Response to the Office of Inspector General's Special Inquiry into the U.S. Nuclear Regulatory Commission's Oversight of Research and Test Reactors

Executive Summary

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a review of the findings presented in the Office of the Inspector General's (OIG) Case No. I2100162 (Agencywide Documents Access and Management System Accession No. ML23272A039) "Special Inquiry into the U.S. Nuclear Regulatory Commission's Oversight of Research and Test Reactors." The OIG inquiry determined that the research and test reactor (RTR) oversight program failed to identify and address problems with the National Institute of Standards and Technology (NIST) test reactor and other RTRs as follows:

- the NRC failed to identify problems with fuel movement, including precursors to later events;
- the NRC's inspection practices often lacked direct observation of activities important to safety;
- RTRs other than the NIST reactor experienced significant fuel oversight issues; and, the agency's RTR program has not been substantively updated for at least two decades and does not reflect the agency's risk-informed and safety culture positions.

The NRC staff acknowledges the OIG's important role and its efforts to assess the NRC's oversight program for the nation's RTRs and the findings documented in their "Special Inquiry" report. Many of OIG's underlying observations were previously identified by the NRC staff as part of our self-assessment activities and program enhancements implemented since 2020, including improvements following the NIST fuel event. In the self-assessment (ML23345A225), the NRC staff did not identify any gaps in the existing inspection program for RTRs. However, the NRC staff made program improvements and identified additional opportunities to enhance the program and update guidance and training in the areas of reactive inspection decision-making process, level of detail in inspection reports, scheduling onsite inspections, and safety culture, which also correspond to the OIG's finding and observations. External and internal assessments of NRC programs offer valuable opportunities to gain insights and enhance the effectiveness and efficiency of our regulatory programs to continuously improve our actions to protect public health and safety.

RTRs are an important component of the Nation's nuclear infrastructure, advancing the state-of-the-art research and training for the next generation of nuclear operators and applications, and the NRC has ensured their safe operations for decades through implementation of regulatory licensing and oversight programs commensurate with their associated public health and safety risks. RTRs are inherently safe and pose limited risk to the public and the environment because of their relatively simple designs, low nuclear material inventory, small physical size, and very low power levels compared to nuclear power reactors. Some reactors are as small as 5 watts, which is equivalent to a light bulb, while the largest is 20 megawatts, each still approximately 88 times smaller than a typical large light water reactor, such as the Ginna Nuclear Power Plant, and 170 times smaller than the most recent light water reactor Vogtle, Unit 3. The general policy for regulation of RTRs is described in Section 104c of the Atomic Energy Act (AEA), which acknowledges this lower risk and important role by requiring the Commission to impose only such minimum amount of regulation as necessary to protect public health and safety and permit the conduct of widespread and diverse research and development. The NRC inspection program for RTRs reinforces this policy in that the program applies a graded approach to the frequency and scope of inspections commensurate with the

risk posed by the facility to ensure that reasonable assurance of adequate protection of people and the environment is maintained.

The NRC staff remains committed to effective licensing and oversight of the nation's RTRs and to protecting the safety of the public and the environment. The NRC staff's review of the OIG report highlighted opportunities to further enhance and improve the RTR inspection program and inspector training. The NRC staff's planned actions to enhance the RTR inspection program and procedures are listed in the conclusion section of this response. The NRC staff plans to implement all actions by October 31, 2024. As these actions are implemented and additional insights are gained through future inspection activities, the NRC staff will continue to assess whether additional enhancements are warranted.

NRC Staff Response to OIG Finding and its Subparts

Finding: NRC's inadequate RTR oversight led to a failure to identify and address problems with the NIST test reactor and other RTRs.

Subpart A: NRC Failed to Identify and Address NIST Event Precursors

NRC Response to Subpart A:

The NRC staff reviewed Subpart A of the report to consider OIG's conclusions in developing enhancements to the RTR oversight program. The conclusions are summarized as follows:

- The NRC failed to monitor and address NIST's implementation of its audit committee's recommendations.

- The NRC did not capture Safety Assessment Committee-identified concerns in its inspection reports.

- The NRC failed to identify and address partially latched fuel element issues at NIST on several occasions.

- The NRC failed to identify and address fuel movement procedure concerns at the NIST test reactor.

The oversight of RTRs is in accordance with guidance in NRC Inspection Manual Chapter (IMC) 2545, "Research and Test Reactor Inspection Program" which specifies that the NRC's inspection policies are guided by the AEA and, within this policy, is implemented under the premise that the licensee is responsible for facility safety and compliance with regulatory requirements, and the NRC inspection program is responsible to independently assess the licensee's fulfilment of those responsibilities. IMC 2545 further states that the enforcement of these requirements must keep in mind the AEA policy of "the minimum amount of regulation …to protect the health and safety of the public and will permit the conduct of widespread and diverse research and development." Consistent with this policy, IMC 2545 provides further guidance for inspectors that particular attention should be placed on assuring the licensee is not penalized for effectively identifying and correcting their own problems.

