NUSCALE™ Power for all humankind

RAIO-0119-64281

January 29, 2019

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. 512 (eRAI No. 9634) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 512 (eRAI No. 9634)," dated November 29, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 512 (eRAI No.9634)," dated January 10, 2019
3. NuScale Power, LLC Response to NRC "Request for Additional Information No. 512 (eRAI No.9634)," dated January 16, 2019

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 responses to the following RAI Questions from NRC eRAI No. 9634:

- 16-60-3
- 16-60-7
- 16-60-9
- 16-60-17
- 16-60-18
- 16-60-21
- 16-60-22
- 16-60-23
- 16-60-24
- 16-60-25
- 16-60-26
- 16-60-27
- 16-60-28
- 16-60-29
- 16-60-30
- 16-60-31
- 16-60-32
- 16-60-33
- 16-60-34
- 16-60-35
- 16-60-40
- 16-60-42
- 16-60-43
- 16-60-46
- 16-60-61
- 16-60-62
- 16-60-63
- 16-60-72
- 16-60-73
- 16-60-78

Other portions of the NuScale response to question 16-60 were previously provided in References 2 and 3.

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 Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8H12
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Attachment 1: eRAI No. 9634, Question 16-60 Cross-Reference Table

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9634

NuScale Tracking Number	NRC RAI Sub-paragraph Number	NuScale Letter No.	Submittal Letter Date	Accession Number
16-60-1	1	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-2	2	pending		
16-60-3	3	RAIO-0119-64281	January 29, 2019	pending
16-60-4	4	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-5	5	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-6	6	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-7	7	RAIO-0119-64281	January 29, 2019	pending
16-60-8	8	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-9	9	RAIO-0119-64281	January 29, 2019	pending
16-60-10	10	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-11	11	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-12	12	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-13	13	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-14	14	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-15	15	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-16	16	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-17	17	RAIO-0119-64281	January 29, 2019	pending
16-60-18	18	RAIO-0119-64281	January 29, 2019	pending
16-60-19	18	pending		
16-60-20	19	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-21	20	RAIO-0119-64281	January 29, 2019	pending
16-60-22	21	RAIO-0119-64281	January 29, 2019	pending
16-60-23	22	RAIO-0119-64281	January 29, 2019	pending
16-60-24	23	RAIO-0119-64281	January 29, 2019	pending
16-60-25	24	RAIO-0119-64281	January 29, 2019	pending
16-60-26	25	RAIO-0119-64281	January 29, 2019	pending
16-60-27	26	RAIO-0119-64281	January 29, 2019	pending
16-60-28	27	RAIO-0119-64281	January 29, 2019	pending
16-60-29	28	RAIO-0119-64281	January 29, 2019	pending
16-60-30	29	RAIO-0119-64281	January 29, 2019	pending
16-60-31	29	RAIO-0119-64281	January 29, 2019	pending
16-60-32	29	RAIO-0119-64281	January 29, 2019	pending
16-60-33	30	RAIO-0119-64281	January 29, 2019	pending
16-60-34	30	RAIO-0119-64281	January 29, 2019	pending
16-60-35	31	RAIO-0119-64281	January 29, 2019	pending
16-60-36	32	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-37	33	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-38	34	RAIO-0119-64111	January 10, 2019	ML19010A409

NuScale Tracking Number	NRC RAI Sub-paragraph Number	NuScale Letter No.	Submittal Letter Date	Accession Number
16-60-39	35	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-40	36	RAIO-0119-64281	January 29, 2019	pending
16-60-41	37.1	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-42	37.2	RAIO-0119-64281	January 29, 2019	pending
16-60-43	37.3	RAIO-0119-64281	January 29, 2019	pending
16-60-44	38	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-45	39	pending		
16-60-46	40	RAIO-0119-64281	January 29, 2019	pending
16-60-47	41	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-48	42	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-49	43	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-50	44	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-51	45	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-52	45	pending		
16-60-53	46	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-54	47	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-55	48	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-56	49	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-57	50	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-58	51	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-59	52	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-60	53	pending		
16-60-61	54	RAIO-0119-64281	January 29, 2019	pending
16-60-62	55	RAIO-0119-64281	January 29, 2019	pending
16-60-63	55	RAIO-0119-64281	January 29, 2019	pending
16-60-64	56, 57, 58	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-65	59	pending		
16-60-66	60	pending		
16-60-67	61	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-68	62	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-69	63	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-70	64	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-71	65	RAIO-0119-64178	January 16, 2019	ML19016A374
16-60-72	66	RAIO-0119-64281	January 29, 2019	pending
16-60-73	67	RAIO-0119-64281	January 29, 2019	pending
16-60-74	68	pending		
16-60-75	69 (i – iv)	pending		
16-60-76	69 (v)	pending		
16-60-77	70	pending		

NuScale Tracking Number	NRC RAI Sub-paragraph Number	NuScale Letter No.	Submittal Letter Date	Accession Number
16-60-78	71	RAIO-0119-64281	January 29, 2019	pending
16-60-79	72	pending		
16-60-80	73	pending		
16-60-81	74	RAIO-0119-64111	January 10, 2019	ML19010A409
16-60-82	75	pending		

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9634

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-3

3. A response is not required because this item is being referred to the NRO technical branch responsible for reviewing FSAR Section 6.4. Markup of Page 6.4-1 of FSAR Section 6.4 in Letter dated June 1, 2018, follow-up to NRC-NuScale public meetings held on 2/26/2018 and 4/3/2018. (Also see response to RAI 01-1.) NuScale is requested to explain why it proposed adding the sentence, “No operator actions are required or credited to mitigate the consequences of design basis events, before or after 72 hours.” This sentence is included in Revision 2 of DCA part 2, FSAR Section 6.4.

NuScale Response:

FSAR Tier 2, section 15.0.0.6.4, Required Operator Actions states:

> There are no operator actions credited in the evaluation of NuScale DBEs. After a DBE, automated actions place the NPM in a safe-state and it remains in the safe-state condition for at least 72 hours without operator action, even with assumed failures.

This is a feature of the NuScale power plant design that is reflected throughout the design and analyses presented in the FSAR including Tier 2, chapters 6, 9, and 15.

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.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-7

7. Please coordinate the response to this sub-question with the response to similar Sub-question 37.3. The applicant is requested to explain whether the N-2L– Power Range Linear Power Permissive, which allows manually bypassing of MPS Functions 3.3.1.**1.a** and 3.3.1.**1.b** with Thermal Power > 15% RTP, should be referred to as the N-2L interlock when it automatically enables these Functions at ≤ 15% RTP. The staff needs to ensure that the terms 'permissive' and 'interlock' are used consistently when referring to MPS operating bypass and enable Functions.

NuScale Response:

Module Protection System interlocks and permissives, including the N-2L Permissive, N-2L Interlock, and N-2H Interlock are described in FSAR Tier 2, Table 7.1-5. Interlocks automatically establish an operating bypass when the interlock condition is met. Permissives allow the manual bypass by the operator of the operating bypass. Operating bypasses are automatically removed when the associated interlock condition or permissive condition is no longer satisfied.

This information is also described in the Applicable Safety Analyses, LCO, and Applicability section of the bases for LCO 3.3.1. As described in the FSAR and the bases, the distinction between functions as used in the NuScale design is that a ‘permissive’ feature allows operator action to implement the bypass, while ‘interlock’ features automatically implement the bypass. Both permissive and interlock functions are automatically removed when the associated condition no longer exists.

The N-2 permissive and interlocks are distinguished by the appended ‘L’ or ‘H’ which indicates whether the condition is entered from below or above the setpoint. N-2L functions are active on increasing power. The N-2H function is active on decreasing power.

MPS function 3.3.1.1.a is described in the bases correctly as a permissive. The permissive may be initiated by the operator when power exceeds the N-2L setpoint from below. The automatic reset as power decreases below the permissive setpoint is consistent with the design and descriptions used for permissive functions.

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.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-9

9. A separate response is not required because the response to this sub-question will be provided with a supplemental response to RAI 9034, Question 16-30, Sub-question a.1. The proposed definition of SDM in Revision 2 of DCA part 4, Section 1.1, departs from the W-STS definition as indicated by the following mark up of the W-STS definition:

SDM shall be the instantaneous amount of reactivity by which the reactor is subcritical or would be subcritical from its present condition assuming:

a. Moderator temperature is 420°F; and

b. All ~~rod cluster control assemblies (RCCAs)~~ CRAs are fully inserted except for the single ~~RCCA~~ assembly of highest reactivity worth, which is assumed to be fully withdrawn. However, with all ~~RCCAs~~ CRAs verified fully inserted by two independent means, it is not necessary to account for a stuck ~~RCCA~~ CRA in the SDM calculation. With any ~~RCCA~~ CRA not capable of being fully inserted, the reactivity worth of ~~the RCCA~~ the affected CRA must be accounted for in the determination of SDM~~, and~~

~~b. In MODES 1 and 2, the fuel and moderator temperatures are changed to the [nominal zero power design level~~].

The change in the order of parts a and b, and the use of CRA instead of RCCA, are editorial administrative changes to reflect NuScale nomenclature and the applicant's preferred presentation. Since the acronym "CRA" is previously defined in the definition of "MODE," not defining it upon its first use in this definition, is acceptable. However, the staff suggests defining the acronym again for clarity. Regardless, subsequent use of the word "assembly" and "assemblies" should be changed to "CRA" and "CRAs" to conform to the improved TS writer's

guide convention concerning acronyms. The W-STS definition does not appear to consider more than one RCCA to be incapable of being fully inserted; however, the W-AP1000-STS SDM definition does consider more than one uninsertable RCCA. Revision 1 of the DCA contains no justification of why NuScale needs to consider more than one CRA that cannot be fully inserted. Finally, the DCA does not justify using the minimum temperature for criticality, 420°F, in place of the statement, "In MODE 1, the fuel and moderator temperatures are changed to the [nominal zero power design level]." (Note that NuScale MODE 1 corresponds to W-STS MODES 1 and 2; and NuScale MODE 2 corresponds to W-STS MODE 3 with RCS average temperature ≥ 420°F.) The applicant is requested to resolve these issues by providing the noted missing justifications, provided they are acceptable to the staff, and by editing the SDM definition to state:

SDM shall be the instantaneous amount of reactivity by which the reactor is subcritical or would be subcritical from its present condition assuming:

a. Moderator temperature is 420°F; and

b. All control rod assemblies (CRAs) are fully inserted except for the single CRA of highest reactivity worth, which is assumed to be fully withdrawn. However, with all CRAs verified fully inserted by two independent means, it is not necessary to account for a stuck CRA in the SDM calculation. With any CRA not capable of being fully inserted, the reactivity worth of the affected CRA must be accounted for in the determination of SDM.

NuScale Response:

The acronym CRA was re-defined in the definition of SHUTDOWN MARGIN (SDM), and the acronym CRA is used in place of the term assembly as requested. Changes were also made to more closely align with the Westinghouse STS definition.

The choice of 420 °F as the reference temperature for shutdown margin calculation is a design choice; regardless of the reference temperature value chosen, the primary importance is to assure consistent calculation of SDM. 420 °F was selected based on the minimum temperature for criticality established by LCO 3.4.2 and it being the limiting zero power design temperature. The temperature is also an appropriate reference point for use in NuScale procedures and analyses. For example, core operating limits report limits related to SDM will be established by reference to this selected temperature. Another example is the use of the 420 °F reference temperature in FSAR Tier 2, Section 15.0.6.3.2, Input Parameters and Initial Conditions.

The NuScale plant operates in a manner that varies reactor average reactor coolant temperature from approximately 425 °F to 545 °F as reactor power increases from 0% rated thermal power (RTP) to 15% RTP, and remains constant above 15% RTP. The use of 420 °F somewhat simplifies operations and procedures used to calculate SDM. These operations are described in Table 5.1-2 of the FSAR, Tier 2 description of the RCS and connecting systems.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

1.1 Definitions

SHUTDOWN MARGIN (SDM)	SDM shall be the instantaneous amount of reactivity by which the reactor is subcritical or would be subcritical from its present condition assuming: a. Moderator temperature is 420 °F; and b. All control rod assemblies (CRAs) are fully inserted except for the single CRA~~assembly~~ of highest reactivity worth, which is assumed to be fully withdrawn. However, with all CRAs verified fully inserted by two independent means, it is not necessary to account for a stuck CRA in the SDM calculation. With any CRA~~(s)~~ not capable of being fully inserted, the reactivity worth of the~~se~~ affected CRA~~assemblies~~ must be accounted for in the determination of SDM.
THERMAL POWER	THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

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Docket No. 52-048

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-17

17. A response is not required because in the November 6, 2018, public meeting conference call, the applicant stated the requested changes will be incorporated in Revision 3 of DCA part 2. In Revision 2 of DCA part 2, FSAR Tier 2 page 3.9-40, last paragraph of Subsection 3.9.4.1.1 under heading **Sensor Coil Assembly**. The first sentence should be two sentences with the indicated corrections:

The sensor coil assembly contains the rod position indication coils. The coil ~~coils the coil~~ assembly slides over the rod travel housing and sits ~~sets~~ on a ledge at the base of the rod travel housing.

NuScale Response:

The location of the sensor coil assembly as been clarified in FSAR 3.9.4.1.1.

Impact on DCA:

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

position. The stepping process now only moves the outer shaft. The control rod drive shaft is lowered, which retracts the plug on the center disconnect rod from the fingers on the coupling, and inserts the fingers into the CRA hub. The additional step compresses the spring in the CRA hub slightly, and ensures the fingers on the coupling are completely seated. The plug on the bottom of the center disconnect rod is inserted by releasing the remote disconnect gripper. The center disconnect rod then falls, with spring assist, to lock the control rod drive shaft to the CRA hub. A lift verification is then performed by observing the difference in lift coil current confirming successful completion of the remote reconnect operation.

RAI 03.09.04-1, RAI 03.09.04-1S1, RAI 03.09.04-2, RAI 03.09.04-2S1, RAI 03.09.04-4, RAI 03.09.04-4S1, RAI 03.09.04-5, RAI 03.09.04-6, RAI 03.09.04-7, RAI 03.09.04-9

In the event that the control rod drive shaft cannot be remotely disconnected from the CRA remotely, an alternate non-remote method is provided to disengage the CRA through the top of the rod travel housing (Figure 4.6-4). Since operation of the remote disconnect mechanism requires the entire CRDM to be operational, there are a number of reasons that could prevent an intentional remote disconnect. This includes, but is not limited to, the inability of the stationary gripper or remote disconnect gripper latches to properly engage, either due to a mechanical failure of the latches, a failure of the drive coils, or a failure of the disconnect verification. In the event that the remote disconnect mechanism operation is not available, the pressure boundary seal weld around the rod travel housing plug is broken, and the plug is removed for tooling access. The top of the control rod drive shaft contains a locking feature that allows for manual lift of the remote disconnect rod and unlock the CRA (Figure 4.6-6).

RAI 03.09.04-1, RAI 03.09.04-2, RAI 03.09.04-4, RAI 03.09.04-5, RAI 03.09.04-7, RAI 03.09.04-9

Drive Coil Assembly

The drive coil assembly slides over the latch housing and sets on a ledge at the base of the latch housing. The drive coil assembly is depicted by Figure 4.6-3.

Sensor Coil Assembly

RAI 03.09.04-1, RAI 03.09.04-2, RAI 03.09.04-4, RAI 03.09.04-5, RAI 03.09.04-6, RAI 03.09.04-7, RAI 03.09.04-9, RAI 16-60

The sensor coil assembly contains the rod position indication coils. ~~t~~The coil assembly slides over the rod travel housing and si~~e~~ts on a ledge at the base of the rod travel housing. The sensor coil assembly is shown in Figure 4.6-4.

3.9.4.1.2 Operation of the Control Rod Drive Mechanisms

RAI 03.09.04-1, RAI 03.09.04-2, RAI 03.09.04-4, RAI 03.09.04-5, RAI 03.09.04-6, RAI 03.09.04-7, RAI 03.09.04-9

The basic CRDM mechanical and operational requirements are discussed in Section 4.6. The following describes the different modes of CRDM operation. Reactor trip, consisting of full insertion of the CRAs into the core at design conditions, is achievable during any part of the CRDM operating modes described below.

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-18

18. The applicant is requested to make the indicated changes or make appropriate equivalent changes:

18.1 A response is not required because in the November 6, 2018, public meeting conference call, the applicant stated the requested change will be incorporated in Revision 3 of DCA part 4. The applicant is requested to change Revision 2 of DCA part 4, Condition A of Subsection 3.1.5 to be consistent with Condition A of Subsection 3.1.6, which is more consistent with STS style and phrasing conventions, as follows: "Shutdown group ~~not within~~ insertion limits not met."

NuScale Response:

See the response to RAI 16-60-26 which aligns the Action requirements and Bases of LCO 3.1.5 and 3.1.6.

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.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-21

20. In Revision 2 of DCA part 4, GTS Bases page B 3.1.5-1, Background section:

20.1 The applicant is requested to clarify the first sentence as indicated:

The insertion limits of the shutdown bank group control rod assemblies (CRAs) are initial assumptions in all safety analyses that assume shutdown ~~group~~ bank CRA insertion upon reactor trip.

The revised sentence is consistent with the design terminology ("shutdown bank CRAs"), which is used in the first sentence of the third paragraph of the Background section. Also, there is no need to capitalize "control rod assemblies."

20.2 The applicant is requested to clarify the third paragraph as indicated:

The shutdown bank CRAs are arranged into two groups; each group has four CRAs that are arranged in radially symmetric positions, and are normally moved together as a group. Therefore, movement of ~~the shutdown~~ a group of shutdown bank CRAs does not introduce radial asymmetries in the core power distribution. The shutdown bank and regulating ~~group~~ bank CRAs provide the required reactivity worth for immediate reactor shutdown upon a reactor trip.

20.3 The applicant is requested to clarify the fourth paragraph as indicated:

The design calculations are performed with the assumption that the CRA shutdown group CRAs are withdrawn prior to the CRA regulating group CRAs. The CRA shutdown group CRAs can be fully withdrawn without the core going critical. This provides available negative reactivity for SDM in the event of unintended dilution of the RCS boron concentration. The CRA shutdown group CRAs are controlled manually or automatically by the control room operator. During

normal unit operation, the CRA shutdown group CRAs are fully withdrawn. The CRA shutdown group CRAs must be completely withdrawn from the core prior to withdrawing the CRA regulating group CRAs during an approach to criticality. The CRA shutdown group CRAs are then left in ~~this~~ the fully withdrawn position until the reactor is shut down. ~~They~~ The eight CRAs of the shutdown bank add negative reactivity to shut down the reactor upon receipt of a reactor trip signal

The applicant is also requested to insert in the above paragraph (1) an explanation of how automatic control "by the control room operator" is distinct from manual control "by the control room *operator"; and (2) a statement about when automatic control of [movement of] CRA shutdown groups is appropriate and designed to be used.*

NuScale Response:

The bases have been modified.

A description of the control rod drive system and its operation is provided in FSAR Tier 2, section 4.6. FSAR Tier 2, section 7.0.4.5 describes the Module Control System (MCS), including the control rod drive system control inputs.

Detailed system design has not been completed, and operating procedures have not been finalized. Procedure finalization will be completed as described in COL Item 13.5-2. The procedures will describe the use of the manual and automatic control alternatives consistent with the licensing basis description in the FSAR. For example, FSAR Tier 2, section 4.1.1 describes the means of reactivity control and arrangement of the CRA in the reactor.

As noted in FSAR section 7.0.4.5.1, rod withdrawal is performed by an operator, although supervisory control of rod insertion may be performed by the MCS controller if reactor power demand requires rod insertion to reduce power. Automatic rod withdrawal may not be performed when thermal reactor power is between zero and 15 percent.

The safety function of the module protection system (MPS) and control rod drive system is independent of the MCS and control rod drive system control portion of the system. If a reactor trip signal is received, the MPS interrupts the electrical power to the control rod drive system de-energizing the mechanism holding the control rods out of the core. This causes the rods to insert by gravity.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.5 Shutdown ~~Group~~Bank Insertion Limits

LCO 3.1.5 Each shutdown bank group shall be within insertion limits specified in the COLR.

~~--NOTE--~~
~~Not applicable to shutdown groups inserted while performing SR 3.1.4.2.~~
~~--~~

APPLICABILITY: MODE 1.

--NOTE--
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~Shutdown group not within limits~~One or more shutdown groups not within insertion limits.	A.1.1 Verify SDM is within the limits specified in the COLR.	1 hour
	OR	
	A.1.2 Initiate boration to restore SDM to within limit.	1 hour
	AND	
	A.2 Restore shutdown groups to within limits.	2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.5.1	Verify each shutdown bank group is within the insertion limits specified in the COLR.	In accordance with the Surveillance Frequency Control Program

3.1 REACTIVITY CONTROL SYSTEMS

3.1.6 Regulating ~~Group~~Bank Insertion Limits

LCO 3.1.6 Each regulating bank group shall be within the insertion limits specified in the COLR.

~~NOTE~~
~~Not applicable to regulating groups inserted while performing SR 3.1.4.2.~~

APPLICABILITY: MODE 1 with $k_{eff} \geq 1.0$.

-----NOTE-----
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more regulating groups not within insertion limits.~~Regulating group insertion limits not met.~~	A.1.1 Verify SDM is within the limits specified in the COLR. OR A.1.2 Initiate boration to restore SDM to within limits. AND A.2 Restore regulating groups to within limits.	1 hour 1 hour 2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 1 with $k_{eff} < 1.0$.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.6.1	Verify each regulating bank group is within the insertion limits specified in the COLR.	In accordance with the Surveillance Frequency Control Program

3.1 REACTIVITY CONTROL SYSTEMS

3.1.8 PHYSICS TESTS Exceptions

LCO 3.1.8 During the performance of PHYSICS TESTS, the requirements of:

LCO 3.1.3, "Moderator Temperature Coefficient (MTC),"
LCO 3.1.4, "Rod Group Alignment Limits,"
LCO 3.1.5, "Shutdown Bank~~Group~~ Insertion Limits," and
LCO 3.1.6, "Regulating Bank~~Group~~ Insertion Limits"

may be suspended provided:

a. SDM is within the limits specified in the COLR, and

b. THERMAL POWER is ≤ 5% RTP.

APPLICABILITY: During PHYSICS TESTS initiated in MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. SDM not within limit.	A.1 Initiate boration to restore SDM to within limit. AND A.2 Suspend PHYSICS TESTS exceptions.	15 minutes 1 hour
B. THERMAL POWER not within limit.	B.1 Open reactor trip breakers.	Immediately

5.6 Reporting Requirements

5.6.3 Core Operating Limits Report (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

3.1.1, “SHUTDOWN MARGIN (SDM)”;

3.1.3, “Moderator Temperature Coefficient (MTC)”;

3.1.4, “Rod Group Alignment Limits”;

3.1.5, “Shutdown Bank~~Group~~ Insertion Limits”;

3.1.6, “Regulating Bank~~Group~~ Insertion Limits”;

3.1.8, “PHYSICS TESTS Exceptions”;

3.1.9, “Boron Dilution Control”;

3.2.1, “Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)”;

3.2.2, “AXIAL OFFSET (AO)”;

3.4.1, “RCS Pressure, Temperature, and Flow Resistance Critical Heat Flux (CHF) Limits”; and

3.5.3, “Ultimate Heat Sink”.

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

[----------------------------------REVIEWER'S NOTE----------------------------------
The COL applicant shall confirm the validity of each listed document and the listed Specifications for the associated core operating limits, or state the valid NRC approved analytical method document and list of associated Specifications.

The COL applicant shall state the valid core reload analysis methodology document and list of associated Specifications.
--]

5.6 Reporting Requirements

5.6.3 Core Operating Limits Report (COLR) (continued)

1. [NuScale Standard Design Certification Analysis (DCA), Part 2, Tier 2, NuScale Final Safety Analysis Report (FSAR), Section 4.3, “Nuclear Design,” Revision 1, March 2018, and TR-0516-49416, “Non-Loss-of-Coolant Accident Analysis Methodology,” Revision 0, May 2016 (NuScale Proprietary).

   (Methodology for Specifications 3.1.1 – SHUTDOWN MARGIN (SDM), 3.1.3 – Moderator Temperature Coefficient, 3.1.4 – Rod Group Alignment Limits, 3.1.5 – Shutdown Bank~~Group~~ Insertion Limits, 3.1.6 - Regulating Bank~~Group~~ Insertion Limits, and 3.1.8 - PHYSICS TESTS Exceptions.)]

2. [NuScale DCA, Part 2, Tier 2, NuScale FSAR, Section 9.3.4, “Chemical and Volume Control System,“ Revision 1, March 2018, and TR-0516-49416, “Non-Loss-of-Coolant Accident Analysis Methodology,” Revision 0, May 2016 (NuScale Proprietary).

   (Methodology for Specification 3.1.9 – Boron Dilution Control.)]

3. [NuScale DCA, Part 2, Tier 2, NuScale FSAR, Sections 4.3, “Nuclear Design,” and 4.4, “Thermal and Hydraulic Design,“ Revision 1, March 2018; TR-0516-49416, “Non-Loss-of-Coolant Accident Analysis Methodology,” Revision 0, May 2016 (NuScale Proprietary); and TR-0915-17564, “Subchannel Analysis Methodology,” Revision 1, September 2015 (NuScale Proprietary).

   (Methodology for Specifications 3.2.1 – Enthalpy Rise Hot Channel Factor ($F\Delta H$), and 3.2.2 – AXIAL OFFSET (AO).)]

4. [NuScale DCA, Part 2, Tier 2, NuScale FSAR, Section 4.4, “Thermal and Hydraulic Design,“ Revision 1, March 2018 and TR-0516-49416, “Non-Loss-of-Coolant Accident Analysis Methodology,” Revision 0, May 2016 (NuScale Proprietary).

   (Methodology for Specification 3.4.1 – RCS Pressure, Temperature, and Flow Resistance CHF Limits.)]

5. [NuScale DCA, Part 2, Tier 2, NuScale FSAR, Section 4.3, “Nuclear Design,” Revision 1, March 2018.

   (Methodology for Specifications 3.5.3 – Ultimate Heat Sink, and 3.8.1 – Nuclear Instrumentation.)]

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.1 SHUTDOWN MARGIN (SDM)

BASES

BACKGROUND

According to GDC 26 (Ref. 1) the reactivity control systems must be redundant and capable of holding the reactor core subcritical when shutdown under cold conditions. Maintenance of the SDM ensures that postulated reactivity events will not damage the fuel.

SDM requirements provide sufficient reactivity margin to assure that specified acceptable fuel design limits (SAFDLs) will not be exceeded for normal shutdown and anticipated operational occurrences (AOOs). As such, the SDM defines the degree of subcriticality that would be obtained immediately following the insertion or scram of all shutdown and regulating bank~~group~~ control rod assemblies (CRAs), assuming that the single CRA of highest reactivity worth is fully withdrawn.

Additionally SDM requirements provide sufficient reactivity margin to ensure that the reactor will remain shutdown at all temperatures with all control rods inserted.

The system design requires that two independent reactivity control systems be provided, and that one of these systems be capable of maintaining the core subcritical under cold conditions. These requirements are provided by the use of movable CRAs and soluble boric acid in the Reactor Coolant System (RCS). The CRA System provides the SDM during power operation and is capable of making the core subcritical rapidly enough to prevent exceeding acceptable fuel damage limits, following all AOOs and postulated accidents, assuming that the CRA of highest reactivity worth remains withdrawn.

