UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

RESEARCH & TEST REACTOR

University of Illinois Urbana-Champaign High Temperature Gas-cooled Research Reactor: Applicability of Nuclear Regulatory Commission Regulations

TOPICAL REPORT

Issued by

Ultra Safe Nuclear Corporation

to

The University of Illinois at Urbana-Champaign

under

USNRC Project No. 99902094

December, 2022

Document Number	**:**	**IMRDD-MMR-22-04**
Release	**:**	**01**
Status	**:**	**Issued**
Issue Date	**:**	**12/08/2022**
NRC Project No.	**:**	**999020904**

CONFIGURATION CONTROL SUMMARY

Document Revision History

Document No.	Rel.	Date	Prepared By	Revision Description
IMRDD-MMR-22-04	01	12/08/2022	MPR Associates, Inc.	Initial Issue for NRC review

Document Approvals

Approvals	Name/Organization	Title	Signature	Date
Preparer	Storm Kauffman MPR Associates, Inc.	Director, Nuclear Technology		12/8/2022
Engineering	Raheem Rashid MPR Associates, Inc.	Project Manager		12/8/2022
Quality Assurance	Sharon Sanders USNC	Director, Quality Assurance		12/09/2022
Nuclear Division	Zackary Rad USNC	Vice President, Regulatory Affairs & Quality		12/09/2022

Approvals	Name/Organization	Title	Signature	Date
Reviewer	Les Foyto UIUC	Licensing Specialist		12/09/2022
Approver	Caleb Brooks UIUC	Associate Professor & Project Lead		12/09/2022

EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) conducts its reactor licensing activities through regulatory requirements codified in Title 10 – Energy of the Code of Federal Regulations (10 CFR) supplemented by various types of guidance. Title 10 Part 50 – Domestic Licensing of Production and Utilization Facilities is the backbone of the regulatory framework for licensing nuclear facilities.

The University of Illinois at Urbana-Champaign (UIUC) is proposing to construct a research reactor (also known as a non-power utilization facility (NPUF)) using high temperature gas-cooled reactor (HTGR) technology. In particular, UIUC plans to build and operate Ultra Safe Nuclear Corporation's (USNC) Micro Modular Reactor™ (MMR™) HTGR-based design. This topical report (TR) provides the determination of applicability of NRC regulations for licensing, construction, and operation of the MMR at UIUC.

The MMR is an HTGR that is designed to operate at 15 MW(t), but the maximum power will be set at that permitted under a research reactor license. The MMR is planned to be licensed at UIUC as a Class 104(c) NPUF, in accordance with 10 CFR 50.21(c). Some regulations apply only to power reactors. Further, because the MMR does not utilize water moderation or cooling, NRC regulations that are specifically applicable only to water-cooled and/or moderated reactors (i.e., light water reactors) are not relevant.

This TR provides a regulatory gap analysis that evaluates the applicability of NRC regulations to the UIUC MMR at a level of detail necessary to assess their relevance to the UIUC MMR. It identifies regulations that are applicable, that are not applicable based on entry conditions (e.g., type of reactor technology, qualification as an NPUF as opposed to a power reactor), that require a different approach (i.e., meet intent), or that require an exemption.

UIUC is requesting NRC review and approval of the methodology used and determinations of applicability/non-applicability of specific regulations identified in this TR as the licensing basis for the MMR at UIUC. NRC approval of the process for treatment of exemptions is also requested; although approval for exemptions will be requested and justified as part of the application submittal.

CONTENTS

ABBREVIATIONS & ACRONYMS

This list contains the abbreviations and acronyms used in this document.

Abbreviation or Acronym	Definition
ACRS	Advisory Committee on Reactor Safeguards
ADS	automatic depressurization system
AEA	Atomic Energy Act of 1954, as amended
AEC	[U. S.] Atomic Energy Commission
AFWS	auxiliary feedwater system [in LWRs]
AGR	Advanced Gas Reactor [fuel test program]
AP1000	[Westinghouse] Advanced Passive 1000 plant
AR	advanced reactor
ATWS	anticipated transient without scram
BNL	Brookhaven National Laboratory
BWR	boiling water reactor
COL	Combined License [per 10 CFR 52]
COLA	Combined License Application [per 10 CFR 52]
CP	Construction Permit [per 10 CFR 50]
CPA	Construction Permit Application [per 10 CFR 50]
DANU	NRC Division of Advanced Reactors and Non-Power Production and Utilization Facilities
DOE	[U.S.] Department of Energy
DSRS	Design Specific Review Standard
ECCS	emergency core cooling system
EIS	environmental impact statement
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
EQ	environmental qualification [of SSC for accident environmental conditions]
ESBWR	Economic Simplified Boiling Water Reactor
ESP	Early Site Permit [under 10 CFR 52]
FCM™	fully ceramic micro-encapsulated
FHR	[Kairos] fluoride [salt-cooled] high temperature Reactor
FSAR	Final Safety Analysis Report
GAO	Government Accountability Office
GDC	General Design Criteria (i.e., Appendix A of 10 CFR 50)
HALEU	high-assay low-enriched uranium (i.e., enriched 5% to 20% in U-235, exclusive)
HEU	highly enriched uranium (i.e., enriched to at least 20% U-235)
HTGR	high temperature gas-cooled reactor
IAW	in accordance with
IMC	[NRC] Inspection Manual Chapter
ISFSI	independent spent fuel storage facility
ISG	Interim Staff Guidance
ISI	in-service inspection

Abbreviation or Acronym	Definition
ITAAC	inspections, test, analyses, and acceptance criteria
KP	Kairos Power, LLC
LER	licensee event report
LEU	low-enriched uranium (i.e., enriched to 5% or less in u-235)
LEU+	low-enriched uranium plus [enriched in range from 5% to 10%]
LLEA	local law enforcement agency (i.e., the local police)
LOCA	loss of coolant accident
LWA	limited work authorization [under 10 CFR 50]
LWR	light-water reactor
MC	monte-carlo [type of analysis]
MHA	maximum hypothetical accident
MMR™	Micro Modular Reactor™
MW	megawatts
NEI	Nuclear Energy Institute
NEIMA	Nuclear Energy Innovation and Modernization Act [115-439 (01/14/2019)]
NFPA	National Fire Protection Association [issues National Fire Code]
NP	non-power
NPUF	non-power utilization facility
NRC	[U.S.] Nuclear Regulatory Commission
NUREG	nuclear regulatory document
OL	operating license [in accordance with 10 CFR 50]
OLA	operating license application
OMB	[U.S.] Office of Management and Budget
PDC	Principal Design Criteria
PORV	power-operated relief valve
PRA	probabilistic risk assessment
PSAR	Preliminary Safety Analysis Report
PWR	pressurized water reactor
QA	quality assurance
RAG	regulation applicability group
RAI	request for additional information [from NRC]
RCIC	reactor cooling isolation condenser
RCP	reactor coolant pump
RCPB	reactor coolant pressure boundary
RCS	reactor coolant system
RG	Regulatory Guide (also “Reg Guide”)
RTR	research and test reactor
SECY	[NRC staff paper informing or proposing an action item to the NRC Commission]
SME	subject matter expert
SMR	small modular reactor
SNM	special nuclear material
SRM	Staff Requirements Memorandum
SRP	Standard Review Plan
SSCs	structures, systems, and components

Abbreviation or Acronym	Definition
TBD	to be determined
TICAP	Technology Inclusive Content of Application Project
TID	Technical Information Document
TMI	Three Mile Island [plant]
TRISO	Tri-structural Iso-tropic
UCO	Uranium carbonate
USNC	Ultra Safe Nuclear Corporation (i.e., the reactor design vendor)
USNRC	U.S. Nuclear Regulatory Commission
U.S.	United States

1.0 INTRODUCTION

A Micro Modular Reactor (MMR™) is being developed by Ultra Safe Nuclear Corporation (USNC) to be built and operated at the University of Illinois at Urbana - Champaign (UIUC) as a Class 104 utilization facility in accordance with 10 CFR 50.21(c).

