NuScaleTRRaisPEm Resource

From: Tabatabai, Omid
Sent: Wednesday, June 22, 2016 5:51 PM
To: Tom Bergman
Cc: 'Steven'; 'Steven Pope'; 'spope@nuscalepower.com'; Steve Unikewicz; 'Steven'; NuScaleTRRaisPEm Resource; Tonacci, Mark; Guy Martin (gmartin@nuscalepower.com); 'Wike, Jennie'; Betancourt, Luis; Ashcraft, Joseph; Taneja, Dinesh; Curtis, David; Truong, Tung; Montague, Michael
Subject: Request for Additional Information Letter No. 3 -- Highly Integrated Protection System (HIPS) Platform Topical Report (CAC No. RQ6005)
Attachments: Final RAI 3 eRAI 8263 - NuScale HIPS TR RAIs.pdf

Tom,

Attached please find NRC staff's request for additional information concerning NuScale topical report entitled, "Highly Integrated Protection System (HIPS) Platform." Please submit your response by August 23, 2016, to the NRC Document Control Desk. If you have any questions, please feel free to contact me.

Thank you,

Omid Tabatabai
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From: Tabatabai, Omid

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June 22, 2016

Mr. Thomas Bergman
Vice President, Regulatory Affairs
NuScale Power, LLC
1100 NE Circle Boulevard, Suite 200
Corvallis, OR 97330

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 3 FOR THE REVIEW OF NUSCALE TOPICAL REPORT, TOPICAL REPORT (TR) 1015-18653, "HIGHLY INTEGRATED PROTECTION SYSTEM PLATFORM (HIPS)," REV 0. (TAC No. RN6110)

Dear Mr. Bergman:

In a December 23, 2015, letter, NuScale Power, LLC, submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Topical Report (TR) 1015-18653, "Highly Integrated Protection System Platform (HIPS)," Rev 0. (Agencywide Documents Access and Management System (ADAMS)) Accession No. ML15363A114. The NRC staff is performing a detailed review of this topical report to enable the staff to reach a conclusion on the safety of the proposed application. The NRC staff has identified that additional information is needed to continue portions of the review. The NRC staff's request for additional information (RAI) is contained in the enclosure to this letter.

To support the review schedule, NuScale is requested to respond within 60 calendar days of the date of this letter. If changes are needed to the topical report, the NRC staff requests that the RAI response include the proposed wording changes.

If you have any questions or comments concerning this matter, you may contact me at 301-415-6616.

Sincerely,

/RA/

Omid Tabatabai, Senior Project Manager
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. PROJ0769
eRAI Tracking No. 8623

Enclosure: Request for Additional Information

Request for Additional Information 3
Issue Date: 06/22/2016
Application Title: NuScale Topical Report
1015-18653, “Highly Integrated Protection System Platform (HIPS),” Rev 0.
Operating Company: NuScale
Docket No. PROJ0769
Review Section: Draft DSRS Section 07.01, “Fundamental Design Principles”

QUESTIONS

07.01. Draft DSRS-1:

Sections 4.2, “Safety Function Module,” and 4.3, “Communication Modules” of the Highly Integrated Protection System Platform (HIPS) topical report provide reference to Regulatory Guide (RG) 1.75, “Criteria for Independence of Electrical Systems.” However, the HIPS topical report does not specify the revision number of RG1.75 that will be used. The NRC staff requests NuScale to state and document what revision of RG1.75 it is referencing in the topical report. Update the topical report accordingly.

07.01. Draft DSRS-2:

10 CFR 50.55a(h)(3) requires compliance with IEEE Std 603-1991. IEEE Std 603-1991, Clause 5.6.1, states, in part, "Redundant portions of a safety system provided for a safety function shall be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function," and Clause 5.6.3, states, in part, "The safety system design shall be such that credible failures in and consequential actions by other systems, as documented in 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard." Digital Instrumentation and Control (I&C) Interim Staff Guidance (DI&C-ISG)-04 provides guidance for meeting the communications independence requirements of IEEE Std. 603-1991, Clause 5.6. When reviewing the HIPS topical report the staff noted four items listed below that require clarifications:

a) Section 4.2, “Safety Function Module” of the HIPS topical report states:

> A nonsafety-related input that is connected to the [safety function module] SFM input sub-module is galvanically isolated from the other inputs on that SFM and all of the other SFMs in the chassis by the channel isolator. The nonsafety-related inputs are for indication only and would only be sent to the monitoring and indication logic function for processing.