The soluble boron system can compensate for fuel depletion during operation and all xenon burnout reactivity changes and maintain the reactor subcritical under cold conditions.

During power operation, SDM control is ensured by operating with the shutdown bank groups fully withdrawn and the regulating bank groups within the limits of LCO 3.1.6, “Regulating Bank~~Group~~ Insertion Limits.”

When the unit is in MODES 2, 3, 4 or 5, the SDM requirements are met by means of adjustments to the RCS boron concentration and the boron requirements for the pool, LCO 3.5.3, "Ultimate Heat Sink" and CRA controls.

BASES

APPLICABLE SAFETY ANALYSES (continued)

SDM satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii). Even though it is not directly observed from the main control room, SDM is considered an initial condition process variable because it is periodically monitored to ensure that the unit is operating within the bounds of accident analysis assumptions.

LCO

SDM is a core design condition that can be ensured during operation through CRA positioning (regulating and shutdown ~~group~~banks) and through the soluble boron concentration.

APPLICABILITY

In MODE 1 with $k_{eff} \geq 1.0$, SDM requirements are ensured by complying with LCO 3.1.5, "Shutdown Bank~~Group~~ Insertion Limits," and LCO 3.1.6, "Regulating Bank~~Group~~ Insertion Limits."

In MODE 1 with $k_{eff} < 1.0$ and in MODES 2, 3, and 4, the SDM requirements are applicable to provide sufficient negative reactivity to meet the assumptions of the safety analyses discussed above.

In MODE 5 the shutdown reactivity requirements are given in LCO 3.5.3, "Ultimate Heat Sink."

ACTIONS

A.1

If the SDM requirements are not met, boration must be initiated promptly. A Completion Time of 15 minutes is adequate for an operator to correctly align and start the required systems and components. It is assumed that boration will be continued until the SDM requirements are met.

In the determination of the required combination of boration flow rate and boron concentration, there is no unique requirement that must be satisfied. Since it is imperative to raise the boron concentration of the RCS as soon as possible, the boron concentration should be a concentrated solution. The operator should begin boration with the best source available for the plant conditions.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.4 Rod Group Alignment Limits

BASES

BACKGROUND

The OPERABILITY (i.e., trippability) of the shutdown and regulating control rod assemblies (CRAs) is an initial assumption in all safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM).

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, “Reactor Design,” and GDC 26, “Reactivity Control System Redundancy and Capability” (Ref. 1), and 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Plants” (Ref. 2).

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking, due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Sixteen CRAs are arranged in four symmetrical groups. There are two shutdown bank groups of four CRAs each and two regulating bank groups of four CRAs each.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

CRAs are moved by their control rod drive mechanisms (CRDMs). Each CRDM moves its CRA one step (approximately 3/8 inch) at a time.

The CRAs are arranged into groups that are radially symmetric. Therefore, movement of the CRAs by group does not introduce radial asymmetries in the core power distribution. The shutdown and regulating CRAs provide the required reactivity worth for immediate reactor shutdown upon a reactor trip. The regulating bank CRAs also provide power level control during normal operation and transients.

BASES

BACKGROUND (continued)

Their movement may be automatically controlled by the reactivity control systems.

The axial position of shutdown and regulating group CRAs is indicated by two separate and independent rod position indication systems.

APPLICABLE SAFETY ANALYSES

CRA misalignment accidents are analyzed in the safety analysis (Ref. 3). The accident analysis defines CRA misoperation as any event with the single failure of a safety-related component and multiple failures of non-safety related controls. The acceptance criteria for addressing CRA inoperability or misalignment are that:

a. With the most reactive CRA stuck out of the core there will be no violations of either:

    1. Specified acceptable fuel design limits (SAFDLs); or

    2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core must remain subcritical after design basis events with all CRAs fully inserted.

Accident and transient analyses associated with CRA misalignment, static and dynamic, account for misalignment of 6 steps at the initiation of the event. The results of the CRA misoperation analysis show that during the most limiting misoperation events, no violations of the SAFDLs, or the SLs on critical heat flux ratio, fuel centerline temperature, or pressurizer pressure occur.

CRA alignment limits and OPERABILITY requirements satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

ACTIONS (continued)

significant, and operation may proceed without further restriction. An alternative to realigning a single misaligned CRA to the group average position is to align the remainder of the group to the position of the misaligned CRA. However, this must be done without violating the group~~bank~~ sequence, overlap, and insertion limits specified in LCO 3.1.5, "Shutdown Bank~~Group~~ Insertion Limits," and LCO 3.1.6, "Regulating Bank~~Group~~ Insertion Limits." The Completion Time of 1 hour is adequate for determining SDM and, if necessary, for initiating boration and restoring SDM.

In this situation, SDM verification must include the worth of any untrippable CRA, in addition to the CRA of maximum worth.

A.2

When Required Action cannot be completed within their Completion Time, the unit must be brought to a MODE or Condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours, which obviates concerns about the development of undesirable xenon and power distributions. The allowed Completion Time of 6 hours is reasonable, based on operating experience, for reaching MODE 2 from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.4.1

Verification that the position of individual rods is within alignment limits allows the operator to detect that a rod is beginning to deviate from its expected position.

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

The SR is modified by a Note that permits it not to be performed for rods associated with an inoperable rod position indicator. The alignment limit is based on rod position indicator which is not available if the indicator is inoperable. LCO 3.1.7, “Rod Position Indication,” provides Actions to verify the rods are in alignment when one or more rod position indicators are inoperable.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.5 Shutdown Bank~~Group~~ Insertion Limits

BASES

BACKGROUND

The insertion limits of the shutdown ~~group~~ bank ~~Control~~ control ~~Rod~~ rod ~~Assemblies~~ assemblies (CRAs) are initial assumptions in all safety analyses that assume shutdown ~~group~~ bank CRA insertion upon reactor trip. The insertion limits directly affect core power distributions and assumptions of available shutdown margin (SDM), ejected CRA worth, and initial reactivity insertion rate.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, "Reactor Design," and GDC 26, "Reactivity Limits" (Ref. 1), and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors" (Ref. 2). Limits on shutdown bank~~group~~ CRA insertion have been established, and all shutdown bank~~group~~ CRA positions are monitored and controlled during power operation to ensure that the reactivity limits, ejected CRA worth, and SDM limits are preserved.

The 16 CRAs are divided among the two regulating bank groups and two shutdown bank groups, with each group consisting of four CRAs in radially symmetric core locations. The shutdown bank CRAs are ~~arranged into groups that are radially symmetric~~normally moved together as a group. Therefore, movement of ~~the shutdown~~a group of shutdown bank CRAs does not introduce radial asymmetries in the core power distribution. The shutdown bank and regulating ~~group~~ bank CRAs provide the required reactivity worth for immediate reactor shutdown upon a reactor trip.

The design calculations are performed with the assumption that CRAs of the shutdown ~~group CRAs~~bank are withdrawn prior to the CRAs in the regulating ~~group~~ bank~~CRAs~~. The CRAs of the shutdown ~~group CRAs~~bank can be fully withdrawn without the core going critical. This provides available negative reactivity for SDM in the event of unintended reduction of the RCS boron concentration~~dilution~~. The shutdown ~~group~~bank CRAs are controlled manually ~~or automatically~~ by the control room operator. During normal unit operation, the shutdown ~~group~~bank CRAs are fully withdrawn. The shutdown ~~group~~bank CRAs must be completely withdrawn from the core prior to withdrawing regulating ~~group~~bank CRAs during an approach to criticality. The shutdown

BASES

BACKGROUND (continued)

~~group~~bank CRAs are then left in ~~this~~ the fully withdrawn position until the reactor is shut down. The~~y~~ eight CRAs of the shutdown bank add negative reactivity to shut down the reactor upon receipt of a reactor trip signal.

APPLICABLE SAFETY ANALYSES

On a reactor trip, all CRAs (~~shutdown group~~eight CRAs in two shutdown bank groups and eight CRAs in two regulating bank group ~~CRA~~s), except the most reactive CRA, are assumed to insert into the core. The shutdown ~~group~~bank and regulating ~~group~~bank CRAs shall be at or above their insertion limits and available to insert the maximum amount of negative reactivity on a reactor trip signal. The regulating ~~group~~bank CRAs may be partially inserted in the core as allowed by LCO 3.1.6, "Regulating ~~Group~~Bank Insertion Limits." The shutdown and regulating ~~group~~bank ~~CRA~~ insertion limits are established to ensure that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM (see LCO 3.1.1, "SHUTDOWN MARGIN (SDM)") following a reactor trip from full power. The combination of regulating ~~group CRAs~~ and shutdown ~~group~~bank CRAs (less the most reactive CRA, which is assumed to be fully withdrawn) ~~is~~are sufficient to take the reactor from full power conditions at rated temperature to zero power, and to maintain the required SDM at rated no load temperature (Ref. 3). The CRA shutdown ~~group~~bank ~~CRA~~ insertion limits also ~~limits~~ ensure that the reactivity worth of an ejected shutdown CRA is within safety analysis assumptions.

The acceptance criteria for addressing CRA shutdown ~~CRA~~ bank and ~~as well as~~ regulating ~~group~~bank ~~CRA~~ insertion limits and CRA inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violation of either:

   1. Specified acceptable fuel design limits; or

   2. Reactor Coolant System pressure boundary ~~damage~~ integrity; and

b. The core remains subcritical after design basis events with all CRAs fully inserted.

The CRA shutdown ~~group~~bank ~~CRA~~ insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

LCO

The CRA shutdown ~~CRAs~~ bank must be within ~~their~~ insertion limits any time the reactor is critical or approaching criticality. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip.

The CRA shutdown ~~group~~bank insertion limits are ~~defined~~ specified in the COLR.

~~The LCO is modified by a Note indicating the LCO requirement is not applicable to shutdown groups being inserted while performing SR 3.1.4.2. The SR verifies the freedom of the rods to move, and may require the shutdown group to move below the LCO limits, which normally violate the LCO. This Note applies to each shutdown group as it's moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.~~

APPLICABILITY

The CRA shutdown ~~group~~bank ~~CRAs~~ must be within ~~their~~ insertion limits, with the reactor in MODE 1. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip. In MODE 2, 3, 4 the shutdown ~~group~~bank CRAs are fully inserted in the core and contribute to the SDM. Refer to LCO 3.1.1, "SHUTDOWN MARGIN (SDM)," for SDM requirements in MODES 2, 3, and 4. LCO 3.5.3, "Ultimate Heat Sink," ensures adequate SDM in MODES 4 and 5.

The Applicability is modified by a Note indicating the LCO requirement is not applicable while performing SR 3.1.4.2. This Note permits exceeding the CRA shutdown bank insertion limits while inserting each CRA in the bank in accordance with SR 3.1.4.2. This Surveillance verifies the freedom of the CRAs to move, and may require a shutdown bank group to move below the insertion limits specified in the COLR, which would normally violate the LCO. This Note applies to each CRA shutdown bank group as the group is moved below the insertion limit to perform the Surveillance. This Note is not applicable should a malfunction stop performance of the Surveillance. Note that the CRA group alignment limits of LCO 3.1.4 remain applicable to the CRAs in the shutdown bank group being exercised while performing this Surveillance.

BASES

ACTIONS

A.1.1, A.1.2, and A.2

When one or more CRA shutdown bank groups ~~CRA~~ is not within insertion limits, 2 hours are allowed to restore the CRA shutdown bank groups ~~CRA~~ to within insertion limits. This is necessary because the available SDM may be significantly reduced with CRA~~one~~ shutdown~~showdown~~ bank groups ~~CRA~~ not within their insertion limits. Also, verification of the SDM or initiation of boration within 1 hour is required, since the SDM in MODE 1 is continuously monitored and adhered to, in part, by the CRA regulating~~control~~ and shutdown ~~group~~bank insertion limits (see LCO 3.1.1).

The allowed Completion Time of 2 hours provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain in an unacceptable condition for an extended period of time.

B.1

~~If the Required Actions and associated Completion Times are not met, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA shutdown bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.5.1

Verification that the CRAs of each shutdown bank group ~~is~~ are within ~~its~~ insertion limits prior to an approach to criticality ensures that when the reactor is critical, or being taken critical, the shutdown bank groups will be available to shut down the reactor, and the required SDM will be maintained following a reactor trip. This SR and Frequency ensure that the CRA shutdown bank groups ~~is~~ are withdrawn before the CRA regulating bank groups are withdrawn during a unit startup.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.

2. 10 CFR 50.46.

3. FSAR, Chapter 15, “Transient and Accident Analysis.”

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.6 Regulating Bank~~Group~~ Insertion Limits

BASES

BACKGROUND

The insertion limits of the regulating bank control rod assemblies (CRAs) are initial assumptions in the safety analyses that assume rod insertion upon reactor trip. The insertion limits directly affect core power and fuel burnup distributions, assumptions of available SDM, and initial reactivity insertion rate.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, “Reactor Design,” GDC 26, “Reactivity Control System Redundancy and Protection,” GDC 28, “Reactivity Limits” (Ref. 1) and 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors” (Ref. 2). Limits on CRA regulating bank group ~~CRA~~ insertion have been established, and all regulating bank group CRA positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking, ejected CRA worth, and SDM limits are preserved.

The 16 CRAs ~~control rod assemblies (CRAs)~~ are divided among ~~the~~ two regulating bank groups and two~~he~~ shutdown bank groups, with each group consisting of four CRAs in radially symmetric core locations. The regulating bank consists of two groups of four CRAs that are electrically paralleled to step simultaneously. See LCO 3.1.4, “Rod Group Alignment Limits,” for regulating and shutdown CRA ~~rod~~ OPERABILITY and alignment requirements, and LCO 3.1.7, “Rod Position Indication,” for CRA position indication requirements.

The regulating bank group insertion limits are specified in the COLR. ~~The~~ Each CRA of a regulating bank group~~s are~~ is required to be at or above ~~the~~ its regulating bank group insertion limits ~~lines~~, as well as within its CRA group alignment limits.

The CRA regulating bank groups ~~CRAs~~ are used for precise reactivity control of the reactor. The positions of the CRAs in a regulating bank group are ~~CRAs is~~ normally controlled automatically by the Module Control System (MCS) together as a group of four CRAs;~~, but~~ a regulating bank group’s CRAs can also be manually controlled both individually and as a group. The~~y~~ CRA regulating bank groups are capable of changing core reactivity very quickly (compared to borating or diluting).

BASES

BACKGROUND (continued)

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, LCO 3.1.4, “Rod Group Alignment Limits,” LCO 3.1.5, “Shutdown ~~Group~~Bank Insertion Limits,” LCO 3.1.6, “Regulating ~~Group~~Bank Insertion Limits,” LCO 3.2.1, “Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$),” and LCO 3.2.2, “AXIAL OFFSET (AO)” provide limits on control component operation and on monitored process variables which ensure that the core operates within the fuel design criteria.

The shutdown and regulating ~~group~~bank insertion and alignment limits and power distribution limits are process variables that together characterize and control the three dimensional power distribution of the reactor core. Additionally, the regulating ~~group~~bank insertion limits control the reactivity that could be added in the event of a rod ejection accident, and the shutdown and regulating ~~group~~bank insertion limits assure the required SDM is maintained.

Operation within the subject LCO limits will prevent fuel cladding failures that would breach the primary fission product barrier and release fission products to the reactor coolant in the event of a loss of coolant accident (LOCA), loss of flow, ejected CRA, or other accident requiring termination by a Reactor Trip System (RTS) trip function.

APPLICABLE SAFETY ANALYSES

The regulating ~~group~~bank insertion limits, $F_{\Delta H}$, and AO LCOs are required to prevent power distributions that could result in fuel cladding failures in the event of a LOCA, loss of flow, ejected CRA, or other accident requiring termination by an RTS trip function.

The acceptance criteria for addressing shutdown and regulating bank group insertion limits and inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violations of either:

    1. specified acceptable fuel design limits; or

    2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core remains subcritical after design basis events with all CRAs fully inserted~~ in the core~~.

BASES

APPLICABLE SAFETY ANALYSES (continued)

As such, the CRA shutdown and regulating ~~group~~bank insertion limits affect safety analysis involving core reactivity and power distributions (Ref. 3).

The SDM requirement is ensured by limiting the ~~control and~~ shutdown and regulating bank~~group~~ insertion limits so that allowable inserted worth of the CRAs is such that sufficient reactivity is available in the CRAs to shut down the reactor to hot zero power with a reactivity margin which assumes the maximum worth CRA remains fully withdrawn upon trip (Ref. 3).

Operation at the insertion limits or AO limits may approach the maximum allowable linear heat generation rate or peaking factor. Operation at the insertion limit may also indicate the maximum ejected CRA worth could be equal to the limiting value in fuel cycles that have sufficiently high ejected CRA worth.

The ~~regulating and~~ shutdown and regulating bank~~group~~ insertion limits ensure that safety analyses assumptions for SDM, ejected rod worth, and power distribution peaking factors are preserved (Ref. 3).

The insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii) in that they are initial conditions assumed in the safety analysis.

LCO

The limits on regulating ~~group~~bank physical insertion as defined in the COLR, must be maintained because they serve the function of preserving power distribution, ensuring that the SDM is maintained, ensuring that ejected CRA worth is maintained, and ensuring adequate negative reactivity insertion is available on trip.

~~The LCO is modified by a Note indicating the LCO requirement is not applicable to control groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the rods to move, and may require the control group to move below the LCO limits, which would normally violate the LCO. This Note applies to each control group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.~~

BASES

APPLICABILITY

The regulating ~~group~~bank physical insertion limits shall be maintained with the reactor in MODE 1 when k_{eff} is ≥ 1.0. These limits must be maintained since they preserve the assumed power distribution, ejected CRA worth, SDM, and reactivity ~~rate~~ insertion rate assumptions. Applicability in MODE 1 with k_{eff} < 1.0, and MODES 2, 3, 4, and 5 is not required, since neither the power distribution nor ejected CRA worth assumptions would be exceeded in these MODES.

~~The applicability requirements have been modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the regulating group to move below the LCO limits, which would violate the LCO.~~The Applicability is modified by a Note indicating the LCO requirement is not applicable to CRA groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the CRAs to move, and may require the regulating bank group to move below the LCO limits, which would normally violate the LCO. This Note applies to each regulating bank group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.

ACTIONS

A.1.1, A.1.2, and A.2

When ~~the~~ one or more regulating bank groups is~~are~~ ~~outside the acceptance~~not within insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ CRA regulating bank group positions; or

b. Moving ~~rods~~ CRA regulating bank groups to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since the SDM in MODE 1 with k_{eff} ~~is~~ ≥ 1.0 is normally ensured by adhering to the ~~control~~ regulating and shutdown ~~group~~bank insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)") has been upset.

The allowed Completion Time of 2 hours for restoring the regulating bank groups to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain outside the insertion limits~~in an unacceptable condition~~ for an extended period of time.

BASES

ACTIONS (continued)

B.1

~~If the Required Actions cannot be completed within the associated Completion Times, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA regulating bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.6.1

Verification of the regulating ~~group~~bank insertion limits is sufficient to detect regulating bank groups that may be approaching the insertion limits.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10, GDC 26, and GDC 28.
2. 10 CFR 50.46.
3. FSAR, Chapter 15, “Transient and Accident Analyses.”

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.7 Rod Position Indication

BASES

BACKGROUND

According to GDC 13 (Ref. 1), instrumentation to monitor variables and systems over their operating ranges during normal operation, anticipated operational occurrences (AOOs), and accident conditions must be OPERABLE. LCO 3.1.7 is required to ensure OPERABILITY of the control rod position indicators to determine control rod positions and thereby ensure compliance with the control rod alignment and power-dependent insertion limits (PDIL).

The OPERABILITY, including position indication, of the shutdown and regulating ~~group~~bank control rod assemblies (CRAs) is an initial assumption in the safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the CRA misalignment safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM). CRA position indication is required to assess OPERABILITY and misalignment.

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to aid compliance with the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

Sixteen CRAs are arranged in four symmetrical groups. Two shutdown bank groups of four CRAs each, and two regulating bank groups of four CRAs each.

CRAs are moved out of the core (up or withdrawn) or into the core (down or inserted) by their control rod drive mechanisms (CRDMs). The CRAs are divided among the regulating bank groups and shutdown bank groups.

BASES

BACKGROUND (continued)

The axial position of shutdown bank CRAs and regulating bank~~group~~ CRAs are determined by two separate and independent ~~systems~~means: the Counter Position Indicators~~ion System~~ (CPIs) (commonly called bank~~group~~ step counters) and the Rod Position Indicators~~ion~~ (RPIs)~~ System~~.

The ~~Counter Position Indication~~CPI counts the commands sent to the CRDM gripper coils from the Control Rod Drive System (CRDS) that moves the CRAs. There is one step counter for each CRDM. The CRA ~~Position Indication System~~CPI is considered highly precise (± 1 step or ± {3/8} inch). If a CRA does not move one step for each command signal, the step counter will still count the command and incorrectly reflect the position of the CRA.

The RPI function of the CRDS provides a highly accurate indication of actual CRA position, but at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube with a center to center distance of 1.125 inches, which is equivalent to 3 steps. To increase the reliability of the system, the inductive coils are alternately connected to two data systems. Thus, if one system fails, the RPI will go on half accuracy with an effective coil spacing of 2.25 inches, which is 6 steps. Therefore, the normal indication accuracy of the RPIs~~ System~~ is ± 3 steps (± 1.125 inches), and the accuracy with one channel of RPI out-of-service is ± 6 steps (± 2.25 inches).

APPLICABLE SAFETY ANALYSES

The regulating and shutdown bank groups CRA position accuracy is essential during power operation. Power peaking, ejected CRA worth, or SDM limits may be violated in the event of a Design Basis Accident (Ref. 2), with regulating or shutdown bank~~group~~ CRAs operating outside their limits undetected. Therefore, the acceptance criteria for CRA position indication is that CRA positions must be known with sufficient accuracy in order to verify the core is operating within the group sequence, overlap, design peaking limits, ejected CRA worth, and within minimum SDM (LCO 3.1.5, “Shutdown Bank~~Group~~ Insertion Limits,” LCO 3.1.6, “Regulating Bank~~group~~ Insertion Limits”). The CRA positions must also be known in order to verify the alignment limits are preserved (LCO 3.1.4, “Rod Group Alignment Limits”). CRA positions are continuously monitored to provide operators with information that assures the unit is operating within the bounds of the accident analysis assumptions.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The CRA position indicator channels satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii). The control rod position indicators monitor CRA position, which is an initial condition of the accident.

LCO

LCO 3.1.7 specifies that the RPIs ~~System~~ and the ~~Counter Position Indication System~~CPI be OPERABLE for each CRA. For the CRA position indicators to be OPERABLE requires meeting the SR of the LCO and the following:

a. The RPI ~~System~~ indicates within 6 steps of the CRA counter ~~demand~~ position indicator as required by LCO 3.1.4, “Rod Group Alignment Limits”;

b. For the RPIs ~~System~~ there are no failed coils; and

c. The ~~Counter Position Indication System~~CPI has been calibrated either in the fully inserted position or to the RPI System.

The 6 step agreement limit between the ~~Rod Position Indication System~~RPIs and the CPI ~~system~~ indicates that the ~~Rod Position Indication System~~RPI is adequately calibrated and can be used for indication of the measurement of CRA position.

A deviation of less than the allowable limit given in LCO 3.1.4 in position indication for a single CRA ensures high confidence that the position uncertainty of the corresponding CRA group is within the assumed values used in the analysis (that specified CRA ~~group~~bank insertion limits).

These requirements provide adequate assurance that CRA position indication during power operation and PHYSICS TESTS is accurate, and that design assumptions are not challenged.

OPERABILITY of the position indicator channels ensures that inoperable, misaligned, or mispositioned CRAs can be detected. Therefore, power peaking, ejected CRA worth, and SDM can be controlled within acceptable limits.

APPLICABILITY

The requirements on the RPI and step counters are only applicable in MODE 1 (consistent with LCOs 3.1.4, 3.1.5, and 3.1.6), because this is the only MODE in which power is generated, and the OPERABILITY and alignment of CRAs has the potential to affect the safety of the unit. In the shutdown MODES, the OPERABILITY of the shutdown and

BASES

APPLICABILITY (continued)

regulating ~~groups~~banks has the potential to affect the required SDM, but this effect can be compensated for by an increase in the boron concentration of the Reactor Coolant System (RCS).

ACTIONS

The ACTIONS table is modified by a Note indicating that a separate Condition entry is allowed for each inoperable ~~counter position indicator~~CPI and each RPI indicator. This is acceptable because the Required Actions for each Condition provide appropriate compensatory actions for each inoperable position indicator.

A.1

When one RPI train per CRDM fails, the position of the CRA can still be determined by use of the In-Core Instrumentation System (ICIS). Normal power operation does not require excessive movement of groups. If a group has been significantly moved, the Actions of B.1 or B.2 below are required. Therefore, verification of CRA position within the Completion Time of 8 hours is adequate to allow continued full power operation, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small.

B.1, B.2, and B.3

When more than one RPI train per CRA fails, additional actions are necessary to ensure that acceptable power distribution limits are maintained, minimum SDM is maintained, and the potential effects of CRA misalignment on associated accident analyses are limited. Placing the rod control function in manual mode ensures unplanned CRA motion will not occur. Together with the position determination available via the ICIS, this will minimize the potential for CRA misalignment. The immediate Completion Time for placing the Rod Control function in manual mode reflects the urgency with which unplanned rod motion must be prevented while in this Condition.

The position of the CRAs may be determined indirectly by use of the ICIS.

BASES

BACKGROUND (continued)

The typical PHYSICS TESTS performed for reload fuel cycles (Ref. 4) in MODE 1 at < 5% RTP are listed below:

a. Critical Boron Concentration – Control Rods Withdrawn;

b. Control Rod Worth; and

c. Isothermal Temperature Coefficient (ITC).

These tests are initiated in MODE 1 at < 5% RTP. These and other supplementary tests may be required to calibrate the nuclear instrumentation or to diagnose operational problems. These tests may cause the operating controls and process variables to deviate from their LCO requirements during their performance.

a. The Critical Boron Concentration – Control Rods Withdrawn Test measures the critical boron concentration at hot zero power (HZP). With rods out, the lead control group is at or near its fully withdrawn position. HZP is where the core is critical (k_{eff} = 1.0), and the Reactor Coolant System (RCS) is at design temperature and pressure for zero power. Performance of this test should not violate any of the referenced LCOs.

b. The Control Rod Worth Test is used to measure the reactivity worth of selected rod groups. This test is performed at HZP and has four alternative methods of performance. The first method, the Boron Exchange Method, varies the reactor coolant boron concentration and moves the selected regulating bank group in response to the changing boron concentration. The reactivity changes are measured with a reactivity computer. This sequence is repeated for the remaining regulating bank group~~s~~. The second method, the Rod Swap Method, measures the worth of a predetermined reference group using the Boron Exchange Method above. The reference group is then nearly fully inserted into the core. The selected group is then inserted into the core as the reference group is withdrawn. The HZP critical conditions are then determined with the selected group fully inserted into the core. The worth of the selected group is calculated based on the position of the reference group with respect to the selected group. This sequence is repeated as necessary for the remaining ~~regulating~~ groups. The third method, the Boron Endpoint Method, moves the selected regulating bank group over its entire length of travel while varying the reactor coolant boron concentration to maintain HZP criticality. The difference in boron concentration is the worth of the

BASES

BACKGROUND (continued)

selected regulating bank group. This sequence is repeated for the remaining ~~regulating~~ groups. The fourth method, Dynamic Rod Worth Measurement (DRWM), moves each group, individually, into the core to determine its worth. The group is dynamically inserted into the core while data is acquired from the excore channel. While the group is being withdrawn, the data is analyzed to determine the worth of the group. This is repeated for each regulating bank and shutdown bank group. Performance of this test will violate LCO 3.1.4, "Rod Group Alignment Limits," LCO 3.1.5, "Shutdown Bank~~Group~~ Insertion Limit," or LCO 3.1.6, "Regulating Bank~~Group~~ Insertion Limits."

c. The ITC Test measures the ITC of the reactor. This test is performed at HZP. The method is to vary the RCS temperature in a slow and continuous manner. The reactivity change is measured with a reactivity computer as a function of the temperature change. The ITC is the slope of the reactivity versus the temperature plot. The test is repeated by reversing the direction of the temperature change and the final ITC is the average of the two calculated ITCs. Performance of this test should not violate any of the referenced LCOs.

