From:	Patrick Boyle
Sent:	Wednesday, December 7, 2022 2:59 PM
To:	thomas.newton@nist.gov; Dimeo, Robert M. (Fed); Strader, Randolph (Fed); Dewey, Steven C. (Fed); Brand, Paul C. (Fed)
Cc:	Josh Borromeo; Cindy Montgomery; Steven Garry; On Yee; Zachary Gran
Subject:	Request for Additional Information Regarding NIST's Request to Operate with Debris in Primary Coolant
Attachments:	NIST Debris LAR RAIs.docx

Dear Dr. Newton,

By letter dated October 10, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22038A031), the National Institute of Standards and Technology (NIST), Center for Neutron Research (NCNR or licensee) submitted proposed changes to the Nation Bureau of Standards reactor (NBSR) Safety Analysis Report.

The U.S. Nuclear Regulatory Commission staff is reviewing your submittal and determined that additional information is required to complete the review.

A request for additional information (RAI) is attached. The draft RAI was sent to you ensure that it was understandable, the regulatory basis for the question was clear, and to determine whether the information was previously docketed.

Based on a discussion Dr. Newton, a response to the attached RAI is requested within 30 days from the date of this email.

The NRC staff considers that timely responses to RAIs help ensure sufficient time is available for staff review and contribute toward the NRC's goal of efficient and effective use of staff resources. If circumstances result in the need to revise the requested response date, please contact me at (301) 415-3936 or Patrick.Boyle@nrc.gov

Patrick Boyle
Project Manager
NRR/DANU/UNPL
U.S. Nuclear Regulatory Commission

Docket Number 50-184
License Number TR-5
EPID: L-2022-LLA-0152

Hearing Identifier: NRR_DRMA
Email Number: 1850

Mail Envelope Properties (SA1PR09MB8654E6F5C64413EE2E316239F01A9)

Subject: Request for Additional Information Regarding NIST's Request to Operate with Debris in Primary Coolant
Sent Date: 12/7/2022 2:58:43 PM
Received Date: 12/7/2022 2:58:00 PM
From: Patrick Boyle

Created By: Patrick.Boyle@nrc.gov

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Post Office: SA1PR09MB8654.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	1400	12/7/2022 2:58:00 PM
NIST Debris LAR RAIs.docx	31272	

Options
Priority: Normal
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:

OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ADDITIONAL INFORMATION

REGARDING AMENDMENT TO OPERATE WITH DEBRIS IN PRIMARY COOLANT SYSTEM

RENEWED FACILITY OPERATING LICENCE TR-5

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NATIONAL BUREAU OF STANDARDS REACTOR

DOCKET NUMBER 50-184

The U.S. Nuclear Regulatory Commission (NRC) staff is continuing its review of the National Institute of Standards and Technology (NIST, the licensee), Center for Neutron Research (NCNR), license amendment request (LAR), provided by letter dated October 19, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22293B808), to modify renewed Facility Operating License number TR-5, to permit reactor operations with some debris from the February 3, 2021, event remaining in the primary coolant system.

As part of the licensee's recovery effort from the February 3, 2021, fuel failure event, some debris was removed from the reactor primary coolant system; however, some debris remains. Accordingly, the licensee requested by letter dated October 19, 2022, a license amendment to make specified changes to the NBSR Safety Analysis Report and allow reactor operation with the remaining debris in the primary coolant system.

Two branches within the Office of Nuclear Reactor Regulation are reviewing the LAR and determined the following information is needed to continue with the review. These requests for additional information (RAIs) were developed based on the listed regulations applicable to the LAR.

Division of Risk Assessment Radiation Protection and Consequence Branch (ARCB)

ARCB RAI 1: Cleanup of RCS

Basis for question: 10 CFR 20.1101(b) requires use of engineering controls to achieve doses to ALARA.

10 CFR 20.1101(b) states the following:

(b) The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

Question 1. Cleanup of RCS

Section H of ECR No. 1251 states that some friable (mobile) particulate matter, sized 5 microns or less, may be present in the heavy water coolant/moderator.

a) Explain the U_3O_8 manufacturing process and as-manufactured fuel particle sizes.

b) Discuss and explain the melting point of aluminum vs uranium oxide. Discuss the likelihood of fuel (meat) melt (U_3O_8) during the event and the likely composition of the particulate matter generated during the event, e.g., aluminum cladding vs. U_3O_8 fuel meat.

c) Describe the impact of operating the reactor with friable uranium particles present considering the potential for the small uranium particles (fines) to fission when exposed to neutrons from the operating reactor.

d) Provide the current isotopic concentrations of radioactivity (soluble and insoluble) in the RCS coolant and in the D2O storage tank.

e) Explain the basis for reactor water filtration in the RCS cleanup system using the relatively large, 5-micron filter pore size, considering filters with a smaller pore size are available for use and have been effective at nuclear power plants in removing fission products from reactor coolant.

f) Describe the NIST the facilities available to handle and store of high activity waste once reactor operations have restarted and additional fission products are generated.

ARCB RAI 2: Occupational Dose

Basis for question: 10 CFR 20.1101(b) requires use of engineering controls to achieve occupational and public doses ALARA.

10 CFR 20.1101(b) states the following:

(b) The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

Question 2. Occupational dose:

The revised FSAR section, 11.1.1.4.3.1 states "The presence of any additional fission products generated from this material being lodged in the core during operations would have a negligible effect on personnel doses."

a) Describe the basis used to determine that occupational doses will be negligible during future operation.

b) Provide information on current radiological conditions in the process room and confinement building (radiation levels and contamination levels, including isotopic breakdown).

c) If there were fuel-related hot particles (e.g., Ce-144 and Pr-144), what effect would the higher energy beta particles have on occupational dose and on the conduct of the radiological protection program?

d) Given that reactor restart will potentially impact facility radiation levels and therefore worker dose, describe opportunities prior to restart to provide increased shielding to reduce general area dose rates on valves, crud traps, heat exchangers, etc.