NuScale needs to demonstrate that any failure of nonsafety-related inputs does not have an adverse impact on the safety functions.

b) Section 7.1.2, “Independence,” Acceptance Criteria 1.B. of NuScale’s Draft Design Specific Review Standard (DSRS), states, in part, that isolation devices should be classified as part of the safety system and powered in accordance with IEEE Std 603-1991 and the guidelines contained in Regulatory Guide 1.75. The NRC staff requests NuScale to provide the classification of the isolators and whether the power for the isolator complies with IEEE Std 603-1991.

c) Section 2.5.4.3, “Actuation and Priority Logic” of the HIPS topical report describes the output modules of the HIPS platform. The NRC staff was not able to identify the preferred states of the output modules in the HIPS topical report. Describe in the topical report how the output module of the HIPS platform provides selectable preferred states for all postulated conditions.) Section 2.5.4.3, “Actuation and Priority Logic” of the HIPS topical report describes the output modules of the HIPS platform. The NRC staff was not able to identify the preferred states of the output modules in the HIPS topical report. The NRC staff requests NuScale to describe how the output module of the HIPS platform provides selectable preferred states for all postulated conditions. Update the topical report accordingly.

07.01. Draft DSRS-3:

10 CFR 50.55a(h)(3) requires compliance with IEEE Std 603-1991. Clause 5.6.3 of IEEE Std. 603-1991 requires safety system design to be such that credible failures in and consequential actions by other systems to not prevent the safety systems from meeting the requirements of this standard. This clause is enumerated by several sub-clauses, including Sub-clause 5.6.3.1, which requires:

1. equipment that is used for both safety and non-safety functions to be classified as part of the safety systems. Isolation devices used to effect a safety system boundary shall be classified as part of the safety system

2. any credible failure on the non-safety side of an isolation device shall not prevent any part of a safety system from meeting its minimum performance requirements during and following any design basis event requiring that safety function. A failure in an isolation device shall be evaluated in the same manner as a failure of other equipment in a safety system.

Section 4.5, “Hard-Wired Module” of the HIPS topical report describes that the Hard-Wired Module (HWM) can receive signals from an enable nonsafety switch and nonsafety-related discrete control signals. In addition, it states that the nonsafety-related signals are isolated from the field and traced on the backplane to those modules that use the signal. Per the

requirements of IEEE Std. 603-1991, Clause 5.6.3.1, the isolation device between safety and non-safety systems must be classified as safety-related.

The HIPS topical report does not provide a discussion of the purpose and function of these signals. The NRC staff requests NuScale to describe: (1) the safety classification of the HWM; (2) the functionality, safety classification, and the intended use of the enable nonsafety switch; (3) how would this feature apply to every safety component; and (4) how the enable nonsafety switch provides sufficient independence to serve as the isolation device between safety and non-safety systems. Update the topical report accordingly.

07.01. Draft DSRS-4:

The NRC Staff Requirements Memorandum for SECY 93-087, dated July 21, 1993, describes the NRC position on diversity and defense-in-depth (D3) requirements to compensate for common-cause software failures. An applicant is, therefore, required to assess the D3 of the proposed I&C system, and if a postulated common-cause failure (CCF) could disable a safety function, then a diverse means, with a documented basis that the diverse means is unlikely to be subject to the same common-mode failure, shall be required to perform either the same function or a different function. In Section 6.4, “HIPS Diversity Summary,” of the HIPS topical report states that "the diversity approach provides other benefits by simplifying the overall I&C systems design since a separate actuation system is not required to mitigate CCFs."

The HIPS topical report does not adequately describe how the built-in diversity eliminates consideration of software CCFs and the need of a separate actuation system. Determination of diversity and defense-in-depth to compensate software CCF is an application specific activity that requires an assessment of a full system design. The NRC staff requests NuScale to describe: (1) how the two different field programmable gate array (FPGA) technologies provide a defense against digital CCFs in the HIPS platform; and (2) how this diversity approach does not require a separate actuation system to mitigate digital CCFs. Update the topical report accordingly.

07.01. Draft DSRS-5:

The NRC Staff Requirements Memorandum (SRM) for SECY 93-087, dated July 21, 1993, describes the NRC position on D3 requirements to compensate for common-cause software failures. In Section 6.2, “Design Diversity” of the HIPS topical report states that "intentional differences are required in the following software tools used for the development of the FPGA: design synthesis, design analysis, physical design, design simulation, and physical programming. Additionally, the design simulation tools utilized by the independent verification and validation (iV&V) teams must be different than those used by the design teams; however, the same tool can be used by iV&V teams for both FPGA types."