APPLICABLE SAFETY ANALYSES

The fuel is protected by LCOs that preserve the initial conditions of the core assumed during the safety analyses. The methods for development of the LCOs that are excepted by this LCO are described in the [NuScale Reload Safety Evaluation Methodology report] (Ref. 5). The above mentioned PHYSICS TESTS, and other tests that may be required to calibrate nuclear instrumentation or to diagnose operational problems, may require the operating control or process variables to deviate from their LCO limitations.

FSAR Chapter 14 defines requirements for initial testing of the facility, including low power PHYSICS TESTS. FSAR Sections 14.2.10.3 and 14.2.10.4 (Ref. 6) summarize the initial criticality and low power tests.

Requirements for reload fuel cycle PHYSICS TESTS are defined in ANSI/ANS-19.6.1-2011 (Ref. 4). Although these PHYSICS TESTS are generally accomplished within the limits for the LCOs, conditions may occur when one or more LCOs must be suspended to make completion of PHYSICS TESTS possible or practical. This is acceptable as long as the fuel design criteria are not violated. When one or more of the requirements specified in:

LCO 3.1.3, "Moderator Temperature Coefficient (MTC);"

BASES

APPLICABLE SAFETY ANALYSES (continued)

LCO 3.1.4, “Rod Group Alignment Limits;”

LCO 3.1.5, “Shutdown Bank~~Group~~ Insertion Limit;” and

LCO 3.1.6, “Regulating Bank~~Group~~ Insertion Limits”

are suspended for PHYSICS TESTS, the fuel design criteria are preserved as long as the power level is limited to ≤ 5% RTP and SDM is within the limits provided in the COLR.

PHYSICS TESTS include measurement of core nuclear parameters or the exercise of control components that affect process variables. Also involved are the movable control components (regulating and shutdown CRA~~rods~~), which are required to shut down the reactor. The limits for these variables are specified for each fuel cycle in the COLR.

As described in LCO 3.0.7, compliance with Test Exception LCOs is optional, and therefore no criteria of 10 CFR 50.36(c)(2)(ii) apply. Test Exception LCOs provide flexibility to perform certain operations by appropriately modifying requirements of other LCOs. A discussion of the criteria satisfied for the other LCOs is provided in their respective Bases.

LCO

This LCO allows the reactor parameters of MTC to be outside their specified limits. In addition, it allows selected regulating and shutdown rods to be positioned outside of their specified alignment and insertion limits. Operation beyond specified limits is permitted for the purpose of performing PHYSICS TESTS and poses no threat to fuel integrity, provided the SRs are met.

The requirements of LCO 3.1.3, LCO 3.1.4, LCO 3.1.5, and LCO 3.1.6 may be suspended during the performance of PHYSICS TESTS provided:

a. SDM is within the limits provided in the COLR; and

b. THERMAL POWER is ≤ 5% RTP.

APPLICABILITY

This LCO is applicable when performing low power PHYSICS TESTS. The Applicability is stated as “During PHYSICS TESTS initiated in MODE 1”. Should the THERMAL POWER exceed 5% RTP, Required Action B.1 requires termination of critical operations by immediately opening the reactor trip breakers.

BASES

ACTIONS

A.1 and A.2

If the SDM requirement is not met, boration must be initiated promptly. A Completion Time of 15 minutes is adequate for an operator to correctly align and start the required systems and components. The operator should begin boration with the best source available for the plant conditions. Boration will be continued until SDM is within limit.

Suspension of PHYSICS TESTS exceptions requires restoration of each of the applicable LCOs to within specification.

B.1

When THERMAL POWER is > 5% RTP, the only acceptable action is to open the reactor trip breakers (RTBs) to prevent operation of the reactor beyond its design limits. Immediately opening the RTBs will shut down the reactor and prevent operation of the reactor outside of its design limits.

SURVEILLANCE REQUIREMENTS

SR 3.1.8.1

Verification that the THERMAL POWER is ≤ 5% RTP will ensure that the unit is not operating in a condition that could invalidate the safety analyses.

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

SR 3.1.8.2

The SDM is verified by performing a reactivity balance calculation, considering the following reactivity effects:

a. RCS boron concentration;

b. Regulating bank group positions;

c. RCS average temperature;

d. Fuel burnup based on gross thermal energy generation;

e. Xenon concentration;

f. Samarium concentration; and

g. Isothermal temperature coefficient (ITC).

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1 Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)

BASES

BACKGROUND

The purpose of this LCO is to establish limits on the power density at any point in the core so that the fuel design criteria are not exceeded and the accident analysis assumptions remain valid. Control of the core power distribution with respect to these limits ensures that local conditions in the fuel rods and coolant channels do not challenge core integrity at any location during either normal operation or a postulated accident analyzed in the safety analyses.

$F_{\Delta H}$ is defined as the ratio of the maximum integrated rod power within the core to the average rod power. Therefore, $F_{\Delta H}$ is a measure of the maximum total power produced in a fuel rod.

$F_{\Delta H}$ is sensitive to fuel loading patterns, regulating bank group insertion, and fuel burnup. $F_{\Delta H}$ typically increases with regulating bank group insertion and typically decreases with fuel burnup.

$F_{\Delta H}$ is not directly measurable but is inferred from a power distribution map obtained with the fixed incore detector system. Specifically, the measurements taken from the fixed incore instrument system are analyzed by a computer to determine $F_{\Delta H}$. This value is calculated continuously with operator notification on unexpected results and validated by engineering in accordance with the surveillance frequency.

The COLR provides peaking limits that ensure that the safety analysis values for critical heat flux (CHF) are not exceeded for normal operation, operational transients, and any transient condition arising from analyzed events. The safety analysis precludes CHF and is met by limiting the minimum critical heat flux ratio (MCHFR) to that value defined in the COLR. All transient events are assumed to begin with an $F_{\Delta H}$ value that satisfies the LCO requirements.

Operation outside the LCO limits may produce unacceptable consequences if an event occurs. The CHF safety analysis ensures that there is no overheating of the fuel that results in possible cladding perforation with the release of fission products to the reactor coolant.

BASES

APPLICABLE SAFETY ANALYSES

Limits on $F_{\Delta H}$ preclude core power distributions that exceed fuel design limits.

There must be at least 95% probability at the 95% confidence level (the 95/95 CHF criterion) that the hottest fuel rod in the core does not experience a CHF condition.

The limits on $F_{\Delta H}$ ensure that the safety analysis values for CHF are not exceeded for normal operation, operational transients, and any transient condition arising from analyzed events. The safety analysis precludes CHF and is met by limiting the MCHFR to that value defined in the COLR. This value provides a high degree of assurance that the hottest fuel rod in the core does not experience a CHF condition.

The allowable $F_{\Delta H}$ limit increases with decreasing power level. This functionality in $F_{\Delta H}$ is included in the analyses that provide the Reactor Core Safety Limits (SLs) of SL 2.1.1. Therefore, any CHF events in which the calculation of the core limits is modeled implicitly use this variable value of $F_{\Delta H}$ in the analyses. Likewise, all transients that may be CHF limited are assumed to begin with an initial $F_{\Delta H}$ as a function of power level defined by the COLR limit equation.

The fuel is protected in part by Technical Specifications, which ensure that the initial conditions assumed in the safety and accident analyses remain valid.

$F_{\Delta H}$ is measured periodically using the fixed incore detector system. Measurements are generally taken with the core at, or near, steady state conditions. Core monitoring and control under transient conditions are accomplished by operating the core within the limits of the LCOs on AO and ~~Group~~Bank Insertion Limits.

$F_{\Delta H}$ satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

$F_{\Delta H}$ shall be maintained within the limits of the relationship provided in the COLR.

The $F_{\Delta H}$ limit identifies the coolant flow channel with the maximum enthalpy rise. This channel has the least heat removal capability and thus the highest probability for a CHF condition.

The limiting value of $F_{\Delta H}$, described by the equation contained in the COLR, is the design radial peaking limit used in the safety analyses.

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.2 AXIAL OFFSET (AO)

BASES

BACKGROUND

The purpose of this LCO is to establish limits on the values of AO in order to limit the amount of axial power distribution skewing to either the top or bottom of the core. By limiting the amount of power distribution skewing, core peaking factors are consistent with the assumptions used in the safety analyses. Limiting power distribution skewing over time also minimizes the xenon distribution skewing, which is a significant factor in axial power distribution control.

The AO limits are selected by considering a range of axial xenon distributions that may occur as a result of large variations of the AO. Subsequently, power peaking factors and power distributions are examined to ensure that the postulated event limits are met. Violation of the AO limits invalidate the conclusions of the accident and transient analyses with regard to fuel cladding integrity. (Ref. 1)

The in-core instrumentation system's neutron detectors are arranged equally spaced radially and axially throughout the core. This neutron detector arrangement promotes an accurate indication for the module control system to analyze core power distributions and will be used to monitor AO.

APPLICABLE SAFETY ANALYSES

The AO is a measure of the axial power distribution skewing to either the top or bottom half of the core. The AO is sensitive to many core related parameters such as regulating bank group positions, core power level, axial burnup, axial xenon distribution, reactor coolant temperature, and boron concentration.

The allowed range of the AO is used in the nuclear design process to confirm that operation within these limits produces core peaking factors and axial power distributions that meet safety analysis requirements.

The limits on the AO ensure that the bounding axial power distribution is not exceeded during either normal operation or in the event of xenon redistribution following power changes. The limits on the AO also restrict the range of power distributions that are used as initial conditions in the analyses of anticipated operational occurrences (AOO), infrequent events (IE), and accidents. This ensures that the fuel cladding integrity is maintained for these postulated accidents. The most important AOO is the Control Rod Misoperation - Single Rod Withdrawal. The most

BASES

APPLICABLE SAFETY ANALYSES (continued)

The NSP2 and NSP4 correlation limits are used for comparison to conditions representative of normal operation, operational transients, anticipated operational occurrences, and accidents other than events that are initiated by rapid reductions in primary system inventory. The Hench-Levy correlation is used to evaluate events for which analyses postulate a rapid reduction in primary system inventory. An assumption for the analysis of these events is that the core power distribution is within the limits of LCO 3.1.6, “Regulating ~~Group~~Bank Insertion Limits”; LCO 3.2.1, "Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)," and LCO 3.2.2, “AXIAL OFFSET (AO).”

The flow resistance in the RCS directly affects the reactor coolant natural circulation flow rate established by THERMAL POWER, RCS pressure, and RCS temperature. The safety analyses assume flow rates that are based on a conservative value of flow resistance through the RCS. Therefore the resistance must be verified to ensure that the assumptions in the safety analyses remain valid.

The pressurizer pressure operating limit and the RCS average~~cold~~ temperature limit specified in the COLR, as shown on the Analytical Design Operating Limits~~Thermal Margins Limit Map~~, correspond to operating~~analytical~~ limits, with an allowance for steady state fluctuations and measurement errors. These are the analytical initial conditions assumed in transient and LOCA analyses.

The RCS CHF parameters satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO specifies limits on the monitored process variables, pressurizer pressure and RCS cold temperature to ensure the core operates within the limits assumed in the safety analyses. It also specifies the limit on RCS flow resistance to ensure that the RCS flow is consistent with the flow assumed in the safety analyses. These variables are contained in the COLR to provide operating and analysis flexibility from cycle to cycle. Operating within these limits will result in meeting CHFR criterion in the event of a CHF-limited transient.

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-22

21. In Revision 2 of DCA part 4, GTS Bases page B 3.1.6-1, Background section:

21.1 The applicant is requested to clarify the second paragraph, second sentence as indicated:

... Limits on CRA regulating group ~~CRA~~ insertion have been established, and all regulating ~~group~~ CRA positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking, ejected CRA worth, and SDM limits are preserved.

21.2 The applicant is requested to clarify the third, fourth, and fifth paragraphs, as indicated:

3rd The ~~control rod assemblies (CRAs)~~ 16 CRAs are divided among the two regulating groups and the two shutdown groups, with each group consisting of four CRAs in radially symmetric core locations. The regulating bank consists of two groups of four CRAs, which ~~that~~ are electrically paralleled to step simultaneously. See LCO 3.1.4, "Rod Group Alignment Limits," for regulating and shutdown ~~rod~~ CRA OPERABILITY and alignment requirements, and LCO 3.1.7, "Rod Position Indication," for CRA position indication requirements.

4th The regulating group insertion limits are specified in the COLR. Each CRA of a ~~The~~ regulating group~~s are~~ is required to be at or above ~~the~~ its regulating group insertion limit lines, as well as within its CRA group alignment limits.

5th The CRA regulating group ~~CRA~~s are used for precise reactivity control of the reactor. The positions of the CRAs in a regulating group are ~~group CRAs is~~ normally controlled automatically by the Module Control System (MCS) together as a group of four CRAs;~~, but~~ a

regulating group's CRAs can also be manually controlled, both individually and as a group. ~~They~~ The CRA regulating groups are capable of changing core reactivity very quickly (compared to borating or diluting).

NuScale Response:

The Bases have been modified.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.4 Rod Group Alignment Limits

BASES

BACKGROUND

The OPERABILITY (i.e., trippability) of the shutdown and regulating control rod assemblies (CRAs) is an initial assumption in all safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM).

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, “Reactor Design,” and GDC 26, “Reactivity Control System Redundancy and Capability” (Ref. 1), and 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Plants” (Ref. 2).

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking, due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Sixteen CRAs are arranged in four symmetrical groups. There are two shutdown bank groups of four CRAs each and two regulating bank groups of four CRAs each.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

CRAs are moved by their control rod drive mechanisms (CRDMs). Each CRDM moves its CRA one step (approximately 3/8 inch) at a time.

The CRAs are arranged into groups that are radially symmetric. Therefore, movement of the CRAs by group does not introduce radial asymmetries in the core power distribution. The shutdown and regulating CRAs provide the required reactivity worth for immediate reactor shutdown upon a reactor trip. The regulating bank CRAs also provide power level control during normal operation and transients.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.5 Shutdown Bank~~Group~~ Insertion Limits

BASES

BACKGROUND

The insertion limits of the shutdown ~~group~~ bank ~~Control~~ control ~~Rod~~ rod ~~Assemblies~~ assemblies (CRAs) are initial assumptions in all safety analyses that assume shutdown ~~group~~ bank CRA insertion upon reactor trip. The insertion limits directly affect core power distributions and assumptions of available shutdown margin (SDM), ejected CRA worth, and initial reactivity insertion rate.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, "Reactor Design," and GDC 26, "Reactivity Limits" (Ref. 1), and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors" (Ref. 2). Limits on shutdown bank~~group~~ CRA insertion have been established, and all shutdown bank~~group~~ CRA positions are monitored and controlled during power operation to ensure that the reactivity limits, ejected CRA worth, and SDM limits are preserved.

The 16 CRAs are divided among the two regulating bank groups and two shutdown bank groups, with each group consisting of four CRAs in radially symmetric core locations. The shutdown bank CRAs are ~~arranged into groups that are radially symmetric~~normally moved together as a group. Therefore, movement of ~~the shutdown~~a group of shutdown bank CRAs does not introduce radial asymmetries in the core power distribution. The shutdown bank and regulating ~~group~~ bank CRAs provide the required reactivity worth for immediate reactor shutdown upon a reactor trip.

The design calculations are performed with the assumption that CRAs of the shutdown ~~group CRAs~~bank are withdrawn prior to the CRAs in the regulating ~~group~~ bank~~CRAs~~. The CRAs of the shutdown ~~group CRAs~~bank can be fully withdrawn without the core going critical. This provides available negative reactivity for SDM in the event of unintended reduction of the RCS boron concentration~~dilution~~. The shutdown ~~group~~bank CRAs are controlled manually ~~or automatically~~ by the control room operator. During normal unit operation, the shutdown ~~group~~bank CRAs are fully withdrawn. The shutdown ~~group~~bank CRAs must be completely withdrawn from the core prior to withdrawing regulating ~~group~~bank CRAs during an approach to criticality. The shutdown

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.6 Regulating Bank~~Group~~ Insertion Limits

BASES

BACKGROUND

The insertion limits of the regulating bank control rod assemblies (CRAs) are initial assumptions in the safety analyses that assume rod insertion upon reactor trip. The insertion limits directly affect core power and fuel burnup distributions, assumptions of available SDM, and initial reactivity insertion rate.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, “Reactor Design,” GDC 26, “Reactivity Control System Redundancy and Protection,” GDC 28, “Reactivity Limits” (Ref. 1) and 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors” (Ref. 2). Limits on CRA regulating bank group ~~CRA~~ insertion have been established, and all regulating bank group CRA positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking, ejected CRA worth, and SDM limits are preserved.

The 16 CRAs ~~control rod assemblies (CRAs)~~ are divided among ~~the~~ two regulating bank groups and two~~he~~ shutdown bank groups, with each group consisting of four CRAs in radially symmetric core locations. The regulating bank consists of two groups of four CRAs that are electrically paralleled to step simultaneously. See LCO 3.1.4, “Rod Group Alignment Limits,” for regulating and shutdown CRA ~~rod~~ OPERABILITY and alignment requirements, and LCO 3.1.7, “Rod Position Indication,” for CRA position indication requirements.

The regulating bank group insertion limits are specified in the COLR. ~~The~~ Each CRA of a regulating bank group~~s are~~ is required to be at or above ~~the~~ its regulating bank group insertion limits~~ lines~~, as well as within its CRA group alignment limits.

The CRA regulating bank groups ~~CRAs~~ are used for precise reactivity control of the reactor. The positions of the CRAs in a regulating bank group are ~~CRAs is~~ normally controlled automatically by the Module Control System (MCS) together as a group of four CRAs;~~, but~~ a regulating bank group’s CRAs can also be manually controlled both individually and as a group. The~~y~~ CRA regulating bank groups are capable of changing core reactivity very quickly (compared to borating or diluting).

BASES

BACKGROUND (continued)

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, LCO 3.1.4, “Rod Group Alignment Limits,” LCO 3.1.5, “Shutdown ~~Group~~Bank Insertion Limits,” LCO 3.1.6, “Regulating ~~Group~~Bank Insertion Limits,” LCO 3.2.1, “Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$),” and LCO 3.2.2, “AXIAL OFFSET (AO)” provide limits on control component operation and on monitored process variables which ensure that the core operates within the fuel design criteria.

The shutdown and regulating ~~group~~bank insertion and alignment limits and power distribution limits are process variables that together characterize and control the three dimensional power distribution of the reactor core. Additionally, the regulating ~~group~~bank insertion limits control the reactivity that could be added in the event of a rod ejection accident, and the shutdown and regulating ~~group~~bank insertion limits assure the required SDM is maintained.

Operation within the subject LCO limits will prevent fuel cladding failures that would breach the primary fission product barrier and release fission products to the reactor coolant in the event of a loss of coolant accident (LOCA), loss of flow, ejected CRA, or other accident requiring termination by a Reactor Trip System (RTS) trip function.

APPLICABLE SAFETY ANALYSES

The regulating ~~group~~bank insertion limits, $F_{\Delta H}$, and AO LCOs are required to prevent power distributions that could result in fuel cladding failures in the event of a LOCA, loss of flow, ejected CRA, or other accident requiring termination by an RTS trip function.

The acceptance criteria for addressing shutdown and regulating bank group insertion limits and inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violations of either:

   1. specified acceptable fuel design limits; or

   2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core remains subcritical after design basis events with all CRAs fully inserted~~ in the core~~.

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

eRAI No.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-23

22. In Revision 2 of DCA part 4, on GTS Bases page B 3.1.5-2 and page B 3.1.5-3,

22.1 The applicant is requested to clarify the first paragraph of the ASA section as indicated:

On a reactor trip, all CRAs (eight ~~shutdown group~~ CRAs in two shutdown groups and eight CRAs in two regulating groups), except the most reactive CRA, are assumed to insert into the core. The CRA shutdown groups and regulating group CRAs shall be at or above their insertion limits and available to insert the maximum amount of negative reactivity on a reactor trip signal. The CRA regulating group CRAs may be partially inserted in the core as allowed by LCO 3.1.6, "Regulating Group Insertion Limits." The CRA shutdown and regulating group ~~CRA~~ insertion limits are established to ensure that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM (see LCO 3.1.1, "SHUTDOWN MARGIN (SDM)") following a reactor trip from full power. The combination of CRA regulating ~~group CRAs~~ and shutdown group CRAs (less the most reactive CRA, which is assumed to be fully withdrawn) is sufficient to take the reactor from full power conditions at rated temperature to zero power, and to maintain the required SDM at rated no load temperature (Ref. 3). The CRA shutdown group ~~CRA~~ insertion limits also ~~limits~~ ensures that the reactivity worth of an ejected shutdown CRA is within safety analysis assumptions.

22.2 The applicant is requested to clarify the second paragraph of the ASA section as indicated:

The acceptance criteria for addressing CRA shutdown ~~CRA~~ group as well as regulating group ~~CRA~~ insertion limits and CRA inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violations of either:

1. Specified acceptable fuel design limits; or

2. Reactor Coolant System pressure boundary ~~damage~~ integrity; and

b. The core remains subcritical after **design basis events** with all CRAs fully inserted.

The CRA shutdown group ~~CRA~~ insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

The applicant is requested to justify the above shaded text, which is in addition to or **different from** the corresponding passage in the W-AP1000 STS Subsection B 3.1.5, on page B 3.1.5- 2. The staff also notes that Acceptance Criteria 'a' and 'b' appear to differ by 'b' not assuming that the most reactive CRA is stuck out. The applicant is requested to justify this apparent inconsistency.

The staff points out that the titles of Subsections 3.1.5 and 3.1.6 also support changing to the phrases "CRA shutdown group(s)" and "CRA regulating group(s)" in place of the phrases "shutdown group CRAs" and "regulating group CRAs."

Subsection B 3.1.6, ASA section, the passage about CRA insertion limits, misalignment, and inoperability, has unexplained phrasing differences with the equivalent passage above. These are (i) the word "either" is included in the CRA shutdown group Criterion a; (ii) the word "acceptable" is omitted in the CRA regulating group Criterion a.1 (it is included in W-STS B 3.1.6, but not in W-AP1000-STS B 3.1.6, which appears to be in error); (iii) the word "damage" is (apparently mistakenly) included in CRA shutdown group Criterion a.2; (iv) the phrase "in the core" is appended to the CRA regulating group Criterion b, but is not in the CRA shutdown group Criterion b.

As also stated in Item 23.1 below, the applicant is requested to reconcile these inconsistencies by correcting the passage so it reads the same in both locations.

22.3 The applicant is requested to modify Subsection B 3.1.5, LCO section as indicated, for consistency with the previous comments:

The CRA shutdown groups ~~CRAs~~ must be within their insertion limits any time the reactor is critical or approaching criticality. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip.

The CRA shutdown group insertion limits are ~~defined~~ specified in the COLR.

The LCO is modified by a Note indicating the LCO requirement is not applicable to shutdown groups being inserted while performing SR 3.1.4.2. The SR verifies the freedom of the rods to move, and may require the shutdown group to move below the LCO limits, which would normally violate the LCO. This Note applies to each shutdown group as ~~it's~~ the group is moved below the insertion limit to perform the ~~SR~~ Surveillance. This Note is not applicable should a malfunction stop performance of the ~~SR~~ Surveillance.

The third paragraph above should be moved to the Applicability section and modified as necessary as requested in Sub-question No. 19 above and Sub-question No. 22.4 below.

22.4 The applicant is requested to modify Subsection B 3.1.5, Applicability section as indicated, for consistency with the previous comments:

The CRA shutdown group CRAs must be within their insertion limits, with the ~~reactor~~ unit in MODE 1. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip. In MODE 1 with keff < 1.0, and in MODE 2, the CRA shutdown groups, whether fully withdrawn or fully inserted in the core, contribute to the SDM. In MODES ~~2, 3,~~ 3 and 4, the CRA shutdown group CRAs are fully inserted in the core and contribute to the SDM. Refer to LCO 3.1.1, "SHUTDOWN MARGIN (SDM)," for SDM requirements in MODE 1 with keff ≤ 1.0, and in MODES 2, 3, and 4. LCO 3.5.3, "Ultimate Heat Sink," ensures adequate SDM in MODE~~S 4 and~~ 5.

The staff also suggests the above indicated changes to make this paragraph consistent with Table 1.1-1 and the NuScale design. The staff also requests the applicant to move the following paragraph from the B 3.1.5 LCO section to the

Applicability section, with suggested clarifying changes:

The ~~LCO~~ Applicability is modified by a Note indicating the LCO is not applicable while performing SR 3.1.4.2. This Note permits exceeding the CRA shutdown group insertion limits while inserting each CRA in the group in accordance with ~~being inserted while performing~~ SR 3.1.4.2. ~~The SR~~ This Surveillance verifies the freedom of the ~~rods~~ CRAs to move, and may require the shutdown group to move below the ~~LCO~~ insertion limits specified in the COLR, which would normally violate the LCO. This Note applies to each CRA shutdown group as ~~it's~~ the group is moved below the insertion limit to perform the ~~SR~~ Surveillance. This Note is not applicable should a malfunction stop performance of the ~~SR~~ Surveillance. Note that while performing this Surveillance, the rod group alignment limits of LCO 3.1.4 remain applicable to the CRAs in the shutdown group being exercised.

NuScale Response:

The changes described in NRC items 22.1, 22.2, and 22.3 of the question are incorporated, with additional modifications made for further clarification.

The bases of TS 3.1.5 are written for the NuScale reactor design and operations so the bases of the Westinghouse AP1000 STS are not appropriate for use. Differences between the bases are the result of those design and operational differences described in the FSAR. The bases were modified where appropriate.

The reactor core design is described in FSAR chapter 4, "Reactor." FSAR section 4.3, "Nuclear Design" provides discussion of the NuScale nuclear design including shutdown margin and long term cooling. Details of the control rod assemblies (CRA) and control rod drive system (CRDS) design are provided in sections 4.2 and 4.6 of the FSAR, respectively. Control of the CRA groups is described in Chapter 7, "Instrumentation," of the FSAR. FSAR Chapter 15, "Transients and Analyses" describes plant response to postulated design basis events, including section 15.4, "Reactivity and Power Distribution Anomalies."

