NuScale Power

RAIO-0518-60069

May 18, 2018

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

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 54 (eRAI No. 8837)," dated June 09, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 54 (eRAI No.8837)," dated August 03, 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:

- 03.11-1
- 03.11-3
- 03.11-4

A majority of the responses to RAI No. 54, eRAI No. 8837 were previously provided in Reference 2. This completes all responses to eRAI 8837.

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

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.: 03.11-1

<u>Regulatory Basis</u>
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.

<u>Question</u>

Note 2 of DCD Table 3C-6, indicates that EQ Zones J, K, L, M, and N are designated as harsh environments in the RXB because these areas contain high and/or moderate energy piping.

However, while the DCD provides total integrated dose (TID) information for EQ Zones A through I, no TID information is provided for EQ Zones J, K, L, M, and N and therefore, no information is provided regarding what TID the equipment in these areas is required to be designed to. Staff notes that even with the non-conservative and low assumed fuel percentage of 0.028%, some of the areas within these zones would likely result in harsh radiological environments based only on the normal operation source terms. Therefore;

a. Please provide the maximum TID values for EQ Zones J, K, L, M, and N in the DCD and describe how they are calculated.
b. Specify if each of these zones is radiologically harsh or mild in the DCD.
c. Describe how it is determined what radiation TID values equipment in these areas are required to be designed to and update the DCD appropriately.

NuScale Response:

Response to Question (a):

A revised accident source term topical report (TR-0915-17565, Rev. 3) is scheduled to be issued in late summer 2018. This topical report will describe the methodology used to develop the revised NuScale accident source terms. Using this revised accident source term methodology, NuScale has performed calculations to determine radiological conditions outside of the containment for equipment qualification purposes, including environmental qualification (EQ) Zones J through N. The maximum normal and accident TID values for EQ zones J through N determined using the revised accident source term have been added to FSAR Tables 3C-6 and 3C-8, respectively.

Response to Question (b):

As discussed by FSAR Section 3.11, plant areas have harsh radiological conditions when the radiation levels exceed 1.0E04 rads gamma for electrical and mechanical equipment, including non-metallics or consumables, such as O-rings; or radiation levels exceed 1.0E03 rads gamma for electronic devices and components. Based on these criteria, EQ zones J and M have harsh radiological conditions. The FSAR Tables 3C-2, 3C-6, and 3C-8 have been updated accordingly.

Response to Question (c):

FSAR Section 12.2.1.13 discusses how areas containing post-accident sources are evaluated for dose consequence. The maximum primary coolant activity released from design basis accidents, that could be released into the bioshield envelope, is assumed to be released instantaneously and homogeneously throughout the bioshield envelope volume. The remaining primary coolant inventory is assumed to be released instantaneously and homogeneously throughout the containment atmosphere, where it shines and leaks into the bioshield envelope at the technical specification leak rate and remains in the envelope's volume for the duration of the event. For EQ zones of the RXB outside the pool envelop the limiting design basis dose rate during normal operations was applied with a 60 year operating life to determine the TID from normal operations environmental qualification.

FSAR Section 3.11.5.2 discusses how radiation doses for environmental qualification are determined. FSAR Tables 3C-6 and 3C-8 are used to determine the radiation dose values for equipment design and specification. As previously discussed, the threshold for harsh radiological conditions for equipment in a given area is >1.0E04 rads gamma for electrical and mechanical equipment, including non-metallics or consumables, such as O-rings; or radiation levels exceed 1.0E03 rads gamma for electronic devices and components.

Impact on DCA:

FSAR Section 3.11 and Appendix 3C have 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 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.

RAI 03.11-1, RAI 03.11-4

~~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.~~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.

RAI 03.11-1, RAI 03.11-4

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, Infrequent Events (IE)

FSAR Section 15.6.2 - radiological consequences of failure of small lines carrying primary coolant outside of containment. Similar to FSAR Section 15.6.5, this covers chemical and volume control systems (CVCS) pipe rupture events that are postulated inside or outside of containment.