The NRC staff's internal self-assessment following the NIST event determined that the root causes of the event were subject to regulatory oversight under the existing inspection

program guidance and inspection procedures and therefore no gaps were identified in the current inspection program. However, the NRC staff acknowledges OIG's underlying observation that oversight of RTRs could be improved in certain areas and that these improvements would help inform oversight of new projects, such as medical isotope facilities and prospective RTRs based on advanced technology. The NRC staff ensures reasonable assurance of safe operation of these facilities through a combination of oversight (routine, supplemental, and reactive inspections) and their licensing basis, taking into consideration the low risk of these facilities. For most research reactors, the licensing basis hypothesizes a very unlikely severe accident to demonstrate that the maximum accidental radiological dose to the public will be less than 100 millirem (mrem). The NIST event was much less severe than considered during licensing and resulted in an acute radiological dose of less than 0.5 mrem, which is significantly lower than the regulatory annual public dose limit of 100 mrem in (Title 10 of the *Code of Federal Regulations* (10 CFR)) 20.1301, "Dose limits for individual members of the public," and is a fraction of the US annual average dose of 300 mrem from natural background sources. This demonstrates that the facility was designed and licensed with substantial safety margin to protect the public.

RTRs are required by technical specifications (TSs) to have an independent group, generally referred to as the safety and audit committee, to provide review and audit of the safety aspects of facility operations and provide recommendations to facility management. The safety committee charter specifies its roles and responsibilities to the licensee, organizational structure, and general reporting requirements. The safety committee issues written reports that may include findings or recommendations to the licensee's senior management. While issues identified by these groups are reviewed by inspectors, they are not typically documented in inspection reports unless the inspector has an actual or potential safety concern. IMC 0615, "Research and Test Reactor Inspection Reports" does not specify documenting findings or recommendations provided by the safety committee in the inspection report. The facility management is responsible for evaluating and dispositioning any recommendations from the licensee's safety committee. However, the inspectors can and do communicate any observations or insights that do not reach the threshold for describing in the inspection report to the licensee during the inspection exit meeting. In response to the OIG's recommendation, the NRC staff plans to update guidance in inspection procedures for the review of safety committee audits and reviews to include guidance for inspectors on assessing the licensee's implementation of the safety and audit committee's recommendations to confirm appropriate follow-up.

NRC licensees are responsible for the safety and security of their facilities, and compliance with regulatory requirements. The NRC uses a graded approach to the inspection program for RTRs by applying frequency and scope of inspections commensurate with the risk posed by the facility to ensure that reasonable assurance of adequate protection of people and the environment is maintained. Consistent with NRC's inspection policies and guidance, the inspector implements a sampling process when conducting inspections that focuses on reviewing risk-significant activities. These inspections are intended to verify licensee performance and compliance with requirements.

NRC Staff Actions

To address OIG's Subpart A conclusions and given that the current inspection guidance already contains provisions to directly observe risk significant activities, the NRC staff is placing a greater emphasis through additional communication with inspectors and orientation of new inspectors on coordination of inspection scheduling with licensees to increase the opportunities

to conduct inspections during reactor operations, fuel movements, and other significant activities. The NRC staff is reemphasizing the direct observation of risk significant activities when establishing inspection schedules. The NRC staff also requested the assistance of the RTR facilities to keep the inspection staff informed of these risk significant activities. Current RTR inspection guidance and policies provide sufficient flexibility to support adding inspection resources on specific inspections as needed to ensure the observation of risk significant activities, such as refueling. Additionally, the NRC staff will update inspection procedure guidance on assessing the licensee's implementation of the safety and audit committee's recommendations.

Subpart B: NRC's Inspection Practices Often Lacked Direct Observation of Activities Important to Safety

NRC Response to Subpart B:

The NRC staff reviewed Subpart B of the report to consider OIG's conclusions in developing enhancements to the RTR oversight program. The conclusions are summarized as follows:

- The NRC performed limited direct observations of fuel movements and other licensee activities important to safety.

- The NRC did not directly observe fuel element latch verifications in the five years prior to the event.

The OIG's inquiry notes that the NRC staff's scheduling of safety inspections was more focused on meeting the required inspection frequency outlined in IMC 2545 instead of focusing on the more risk significant activities occurring at the facility. The NRC staff evaluated the inspection program and determined that it contains sufficient flexibility to optimize the use of inspection resources and conduct inspections commensurate with the safety significance of the RTR. Moreover, the NRC staff schedules inspections considering several factors in addition to the required inspection frequency. This includes the need to conduct pre-inspection planning and post inspection documentation and enforcement activities, the research and development activities occurring at the RTRs, the RTR resources available to support inspection activities, and the inspectors' schedules. Although the NRC staff places a focus on NRC's on-site presence along with implementing the inspection frequency, unlike power reactors, the operational activities at RTRs are less predictable and driven by academic research and other services performed by the facility and involves frequent changes to its operational plans. These factors make inspection scheduling at RTRs during specific activities challenging.