The specific differences described in section 22.4 were addressed with the staff as Key Issue 21 related to General Design Criteria 27. This was resolved as described in SECY 18-0099, and further in responses to the following eRAI:

- 9487 15-5 dated July 13, 2018 (ML18194A947)

- 9488 15-21 dated July 12, 2018 (ML18193B181)
- 9489 15-20 dated July 13, 2018 (ML18194A952)
- 9495 15-16 dated June 27, 2018 (ML18178A418)
- 9496 15-19 dated July 9, 2018 (ML18190A458)
- 9498 15-9 dated June 28, 2018 (ML18179A249)

The changes proposed in the first portion of item 22.4 are not consistent with the design and operation of a NuScale reactor so they were not incorporated. Specifically, the withdrawal of the CRA shutdown groups result in entry into MODE 1. Additionally, the ultimate heat sink (UHS) ensures adequate shutdown margin (SDM) during some portions of MODE 4 operations; specifically when the module is disassembled exposing the reactor vessel and reactor recirculation valves to the UHS. This continues until one or more reactor vessel flange bolts is de-tensioned to enter MODE 5. Similar conditions exist during re-assembly of the module.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

BACKGROUND (continued)

~~group~~bank CRAs are then left in ~~this~~ the fully withdrawn position until the reactor is shut down. The~~y~~ eight CRAs of the shutdown bank add negative reactivity to shut down the reactor upon receipt of a reactor trip signal.

APPLICABLE SAFETY ANALYSES

On a reactor trip, all CRAs (~~shutdown group~~eight CRAs in two shutdown bank groups and eight CRAs in two regulating bank group ~~CRA~~s), except the most reactive CRA, are assumed to insert into the core. The shutdown ~~group~~bank and regulating ~~group~~bank CRAs shall be at or above their insertion limits and available to insert the maximum amount of negative reactivity on a reactor trip signal. The regulating ~~group~~bank CRAs may be partially inserted in the core as allowed by LCO 3.1.6, "Regulating ~~Group~~Bank Insertion Limits." The shutdown and regulating ~~group~~bank ~~CRA~~ insertion limits are established to ensure that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM (see LCO 3.1.1, "SHUTDOWN MARGIN (SDM)") following a reactor trip from full power. The combination of regulating ~~group CRAs~~ and shutdown ~~group~~bank CRAs (less the most reactive CRA, which is assumed to be fully withdrawn) ~~is~~are sufficient to take the reactor from full power conditions at rated temperature to zero power, and to maintain the required SDM at rated no load temperature (Ref. 3). The CRA shutdown ~~group~~bank ~~CRA~~ insertion limits also ~~limits~~ ensure that the reactivity worth of an ejected shutdown CRA is within safety analysis assumptions.

The acceptance criteria for addressing CRA shutdown ~~CRA~~ bank and ~~as well as~~ regulating ~~group~~bank ~~CRA~~ insertion limits and CRA inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violation of either:

   1. Specified acceptable fuel design limits; or

   2. Reactor Coolant System pressure boundary ~~damage~~ integrity; and

b. The core remains subcritical after design basis events with all CRAs fully inserted.

The CRA shutdown ~~group~~bank ~~CRA~~ insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

LCO

The CRA shutdown ~~CRAs~~ bank must be within ~~their~~ insertion limits any time the reactor is critical or approaching criticality. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip.

The CRA shutdown ~~group~~bank insertion limits are ~~defined~~ specified in the COLR.

~~The LCO is modified by a Note indicating the LCO requirement is not applicable to shutdown groups being inserted while performing SR 3.1.4.2. The SR verifies the freedom of the rods to move, and may require the shutdown group to move below the LCO limits, which normally violate the LCO. This Note applies to each shutdown group as it's moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.~~

APPLICABILITY

The CRA shutdown ~~group~~bank ~~CRAs~~ must be within ~~their~~ insertion limits, with the reactor in MODE 1. This ensures that a sufficient amount of negative reactivity is available to shut down the reactor and maintain the required SDM following a reactor trip. In MODE 2, 3, 4 the shutdown ~~group~~bank CRAs are fully inserted in the core and contribute to the SDM. Refer to LCO 3.1.1, "SHUTDOWN MARGIN (SDM)," for SDM requirements in MODES 2, 3, and 4. LCO 3.5.3, "Ultimate Heat Sink," ensures adequate SDM in MODES 4 and 5.

The Applicability is modified by a Note indicating the LCO requirement is not applicable while performing SR 3.1.4.2. This Note permits exceeding the CRA shutdown bank insertion limits while inserting each CRA in the bank in accordance with SR 3.1.4.2. This Surveillance verifies the freedom of the CRAs to move, and may require a shutdown bank group to move below the insertion limits specified in the COLR, which would normally violate the LCO. This Note applies to each CRA shutdown bank group as the group is moved below the insertion limit to perform the Surveillance. This Note is not applicable should a malfunction stop performance of the Surveillance. Note that the CRA group alignment limits of LCO 3.1.4 remain applicable to the CRAs in the shutdown bank group being exercised while performing this Surveillance.

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-24

23. In Revision 2 of DCA part 4, on GTS Bases page B 3.1.6-2 and page B 3.1.6-3,

    23.1 The applicant is requested to clarify the second and third paragraphs of the ASA section, as indicated:

    The acceptance criteria for addressing CRA shutdown and regulating group insertion limits and inoperability or misalignment are that:

    a. With the most reactive CRA stuck out there will be no violations of:

       1. specified acceptable fuel design limits; or

       2. Reactor Coolant System (RCS) pressure boundary integrity; and

    b. The core remains subcritical after **design basis events** with all CRAs fully inserted in the core.

    As such, the CRA shutdown and regulating group insertion limits affect safety analysis involving core reactivity and power distributions (Ref. 3).

The SDM requirement is ensured by limiting the control and shutdown group insertion limits so that allowable inserted worth of the CRAs is such that sufficient reactivity is available in the CRAs to shut down the reactor to hot zero power with a reactivity margin which assumes the maximum worth CRA remains fully withdrawn upon trip (Ref. 3).

*The applicant is requested to justify the above shaded text, which is in addition to or **different from** the corresponding passage in the W-STS Subsection B 3.1.6, on page B 3.1.6-2. The staff also notes that Acceptance Criteria 'a' and 'b' appear to differ by 'b' not assuming that the most reactive CRA is stuck out. The applicant is requested to justify this apparent inconsistency.*

The staff points out that the titles of Subsections 3.1.5 and 3.1.6 also support changing to the phrases "CRA shutdown group(s)" and "CRA regulating group(s)" in place of the phrases "shutdown group CRAs" and "regulating group CRAs."

In Subsection B 3.1.5, ASA section, the passage about CRA insertion limits, misalignment, and inoperability has unexplained phrasing differences with the equivalent passage above. These are (i) the word "either" is included in the CRA shutdown group Criterion a; (ii) the word "acceptable" is omitted in the CRA regulating group Criterion a.1 (it is included in W-STS B 3.1.6, but not in W-AP1000-STS B 3.1.6, which appears to be in error); (iii) the word "damage" is (apparently mistakenly) included in CRA shutdown group Criterion a.2; (iv) the phrase "in the core" is appended to the CRA regulating group Criterion b, but is not in the CRA shutdown group Criterion b.

As also stated in Item 22.2 above, the applicant is requested to reconcile these inconsistencies by correcting the passage so it reads the same in both locations.

23.2 In the Subsection B 3.1.6, Applicability section, in the first paragraph, second sentence, the applicant is requested to change the phrase "reactivity rate insertion assumptions" to "reactivity insertion rate assumptions"; in the second paragraph, second sentence, the applicant is requested to change "freedom of the rods to move," to "freedom of the CRAs to move,"

NuScale Response:

The bases of TS 3.1.6 are written for the NuScale reactor design and operations; the bases of the Westinghouse AP1000 STS are not appropriate for use. Differences between the bases are the result of those design and operational differences described in the FSAR. Changes were made to the bases.

The reactor core design is described in FSAR Tier 2 Chapter 4, "Reactor." FSAR section 4.3, "Nuclear Design" provides discussion of the NuScale nuclear design including shutdown margin and long term cooling. Details of the control rod assembly (CRA) and control rod drive system design are provided in sections 4.2 and 4.6 of the FSAR, respectively. Control of the CRA groups is described in FSAR Tier 2, Chapter 7, "Instrumentation," of the FSAR. FSAR Tier 2, Chapter 15, "Transients and Analyses" describes plant response to postulated design basis events, including section 15.4, "Reactivity and Power Distribution Anomalies."

The specific differences described in section 23.1 were addressed with the staff as Key Issue 21 related to General Design Criteria 27. This was resolved as described in SECY 18-0099, and further in responses to the following eRAI:

- 9487 15-5 dated July 13, 2018 (ML18194A947)
- 9488 15-21 dated July 12, 2018 (ML18193B181)
- 9489 15-20 dated July 13, 2018 (ML18194A952)
- 9495 15-16 dated June 27, 2018 (ML18178A418)
- 9496 15-19 dated July 9, 2018 (ML18190A458)
- 9498 15-9 dated June 28, 2018 (ML18179A249)

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

BACKGROUND (continued)

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, LCO 3.1.4, “Rod Group Alignment Limits,” LCO 3.1.5, “Shutdown ~~Group~~Bank Insertion Limits,” LCO 3.1.6, “Regulating ~~Group~~Bank Insertion Limits,” LCO 3.2.1, “Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$),” and LCO 3.2.2, “AXIAL OFFSET (AO)” provide limits on control component operation and on monitored process variables which ensure that the core operates within the fuel design criteria.

The shutdown and regulating ~~group~~bank insertion and alignment limits and power distribution limits are process variables that together characterize and control the three dimensional power distribution of the reactor core. Additionally, the regulating ~~group~~bank insertion limits control the reactivity that could be added in the event of a rod ejection accident, and the shutdown and regulating ~~group~~bank insertion limits assure the required SDM is maintained.

Operation within the subject LCO limits will prevent fuel cladding failures that would breach the primary fission product barrier and release fission products to the reactor coolant in the event of a loss of coolant accident (LOCA), loss of flow, ejected CRA, or other accident requiring termination by a Reactor Trip System (RTS) trip function.

APPLICABLE SAFETY ANALYSES

The regulating ~~group~~bank insertion limits, $F_{\Delta H}$, and AO LCOs are required to prevent power distributions that could result in fuel cladding failures in the event of a LOCA, loss of flow, ejected CRA, or other accident requiring termination by an RTS trip function.

The acceptance criteria for addressing shutdown and regulating bank group insertion limits and inoperability or misalignment are that:

a. With the most reactive CRA stuck out there will be no violations of either:

    1. specified acceptable fuel design limits; or

    2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core remains subcritical after design basis events with all CRAs fully inserted ~~in the core~~.

BASES

APPLICABLE SAFETY ANALYSES (continued)

As such, the CRA shutdown and regulating ~~group~~bank insertion limits affect safety analysis involving core reactivity and power distributions (Ref. 3).

The SDM requirement is ensured by limiting the ~~control and~~ shutdown and regulating bank~~group~~ insertion limits so that allowable inserted worth of the CRAs is such that sufficient reactivity is available in the CRAs to shut down the reactor to hot zero power with a reactivity margin which assumes the maximum worth CRA remains fully withdrawn upon trip (Ref. 3).

Operation at the insertion limits or AO limits may approach the maximum allowable linear heat generation rate or peaking factor. Operation at the insertion limit may also indicate the maximum ejected CRA worth could be equal to the limiting value in fuel cycles that have sufficiently high ejected CRA worth.

The ~~regulating and~~ shutdown and regulating bank~~group~~ insertion limits ensure that safety analyses assumptions for SDM, ejected rod worth, and power distribution peaking factors are preserved (Ref. 3).

The insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii) in that they are initial conditions assumed in the safety analysis.

LCO

The limits on regulating ~~group~~bank physical insertion as defined in the COLR, must be maintained because they serve the function of preserving power distribution, ensuring that the SDM is maintained, ensuring that ejected CRA worth is maintained, and ensuring adequate negative reactivity insertion is available on trip.

~~The LCO is modified by a Note indicating the LCO requirement is not applicable to control groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the rods to move, and may require the control group to move below the LCO limits, which would normally violate the LCO. This Note applies to each control group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.~~

BASES

APPLICABILITY

The regulating ~~group~~bank physical insertion limits shall be maintained with the reactor in MODE 1 when k_{eff} is ≥ 1.0. These limits must be maintained since they preserve the assumed power distribution, ejected CRA worth, SDM, and reactivity ~~rate~~ insertion rate assumptions. Applicability in MODE 1 with k_{eff} < 1.0, and MODES 2, 3, 4, and 5 is not required, since neither the power distribution nor ejected CRA worth assumptions would be exceeded in these MODES.

~~The applicability requirements have been modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the regulating group to move below the LCO limits, which would violate the LCO.~~The Applicability is modified by a Note indicating the LCO requirement is not applicable to CRA groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the CRAs to move, and may require the regulating bank group to move below the LCO limits, which would normally violate the LCO. This Note applies to each regulating bank group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.

ACTIONS

A.1.1, A.1.2, and A.2

When ~~the~~ one or more regulating bank groups is~~are~~ ~~outside the acceptance~~not within insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ CRA regulating bank group positions; or

b. Moving ~~rods~~ CRA regulating bank groups to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since the SDM in MODE 1 with k_{eff} ~~is~~ ≥ 1.0 is normally ensured by adhering to the ~~control~~ regulating and shutdown ~~group~~bank insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)") has been upset.

The allowed Completion Time of 2 hours for restoring the regulating bank groups to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain outside the insertion limits~~in an unacceptable condition~~ for an extended period of time.

NUSCALE
Power for all humankind

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-25

24. In Revision 2 of DCA part 4, on GTS pages 3.1.5-1 and 3.1.5-2; and GTS Bases pages B 3.1.5-3 and B 3.1.5.4:

24.1 In the Bases discussion of Action A, the first sentence ("When one shutdown group CRA is not within insertion limits, 2 hours are allowed to restore the shutdown group CRA to within insertion limits.") clearly conveys that Condition A ("Shutdown group not within limits.") describes the situation of just one CRA in one of the two shutdown groups "not [being] within [insertion] limits." However, to ensure the meaning is unambiguous, the applicant is requested to revise the Condition statement to say "<u>One s</u>hutdown group <u>with one CRA</u> not within <u>shutdown group insertion</u> limits."

24.2 In the Bases discussion of Action A, the applicant is requested to revise the first paragraph for consistency with the previous comments and NuScale terminology:

When one <u>CRA in one</u> shutdown group ~~CRA~~ is not within insertion limits, 2 hours are allowed to restore the <u>CRA to within its</u> shutdown group ~~CRA to within~~ insertion limits. This is necessary because the available SDM may be significantly reduced with one ~~showdown group~~ CRA not within ~~their~~ <u>its shutdown group</u> insertion limits. Also, verification of the <u>required</u> SDM <u>within 1 hour,</u> or initiation of boration ~~within 1 hour~~ <u>to</u> <u>restore SDM to within the limits of LCO 3.1.1 within 1 hour</u> is required, since the SDM in MODE 1 is *continuously monitored* and adhered to, in part, by <u>meeting</u> the ~~control~~ <u>CRA</u> <u>regulating group</u> and shutdown group insertion limits ~~(see LCO 3.1.1)~~.

The applicant is requested to explain how SDM is continuously monitored in MODE 1; else remove this assertion.

24.3 In the Bases discussion of SR 3.1.5.1, the applicant is requested to revise the first and second paragraphs for consistency with previous comments and NuScale terminology:

Verification that the CRAs of each shutdown group ~~is within its~~ are within the shutdown group insertion limits within 12 hours prior to an approach to criticality, and at regular intervals thereafter, ensures that when the reactor is critical, or being taken critical, the shutdown group will be available to shut down the reactor, and the required SDM will be maintained following a reactor trip. ~~This SR and~~ The first Surveillance Frequency ensures that the two shutdown groups ~~is~~ are withdrawn before the regulating groups are withdrawn during a unit startup, since the reactor is normally taken critical by withdrawing the regulating groups after the shutdown groups are fully withdrawn.

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

The staff notes that the Frequency of SR 3.1.5.1 is "In accordance with the Surveillance Frequency Control Program"; and that FSAR Table 16.1-1 states that the base Frequency is 12 hours. It is understood that before entering MODE 1, LCO 3.1.5 shutdown group insertion limits must be satisfied, and that requires fully withdrawing the two shutdown groups from the core. The 12 hour Frequency plus the 3 hour extension of SR 3.0.2 means that regulating group withdrawal may begin no more than 15 hours since the shutdown group insertion limits were last verified. The applicant is requested to modify the Frequency of SR 3.1.5.1 by inserting a Frequency as described in the above paragraph, but which is not subject to the Surveillance Frequency Control Program and the 25% extension of SR 3.0.2. The revised Frequency would say:

Once within 12 hours prior to an approach to criticality AND

In accordance with the Surveillance Frequency Control Program

---

NuScale Response:

The description and bases for LCO 3.1.5, Condition A have been modified to align with the Condition description in other PWR STS. The Condition applies when one or more shutdown

groups are not meeting their insertion limits. The bases were also modified to reflect this Condition.

Shutdown margin (SDM) is continuously monitored by available instrumentation indication and alarms that provide indication of the factors that affect SDM including individual and group control rod assembly (CRA) positions, RCS temperatures, reactor power, and rate of change of reactor power, if applicable. Conservative evaluation of potential adverse effect on SDM due to the inability to insert the CRA with the highest worth is considered. Monitoring is implemented by procedural implementation of the Core Operating Limits Report required by TS 5.6.3.

The proposed modification of the Frequency applicable to SR 3.1.5.1 was not incorporated as it is unnecessary. While SR 3.0.2 permits a 25% extension to the surveillance interval, plant procedures will not be written assuming this extended frequency as that would contradict the intent of SR 3.0.2 as described in the final paragraphs of the associated Bases. The proposed additional frequency is also inappropriately vague, with the proposed initiating condition specified as "prior to an approach to criticality." Plant procedures will define the actions taken to approach criticality. However the steps to approach criticality will involve a variety of activities including plant heatup, system alignments, adjustments to RCS chemistry including boron concentration. Conceptually, the approach to criticality begins with the reinstallation of the module in its operating position.

Clearly the intent of this surveillance is to verify the CRA shutdown groups are fully withdrawn and available to provide shutdown capability 'close to' the time the reactor achieves criticality. The 12 hour base frequency ensures that procedures will be drafted to verify the CRA are fully withdrawn within 12 hours of initiating the plant activities that will cause the reactor to reach criticality. This may require verification more than once during this activity. Note also that the NuScale reactor design involves only two CRA shutdown groups, and deviations from the fully withdrawn position would be readily noticeable to plant staff.

Finally, the proposed change is inconsistent with the industry traveler applicable to the adoption of the surveillance frequency control program for the corresponding PWR specifications. The PWR specifications do not include a 'once prior to' frequency; apparently indicating that the 12 hour base frequency when considered with the bases of SR 3.0.2, are adequate. See TSTF-425-A, Revision 3, "Relocate Surveillance Frequencies to Licensee Control - RITSTF Initiative 5b."

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.5 Shutdown ~~Group~~Bank Insertion Limits

LCO 3.1.5 Each shutdown bank group shall be within insertion limits specified in the COLR.

~~-----NOTE-----~~
~~Not applicable to shutdown groups inserted while performing SR 3.1.4.2.~~

APPLICABILITY: MODE 1.

-----NOTE-----
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~Shutdown group not within limits~~One or more shutdown groups not within insertion limits.	A.1.1 Verify SDM is within the limits specified in the COLR. OR A.1.2 Initiate boration to restore SDM to within limit. AND A.2 Restore shutdown groups to within limits.	1 hour 1 hour 2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 2.	6 hours

BASES

ACTIONS

A.1.1, A.1.2, and A.2

When one or more CRA shutdown bank groups ~~CRA~~ is not within insertion limits, 2 hours are allowed to restore the CRA shutdown bank groups ~~CRA~~ to within insertion limits. This is necessary because the available SDM may be significantly reduced with CRA~~one~~ shutdown~~showdown~~ bank groups ~~CRA~~ not within their insertion limits. Also, verification of the SDM or initiation of boration within 1 hour is required, since the SDM in MODE 1 is continuously monitored and adhered to, in part, by the CRA regulating~~control~~ and shutdown ~~group~~bank insertion limits (see LCO 3.1.1).

The allowed Completion Time of 2 hours provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain in an unacceptable condition for an extended period of time.

B.1

~~If the Required Actions and associated Completion Times are not met, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA shutdown bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.5.1

Verification that the CRAs of each shutdown bank group ~~is~~ are within ~~its~~ insertion limits prior to an approach to criticality ensures that when the reactor is critical, or being taken critical, the shutdown bank groups will be available to shut down the reactor, and the required SDM will be maintained following a reactor trip. This SR and Frequency ensure that the CRA shutdown bank groups ~~is~~ are withdrawn before the CRA regulating bank groups are withdrawn during a unit startup.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.

2. 10 CFR 50.46.

3. FSAR, Chapter 15, “Transient and Accident Analysis.”

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Docket No. 52-048

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-26

25. In Revision 2 of DCA part 4, on GTS page 3.1.5-1 and page 3.1.6-1: The applicant is requested to explain why Subsection 3.1.5 Condition A ("[One s]hutdown group not within [insertion] limits."), and Subsection 3.1.6 Condition A ("Regulating group insertion limits not met.") are phrased differently, when the only difference is which kind of CRA group is addressed.

NuScale Response:

Condition A of LCO 3.1.5 and 3.1.6 have been changed to read consistently as

> "One or more [regulating or shutdown] groups not within insertion limits."

Conforming changes were made to the Actions sections of the bases for 3.1.5 and 3.1.6.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.5 Shutdown ~~Group~~Bank Insertion Limits

LCO 3.1.5 Each shutdown bank group shall be within insertion limits specified in the COLR.

~~NOTE~~
~~Not applicable to shutdown groups inserted while performing SR 3.1.4.2.~~

APPLICABILITY: MODE 1.

--NOTE--
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. ~~Shutdown group not within limits~~One or more shutdown groups not within insertion limits.	A.1.1	Verify SDM is within the limits specified in the COLR.	1 hour
	OR		
	A.1.2	Initiate boration to restore SDM to within limit.	1 hour
	AND		
	A.2	Restore shutdown groups to within limits.	2 hours
B. Required Action and associated Completion Time not met.	B.1	Be in MODE 2.	6 hours

3.1 REACTIVITY CONTROL SYSTEMS

3.1.6 Regulating ~~Group~~Bank Insertion Limits

LCO 3.1.6 Each regulating bank group shall be within the insertion limits specified in the COLR.

~~NOTE~~
~~Not applicable to regulating groups inserted while performing SR 3.1.4.2.~~

APPLICABILITY: MODE 1 with $k_{eff} \geq 1.0$.

-----NOTE-----
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more regulating groups not within insertion limits.~~Regulating group insertion limits not met.~~	A.1.1 Verify SDM is within the limits specified in the COLR. OR A.1.2 Initiate boration to restore SDM to within limits. AND A.2 Restore regulating groups to within limits.	1 hour 1 hour 2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 1 with $k_{eff} < 1.0$.	6 hours

BASES

ACTIONS

A.1.1, A.1.2, and A.2

When one or more CRA shutdown bank groups ~~CRA~~ is not within insertion limits, 2 hours are allowed to restore the CRA shutdown bank groups ~~CRA~~ to within insertion limits. This is necessary because the available SDM may be significantly reduced with CRA~~one~~ shutdown~~showdown~~ bank groups ~~CRA~~ not within their insertion limits. Also, verification of the SDM or initiation of boration within 1 hour is required, since the SDM in MODE 1 is continuously monitored and adhered to, in part, by the CRA regulating~~control~~ and shutdown ~~group~~bank insertion limits (see LCO 3.1.1).

The allowed Completion Time of 2 hours provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain in an unacceptable condition for an extended period of time.

B.1

~~If the Required Actions and associated Completion Times are not met, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA shutdown bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.5.1

Verification that the CRAs of each shutdown bank group ~~is~~ are within ~~its~~ insertion limits prior to an approach to criticality ensures that when the reactor is critical, or being taken critical, the shutdown bank groups will be available to shut down the reactor, and the required SDM will be maintained following a reactor trip. This SR and Frequency ensure that the CRA shutdown bank groups ~~is~~ are withdrawn before the CRA regulating bank groups are withdrawn during a unit startup.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.

2. 10 CFR 50.46.

3. FSAR, Chapter 15, “Transient and Accident Analysis.”

BASES

APPLICABILITY

The regulating ~~group~~bank physical insertion limits shall be maintained with the reactor in MODE 1 when k_{eff} is ≥ 1.0. These limits must be maintained since they preserve the assumed power distribution, ejected CRA worth, SDM, and reactivity ~~rate~~ insertion rate assumptions. Applicability in MODE 1 with k_{eff} < 1.0, and MODES 2, 3, 4, and 5 is not required, since neither the power distribution nor ejected CRA worth assumptions would be exceeded in these MODES.

~~The applicability requirements have been modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the regulating group to move below the LCO limits, which would violate the LCO.~~The Applicability is modified by a Note indicating the LCO requirement is not applicable to CRA groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the CRAs to move, and may require the regulating bank group to move below the LCO limits, which would normally violate the LCO. This Note applies to each regulating bank group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.

ACTIONS

A.1.1, A.1.2, and A.2

When ~~the~~ one or more regulating bank groups is~~are~~ ~~outside the acceptance~~not within insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ CRA regulating bank group positions; or

b. Moving ~~rods~~ CRA regulating bank groups to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since the SDM in MODE 1 with k_{eff} ~~is~~ ≥ 1.0 is normally ensured by adhering to the ~~control~~ regulating and shutdown ~~group~~bank insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)") has been upset.

The allowed Completion Time of 2 hours for restoring the regulating bank groups to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain outside the insertion limits~~in an unacceptable condition~~ for an extended period of time.

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NRC Question No.: 16-60-27

26. In Revision 2 of DCA part 4, on GTS Bases page B 3.1.6-4. In the discussion of Action A, the first sentence has a grammatical error: "When the regulating *group **are** outside* the ~~acceptance~~ <u>specified</u> insertion limits, ***they*** must be restored to within those limits." The word "group" would need to be "groups" to match the verb "are" and the pronoun "they." However, the statement of Condition A ("Regulating group insertion limits not met.") is ambiguous because it cannot be concluded whether the Condition applies to one or both regulating groups. Required Action A.2 ("Restore regulating group to within limits.") seems to imply that just one regulating group is the intended meaning. Also, the last paragraph of the Bases discussion refers to "restoring the regulating group to within insertion limits,..." The applicant is requested to revise Subsection 3.1.6, Condition A and the Bases to make clear the intended meaning.

NuScale Response:

The bases have been changed to address the identified concern.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.6 Regulating ~~Group~~Bank Insertion Limits

LCO 3.1.6 Each regulating bank group shall be within the insertion limits specified in the COLR.

~~NOTE~~
~~Not applicable to regulating groups inserted while performing SR 3.1.4.2.~~

APPLICABILITY: MODE 1 with $k_{eff} \geq 1.0$.

--NOTE--
This LCO not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more regulating groups not within insertion limits.~~Regulating group insertion limits not met.~~	A.1.1 Verify SDM is within the limits specified in the COLR.	1 hour
	OR	
	A.1.2 Initiate boration to restore SDM to within limits.	1 hour
	AND	
	A.2 Restore regulating groups to within limits.	2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 1 with $k_{eff} < 1.0$.	6 hours

BASES

APPLICABILITY

The regulating ~~group~~bank physical insertion limits shall be maintained with the reactor in MODE 1 when k_{eff} is ≥ 1.0. These limits must be maintained since they preserve the assumed power distribution, ejected CRA worth, SDM, and reactivity ~~rate~~ insertion rate assumptions. Applicability in MODE 1 with k_{eff} < 1.0, and MODES 2, 3, 4, and 5 is not required, since neither the power distribution nor ejected CRA worth assumptions would be exceeded in these MODES.

