



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 25, 2024

Dr. Caleb S. Brooks, Associate Professor
Department of Nuclear, Plasma,
and Radiological Engineering
University of Illinois at Urbana-Champaign
Talbot Laboratory, Room 111C, MC-234
104 South Wright St.
Urbana, IL 61801

SUBJECT: UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN – SAFETY EVALUATION
FOR TOPICAL REPORT TITLED “HIGH-TEMPERATURE GAS-COOLED
RESEARCH REACTOR: APPLICABILITY OF NUCLEAR REGULATORY
COMMISSION REGULATIONS,” RELEASE 4 (EPID L-2022-NFN-0008)

Dear Dr. Brooks:

By letter dated December 9, 2022 (Agencywide Documents Access and Management System Accession No. ML22343A282), the University of Illinois at Urbana-Champaign (UIUC) submitted the topical report (TR) “University of Illinois Urbana-Champaign High Temperature Gas-cooled Research Reactor: Applicability of Nuclear Regulatory Commission Regulations,” Release 1, for U.S. Nuclear Regulatory Commission (NRC) staff review. Following several interactions with the NRC staff, UIUC submitted Release 4 of the TR by letter dated March 15, 2024 (ML24075A304).

The NRC staff’s safety evaluation (SE) for the TR, Release 4, is enclosed. The enclosed SE will be made publicly available.

The enclosed SE finds that Release 4 of the TR identified a generally acceptable list of applicable regulatory requirements for use in developing a license application for the described UIUC Micro Modular Reactor research reactor, subject to the limitations and conditions listed in the enclosed SE.

The NRC staff requests that UIUC publish an accepted version of this TR within 3 months of receipt of this letter. The accepted version should incorporate this letter and the enclosed SE after the title page. The accepted version should include an “-A” (designating “accepted”) following the TR identifier.

If you have any questions, please contact Paulette Torres at (301) 415-5656, or by email at Paulette.Torres@nrc.gov.

Sincerely,



Signed by Cruz, Holly
on 07/25/24

Holly D. Cruz, Acting Chief
Non-Power Production and Utilization Facility
Licensing Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Project No.: 99902094

Enclosure:
As stated

cc: GovDelivery Subscribers

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**UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN – SAFETY EVALUATION FOR
TOPICAL REPORT TITLED “HIGH-TEMPERATURE GAS-COOLED RESEARCH REACTOR:
APPLICABILITY OF NUCLEAR REGULATORY COMMISSION REGULATIONS,” RELEASE 4
(EPID L-2022-NFN-0008)**

APPLICANT INFORMATION

Applicant: University of Illinois at Urbana-Champaign
Applicant Address: 104 South Wright St.
Urbana, IL 61801
Docket/Project No(s): 99902094

APPLICATION INFORMATION

Submittal Date: December 9, 2022

Submittal Agencywide Documents Access and Management System (ADAMS) Accession No.: ML22343A282 - University of Illinois at Urbana-Champaign (UIUC, the applicant) Applicability of U.S. Nuclear Regulatory Commission (NRC) Regulations Topical Report (TR), Release 1

Supplement ADAMS Accession No(s):

- ML23242A329 - UIUC, Submittal of Revised UIUC Applicability of NRC Regulations TR, Release 2, dated August 30, 2023
- ML23345A236 - UIUC, Response to NRC Request for Additional Information regarding UIUC Applicability of NRC Regulations TR, Release 2, dated December 11, 2023
- ML24060A265 - UIUC, Submittal of Revised UIUC Applicability of NRC Regulations TR, Release 3, dated February 29, 2024
- ML24075A304 - UIUC, Submittal of Revised UIUC Applicability of NRC Regulations TR, Release 4, dated March 15, 2024

Other Communication ADAMS Accession No(s):

- ML23159A036 - USNRC, Public Meeting Notice Regarding the NRC Staff's Review of UIUC Applicability of NRC Regulations TR, dated May 24, 2023
- ML23151A544 - USNRC, Proposed Discussion Topics regarding NRC Staff's Review of UIUC Applicability of NRC Regulations TR, dated May 31, 2023
- ML23158A252 - UIUC, Presentation Addressing Proposed Discussion Topics, dated June 7, 2023
- ML24031A626 - USNRC, Summary of the January 24, 2024, Public Meeting regarding UIUC Applicability of NRC Regulations TR, dated January 31, 2024