1.1. PURPOSE

The purpose of this topical report (TR) is to provide a gap analysis that evaluates the applicability of NRC regulations to the UIUC MMR at a level of detail necessary to assess their relevance and to establish the process for identifying exemptions to NRC regulations (Reference 1). The requested scope of NRC review and approval is identified in Section 1.5.

1.2. BACKGROUND

The MMR is a high temperature gas-cooled reactor (HTGR) designed to operate at 15 MW(t) but limited to the lower of that or the research reactor power limit for UIUC. It uses an inert gas, helium, as the heat transfer fluid. The reactor will be fueled with High Assay Low-Enriched Uranium (HALEU) at an enrichment between 5% and 20% ^{235}U in the form of tri-structural isotropic (TRISO) particles embedded in silicon carbide Fully Ceramic Micro-Encapsulated (FCM™) pellets that are stacked in columns in solid hexagonal graphite blocks. The MMR has a plant life set by its core operating life, which is designed to be approximately 20 years with no need for refueling. The MMR is designed for passive safety response to design basis accidents, and relies on functional containment as the primary means to limit release of radioactivity to the environment.

The UIUC MMR will be licensed under 10 CFR 50, and the construction permit application (CPA) is planned for submittal to the NRC in 2024. As a non-water, non-power reactor, the UIUC MMR does not match the underlying assumptions that form the basis for many NRC regulations. The Nuclear Energy Innovation and Modernization Act (NEIMA) directed the NRC to develop licensing strategies that include the use of TRs to improve the efficiency, timeliness, and cost-effectiveness of licensing reviews.

In Reference 3, the NRC discusses approaches to improving the timeliness and efficiency of advanced reactor licensing reviews through early interactions. A key action is submitting TRs for staff review and approval: principal design criteria (PDC), licensing basis events, safety-classification methodology, fuel qualification and testing plans, accident source term, etc. Preparation and submittal of documents on these matters is underway. In addition, Reference 3 suggests other interactions, including providing “a regulatory gap analysis report listing those 10 CFR 50 or 52 requirements for which the applicant plans to request an exemption or seek a case-specific order or rule of particular applicability.” Reference 3 notes that regulatory gap analysis for non-LWRs should consider the NRC staff draft white paper (Reference 4 and subsequent revisions) on relevance of regulations to non-LWRs.

1.3. REGULATORY EXPECTATIONS

The NRC is continuing to develop requirements and guidance for non-LWRs. The applicability of regulations in this TR is consistent with the current NRC framework for non-light water, non-power reactors and provides reasonable assurance of adequate protection of public health and safety. The process and results of this assessment are consistent with NRC action (Reference 5) on a similar effort by Kairos Power LLC.

The non-light water MMR design in a non-power role is specifically excluded from a number of regulations.

- The determination of relevance of regulations is based on the UIUC MMR meeting the following criteria that limit applicability of some regulations:
  - Operation as a non-power Class 104(c) research reactor. Although the reactor design power rating is 15 MW(t), licensed power will not exceed the lesser of that or the maximum allowable power for qualifying as a research reactor.
  - Use of TRISO fuel particles in pellets formed of a FCM matrix and held in graphite blocks to provide functional containment.
  - Core cooling using a primary heat transfer fluid, helium, that is single phase, chemically inert, and normally operated at less than 500 psig with an accident analysis demonstrating fuel performance limits are met for a complete blow down.
  - The nuclear plant is effectively buffered from external transients by an intermediate molten salt loop. The MMR at UIUC will be tied into the campus utility systems in the nearby Abbott Power Plant. However, the revenue from operation will not exceed the criteria of the Atomic Energy Act to qualify as a Class 104(c) non-power utilization facility.

1.4. SCOPE

UUIC will be applying for a 10 CFR 50 construction permit (CP) and subsequent operating license (OL), using the guidance of the NUREG-1537 (Reference 6) standard review plan. This TR is part of pre-submittal activities to support NRC review of the CP and OL applications.

UIUC is the license applicant and owner/operator of the MMR NPUF, with USNC as reactor designer/vendor/original equipment manufacturer and fuel supplier.

This TR considers regulations associated with preparing the CP and subsequent OL for a research reactor facility in accordance with 10 CFR 50. The facility will be licensed under the provisions of 10 CFR 50.21 as a Class 104(c), non-power utilization facility (NPUF). The MMR is also a non-LWR. These characterizations limit applicability of some NRC regulations.

This TR focuses on relevance of regulations to the UIUC MMR. NRC guidance documents such as regulatory guides are not addressed, because exemptions are not required to deviate from them. Advance agreement on applicability of NRC regulations to the UIUC MMR CP and OL applications will allow the review to proceed in a more efficient and timely manner and is consistent with guidance in Reference 3.

The UIUC preliminary safety analysis report (PSAR) and final safety analysis report (FSAR) will address guidance in accordance with the research reactor standard review plan (Reference 6), as is outlined in Reference 7.

UIUC is not following a combined construction and operating licensing application (COLA) approach for the MMR. Therefore, regulations in 10 CFR 52 are not applicable and will not be individually dispositioned in this TR.

The safety classification of plant structures, systems, and components (SSCs) will be established on a deterministic basis. Therefore, considerations associated with NEI 18-04 and the Technology Inclusive Content of Application Project (TICAP) are not discussed.

1.5. NRC ACTION REQUESTED

UIUC requests that NRC review (Reference 2) and approval of determine acceptability of:

1. The process for determining applicability of regulations to the UIUC MMR (Section 4.1)
2. Applicability/non-applicability of specific regulations identified in this TR as the licensing basis for the MMR at UIUC (Attachment 1)
3. The methodology for identifying and justifying regulatory exemptions (Section 5.0)

2.0 MMR™ TECHNOLOGY

The proposed MMR at UIUC involves technology and safety capabilities considerably different from LWR technology that is the focus of many regulations. For example, the MMR does not require an active or passive emergency core cooling system (ECCS) to rapidly replenish primary coolant to recover the fuel in the event of a rupture of the primary pressure boundary. Large safety margins are provided by:

- Fuel is comprised of tri-structural isotropic (TRISO) particles, which provide a highly effective fission product retention capability. In response to an Electric Power Research Institute (EPRI) TR on the performance of TRISO fuel (Reference 8), the NRC issued a safety evaluation report (Reference 9) with some limitations and conditions that are considered in the MMR design. The superior fission product retention capability of TRISO fuel particles enables the concept of "functional containment" in which these particles serve as the principal containment barrier when operated within the range of experimental qualification. Functional containment is recognized in Regulatory Guide 1.232 (Reference 10), which provides Principal Design Criteria (PDC) for HTGR use in lieu of 10 CFR 50 Appendix A "General Design Criteria" (GDC). Note that RG 1.232 scope is limited to nuclear power reactors, consistent with the GDC.
- A unique feature of the MMR fuel is that the TRISO particles are encased in a Fully Ceramic Micro-encapsulated™ (FCM™) pellet of silicon carbide that provides an additional layer of defense-in-depth for the retention of fission products.
- Low power density of active fuel region leads to slow fuel heat up during loss of heat removal events.
- Low thermal power results in a small inventory available for release of the most limiting short-lived fission products for public safety, such as I-131 and Kr-85. The increased inventory of long-lived fission products associated with a long core life is addressed.
- The low power rating also reduces the decay heat that must be removed in postulated accident, simplifying passive decay heat removal.
- Heat transfer fluid used for core cooling during normal operation is an inert, chemically stable, gas (helium) at less than 500 psig.
- Safety-related core cooling is passive and capable of maintaining fuel and component temperatures below limits with no helium, electrical power, or operator action.
- Secondary heat transfer is by a molten salt loop that effectively isolates the reactor from transients in the adjacent plant power conversion system.
- The reactor is below ground. Although it does not have nor need a leak-tested containment building, it is surrounded by a concrete structure (the citadel) that serves as a barrier to release of radioactivity to the environment and provides protection against external hazards.