~~The applicability requirements have been modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the regulating group to move below the LCO limits, which would violate the LCO.~~The Applicability is modified by a Note indicating the LCO requirement is not applicable to CRA groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the CRAs to move, and may require the regulating bank group to move below the LCO limits, which would normally violate the LCO. This Note applies to each regulating bank group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.

ACTIONS

A.1.1, A.1.2, and A.2

When ~~the~~ one or more regulating bank groups is~~are~~ ~~outside the acceptance~~not within insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ CRA regulating bank group positions; or

b. Moving ~~rods~~ CRA regulating bank groups to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since the SDM in MODE 1 with k_{eff} ~~is~~ ≥ 1.0 is normally ensured by adhering to the ~~control~~ regulating and shutdown ~~group~~bank insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)") has been upset.

The allowed Completion Time of 2 hours for restoring the regulating bank groups to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain outside the insertion limits~~in an unacceptable condition~~ for an extended period of time.

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Docket No. 52-048

eRAI No.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-28

27. In Revision 2 of DCA part 4, on GTS Bases page B 3.1.6-4: In the discussion of Action A, the applicant is requested to make the suggested editorial improvements, as indicated:

<u>A.1.1, A.1.2, and A.2</u>

When the <u>position of a CRA of a</u> regulating group ~~are~~ <u>is</u> outside the ~~acceptance~~ <u>acceptable regulating group</u> insertion limits <u>specified in the COLR</u>, ~~they~~ <u>the</u> <u>CRA position</u> must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ <u>CRA</u> position; or

b. ~~Moving rods~~ <u>Move CRAs</u> to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required ~~in~~ <u>within</u> 1 hour, since the SDM in MODE 1 with keff ~~is~~ ≥ 1.0<u>, which</u> is normally ensured by adhering to the ~~control~~ <u>regulating group</u> and shutdown group insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)"), has been upset.

The allowed Completion Time of 2 hours for restoring the regulating group to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain ~~in an unacceptable condition~~ <u>outside the insertion</u> <u>limits</u> for an extended period of time.

NuScale Response:

The bases were modified to address the substance of the identified concerns. However, some changes were not incorporated as they deviated from the standard technical specifications (STS) bases for similar specifications in NUREG-1431, revision 4, without a NuScale-specific reason to do so. This is consistent with the NuScale design specific review standard expressed intent to remain similar to STS unless a NuScale-specific reason (e.g. design, operations, etc.) exists to make the change.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

APPLICABILITY

The regulating ~~group~~bank physical insertion limits shall be maintained with the reactor in MODE 1 when k_{eff} is ≥ 1.0. These limits must be maintained since they preserve the assumed power distribution, ejected CRA worth, SDM, and reactivity ~~rate~~ insertion rate assumptions. Applicability in MODE 1 with k_{eff} < 1.0, and MODES 2, 3, 4, and 5 is not required, since neither the power distribution nor ejected CRA worth assumptions would be exceeded in these MODES.

~~The applicability requirements have been modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the regulating group to move below the LCO limits, which would violate the LCO.~~The Applicability is modified by a Note indicating the LCO requirement is not applicable to CRA groups being inserted while performing SR 3.1.4.2. This SR verifies the freedom of the CRAs to move, and may require the regulating bank group to move below the LCO limits, which would normally violate the LCO. This Note applies to each regulating bank group as it is moved below the insertion limit to perform the SR. This Note is not applicable should a malfunction stop performance of the SR.

ACTIONS

A.1.1, A.1.2, and A.2

When ~~the~~ one or more regulating bank groups is~~are~~ ~~outside the acceptance~~not within insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

a. Reduce power to be consistent with ~~rod~~ CRA regulating bank group positions; or

b. Moving ~~rods~~ CRA regulating bank groups to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since the SDM in MODE 1 with k_{eff} ~~is~~ ≥ 1.0 is normally ensured by adhering to the ~~control~~ regulating and shutdown ~~group~~bank insertion limits (see LCO 3.1.1, "Shutdown Margin (SDM)") has been upset.

The allowed Completion Time of 2 hours for restoring the regulating bank groups to within insertion limits, provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain outside the insertion limits~~in an unacceptable condition~~ for an extended period of time.

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Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-29

28. *The applicant is requested to treat this comment as a global comment on the Bases.*

- In Revision 2 of DCA part 4, on GTS Bases page B 3.1.5-3: The Bases for Action B.1 begins, "If the Required Actions and associated Completion Times are not met, the unit must be brought to a MODE where the LCO is not applicable."
- In Revision 2 of DCA part 4, on GTS Bases page B 3.1.6-4: The Bases for Action B.1 begins, "If the Required Actions cannot be completed within the associated Completion Times, the unit must be brought to a MODE where the LCO is not applicable."
- In Revision 2 of DCA part 4, on GTS Bases page B 3.1.7-5: The Bases for Action E.1 begins, "If the Required Actions cannot be completed within the associated Completion Time, the unit must be brought to a MODE in which the requirement does not apply."

There is no reason why these statements should not be identical, nor why they refer to "Required Actions" and "Completion Times"; the associated Condition statements all say "Required Action and associated Completion Time..."

The applicant is requested to replace these and all such sentences with a standard sentence, such as: "If a Required Action [of Condition A or B...] cannot be accomplished within its associated Completion Time[*, or if the LCO is not met as specified by another condition statement in the same Action table row,*] the unit must be brought to a MODE ['where the LCO is not applicable' *or* 'in which the LCO does not apply']."

Some Bases for default Actions provide an acceptable alternative to the preceding statement, by describing the action [sometimes from a list of action descriptions] which is not

accomplished within the specified Completion Time. *The applicant is requested to verify the clarity and accuracy of such Bases statements.*

NuScale Response:

The bases of 3.1.5, 3.1.6, and 3.1.7 were revised as requested.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

ACTIONS

A.1.1, A.1.2, and A.2

When one or more CRA shutdown bank groups ~~CRA~~ is not within insertion limits, 2 hours are allowed to restore the CRA shutdown bank groups ~~CRA~~ to within insertion limits. This is necessary because the available SDM may be significantly reduced with CRA~~one~~ shutdown~~showdown~~ bank groups ~~CRA~~ not within their insertion limits. Also, verification of the SDM or initiation of boration within 1 hour is required, since the SDM in MODE 1 is continuously monitored and adhered to, in part, by the CRA regulating~~control~~ and shutdown ~~group~~bank insertion limits (see LCO 3.1.1).

The allowed Completion Time of 2 hours provides an acceptable time for evaluating and repairing minor problems without allowing the unit to remain in an unacceptable condition for an extended period of time.

B.1

~~If the Required Actions and associated Completion Times are not met, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA shutdown bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.5.1

Verification that the CRAs of each shutdown bank group ~~is~~ are within ~~its~~ insertion limits prior to an approach to criticality ensures that when the reactor is critical, or being taken critical, the shutdown bank groups will be available to shut down the reactor, and the required SDM will be maintained following a reactor trip. This SR and Frequency ensure that the CRA shutdown bank groups ~~is~~ are withdrawn before the CRA regulating bank groups are withdrawn during a unit startup.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.

2. 10 CFR 50.46.

3. FSAR, Chapter 15, “Transient and Accident Analysis.”

BASES

ACTIONS (continued)

B.1

~~If the Required Actions cannot be completed within the associated Completion Times, the unit must be brought to a MODE where the LCO is not applicable.~~If the CRA regulating bank groups cannot be restored to within their insertion limits within two hours, the unit must be brought to a MODE where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable for reaching the required MODE from full power conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.1.6.1

Verification of the regulating ~~group~~bank insertion limits is sufficient to detect regulating bank groups that may be approaching the insertion limits.

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

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10, GDC 26, and GDC 28.

2. 10 CFR 50.46.

3. FSAR, Chapter 15, “Transient and Accident Analyses.”

BASES

ACTIONS (continued)

Verification of CRA position once per 8 hours is adequate for allowing continued full power operation for a limited, 24 hour period, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small. The 24 hour Completion Time provides sufficient time to troubleshoot and restore the ~~C~~RPI system to operation while avoiding the plant challenges associated with the shutdown without full CRA position indication.

Based on industry experience, normal power operation does not require excessive CRA movement. If one or more CRAs has been significantly moved, the Required Action of C.1 below is required.

C.1

The Required Action clarifies that when one or more CRAs with inoperable position indicators have been moved in excess of 6 steps in one direction since the position was last determined, the Required Actions of A.1 or B.1 are still appropriate but must be initiated promptly under Required Action C.1 to begin verifying that these CRAs are still properly positioned relative to their group positions.

D.1 and D.2

With one counter~~demand~~ position indicator per group inoperable, the CRA positions can be determined by the RPI System. Since normal full power operation does not require excessive movement of CRAs, verification by administrative means that the CRDS position indicators are OPERABLE and the most withdrawn CRA and the least withdrawn CRA are ≤ 6 steps apart within the allowed Completion Time of once every 8 hours is adequate

E.1

If a~~the~~ Required Action~~s~~ of Condition A, B, C, or D cannot be completed within the associated Completion Time, the unit must be brought to a MODE in which the LCO~~requirement~~ does not apply. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours. The allowed Completion Time is based on reaching the required MODE from full power conditions in an orderly manner.

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-30

29. In Revision 2 of DCA part 4, on GTS pages 3.1.7-1 and 3.1.7-2, acronym definition and usage in statement of LCO 3.1.7; Actions table Note; Conditions A, B, C; and D; and Required Actions A.1, B.1, B.2, C.1, D.1, and D.2. With the understanding that each of the 16 CRAs has one control rod drive mechanism (CRDM), two rod position indicators (RPIs), and one counter position indicator (CPI), the staff suggests the following editorial improvements in clarity and consistency, as shown by markup (ignore formatting) :

LCO 3.1.7 The Control Rod Drive System (CRDS) Rod Position Indication ~~(RPI)~~ System (RPIS) and the Control Rod Assembly (CRA) Counter Position Indication ~~(CPI)~~ System (CPIS) shall be OPERABLE.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each inoperable CRDS rod position indicator (RPI) and each CRA counter position indicator (CPI).

A. One or more CRAs with one RPI ~~per CRDM~~ inoperable ~~for one or more CRDMs~~.

A.1 Verify the position of ~~the~~ each CRA with an inoperable ~~position indicators~~ RPI by using ~~with~~ the Module Control System (MCS). | Once per 8 hours

B. One or more ~~More than one RPI per CRDM~~ CRAs with two RPIs inoperable.

B.1 Place ~~the~~ affected CRAs under manual control. | Immediately

AND

B.2 Verify the position of ~~the~~ each affected CRA ~~with inoperable CRDS position indicators~~ indirectly by using the incore detectors. | Once per 8 hours

AND

B.3 Restore ~~inoperable rod position indicators~~ one RPI per CRA to OPERABLE status ~~such that a maximum of one RPI per CRDM is inoperable~~. | 24 hours

C. One or more ~~control rod drive mechanisms (CRDMs)~~ CRAs with one or two RPIs ~~inoperable position indicators~~ inoperable that have been moved in excess of 6 steps in one direction since the last position determination of the affected CRAs ~~position~~.

C.1 Verify the position of ~~the~~ each affected CRA ~~with inoperable position indicators~~ by using the MCS.
| 4 hours

D. One or more CRAs with ~~CRA~~ CPI ~~position indicator~~ inoperable ~~for one or more CRAs~~.

The phrase "by administrative means" for verifying operability of all RPIs for all affected groups (groups with one or more CRAs with the CPI inoperable) is unclear, and is not explained in the Bases for Actions D.1 and D.2, which state:

With one *demand* position indicator per group inoperable, the CRA positions can be determined by the RPI System. Since normal full power operation does not require excessive movement of CRAs, verification by administrative means that CRDS [CRA] position indicators are OPERABLE and the most withdrawn CRA and the least withdrawn CRA are ≤ 6 steps apart within the allowed Completion Time of once every 8 hours is adequate.

NuScale Response:

Changes have been made to LCO 3.1.7 and the associated bases to clarify that the Rod Position Indicators (RPIs) and Counter Position Indicators (CPIs) are not distinct systems in the NuScale design. The RPIs and CPIs are features of the control rod drive mechanism system as described in FSAR Tier 2, section 4.6.

The term 'administrative means' is consistent with usage in NUREG-1431 Revision 4 volumes 1 and 2. 'Administrative means' is reference to approved procedures prepared, reviewed, and maintained in accordance with FSAR Tier 2, chapter 13, 10 CFR 50.59, and as required by technical specification 5.4. Additional details regarding what 'administrative means' are and the basis for their acceptability will be developed when operating procedures are written as required by COL item 13.5-2.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.7 Rod Position Indication (RPI)

LCO 3.1.7 The Control Rod Drive System (CRDS) Rod Position Indicators~~ion~~ (RPIs) ~~System~~ and the Control Rod Assembly (CRA) Counter Position Indicators~~ion~~ (CPIs)~~ System~~ shall be OPERABLE.

APPLICABILITY: MODE 1.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each inoperable CRDS rod position indicator and each CRA counter position indicator.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One RPI per CRDM inoperable for one or more CRDMs.	A.1 Verify the position of the CRA with inoperable position indicators with the Module Control System (MCS).	Once per 8 hours
B. More than one RPI per CRDM inoperable.	B.1 Place the CRA under manual control.	Immediately
	AND	
	B.2 Verify the position of the CRA with inoperable CRDS position indicators indirectly by using the incore detectors.	Once per 8 hours
	AND	

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.7.1	Verify each RPI channel agrees within 6 steps of the group counter~~demand~~ position indication for the full indicated range of CRA travel.	Prior to criticality after coupling of one or more CRA to the associated CRDM

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.7 Rod Position Indication

BASES

BACKGROUND

According to GDC 13 (Ref. 1), instrumentation to monitor variables and systems over their operating ranges during normal operation, anticipated operational occurrences (AOOs), and accident conditions must be OPERABLE. LCO 3.1.7 is required to ensure OPERABILITY of the control rod position indicators to determine control rod positions and thereby ensure compliance with the control rod alignment and power-dependent insertion limits (PDIL).

The OPERABILITY, including position indication, of the shutdown and regulating group control rod assemblies (CRAs) is an initial assumption in the safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the CRA misalignment safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM). CRA position indication is required to assess OPERABILITY and misalignment.

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to aid compliance with the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

Sixteen CRAs are arranged in four symmetrical groups. Two shutdown groups of four CRAs each, and two regulating groups of four CRAs each.

CRAs are moved out of the core (up or withdrawn) or into the core (down or inserted) by their control rod drive mechanisms (CRDMs). The CRAs are divided among the regulating groups and shutdown groups.

BASES

BACKGROUND (continued)

The axial position of shutdown CRAs and regulating group CRAs are determined by two separate and independent ~~systems~~means: the Counter Position Indicators~~ion System~~ (CPIs) (commonly called group step counters) and the Rod Position Indicators~~ion~~ (RPIs)~~ System~~.

The ~~Counter Position Indication~~CPI counts the commands sent to the CRDM gripper coils from the Control Rod Drive System (CRDS) that moves the CRAs. There is one step counter for each CRDM. The CRA ~~Position Indication System~~RPI is considered highly precise (± 1 step or ± {3/8} inch). If a CRA does not move one step for each command signal, the step counter will still count the command and incorrectly reflect the position of the CRA.

The RPI function of the CRDS provides a highly accurate indication of actual CRA position, but at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube with a center to center distance of 1.125 inches, which is equivalent to 3 steps. To increase the reliability of the system, the inductive coils are alternately to two data systems. Thus, if one system fails, the RPI will go on half accuracy with an effective coil spacing of 2.25 inches, which is 6 steps. Therefore, the normal indication accuracy of the RPIs~~ System~~ is ± 3 steps (± 1.125 inches), and the accuracy with one channel of RPI out-of-service is ± 6 steps (± 2.25 inches).

APPLICABLE SAFETY ANALYSES

The regulating and shutdown groups CRA position accuracy is essential during power operation. Power peaking, ejected CRA worth, or SDM limits may be violated in the event of a Design Basis Accident (Ref. 2), with regulating or shutdown group CRAs operating outside their limits undetected. Therefore, the acceptance criteria for CRA position indication is that CRA positions must be known with sufficient accuracy in order to verify the core is operating within the group sequence, overlap, design peaking limits, ejected CRA worth, and within minimum SDM (LCO 3.1.5, “Shutdown Group Insertion Limits,” LCO 3.1.6, “Regulating group Insertion Limits”). The CRA positions must also be known in order to verify the alignment limits are preserved (LCO 3.1.4, “Rod Group Alignment Limits”). CRA positions are continuously monitored to provide operators with information that assures the unit is operating within the bounds of the accident analysis assumptions.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The CRA position indicator channels satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii). The control rod position indicators monitor CRA position, which is an initial condition of the accident.

LCO

LCO 3.1.7 specifies that the RPIs ~~System~~ and the ~~Counter Position Indication System~~CPI be OPERABLE for each CRA. For the CRA position indicators to be OPERABLE requires meeting the SR of the LCO and the following:

a. The RPI ~~System~~ indicates within 6 steps of the CRA counter ~~demand~~ position indicator as required by LCO 3.1.4, "Rod Group Alignment Limits";

b. For the RPIs ~~System~~ there are no failed coils; and

c. The ~~Counter Position Indication System~~CPI has been calibrated either in the fully inserted position or to the RPI System.

The 6 step agreement limit between the ~~Rod Position Indication System~~RPIs and the CPI ~~system~~ indicates that the ~~Rod Position Indication System~~RPI is adequately calibrated and can be used for indication of the measurement of CRA position.

A deviation of less than the allowable limit given in LCO 3.1.4 in position indication for a single CRA ensures high confidence that the position uncertainty of the corresponding CRA group is within the assumed values used in the analysis (that specified CRA group insertion limits).

These requirements provide adequate assurance that CRA position indication during power operation and PHYSICS TESTS is accurate, and that design assumptions are not challenged.

OPERABILITY of the position indicator channels ensures that inoperable, misaligned, or mispositioned CRAs can be detected. Therefore, power peaking, ejected CRA worth, and SDM can be controlled within acceptable limits.

APPLICABILITY

The requirements on the RPI and step counters are only applicable in MODE 1 (consistent with LCOs 3.1.4, 3.1.5, and 3.1.6), because this is the only MODE in which power is generated, and the OPERABILITY and alignment of CRAs has the potential to affect the safety of the unit. In the shutdown MODES, the OPERABILITY of the shutdown and

BASES

ACTIONS (continued)

Verification of CRA position once per 8 hours is adequate for allowing continued full power operation for a limited, 24 hour period, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small. The 24 hour Completion Time provides sufficient time to troubleshoot and restore the ~~C~~RPI system to operation while avoiding the plant challenges associated with the shutdown without full CRA position indication.

Based on industry experience, normal power operation does not require excessive CRA movement. If one or more CRAs has been significantly moved, the Required Action of C.1 below is required.

C.1

The Required Action clarifies that when one or more CRAs with inoperable position indicators have been moved in excess of 6 steps in one direction since the position was last determined, the Required Actions of A.1 or B.1 are still appropriate but must be initiated promptly under Required Action C.1 to begin verifying that these CRAs are still properly positioned relative to their group positions.

D.1 and D.2

With one counter~~demand~~ position indicator per group inoperable, the CRA positions can be determined by the RPI System. Since normal full power operation does not require excessive movement of CRAs, verification by administrative means that the CRDS position indicators are OPERABLE and the most withdrawn CRA and the least withdrawn CRA are ≤ 6 steps apart within the allowed Completion Time of once every 8 hours is adequate

E.1

If a~~the~~ Required Action~~s~~ of Condition A, B, C, or D cannot be completed within the associated Completion Time, the unit must be brought to a MODE in which the LCO~~requirement~~ does not apply. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours. The allowed Completion Time is based on reaching the required MODE from full power conditions in an orderly manner.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.1.7.1

Verification that each~~the~~ RPI channel agrees within 6 steps the counter~~demand~~ position indication~~within 6 steps~~ provides assurance that the RPI channel is operating correctly.

This surveillance is performed prior to reactor criticality after coupling of one or more~~the~~ CRAs to the associated CRDM, as there is the potential for unnecessary unit transients if the SR were performed with the reactor critical~~at power~~.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 13.

2. FSAR Chapter 15, "Transient and Accident Analysis."

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-31

The applicant is requested to respond to the following items:

(i) Is a "demand position indicator" the same as a CPI? If so, the applicant is requested to only use "CPI." If not, the Bases needs to explain the distinction.

(II) Does each CRA in each group have its own CPI? Or do the four CRAs in each of the four groups use the same CPI; i.e., one CPI per group?

NuScale Response:

The term 'demand position indicator' has been replaced in the bases and LCO 3.1.7 with 'counter position indicator.'

The final design details of the control rod drive mechanisms and associated indicators has not been finalized beyond that described in FSAR 4.6 and TS LCO 3.1.7 bases. The group counter position indicator will mathematically determine the group of four CRA positions by maintaining a running tally of the position commands to the control rod assembly (CRA) group to insert or withdraw. The digital design of the NuScale plant may provide the flexibility to implement an individual CRA counter position indicating capability, however that level of detail has not been finalized.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.7 Rod Position Indication

BASES

BACKGROUND

According to GDC 13 (Ref. 1), instrumentation to monitor variables and systems over their operating ranges during normal operation, anticipated operational occurrences (AOOs), and accident conditions must be OPERABLE. LCO 3.1.7 is required to ensure OPERABILITY of the control rod position indicators to determine control rod positions and thereby ensure compliance with the control rod alignment and power-dependent insertion limits (PDIL).

The OPERABILITY, including position indication, of the shutdown and regulating group control rod assemblies (CRAs) is an initial assumption in the safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the CRA misalignment safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM). CRA position indication is required to assess OPERABILITY and misalignment.

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to aid compliance with the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

Sixteen CRAs are arranged in four symmetrical groups. Two shutdown groups of four CRAs each, and two regulating groups of four CRAs each.

CRAs are moved out of the core (up or withdrawn) or into the core (down or inserted) by their control rod drive mechanisms (CRDMs). The CRAs are divided among the regulating groups and shutdown groups.

BASES

BACKGROUND (continued)

The axial position of shutdown CRAs and regulating group CRAs are determined by two separate and independent ~~systems~~means: the Counter Position Indicators~~ion System~~ (CPIs) (commonly called group step counters) and the Rod Position Indicators~~ion~~ (RPIs)~~ System~~.

The ~~Counter Position Indication~~CPI counts the commands sent to the CRDM gripper coils from the Control Rod Drive System (CRDS) that moves the CRAs. There is one step counter for each CRDM. The CRA ~~Position Indication System~~RPI is considered highly precise (± 1 step or ± {3/8} inch). If a CRA does not move one step for each command signal, the step counter will still count the command and incorrectly reflect the position of the CRA.

The RPI function of the CRDS provides a highly accurate indication of actual CRA position, but at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube with a center to center distance of 1.125 inches, which is equivalent to 3 steps. To increase the reliability of the system, the inductive coils are alternately to two data systems. Thus, if one system fails, the RPI will go on half accuracy with an effective coil spacing of 2.25 inches, which is 6 steps. Therefore, the normal indication accuracy of the RPIs~~ System~~ is ± 3 steps (± 1.125 inches), and the accuracy with one channel of RPI out-of-service is ± 6 steps (± 2.25 inches).

APPLICABLE SAFETY ANALYSES

The regulating and shutdown groups CRA position accuracy is essential during power operation. Power peaking, ejected CRA worth, or SDM limits may be violated in the event of a Design Basis Accident (Ref. 2), with regulating or shutdown group CRAs operating outside their limits undetected. Therefore, the acceptance criteria for CRA position indication is that CRA positions must be known with sufficient accuracy in order to verify the core is operating within the group sequence, overlap, design peaking limits, ejected CRA worth, and within minimum SDM (LCO 3.1.5, “Shutdown Group Insertion Limits,” LCO 3.1.6, “Regulating group Insertion Limits”). The CRA positions must also be known in order to verify the alignment limits are preserved (LCO 3.1.4, “Rod Group Alignment Limits”). CRA positions are continuously monitored to provide operators with information that assures the unit is operating within the bounds of the accident analysis assumptions.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The CRA position indicator channels satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii). The control rod position indicators monitor CRA position, which is an initial condition of the accident.

LCO

LCO 3.1.7 specifies that the RPIs ~~System~~ and the ~~Counter Position Indication System~~CPI be OPERABLE for each CRA. For the CRA position indicators to be OPERABLE requires meeting the SR of the LCO and the following:

a. The RPI ~~System~~ indicates within 6 steps of the CRA counter ~~demand~~ position indicator as required by LCO 3.1.4, “Rod Group Alignment Limits”;

b. For the RPIs ~~System~~ there are no failed coils; and

c. The ~~Counter Position Indication System~~CPI has been calibrated either in the fully inserted position or to the RPI System.

The 6 step agreement limit between the ~~Rod Position Indication System~~RPIs and the CPI ~~system~~ indicates that the ~~Rod Position Indication System~~RPI is adequately calibrated and can be used for indication of the measurement of CRA position.

A deviation of less than the allowable limit given in LCO 3.1.4 in position indication for a single CRA ensures high confidence that the position uncertainty of the corresponding CRA group is within the assumed values used in the analysis (that specified CRA group insertion limits).

These requirements provide adequate assurance that CRA position indication during power operation and PHYSICS TESTS is accurate, and that design assumptions are not challenged.

OPERABILITY of the position indicator channels ensures that inoperable, misaligned, or mispositioned CRAs can be detected. Therefore, power peaking, ejected CRA worth, and SDM can be controlled within acceptable limits.

APPLICABILITY

The requirements on the RPI and step counters are only applicable in MODE 1 (consistent with LCOs 3.1.4, 3.1.5, and 3.1.6), because this is the only MODE in which power is generated, and the OPERABILITY and alignment of CRAs has the potential to affect the safety of the unit. In the shutdown MODES, the OPERABILITY of the shutdown and

BASES

ACTIONS (continued)

Verification of CRA position once per 8 hours is adequate for allowing continued full power operation for a limited, 24 hour period, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small. The 24 hour Completion Time provides sufficient time to troubleshoot and restore the ~~C~~RPI system to operation while avoiding the plant challenges associated with the shutdown without full CRA position indication.

Based on industry experience, normal power operation does not require excessive CRA movement. If one or more CRAs has been significantly moved, the Required Action of C.1 below is required.

C.1

The Required Action clarifies that when one or more CRAs with inoperable position indicators have been moved in excess of 6 steps in one direction since the position was last determined, the Required Actions of A.1 or B.1 are still appropriate but must be initiated promptly under Required Action C.1 to begin verifying that these CRAs are still properly positioned relative to their group positions.

D.1 and D.2

With one counter~~demand~~ position indicator per group inoperable, the CRA positions can be determined by the RPI System. Since normal full power operation does not require excessive movement of CRAs, verification by administrative means that the CRDS position indicators are OPERABLE and the most withdrawn CRA and the least withdrawn CRA are ≤ 6 steps apart within the allowed Completion Time of once every 8 hours is adequate

E.1

If a~~the~~ Required Action~~s~~ of Condition A, B, C, or D cannot be completed within the associated Completion Time, the unit must be brought to a MODE in which the LCO~~requirement~~ does not apply. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours. The allowed Completion Time is based on reaching the required MODE from full power conditions in an orderly manner.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.1.7.1

Verification that each~~the~~ RPI channel agrees within 6 steps the counter~~demand~~ position indication~~within 6 steps~~ provides assurance that the RPI channel is operating correctly.