The guidance in IMC 2545 identifies that the performance-based approach to inspection emphasizes observing activities and the results of licensee programs over reviewing procedures and records. However, the NRC staff acknowledges that inspections would benefit from better coordination with operational activities to overcome the inherent challenges in coordinating on-site inspector presence with actual operational activities that are often rescheduled to accommodate facility fact of life changes. The NRC staff's internal self-assessment of the NRC's RTR oversight program also identified the need to reemphasize existing internal processes and procedures for conducting inspections at RTRs including emphasis on observing operational activities. This improvement was presented to the Commission during the Agency Action Review Meeting briefing in June 2023.

NRC Staff Actions

Similar to Subpart A, to address OIG's conclusions for Subpart B and given that the current inspection guidance already contains provisions to directly observe risk significant activities, the NRC staff is placing a greater emphasis on coordination of inspection scheduling with licensees to increase the opportunities to conduct inspections during reactor operations, fuel movements, and other significant activities. The NRC staff is reemphasizing the direct observation of risk significant activities when establishing inspection schedules. The NRC staff is also requesting the assistance of the RTR facilities to keep the NRC inspection staff informed of these risk significant activities. Current RTR inspection guidance and policies provide sufficient flexibility to support additional inspection resources on specific inspections as needed to ensure the observation of risk significant activities, such as refueling.

Subpart C: NRC's Inadequate Oversight Extends to Other RTRs

NRC Response to Subpart C:

The NRC staff reviewed Subpart C of the report to consider OIG's conclusions in developing enhancements to the RTR oversight program. The conclusions are summarized as follows:

- The NRC did not directly observe fuel movement at Aerotest.

- The NRC did not take timely action on damaged fuel at Aerotest. Specifically, the NRC acknowledged the presence of precursors to fuel damage during inspections conducted in 2005, 2007, and 2009.

- Aerotest staff made several changes to the facility between 2000 and 2010 without required documentation or revisions to the license or TSs. These changes included:

  - Use of TRIGA (Training, Research, Isotopes, General Atomics) fuel with different weight percentage and cladding type; and,
  - Operation with mixed core of fuel elements with different characteristics.

- The NRC may have failed to identify the exceedance of an occupational dose limit and the Aerotest facility's departure from an as low as is reasonably achievable (ALARA) culture.

- The NRC failed to identify that Aerotest had TSs that were inadequate under 10 CFR 50.36, "Technical specifications."

- The NRC had failed to take action on relevant license amendment requests (LARs) the University of Texas (UT) submitted between 2008 and 2012.

- The NRC was not onsite for UT fuel movements related to the aluminum-cladded elements and missed an opportunity to identify conditions relevant to the licensee's noncompliance.

- The NRC failed to act on licensee amendment requests from UT to update fuel-related TSs for aluminum-cladded fuel.

The NRC staff evaluated each concern for both Aerotest and UT to identify possible additional enhancements to its oversight of RTRs where appropriate. A summary of the review is provided below.

Aerotest Radiography and Research Reactor (Aerotest)

Evaluation of Actions Taken on Damaged Fuel

The TS for TRIGA reactors has specific criteria for identifying fuel elements as damaged. While swelling in a TRIGA fuel element does not necessarily define the element as damaged fuel, the NRC staff acknowledges that swelling is an early precursor to potential fuel failure. In relation to the 2012 fuel elements cracking event, even though the cause of the cracking of the fuel elements was undetermined by the licensee, the NRC staff monitored the situation and noted that there was no radiological release to workers or the public as a result of the cracked fuel elements. In January 2012, the NRC staff evaluated the cracking fuel event using Management Directive 8.3, "NRC Incident Investigation Program." The NRC staff documented its decision not to conduct a reactive inspection which was based on the event not resulting in a violation of any TS limit or any release of radioactive material or worker dose. The staff also considered other factors, such as openness, public interest, and public safety, in making this determination.

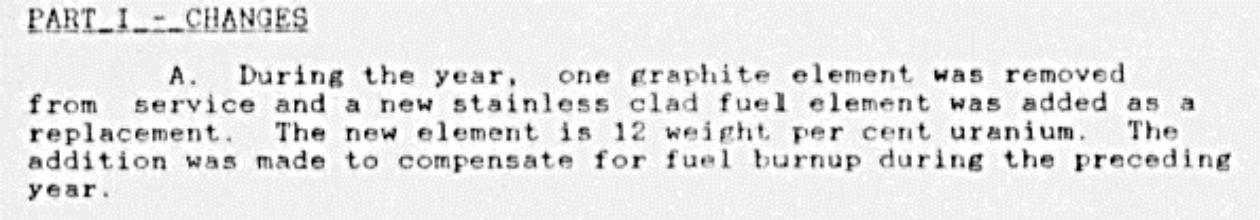
The NRC staff acknowledges that direct observation of licensee activities is important to safety, therefore, the NRC staff is reemphasizing the direct observation of risk significant activities when establishing inspection schedules. Additionally, the NRC staff plans on enhancing RTR inspector training and updating inspection guidance to increase awareness of precursors that may lead to fuel element damage.

Evaluation of Facility Changes

The NRC staff evaluated the changes to the cladding type, weight percentage of the fuel, and the operation with a mixed core of fuel elements with different characteristics and determined that those changes occurred in early 1990-time frame and staff associated oversight activities were adequate. A summary of the NRC staff evaluation is provided below.