Enclosure

Brief Description of the Topical Report: By letter dated December 9, 2022, UIUC submitted Release 1 of TR, “University of Illinois Urbana-Champaign High Temperature Gas-cooled Research Reactor: Applicability of Nuclear Regulatory Commission Regulations,” for the NRC staff’s review. The TR reflects UIUC’s screening of Title 10, “Energy,” of the *Code of Federal Regulations* (10 CFR), Chapter I, “Nuclear Regulatory Commission,” to determine regulations applicable to a research reactor, including requirements in 10 CFR Part 20, “Standards for Protection Against Radiation”; Part 50, “Domestic Licensing of Production and Utilization Facilities”; Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions”; Part 70, “Domestic Licensing of Special Nuclear Material”; Part 73, “Physical Protection of Plants and Materials”; and Part 74, “Material Control and Accounting of Special Nuclear Material.”

The NRC staff arranged a public meeting with UIUC on June 8, 2023, that resulted in UIUC submitting revised TR (Release 2) and a second public meeting with UIUC on January 24, 2024, that resulted in UIUC submitting revised TR (Release 3). After additional clarification discussions, UIUC submitted revised TR (Release 4).

In Release 4 of the TR, UIUC requested NRC review and approval of the TR to determine applicability of specific regulations as part of the licensing requirements for the Ultra Safe Nuclear Corporation’s Micro Modular Reactor (MMR™) high-temperature, gas-cooled reactor (HTGR) design proposed for UIUC. The request was submitted assuming the MMR at UIUC would meet the criteria for licensing as a Class 104c. research reactor in accordance with 10 CFR 50.21(c). In TR Section 1.5, “NRC Action Requested,” UIUC stated that the TR description of the methodology developed and employed for determining the applicability of regulations was provided for informational purposes only; UIUC states that it is only requesting NRC review and approval of the TR “to determine acceptability of specific regulations identified in [the] TR as the licensing basis for the MMR at UIUC, listed in Attachment 1, ‘Assignment of NRC Regulations to UIUC-MMR Regulation Applicability Groups’” of the TR.

For additional details on the submittal, please refer to the documents located at the ADAMS Accession No(s). identified above.

EVALUATION CRITERIA

UIUC is pursuing the licensing of an MMR design as a non-commercial research reactor. The applicant stated that UIUC will be applying for a construction permit (CP) and subsequent operating license (OL) under 10 CFR Part 50 regulations. The applicant also stated an intent to license the research reactor as a Class 104c. facility under 10 CFR 50.21(c).

To facilitate future licensing actions, it is useful to identify the specific regulatory framework applicable to the UIUC MMR during the initial stages of the licensing process. Certain definitions provided in 10 CFR 50.2 are relevant to the applicability of regulations, including the following:

- *Non-power reactor* means a research or test reactor licensed under §§ 50.21(c) or 50.22 of this part for research and development.
- *Testing facility* means a nuclear reactor which is of a type described in § 50.21(c) of this part and for which an application has been filed for a license authorizing operation at:
 - (1) A thermal power level in excess of 10 megawatts; or
 - (2) A thermal power level in excess of 1 megawatt, if the reactor is to contain:
 - (i) A circulating loop through the core in which the applicant proposes to conduct fuel experiments; or

- (ii) A liquid fuel loading; or
- (iii) An experimental facility in the core in excess of 16 square inches in cross-section.

In order to be licensed as a non-commercial (Type 104) research reactor, the provisions of 10 CFR 50.22 require that no more than 50 percent of the annual cost of owning and operating the facility is devoted to the production of materials, products, or energy for sale or commercial distribution, or to the sale of services, other than research and development or education or training.¹

Given that the UIUC intends to submit an application to license the MMR as a research reactor in accordance with 10 CFR 50.21(c), NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors – Format and Content," which was issued in February 1996 (Reference 1), serves as guidance. Appendix A, "Applicability of Selected Regulations in Title 10, Chapter I, of the Code of Federal Regulations to Non-Power Reactors," of NUREG-1537, Part I, informs the applicability to research reactors of NRC regulations existing at the time of NUREG-1537 issuance. However, it may not provide accurate information regarding applicability of regulations modified since that time and does not address regulations added since that time.