This surveillance is performed prior to reactor criticality after coupling of one or more~~the~~ CRAs to the associated CRDM, as there is the potential for unnecessary unit transients if the SR were performed with the reactor critical~~at power~~.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 13.
2. FSAR Chapter 15, "Transient and Accident Analysis."

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-32

(iii) The phrasing of SR 3.1.7.1 is ambiguous. Consider the following suggested clarifications:

SR 3.1.7.1 For each CRA, verify ~~Verify~~ each RPI channel agrees within 6 steps of the group step counter demand position for the full indicated range of CRA travel. | Prior to reactor criticality after coupling ~~of one or more~~ each CRA to the associated CRDM for one or more CRAs

Also consider the following edit of the associated Bases (page B 3.1.7-5):

SR 3.1.7.1

Verification that the ~~Counter Position Indication~~ CPI (group step counter demand position) agrees with ~~the~~ each direct-reading RPI ~~and demand position~~ channel within 6 steps provides assurance that the RPI channel is operating correctly.

This surveillance is performed prior to reactor criticality after coupling of one or more CRAs to the associated CRDM, as there is the potential for unnecessary unit transients ~~if~~ were the ~~SR~~ Surveillance ~~were~~ performed with the reactor ~~at power~~ critical in MODE 1.

The applicant is requested to describe in the Bases how SR 3.1.7.1 is performed; in particular, are the two RPI channels on each CRA of a shutdown group or regulating group compared to the CPI group step counter demand position, at each step, (1) for each RPI channel for each CRA, (2) for each RPI channel for each group of four CRAs, (3) for both RPI channels for each CRA, or (4) for both RPI channels for each group of four CRAs? Also, can the surveillance be performed in MODE 3, as well as MODE 2?

The staff notes that Revision 2 of DCD Tier 2 page 4.3-56, Figure 4.3-18: Control Rod and Incore Instrument Locations, indicates that

Regulating Bank consists of

Group 1 Four CRAs – inner ring (**0**, 3π/6, **6π/6**, 9π/6) (**0°**, 90°, **180°**, 270°)

Group 2 Four CRAs – outer ring (**0**, 3π/6, **6π/6**, 9π/6) (**0°**, 90°, **180°**, 270°)

Shutdown Bank consists of

Group 3 Four CRAs – middle ring (**2π/6**, 5π/6, **8π/6**, 11π/6) (**60°**, 150°, **240°**, 330°)

Group 4 Four CRAs – middle ring (**π/6**, 4π/6, **7π/6**, 10π/6) (**30°**, 120°, **210°**, 300°)

The applicant is requested to describe in the Background section of Subsections B 3.1.4, B 3.1.5, B 3.1.6, and B 3.1.7 that there are two CRA shutdown groups of four CRAs each and two CRA regulating groups of four CRAs each. The applicant is also requested to describe in the Bases for SR 3.1.4.2 and in the Background section of Subsection B 3.1.7, how the CPI is maintained consistent with the RPI indicated position during performance of SR 3.1.4.2, the surveillance involving manual movement of each CRA by four steps individually.

NuScale Response:

SR 3.1.7.1 has been modified. The suggested clarifications were considered in the making the changes, however some were determined inappropriate or unnecessary. The changes also address the response to RAI 16-60-30 and 16-60-31. The bases for SR 3.1.7.1 were also clarified.

The details of operating procedures including surveillance tests, will be developed as described in FSAR Tier 2, chapter 13 and as required by COL item 13.5-2. The details of the control rod drive mechanism including position capabilities and operation have not been finalized beyond the level of detail provided in the FSAR. Procedures are required to be written consistent with

the design and licensing basis of the plant by 10 CFR 50.59 and as required by technical specification 5.4. These requirements will ensure that the performance of the SR is appropriate to demonstrate the OPERABILITY of the RPI channels.

Descriptive information has been added to the bases of LCO 3.1.4, 3.1.5, 3.1.6, and 3.1.7.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.7.1	Verify each RPI channel agrees within 6 steps of the group counter~~demand~~ position indication for the full indicated range of CRA travel.	Prior to criticality after coupling of one or more CRA to the associated CRDM

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.7 Rod Position Indication

BASES

BACKGROUND

According to GDC 13 (Ref. 1), instrumentation to monitor variables and systems over their operating ranges during normal operation, anticipated operational occurrences (AOOs), and accident conditions must be OPERABLE. LCO 3.1.7 is required to ensure OPERABILITY of the control rod position indicators to determine control rod positions and thereby ensure compliance with the control rod alignment and power-dependent insertion limits (PDIL).

The OPERABILITY, including position indication, of the shutdown and regulating group control rod assemblies (CRAs) is an initial assumption in the safety analyses that assume CRA insertion upon reactor trip. Maximum CRA misalignment is an initial assumption in the CRA misalignment safety analysis that directly affects core power distributions and assumptions of available shutdown margin (SDM). CRA position indication is required to assess OPERABILITY and misalignment.

Mechanical or electrical failures may cause a CRA to become inoperable or to become misaligned from its group. CRA inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available CRA worth for reactor shutdown. Therefore, CRA alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on CRA alignment and OPERABILITY have been established, and CRA positions are monitored and controlled during power operation to aid compliance with the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

Sixteen CRAs are arranged in four symmetrical groups. Two shutdown groups of four CRAs each, and two regulating groups of four CRAs each.

CRAs are moved out of the core (up or withdrawn) or into the core (down or inserted) by their control rod drive mechanisms (CRDMs). The CRAs are divided among the regulating groups and shutdown groups.

BASES

BACKGROUND (continued)

The axial position of shutdown CRAs and regulating group CRAs are determined by two separate and independent ~~systems~~means: the Counter Position Indicat<u>ors</u>~~ion System~~ (CPI<u>s</u>) (commonly called group step counters) and the Rod Position Indicat<u>ors</u>~~ion~~ (RPI<u>s</u>)~~ System~~.

The ~~Counter Position Indication~~<u>CPI</u> counts the commands sent to the CRDM gripper coils from the Control Rod Drive System (CRDS) that moves the CRAs. There is one step counter for each CRDM. The CRA ~~Position Indication System~~<u>RPI</u> is considered highly precise (± 1 step or ± {3/8} inch). If a CRA does not move one step for each command signal, the step counter will still count the command and incorrectly reflect the position of the CRA.

The RPI function of the CRDS provides a highly accurate indication of actual CRA position, but at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube with a center to center distance of 1.125 inches, which is equivalent to 3 steps. To increase the reliability of the system, the inductive coils are alternately to two data systems. Thus, if one system fails, the RPI will go on half accuracy with an effective coil spacing of 2.25 inches, which is 6 steps. Therefore, the normal indication accuracy of the RPI<u>s</u>~~ System~~ is ± 3 steps (± 1.125 inches), and the accuracy with one channel of RPI out-of-service is ± 6 steps (± 2.25 inches).

APPLICABLE SAFETY ANALYSES

The regulating and shutdown groups CRA position accuracy is essential during power operation. Power peaking, ejected CRA worth, or SDM limits may be violated in the event of a Design Basis Accident (Ref. 2), with regulating or shutdown group CRAs operating outside their limits undetected. Therefore, the acceptance criteria for CRA position indication is that CRA positions must be known with sufficient accuracy in order to verify the core is operating within the group sequence, overlap, design peaking limits, ejected CRA worth, and within minimum SDM (LCO 3.1.5, “Shutdown Group Insertion Limits,” LCO 3.1.6, “Regulating group Insertion Limits”). The CRA positions must also be known in order to verify the alignment limits are preserved (LCO 3.1.4, “Rod Group Alignment Limits”). CRA positions are continuously monitored to provide operators with information that assures the unit is operating within the bounds of the accident analysis assumptions.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The CRA position indicator channels satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii). The control rod position indicators monitor CRA position, which is an initial condition of the accident.

LCO

LCO 3.1.7 specifies that the RPIs ~~System~~ and the ~~Counter Position Indication System~~CPI be OPERABLE for each CRA. For the CRA position indicators to be OPERABLE requires meeting the SR of the LCO and the following:

a. The RPI ~~System~~ indicates within 6 steps of the CRA counter ~~demand~~ position indicator as required by LCO 3.1.4, "Rod Group Alignment Limits";

b. For the RPIs ~~System~~ there are no failed coils; and

c. The ~~Counter Position Indication System~~CPI has been calibrated either in the fully inserted position or to the RPI System.

The 6 step agreement limit between the ~~Rod Position Indication System~~RPIs and the CPI ~~system~~ indicates that the ~~Rod Position Indication System~~RPI is adequately calibrated and can be used for indication of the measurement of CRA position.

A deviation of less than the allowable limit given in LCO 3.1.4 in position indication for a single CRA ensures high confidence that the position uncertainty of the corresponding CRA group is within the assumed values used in the analysis (that specified CRA group insertion limits).

These requirements provide adequate assurance that CRA position indication during power operation and PHYSICS TESTS is accurate, and that design assumptions are not challenged.

OPERABILITY of the position indicator channels ensures that inoperable, misaligned, or mispositioned CRAs can be detected. Therefore, power peaking, ejected CRA worth, and SDM can be controlled within acceptable limits.

APPLICABILITY

The requirements on the RPI and step counters are only applicable in MODE 1 (consistent with LCOs 3.1.4, 3.1.5, and 3.1.6), because this is the only MODE in which power is generated, and the OPERABILITY and alignment of CRAs has the potential to affect the safety of the unit. In the shutdown MODES, the OPERABILITY of the shutdown and

BASES

ACTIONS (continued)

Verification of CRA position once per 8 hours is adequate for allowing continued full power operation for a limited, 24 hour period, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small. The 24 hour Completion Time provides sufficient time to troubleshoot and restore the ~~C~~RPI system to operation while avoiding the plant challenges associated with the shutdown without full CRA position indication.

Based on industry experience, normal power operation does not require excessive CRA movement. If one or more CRAs has been significantly moved, the Required Action of C.1 below is required.

C.1

The Required Action clarifies that when one or more CRAs with inoperable position indicators have been moved in excess of 6 steps in one direction since the position was last determined, the Required Actions of A.1 or B.1 are still appropriate but must be initiated promptly under Required Action C.1 to begin verifying that these CRAs are still properly positioned relative to their group positions.

D.1 and D.2

With one counter~~demand~~ position indicator per group inoperable, the CRA positions can be determined by the RPI System. Since normal full power operation does not require excessive movement of CRAs, verification by administrative means that the CRDS position indicators are OPERABLE and the most withdrawn CRA and the least withdrawn CRA are ≤ 6 steps apart within the allowed Completion Time of once every 8 hours is adequate

E.1

If a~~the~~ Required Action~~s~~ of Condition A, B, C, or D cannot be completed within the associated Completion Time, the unit must be brought to a MODE in which the LCO~~requirement~~ does not apply. To achieve this status, the unit must be brought to at least MODE 2 within 6 hours. The allowed Completion Time is based on reaching the required MODE from full power conditions in an orderly manner.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.1.7.1

Verification that each~~the~~ RPI channel agrees within 6 steps the counter~~demand~~ position indication~~within 6 steps~~ provides assurance that the RPI channel is operating correctly.

This surveillance is performed prior to reactor criticality after coupling of one or more~~the~~ CRAs to the associated CRDM, as there is the potential for unnecessary unit transients if the SR were performed with the reactor critical~~at power~~.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 13.
2. FSAR Chapter 15, "Transient and Accident Analysis."

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-33

30. In Revision 2 of DCA part 4, on GTS page 3.1.7-1, Required Action B.2 of Subsection 3.1.7 is the only place in the Specifications where the term "**incore detectors**" is used. SR 3.2.2.1 is the only place in the Specifications where the term "**OPERABLE in-core instrumentation channels** is used." The Bases refer to this neutron monitoring instrumentation as follows:

-- Page B 3.1.7-4, Subsection B 3.1.7, Actions section, first sentence under Action A.1:

When one RPI train per CRDM fails, the position of the CRA can still be determined by use of the **In-Core Instrumentation System (ICIS)**.

The applicant is requested to consider whether the phrase "RPI train" is appropriate since Subsection 3.1.7 does not use this phrase.

-- Page B 3.2.1-1, first sentence of fourth paragraph of the Background section of Subsection B 3.2.1:

$F\Delta H$ is not directly measurable but is inferred from a power distribution map obtained with the **fixed incore detector system**. Specifically, the measurements taken from the **fixed incore instrument system** are analyzed by a computer to determine $F\Delta H$.

-- Page B 3.2.1-2, first sentence of sixth paragraph of the Applicable Safety Analyses section of Subsection B 3.2.1:

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FΔH is measured periodically using the **fixed incore detector system**. Measurements are generally taken with the core at, or near, steady state conditions.

-- Page B 3.2.1-3, first sentence of the Surveillance Requirements section of Subsection B 3.2.1:

The value of FΔH is determined by using the **fixed incore detector system** to obtain a flux distribution map.

-- Page B 3.2.2-1, first and second sentences of third paragraph of the Background section of Subsection B 3.2.2:

The **in-core instrumentation system's neutron detectors** are arranged equally spaced radially and axially throughout the core. This **neutron detector** arrangement promotes an accurate indication for the **M**odule **C**ontrol **S**ystem to analyze core power distributions and will be used to monitor AO.

-- Page B 3.2.2-2, first sentence of the LCO section of Subsection B 3.2.2:

Information about the unit's AO is provided to the operator from the **incore instrumentation system (ICIS)**. (Ref. 2) Separate signals are taken from the four **detectors** on each of the 12 strings of **in-core instrumentation**. The AO is defined in Section 1.1.

The applicant is requested to revise the above sentences to use a more consistent terminology for the Incore Instrumentation System (ICIS) fixed neutron detectors; also describe in the Bases for Subsections B 3.1.7, B 3.2.1, and B 3.2.2, the number of neutron detector strings and the number of neutron detectors in each ICIS channel.

NuScale Response:

The term 'OPERABLE' in SR 3.2.2.1 has been removed from the SR and the bases discussions. The term 'channel' has been eliminated from the discussion of in-core neutron detector use in SR 3.2.2.1 because the in-core instruments are not arranged or operated in this manner.

The bases for LCO 3.1.7, LCO 3.2.1, and LCO 3.2.2 have been revised to use terminology consistent with the description provided in FSAR Tier 2, Section 7.0.4.7.

A discussion of the required in-core neutron detector functionality with respect to satisfying the surveillance requirement was added to the bases for SR 3.2.2.1.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.7 Rod Position Indication (RPI)

LCO 3.1.7 The Control Rod Drive System (CRDS) Rod Position Indicators~~ion~~ (RPIs) ~~System~~ and the Control Rod Assembly (CRA) Counter Position Indicators~~ion~~ (CPIs) ~~System~~ shall be OPERABLE.

APPLICABILITY: MODE 1.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each inoperable CRDS rod position indicator and each CRA counter position indicator.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One RPI per CRDM inoperable for one or more CRDMs.	A.1 Verify the position of the CRA with inoperable position indicators with the Module Control System (MCS).	Once per 8 hours
B. More than one RPI per CRDM inoperable.	B.1 Place the CRA under manual control.	Immediately
	<u>AND</u>	
	B.2 Verify the position of the CRA with inoperable CRDS position indicators indirectly by using the in-core neutron detectors.	Once per 8 hours
	<u>AND</u>	

3.2 POWER DISTRIBUTION LIMITS

3.2.2 AXIAL OFFSET (AO)

LCO 3.2.2 The AO shall be maintained within the limits specified in the COLR.

APPLICABILITY: MODE 1 with THERMAL POWER ≥ 25% RTP.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. AO not within limits.	A.1	Reduce THERMAL POWER to < 25% RTP.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.2.1	Verify AO within limits using ~~all OPERABLE~~ in-core instrumentation ~~channels~~neutron detectors.	In accordance with the Surveillance Frequency Control Program

BASES

APPLICABILITY (continued)

regulating ~~groups~~banks has the potential to affect the required SDM, but this effect can be compensated for by an increase in the boron concentration of the Reactor Coolant System (RCS).

ACTIONS

The ACTIONS table is modified by a Note indicating that a separate Condition entry is allowed for each inoperable ~~counter position indicator~~CPI and each RPI indicator. This is acceptable because the Required Actions for each Condition provide appropriate compensatory actions for each inoperable position indicator.

A.1

When one channel of RPI ~~train~~sensors per CRDM fails, the position of the CRA can still be determined by use of the ~~I~~in-~~C~~core ~~I~~instrumentation ~~S~~system~~ (ICIS)~~. Normal power operation does not require excessive movement of groups. If a group has been significantly moved, the Actions of B.1 or B.2 below are required. Therefore, verification of CRA position within the Completion Time of 8 hours is adequate to allow continued full power operation, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small.

B.1, B.2, and B.3

When more than one channel of RPI ~~train~~ sensors per CRA fails, additional actions are necessary to ensure that acceptable power distribution limits are maintained, minimum SDM is maintained, and the potential effects of CRA misalignment on associated accident analyses are limited. Placing the rod control function in manual mode ensures unplanned CRA motion will not occur. Together with the position determination available via the ~~ICIS~~in-core instrumentation system, this will minimize the potential for CRA misalignment. The immediate Completion Time for placing the Rod Control function in manual mode reflects the urgency with which unplanned rod motion must be prevented while in this Condition.

The position of the CRAs may be determined indirectly by use of the ~~ICIS.~~in-core instrumentation system neutron detectors. Plant procedures define the required number and locations of in-core neutron detectors that must function to permit evaluation of the CRA position.

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1 Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)

BASES

BACKGROUND

The purpose of this LCO is to establish limits on the power density at any point in the core so that the fuel design criteria are not exceeded and the accident analysis assumptions remain valid. Control of the core power distribution with respect to these limits ensures that local conditions in the fuel rods and coolant channels do not challenge core integrity at any location during either normal operation or a postulated accident analyzed in the safety analyses.

$F_{\Delta H}$ is defined as the ratio of the maximum integrated rod power within the core to the average rod power. Therefore, $F_{\Delta H}$ is a measure of the maximum total power produced in a fuel rod.

$F_{\Delta H}$ is sensitive to fuel loading patterns, regulating bank group insertion, and fuel burnup. $F_{\Delta H}$ typically increases with regulating bank group insertion and typically decreases with fuel burnup.

$F_{\Delta H}$ is not directly measurable but is inferred from a power distribution map obtained with the fixed in-core ~~detector system~~neutron detectors. Specifically, the measurements taken from the fixed in-core instrument system are analyzed by a computer to determine $F_{\Delta H}$. This value is calculated continuously with operator notification on unexpected results and validated by engineering in accordance with the surveillance frequency.

The COLR provides peaking limits that ensure that the safety analysis values for critical heat flux (CHF) are not exceeded for normal operation, operational transients, and any transient condition arising from analyzed events. The safety analysis precludes CHF and is met by limiting the minimum critical heat flux ratio (MCHFR) to that value defined in the COLR. All transient events are assumed to begin with an $F_{\Delta H}$ value that satisfies the LCO requirements.

Operation outside the LCO limits may produce unacceptable consequences if an event occurs. The CHF safety analysis ensures that there is no overheating of the fuel that results in possible cladding perforation with the release of fission products to the reactor coolant.

BASES

APPLICABLE SAFETY ANALYSES

Limits on $F_{\Delta H}$ preclude core power distributions that exceed fuel design limits.

There must be at least 95% probability at the 95% confidence level (the 95/95 CHF criterion) that the hottest fuel rod in the core does not experience a CHF condition.

The limits on $F_{\Delta H}$ ensure that the safety analysis values for CHF are not exceeded for normal operation, operational transients, and any transient condition arising from analyzed events. The safety analysis precludes CHF and is met by limiting the MCHFR to that value defined in the COLR. This value provides a high degree of assurance that the hottest fuel rod in the core does not experience a CHF condition.

The allowable $F_{\Delta H}$ limit increases with decreasing power level. This functionality in $F_{\Delta H}$ is included in the analyses that provide the Reactor Core Safety Limits (SLs) of SL 2.1.1. Therefore, any CHF events in which the calculation of the core limits is modeled implicitly use this variable value of $F_{\Delta H}$ in the analyses. Likewise, all transients that may be CHF limited are assumed to begin with an initial $F_{\Delta H}$ as a function of power level defined by the COLR limit equation.

The fuel is protected in part by Technical Specifications, which ensure that the initial conditions assumed in the safety and accident analyses remain valid.

$F_{\Delta H}$ is measured periodically using the fixed in-core ~~detector~~instrument system. Measurements are generally taken with the core at, or near, steady state conditions. Core monitoring and control under transient conditions are accomplished by operating the core within the limits of the LCOs on AO and ~~Group~~Bank Insertion Limits.

$F_{\Delta H}$ satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

$F_{\Delta H}$ shall be maintained within the limits of the relationship provided in the COLR.

The $F_{\Delta H}$ limit identifies the coolant flow channel with the maximum enthalpy rise. This channel has the least heat removal capability and thus the highest probability for a CHF condition.

The limiting value of $F_{\Delta H}$, described by the equation contained in the COLR, is the design radial peaking limit used in the safety analyses.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1

The value of $F_{\Delta H}$ is determined by using the fixed in-core ~~detector~~instrument system to obtain a flux distribution map. A data reduction computer program then calculates the maximum value of $F_{\Delta H}$ from the measured flux distributions. The in-core instrument design and procedures incorporate the methods and process for measuring $F_{\Delta H}$ using the available in-core instrumentation. The procedures include verification that adequate instrument indications are available to provide a representative value of $F_{\Delta H}$ consistent with the methodology used to establish the $F_{\Delta H}$ limits in the COLR. This assures that the $F_{\Delta H}$ is within limits of the LCO. After each refueling, $F_{\Delta H}$ must be determined in MODE 1 prior to exceeding 25% RTP. This requirement ensures that $F_{\Delta H}$ limits are met at the beginning of each fuel cycle and in accordance with the misload event analysis. (Ref. 1)

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

REFERENCES

1. FSAR, Chapter 15, “Transient and Accident Analysis.”

BASES

APPLICABLE SAFETY ANALYSES (continued)

important IE is the Uncontrolled Control Rod Assembly Withdrawal from Power. The most important accident is the Rod Ejection Accident.

The limits on the AO satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

Information about the unit's AO is provided to the operator from the in-core instrumentation system ~~(ICIS)~~. (Ref. 2) Separate signals are taken from the four neutron detectors on each of the 12 strings of in-core instrumentation. The AO is defined in Section 1.1.

The AO limits are provided in the COLR. Figure B 3.2.2-1 shows a typical AO limit.

APPLICABILITY

The AO requirements are applicable in MODE 1 ≥ 25% RTP when the combination of THERMAL POWER and core peaking factors are of primary importance in safety analysis.

The value of the AO does not affect the limiting accident consequences with THERMAL POWER < 25% RTP and for lower operating power MODES.

ACTIONS

A.1

AO is a controllable and measurable parameter. With AO not within LCO limits, action must be taken to place the unit in a MODE or condition in which the LCO requirements are not applicable. Reducing THERMAL POWER to < 25% RTP places the core in a condition for which the value of the AO is not important in the applicable safety analyses.

The associated Completion Time of 6 hours is reasonable, considering the probability of an accident occurring during the time period that would require AO to be within the LCO limits, and the time for reaching < 25% RTP from full power conditions in an orderly manner and without challenging plant systems.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.2.1

This Surveillance verifies that the AO, as indicated by the in-core instrumentation system~~ICIS~~, is within its specified limits.

The in-core instrument design and procedures incorporate the methods and process for verifying the AO is within limits using the available in-core instrumentation. The surveillance procedures include verification that adequate instrument indications are available to provide a representative value of the AO consistent with the methodology used to establish the AO limits in the COLR. This assures that the AO is within limits of the LCO.

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

REFERENCES

1. FSAR, Chapter 15, "Transient and Accident Analysis."
2. FSAR, Chapter 4, "Reactor."

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Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-34

In addition, the applicant is requested to revise the Bases to state (1) the minimum number of neutron detectors for a channel to be operable, and (2) the minimum number of operable neutron detectors and the minimum number of operable ICIS fixed neutron detector channels needed to produce an adequate core flux map.

NuScale Response:

The bases for LCO 3.1.7, LCO 3.2.1, and LCO 3.2.2 have been revised to describe the procedural requirements that will define the functional capability requirements of the in-core instrumentation system that are required to perform the described functions.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

APPLICABILITY (continued)

regulating ~~groups~~banks has the potential to affect the required SDM, but this effect can be compensated for by an increase in the boron concentration of the Reactor Coolant System (RCS).

ACTIONS

The ACTIONS table is modified by a Note indicating that a separate Condition entry is allowed for each inoperable ~~counter position indicator~~CPI and each RPI indicator. This is acceptable because the Required Actions for each Condition provide appropriate compensatory actions for each inoperable position indicator.

A.1

When one channel of RPI ~~train~~sensors per CRDM fails, the position of the CRA can still be determined by use of the ~~I~~in-~~C~~core ~~I~~instrumentation ~~S~~system ~~(ICIS)~~. Normal power operation does not require excessive movement of groups. If a group has been significantly moved, the Actions of B.1 or B.2 below are required. Therefore, verification of CRA position within the Completion Time of 8 hours is adequate to allow continued full power operation, since the probability of simultaneously having a CRA significantly out of position and an event sensitive to that CRA position is small.

B.1, B.2, and B.3

When more than one channel of RPI ~~train~~ sensors per CRA fails, additional actions are necessary to ensure that acceptable power distribution limits are maintained, minimum SDM is maintained, and the potential effects of CRA misalignment on associated accident analyses are limited. Placing the rod control function in manual mode ensures unplanned CRA motion will not occur. Together with the position determination available via the ~~ICIS~~in-core instrumentation system, this will minimize the potential for CRA misalignment. The immediate Completion Time for placing the Rod Control function in manual mode reflects the urgency with which unplanned rod motion must be prevented while in this Condition.

The position of the CRAs may be determined indirectly by use of the ~~ICIS.~~in-core instrumentation system neutron detectors. Plant procedures define the required number and locations of in-core neutron detectors that must function to permit evaluation of the CRA position.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1

The value of $F_{\Delta H}$ is determined by using the fixed in-core ~~detector~~instrument system to obtain a flux distribution map. A data reduction computer program then calculates the maximum value of $F_{\Delta H}$ from the measured flux distributions. The in-core instrument design and procedures incorporate the methods and process for measuring $F_{\Delta H}$ using the available in-core instrumentation. The procedures include verification that adequate instrument indications are available to provide a representative value of $F_{\Delta H}$ consistent with the methodology used to establish the $F_{\Delta H}$ limits in the COLR. This assures that the $F_{\Delta H}$ is within limits of the LCO. After each refueling, $F_{\Delta H}$ must be determined in MODE 1 prior to exceeding 25% RTP. This requirement ensures that $F_{\Delta H}$ limits are met at the beginning of each fuel cycle and in accordance with the misload event analysis. (Ref. 1)

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

REFERENCES

1. FSAR, Chapter 15, “Transient and Accident Analysis.”

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.2.1

This Surveillance verifies that the AO, as indicated by the in-core instrumentation system~~ICIS~~, is within its specified limits.

The in-core instrument design and procedures incorporate the methods and process for verifying the AO is within limits using the available in-core instrumentation. The surveillance procedures include verification that adequate instrument indications are available to provide a representative value of the AO consistent with the methodology used to establish the AO limits in the COLR. This assures that the AO is within limits of the LCO.