Aerotest's "Hazard Summary Report" dated September 30, 1964 (ML18044A100), specifies the cladding material of the TRIGA fuel elements as aluminum. For initial criticality of the reactor in July 1965, the core contained only aluminum clad TRIGA fuel elements. The regulations in 1992 for 10 CFR 50.59, "Changes, tests and experiments," paragraph (b)(2) required the licensee to submit an annual report containing a brief description of any changes, tests, and experiments, including a summary of the safety evaluation of each. Section 50.59(a)(1) of 10 CFR allowed the licensee to make changes to the facility unless a proposed change, test, or experiment involved a TS change or an unreviewed safety question. The TSs approved in 1965, as amended, did not specify a requirement for TRIGA fuel weight percent and cladding type. In Aerotest's annual report "Annual Summary of Changes, Tests and Experiments," submitted to the NRC (ML20082C125), for the period ending on June 30, 1991, Aerotest identified adding "new" TRIGA fuel elements of a different weight percent and cladding material (see figure 1). This facility change that occurred in 1990 or 1991 would result in Aerotest operating with a mixed core of fuel elements with different percentages and cladding types.

Figure 1: Excerpt from Aerotest Annual Report Ending 1991

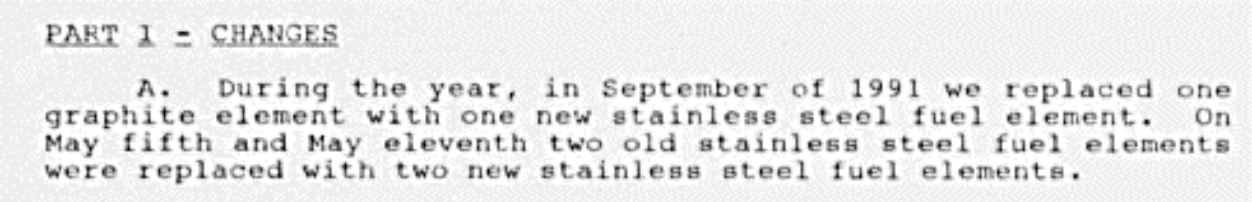


PART I - CHANGES

A. During the year, one graphite element was removed from service and a new stainless clad fuel element was added as a replacement. The new element is 12 weight per cent uranium. The addition was made to compensate for fuel burnup during the preceding year.

The following year in 1992, Aerotest reported in its annual report (ML20102B259), other instances of replacing TRIGA fuel elements with "new" stainless steel fuel elements (see figure 2)

Figure 2: Excerpt from Aerotest Annual Report Ending 1992



PART I - CHANGES

A. During the year, in September of 1991 we replaced one graphite element with one new stainless steel fuel element. On May fifth and May eleventh two old stainless steel fuel elements were replaced with two new stainless steel fuel elements.

The NRC inspected changes to the facility and documented the results in reports dated June 14, 1991 (ML19302E697), and February 23, 1993 (ML20044C419). The inspectors concluded that "no changes had been made to the facility or procedures that would require a safety evaluation pursuant to 10 CFR Part 50.59."

Changes and evaluations in accordance with 10 CFR 50.59 have been an area of focus for the NRC staff and the RTR community to provide clarity and guidance, especially given the RTR licensees' infrequent use of this process and the limited guidance that was directly applicable to RTRs. For example, in 2000, Nuclear Energy Institute (NEI) 96-07, Revision 1, "Guidelines for 10 CFR 50.59 Implementation," was issued and Regulatory Guide (RG) 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," endorsed the guidance which is applicable to RTRs. Further, additional RTR-specific 10 CFR 50.59 guidance was issued in February 2022, namely RG 2.8, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments at Non-Power Production or Utilization Facilities," endorsing NEI-21-06, "Guidelines for 10 CFR 50.59 Implementation at Non-Power Production or Utilization Facilities" (ML21236A089). Additionally, the NRC staff and the RTR community have continued to engage in dialogues on the change process to share experience and gain more clarity. The issuance of these guidance documents as well as the NRC staff's interaction with the RTR community regarding the 10 CFR 50.59 change process has improved the quality of these evaluations.

Evaluation of ALARA Concerns

ALARA is a principle for minimizing radiation dose by using three basics concepts of time, distance, and shielding. The primary ALARA concern for the Aerotest facility was the Accounting Office located adject to the Waste Storage Tanks and Sump. The NRC staff determined that the maximum radiation levels in the Accounting Office between October 2010 and June 2017 were approximately 0.116 mrem per hour if averaged over the entire quarter. If

an individual performed activities for 40 hours a week in that room, that individual would receive an estimated maximum of 4.63 mrem per week. The licensee did implement an ALARA program and, as stated in the Aerotest's 2005 safety analysis report (SAR) (ML13120A327), the Aerotest Operations policy is that weekly cumulative whole-body exposures are limited to less than 100 mrem, unless higher exposures are specifically approved by the Radiological Safety Officer. An individual working in the Accounting Office for 40 hours a week would achieve less than 5 percent of the licensee's set weekly exposure limit. While the primary responsibility for ALARA and radiation protection lies with the licensee and individual workers, the NRC staff verifies through inspections that the licensee implements certain administrative and engineered controls to support the ALARA principles as defined in 10 CFR 20.1003, "Definitions." After Aerotest ceased operation in December 2010, the worker radiation exposure was reduced from approximately 3,000 mrem during the 2009 and 2010 timeframe to 276 mrem in 2011 and 28 mrem in 2012. The NRC staff believes that the implementation of Aerotest's ALARA Program and current inspection guidance in Inspection Procedure (IP) 69001, "Class II Research and Test Reactors," are sufficient to support ALARA principles.