In addition, Section 6.4, “HIPS Diversity Summary,” of the HIPS topical report further states that "the HIPS platform will meet requirements for having a design team and an independent verification and validation team; however, the HIPS platform will not require an additional

independent design or verification and validation team since it would provide minimal benefits in eliminating digital CCFs."

The HIPS topical report is not clear why the HIPS platform will not require an additional independent design or verification and validation team because “it would provide minimal benefits in eliminating digital CCFs.” The NRC staff requests NuScale to describe: (1) why the HIPS platform will not require an additional independent design or verification and validation team, and (2) why is acceptable the use of the same iV&V Design Simulation Tool for both FPGA types. Update the HIPS topical report accordingly.

07.01. Draft DSRS-6:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. Clause 5.7 of IEEE Std 603-1991, states that "Capability for testing and calibration of safety system equipment shall be provided while retaining the capability of the safety systems to accomplish their safety functions. The capability for testing and calibration of safety system equipment shall be provided during power operation and shall duplicate, as closely as practicable, performance of the safety system."

Section 8.2, “Testing” of the HIPS topical report describes the testing of the HIPS platform from the inputs to the outputs using self-testing in the individual modules and traditional surveillance testing. The HIPS topical report does not provide specific details on the modules built-in self-testing (BIST) capabilities. The NRC staff requests NuScale to provide specific details on the design capabilities of the self-testing features, and their intended use and how IEEE Std. 603-1991, Clauses 5.1 and 5.7 are met. Also, provide sufficient information to conclude that the periodic testing, including self-testing, meets the requirements stated above, specifically, address the following in the topical report:

a) Describe the self-testing features that are performed in the SFM and EIM.

b) Provide the safety classification of the BIST feature.

c) Discuss the surveillance periodic testing of the actuation and priority logic.

d) Describe which failures that have been identified through analysis but cannot be detected through equipment or diagnostics, and how those undetected failures are addressed.

e) Describe the influence that self-tests and other surveillance tests have on the safety function and describe any mechanisms that support the conclusions.

f) Discuss the coverage capabilities of the self-testing features. Are the self-testing features intended to detect all failures/faults, hardware or software, within the protection system including instrument channels?

g) Describe the provisions for the HIPS platform to provide calibration and testing execute features.

Update the HIPS topical report accordingly.

07.01. Draft DSRS-7:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. Clause 5.7 of IEEE Std. 603-1991, requires that the safety system shall have the capability for test and calibration while retaining the ability to accomplish its safety function, and that this capability be provided during power operation and shall duplicate as closely as practicable, performance of the safety function.

In Section 2.5.1.1, "Input Sub-Module" of the HIPS topical report only specifies different analog input types that the input sub-module can receive. Is the input sub-module capable of accepting other types of input? If so, provide sufficient information in the HIPS topical report to describe all different input types.

07.01. Draft DSRS-8:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. Clause 5.7 of IEEE Std 603-1991, requires that the safety system shall have the capability for test and calibration while retaining the ability to accomplish its safety function, and that this capability be provided during power operation and shall duplicate as closely as practicable, performance of the safety function.

Section 8.2, "Testing" of the HIPS topical report describes the testing of the HIPS platform from the inputs to the outputs using self-testing in the individual modules and traditional surveillance testing. The HIPS topical report does not provide any details on the automatic calibration tests for the input sub-modules to provide detection of operability and correction for drift. The staff requests NuScale to provide detailed information regarding the self-calibrate features of the HIPS platform and how it complies with Clause 5.7 of IEEE Std 603-1991.

07.01. Draft DSRS-9:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. IEEE Std. 603-1991, Clause 5.9, describes access control requirements for safety systems. The HIPS topical report is missing information regarding the provisions for secure development and operational environment (SDOE) of the HIPS Platform. The NRC staff requests NuScale to describe in the HIPS topical report how the HIPS platform conforms to the regulatory positions 2.1 through 2.5 of Regulatory Guide 1.152.

07.01. Draft DSRS-10:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. Clause 6.7 of IEEE Std. 603-1991, requires, in part, that capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During

such operation, the sense and command features shall continue to meet the requirements of Clauses 5.1 and 6.3.