ARCB RAI 3: Public Dose

Basis for question:

10 CFR 20.1101(d) states the following:

(d) To implement the ALARA requirements of § 20.1101 (b), and notwithstanding the requirements in §20.1301 of this part, a constraint on air emissions of radioactive material to the environment, excluding Radon222 and its daughters, shall be established by licensees other than those subject to § 50.34a, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1 mSv) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee shall report the exceedance as provided in § 20.2203 and promptly take appropriate corrective action to ensure against recurrence.

Stack Effluent Monitor Calibration

The stack effluent monitor is calibrated to Ar-41 and its efficiency factor (cpm/μCi/cc) is based on Ar-41. What is the correlation between the stack monitor's output (in unit of cpm based on Ar-41 calibration) to the monitor's output based on a fresh fission product mix of noble gases?

How will accident dose assessment be performed given the difference in the efficiency factors for Ar-41 vs. a fresh mix of noble gas radionuclides?

In the NIST document titled "Potential Release of Fission Products from the NCNR Reactor During Startup Operations," the summary states: "The 5000 cpm limit on the reactor stack count rate would result in only an insignificant dose to the public of 0.2 mrem/day dose to the public. Thus, this limit is very conservative and protective to both the public and the environment."

a) Explain how a 0.2 mrem/day dose to the public is very conservative in comparison to a 10 mrem/year annual ALARA dose constraint of 10 CFR 20.1101(d).

b) Provide a discussion of how facility operation would be modified if there are increased levels of effluents challenging the 10 mrem/year annual ALARA dose constraint of 10 CFR 20.1101(d).

c) Describe potential or anticipated corrective actions to ensure against recurrence if the 10 mrem/yr. ALARA constraint is challenged.

Division of New and Renewed Licenses - Vessels and Internals Branch (NVIB)

NVIB RAI 1: Degraded Pump Condition

Basis for question:

10 CFR 50.36(c)(2)(i) states in part:

Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility.

10 CFR 50.34(a)(1)(ii)((D) requires:
[The following power reactor design characteristics and proposed operation will be taken into consideration by the Commission:] The safety features that are to be engineered into the facility and those barriers that must be breached as a result of an accident before a release of radioactive material to the environment can occur. Special attention must be directed to plant design features intended to mitigate the radiological consequences of accidents. In performing this assessment, an applicant shall assume a fission product release from the core into the containment assuming that the facility is operated at the ultimate power level contemplated. The applicant shall perform an evaluation and analysis of the postulated fission product release, using the expected demonstrable containment leak rate and any fission product cleanup systems intended to mitigate the consequences of the accidents, together with applicable site characteristics, including site meteorology, to evaluate the offsite radiological consequences. Site characteristics must comply with part 100 of this chapter

Also, 50.34(a)(2) requires:
A description and analysis of the structures, systems, and components of the facility, with emphasis upon performance requirements, the bases, with technical justification therefore, upon which such requirements have been established, and the evaluations required to show that safety functions will be accomplished.

Background
As part of the licensee's recovery effort from the February 3, 2021, fuel failure event, some debris was removed from the reactor primary coolant system; however, some debris remains. Accordingly, the licensee requested by letter dated October 19, 2022, a license amendment to make specified changes to the NBSR Safety Analysis Report (SAR) and allow reactor operation with the remaining debris in the primary coolant system.

SAR Section 5.2.2.3.1 indicates that the four D2O Main Circulating Pumps are single-stage, shaft-sealed, centrifugal pumps operated in parallel to circulate the primary coolant from the Reactor Vessel to the Main Heat Exchangers, and that during normal operation, three pumps are run to maintain the necessary flow, with the fourth serving as an installed spare.

In its submittal, the licensee stated that "one primary pump suffers from an as-yet undiagnosed issue: the pump appears to be noisy" and indicated that it has contracted

for pump repair services to inspect the pump and replace and/or repair as appropriate. The licensee affirmed that this is not a safety issue.

Issue

The licensee did not provide a basis that the as-yet undiagnosed issue in one of the primary pumps is not attributed to the remaining debris in the reactor primary coolant system from the February 3, 2021, fuel failure event. Therefore, the licensee has not justified that the root cause for this undiagnosed issue in one of the primary pumps is not applicable to the remaining three D2O main circulating pumps or the other pumps in the primary coolant system (e.g., redundant shutdown pumps, storage tank pumps, and experimental cooling pumps).

Additionally, the licensee has not provided a basis to support its statement that the "as-yet undiagnosed issue in one of the primary pumps" is not a safety issue.

Question 1 – Primary Pump Condition

Provide a status update, including a root-cause, for the undiagnosed issue in one of the primary pumps that appears to be noisy, which is discussed in the submittal dated October 19, 2022.

a) Clarify whether this undiagnosed issue in one of the primary pumps that appears to be noisy was present prior to the February 3, 2021, fuel failure event.

b) Justify that this undiagnosed issue in one of the primary pumps is *not* attributed to the remaining debris in the reactor primary coolant system.

c) If the undiagnosed issue *is* attributed to the remaining debris, justify that the remaining three D2O main circulating pumps or the other pumps in the primary coolant system (e.g., redundant shutdown pumps, storage tank pumps, and experimental cooling pumps) will not also be eventually impacted.

d) Provide a basis to support the statement in the submittal dated October 19, 2022, that the undiagnosed issue in one of the primary pumps is not a safety issue.