Other Design Basis Events

FSAR Section 3.6 - high energy line breaks (HELB) outside containment. This covers HELB outside of containment that are not already addressed by FSAR Sections 15.1.5, 15.2.8, or 15.6.5, such as the postulated rupture of the module heatup system (MHS) piping in the gallery areas of the RXB.

FSAR Section 3.6 - moderate energy line breaks (MELB) outside containment.

Normal and Bounding Conditions

Containment vessel and reactor building pressure and humidity experienced during the indicated DBE are shown in Table 3C-7. Equipment that is required to perform a design function related to safety, and could potentially be subjected to the design basis environments, is qualified to these conditions for the required operating time.

RPV and containment vessel metal temperatures in the lower (liquid) space with corresponding liquid temperatures for the bounding DBAs are shown on Figure 3C-1. RPV and containment vessel metal temperatures in the upper (vapor) space with corresponding vapor temperatures for the bounding DBAs are shown on Figure 3C-2. The average vapor temperatures at the top of module for the bounding DBAs, and assuming a vented bioshield, are shown on Figure 3C-3. The maximum vapor temperatures for elevation 145' in the RXB from the same bounding DBAs are shown on Figure 3C-4.

Design Basis Event Radiation Doses

RAI 03.11-1, RAI 03.11-4

~~The accident integrated doses are based on the guidance provided in Regulatory Guide 1.183 for equipment following design basis events (as provided in TR-0915-17565-P (Reference 3C-5)). The doses resulting from this DBA source term bound those from all other design basis accidents.~~NuScale Topical Report, TR-0915-17565-P (Reference 3C-5) provides the methodology for determining the accident source terms for equipment following design basis events. The limiting event and associated source terms from the design basis accidents discussed above were used to determine total integrated doses for equipment qualification.

The accident conditions integrated doses within the reactor building were determined using the maximum normal core radionuclide inventory. The maximum normal core inventory bounds the equilibrium cycle burnup for the NuScale Power Module reactor and is representative of operating cycle characteristics for environmental qualification purposes. The required dose used for environmental qualification considers the total

RAI 03.11-1, RAI 03.11-4

Table 3C-2: Designated Harsh Environment Areas

Area	Basis	Comment/Remarks
EQ Zones A, B, C, D, E and F	Harsh environment as a result of primary and secondary HELBs potential to occur in this area Total integrated dose (60 yrs + accident) > 1.0E4 Rads	Inaccessible post-accident and during normal operation.
EQ Zone G	Harsh environment as a result of primary and secondary HELBs potential to occur in this area Total integrated dose (60 yrs + accident) > 1.0E4 Rads	Inaccessible post-accident
EQ Zone H	Harsh environment as a result of primary and secondary HELBs potential to occur in the Top of Module (TOM) ≥ 120F and > 18F increase above normal operating conditions with RH ≥85%	Harsh due to HELBs potential to occur under the bioshield
EQ Zone I	Harsh environment as a result of primary and secondary HELBs potential to occur in the TOM Total integrated dose (60 yrs + accident) > 1.0E4 Rads	
EQ Zones J, K, L, M, and N	These areas will contain high and moderate energy piping. Total integrated dose exceed > 1.0E3 Rads (60 year normal + 30 day accident dose) for equipment with solid state circuitry and > 1.0E4 Rads (60 year normal + 30 day accident dose) for electrical or mechanical equipment.	Harsh by preliminary design for HELBs. Zone J is harsh due to post-accident radiological equipment qualification requirements exceeding source term doses of > 1.0E4 Rads (60 year normal + 30 day accident dose) for electrical or mechanical equipment. Zone M is harsh due to post-accident radiological equipment qualification requirements exceeding source term doses of > 1.0E3 Rads (60 year normal + 30 day accident dose) for equipment with solid state circuitry.