Evaluation of Technical Specifications

Aerotest was licensed prior to the NRC promulgating 10 CFR 50.36(c), which requires TS to contain a fuel temperature safety limit; therefore, the Aerotest TS did not contain such safety limit. However, the Aerotest TSs contained other limits, engineered features, and operating conditions to provide reasonable assurance that public and worker safety would be protected. Consistent with the past precedent set by other licensees during license renewal, Aerotest recognized the lack of a fuel safety limit in its TSs and proposed TSs that included a fuel temperature safety limit in its license renewal application. The NRC staff accepted this approach for RTRs to update its TSs for license renewal. Aerotest's license renewal application was later withdrawn and eventually the facility entered decommissioning phase. A summary of the NRC staff's evaluation is provided below.

Section 50.36(a)(1) of 10 CFR requires each applicant for a license authorizing operation of a utilization facility to include TS in accordance with the requirements in 10 CFR 50.36. In 1965, when the AeroJet operating license was issued, the regulations (10 CFR 50.36) did not require safety limits, limiting conditions for operation, surveillances, design features, and administrative controls. In 1974, the license was transferred from AeroJet General Corporation to Aerotest Operations, Inc. As part of the license transfer, the NRC approved a revised TS to reflect the licensee's name change. Although the 1974 TS did not contain a safety limit for fuel temperature, safe operation was ensured by other TS parameters and limiting conditions for operation including a steady-state power level limit, core configuration, minimum shutdown margin, and maximum reactivity rates to name a few. In 2005, the licensee proposed a TS safety limit in its license renewal application. However, the licensee subsequently withdrew its request for license renewal and permanently shut down in 2010 without incorporating the updated TS. The NRC staff notes that almost all RTRs have undergone license renewal and that all RTRs, including the few that are activity pursuing license renewal, have adequate safety limits in TS to help ensure safe operation of the facility.

University of Texas at Austin

The NRC staff reviewed the events that led to OIG's conclusion that had the NRC acted on a certain licensing action submitted between 2008 and 2012, the May 2023 event of using aluminum clad fuel elements may have been averted. While the NRC staff determined that additional license amendments would have been required for the facility to operate with

aluminum clad fuel elements, there were no licensing decisions requested regarding these elements. In terms of licensing action timeliness, the NRC staff has since implemented several initiatives including licensing review metrics to ensure actions are processed in a timely manner, including the use of acceptance reviews. A summary of the NRC staff's review for this OIG conclusion is provided below.

The UT LAR dated March 22, 2004 (ML040910231), requested a change to paragraph 2.B.(2) of license R-129 to increase the special nuclear material (SNM) limit to receive, possess, and use up to 9.5 kilograms of contained uranium-235 in the form of TRIGA fuel because of a licensee delay in shipping out spent fuel, to receive a replacement instrument fuel element, and to proceed with the planned acquirement of additional TRIGA fuel by the end of 2005. The current UT license, appendix A, TS 5.3.1, "Fuel Elements," item c, only authorizes a stainless-steel design feature for TRIGA elements (see figure 3).

Figure 3: Excerpt from University of Texas 2004 Technical Specifications

5.3 Reactor Core and Fuel

5.3.1 Fuel Elements

Specification(s)

The standard TRIGA fuel element at fabrication shall have the following characteristics:

a. Uranium content: 8.5 Wt% uranium enriched to a nominal 19.7% Uranium-235.

b. Zirconium hydride atom ratio: nominal 1.6 hydrogen to zirconium, ZrH_x.

c. Cladding: 304 stainless steel, nominal .020 inches thick.

For the licensee to use aluminum clad TRIGA fuel elements in the reactor core, a change to TS 5.3.1(c) would be required. Also, aluminum clad TRIGA fuel elements have a lower safety limit compared to the stainless-steel fuel elements, due to a lower melting temperature, to ensure the integrity of the cladding is maintained. Therefore, a change to TS 2.1, "Safety Limit," would also be required for the use of aluminum clad TRIGA fuel elements. In the 2004 LAR, the licensee only requested a SNM possession limit increase. It is common practice for RTRs to receive and possess fuel while they develop the technical justification and receive the necessary regulatory approvals to use the fuel in the core. The revised possession limit must be authorized by the NRC prior to the receipt of the fuel. The licensee is responsible for ensuring that a different type of fuel is adequately controlled and not used in the core until it is authorized by the license. The licensee is also responsible for fully describing the changes when requesting to amend the license or TS per 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit." Currently, only Dow Chemical Company, University of Utah, and U.S. Geological Survey research reactors are authorized by the NRC to use a mixed reactor core of stainless-steel and aluminum clad TRIGA fuel elements. For instance, the TS safety limit for a facility that uses a mix of aluminum and stainless-steel clad TRIGA elements would be as follows (see figure 4).