This report does not provide a detailed description of MMR safety features nor an assessment of the ability to meet the NRC requirements for protection of the health and safety of the public. The PSAR and ultimately the FSAR will contain the safety basis for the MMR. Table 2-1 is a high-level summary of key features of the MMR design and the significance of differences from LWRs to assist in understanding the justifications for non-applicability of certain regulations discussed later.

Table 2-1. MMR Key Features and Differences from Operating LWRs

Feature	MMR	LWR	Remarks
Operating power level	Lower of 15 MW(t) or allowed research reactor maximum power	3000 to 4400 MW(t) (AP1000 3415 MW(t))	Full MMR power is less than decay heat of large LWR more than 24 hours after shutdown; short-lived fission product inventory is small
Heat transfer fluid	Helium – inert gas; single phase under all conditions; low stored energy	Water – also serves as moderator; scrubs fission products; high stored energy; undergoes phase change that causes high pressure and temperature in surrounding structure	Water coolant causes corrosion, and blowdown can damage safety systems by impingement, pressure, moisture, and temperature
Containment	Functional: TRISO integrity at high temperatures, with supplemental passive barriers for defense-in-depth, continuously confirmed by radiological monitoring while operating	Large containment building: subject to high pressure and temperature; many penetrations requiring active isolation, periodic leak testing, and maintenance	Functional containment is a barrier or set of barriers that effectively limit physical transport of radioactive material to the environment and serve as basis for the revised PDC in RG 1.232
Confinement	Citadel features	N/A	Below ground vault provides fission product barrier, shielding, protection from external hazards
Safety-related ac power systems	None	Class 1E ac distribution and emergency diesel generators	MMR safety is provided by passive systems
Refueling frequency	None (core and plant life are the same)	Every 1.5 to 2 years	Eliminates used fuel handling and storage risk
Fuel form	Uranium oxycarbide (UCO) TRISO particles encased in FCM pellets in a hexagonal graphite fuel blocks	Uranium dioxide pellets encased in zirconium alloy tubes	Negligible fission product release from MMR during operation or accidents
Fuel (^{235}U) enrichment	High assay LEU (HALEU) < 19.75% ^{235}U	LEU < 5% ^{235}U	Both are low-enriched uranium; MMR higher enrichment provides for longer core life
Fuel damage temperature	> 3272˚F (1800˚C)	2200˚F (1204˚C)	Zirconium-water reactions start at about 1800˚F in LWRs
Emergency replenishment of coolant	None; fuel limits met for unmitigated primary system blowdown	Emergency Core Cooling System (ECCS) needed	Must quickly recover LWR fuel with water if loss of coolant occurs
Hydrogen management	External/internal flooding might release hydrogen (graphite-water reaction)	Zirconium-water reaction produces hydrogen if clad exceeds 2200˚F	Acceptance criteria limit mass of LWR fuel clad reacted
Primary system corrosion mechanisms	While helium itself is non-corrosive, contaminants must be controlled to low levels to avoid degradation of graphite and other materials	Various types of stress corrosion cracking; boric acid corrosion (PWRs)	Helium is inert whereas hot water is corrosive unless water chemistry is carefully controlled

2.1. KEY DESIGN FEATURES FOR DETERMINING APPLICABILITY OF REGULATIONS

In the NRC Staff Safety Evaluation Report (SER) for the Kairos regulatory gap analysis (Reference 5), the NRC staff identified key design features that served as justification for differences from LWR requirements.

- Chemically stable coolant – the NRC staff noted that verification of molten salt coolant performance will be necessary. The MMR will use an inert gas, helium, as its heat transfer medium. Helium has previously been used in licensed HTGRs in the U.S. and elsewhere is chemically stable.
- TRISO fuel particles and fuel pebbles – Reference 5 notes the need to confirm performance criteria are consistent with the methodology described in SECY-18-0096, "Functional Containment Performance Criteria for Non-Light-Water-Reactors" (Reference 11). The NRC notes that this includes identifying event sequences and the associated SSCs. Functional containment performance criteria include not only radionuclide retention but also reactivity control and decay heat removal. These aspects will be addressed for the UIUC MMR in subsequent pre-submittal reports and in the PSAR. Note also that the MMR holds its TRISO fuel in FCM compacts in non-moving graphite blocks, eliminating concerns with mechanical wear and variable burnup of pellets but requiring confirmation of FCM capability.
- Intermediate coolant loop – the secondary coolant should be demonstrated as chemically compatible with the reactor coolant. In the MMR design, the inert helium eliminates the possibility of primary/secondary coolant chemical interactions. Although the MMR does not rely on the molten salt secondary coolant for safety-related functionality, it does provide a means to isolate the reactor from transients external to the nuclear plant. Also, the molten salt will include activity from neutron irradiation that must be considered as part of the radiological consequences of design basis events.
- Near atmospheric pressure of reactor coolant system – the NRC staff states that the low-pressure molten salt reactor coolant system in the Kairos design results in a "fundamentally different risk profile," compared to LWRs. Although the MMR primary system is pressurized, the operating pressure is considerably below that in LWRs, the helium coolant is single phase and contains a small amount of stored energy, and blowdown of the reactor coolant system will not challenge the functionality of safety-related SSCs or functional containment.
- Maintain coverage of fuel with reactor coolant – although this is necessary for consistency with design basis event assumptions for many reactor technologies (e.g., LWR, molten salt), it is not meaningful for an HTGR nor necessary for the MMR, which is analyzed for adequacy of safety-related core cooling with the condition of the helium heat transfer system vented.

3.0 REGULATORY FOUNDATIONS

The Atomic Energy Act of 1954 (P.L. 83–703), as amended, provides the statutory authority for the NRC to regulate nuclear facilities. The NRC conducts its reactor licensing activities primarily through regulatory requirements found in Title 10 – Energy of the Code of Federal Regulations (10 CFR) Parts 50 and 52 supplemented by various types of guidance. Administrative and detailed technical provisions are commingled and distributed throughout 10 CFR Parts 1 to 199. Most of these 10 CFR Parts are non-technical or non-utilization facility regulations and, therefore, considered of little or no relevance to designing new reactors. Requirements that may be technology specific are mostly in 10 CFR 20, 50, 51, 52, 71, 72, 73, and 100. The applicability of many items in these Parts of Title 10 is defined within the individual regulations. Even where this is not the case, most of these Parts provide a process for requesting exemptions under specific circumstances with suitable justification.

The 10 CFR 50 approach to licensing a nuclear reactor plant is a well-established two-step process, having been used to license the current US fleet of nuclear reactors within both Class 103 and 104 licenses. The two-part process involves obtaining a CP to build the nuclear plant followed by approval of an OL. All currently operating reactors in the U.S. were licensed in accordance with this approach. Subsequently, the 10 CFR 52 combined operating license (COL) application alternative was issued in 1989 to reduce the potential to delay operation of a construction-complete plant, i.e., build and operate what was licensed. Experience with Part 52 has shown that considerable effort and potential for delay may occur if the application is submitted before detailed design is complete. The UIUC MMR application will use the Part 50 licensing pathway, and Part 52 regulations are not applicable to the project.

3.1. APPLICABILITY OF EXISTING REGULATIONS TO NON-LWR TECHNOLOGIES

The NRC, and its predecessor agency the U.S. Atomic Energy Commission (AEC), previously licensed non-LWRs (i.e., Peach Bottom Unit 1, Fort St. Vrain, Fermi 1). With these non-LWRs in operation (Fort St. Vrain was last to shut down in 1989), restricting applicability of some regulations specific to LWRs was informed by expert knowledge gained in reviewing those non-LWR designs. Therefore, the limitations of applicability to LWRs were actually exercised. Since that time, Part 50 has been continuously refined to address LWR reactor designs, including limited generic content that can be extended to non-LWR designs such as the MMR. However, developing regulations for non-LWRs has only recently become a priority.