NRC regulations include provisions that provide some regulatory flexibility. All Parts of Chapter I of Title 10 within the scope of the TR include provisions for specific exemptions from individual regulations. The requirements of 10 CFR 50.12, "Specific exemptions," state, in part, that the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of the NRC regulations in Part 50 when:

- 1) The exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security; and
- 2) Special circumstances are present.

Special circumstances listed in 10 CFR 50.12(a)(2) include:

- (ii) Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule; or
- (iv) The exemption would result in benefit to the public health and safety that compensates for any decrease in safety that may result from the grant of the exemption.

The specific exemption requirements in other Parts of Chapter I of Title 10 generally do not require the presence of special circumstances but are otherwise similar.

¹ The staff acknowledges that section 601, "Technical Correction," of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024, also known as the ADVANCE Act, amended section 104c. of the Atomic Energy Act of 1954 (AEA), as amended, to specify that the NRC may issue a license under section 104c. for a utilization facility useful in the conduct of research and development if two conditions are satisfied: (A) not more than 75 percent of the annual costs to the licensee of owning and operating the facility are devoted to the sale, other than for research and development or education and training of (i) non-energy services; (ii) energy; or (iii) a combination of nonenergy services and energy; and (B) not more than 50 percent of the annual costs to the licensee of owning and operating the facility are devoted to the sale of energy. See Pub. L. No. 118-67, div. B, section 601 (to be codified at 42 U.S.C. section 2134(c)). This amendment to AEA section 104a. became effective immediately upon enactment of the ADVANCE Act on July 9, 2024.

The NRC staff issued a draft document, titled “Updated NRC Staff Draft White Paper – Analysis of Applicability of NRC Regulations for Non-Light Water Reactors” (Draft White Paper), dated July 2021 (Reference 2), that provisionally identified NRC regulations in Part 50 and Part 52 that are generically either applicable or inapplicable to licensing of non-light-water power reactors (non-LWRs).² The UIUC TR referenced the general methodology found in the draft white paper, with consideration of the UIUC MMR intended status as a research reactor, to evaluate the applicability of regulations and identify potential exemptions necessary for the MMR research reactor design.

After the submission of Release 4 of the UIUC TR, the NRC staff issued Division of Advanced Reactors and Non-Power Production and Utilization Facilities (DANU) Interim Staff Guidance (ISG) 2022-01, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap,” March 2024 (Reference 3) (Roadmap ISG). Appendix B, “Analysis of Applicability of NRC Regulations to Non-Light-Water Power Reactors,” to DANU-ISG-2022-01 includes an analysis of the applicability of NRC regulations to advanced power reactors. While Appendix B to the Roadmap ISG includes a significant amount of information that remained unchanged from the Draft White Paper, Appendix B also includes corrections to several errors in the Draft White Paper. The NRC staff reviewed the UIUC TR based on the information in Appendix B to the Roadmap ISG (considering that the proposed UIUC MMR would be a research reactor).

A previous review provides a precedent for evaluation of regulatory applicability to a Non-Power Reactor. By letter dated January 18, 2022 (Reference 4), Kairos Power LLC submitted Revision 4 of TR KP-TR-004-NP, “Regulatory Analysis for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor,” which addressed applicability of NRC regulations for both a proposed power reactor and a proposed test reactor. A test reactor is classified as a non-power reactor by the definition of “Non-power reactor” in 10 CFR 50.2, but test reactors are subject to some regulations not applicable to research reactors. The NRC staff accepted Revision 4 of KP-TR-004-NP and determined that, with some exceptions identified in the safety evaluation (SE), the report identified regulations applicable to the proposed Kairos reactors. Kairos forwarded the approved version of KP-TR-004-NP with the associated NRC SE by letter dated June 8, 2022 (Reference 5).