Figure 4: Excerpt from University of Utah Technical Specifications – Safety Limit

Specifications

1. The temperature in a stainless-steel clad, high hydride fuel element shall not exceed 1,000 °C (1,273.15 °K) under any conditions of operation, and
2. The temperature in an aluminum clad, low hydride fuel element shall not exceed 500 °C (773.15 °K) under any conditions of operation.

Both the 2008 and 2010 UT LARs (ML080920755 and ML101241147, respectively) were an administrative change to a TS definition and only requested to change the definition of "Fuel Element, Standard" to include aluminum clad fuel elements similar to a definition used by General Atomics (TRIGA fuel and reactor vendor). Section 50.36(c) of 10 CFR does not require TS to contain definitions. Definitions only provide uniform interpretation of terms that are used in the TS. In the 2008 and 2010 LARs, the licensee did not specifically request to use aluminum clad TRIGA fuel elements in the core. If requesting to use aluminum clad TRIGA fuel, the licensee is required to develop a technical justification to support the determination that aluminum clad TRIGA fuel elements are safe to use in the core. In addition, UT would need to request a change to the TRIGA fuel element cladding design feature, as specified in TS 5.3.1, "Fuel Elements" (see figure 4).

TS 5.3.1 requires that TRIGA fuel elements for use in the UT core are clad with 304 stainless-steel. The NRC staff also notes that the fuel element cladding thickness differs between stainless-steel and aluminum clad fuel elements. The licensee did not provide a technical justification or propose a change to TS 5.3.1 in either the 2008 or 2010 LARs submitted to the NRC.

On February 8, 2012 (ML12082A145), UT submitted a LAR for another change to the definition of "Fuel Element, Standard" that only references stainless-steel clad fuel elements and not aluminum clad TRIGA fuel elements (see figure 5). UT's basis for the change was editorial in nature and does not affect safety. On August 19, 2016 (ML16252A219), UT requested the NRC include these proposed changes to the facility operating license for license renewal.

Hence, in aggregate, in its licensing actions requested between 2008 and 2016, UT did not specifically request to use aluminum clad TRIGA fuel elements in the core and did not develop a technical justification to support the determination that aluminum clad TRIGA fuel elements are safe to use in the core. As such, the NRC did not review, nor approve, the use of aluminum clad TRIGA fuel elements in the UT core.

Figure 5: Excerpt from University of Texas 2012 license amendment request

CURRENT	PROPOSED
1.5 Fuel Element, Standard A fuel element is a single TRIGA element of standard type. Fuel is U-ZrH clad in stainless steel clad. Hydrogen to zirconium ratio is nominal 1.6.	1.5 Fuel Element, Standard A fuel element is a single TRIGA element of standard type. Fuel is U-ZrH (<20% enriched uranium) clad in stainless steel. Hydrogen to zirconium ratio is nominal 1.6.

This change is editorial in nature, and does not affect safety.

Timeliness of licensing actions is a focus area for the NRC staff and the RTR community, and the NRC staff has implemented several initiatives including licensing guidance, robust pre-application engagement, and timely acceptance reviews to ensure timely actions on all LARs. That said, the NRC staff concludes that issuance of either the 2004, 2008, and 2010 amendment requests would not have prevented the May 2023 event because the requests were unrelated to authorization to use aluminum clad TRIGA fuel in the core.

NRC Staff Actions

Regardless of the assessment of the 2008 to 2012 LARs, to address OIG's conclusions in Subpart C, the NRC staff plans to enhance inspector training and guidance on the precursors that could lead to fuel element damage. Additionally, as previously described, the NRC staff is placing additional emphasis on observing risk-significant operational activities during inspections. The NRC staff has made many updates to its processes and procedures (e.g., 10 CFR 50.59 guidance) that resulted in improvements to address OIG's additional conclusions.

Subpart D: RTR Inspection Program Policy and Guidance are Outdated

NRC Response to Subpart D:

The NRC staff reviewed Subpart D of the report to consider OIG's conclusions in developing enhancements to the RTR oversight program. These conclusions are summarized as follows:

- The NRC has not implemented the risk-informed approach recommendations from NUREG-2150, "A Proposed Risk Management Regulatory Framework" in the RTR inspection program policy and guidance.

- Safety culture was not implemented in the RTR inspection program as recommended in the NRC's Safety Culture Policy Statement.

- The NRC has not updated the safety aspect of IMC 2545, "Research and Test Reactor Inspection Program," since 2004, which is inconsistent with IMC 2545.

- The last major revision to the safety inspection program documents was in 2004, and the 2004 IPs underestimate the resources needed to complete all requirements.