The means of distinguishing relevance of specific regulations to specific reactor types has been entry conditions limiting applicability in recognition of technology differences. As noted in SECY-18-0096 (Reference 11):

> *"The NRC's existing regulations and guidance for nuclear reactors were primarily developed for LWRs and the specific events and phenomena related to zirconium clad fuel and water coolant… Non-LWR technologies have operating conditions, coolants, and fuel forms that differ from LWRs. These differences may allow or possibly require different approaches to fulfilling the safety function of limiting the release of radioactive materials."*

Further, NRC regulations have been refined repeatedly for over half a century to define the attributes of a safe design for pressurized and boiling water reactors, which rely on similar safety features. Many of these specializations are explicitly identified for limited applicability (e.g., 10 CFR 50.46 *"Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors"*). However, in other instances, the water-focused nature of requirements is obscure (e.g., 10 CFR 50 Appendix A criteria for containment) or regulations include an unintended LWR bias in that they assume or stipulate characteristics or features that are unnecessary or unsuitable for other reactor types. A few examples are:

Loss of Coolant Accident (LOCA). Many regulations are tied to protection against LOCAs. In a LWR, a LOCA begins with a rupture of the reactor coolant primary pressure boundary (RCPB). Coolant potentially is lost to the point that the fuel clad breaches because it is no longer cooled by water and the fuel overheats and releases fission products. With the rupture discharging a large amount of mass and energy into it, the containment structure must be designed specifically to limit release of radioactivity to the environment during the sustained period that high temperature and pressure persists even after the LOCA blowdown subsides.

The MMR may also suffer a rupture of the primary (helium) pressure boundary, but the TRISO fuel particles limit release of radioactivity very effectively: the fuel itself is the primary containment barrier and is likely to meet radiological dose limits without crediting any other barriers except for defense in depth. Additionally, the pressure created by blowing down into the reactor cavity is relieved quickly by normal leakage, removing the driving force to push radioactivity into the environment. An HTGR is susceptible to some different events such as air ingress into the core in a pressure boundary rupture scenario, but no rapid replenishment of coolant, safety-related ac power, or restoration of flow is necessary to maintain fuel integrity. Thus, most regulations originating out of LWR LOCA scenarios are not relevant for an HTGR.

- Staffing Requirements. Control room operator staffing requirements in 10 CFR 50.54 are based on ensuring sufficient personnel are available to monitor, control, and respond to changes in operating conditions of a design with many active and interacting systems. During shutdown conditions, personnel monitor active decay heat removal and are available to take corrective actions

  In a passive safety design such as the MMR, however, operator intervention is the exception and not a requirement to cope with design basis events. A truly passive decay heat removal capability does not require continuous attention.

Having recognized the need to address non-LWR safety in 10 CFR 50, 52 and other applicable regulations, the NRC, with stakeholder input and direction from Congress, has been making strides toward introducing technology neutral requirements and guidelines that either replace or augment the existing regulatory requirements for non-LWR designs. This is still a work in progress: the NRC has issued some guidance documents (e.g., Regulatory Guide 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors") and is preparing a new set of regulations for non-LWRs, which is expected to be issued as 10 CFR

Part 53. However, the timing of the new Part 53 does not support the schedule for UIUC licensing. The NRC staff has prepared a number of draft guidance documents; these have been referenced by others in TRs and other pre-engagement submittals. This draft documentation and NRC's discussion of future guidance are considered in establishing the approach discussed in this TR.

10 CFR 50.34(a)(3)(i) states that Appendix A, "General Design Criteria for Nuclear Power Plants," establishes minimum requirements for the principal design criteria (PDC) for water-cooled nuclear power plants similar in design and location to plants for which CPs have previously been issued and provides guidance to applicants for CPs in establishing PDC for other types of nuclear power units. Section C of RG 1.232 states

> *"This RG provides guidance to reactor designers, applicants, and licensees of non-LWR designs for developing PDC. Since the GDC in 10 CFR 50 Appendix A are not regulatory requirements for non-LWR designs but provide guidance in establishing the PDC for non-LWR designs, non-LWR applicants would not need to request an exemption from the GDC in 10 CFR Part 50 when proposing PDC for a specific design."*

As shown in Attachment 1, the MMR to be constructed at UIUC will address PDCs without the need for an exemption, as specified in RG 1.232 and because the scope of both 10 CFR 50 Appendix A and RG 1.232 is applicable only to nuclear power reactors. The UIUC MMR will meet the intent of the MHTGR PDC in the regulatory guide.

4.0 APPLICABILITY OF SPECIFIC REGULATIONS TO MMR TECHNOLOGY

Although regulation of non-LWRs has been discussed extensively since the 1990s, the NRC has thus far issued or endorsed only limited official guidance interpreting relevance of specific, existing regulations, or codified regulations that would apply to non-LWRs. Existing regulations specifically stating applicability to LWR structures, systems and components are appropriately limited to LWR technologies. Overall, Title 10 contains many items that either are not or only partially relevant to non-LWR designs such as the HTGR-based MMR design.

Regulation Applicability Groups (RAGs) have been defined (Table 4-1) to categorize the relevance of various specific regulations in accordance with entry conditions or other plain language direction. This section describes the process for assignment of current regulations to a RAG, and the basis for placing a regulation in a specific group. Requirements in 10 CFR Parts 1 through 199 were evaluated, but Part 50 contains the majority of the regulations requiring evaluation for the UIUC MMR. The group assignments go down from the Part level to subparts and below, as necessary. Associated regulatory guidance documents are discussed only where appropriate to support the basis.

Table 4-1. Regulation Applicability Groups for MMR at UIUC

Group	Basis
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 (see Section 4.1) 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 D_2O • Specific time frame: applications submitted prior to 2023 • Specific license application: those that reference a specific project • Application type: other than Part 50 construction permit and OL
2 N/A to NPUF	NPUFs do not need to meet regulations that have entry conditions pertaining to "power reactor." Based upon UIUC qualifying for a Class 104(c) license, which is a non-power reactor, the power reactor regulations are not applicable.
3 Applicable as is	Regulation applies, but portions within down to the paragraph level may not be applicable and would be so noted as exceptions in the subsequent row(s).
3A Modified/partial	Regulation applies subject to specific modifications or only in part, which are not considered to be significant deviations that require an exemption.
3B Meets intent	The underlying safety basis is relevant and must be addressed, but an alternative approach would be more appropriate for the MMR design. Justification to be provided in PSAR and FSAR.
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 will materially deviate from the regulation. UIUC plans to request an exemption.

The process for assigning regulations (or subsections thereof) to the MMR RAGs defined in Table 4-1 takes into consideration available guidance and precedents. The presence of entry conditions is the primary means to determine relevance, such as regulations labeled or otherwise delineated as applicable to specific reactor types, license types, etc. (see Table 4--2). As the completeness of the regulations has not been confirmed through past use for a high temperature gas-cooled research reactor, implementing all the exclusions could leave gaps. If a regulation is not applicable because of an entry condition but the intent is relevant to the UIUC MMR *and* an alternative regulation does not cover the need, then the regulation would be marked as 3B Meets Intent to ensure the underlying principles are satisfied. Otherwise, it is classified as N/A in accordance with groups 1, 2 or 3D of Table 4-2. For those regulations not excluded by an entry condition, the regulation is assessed to determine if it is applicable as-is, only partially applicable or otherwise needs modification, is administrative, or should be considered for exemption.

Where possible, an entire Part or paragraph is evaluated as a unit. However, in many cases and especially in Part 50, entry conditions exist below the paragraph level. For those, a single regulation is assessed as far as necessary down the CFR hierarchy.