TECHNICAL EVALUATION

To support future licensing actions, UIUC has reviewed the NRC’s regulations to identify requirements prior to submission of a formal license application in order to support a more efficient and timely review. The applicant compared MMR technology to the light-water reactor (LWR) technology that is reflected in many regulations and evaluated the applicability of regulations for licensing of the UIUC MMR.

² The Draft White Paper included the following disclaimer:

The NRC staff has prepared this draft white paper and is releasing it to support an upcoming advanced reactor stakeholder meeting. The U.S. Nuclear Regulatory Commission (NRC) staff intends this draft white paper to facilitate discussion at the meeting but is not soliciting written Comments on it. The contents of this document are subject to change and should not be interpreted as official agency positions. Ultimately, the NRC staff plans to issue guidance on the applicability of current NRC regulations to non-light water reactors and will seek public comments on the guidance document.

1. APPLICABILITY OF REGULATIONS TO NON-LWR TECHNOLOGIES

1.1. MMR Design Features

Section 2.0 of the TR describes key design features that distinguish the MMR design from LWRs. The MMR primary coolant loop uses helium circulated via pumps to cool the reactor. UIUC states that the reactor will be fueled with Tri-Structural Isotropic (TRISO) fuel particles embedded in silicon carbide Fully Ceramic Micro-Encapsulated pellets. UIUC intends to credit the barriers associated with the TRISO fuel as part of a functional containment, as described in SECY-18-0096, "Functional Containment Performance Criteria for Non-Light-Water-Reactors," issued September 28, 2018 (Reference 6). The intermediate coolant loop contains molten salt for transferring heat from the helium to the electrical power generation side of the facility, which UIUC states provides a means to separate the reactor from external transients. While still pressurized, UIUC states that the MMR will have a lower operating pressure and much lower stored energy than an LWR. UIUC also states that safety-related, passive decay heat removal is available without helium, electrical power, or operator action. The applicant summarized features differentiating the MMR from operating LWRs in table 2-1, "MMR Key Features and Differences from Operating LWRs," in Release 4 of the TR.

Section 3.0 of the TR includes a discussion on regulatory foundations for licensing a nuclear reactor. UIUC highlights certain parts of 10 CFR Chapter I and the licensing process, precedent with previous advanced designs licensed by the Atomic Energy Commission, and references examples of regulations not applicable to the MMR design given fundamental design differences relative to LWRs and specific entry conditions indicating applicability to LWRs. The key design features highlighted by UIUC are described to show differentiation from current LWRs and the design focused regulations associated with them. The applicant stated that entry conditions would be used in the determination of regulation applicability with considerations of design differences from LWRs to inform exemptions and applicability of regulations.

1.2. NRC Staff Evaluation

Appendix B to DANU-ISG-2022-01 states that some regulations may be inapplicable to a particular non-LWR design or application because of entry conditions already present in the rule. In these cases, the applicant is expected to document and support its claim that a requirement is inapplicable because of the entry condition. The NRC staff considered section 2.0 of the TR as information only in the context of supporting a determination that entry conditions associated with LWR technology would not apply. The NRC staff makes no evaluation regarding the adequacy of the design.

As part of the review to establish regulatory applicability, the NRC staff evaluated design features that differentiate the MMR design from that of LWRs. The NRC staff concludes that the inclusion of an inert helium coolant and other features summarized in table 2-1 of the TR adequately support a determination that entry conditions that specifically limit the applicability of a regulation to LWRs, including Boiling Water Reactors (BWRs) and Pressurized Water Reactors (PWRs) or systems or components that perform functions unique to those types of designs, would not be applicable to the UIUC MMR design. The staff also notes that the UIUC MMR would also be excluded from these regulations as a research reactor.

