the measured dose is higher than the calculated dose.

3.11.6 Qualification of Mechanical Equipment

Mechanical equipment is qualified and documented in accordance with the General Design Criteria 1, 2, 4, and 23 as demonstrated by the approach presented in this section.

GDC 1 and 4 and Appendix B to 10 CFR Part 50 (Criteria III, "Design Control," XI, "Test Control," and XVII, "Quality Assurance Records") contain the following requirements related to generic equipment qualification methodology which applies to mechanical qualification of equipment:

- Components are designed to be compatible with the postulated environmental conditions, including those associated with loss-of-coolant accidents.
- Measures are established for the selection and review of the suitability of application of materials, parts, and equipment that are essential to safety-related functions.
- Design control measures are established for verifying the adequacy of design.
- Equipment qualification records are maintained and include the results of tests and materials analyses.

Mechanical components, including passive components, are qualified to perform their required functions under the appropriate environmental effects of normal, abnormal, accident, and post-accident conditions as required by GDC 4 and 10 CFR 50 Appendix B. Mechanical equipment qualification verifies the design is capable of functioning during normal, abnormal and accident conditions and includes the effects of the fluid medium (e.g., borated water) on the environmental conditions.

For mechanical equipment located in a mild environment, acceptable environmental design is demonstrated by the design and purchase specifications for the equipment. The specifications contain a description of the functional requirements for a specific environmental zone during normal environmental conditions and anticipated operational occurrences. The programs identified in Section 3.11.2.1 for verifying that electrical equipment located in a mild environment are capable of performing their intended function will also be applied to mechanical equipment located in a mild environment. For mechanical equipment that must function during or following exposure to a harsh environment, compliance with the environmental design provisions of GDC 4 are generally

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NRC Question No.: 03.11-9

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Section 15.0.3.8.1 discusses line breaks outside of containment, including chemical and volume control system (CVCS) line breaks. It is unclear if CVCS line breaks have been

considered in the EQ analysis and how CVCS line breaks could affect equipment outside containment requiring qualification. Therefore, please discuss doses outside containment as a result of potential line breaks and how the doses effect the TIDs of equipment and zones outside of containment.

NuScale Response:

All design basis accidents were evaluated and considered in the EQ analysis. Specifically, CVCS line breaks outside of containment would not affect the TIDs of equipment outside of containment. The dose from the source in an intact CVCS line is accounted for in the analysis. If the line break occurs outside of the module bay, the CVCS source (contaminated water) would fall down the pipe chase and collect in the sumps at the bottom level of the plant, where there is no equipment being qualified. Since the CVCS line is isolated in an accident, this would drain the CVCS line near equipment, and actually lower the dose to that equipment. Any additional airborne dose from a CVCS line break in the module bay are bounded by other accidents, such as the fuel handling accident, of which the doses were added for EQ analysis. The potential airborne dose from a CVCS line break ouside of the module bay would be limited in consequence, and manifest in the lower regions of the reactor building, below the pipe chase where the coolant collects in the drains and sumps, which is away from equipment needing qualification.

The associated post-accident radiation zone maps were submitted in the response to RAI 8775, Question 12.3-1.

Impact on DCA:
There are no impacts to the DCA as a result of this response.

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 8837
Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-10

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

In DCD Section 3C.5, under Environmental Qualification of Mechanical Equipment, it states

that, “Equipment that only has the design function related to safety of maintaining its structural integrity, for support or to protect the integrity of a pressure boundary, is qualified in accordance with the requirements specified in Section 5.2.1.” There is no discussion of the effects of radiation on equipment in DCD Section 5.2.1. Please discuss how the effects of radiation are considered for equipment that only has the design function related to safety of maintaining its structural integrity. Update the DCD as appropriate.

NuScale Response:

The statement in FSAR Appendix 3C.5 indicating equipment is qualified "in accordance with the requirements in Section 5.2.1" has been revised to correctly reference Section 3.11. The revised FSAR that provides this correction in redline/strikeout fashion is included in the response to this RAI.

Impact on DCA:

Appendix 3C.5 has been revised as described in the response above and as shown in the markup provided in this response.

and acceptance criteria. The design specification also provides the basis for establishing the EQ of the specific equipment or the family of equipment.