Upon completion of preliminary grouping in accordance with the entry conditions in Table 4-2, the results were compared to other sources of potentially relevant information, such as:

1. NRC staff draft white paper – "Analysis of Applicability of NRC Regulations for Non-Light Water Reactors," dated September 2020 (Reference 4) and updated in July 2021 (Reference 12).
2. Kairos Power reactor "Regulatory Analysis" TR (Reference 13) – the methodology was generally found acceptable by the NRC (Reference 5).
3. NRC letter dated November 2020 identifying applicability of a limited set of regulations to the proposed Aurora microreactor design (Reference 14).

If the preliminary grouping differed from one of these references, the UIUC MMR group assignment was reassessed. This resulted in a RAG change in some cases, but the groupings in the cited references were not viewed as dispositive, given different reactor technology or licensing conditions.

Also, publicly available information from the Kairos Power and Oklo Power projects was used to assess the general logic and completeness of this TR in the absence of established regulatory precedent for new design non-LWRs.

4.1. APPLICABILITY IDENTIFIED IN REGULATIONS VIA ENTRY CONDITIONS

Some regulations contain criteria called *"entry conditions"* by the NRC that specify the population of NRC-regulated activities to which they apply. Entry conditions for regulations are based on a variety of distinctions, as summarized in Table 4-2. There are many instances in 10 CFR 50 where a paragraph or underlying sub-paragraph of a regulation identifies limited applicability in terms of these various entry conditions, such as:

- {a} 50.61(2) defines Pressurized Thermal Shock Event as "an event or transient in pressurized water reactors (PWRs)...."
- {b} 50.34(f) states each applicant for a light-water-reactor construction permit or...." Specific items of these Three Mile Island accident actions are further restricted, such as 50.34(f)(1)(ii) and (iv) are labeled “Applicable to PWR’s only” whereas 50.34(f)(1)(v) through (xi) are marked as “Applicable to BWR’s only.” The ESBWR Design Control Document (Reference 15) identifies these criteria in Tier 2 Table 1A-1.
- {c} 50.46(a)(1)(i) starts "Each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets..."
- {d} 50.54(o) stipulates "Primary does not request exemptions from those labeled to be for PWR reactor containments for water cooled power reactors, other than facilities for which the certifications required under 50.82(a)(1) or 52.110(a)(1) of this chapter have been submitted, shall be subject to the requirements set forth in appendix J to this part." Additionally, Appendix J is titled "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors" and its Introduction paragraph state its purpose is "...tests of the leak-tight integrity of the primary reactor containment, and systems and components which penetrate containment of water-cooled power reactors...."
- {e} 50.36(a)(2) stipulates "(2) Each applicant for a design certification or manufacturing license under part 52 of this chapter shall include...." This type of limitation is used throughout 10 CFR 50 to identify which type of license requires specific actions.
- {f} Appendix I is titled, in part "...to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." There are over 20 instances where the appendix specifies use for "light-water-cooled" reactors. However, there is considerable variation in the exact wording.
- {g} 50.55a(g)(6)(ii)(D) *Augmented ISI Requirements Reactor vessel head inspections— (1) Implementation.* Holders of operating licenses or combined licenses for pressurized-water reactors as of or after June 3, 2020 shall implement the requirements of..."

For above examples {a}, {b}, {e}, and {g}, the NRC does not require an application excluded by the entry condition to request an exemption from each (e.g., the design certification application for the Economic Simplified Boiling Water Reactor (ESBWR) did not need an exemption from those items in {b} which applied only to PWRs but did for 50.34(f)(2)(iv) which was not restricted to PWRs (see Reference 16 and Section 1.10 of Reference 15). It would be, therefore, inconsistent with regulatory precedent for the NRC to expect applications for non-LWRs to request an exemption from a requirement that is clearly not relevant and explicitly identified as limited to LWRs, such as examples {c}, {d}, and {f}.

Note that some regulations define limited applicability in their titles. For example, Appendix J to Part 50 is titled “Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors.” This is more obvious but consistent with the entry condition in the 50.54(o) which begins “Primary reactor containments for water cooled power reactors…”

Table 4-2. Entry Conditions for Regulation Applicability

Entry Condition Type	Applicable Conditions	Conditions Not Applicable to UIUC
Utilization facility (i.e., reactor)	Utilization facility	Production facility, byproduct material licensee
Class 104 10 CFR 50.21c	Non-power utilization facility Non-power reactor Research reactor	Stationary power reactor Commercial reactor Power reactor Test reactor Class 103 licensee
License pathway	Part 50 Construction permit applicant OL applicant	Part 52 Design certification Standard design approval Manufacturing license Combined operating license
Reactor technology	Gas-cooled thermal spectrum reactor (HTGR)	Water-cooled reactor Pressurized water reactor (PWR) Boiling water reactor (BWR) Metal clad fuel Medical or isotope reactor
Timing of application	Construction permit application submittal in 2023	Submitted application prior to 2023
Number of units on site	Single unit	Multi-unit site

Applying these entry conditions to determine the need to comply with specific regulations is an established, proven process. Changes in regulations implemented by rulemaking completed within six months of docketing of the CPA will be addressed in accordance with the process described herein.

4.2. NRC DRAFT STAFF WHITE PAPER

During late 2020 and the first part of 2021, the NRC staff issued a draft white paper (Reference 4) providing a detailed breakdown of applicability of existing regulations to non-LWRs, held meetings, and revised the white paper (Reference 12), to facilitate discussion with stakeholders. The document was marked draft with a disclaimer on its cover page that its contents were subject to change and should not be interpreted as agency positions. Its appendix describes a process to use the NRC categorization of applicability of regulations and how to determine the need to request an exemption (the latter is discussed in the next section of this report). This draft appendix starts by stating that a regulation found to not be applicable to any non-LWR need not be addressed in a license application:

> *"There is no expectation that applicants address regulations that are not applicable to any non-LWR on their face."*

The NRC acknowledged that a wider population of regulations than listed might be found to not be applicable to certain types of reactors but that the staff was not ready to do so.
The NRC subsequently included it as Appendix D of a draft interim staff guidance (ISG) document (Reference 17).

The NRC staff white paper grouped regulations into six categories and provides a table for each category listing the regulations and denoting whether each is applicable to a non-LWR power reactor. The categories are listed below, with annotations regarding their relevance to the UIUC MMR in italics.

1. Part 50 regulations to be considered by non-LWR designers (i.e., applicable). *These should be considered for the MMR, but may not be applicable to research reactors.*
2. Select Part 52, Subparts B through D, expected by the NRC staff to be used for most non-LWRs (i.e., applicable). *As the UIUC MMR is being licensed under Part 50, these are not relevant.*
3. Regulations from parts of Title 10, other than Parts 50 and 52, that may apply to non-LWRs at some stage in the licensing process (i.e., potentially applicable). *These should be considered for the MMR, but may not be applicable to research reactors*.
4. Requirements under 10 CFR 50.34(f) (i.e., Three Mile Island (TMI) accident action items) that are only applicable for Part 52 applications because Part 50 has entry conditions that restrict applicability. Applicants are required to demonstrate compliance with the technically relevant TMI items. The NRC notes that the term "technically relevant" allows for a greater degree of flexibility in meeting the regulation. If a sound case can be made that the requirement in question is not technically relevant to a design, the requirement is satisfied without a need for an exemption. The tables in the draft white paper provide generic applicability determinations for non-LWRs, with entry conditions for technical relevancy listed for some items. If the entry conditions are not met, then the regulations are considered not applicable. The 10 CFR 50.34(f) citations not listed are considered not applicable. *Although unlikely to be relevant, these should be considered for the MMR, but may not be applicable to research reactors.*
5. Regulations associated with fission product release, criticality, and the RCPB for which the underlying regulatory basis applies generically, but where regulations contain language that is specific to LWRs. The safety basis of various advanced reactor designs varies widely enough that a generic resolution for each is not currently practical. The NRC states that non-LWR applicants are expected to request exemptions from these regulations, but the precise nature of a requested exemption will depend on the specific technology and how other regulations are being met. *These should be considered for the MMR, but may not be applicable to research reactors*.
6. Regulations in Parts 50 and 52 that apply to all power reactors but reference a 10 CFR 50 regulation that refers specifically to LWRs (i.e., likely not applicable). Because these regulations apply to all power reactors, non-LWR power reactor applicants under 10 CFR Parts 50 or 52 would likely request exemptions from these requirements or could choose to demonstrate compliance. If the application contains the design information already required by NRC regulations to be included in the application, such information should form sufficient bases for these exemptions. Applicants do not need to include the exemption information (e.g., justification of need, scope, evaluation against exemption criteria) of 10 CFR 50.12 but would, instead, include a statement requesting an exemption because the design is a non-LWR and, therefore, not subject to the referenced Part 50 regulations. *These are not applicable for the MMR, a research reactor, and do not require an exemption because of the power reactor entry condition*.