The HIPS topical report states that the two-out-of-four coincidence logic for safety I&C systems would be changed to a two-out-of-three control logic if one channel is tripped. The topical report does not provide adequate design information on how the coincidence voting logic will be modified to meet the above regulatory requirements for both reactor trip and engineered safety features systems in the HIPS design when one channel is in a maintenance mode and at the same time another channel is tripped. Additionally, the HIPS topical report does not provide details on how the bypass mode will be set and reset for a channel. The staff requests NuScale to provide the following information:

a) Describe how the voting logic would be altered for all reactor trip and engineered safety features functions for cases of single failure, maintenance bypass, and both simultaneously.

b) Provide design information on where the maintenance bypass mode will be on trip and bypass for a channel.

c) Describe how bypassing a SFM will maintain the availability of individual functions in each safety channel?

d) Discuss how the maintenance bypass is maintained in the presence of a single failure.

e) Describe how the HIPS platform supports implementation of maintenance bypass in accordance with technical specifications.

07.01. Draft DSRS-11:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. Clause 6.7 of IEEE Std. 603-1991, requires, in part, that capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During such operation, the sense and command features shall continue to meet the requirements of Clauses 5.1 and 6.3.

The HIPS topical report states that the SFM is the only module that can be modified while installed in the chassis. This is limited to tunable parameters and setpoints that require periodic modification. The NRC staff requests NuScale to describe how many SFMs can be modified at a time. Update the HIPS topical report accordingly.

07.01. Draft DSRS-12:

10 CFR 50.55a(h) requires compliance with IEEE Std 603-1991. IEEE Std 603-1991 does not directly discuss digital systems, but states that guidance on the application of the criteria in IEEE Std 603-1991 for safety systems using digital programmable computers is provided in IEEE/ANS 7-4.3.2-1982. Guidance on applying the safety system criteria to computer-based safety systems is provided in Regulatory Guide 1.152, Revision 3, which endorses IEEE Std. 7-4.3.2-2003 (an updated version to the 1982 edition). Clause 5.5.1 of IEEE Std 7-4.3.2-2003 states the computer to be designed to perform its safety function when subjected to conditions, external or internal, that have significant potential for defeating the safety function. Clause 5.5.1 further states the ability to place the safety system in its preferred failure mode in the presence of a computer failure. Lastly, Clause 5.5.1 states the retention of the safety system's ability to perform its safety functions when a computer system restart operation occurs.

Section 2.5.1, "Safety Function Module" of the HIPS topical report describes the information that is contained in the non-volatile memory (NVM) (e.g., trip setpoints) and how the tunable parameters are modified during operation. However, the NRC staff was not able to find any discussion regarding the functionality of the NVM, and how the integrity of memory is maintained during all postulated conditions. The NRC staff requests NuScale to describe: (1) the functionality of the NVM, and (2) how the integrity of memory is maintained during all postulated conditions for the different types of FPGAs.

07.01. Draft DSRS-13:

10 CFR 50.55a(h) requires compliance with IEEE Std. 603-1991. IEEE Std. 603-1991 does not directly discuss digital systems, but states that guidance on the application of the criteria in IEEE Std 603-1991 for safety systems using digital programmable computers is provided in IEEE/ANS 7-4.3.2-1982. Guidance on applying the safety system criteria to computer-based safety systems is provided in Regulatory Guide 1.152, Revision 3, which endorses IEEE Std. 7-4.3.2-2003 (an updated version to the 1982 edition). Clause 5.5.3 of IEEE Std 7-4.3.2-2003 states, in part, that whenever self-diagnostics are applied, for the system design address: 1) self-diagnostics performed during system startup, 2) self-diagnostics performed periodically while the computer system is operating, and 3) failure reporting of the self-diagnostic results.

Section 8 of the HIPS topical report discusses the capabilities of fault detection and self-diagnostics for an overall system while the computer system is operating. However, the NRC staff was not able to find any discussion regarding the self-diagnostics performed during system startup. The NRC staff requests NuScale to describe: (1) the self-diagnostics performed during system startup, and (2) the self-diagnostic test failure reporting during system startup. Update the HIPS topical report accordingly.

07.01. Draft DSRS-14:

10 CFR 50.55a(h) requires compliance with IEEE Std. 603-1991. IEEE Std. 603-1991 states that guidance on the application of the criteria in IEEE Std 603-1991 for safety systems using digital programmable computers is provided in IEEE/ANS 7-4.3.2-1982. Guidance on applying

the safety system criteria to computer-based safety systems is provided in Regulatory Guide 1.152, Revision 3, which endorses IEEE Std. 7-4.3.2-2003 (an updated version to the 1982 edition). Clause 5.11 of IEEE Std. 7-4.3.2-2003, provides, in part, means to retrieve the firmware identification information from the software maintenance tools. The HIPS topical report does not provide adequate information to enable the staff to identify software maintenance tools that may be used to retrieve/confirm the configuration of the installed equipment (e.g. FPGA). The NRC staff requests NuScale to describe how the HIPS platform supports this function as described in IEEE Std. 7-4.3.2-2003, Clause 5.11.