2. APPLICABILITY IDENTIFIED IN REGULATIONS VIA ENTRY CONDITIONS

2.1. Determination of Applicability

The applicant noted the differing applicability of NRC regulations based on reactor technology and other factors in section 4.0, “Applicability of Specific Regulations to MMR Technology,” of Release 4 of the TR. The applicant developed a process to categorize regulations with respect to relevance considering the entry conditions or other plain language included in the regulation. In table 4-1 of the TR, UIUC proposed eight different regulatory applicability groups distinguished by the applicability of entry conditions, other plain language direction, or actions expected to be necessary for compliance with the regulations. The applicant defined the Regulation Applicability Groups (RAGs) as follows:

- **1 N/A** – HTGR/MMR technology differs in fundamental ways from that of LWRs. The capability, system, or feature is not required. Regulations in this group are not applicable because they have entry criteria ... pertaining to:
 - Facility type: those that are not a utilization facility (i.e., not a reactor)
 - Reactor type: specifically applicable to a LWR (PWR, BWR) or D₂O [Heavy Water Reactor]
 - Specific time frame: applications submitted prior to 2023
 - Specific license application: those that reference a specific project
 - Application type: other than Part 50 [CP] and [OL]
- **2 N/A to NPUF** [non-power production or utilization facility] – NPUFs do not need to meet regulations that have entry conditions pertaining to a “nuclear power plant,” “power reactor,” or similar. Based upon UIUC qualifying for a Class [104c.] license, which is a [NPUF], the power reactor regulations are not applicable.
- **3 Applicable as is** – Regulation applies, although there may be sub-paragraphs that have their own specific entry conditions as noted.
- **3A Modified/partial** – Regulation applies, with some specific limitations or modifications, which are not considered to be significant deviations that require an exemption, or where portions down to the paragraph level may not be applicable and would be so noted as N/A in the subsequent row(s).
- **3B Meets intent** – Regulation applies and the underlying safety basis is relevant, but the means of implementation are subject to interpretation. The UIUC approach is considered to meet the intent of the regulation and not require an exemption. An alternative approach would be more appropriate for the MMR design to meet the regulation. This will be provided in the [preliminary safety analysis report] and [final safety analysis report].
- **3C Administrative** – Applies but does not affect design or technical requirements.
- **3D NRC, not applicant** – Regulation pertains to NRC activities not relevant to an applicant or licensee.
- **4 Request exemption** – UIUC may deviate from the regulation. UIUC may request an exemption.

Section 4.1 of the TR describes the process of determining “Entry Conditions for Regulation Applicability” given in TR table 4-2. The table lists phrases indicating conditions applicable to the proposed UIUC MMR and conditions not considered applicable to the proposed UIUC MMR that may appear in specific regulations.

Section 4.1 of the TR also references TR table 5.1, “Steps in Process to Evaluate NRC Regulation Applicability to UIUC MMR,” to define a process to determine applicability of individual regulations. The following list summarizes the guidance in TR table 5.1:

- Search regulations to identify terms characterized as “entry conditions” (see TR table 4-2) and determine applicability to the UIUC MMR.
- Compare results of the applicability determination to the following existing assessments of regulatory applicability, and reconcile differences:
 - Kairos TR KP-TR-004-NP, Revision 4, list of applicable regulations and associated NRC SE;
 - Guidance in NRC Draft White Paper;³ and
 - Appendix A to NUREG-1537
- Resolve remaining questions through review of statements of consideration for the associated regulations in the *Federal Register* and other documents developed by the NRC.

In the remainder of section 4.0 of the TR, the applicant described consideration of other information addressing applicability of regulations. The applicant assessed use of the NRC Draft White Paper in determining the applicability of regulations to the UIUC MMR in section 4.2 of the TR. In section 4.3 of the TR, the applicant described the NRC evaluation of the Kairos KP-TR-004-NP and noted that differences from accepted applicability determinations for the Kairos test reactor would derive primarily from technology differences (high temperature gas-cooled reactor vs. molten-salt-cooled reactor) and the difference in power rating (research reactor vs. test reactor). The applicant did not consider a submittal from Oklo Power, LLC, relevant to the UIUC MMR design. The applicant also described consideration of licensing alternatives to define applicable regulations, including future rulemaking, NRC hearing Orders, and Rules of Particular Applicability, but the applicant elected to evaluate the normal licensing process with exemptions.

Section 5.0, “Exemption Process,” of the TR outlines the applicant’s review of regulations to determine whether exemptions would be necessary. This section describes the exemption process and the method to identify applicable regulations and, from those, determine if an exemption would be necessary. Section 5.6, “UIUC Approach,” describes the specific methodology for determining regulatory applicability and includes table 5-1, which was addressed previously in this section of the SE.