RAI 03.11-1, RAI 03.11-4, RAI 03.11-16

Table 3C-6: Normal Operating Environmental Conditions

Zone(2)	Temperature (°F)	Pressure (psig) (Nominal)	Maximum Relative Humidity (%) (1)	60 Years Integrated N Dose (Rads)		60 Years Integrated γ Dose (Rads) (Includes fission γ, N-γ, coolant)		Water Level (ft. above RXB pool floor)
A	487 (lower RPV wall)	<(-14.6)(32)	0	2.42E8		9.01E10		47' (inside CNV for refueling)
B	491 (RPV wall) 295 (CNV wall)	<(-14.6)(32)	0	6.71E8		4.51E10		(inside CNV for refueling)
C	551 (RPV wall)	<(-14.6)(32)	0	1.10E9		4.11E7		47' (inside CNV for refueling)
D	618 (outside top of PZR) 295 (CNV wall)	<(-14.6)(32)	0	6.00E7		3.01E6		47' (inside CNV for refueling)
E	581 (surface of MS piping)	<(-14.6)(32)	0	4.77E7		2.26E6		47' (inside CNV for refueling)
F	295 (upper CNV volume)	<(-14.6)(32)	0	3.55E7		1.51E6		-
G	140	0	<100	1.85E6		4.35E4		-
H	1050	0	<100	above bioshield	2.65E1	above bioshield	1.60E3	-
				EL 145	5.50E0	EL 145	3.90E2	
I	140	0 plus submergence head	N/A	pool center	0	pool center (coolant only)	4.654.93E3	69' (normal operating level outside CNV)
				next to operating module	8.70E7	next to operating module	1.53E10	
J	105	0	<100	0		6.53E04		-
K	85	0	<100	0		1.58E01		-
L	85	0	<100	0		1.58E01		-
M	105	0	<100	0		5.26E00		-
N	105	0	<100	0		-		-

Notes:

1. Normal service relative humidity outside of the containment vessel is shown as <100%; the relative humidity inside the containment vessel is 0% because the environment is normally maintained in a vacuum.
2. ~~DCA EQ Zones J, K, L, M, and N are isolated from the RXB Pool and bioshield areas but are preliminarily designated as harsh environments in the RXB because these areas contain high or moderate energy piping.~~

23. The pressure inside the CNV is maintained less than the saturation pressure corresponding to the reactor pool pressure; this results in a vacuum.

34. The boron concentration in the pool areas will be nominally 1800 ppm. EPRI primary water chemistry guidelines show the pH of a pool with 1800 ppm boron concentration to be 4.75.

RAI 03.11-1, RAI 03.11-4, RAI 03.11-16

Table 3C-7: Design Basis Event Environmental Conditions

Zone(3)	DBE	Temperature (F)	DBE	Pressure (psig)(2)	DBE	Relative Humidity (%)	Water Level (ft. above RXB pool floor)	Water Spray (pipe rupture)
A	HELB	See Figure 3C-1	HELB	958.4	All Events	100	24 (inside CNV to support ECCS operation)	-
B	HELB	See Figure 3C-1	HELB	958.4	All Events	100	24 (inside CNV to support ECCS operation)	-
C	HELB	See Figure 3C-2	HELB	958.4	All Events	100	-	Yes
D	HELB	See Figure 3C-2	HELB	958.4	All Events	100	-	Yes
E	HELB	See Figure 3C-2	HELB	958.4	All Events	100	-	Yes
F	HELB	See Figure 3C-2	HELB	958.4	All Events	100	-	Yes
G	HELB	See Figure 3C-3	HELB	2.5	All Events	100	-	Yes
H	Conditions resulting from HELB and fuel handling accident (FHA) in the pool area/top of module (TOM)	See Figure 3C-4	Conditions resulting from HELB and FHA in the pool area/ TOM	2.75	Conditions resulting from HELB and FHA in the pool area/ TOM	100	-	-

Table 3C-7: Design Basis Event Environmental Conditions (Continued)

Zone(3)	DBE	Temperature (F)	DBE	Pressure (psig)(2)	DBE	Relative Humidity (%)	Water Level (ft. above RXB pool floor)	Water Spray (pipe rupture)
I	Conditions resulting from HELB and FHA in the pool area/ TOM	212(1)	Conditions resulting from HELB and FHA in the pool area/ TOM	2.75 (Equipment located below water level will be affected by hydrostatic pressure plus atmospheric overpressure)	Conditions resulting from HELB and FHA in the pool area/ TOM	N/A	75 (top of pool, not DBA condition)	-

Notes:

1. The long term pool temperature will remain at 212°F due to all modules being on DHRS from a loss of power. Equipment exposed to this environment will need to be qualified at 212°F for as long as the equipment is required as specified in Table 3.11-1.
2. Refer to TR-0516-49084Table 6.2-4a for the CNV pressure for the spectrum analyses of primary and secondary mass and energy releases. NRELAP5 was used for development of the pressure and temperature envelop for qualification of equipment within containment and has been shown to be equivalent to COMTEMPT-LT for this purpose.
3. DCA EQ Zones J, K, L, M, and N are isolated from the RXB Pool and bioshield areas but are preliminarily designated as harsh environments in the RXB because these areas contain high or moderate energy piping.DCA EQ Zones J, K, L, M, and N are preliminarily designated as harsh environments in the RXB because these areas contain high or moderate energy piping. Additionally, Zone J is harsh due to post-accident radiological equipment qualification exceeding source term doses > 1.0E4 Rads (60 year normal + 30 day accident dose) for electrical or mechanical equipment. Zone M is harsh due to post-accident radiological equipment qualification requirements exceeding source term doses of > 1.0E3 Rads (60 year normal + 30 day accident dose) for equipment with solid state circuitry.
4. The CNV post-accident pH for any postulated accident that results in core damage is 6.9 at 1000 ppm boron concentration and 8.3 at 200 ppm boron concentration. These values remain essentially unchanged between 25C and 200C.