NRC provided a diagram of the process proposed in the draft white paper (repeated here as Figure 4-1) but annotated in orange with details of the UIUC MMR process. The entry condition screening is similar to the NRC's process, with exclusion expanded to include entry conditions pertaining to power reactors. Item with orange ✖ is not relevant because UIUC and USNC provide the exclusion and exemption justifications.

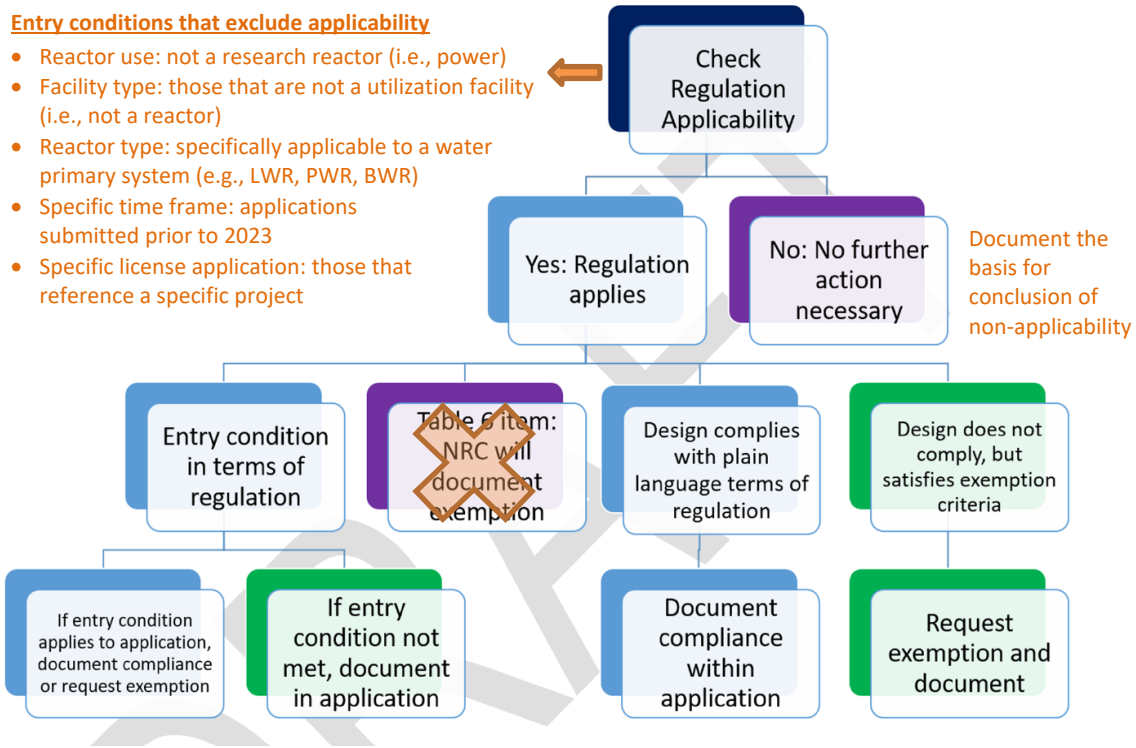

Figure 4-1. Draft NRC White Paper Logic Diagram for Non-LWR Regulation Applicability (Reference 17)

4.2.1. Topical Areas Potentially Requiring Exemptions for Non-LWRs

Table 5 of the draft NRC staff white paper discusses the need for design-specific consideration of three areas: fission product release, criticality, and the RCPB. For each, the NRC states the underlying regulatory basis applies to all reactor technologies, but the regulations contain language that is specific to LWR designs. For the UIUC MMR, each of these is also subject to non-power reactor applicability:

1. Fission product release – 10 CFR 50.34(a)(1)(ii)(D): As 50.34(a)(1) states stationary power reactors should comply with paragraph (a)(1)(ii), this regulation is excluded because the UIUC MMR is a non-power reactor.
2. Criticality monitoring – 10 CFR 50.68(b): Requirements in 50.68 and 70.24 are focused on safety of fuel handling outside the reactor vessel (i.e., unshielded). Paragraph 50.68(a) limits applicability to a nuclear power reactor, requiring compliance with either 50.68(b) or 70.24, and 70.24(d)(1) states 70.24(a) to (c) do not apply to a power reactor complying with paragraph (b) of 50.68. The assumption

is fuel above five percent enrichment requires criticality monitors, but no refueling is required during the MMR life. Safety of fuel handling outside the reactor during initial fuel loading and defueling at end of core life will be shown acceptable without a permanently installed criticality accident monitoring system. The NRC staff white paper states that "In the absence of an exemption, a non-LWR application will be required to describe criticality monitoring required by 10 CFR 70.24." As the UIUC MMR will have fuel enriched above the five percent limit in 50.68(b)(7) and will not require water for moderation, an exemption is considered to be needed. Justification to show criticality is prevented and monitoring is not required will be provided as part of the CPA.

3. RCPB (10 CFR 50.2, 50.36(c)(2)(ii), 50.49(b), 50.65, 10 CFR 50 Appendix S):
    a. 50.2 - *reactor coolant pressure boundary* is defined as all those pressure-containing components of "boiling and pressurized water-cooled nuclear power reactors." The UIUC MMR is a non-power HTGR, making the definition not applicable on two grounds. However, RG 1.232 redefines GDC 14 *Reactor Coolant Pressure Boundary* as the *Reactor Helium Pressure Boundary*. RG 1.232, however, is identified as applicable to nuclear power plants, consistent with 10 CFR 50 Appendix A. Similarly, the definition of *basic component* in regard to the RCPB is limited to power reactors.
    b. 50.36(c)(2)(ii) – although the MMR safety is based on functional containment, maintaining integrity of the helium pressure boundary is appropriate as a defense in depth by reducing occurrence of events potentially leading to a design basis transient. The UIUC MMR will meet the intent of this regulation.
    c. 50.49(b) – this paragraph requires environmental qualification of safety-related electrical equipment that is relied on to ensure the integrity of the RCPB. The MMR uses passive means to ensure safety and is not reliant on any electrical equipment to maintain helium pressure boundary integrity.
    d. 50.65 – monitoring of safety-related and nonsafety-related SSCs important to ensure RCPB integrity is required. The UIUC MMR design will meet the intent of this regulation as a defense in depth measure.
    e. 10 CFR 50 Appendix S – this appendix has an entry condition (in the title) limiting it to power reactors. Therefore, it is not applicable to the UIUC MMR.