2.2. NRC Staff Evaluation

The NRC staff reviewed TR table 4-2 and considers the proposed entry condition types (utilization facility, Class 104c. license, 10 CFR Part 50 license pathway, HTGR technology, timing of [CP] application, single unit site) appropriate to identify which regulations are not

³ The NRC staff did not issue the Draft White Paper as guidance to applicants or as staff guidance. The Roadmap ISG serves both of those functions.

applicable to UIUC due to its unique design and facility-specific attributes. The presence of entry conditions identified in existing regulations limit the applicability of regulations based on the facility type, the license class, the licensing pathway, the reactor technology, and other administrative factors. NRC guidance in Appendix B to DANU-ISG-2022-001 indicates that the regulations are considered not applicable if the entry conditions contained in the regulations are not met. Therefore, the NRC staff notes that consideration of the entry conditions characterized in TR table 4-2 and the process outlined in table 5-1 appears to be an appropriate framework to identify existing regulations applicable to the proposed UIUC MMR. However, the staff does not make any findings on this process because UIUC stated that it was provided for information only and not for NRC approval.

The NRC staff reviewed the defined RAGs used for sorting the results into specific categories. The NRC staff notes that the RAGs reflect the basis for non-applicability of certain regulations and the technical relevance of regulations determined to be applicable, except with respect to RAGs “3A Modified/partial” and “3B Meets intent.” With respect to RAG 3A, the staff notes that “significance” of a deviation from the regulations is not a consideration in whether an exemption would be needed. With respect to RAG 3B, “meeting the intent” of a regulation appears similar to one of the special circumstances that must be present for the Commission to consider exemptions from 10 CFR Part 50 regulations, namely in 10 CFR 50.12(a)(2)(ii), application of the regulation in the particular circumstances is not necessary to meet the underlying purpose of the regulation. However, the staff does not make any findings on the RAGs because they are part of the process that was provided for information only and not for NRC approval. The NRC staff evaluated the specific regulations where UIUC identified RAG “3A Modified/partial” or “3B Meets Intent,” in section 3, “Results,” of this SE to verify appropriate categorization of Part 50 regulations.

3. RESULTS

3.1. UIUC Presentation of Results

In section 6.0, “Summary of Planned Approach,” of the TR, the applicant stated that the results of the regulatory review are provided in Attachment 1, “Assignment of NRC Regulations to UIUC-MMR Regulation Applicability Groups,” and identified potential exemptions. Attachment 1 of the TR lists Chapter 1 of 10 CFR (Parts 1 to 199) to identify each Part and relevant individual regulation, lists the applicability of the regulatory requirements to the UIUC MMR design in accordance with the RAGs described above, and provides a basis for the RAG categorization. Attachment 1 does not address requirements in 10 CFR Part 52 because the selected licensing approach using the regulations of 10 CFR Part 50 to develop an application for a CP and subsequent OL do not reference 10 CFR Part 52.

In section 6.1, “Expected Exemptions,” the applicant determined that virtually all regulations that may have been considered for exemptions were found to not be applicable to the proposed UIUC MMR based on entry conditions. The applicant identified potential exemptions related to 10 CFR Part 73, “Physical Protection of Plants and Materials,” and 10 CFR Part 74, “Material Control and Accounting of Special Nuclear Material,” considering on-going rulemaking⁴ for

⁴ “Rulemaking for Enhanced Security of Special Nuclear Material,” Regulations.gov Docket ID: NRC-2014-0118, Regulation Identifier Number (RIN): 3150-AJ41. This rulemaking would amend the NRC's regulations to make generically applicable security requirements imposed in security orders after the events of September 11, 2001. The scope of this rulemaking could affect the physical protection capabilities and material accounting practices at nuclear plants and fuel cycle facilities.

protection of special nuclear material (SNM) that could affect the definitions of enrichment and quantities of SNM considered to be of strategic significance.