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

REFERENCES

1. FSAR, Chapter 15, "Transient and Accident Analysis."
2. FSAR, Chapter 4, "Reactor."

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-35

31. In Revision 2 of DCA part 4, on GTS page 3.1.9-1, the LCO statement of Subsection 3.1.9, regarding the maximum CVCS makeup pump demineralized water flow path flowrate, should state that the "flowrate ~~is~~ shall be within the limits specified in the COLR", which is appropriate for an LCO statement, and consistent with the other two LCO statements about CVCS DWSI valve operability and boric acid storage tank boron concentration limits.

In Revision 2 of DCA part 2, on page 15.4-23, FSAR Section 15.4.6.3.4, "Boron Mixing, Thermal Hydraulic, and Subchannel Analyses -- Input Parameters and Initial Conditions," states "A minimum makeup temperature of 40 degrees F is assumed for the analysis of boron dilution of the RCS during Modes 1 through 3." Since this temperature assumption is not explicitly surveilled or specified by LCO 3.1.9, the applicant is requested to include the rationale for omitting this makeup water minimum temperature limit from LCO 3.1.9 both in the Applicable Safety Analyses section of Subsection B 3.1.9, and in FSAR Section 15.4.6.3.4. That rationale should justify that there exists a reasonable expectation of ambient temperatures always exceeding 40 degrees F in the vicinity of the demineralized water storage tank, thereby precluding the injection of water with a temperature of < 40 degrees F into the RCS with the unit in Mode 1, 2, or 3.

NuScale Response:

The 3.1.9 LCO statement has been modified to include "shall be" in place of the existing "is."

The 40 ºF used in the boron dilution analysis was chosen because the density of water is approximately at a maximum at that temperature. This maximizes the mass of unborated water injected and the dilution. This simplifies and provides a common baseline for boron effects

analyses. Boron concentration limits are described and implemented in accordance with plant procedures so that the assumptions of the core operating limits report (COLR) are appropriately implemented. Consistent with industry practice, effects of temperature differences will be addressed by the implementing procedures required to implement the COLR and technical specification requirements.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.9 Boron Dilution Control

LCO 3.1.9 Two CVCS demineralized water isolation valves shall be OPERABLE.

AND

Boric Acid supply boron concentration shall be within the limits specified in the COLR.

AND

Maximum CVCS makeup pump demineralized water flow path flowrate shall be~~is~~ within the limits specified in the COLR.

APPLICABILITY: MODES 1, 2, and 3.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One CVCS demineralized water isolation valve inoperable.	A.1 Restore CVCS demineralized water isolation valves to OPERABLE status.	72 hours

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NRC Question No.: 16-60-40

36. A response is not required because this item is being referred to the NRO technical branch responsible for reviewing FSAR Section 10.3. In Revision 2 of DCA part 2, FSAR page 10.3-3, Section 10.3.2.1, states, "The MSS piping upstream of the secondary MSIVs is designed to not exceed its service limits during a design basis event. Administrative procedures preclude filling the SG and MSS piping water-solid during normal operation, as well as during DHRS operation." The staff requests that the applicant explain how these administrative procedures would be implemented to ensure this is done during DHRS operation that was automatically initiated, without operator action

---

NuScale Response:

Decay Heat Removal System (DHRS) actuation by the engineered safety features actuation system system is described in FSAR Tier 2, chapter 7 and FSAR Tier 2, section 5.4.3.

System operation is automatically initiated using equipment required to be OPERABLE in accordance with LCOs 3.5.2, 3.7.1 and 3.7.2. When an OPERABLE system is actuated, the 'working inventory', is the water in the DHR heat exchanger, steam and feedwater lines between the main steam and feedwater isolation lines at the time the initiation occurs.

As described in the FSAR, the operation of the DHRS requires it to be isolated from the main steam and feedwater lines and the DHRS actuation valves to open. The isolation of these lines and opening of the DHRS actuation valves occurs without operator action. No manual changes to the DHRS inventory are possible once the system actuates.

Plant procedures described in FSAR section 13.5, and developed as required by COL item 13.5-1 will govern operation of plant systems including the steam generator and main steam system during all plant operations, including response to DHRS actuation.

Procedures are written to implement the safety and licensing basis as required by the facility operating license, 10 CFR 50.59, and technical specification 5.4.1. The system design description and licensing basis provided in the FSAR will be addressed in the required procedures. This includes expectations related to DHRS inventory as described in FSAR section 10.3.2.1.

Impact on DCA:

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

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eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-42

37.2 In Revision 2 of DCA part 4, the various Required Actions to isolate the demineralized water source to the CVCS makeup pumps are phrased in a variety of ways; these Actions are LCO 3 1.9 Action B, LCO 3.3.1 Actions H and M, LCO 3.3.3 Action E, and LCO 3.3.4 Action E. The staff requests that the applicant consider phrasing these Required Actions more consistently, since they all intend to accomplish the same objective of precluding the CVCS system from injecting demineralized water and diluted boric acid from the boron addition system into the RCS.

NuScale Response:

LCO 3.3.1 Required Actions H.1 and M.4 have been modified to align consistently with the Required Actions of LCOs 3.1.9, 3.3.3, and 3.3.4. The bases discussion of the modified Required Actions were also modified to reflect these changes.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. As required by Required Action C.1 and referenced in Table 3.3.1-1.	D.1	Open reactor trip breakers.	6 hours
E. As required by Required Action C.1 and referenced in Table 3.3.1-1.	E.1	Reduce THERMAL POWER to below the N-2L interlock.	6 hours
F. As required by Required Action C.1 and referenced in Table 3.3.1-1.	F.1	--------------NOTE---------------- ~~CVCS f~~Flow path~~(s)~~ may be unisolated intermittently under administrative controls. ------------------------------------- Isolate the CVCS flow to the Reactor Coolant System (RCS).	6 hours
G. As required by Required Action C.1 and referenced in Table 3.3.1-1.	G.1	Open pressurizer heater breakers.	6 hours
H. As required by Required Action C.1 and referenced in Table 3.3.1-1.	H.1	~~Isolate demineralized water flow path to RCS.~~Isolate dilution source flow paths in the CVCS makeup line by use of at least one closed manual or one closed and de-activated automatic valve.	1 hour

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
M. (continued)	M.4 Isolate dilution source flow paths in the CVCS makeup line by use of at least one closed manual or one closed and de-activated automatic valve.~~Isolate demineralized water flow to the reactor coolant system.~~	96 hours
	AND	
	M.5 Open pressurizer heater breakers.	96 hours
N. As required by Required Action C.1 and referenced in Table 3.3.1-1.	N.1 Be in MODE 2.	6 hours
	AND	
	N.2.1 Be in MODE 3 with RCS temperature below the T-2 interlock.	48 hours
	OR	
	N.2.2 Be in MODE 3 with Containment Water Level above the L-1 interlock.	48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.1.1	Perform CHANNEL CHECK on each required channel listed in Table 3.3.1-1.	In accordance with the Surveillance Frequency Control Program

BASES

ACTIONS (continued)

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by isolating the CVCS flowpath to the RCS. The allowed Completion Time of 6 hours is reasonable, based on operating experience, for aligning the system in an orderly manner.

Required Action F.1 is modified by a Note that allows isolated ~~penetration~~ flow paths to be unisolated intermittently under administrative controls. These administrative controls consist of stationing a dedicated operator at the device controls, who is in continuous communication with the control room. In this way, the penetration can be rapidly isolated when a need for isolation is indicated. This allowance permits the isolation signal to be reset when appropriate conditions exist to do so.

G.1

Condition G is entered when Condition C applies to Functions that result in automatic removal of electrical power from the pressurizer heaters as listed in Table 3.3.1-1.

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by opening the power supply breakers to the pressurizer heaters. The allowed Completion Time for G.1 of 6 hours is reasonable, based on operating experience, for reaching the required conditions in an orderly manner.

H.1

Condition H is entered when Condition C applies to Functions that result in automatic isolation of the demineralized water system as listed in Table 3.3.1-1.

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by isolating the dilution source flow paths in the CVCS makeup line by use of at least one closed manual or one closed and de-activated automatic valve. ~~demineralized water~~

BASES

ACTIONS (continued)

~~flowpath to the RCS.~~ The allowed Completion Time for H.1 of 1 hour is reasonable, based on operating experience, for reaching the required condition in an orderly manner.

I.1 and I.2

Condition I is entered when Condition C applies to Functions that result in a DHRS or ECCS actuation, as listed in Table 3.3.1-1.

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by Required Actions I.1 and I.2.

I.1 places the unit in MODE 2 within 6 hours. This action limits the time the unit may continue to operate with a limited or inoperable automatic channel.

I.2 requires the unit to be in MODE 3 and PASSIVELY COOLED within 36 hours of entering the Condition. These conditions assure adequate passive decay heat transfer to the UHS and result in the unit being in a condition for which the LCO no longer applies.

Completion Times are established considering the likelihood of a LOCA event that would require ECCS or DHRS actuation. They also provide adequate time to permit evaluation of conditions and restoration of channel OPERABILITY without challenging plant systems during a shutdown.

J.1

As listed in Table 3.3.1-1, Condition J is entered when Condition C applies to Function 24.a, "High RCS Pressure - Low Temperature Overpressure Protection (LTOP)," which results in actuation of the LTOP system.

If a Required Action associated with Condition A or B cannot be completed within the required Completion Time, or three or more channels of this Function are inoperable, the unit must be brought to a MODE or other specified condition where the LCO and Required Actions for this Function do not apply. This is accomplished by opening at least two RVVs. The Completion Time of 1 hour is reasonable, based on operating experience, for establishing an RCS vent flow path sufficient to ensure low temperature overpressure protection.

BASES

ACTIONS (continued)

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by Required Actions M.1, M.2, M.3, M.4, and M.5.

M.1 places the unit in MODE 2 within 6 hours. This action limits the time the unit may continue to operate with a limited or inoperable automatic channel. M.2 requires the unit to be in MODE 3 and PASSIVELY COOLED within 36 hours of entering the Condition. These conditions assure adequate passive decay heat transfer to the UHS and result in the unit being in a condition for which the DHRS OPERABILITY is no longer required.

M.3 places the unit in MODE 3 with RCS temperature below the T-2 interlock within 36 hours of entering the condition. This condition assures the unit will maintain the RCS depressurized and the unit being in a condition for which the LCO no longer applies.

M.4 isolates the dilution source flow paths in the CVCS makeup line by use of at least one closed manual or one closed and de-activated automatic valve~~demineralized water flowpath to the RCS~~ within 36 hours. This completes the function of the DWSI.

M.5 opens the power supply breakers to the pressurizer heaters within 36 hours.

Completion Times are established considering the likelihood of a design basis event that would require automatic actuation during the period of inoperability. They also provide adequate time to permit evaluation of conditions and restoration of channel OPERABILITY without challenging plant systems during a shutdown.

N.1 and N.2

Condition N is entered when Condition C applies to Functions that result in the actuation of DHRS on Low Low Pressurizer Level as listed in Table 3.3.1-1.

If the Required Actions associated with this Condition cannot be completed within the required Completion Time, the unit must be brought to a MODE or other specified condition where the Required Actions do not apply. This is accomplished by Required Actions N.1 and N.2. N.1 places the unit in MODE 2 within 6 hours. This action limits the time the unit may continue to operate with a limited or inoperable DHRS automatic channel. N.2 places the unit in MODE 3 with RCS temperature

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

eRAI No.: 9634

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NRC Question No.: 16-60-43

37.3 Coordinate response to this sub-question with the response to similar Sub-question No. 7. In Revision 2 of DCA part 4, Required Action E.1 of LCO 3.3.1 states "Reduce THERMAL POWER" to below the N-2L interlock. | 6 hours"; this Action applies to the following MPS Functions which are applicable in Mode 1 with power above the N-2H interlock according to Footnote (b) of Table 3.3.1-1.

2.a RTS on High Power Range Positive and Negative Rate

18.a RTS on Low Main Steam Pressure

18.b DHRS on Low Main Steam Pressure

18.c PHT on Low Main Steam Pressure

The staff observes that to be consistent, Required Action E.1 ought to say N-2H instead of N-2L. However, since both interlocks use 15% RTP to switch from active to inactive, this error appears to have no practical impact on the meaning of the action statement. Nevertheless, the applicant is requested to make this correction

---

NuScale Response:

Module Protection System (MPS) interlocks and permissives, including the N-2L Permissive, N-2L Interlock, and N-2H Interlock are described in FSAR Tier 2, Table 7.1-5. Interlocks automatically establish an operating bypass when the interlock condition is met. Permissives

allow the manual bypass by the operator of the operating bypass. Operating bypasses are automatically removed when the associated interlock condition or permissive condition is no longer satisfied.

This information is also described in the APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY section of the bases for LCO 3.3.1. As described in the FSAR and the bases, the distinction between functions as used in the NuScale design is that a ‘permissive’ feature allows operator action to implement the bypass, while ‘interlock’ features automatically implement the bypass. Both permissive and interlock functions are automatically removed when the associated condition no longer exists.

The N-2 permissive and interlocks are distinguished by the appended ‘L’ or ‘H’ which indicates whether the condition is entered from below or above the setpoint. N-2L functions are active on increasing power. The N-2H function is active on decreasing power.

MPS function 3.3.1.1.a is described in the bases correctly as a permissive. The permissive may be initiated by the operator when power exceeds the N-2L setpoint from below. The automatic reset as power decreases below the permissive setpoint is consistent with the design and descriptions used for permissive functions.

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.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-46

40. In Revision 2 of DCA part 4, on GTS page B 3.4.9-2, the second paragraph of the Applicable Safety Analyses section of Subsection B 3.4.9, states in part:

> The analysis for design basis accidents and transients other than a SGTF assume the SG tubes retain their structural integrity (i.e., they are assumed not to fail.) In these analyses, the steam discharge to the atmosphere is based on the total primary to secondary LEAKAGE from all SGs *or is assumed to increase as a result of accident induced conditions*.

The phrase in italics appears to be incorrect given that NuScale's accident induced leakage doesn't account for a potential increase in operational leakage due to accident conditions. The applicant is requested to revise the statement to be consistent with the accident analyses for non-SGTF events.

NuScale Response:

The phrase "*or is assumed to increase as a result of accident induced conditions."* has been removed from the bases of LCO 3.4.9. No additional leakage is assumed.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

APPLICABLE SAFETY ANALYSES

The steam generator tube failure (SGTF) accident is the limiting design basis event for SG tubes and avoiding an SGTF is the basis for this Specification. The analysis of a SGTF event assumes a bounding primary to secondary LEAKAGE rate equal to the operational LEAKAGE rate limits in LCO 3.4.5, "RCS Operational LEAKAGE," plus the leakage rate associated with a double-ended failure of a single tube. The accident analysis for a SGTF assumes the contaminated secondary fluid is only briefly released to the atmosphere via safety valves and the majority is discharged to the main condenser.

The analysis for design basis accidents and transients other than a SGTF assume the SG tubes retain their structural integrity (i.e., they are assumed not to fail.) In these analyses, the steam discharge to the atmosphere is based on the total primary to secondary LEAKAGE from all SGs. ~~or is assumed to increase as a result of accident induced conditions.~~ For accidents that do not involve fuel damage, the primary coolant activity level of DOSE EQUIVALENT I-131 is assumed to be equal to the LCO 3.4.8, "RCS Specific Activity," limits. For accidents that assume fuel damage, the primary coolant activity is a function of the amount of activity released from the damaged fuel. The dose consequences of these events are within the limits of GDC 19 (Ref. 2), 10 CFR 50.34 (Ref. 3) or the NRC approved licensing basis (e.g., a small fraction of these limits).

Steam generator tube integrity satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The LCO requires that SG tube integrity be maintained. The LCO also requires that all SG tubes that satisfy the plugging criteria be plugged in accordance with the Steam Generator Program.

During an SG inspection, any inspected tube that satisfies the Steam Generator Program plugging criteria is removed from service by plugging. If a tube was determined to satisfy the plugging criteria but was not plugged, the tube may still have tube integrity.

In the context of this Specification, a SG tube is defined as the entire length of the tube, including the tube wall, between the tube-to-tubesheet weld at the tube inlet and the tube-to-tubesheet weld at the tube outlet. The tube-to-tubesheet weld is not considered part of the tube.

A SG tube has tube integrity when it satisfies the SG performance criteria. The SG performance criteria are defined in Specification 5.5.4, "Steam Generator Program," and describe acceptable SG tube performance. The Steam Generator Program also provides the evaluation process for determining conformance with the SG performance criteria.

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-61

54. In Revision 2 of DCA part 4, on Page B 3.1.8-6, References section: Be sure to update Reference 5. "NuScale Reload Safety Evaluation Methodology (later)."

NuScale Response:

Reference 5 of the bases for LCO 3.1.8, PHYSICS TESTS Exceptions was modified to use square brackets and the term '(later)' was removed. This is consistent with the industry practice and ensures that the appropriate actual document reference is updated in accordance with COL Item 16.1-1.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

SURVEILLANCE REQUIREMENTS (continued)

Using the ITC accounts for Doppler reactivity in this calculation because the reactor is subcritical or critical but below the point of adding heat, and the fuel temperature will be changing at the same rate as the RCS.

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

REFERENCES

1. 10 CFR 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.”
2. 10 CFR 50.59, “Changes, Tests and Experiments.”
3. Regulatory Guide 1.68, Revision 4, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” June 2013.
4. ANSI/ANS-19.6.1-2011, “Reload Startup Physics Tests for Pressurized Water Reactors,” American National Standards Institute, January 13, 2011.
5. [“NuScale Reload Safety Evaluation Methodology ~~(later)~~.”]
6. FSAR Chapter 14, “Initial Test Program and Inspections, Tests, Analyses, and Acceptance Criteria.”

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-62

55. In Revision 2 of DCA part 4, Subsection B 3.1.9: (i) on Page B 3.1.9-1, third paragraph of Background section, first sentence: The applicant is requested to clarify that there are four channels of MPS instrumentation Functions that send trip signals to Divisions 1 and 2 of ESFAS DWSI Logic and Actuation. Consider the following suggested revision:

There are two demineralized water isolation valves in series; one controlled by Division I of the MPS ESFAS DWSI Logic and Actuation, and one controlled by Division II of the MPS ESFAS DWSI Logic and Actuation. MPS instrumentation Functions, each with four measurement channels, that initiate DWSI actuation signals to each Logic and Actuation division are described in Subsection B 3.3.1, "Module Protection System (MPS) Instrumentation," and are specified in Table 3.3.1-1.

(ii) On Page B 3.1.9-2, fourth paragraph of ASA section: The applicant is requested to clearly state that "the maximum allowed CVCS dilution flow rate ranges from the maximum flow of one makeup pump at lower reactor power levels to the maximum flow of two makeup pumps at higher reactor power levels, as specified in the COLR."

(iii) On Page B 3.1.9-2, fifth paragraph of ASA section: The applicant is requested to revise the second sentence to address the limits on dilution flow rate, as indicated by the following suggestion: "The COLR limits on boron concentration in the boric acid supply and the CVCS makeup pump demineralized water flow path flow rate ~~satisfies~~ satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii)."

(iv) On Page B 3.1.9-3, third paragraph of Applicability section: Insert a space between the first and second sentences.

(v) On Page B 3.1.9-3, fourth paragraph of Applicability section: The applicant is requested to revise the first sentence for clarity, as indicated by the following suggestion: "In MODES 4 and 5, a dilution event is precluded because the CVCS RCS injection and discharge flow paths ~~is~~ are not connected to the ~~normal CVCS~~ RCS, thus eliminating the possibility of a boron dilution event in the RCS."

NuScale Response:

The first comment was incorporated into the Background section of the bases for LCO 3.1.9.

The second comment is not strictly accurate as the flow limit used in the analyses and established in the COLR can be greater than or equal to the maximum flow of one makeup pump. This permits conservative analysis while ensuring that the flow rate cannot be exceeded by a single pump in operation. The same is true of higher power levels where the analyses and COLR limit may be greater than or equal to the maximum flow of two makeup pumps. Additional analyses may permit adjustments to these limits if performed in accordance with the approved methodologies listed in TS 5.6.3. No change is planned for this comment.

The third, fourth, and fifth comments were incorporated as provided.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.9 Boron Dilution Control

BASES

BACKGROUND

One of the principle functions of the Chemical Volume and Control System (CVCS) is to maintain the reactor coolant chemistry conditions by controlling the concentration of boron in the coolant for unit startups, normal dilution to compensate for fuel depletion, and shutdown boration. In the dilute mode of operation, unborated demineralized water may be supplied directly to the Reactor Coolant System (RCS).

Although the CVCS is not considered a safety related system, certain isolations of the system are considered safety related functions. The appropriate components have been classified and designed as safety related. A CVCS safety related function is the termination of inadvertent boron dilution.

There are two demineralized water isolation valves in series; one controlled by Division I of the MPS ESFAS DWSI Logic and Actuation, and one controlled by Division II of the MPS ESFAS DWSI Logic and Actuation. MPS instrumentation Functions, each with four measurement channels, that initiate DWSI actuation signals to each Logic and Actuation division are described in Subsection B 3.3.1, "Module Protection System (MPS) Instrumentation," and are specified in Table 3.3.1-1.~~, and one controlled by Division II of the MPS.~~

The boric acid storage tank and boric acid batch tank contain the boric acid solution used to supply the CVCS to control the boron concentration of the reactor coolant system. The boron concentration of the boric acid supply is specified in the COLR so that it does not become an inadvertent source of uncontrolled dilution.

BASES

APPLICABLE SAFETY ANALYSES

One of the initial assumptions in the analysis of an inadvertent boron dilution event (Ref. 1) is the assumption that the increase in core reactivity, created by the dilution event, can be detected by the NMS instrumentation. The NMS will provide neutron flux and flux rate signals to the MPS, and the MPS instrumentation will then determine if actuation of the CVCS demineralized water isolation valves is necessary to terminate the boron dilution event. Thus the demineralized water isolation valves are components which function to mitigate an AOO.

The demineralized water isolation valves isolate on actuation signals initiated by the low RCS flow, High Subcritical Multiplication or reactor trip system (RTS). The low RCS Flow actuation signal is designed to ensure boron dilution cannot be performed at low RCS flowrates where the loop time is too long to be able to detect the reactivity change in the core within sufficient time to mitigate the event. The High Subcritical Multiplication actuation signal is designed to detect and mitigate inadvertent subcritical boron dilution events in MODES 2 and 3.

The RTS actuation initiates a signal to isolate the demineralized water isolation valves to support a reactor trip. The demineralized water isolation valves prevent the designed source of dilution water from contributing to events when these conditions exist. The analysis for an inadvertent boron dilution event assumes that the diluting flow is from the demineralized water source, however the boric acid storage tank and boric acid batch tank also supply flow to the CVCS. Controlling the boron concentration in these supplies ensures that they are not a source of dilution water. Thus the boric acid supply boron concentration is an assumption of the boron dilution accident.

Another initial assumption of the inadvertent boron dilution event (Ref. 1) is that the maximum CVCS dilution flow is limited at reduced power levels. The lowest maximum acceptable demineralized water flow rate is that provided by one CVCS makeup pump. And the maximum acceptable demineralized water flow rate varies with core design and boron concentration in the RCS. The initial safety analysis assumption limits maximum flow to that provided by a single makeup pump, however analyses may be performed consistent with approved methodologies listed in TS 5.6.3, "Core Operating Limits Report" to permit adjustments to the maximum demineralized water flow limit as a function of core design and boron concentration in the RCS.

CVCS demineralized water isolation valves satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii). The boron concentration in the boric acid supply and the CVCS makeup pump demineralized water flow path flowrate satisfy~~satisfies~~ Criterion 2 of 10 CFR 50.36(c)(2)(ii).

BASES

LCO

The requirement that two demineralized water isolation valves be OPERABLE assures that there will be redundant means available to terminate an inadvertent boron dilution event. The requirement that the boron concentration of the boric acid supply be maintained within the limits specified in the COLR ensures that the supply is not a source to the CVCS that could result in an inadvertent boron dilution event.

The limits on maximum CVCS makeup pump demineralized water flow path flowrate are established by restricting the flow that can be provided during system operation to within the limits in the COLR. The restrictions may be implemented by use of at least one closed manual or one closed and de-activated automatic valve, or by removing the power supply from one CVCS makeup pump.

APPLICABILITY

The requirement that two demineralized water isolation valves be OPERABLE, and that the boric acid storage tank boron concentration and maximum CVCS makeup pump demineralized water flow path flowrate is within the limits specified in the COLR is applicable in MODES 1, 2, and 3. In these MODES, a boron dilution event is considered possible, and the automatic closure of these valves is assumed in the safety analysis. The boron concentration of the boric acid sources are not assumed to be capable of causing a dilution event by the boron dilution event analysis. The maximum CVCS makeup pump demineralized water flow path flowrate is an assumption of the boron dilution event.

In MODE 1 < 15% RTP, the detection and mitigation of a boron dilution event would be signaled by a High Source or Intermediate Range Log Power Rate or a High Source Range Count Rate.

In MODE 1 ≥ 15% RTP, the detection and mitigation of a boron dilution event would be signaled by a High Power Range Rate or High Power Range Linear Power. In MODES 2 and 3, the detection and mitigation of a boron dilution event would be signaled by a Source Range High Count Rate trip, a trip on Source Range High Log Power Rate, or a trip on High Subcritical Multiplication, or low RCS flow.

In MODES 4 and 5, a dilution event is precluded because the CVCS RCS injection and discharge flow paths are~~is~~ not connected to the ~~normal CVCS~~RCS, thus eliminating the possibility of a boron dilution event in the RCS. Pool volume is sufficient to minimize the potential for boron dilution during MODE 5 within the surveillance intervals provided by LCO 3.5.3, Ultimate Heat Sink.

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

eRAI No.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-63

[55. (ii) second separate issue] …In addition, which Subsection 5.6.3 listed methodology is used to determine the maximum allowed CVCS demineralized water flow path flow rate as a function of core design, RCS boron concentration, and core thermal power?

NuScale Response:

The development of operating limits specified in the COLR is an iterative process using design information as described in the FSAR, operating experience and intentions, and application of the methodologies listed in TS 5.6.3. The development of the COLR requires balancing and optimizing the inputs to the methodologies while ensuring the plant continues to operate within the licensing basis as demonstrated by applying the methodologies. That process is sometimes referred to as a 'reload analysis methodology' or by similar terms. The process is not listed in TS 5.6.3 because it is not a separate methodology. Demonstration of the adequacy of the limits derived through experience, survey, or analyses of the chosen maximum allowed CVCS demineralized water flow path flow rate as a function of core design, RCS boron concentration, and core thermal power is described in TR-0516-49416, “Non-Loss-of-Coolant Accident Analysis Methodology,” Revision 0, May 2016 (NuScale Proprietary) as listed in TS 5.6.3.b.2. To reiterate, before operation the chosen limits defined in the COLR are shown to meet all applicable acceptance criteria in the plant safety analysis.

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.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-72

66. Based on Revision 2 of DCA part 4, Subsection 3.3.3. The applicant is requested to revise:

(i) Condition A as indicated:

A. ~~One or more divisions of the~~ LTOP ~~Logic and Actuation~~ actuation Function with one or both Logic and Actuation divisions inoperable.