4.3. KAIROS POWER LLC

As part of their pre-application engagement, Kairos Power LLC submitted a TR in January 2019 to identify the regulatory requirements applicable to the Kairos Power Fluoride Salt-Cooled High Temperature Reactor (KP-FHR). Subsequently, Kairos decided to first license and build a scaled version of KP-FHR as a test reactor (Hermes) rated at 35 MW(t), according to other documentation. Revision 4 of the TR (Reference 13 considers the latest NRC draft staff guidance including the above described white paper, reflects several iterations of

discussions and RAIs with the NRC staff, and identifies regulation applicability based on screening for a non-power/test reactor with some similar features (non-LWR with TRISO fuel and functional containment).

The Kairos TR categorizes regulation applicability as shown in Reference 13 to determine if they are applicable to both the HERMES test reactor and the KP-FHR power reactor, to only the KP-FHR power reactor, or not at all.

The Kairos TR considered the full set of NRC regulations in 10 CFR Parts 1 through 199 and used Regulatory Guides, Standard Review Plans, Interim Staff Guidance, and generic communications to interpret them. The report identifies regulations that apply, do not apply, do not apply but are relevant, or require an exemption from the regulations. Kairos notes that although some regulations do not literally apply, the intent is considered relevant. Kairos Power sought NRC approval to apply the TR for future applications under Part 50 or Part 52.

This TR uses an approach like that of Kairos to arrive at similar conclusions regarding applicability of specific regulations, allowing for technology differences. However, the Hermes test reactor is subject to some different regulations than the UIUC MMR research reactor (e.g., accident radiation dose limits of 10 CFR 100).

4.3.1. NRC Response

In Reference 5, the NRC staff concludes that the Kairos methodology is acceptable for determining applicable regulatory requirements and that identifying regulations as applicable, not applicable, or requiring an exemption is appropriate. However, the other distinctions regarding administrative, process, design, etc. (i.e., were not assessed, as the assignments "do not alter regulatory requirements)."

The NRC concluded that (except for 10 CFR 50.46 and 46c applicability to a test reactor) the regulations designated as "exemption" may apply (in whole or in part) to the licensing of the Kairos design. Therefore, the NRC declined to act on exemption requests, stating

> *"Accordingly, 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.*
>
> *"Although the NRC staff does not reach a conclusion regarding the appropriateness of all screening criteria, the NRC staff generally finds that the methodology described in the TR is a detailed approach and is acceptable to identify the design and licensing requirements applicable to the KP-FHR."*

The NRC Safety Evaluation provides some generic feedback on the methodology used by Kairos:

- Kairos correctly categorized the applicability of the regulations listed in the appendices for a power or test reactor.

- Kairos' determination "largely conforms with expected applicability of regulations for a generic non-LWR design, as described in the NRC staff draft white paper on that topic" (Reference 12).
- Applications must demonstrate compliance with regulations designated as applicable.
- Those regulations designated as inapplicable need not be met and no information related to these regulations is required in a future application that references the TR, subject to limitations and conditions identified.
- Using knowledge of general design characteristics of the Kairos design submitted as part of pre-application activities, the NRC staff concluded that information was sufficient to distinguish the Kairos design from a LWR design, confirming that requirements applicable to LWRs only do not apply to the proposed Kairos reactor.
- Because inaccuracies were found in some justifications, the NRC staff does not approve the stated bases for the applicability determination, even though the inaccuracies did not invalidate the applicability determination.
- Table entries in the TR sometimes lacked a consistent level of detail, and requirements at a lower level may have applicability different from the higher level of 10 CFR in which they reside.
- Determination of applicable regulations at the time of application submittal may be influenced by ongoing rulemaking efforts at the agency.[1]

Finally, the NRC noted the following process-related caveats:

- The key design criteria (see Section 2.1) noted by the NRC as a technical basis for their review must be met for a Kairos application referencing the TR.
- The NRC will "evaluate an application against the Commission's regulations at the time of a license application submittal." The safety evaluation "does not override the requirements within the regulations themselves." During detailed review of an application, "subsequent NRC interpretations of its regulations…would take precedence over the positions in this TR."[2]
- Despite the determination of applicability, future submittals might refer to some excluded requirements or the NRC might use excluded regulations to inform decisions.
- "Regulatory applicability may depend on the scope of the submittal" (i.e., combined license vs. construction permit).

[1] As the "freeze date" for regulation applicability is generally six months prior to docketing, this statement is interpreted to not expect an application to address rulemaking in progress as of the freeze date.

[2] Presumably, "subsequent NRC interpretations of its regulations" means subsequent to approval of the TR, not subsequent to NRC issuance of the permit or license.

The UIUC methodology described in this TR is aligned with the NRC approval of Kairos' most recent submittal. This TR includes additional relevant information sought by the NRC.

Differences from the approved Kairos applicability determination of specific regulations derives primarily from the technology (HTGR vs. molten salt) and power rating category (research vs. test).

4.4. OKLO POWER, LLC

Whereas Kairos submitted a CPA under 10 CFR 50, Oklo Power LLC submitted a combined license application, intending to obtain a combined construction permit and operating license (COL) under 10 CFR 52. The application included an assessment of applicability of specific regulations. The Oklo license application was rejected by the NRC in January 2020. However, the NRC issued a letter (Reference 14) in November 2020 providing the results of NRC staff review of regulations that Oklo had identified as not applicable to its design. Because of the differences from the Oklo plant in design, licensing pathway, and research reactor designation, the NRC guidance to Oklo was not considered useful for the UIUC MMR.

4.5. UIUC MMR REGULATORY RELEVANCE

The regulations in 10 CFR Parts 1 through 199 were reviewed for applicability to the UIUC MMR license application. Section 5.6 provides an explanation of the process used to determine relevance of regulations to the UIUC MMR project.

4.6. LICENSING ALTERNATIVES

As part of determining how to better accommodate reactor technologies different than assumed for regulations, the NRC has considered alternatives to the normal approach of either compliance with or exemption from regulations. As a result of internal assessments and the provisions of NEIMA, the NRC has focused on creating a new licensing framework by developing 10 CFR Part 53 for non-LWRs, which would take the place of Parts 50 and 52 for at least the technical requirements. Although the NRC is trying to expedite development of Part 53, the UIUC MMR schedule requires seeking a construction permit and operating license before Part 53 is expected to be ready.

In the meantime, the NRC has been pursuing a few initiatives in specific areas, as discussed in Enclosure 1 of SECY 20-0093 (Reference 18). These topics include physical security, emergency preparedness, staffing, aircraft impact, etc. Applicability to the UIUC MMR of revised regulations issued before the freeze dates for the CPA and OLA will be considered.

The NRC points out that procedural alternatives to exemptions have been used successfully in the past to license new technologies. Enclosure 2 of SECY 20-0093 (Reference 18) describes three licensing approaches:

1. Normal licensing process – use exemptions where needed and impose additional requirements through license conditions or rulemaking for non-LWR considerations.

NRC identified minimal schedule impact but potentially adverse to standardization across different applications, burdensome documentation, because of the "relatively burdensome documentation preparation and associated review."

2. Hearing order – a hearing order defining the applicable license review standards and any special standards or instructions. This approach was used for the Louisiana Energy Services, L.P., enrichment facility application. Although possibly most flexible, it was considered to have the highest likelihood of leading to litigation.

3. Rule of particular applicability – requirements tailored to a specific docket could allow for future efficiency gains if subsequent rulemaking for micro-reactors were desired by establishing a precedent. Disadvantages include considerable early applicant and staff effort and having to wait for the rule to be promulgated before issuance of the license.

   An applicant may request that the staff develop a rule of particular applicability or an order (for example, as part of the Commission's notice of docketing and opportunity to request a hearing on the application) to identify requirements particular to its design in lieu of or in addition to seeking exemptions from the applicable requirements. Orders and rules of particular applicability are case-specific, do not apply generically to all non-LWRs, and would require resources and substantial preapplication engagement. During pre-application engagement, the NRC staff and applicant would work together to identify areas where such an order or rule would be useful to clarify the relationship between current regulatory requirements and a specific design and reduce or obviate the need for exemptions. These options are available for use in connection with a specific application, especially in cases where an applicant has a mature design and desires early Commission engagement. At this time, this approach is not anticipated to be used for the MMR.