Environmental Qualification of Electrical Equipment

The environmental conditions for which equipment is qualified are the most severe conditions resulting from the DBE for which the equipment is required to perform its design function related to safety. The equipment qualification life of electrical and mechanical equipment is established as a conservative 60 years unless otherwise noted on the equipment's specification. Periodic inspection and testing shall be used during the life of the equipment to verify its ongoing qualification.

The amount of time, after a design basis event, for which some equipment must remain functional, may be a few minutes or several hours depending on its design function related to safety.

RAI 03.11-10

Environmental Qualification of Mechanical Equipment

Both passive and active mechanical equipment (Reference 3C-3) is qualified according to the criteria and methodology described in this document. Non-metallic components like O-rings, seals, gaskets, and lubricants for mechanical equipment with a design function related to safety are also qualified in accordance with these criteria. Equipment that only has the design function related to safety of maintaining its structural integrity, for support or to protect the integrity of a pressure boundary, is qualified in accordance with the requirements specified in Section ~~5.2.1~~3.11. The design specification will also identify if qualification to ASME QME-1 is required for active mechanical equipment.

3C.5.1 Normal Operating Conditions

Normal operating conditions are summarized in Table 3C-6. For qualification under normal operating conditions, the equipment is mounted, connected, interfaced, and operated in a manner that simulates its normal inservice conditions, and the equipment's design functions related to safety are demonstrated during exposure to normal service conditions. Data are recorded for later reference as required by Section 3C.8.

Normal Radiation Dose

The normal radiation integrated doses for equipment are based on the maximum normal reactor coolant system (RCS) radionuclide activities and system parameters to determine bounding normal cumulative doses both inside and outside of the containment, as shown in Table 3C-6. These values were determined based on 60 years (bounding environmental qualification life) of continuous operation and steady-state operating conditions, and take into account radiation exposure because of recirculatory fluid for equipment outside the containment.

The integrated doses shown in Table 3C-6 represent the direct dose to equipment and bound any additional airborne doses.

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 8837
Date of RAI Issue: 06/08/2017

NRC Question No.: 03.11-11

Regulatory Basis
10 CFR 50.49 and 10 CFR Part 50, Appendix A, Criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

DSRS Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, and post-design basis events.

DSRS Section 3.11 also states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety are acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program should be in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of DSRS Section 3.11.

Finally, RGs 1.89 and 1.183 provide guidance on how to perform the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding or the technical specification primary coolant activity limits, would be an acceptable assumption to use in calculating the normal operation equipment qualification dose.

Question

DCD Section 3C.4.2, under Radiation Aging, states that, "Radiation aging may be performed separately from the accident radiation exposure or the accident radiation exposure may be

performed as part of the radiation aging." Please clarify the intent of this statement.

1. Is the intent to say that in some cases accident radiation exposure is not considered in combination with the normal operational radiation exposure? If so, please justify why it is acceptable to not consider the total integrated dose to components and only to consider the normal operation and accident exposure separately. In addition, provide additional information regarding when this approach is applied; or

2. Is the intent that one device can be radiation aged, while another device can be tested for accident dose? If so, please justify why it is acceptable to use this approach and provide additional information regarding when this approach is applied.

NuScale Response:

The discussion in FSAR Appendix 3C.4.2 regarding radiation aging is intended to clarify that the radiation aging during a qualification test program may be done separately from or concurrently with the accident radiation exposure. This does not mean that the degradation from the accident dose does not need to be considered in combination with the degradation from the normal dose exposure. This statement is indicating that the radiation exposure can be performed in one exposure, simulating the total integrated dose (normal plus accident), or that it can be performed in separate exposures (one for normal and one for the accident dose). Either test sequence is considered consistent with Sections 6.3.2 and 6.3.3 of IEEE 323-1974 and would result in exposing the test specimens to the same total integrated dose. The use of multiple radiation exposures would need to be performed on the same test specimen(s), to satisfy the fully sequential test sequence requirements of IEEE 323-1974.

The goal and objective of an accelerated program is to place the test specimen(s) in an end-of-life condition prior to exposure to the simulated accident condition. The discussion in Appendix 3C.4.2 is specifically intended to allow flexibility in defining the specific test sequence, with consideration of factors, such as the applicability of test sequence synergistic effects, the relative magnitude of the normal dose compared to the accident dose, as well as the time to perform the irradiation.

Impact on DCA:
There are no impacts to the DCA as a result of this response.