RAI 03.11-1, RAI 03.11-2S1, RAI 03.11-4

Table 3C-8: Accident EQ Radiation Dose

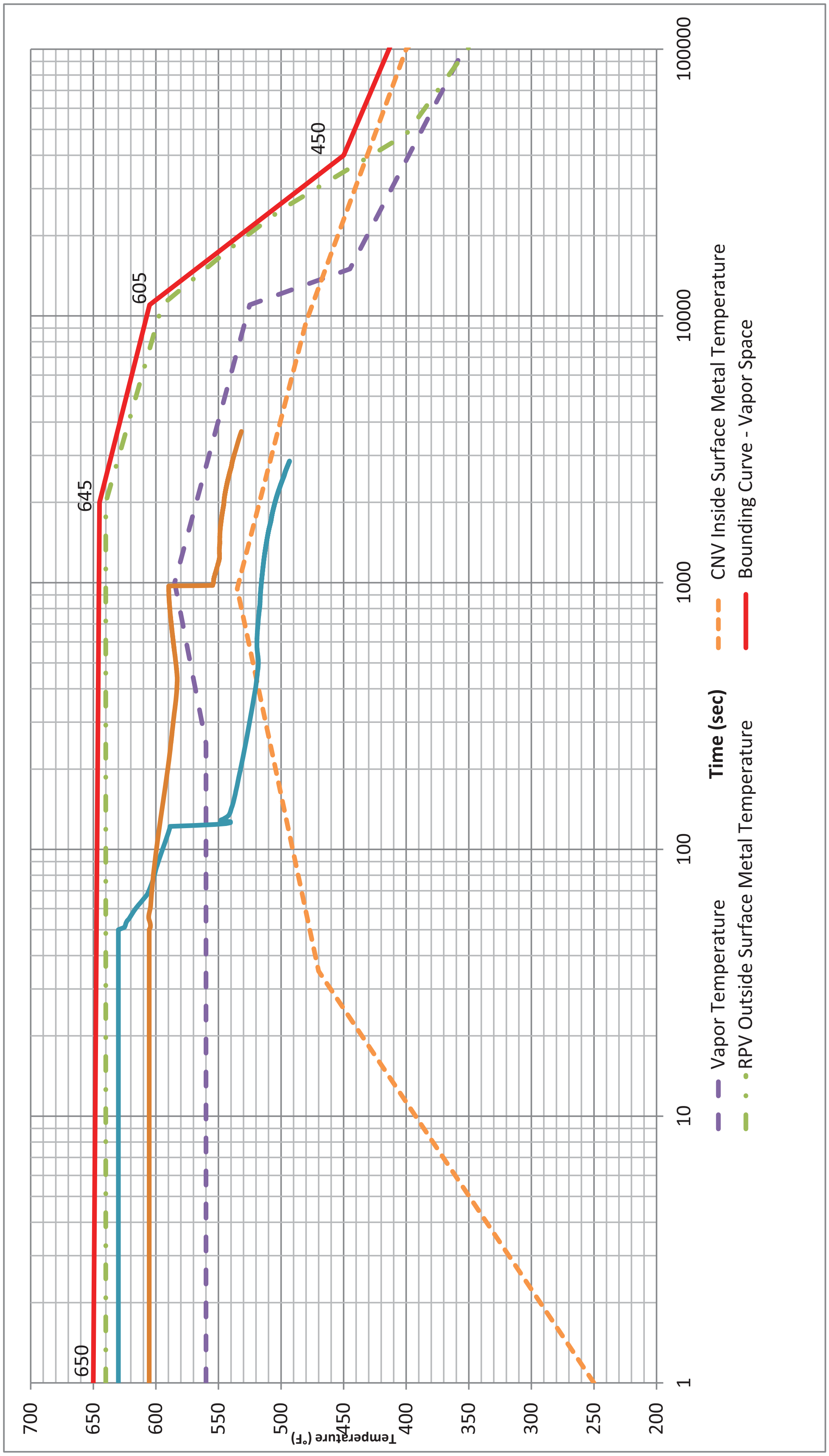
Zone(1)	Dose	Accident Integrated Dose (rads)				
		1 hour	36 hours	72 hours	720 hours	2400 hours
A	Integrated β	06.40E02	2.11E68.89E03	3.56E61.23E04	1.44E72.59E04	3.15E72.82E04
	Integrated γ	02.09E03	6.05E62.10E04	1.06E72.78E04	6.07E76.55E04	1.52E88.84E04
B	Integrated β	06.40E02	2.11E68.89E03	3.56E61.23E04	1.44E72.59E04	3.15E72.82E04
	Integrated γ	02.09E03	6.05E62.10E04	1.06E72.78E04	6.07E76.55E04	1.52E88.84E04
C	Integrated β	02.91E05	1.39E94.38E06	2.40E96.38E06	8.63E92.00E07	1.57E103.94E07
	Integrated γ	08.96E05	2.54E99.07E06	4.39E91.20E07	2.35E102.85E07	5.73E103.84E07
D	Integrated β	02.91E05	1.39E94.38E06	2.40E96.38E06	8.63E92.00E07	1.57E103.94E07
	Integrated γ	08.96E05	2.54E99.07E06	4.39E91.20E07	2.35E102.85E07	5.73E103.84E07
E	Integrated β	02.91E05	1.39E94.38E06	2.40E96.38E06	8.63E92.00E07	1.57E103.94E07
	Integrated γ	08.96E05	2.54E99.07E06	4.39E91.20E07	2.35E102.85E07	5.73E103.84E07
F	Integrated β	02.91E05	1.39E94.38E06	2.40E96.38E06	8.63E92.00E07	1.57E103.94E07
	Integrated γ	08.96E05	2.54E99.07E06	4.39E91.20E07	2.35E102.85E07	5.73E103.84E07
G	Integrated β	07.58E01	4.94E53.13E03	1.45E66.28E03	2.06E79.58E04	6.84E76.33E05
	Integrated γ	07.27E03	2.82E57.71E04	7.51E51.05E05	1.54E73.34E05	8.98E76.66E05
H	Integrated β	05.50E01	2.11E31.69E03	6.24E32.99E03	8.83E41.56E04	2.93E52.48E04
	Integrated γ	07.65E01	1.21E32.32E03	3.22E34.08E03	6.60E42.22E04	3.85E53.95E04
I	Integrated β+	6.40E00	1.60E02	2.69E02	1.80E03	4.75E03
	Integrated γ	25.61.94E01	5.83E25.78E02	1.12E31.02E03	8.3E37.89E03	2.5E42.25E04
J	Integrated β	-	-	-	-	-
	Integrated γ	6.17E02	1.24E04	1.71E04	3.95E04	5.39E04
K	Integrated β	-	-	-	-	-
	Integrated γ	1.56E-02	3.00E-01	3.73E-01	4.74E-01	4.76E-01
L	Integrated β	-	-	-	-	-
	Integrated γ	1.56E-02	3.00E-01	3.73E-01	4.74E-01	4.76E-01
M	Integrated β	-	-	-	-	-
	Integrated γ	3.60E01	6.81E02	8.94E02	1.85E03	2.63E03
N	Integrated β	-	-	-	-	-
	Integrated γ	2.78E-04	5.70E-03	7.00E-03	7.00E-03	7.00E-03

Notes:

1. DCA EQ Zones J, K, L, M, and N are isolated from the RXB Pool and bioshield areas but are preliminarliy designated as harsh environments in the RXB because these areas contain high or moderate energy piping.