3.2. NRC Staff Evaluation

The NRC staff reviewed UIUC's assignment of RAGs for the MMR at UIUC as listed in Attachment 1. The NRC staff considers the lists of regulatory applicability determinations to be references that can inform the content of future licensing applications that will be subject to NRC staff review.

The NRC staff reviewed the UIUC RAGs against 10 CFR for consistency. The NRC staff compared the regulations identified as RAG "1 N/A," in Attachment 1 of the TR with regulations identified as not applicable to non-LWRs in table 1, "10 CFR Part 50 Requirements, as applicable to applications under Part 50 for non-LWRs," and table 3, "Other regulations that may apply to non-LWRs," of Appendix B to DANU-ISG-2022-01. The NRC staff found generally good agreement, with the exception that the TR identified additional regulations, such as those applicable only to Part 52 license or design certification requirements, that were not applicable based on the intended licensing approach for the UIUC MMR. The NRC staff also compared the regulations identified as RAG "2 N/A to NPUF," in the TR with regulations identified as not applicable to the Kairos Hermes Test Reactor based on applicability to power reactors only. The NRC staff concluded that the results were generally consistent between reports, with the exception of certain requirements discussed below and those that are applicable to test reactors but not research reactors, such as some provisions of 10 CFR Part 100, "Reactor Site Criteria."

In the table below, the NRC staff listed observations regarding the RAGs and the associated "Rationale/Justification/Comments" proposed by UIUC in Attachment 1 of the TR. If a particular regulation is not included in the NRC evaluation, this means the NRC staff has no comment on whether the regulation meets the RAG assigned by UIUC in Attachment 1 of the TR. The NRC staff did not individually evaluate comments providing justification for the RAGs assigned by UIUC, and, therefore, the NRC staff makes no finding or conclusion with regard to the specific comments as bases for the assigned RAG.

Regulation(s)	Observations
10 CFR 50.2	This regulation provides definitions of specific terms, such as reactor coolant pressure boundary (RCPB). UIUC assigned RAG “3B Meets intent,” to this regulation. In Appendix B to DANU-ISG-2022-01, the NRC staff indicated that definitions are not stand-alone requirements. The NRC staff determined that definitions, including changes to definitions, should be addressed in conjunction with the implementing regulation(s) that rely on the definitions.
10 CFR 50.36(c)(2)(ii)(A)	This regulation requires that installed instrumentation used to detect, and indicate in the control room, a significant abnormal degradation of the RCPB be subject to a limiting condition for operation in the facility technical specifications. UIUC indicates that the intent of this regulation would be met (i.e., RAG “3B Meets intent”). UIUC provided notes justifying the RAG “3B Meets intent,” on the basis that the principal design criteria (PDC) for modular high temperature gas-cooled reactors in Regulatory Guide 1.232 (Reference 7) replace “reactor coolant pressure boundary” with “helium pressure boundary” in select PDC. This change relates to table 5, “Areas with anticipated exemptions,” of Appendix B to DANU-ISG-2022-01, which identifies RCPB as a topical area that has particular safety significance for LWRs because the RCPB acts as a fission product barrier and is defined specifically for LWRs in 10 CFR 50.2. In this application, the use of RAG “3B Meets intent,” suggests an exemption may be necessary to apply alternate criteria in 10 CFR 50.36. In table 5 of Appendix B to DANU-ISG-2022-01, the NRC staff recommended consideration of a rule of particular applicability to implement alternatives to defined terms in this regulation.
10 CFR 74.1, 74.2, 74.4 to 8, 74.11, 74.13, 74.15, 74.17, 74.19, 74.81 to 84	Attachment 1 to the TR places these regulations in the RAG “2 N/A to NPUF” without clear justification. These regulations relate to control and accounting of SNM, do not include entry conditions related to power reactors and are identified as applicable to the Kairos Hemes Test Reactor in KP-TR-004-NP, Revision 4. The NRC staff recognizes that UIUC identified 10 CFR Part 74 as an area subject to ongoing rulemaking where the applicant may seek exemption(s) and notes that 10 CFR 74.17 and 74.19 have other entry conditions that may not apply to the UIUC MMR for reasons other than licensing as an NPUF.