07.01. Draft DSRS-15:

10 CFR 50.55a(h) requires compliance with IEEE Std. 603-1991. The scope of IEEE Std. 603-1991 includes all instrumentation & controls safety systems. Regulatory Guide 1.153, Revision 1, states, in part, “conformance with the requirements of IEEE Std. 603-1991 provides a method acceptable to the NRC staff for satisfying the Commission's regulations with respect to the design, reliability, qualification, and testability of the power, instrumentation, and control portions of the safety systems of nuclear power plants.”

Appendix A of the HIPS topical report claims either partial of full conformance to IEEE Std. 603-1991. However, it is not clear to the NRC staff how the HIPS design concepts conform to the Regulatory Guide 1.153, and the referenced standard, IEEE Std. 603-1991. The NRC staff requests NuScale to explain the basis for its claims, specifically, conformance to Regulatory Guide 1.153, and compliance to associated clauses in IEEE Std. 603-1991. Update the HIPS topical report accordingly.

07.01. Draft DSRS-16:

10 CFR 50.55a(h) requires compliance with IEEE Std. 603-1991. IEEE Std. 603-1991 states that guidance on the application of the criteria in IEEE Std 603-1991 for safety systems using digital programmable computers is provided in IEEE/ANS 7-4.3.2-1982. Guidance on applying the safety system criteria to computer based safety systems is provided by Regulatory Guide 1.152, Revision 3, which endorses IEEE Std. 7-4.3.2-2003 (an updated version to the 1982 edition). IEEE Std. 7-4.3.2-2003 specifies computer-specific criteria (incorporating hardware, software, firmware, and interfaces) to supplement the criteria in IEEE Std. 603-1998. Although IEEE Std. 7-4.3.2-2003 references IEEE Std. 603-1998, IEEE Std. 603-1991 and the correction sheet dated January 30, 1995 remains the requirement for safety systems in accordance with 10 CFR 50.55a(h).

Appendix B of the HIPS topical report claims either partial of full conformance to IEEE Std 7-4.3.2-2003. However, it is not clear to the NRC staff how the HIPS design concepts conform to the Regulatory Guide 1.152, and the endorsed standard, IEEE Std 7-4.3.2-2003. The NRC staff requests NuScale to explain the basis for its claims, specifically, conformance to Regulatory Guide 1.152, and associated clauses in the endorsed industry standard. Update the HIPS topical report accordingly.

07.01. Draft DSRS-17:

10 CFR 50.55a(h) requires compliance with IEEE Std. 603-1991. IEEE Std. 603-1991, Clause 5.6.1, states, in part, “Redundant portions of a safety system provided for a safety function shall be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function,” and Clause 5.6.3, states, in part, “The safety system design shall be such that credible failures in and consequential actions by other systems, as documented in 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard.” DI&C-ISG-04 provides guidance for meeting the communications independence requirements of IEEE Std. 603-1991, Clause 5.6.

Appendix C of the HIPS topical report claims either partial or full conformance to DI&C ISG-04. It is not clear to the NRC staff how the HIPS design concepts conform to the staff positions in DI&C ISG-04. The NRC staff requests NuScale to explain the basis for its claim, specifically, conformance to staff positions in DI&C ISG-04. Update the HIPS topical report accordingly.

07.01. Draft DSRS-18:

The NRC Staff Requirements Memorandum for SECY 93-087, dated July 21, 1993, describes the NRC position on D3 requirements to compensate for common-cause software failures. This requires an applicant to assess the diversity and defense-in-depth of the proposed I&C system, and if a postulated common-cause failure could disable a safety function, then a diverse means, with a documented basis that the diverse means is unlikely to be subject to the same common-mode failure, shall be required to perform either the same function or a different function.

Appendix D of the HIPS topical report claims either partial of full conformance to SRM for SECY-93-087. However, it is not clear to the NRC staff how the HIPS design concepts comply with SRM for SECY-93-087. The NRC staff requests NuScale to explain the basis for its claim, specifically, compliance to the staff position as stated in the SRM for SECY-93-087. Update the HIPS topical report accordingly.