RAI 03.11-1, RAI 03.11-4

Figure 3C-2: Containment Vapor Space Metal and Gas Temperatures with Bounding Curve (Zones C, D, E, and F)



NuScale Power

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

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

NRC Question No.: 03.11-3

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 indicates that the accident integrated doses one hour after an accident in all areas is zero. Given that NuScale has stated that it followed RG 1.183, the staff cannot confirm that NuScale has applied guidance in Section 3.3 regarding release timing. Please provide additional information explaining how Section 3.3 was implemented or justification for the alternative approach applied.

NuScale Response:

A revised accident source term topical report (TR-0915-17565, Rev. 3) is scheduled to be issued in late summer 2018. This topical report will describe the methodology used to develop the revised NuScale accident source term, including what was followed and what deviations were taken from RG 1.183.

As discussed in FSAR Section 12.2.1.13, the maximum primary coolant activity released for the design basis accidents, that could be released into the bioshield envelope, is assumed to be released instantaneously into the bioshield volume and the remaining primary coolant is assumed to be instantaneously released into the containment atmosphere, where it shines and leaks into the bioshield envelope at the technical specification rate throughout the duration of the event. This conservative approach is now employed resulting in non-zero dose rates one hour after an accident. FSAR Table 3C-8 "Accident EQ Radiation Dose" has been updated to reflect the non-zero dose rates.

Impact on DCA:

Table 3C-8 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 03.11-1, RAI 03.11-2S1, RAI 03.11-4