- The RTR inspection program does not have a self-assessment process to determine if the program meets its established goals and intended outcomes.

Lack of a risk-informed approach in RTR inspection program

The NRC staff evaluated the history of the finding and recommendations for RTRs in NUREG-2150. At the request of the NRC Chairman, an NRC Risk Management Task Force was chartered to develop a strategic vision and options for adopting a more comprehensive, holistic, risk-informed, performance-based regulatory approach for reactors (including RTRs), materials, waste, fuel cycle, and transportation that would continue to ensure the safe and secure use of nuclear material. The task force issued NUREG-2150 that describes a proposed risk management regulatory approach that could be used to improve consistency among the NRC's various programs and discusses implementing such a framework for specific program

areas. NUREG-2150, in part, describes the implementation of a proposed Risk Management Regulatory Framework for nonpower reactors. The task force developed findings and recommendations on changes that would be needed to ensure that the proposed risk management framework would be implemented in 10 to 15 years. The NRC Chairman requested the staff to review NUREG-2150 and provide options and recommendation to the Commission, including the potential for adopting the proposed Risk Management Regulatory Framework through a Commission policy statement (ML121660102). On December 18, 2015, the NRC staff summitted SECY-15-0168 (ML15265A488), in response to the Chairman's request. The NRC staff recommended that the Commission not develop and issue an agencywide risk management policy statement. The NRC staff's recommendation was based on an analysis of the expected benefit of a policy statement compared to the resource expenditure to create the statement and was informed by public feedback. The NRC staff compared the resource expenditure to create and implement a policy statement across the program offices and concluded the NRC resources are not justified and are better focused on issues of greater safety significance. On March 9, 2016, the Commission issued a Staff Requirements Memorandum (ML16069A370), and approved the NRC staff's recommendation to refrain from developing an overarching, agencywide risk management policy statement. As a result of the Commissions direction, the NRC staff did not implement the recommendations of NUREG-2150 in the RTR inspection program policy and guidance.

The NRC staff's position is that the current oversight and inspection program for RTRs is risk informed based on the risk posed to the public by facility operation. The RTR inspection program uses a 2 megawatts threshold to define the inspection program and the frequency by which it is implemented at a facility. RTRs are not required by NRC regulations to develop and maintain a probabilistic risk assessment for their facilities. A probabilistic-risk-assessment-oriented approach for RTRs would be resource intensive to develop and maintain and provide limited benefit in informing facility risk assessment. Instead, during licensing as described in the SARs for RTRs, licensees perform deterministic accident analyses that typically demonstrate a large margin to safety limits. The NRC staff's position is that the current RTR licensing and oversight approach is appropriately risk-informed, and the NRC staff is reemphasizing the direct observation of risk significant activities when establishing inspection schedules.

In spring 2020, the NRC staff developed and piloted supplemental guidance to augment the decision-making guidance in Management Directive 8.3 aimed at enhancing the NRC's oversight response to an event at an RTR. As a result of the NIST event, the NRC staff identified further enhancements to the pilot supplemental guidance. These enhancements were included in the supplemental guidance, which was issued in October of 2022 (ML22257A162).

Lack of safety culture element in RTR inspection program

Operating experience demonstrates that there is a clear nexus between safety culture and the occurrence of events at a facility. The NRC staff acknowledges the importance of positive safety culture traits at RTR facilities within the NRC oversight program and is taking several steps to bolster a healthy safety culture in RTR facilities. The current qualification program for RTR inspectors includes training on the Commission's Safety Culture Policy Statement, safety culture traits, and safety conscious work environment. In addition, the NRC staff plans to include safety culture guidance in the RTR inspection program, procedures, and training to provide the inspector additional tools to detect potential fragility in a licensee's safety culture. Based on an inspector's observations of a licensee's safety culture and using risk-informed decision making, the inspector could recommend to NRC management that the NRC consider performing an

assessment of the licensee's safety culture. Further, the inspector's observations could be considered as an input to the NRC staff's decision to perform reactive inspections as a result of a licensee event. These changes to the inspection program and guidance could also inform future programs and guidance for advanced technology as described in section IV, "Future Licensees and the NRC's RTR Program," of the OIG report.

Moreover, the NRC staff is applying additional focus on sharing operational experience amongst the RTR community. For example, on June 13, 2023, the NRC staff issued Information Notice 2023-03, "Recent Human Performance Issues at NonPower Production and Utilization Facilities" (ML23059A539), outlining operational issues for several facilities that highlighted the need for a strong safety culture. Also, the NRC staff is focusing on communicating operating experience insights and lessons learned in appropriate venues including trade conferences and periodic meetings with the RTR community.

To communicate the importance of safety culture and operating experience, the NRC staff developed a public non-power production and utilization facilities (NPUFs) inspection report webpage and is developing an operational experience dashboard that is publicly accessible to enhance sharing of reactor operating experience in the community. Additionally, the NRC staff aided RTR licensees in accessing the International Atomic Energy Agency's (IAEA) international operating experience database, known as the Incident Reporting System for Research Reactors to enable the sharing of international operational experiences. During public meetings and conferences, the NRC staff will continue to promote the use of the IAEA operating experience database to RTR licensees to share operating experience and lessons learned that could help prevent the occurrence of similar events at their respective RTRs.