(ii) Condition B statement so that "required" is not needed to modify the word "Function" as indicated:

B. One ~~division of required~~ or more actuation Functions, ~~function in Table 3.3.3-1 inoperable~~ other than the LTOP ~~function~~ actuation Function, with one ESFAS Logic and Actuation division inoperable.

(iii) Required Action B.1

B.1 Enter the Condition referenced in Table 3.3.3-1 for the affected Function~~(s)~~. | 6 hours

(iv) Actions table by using title case for the word "function"; i.e., "Function" in Required Action B.1 and Conditions C, D, E, F, G; and for "reactor coolant system" in Required Action E.1; i.e., "Reactor Coolant System" (to match Required Action F.1, *and Required Actions E.1*

and F.1 of Subsection 3.3.4).

(v) Condition G, second condition statement for consistency with the Function's title in Table 3.3.3-1 and Conditions C, D, E, and F, as indicated:

G. Both divisions of Pressurizer Heater Trip ~~de-energization~~ actuation Function ~~function~~ inoperable.

NuScale Response:

Technical Specification LCO 3.3.3 was modified to address the issues identified in this RAI. Conforming changes were made to the bases.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.3 INSTRUMENTATION

3.3.3 Engineered Safety Features Actuation System (ESFAS) Logic and Actuation

LCO 3.3.3 Engineered Safety Features Actuation System (ESFAS) Logic and Actuation divisions required for each Function in Table 3.3.3-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.3-1.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LTOP actuation Function with one or both Logic and Actuation divisions inoperable.~~One or more divisions of the LTOP Logic and Actuation Function inoperable.~~	A.1 Open two reactor vent valves (RVVs).	1 hour
B. One or more actuation Functions, other than the LTOP actuation Function, with one ESFAS Logic and Actuation division inoperable.~~One division of required ESFAS function in Table 3.3.3-1 inoperable other than LTOP function.~~	B.1 Enter the Condition Referenced in Table 3.3.3-1 for the affected ~~f~~Function~~(s)~~.	6 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
C. As required by Required Action B.1 and referenced in Table 3.3.3-1. OR Both divisions of ECCS actuation ~~f~~Function inoperable. OR Both divisions of DHRS actuation ~~f~~Function inoperable.	C.1 AND C.2	Be in MODE 2. Be in MODE 3 and PASSIVELY COOLED.	6 hours 36 hours
D. As required by Required Action B.1 and referenced in Table 3.3.3-1. OR Both divisions of Containment Isolation actuation ~~f~~Function inoperable.	D.1 AND D.2	Be in MODE 2. Be in MODE 3 with RCS temperature below the T-2 interlock.	6 hours 48 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. As required by Required Action B.1 and referenced in Table 3.3.3-1. OR Both divisions of Demineralized Water Supply Isolation actuation ~~f~~Function inoperable.	E.1	---------------NOTE--------------- Flow path~~(s)~~ may be unisolated intermittently under administrative controls. -------------------------------------- ~~Isolate the flow path from the demineralized water storage tank to the reactor coolant system~~Isolate dilution source flow paths in the CVCS makeup line by use of at least one closed manual or one closed and de-activated automatic valve.	1 hour
F. As required by Required Action B.1 and referenced in Table 3.3.3-1. OR Both divisions of CVCS Isolation actuation ~~f~~Function inoperable.	F.1	----------------NOTE-------------- Flow path~~(s)~~ may be unisolated intermittently under administrative controls. -------------------------------------- Isolate the~~CVCS charging and letdown~~ flow paths from the CVCS to the Reactor Coolant System by use of at least one closed manual or one closed and de-activated automatic valve.	1 hour

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. As required by Required Action B.1 and referenced in Table 3.3.3-1. OR Both divisions of Pressurizer Heater trip actuation~~de-energization~~ ~~f~~Function inoperable.	G.1 ----------------NOTE-------------- ~~Heater(s) may be energized~~Pressurizer heater breakers may be closed intermittently under ~~manual~~ administrative controls. ------------------------------------- Open pressurizer heater breakers.~~De-energize Pressurizer Heaters.~~	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.3.1	Perform ACTUATION LOGIC TEST.	In accordance with the Surveillance Frequency Control Program
SR 3.3.3.2	------------------------------NOTE------------------------------- Not required to be met for pressurizer heater breakers that are open or closed under ~~manual~~administrative control. --- Verify ~~required~~ pressurizer heater breaker response time is within limits.	In accordance with the Surveillance Frequency Control Program

BASES

ACTIONS

When the required ESFAS logic for the Actuation Functions listed in Table 3.3.3-1 are inoperable, the unit is outside the safety analysis, if applicable in the current MODE of operation. Required Actions must be initiated to limit the duration of operation or to place the unit in a MODE or other applicable condition in which the Condition no longer applies.

A Note has been added to the ACTIONS to clarify the application of the Completion Time rules. The Conditions of this Specification may be entered independently for each Actuation Function. The Completion Time for the inoperable ~~f~~Function will be tracked separately for each ~~f~~Function, starting from the time the Condition was entered for that Actuation Function.

A.1

Condition A applies if one or more divisions of the LTOP Logic and Actuation Function are inoperable. The Required Action is to open two reactor vent valves (RVVs) within one hour. This places the unit in a condition in which the LCO no longer applies. The one hour completion time provides adequate time to either immediately restore the inoperable logic or take manual action to open the RVVs, which establishes an RCS vent flow path sufficient to ensure low temperature overpressure protection.

B.1

Condition B applies if one division of an ESFAS actuation logic ~~f~~Function is inoperable. This Condition is not applicable to LTOP actuation logic.

The redundant signal paths and logic of the OPERABLE division provides sufficient capability to automatically actuate the required ESFAS function with a single division of logic OPERABLE.

If one division of ~~A~~actuation~~CTUATION~~ Function~~UNCTION~~ logic cannot be restored to OPERABILITY within six hours, then the Conditions listed in Table 3.3.3-1 must be entered to limit the duration of operation with an inoperable division and to place the unit in a MODE or other applicable condition in which the LCO no longer applies. The six hour limit provides a reasonable time during which the actuation system may be restored to OPERABILITY.

BASES

ACTIONS (continued)

C.1 and C.2

If Required Action B.1 directs entry into Condition C as specified in Table 3.3.3-1, or if both divisions of ECCS or DHRS are inoperable the unit is outside its design basis ability to automatically mitigate a postulated event.

With one division of actuation logic inoperable the redundant signal paths and logic of the OPERABLE division provide sufficient capability to automatically actuate the ECCS or DHRS if required.

C.1 requires the unit to be in MODE 2 within 6. This action limits the time the unit may continue to operate with limited or inoperable automatic actuation logic.

C.2 requires the unit to be in MODE 3 and PASSIVELY COOLED within 36 hours of entering the Condition. This condition assures adequate passive decay heat transfer to the UHS and result in the unit being in a condition for which the LCO no longer applies.

Completion Times are established considering the likelihood of a LOCA event that would require ECCS or DHRS actuation. They also provide adequate time to permit evaluation of conditions and restoration of actuation logic OPERABILITY without challenging plant systems during a shutdown.

D.1 and D.2

If Required Action B.1 directs entry into Condition D as specified in Table 3.3.3-1, or if both divisions of the containment isolation actuation ~~f~~Function are inoperable then the unit is outside its design basis ability to automatically mitigate some design basis events.

With one division of actuation logic inoperable, the redundant signal paths and logic of the OPERABLE division provide sufficient capability to automatically actuate the CIS if required.

D.1 requires the unit to be in MODE 2 within 6 hours of entering the Condition. This action limits the time the unit may continue to operate with limited or inoperable CIS automatic actuation logic.

D.2 requires the unit to be placed in MODE 3 with RCS temperature below the T-2 interlock within 48 hours of entering the Condition. This

BASES

ACTIONS (continued)

condition assures the unit will maintain the RCS depressurized, and the unit being in a condition for which the LCO no longer applies.

Completion Times are established considering the low probability of a design basis event that would require CIS actuation during the period of inoperability. They also provide adequate time to permit evaluation of conditions and restoration of actuation logic OPERABILITY without challenging plant systems during a shutdown.

E.1

If Required Action B.1 directs entry into Condition E as specified in Table 3.3.3-1, or if both divisions of demineralized water supply isolation actuation are inoperable then the unit is outside its design basis ability to automatically mitigate some design basis events.

With one division of actuation logic inoperable, the redundant signal paths and logic of the OPERABLE division provide sufficient capability to automatically actuate the DWSI if required.

In this condition the demineralized water supply flow path(s) to the RCS must be isolated within 1 hour to preclude an inadvertent boron dilution event.

Isolation can be accomplished by manually isolating the demineralized water isolation valve(s). Alternatively, the dilution path may be isolated by closing appropriate isolation valve(s) in the flow path(s) from the demineralized water storage tank to the RCS.

The Required Action is modified by a Note allowing the flow path(s) to be unisolated intermittently under administrative controls. These administrative controls consist of stationing a dedicated operator at the valve controls, who is in continuous communication with the main control room. In this way, the flow path can be isolated when a need for isolation is indicated.

F.1

If Required Action B.1 directs entry into Condition F as specified in Table 3.3.3-1, or if both divisions of the CVCS isolation actuation ~~f~~Function are inoperable then the unit is outside its design basis ability to automatically mitigate some design basis events.

BASES

ACTIONS (continued)

With one division of actuation logic inoperable, the redundant signal paths and logic of the OPERABLE division provide robust capability to automatically actuate the CVCSI if required.

F.1 requires the isolation of flow paths from the CVCS to the reactor coolant system within 1 hour of entering the Condition. The Action is modified by a Note that permits the flow path(s) to be unisolated intermittently under administrative controls. This Note limits the likelihood of an event by requiring additional administrative control of the CVCS flow paths. These administrative controls consist of stationing a dedicated operator at the valve controls, who is in continuous communication with the main control room. In this way, the flow path(s) can be isolated when a need for isolation is indicated. This permits the unit to continue to operate while in the Condition.

G.1

If Required Action B.1 directs entry into Condition G as specified in Table 3.3.3-1, or if both divisions of the pressurizer heater trip actuation ~~f~~Function are inoperable then the unit is outside its design basis ability to automatically mitigate some design basis events.

With one division of actuation logic inoperable, the redundant signal paths and logic of the OPERABLE division provide sufficient capability to automatically actuate the PHT if required.

G.1 requires de-energization of the pressurizer heaters within 6 hours of entering the Condition. This action limits the time the unit may continue to operate with limited or inoperable PHT automatic actuation logic. The Action is modified by a Note that permits the heaters to be energized intermittently under administrative controls. These administrative controls consist of stationing a dedicated operator at the breaker controls, who is in continuous communication with the main control room. In this way, the pressurizer heaters can be de-energized when a need for de-energization is indicated. This permits the unit to continue to operate while in the Condition.

The completion time was established considering the likelihood of a design basis event that would require automatic de-energization.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.3.1

An ACTUATION LOGIC TEST on each ESFAS division is performed to ensure the division will perform its intended function when needed. These tests verify that the ESFAS actuation ~~f~~Functions are capable of performing their intended function, from the SVMs through actuation of the ESF Components.

MPS testing from the input sensors to the SVMs is addressed by surveillance requirements specified in LCO 3.3.1, “Module Protection System (MPS) Instrumentation.” The ESFAS logic and actuation circuitry functional testing is accomplished with continuous system self-testing features on the SVMs and EIMs and the communication between them. The self-testing features are designed to perform complete functional testing of all circuits on the SVM and EIM, with the exception of the actuation and priority logic (APL) circuitry. The self-testing includes testing of the voting and interlock/permissive logic functions. The built-in self-testing will report a failure to the operator and place the SVM or EIM in a fail-safe state.

The only portion of the ESFAS logic and actuation circuitry that is not self-tested is the APL. The manual actuation switches, enable nonsafety control switches, main control room isolation switches, override switches, and operating bypass switches do not include self-testing features. The manual actuation switches are addressed by surveillance requirements specified in LCO 3.3.4, "Manual Actuation Functions."

The ACTUATION LOGIC TEST includes testing of the APL on all ESFAS EIMs, the enable nonsafety control switches, the main control room isolation switches, the override switches, and the operating bypass switches. The ACTUATION LOGIC TEST includes a review of any alarms or failures reported by the self-testing features.

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

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Power for all humankind

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

eRAI No.: 9634
Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-73

67. Based on Revision 2 of DCA part 4, Subsection 3.3.4: The applicant is requested to revise Required Actions A.1 and B.1, as indicated:

A.1 Enter the Condition referenced in Table 3.3.4-1 for the affected Function~~(s)~~. | 48 hours

B.1 Enter the Condition referenced in Table 3.3.4-1 for the affected Function~~(s)~~. | 6 hours

The "(s)" is not consistent with Example 1.3-5, and should be removed. The staff suggests using title case for "Function" in the context of a GTS Section 3.3 Function. The staff also suggests modifying "Function" to say "affected Function" for clarity.

NuScale Response:

Technical Specification LCO 3.3.4 was modified to address the issues identified in this RAI. Conforming changes were made to the bases.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

3.3 INSTRUMENTATION

3.3.4 Manual Actuation Functions

LCO 3.3.4 Each manual actuation division for each Function in Table 3.3.4-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.4-1.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Functions with one manual actuation division inoperable.	A.1 Enter the Condition referenced in Table 3.3.4-1 for the affected ~~f~~Function~~(s)~~.	48 hours
B. One or more Functions with two manual actuation divisions inoperable.	B.1 Enter the Condition referenced in Table 3.3.4-1 for the affected ~~f~~Function~~(s)~~.	6 hours
C. As required by Required Action A.1 or B.1 and referenced in Table 3.3.4-1.	C.1 Open reactor trip breakers.	Immediately
D. As required by Required Action A.1 or B.1 and referenced in Table 3.3.4-1.	D.1 Be in MODE 2. AND D.2 Be in MODE 3 and PASSIVELY COOLED.	24 hours 72 hours

B 3.3 INSTRUMENTATION

B 3.3.4 Manual Actuation Functions

BASES

BACKGROUND

The ~~m~~Manual ~~a~~Actuation ~~f~~Function portion of the module protection system (MPS) provides means to manually initiate the automatic actuations provided by the system to protect against violating the core fuel design limits, maintaining reactor coolant pressure boundary integrity, and not exceeding radiological dose limits during anticipated operational occurrences (AOOs) and postulated accidents. This LCO applies to components and functions from the manual actuation switches in the control room to the RTS and ESFAS Equipment Interface Modules (EIMs). EIM logic and actuated equipment OPERABILITY is addressed in LCO 3.3.2, “Reactor Trip System (RTS) Logic and Actuation” and LCO 3.3.3, “Engineered Safety Features Actuation System (ESFAS) Logic and Actuation,” as well as LCO applicable to individual actuated components and systems, e.g., LCO 3.5.1, “Emergency Core Cooling System (ECCS).”

Manual switches in the main control room allow the operator to initiate a reactor trip if necessary. The manual switches are connected to the RTS hardwired modules (HWM) of the MPS. The HWM converts the manual switch position to appropriate signals and routes them to the division RTS EIMs to cause a reactor trip (Ref. 1).

Manual switches in the main control room also include switches for each automatic ESF function at the division level. These manual switches are connected to the ESFAS HWM of the MPS. The HWM converts the manual switch position to appropriate signals and routes them to the division ESFAS EIMs to cause an actuation.

A description of the MPS Instrumentation that causes automatic initiation of MPS protective functions is provided in the Bases for LCO 3.3.1, “Module Protection System (MPS) Instrumentation.”

BASES

APPLICABLE SAFETY ANALYSES, LCOs, and APPLICABILITY

The MPS functions to maintain the SLs during all AOOs and mitigates the consequences of DBAs in MODES 1, 2, and 3.

The LCO requires each ~~m~~Manual ~~a~~Actuation ~~f~~Function division~~s~~ performing an RTS or ESFAS Function, listed in Table 3.3.4-1, to be OPERABLE.

The safety analyses, LCO OPERABILITY and applicability requirements of ~~m~~Manual ~~a~~Actuation ~~f~~Functions listed in Table 3.3.4-1 are discussed in the Bases for LCO 3.3.2, “Reactor Trip System (RTS) Logic and Actuation,” and LCO 3.3.3, “Engineered Safety Features Actuation System (ESFAS) Logic and Actuation.” While not specifically credited in the safety analyses, manual actuation of the ~~f~~Functions provides defense in depth to mitigate postulated events, and provides operators with the ability to address other events that may occur with the assistance of the automatic actuation portions of the MPS.

The ~~m~~Manual ~~a~~Actuation ~~f~~Functions satisfy~~ies~~ Criterion 4 of 10 CFR 50.36(c)(2)(ii).

ACTIONS

A Note has been added in the ACTIONS to clarify the application of Completion Time rules. Separate Condition entry is allowed for each Function listed in Table 3.3.4-1. The Completion Time(s) of the inoperable Function will be tracked separately for each Function starting from the time the Condition was entered for that Function.

A.1

Condition A applies if one or more Functions with one manual actuation division inoperable. Required Action A.1 requires the Condition associated with the inoperable ~~f~~Function~~(s)~~ listed in Table 3.3.4-1 to be corrected, or the Condition listed in Table 3.3.4-1 to be entered within 48 hours. In this condition, one division of manual actuation remains OPERABLE and the automatic MPS actuation capabilities remain available to perform the safety function consistent with the limits of LCO 3.3.1, 3.3.2, and 3.3.3.

The Completion Time of 48 hours is based on continued operation in conformance with the design basis for automatic actuation of protective functions, as well as an OPERABLE means of manually actuating the protective functions. The time also provides adequate opportunity to identify and implement corrective actions to restore a ~~m~~Manual ~~a~~Actuation ~~f~~Function without entering the Condition specified in Table 3.3.4-1.

BASES

ACTIONS (continued)

B.1

Condition B applies to the ~~m~~Manual ~~a~~Actuation ~~f~~Functions identified in Table 3.3.4-1. Condition B addresses the situation where one or more Functions have both manual actuation divisions inoperable. One manual actuation division consists of an actuation switch and the associated hardware (such as contacts and wiring) up to but not including the affected EIMs. EIM OPERABILITY is addressed in LCO 3.3.2 and LCO 3.3.3.

With both manual actuation divisions inoperable, the Condition listed in Table 3.3.4-1 must be entered in 6 hours. In this Condition, the automatic MPS actuations remain available to perform the design basis safety functions consistent with the limits of LCO 3.3.1, 3.3.2, and 3.3.3. The Completion Time of 6 hours provides adequate opportunity to identify and implement corrective actions to restore a ~~m~~Manual ~~a~~Actuation ~~f~~Function without entering the Condition specified in Table 3.3.4-1.

C.1

If Required Actions A.1 or B.1 direct entry into Condition C as specified in Table 3.3.4-1, then the reactor trip breakers must be opened immediately. Opening the reactor trip breakers satisfies the safety function of the system and places the unit in a MODE or specified conditions in which the LCO no longer applies.

The immediate completion time is consistent with the importance of the ability to initiate a manual reactor trip using the actuation ~~f~~Function.

D.1 and D.2

If Required Actions A.1 or B.1 direct entry into Condition D as specified in Table 3.3.4-1, then Condition D provides 24 hours to restore the manual actuation capability to OPERABLE status before the unit must be in MODE 2. Required Action D.2 requires the unit be in MODE 3 and PASSIVELY COOLED within 72 hours of entering the condition. The Completion Times provide opportunity for correction of the identified inoperability while maintaining the reactor coolant system closed, minimizing the transients and complexity of a return to operation when OPERABILITY is restored.

BASES

ACTIONS (continued)

The Completion Times are reasonable because the credited automatic actuation ~~f~~Function remains OPERABLE as specified in LCO 3.3.3, and alternative means of manually initiating the safety function remain available, e.g., manually initiating individual MPS division trip logic and component-level actuations.

E.1

If Required Actions A.1 or B.1 direct entry into Condition E as specified in Table 3.3.4-1, then Action E.1 requires the dilution source~~DWSI~~ flow paths to be isolated if the ~~m~~Manual ~~a~~Actuation ~~f~~Function is not restored within 1 hour. The Action includes a Note that permits the flow path to be opened intermittently under administrative controls. This permits operation of the unit while actions to restore the actuation ~~f~~Function are underway.

The Completion Times are reasonable because the credited automatic actuation function remains OPERABLE as specified in LCO 3.3.3, and alternative means of manually initiating the safety function remain available, e.g., manually initiating individual MPS division trip logic and component-level actuations.

F.1

If Required Actions A.1 or B.1 direct entry into Condition F as specified in Table 3.3.4-1, then Action F.1 requires the CVCS~~I~~ flow paths to be isolated if the ~~m~~Manual ~~a~~Actuation ~~f~~Function is not restored within 1 hour. The Action includes a Note that permits the flow path to be opened intermittently under administrative controls. This permits operation of the unit while actions to restore the actuation ~~f~~Function are underway.

The Completion Times are reasonable because the credited automatic actuation function remains OPERABLE as specified in LCO 3.3.3, and alternative means of manually initiating the safety function remain available, e.g., manually initiating individual MPS division trip logic and component-level actuations.

BASES

ACTIONS (continued)

G.1

If Required Actions A.1 or B.1 direct entry into Condition G as specified in Table 3.3.4-1, then Action G.1 requires the pressurizer heaters to be de-energized if the ~~m~~Manual ~~a~~Actuation ~~f~~Function is not restored within 24 hours. The Action includes a Note that permits the heaters to be energized intermittently under administrative controls. This permits operation of the unit while actions to restore the actuation ~~f~~Function are underway.

The Completion Times are reasonable because the credited automatic actuation function remains OPERABLE as specified in LCO 3.3.3, and alternative means of manually initiating the safety function remain available, e.g., manually initiating individual MPS division trip logic and component-level actuations.

H.1

If Required Actions A.1 or B.1 direct entry into Condition H as specified in Table 3.3.4-1, then Condition H requires two RVVs to be opened immediately which places the facility in a configuration in which an overpressure event in the reactor vessel is not possible. The Completion Time is reasonable given the need to ensure overpressure protection to the reactor vessel.

I.1 and I.2

If Required Actions A.1 or B.1 direct entry into Condition I as specified in Table 3.3.4-1, then the unit must be placed in MODE 2 within 6 hours and in MODE 3 with the RCS temperature below the T-2 interlock within 48 hours. Reducing the RCS temperature to below the T-2 interlock places the unit in a MODE or specified condition in which the LCO no longer applies.

The Completion Times are reasonable because the credited automatic actuation function remains OPERABLE as specified in LCO 3.3.3, and alternative means of manually initiating the safety function remain available, e.g., manually initiating individual MPS division trip logic and component-level actuations.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.4.1

SR 3.3.4.1 is the performance of an actuation device operational test of ~~m~~Manual ~~a~~Actuation ~~f~~Functions listed in Table 3.3.4-1. The test shall independently verify the OPERABILITY of the actuated devices that function as a result of the actuation ~~f~~Functions listed in Table 3.3.4-1. These tests verify that the ~~m~~Manually ~~a~~Actuated ~~f~~Functions are capable of performing their intended functions.

This surveillance addresses testing of the MPS from and including the manual actuation switches located in the control room to the hardwired modules and the input signals to the associated equipment interface modules for the actuation ~~f~~Function in test. The EIM functions are tested in accordance with LCO 3.3.2 and 3.3.3.

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

REFERENCES

1. FSAR, Chapter 7, "Instrumentation and Controls."

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

eRAI No.: 9634

Date of RAI Issue: 11/29/2018

NRC Question No.: 16-60-78

71. A response is not required because the applicant stated in an email dated November 12, 2018, to follow up the November 6, 2018, public meeting conference call, that it would address this purely editorial item in Revision 3 of DCA part 4. In Revision 2 of DCA part 4, on page B 3.1.5-3, in the next to last paragraph of the Background section of Subsection B 3.5.1, the first two sentences need editing for improved clarity. The applicant is requested to make the changes to the first sentence suggested by markup, or provide an equivalent change:

In MODE 4 the ECCS is not required ~~when~~ because the ECCS valves are open and de-energized, ~~or~~ and the unit is being PASSIVELY COOLED, which ~~ensuring~~ ensures decay heat removal is being accomplished.

The applicant is requested to clarify the second sentence to more clearly describe the pool water flow path during the unbolting and removal of the upper part of the containment, and movement of the RPV and lower containment to the reactor tool. The second sentence states:

Additionally, in MODE 4 during module relocation between the containment tool and the reactor tool, the de-energized and opened RRVs provide direct communication between the reactor pool water inside the containment and the RCS.

NuScale Response:

Changes to the Background section of the bases of LCO 3.5.1 were made to address the concerns that were identified.

During all refueling operations involving handling of the reactor core, the core and lower portions of the reactor vessel remain submerged. While unbolting and removing the upper part of the containment the containment volume is opened to the reactor pool. When the lower containment vessel is unbolted at the containment flange tool, the already flooded containment vessel internal volume is 'opened' to communicate with the reactor pool.

The upper containment vessel and entire reactor vessel are then moved to the refueling tool with the reactor vessel and containment open to the reactor pool.

With the containment open to the reactor pool in these conditions, the RRVs are in direct contact with the reactor pool. However heat transfer to the reactor pool in this condition is primarily by conduction through the reactor vessel, with additional cooling by limited convection through the open RRVs.

When the upper containment vessel and reactor vessel upper sections are unbolted at the reactor vessel flange and removed from the lower reactor vessel at the refueling tool, cooling transitions as the lower vessel is open to the reactor pool. Convective heat transfer directly to the reactor pool is the primary heat removal mechanism during these operations.

A description of the refueling evolution and equipment at the NuScale plant is provided in FSAR in section 9.1.

Impact on DCA:

The Technical Specifications have been been revised as described in the response above and as shown in the markup provided in this response.

BASES

BACKGROUND (continued)

Specification 3.3.1 describes the instrumentation and actuation logic for ECCS actuation. In applicable design basis accident scenarios, this actuation setpoint is sufficient to ensure the core remains cooled and covered.

In MODE 3 the RVVs provide Low Temperature Over-Pressure (LTOP) protection for the RCS as described in LCO 3.4.10.

In MODE 3 in PASSIVE COOLING, the ECCS is either performing its design function to support the transfer of decay heat from the reactor core to the containment vessel so the system or alternative means of removing decay heat have been established and the system is no longer required to be OPERABLE.

In MODE 4 the ECCS is not required ~~when~~because the ECCS valves are open and de-energized, and~~or~~ the unit is being ~~PASSIVELY COOLED~~passively cooled ~~ensuring~~which ensures decay heat removal is being accomplished. Additionally, in MODE 4 during module relocation between the containment tool and the reactor tool, the de-energized and opened RRVs are open between the UHS water inside the containment and the RCS. In MODE 5, core cooling is accomplished by conduction through the RPV wall to the ultimate heat sink until the upper containment and upper RPV are separated from the lower RPV and the reactor core.~~Additionally, in MODE 4 during module relocation between the containment tool and the reactor tool, the de energized and opened RRVs provide direct communication between the UHS water inside the containment and the RCS. During this period, and while in MODE 5, core cooling is accomplished by conduction through the reactor pressure vessel wall to the ultimate heat sink.~~ Once the RPV is separated at the flange during disassembly the lower RPV internals and reactor core are ~~RCS is~~ in direct contact with the ~~UHS~~reactor pool thereby ensuring adequate cooling by direct contact with the ultimate heat sink. Therefore the ECCS is not required to be OPERABLE in MODE 5.

The ECCS valves are OPERABLE when they are closed and capable of opening upon receipt of an actuation signal, or are open performing their intended function. FSAR Section 6.3 describes the ECCS design (Ref. 1).