Table 3C-8: Accident EQ Radiation Dose

Zone~~(1)~~	Dose	Accident Integrated Dose (rads)				
		1 hour	36 hours	72 hours	720 hours	2400 hours
A	Integrated β	~~0~~6.40E02	~~2.11E6~~8.89E03	~~3.56E6~~1.23E04	~~1.44E7~~2.59E04	~~3.15E7~~2.82E04
	Integrated γ	~~0~~2.09E03	~~6.05E6~~2.10E04	~~1.06E7~~2.78E04	~~6.07E7~~6.55E04	~~1.52E8~~8.84E04
B	Integrated β	~~0~~6.40E02	~~2.11E6~~8.89E03	~~3.56E6~~1.23E04	~~1.44E7~~2.59E04	~~3.15E7~~2.82E04
	Integrated γ	~~0~~2.09E03	~~6.05E6~~2.10E04	~~1.06E7~~2.78E04	~~6.07E7~~6.55E04	~~1.52E8~~8.84E04
C	Integrated β	~~0~~2.91E05	~~1.39E9~~4.38E06	~~2.40E9~~6.38E06	~~8.63E9~~2.00E07	~~1.57E10~~3.94E07
	Integrated γ	~~0~~8.96E05	~~2.54E9~~9.07E06	~~4.39E9~~1.20E07	~~2.35E10~~2.85E07	~~5.73E10~~3.84E07
D	Integrated β	~~0~~2.91E05	~~1.39E9~~4.38E06	~~2.40E9~~6.38E06	~~8.63E9~~2.00E07	~~1.57E10~~3.94E07
	Integrated γ	~~0~~8.96E05	~~2.54E9~~9.07E06	~~4.39E9~~1.20E07	~~2.35E10~~2.85E07	~~5.73E10~~3.84E07
E	Integrated β	~~0~~2.91E05	~~1.39E9~~4.38E06	~~2.40E9~~6.38E06	~~8.63E9~~2.00E07	~~1.57E10~~3.94E07
	Integrated γ	~~0~~8.96E05	~~2.54E9~~9.07E06	~~4.39E9~~1.20E07	~~2.35E10~~2.85E07	~~5.73E10~~3.84E07
F	Integrated β	~~0~~2.91E05	~~1.39E9~~4.38E06	~~2.40E9~~6.38E06	~~8.63E9~~2.00E07	~~1.57E10~~3.94E07
	Integrated γ	~~0~~8.96E05	~~2.54E9~~9.07E06	~~4.39E9~~1.20E07	~~2.35E10~~2.85E07	~~5.73E10~~3.84E07
G	Integrated β	~~0~~7.58E01	~~4.94E5~~3.13E03	~~1.45E6~~6.28E03	~~2.06E7~~9.58E04	~~6.84E7~~6.33E05
	Integrated γ	~~0~~7.27E03	~~2.82E5~~7.71E04	~~7.51E5~~1.05E05	~~1.54E7~~3.34E05	~~8.98E7~~6.66E05
H	Integrated β	~~0~~5.50E01	~~2.11E3~~1.69E03	~~6.24E3~~2.99E03	~~8.83E4~~1.56E04	~~2.93E5~~2.48E04
	Integrated γ	~~0~~7.65E01	~~1.21E3~~2.32E03	~~3.22E3~~4.08E03	~~6.60E4~~2.22E04	~~3.85E5~~3.95E04
I	Integrated β~~+~~	6.40E00	1.60E02	2.69E02	1.80E03	4.75E03
	Integrated γ	~~25.6~~1.94E01	~~5.83E2~~5.78E02	~~1.12E3~~1.02E03	~~8.3E3~~7.89E03	~~2.5E4~~2.25E04
J	Integrated β	-	-	-	-	-
	Integrated γ	6.17E02	1.24E04	1.71E04	3.95E04	5.39E04
K	Integrated β	-	-	-	-	-
	Integrated γ	1.56E-02	3.00E-01	3.73E-01	4.74E-01	4.76E-01
L	Integrated β	-	-	-	-	-
	Integrated γ	1.56E-02	3.00E-01	3.73E-01	4.74E-01	4.76E-01
M	Integrated β	-	-	-	-	-
	Integrated γ	3.60E01	6.81E02	8.94E02	1.85E03	2.63E03
N	Integrated β	-	-	-	-	-
	Integrated γ	2.78E-04	5.70E-03	7.00E-03	7.00E-03	7.00E-03

~~Notes:~~

~~1. DCA EQ Zones J, K, L, M, and N are isolated from the RXB Pool and bioshield areas but are preliminarliy designated as harsh environments in the RXB because these areas contain high or moderate energy piping.~~

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

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

NRC Question No.: 03.11-4

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

The DCD doesn't describe the assumptions used to determine radiological conditions outside of containment and inside the plant for EQ purposes during and following accidents. For example, there is no discussion of accident source terms outside of containment or radioactive material released to the plant atmosphere following design basis accidents and how it impacts the TID to equipment. In addition, there is no information available for staff to assess the radiological conditions in the general plant areas during and following an accident (such as radiation zone maps). These assumptions and information are important in demonstrating that the requirements of 10 CFR 50.49 and GDC 4 are met. Please provide this information.

NuScale Response:

A revised accident source term topical report (TR-0915-17565, Rev. 3) is scheduled to be issued in late summer 2018. This topical report will describe the methodology used to develop the revised NuScale accident source term. Using this revised accident source term, NuScale has performed calculations to determine radiological conditions outside of the containment for environmental qualification purposes for all accident scenarios including Category 1 design basis events and a Category 2 maximum hypothetical accident. The maximum dose from any scenario in any given zone was chosen to bound all credible scenarios/design basis accidents.

Zone maps are depicted by new FSAR Figures 12.3-4a through 12.3-4d, which were transmitted by the response to eRAI 9278, Question 32, NuScale letter RAIO-05128-59929 dated May 16, 2018. A reference to the zone maps was added to FSAR Section 3.11.5.2.

Impact on DCA:

FSAR Section 3.11 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 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.

RAI 03.11-1, RAI 03.11-4

~~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.~~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.

RAI 03.11-1, RAI 03.11-4

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,