Lack of safety inspection program updates

The NPUF oversight and licensing branches hold an annual joint branch meeting to review the licensing and oversight activities at each RTR facility over the prior year to identify common performance issues or concerns, operational experience, and trends for consideration in current regulatory programs including any recommended changes, if needed. Additionally, the NRC staff made several enhancements to and reviewed the RTR inspection program since 2020. These enhancements and reviews are documented in an internal self-assessment report (ML23345A225). As indicated above, the NRC staff's recent internal self-assessment of the NRC's RTR oversight program found no significant gaps in the inspection program and guidance; however, several enhancements to internal processes and procedures were identified. The NRC staff has determined that the combination of site-specific licensing bases, a robust emergency response infrastructure, and the current oversight program are appropriately risk-informed by the application of inspection scope and frequency and continue to provide appropriate protection to public health and safety and the environment for RTRs.

To maximize the enduring benefit of the program self-assessment, the NRC staff plans to further enhance its current program assessment activities to formalize a recurring self-assessment process and document the conclusions to determine if the oversight program continues to meet its established goals of protecting public health and safety. These results will be documented and presented to responsible NRC management. The NRC staff also plans to include guidance into IMC 2545 on performing a periodic review of the RTR IMCs and IPs.

Inadequate resource estimates to support inspection requirements

In terms of the overall RTR oversight program resources, management continually evaluates staffing resource needs and skills gaps in the budgeting and strategic workforce planning processes. Use of these processes recently identified the need for additional inspection resources for the growth in the number of future NPUFs. Additionally, management has utilized flexibilities to provide better balance of inspector responsibilities that considers complexity of the RTR facilities and has encouraged cross-training and cross-qualifying staff to provide flexibility in assigning branch resources to inspections. The combination of these processes and management's use of existing flexibilities for assigning resources ensure inspection resources are available to support inspections at RTR facilities.

Regarding resources estimated for specific inspection activities, as stated in the IPs, the resource estimate for each IP is for planning purposes and an inspector can exceed the direct inspection resource estimate, if needed, to complete an inspection activity. The NRC staff reemphasized the flexibility in the inspection resource estimates with the inspectors to ensure their awareness. In addition, the NRC staff plans to formalize a recurring self-assessment process that includes assessing estimated hours and sample sizes for RTR inspection procedures to support adequate inspection resources. If new or revised information is presented that could impact inspection resources, the NRC staff will evaluate and revise, if necessary, estimated hours in the IPs using the process to be described in IMC 2545 for updating RTR IMCs and IPs.

NRC Staff Actions

To address the conclusions described in Subpart D of the OIG report, the NRC staff is reemphasizing the direct observation of risk significant activities when establishing inspection schedules. The NRC staff plans on enhancing inspector training and inspection procedures to increase awareness and recognition of potential weaknesses in a licensee's safety culture and taking appropriate agency actions. Additionally, the NRC staff will include guidance in IMC 2545 on performing a periodic review of the RTR IMCs and IPs. During the periodic review of the IPs, the NRC staff will evaluate individual IP hour estimates to ensure sufficiency of resources. Additionally, the NRC staff will continue to share safety culture operating experience with RTR licensees in different venues, such as public meetings, conferences, and on the NRC public website.

Conclusion

The NRC staff appreciates OIG's efforts and valuable insights of the NRC's oversight program for the Nation's RTRs. The NRC staff determined that the combination of site-specific licensing bases, a robust emergency response infrastructure, and the current oversight program are appropriately risk-informed and continue to provide adequate protection to public health and safety and the environment for RTRs. The NRC staff's recent internal self-assessment (ML23345A225), of the NRC's RTR oversight program found no significant gaps that would impact the safe operation of RTRs. Several enhancements to internal processes and procedures were identified in the self-assessment and, some of which, were also identified by the OIG in the report. The NRC staff is taking the following actions:

- Reemphasizing the direct observation of risk significant activities when establishing inspection schedules at RTRs.

- Update inspection guidance on assessing the licensee's implementation of the safety and audit committee's recommendations for appropriate follow-up.

- Enhance inspector training and inspection procedures to increase awareness and recognition of potential weaknesses in a licensee's safety culture and taking appropriate agency actions.

- Enhance inspector training and guidance on the precursors that could lead to fuel element damage.

- Develop a public NPUFs inspection report webpage and operational experience dashboard that is easily accessible for the licensees and members of the public to enhance sharing of reactor operating experience within the community and continue to communicate the importance of using the IAEA's operating experience database for RTRs in sharing operational experience and lessons learned.

- Enhance the current annual licensing and oversight program review to include a formalized self-assessment process and document the assessment conclusions to determine if the RTR oversight program continues to meet its established goals of protecting the public and the environment.

- Incorporate the RTR inspection program in IMC 2545 to enhance guidance for performing a periodic review of IMCs and IPs for RTRs.

Date of planned completion for all actions: October 31, 2024

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