The NRC staff reviewed the regulations that UIUC designated as RAG “4 Request exemption.” The NRC concludes that the regulations designated as RAG “4 Request exemption” in 10 CFR Part 73 and 10 CFR Part 74 may apply (in whole or in part) to the licensing of the UIUC MMR. The NRC staff’s consideration of whether an exemption is appropriate or can be justified will await consideration of detailed information submitted in a license application or specific exemption request. This SE does not reach any conclusion as to the acceptability or viability of any exemption request. The evaluation of whether an exemption should be granted would occur after the submittal of a specific exemption request and would be documented in the SE associated with a future licensing submittal.

Regardless of the conclusions with respect to the current NRC regulations, the NRC staff will evaluate a future application against the Commission's regulations at the time of a license application submittal. The positions stated in this SE do not override the requirements in the regulations themselves. During detailed review of an application, subsequent NRC analysis of its regulations in the context of the more complete design information in the application could take precedence over the positions stated in this SE.

4. LIMITATIONS AND CONDITIONS

An applicant may reference the TR for use as applied to the applicant's facility only if the applicant demonstrates compliance with the following limitations and conditions:

1. Applications referencing this TR must be for a type Class 104c. license for a non-power research reactor, consistent with 10 CFR 50.21(c) and 10 CFR 50.22.
2. The SE applies only to a reactor located at UIUC with a design of the type described in section 2.0 of the TR, which includes the following key attributes:
 - a. A functional containment design using TRISO fuel enriched to less than 20 percent U-235.
 - b. An inert, gaseous, and non-condensable coolant.
 - c. A pressure boundary maintaining the coolant above atmospheric pressure during normal operation.

The NRC staff makes no findings with respect to the acceptability of the design.

3. The NRC staff's approval of this TR does not endorse the use of Attachment 1 to the TR as a final comprehensive list of applicable regulations used by the NRC to evaluate a future UIUC MMR application. Rather, Attachment 1 to the TR serves only as identification of generally applicable regulations for the applicant's use in developing an application for a CP or OL under 10 CFR Part 50. The NRC staff will determine the full scope of regulations that apply to a future application at the time of submittal based on the regulations that are in effect at that time. For example, regulatory applicability may be affected by future regulatory changes. At the time of approval of this evaluation, the applicability statements in Attachment 1 to the TR are generally correct for the described UIUC MMR.
4. This SE does not override the requirements within the regulations themselves. The information provided in this TR was used to provide an assessment of applicability based on the information available to the NRC staff at the time of the review and represents one potentially adequate method for complying with the regulations. If at the time of the detailed review of an application the applicability determinations noted here conflict with any regulatory requirements or subsequent NRC interpretations of its regulations, those requirements and interpretations would take precedence over the positions in this TR.

CONCLUSION

The NRC staff determined that Attachment 1 to the TR identified a generally acceptable list of applicable regulatory requirements for use in developing a license application for the described UIUC MMR research reactor, subject to the limitations and conditions listed in section 4.0 of this SE. With the exception of the items identified in section 3.2 above, the applicability determinations in Attachment 1 generally identify regulations applicable to the proposed UIUC MMR. A more detailed evaluation of applicable regulations and other necessary requirements for licensing the UIUC MMR will be conducted following the

completion of the facility's design and submittal of a license application. A final NRC staff determination regarding the applicable regulations will await review at the time of a license application submittal based on the regulations that are in effect at that time.

REFERENCES

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3. USNRC, Division of Advanced Reactors and Non-Power Production and Utilization Facilities (DANU), Interim Staff Guidance (ISG), DANU-ISG-2022-01, "Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap," March 2024, ML23277A139.
4. Kairos Power LLC, "Regulatory Analysis for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor," Revision 4, January 18, 2022, ML22018A159.
5. Kairos Power LLC, Approved Version of - "Regulatory Analysis for The Kairos Power Fluoride Salt-Cooled High Temperature Reactor," Revision 4, including NRC Safety Evaluation, June 8, 2022, ML22159A356.
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7. USNRC, Regulatory Guide 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors," Revision 0, April 2018, ML17325A611.

Principal Contributors: S. Jones, NRR
P. Torres, NRR
B. Travis, NRR

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