This TR assumes the normal licensing process because it is more closely aligned with the experience of licensees and the staff. NRC stated that the exemption justification process also would be useful if the NRC decided to pursue project or design-specific rulemaking. Using non-applicability conclusions based on entry conditions will reduce the number of exemptions that need to be processed, thereby improving efficiency and timeliness of the UIUC CPA and OLA reviews.

5.0 EXEMPTION PROCESS

5.1. PROCESS FOR EXEMPTIONS FOR 10 CFR 50

The NRC has a process for applicants to request exemptions from specific regulation(s) in the U.S. Code of Federal Regulations. Each major part of Title 10 of the Code of Federal Regulations has a process for requesting and justifying an exemption to a regulation if certain criteria are met. As the majority of licensing requirements applicable to the UIUC MMR are in 10 CFR Part 50, the exemption process defined in 10 CFR 50.12 is described below with modified wording for brevity and clarity.[3]

10 CFR 50.12(a) The Commission may grant exemptions to regulations in 10 CFR 50 that are

(1) Authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security

(2) At least one of the following special circumstances must be present

(i) Conflict with other NRC rules or requirements

(ii) Applying the regulation is not necessary to achieve the intended purpose

(iii) Compliance would involve undue hardship or costs significantly in excess of those expected

(iv) The exemption would provide a net benefit to the public health and safety

(v) The exemption would provide only temporary relief from the applicable regulation

(vi) Other special circumstances not considered when the regulation was adopted

5.1.1. Exemption Process in Other Parts

The procedural requirements for other Parts of Title 10 are either similar or simplified. For example, Part 74 just states that the

> *"The Commission may, upon application of any interested person or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not endanger life or property or the common defense and security, and are otherwise in the public interest."*

5.2. SUITABILITY OF AN EXEMPTION

The purpose of the exemption requests for non-LWRs such as the MMR is to acknowledge acceptability of differences in technical and design bases and administrative functions to justify how to ensure the health and safety of the public and protection of the environment. Each exemption request is expected to include a specific explanation of how these criteria will be met.

[3] Note that 50.12(b) pertains to an exemption that would allow performing activities in advance of issuance of a construction permit and is omitted, as it is not relevant to the topic at hand, which is applicability of regulations to a non-LWR research reactor.

In general, the basis for an exemption will be:

- Technical and regulatory criteria were developed primarily for LWRs and do not address alternative HTGR design features. Their use will not present an undue risk to the public health and safety and is consistent with the common defense and security.
- One or more of the following special circumstances exist
  - Applying the regulation is not necessary because the non-LWR design provides protection of the public and environment through alternative means.
  - Compliance would involve undue hardship or costs significantly in excess of those expected. For example, imposition of the regulation for emergency ac power would require substantial additional cost for a design accomplishing long-term cooling by passive means.
  - When 10 CFR 50.12 for granting of exemptions was issued, the focus was on LWR safety. Licensing of reactors using alternative technologies to accomplish protection of the public and environment for a non-LWR was not addressed when the regulation was adopted.

5.3. EVALUATIONS OF REGULATORY CONSIDERATIONS FOR NON-LWR TECHNOLOGIES

SECY-20-0093, "Policy and Licensing Considerations Related to Micro-Reactors" (Reference 18) discusses licensing topics related to low power reactors that may necessitate departures from current regulations, related guidance, and past precedents.

> *"Some NRC regulations are written as prescriptive requirements independent of the size and potential consequences of the facility and would likely give rise to exemption requests in micro-reactor applications. In particular, prescriptive staffing and operational requirements developed with large LWR facilities in mind may be more extensive than micro-reactors require to operate safely. Provided a micro-reactor applicant can demonstrate the safety and security of its design and show the facility represents a low risk, the staff recognizes that different licensing and regulatory approaches are appropriate for such facilities.…*
>
> *"Because of the significant differences between large LWRs and micro-reactors, the staff is receptive to requests for exemptions from the existing regulations in the areas above and would evaluate such exemptions on a case-by-case basis using existing agency processes…*
>
> *"In the near term, the staff plans to license micro-reactors under the existing regulations for power reactor licenses in 10 CFR Parts 50 and 52."*

The viability of a microreactor project hinges on predictable, efficient regulatory review. Studies performed by and for the NRC have repeatedly acknowledged the inefficiency of attempting to apply regulations tailored for LWRs to non-LWRs.

- In 2016, "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness" (Reference 19) commented on the efficiency of review of non-LWR applications using regulations and policy aimed at LWR designs:

"The NRC is fully capable of reviewing and reaching a safety, security, or environmental finding on a non-LWR design if an application were to be submitted today. However, the agency has also acknowledged the potential inefficiencies for non-LWR applications submitted under 10 CFR Part 50 or Part 52 that are reviewed against existing LWR criteria, using LWR-based processes, and licensed through the use of regulatory exemptions and imposition of new requirements where design-specific review, analysis, and additional engineering judgement may be required."

- In a briefing for the Commission on April 24, 2018 (Reference 20), a member of the staff of the Office of New Reactors stated:

  "With respect to the existing regulatory structures of CFR Part 50 and Part 52, we believe that they offer flexibility, but not necessarily efficiency. While we have said many times that we can review advanced reactors using the existing regulations, we have also been clear regarding the inefficiency associated with a large number of exemptions. If the resources were available, particularly off-fee based resources, I believe that revising our regulatory requirements to more clearly align with the wide spectrum of potential technologies and uses in a risk-informed and performance-based manner, would significantly increase our review efficiency. It will also be important for us to incorporate the Commission's direction to use risk-informed, design-specific review standards for small modular reactors into our approach for advanced reactor reviews."

- Further, a 2019 review conducted by Brookhaven National Laboratory that was commissioned by NRC (Reference 21) stated:

  "Currently, review and licensing of non-LWR applications requires submittals under 10 CFR Part 50 or 52 that are reviewed against existing LWR criteria, developed largely based on experience with LWR technology, and would necessitate the use of regulatory exemptions and imposition of new requirements where design-specific review, analysis, and additional engineering judgment is required. The vision and strategy, when implemented, is developed to address these potential inefficiencies and provide regulatory certainty for non-LWR applicants."

- The Government Accountability Office (GAO) 2015 report "Nuclear Reactors - Status and challenges in development and deployment of new commercial concepts" (Reference 22) identifies information provided by the NRC that acknowledges the difficulty of use of exemptions for non-LWR licensing:

  "Because of the need for more adjustments and exemptions to apply these processes to an advanced reactor design, time frames for an advanced reactor design would be longer, according to DOE and NRC officials and members of our expert group…"

  "Furthermore, the current NRC certification or licensing processes were described to us by former and current NRC staff as being focused on the reactors that have been built—that is, large LWRs. According to reactor designers, certifying or licensing an

advanced reactor may be particularly time-consuming and difficult, and the need for exemptions to and interpretation of the current processes if applied to advanced reactors could introduce economic uncertainty for the applicants…

"According to the NRC, any new reactor technology can be certified or licensed using existing 10 CFR Part 50 or 52 regulations. However, these deterministic regulations were developed for existing large LWRs, so exemptions would be needed for reactor designs differing significantly from existing large LWRs, or the regulations would otherwise need to be adapted, according to reactor designers and NRC officials. According to NRC officials, these exemptions must be specifically applied for by reactor designers or license applicants before the NRC will actively pursue them, and the pre-application discussions between reactor designers and NRC are intended to help identify these exemption items. Several reactor designers told us that they would like regulations changed in order to lessen the uncertainty introduced by relying on exemptions during the DC or licensing process. According to reactor designers, the uncertainty associated with the need for exemptions increases their development risk by potentially increasing the length of the multiple year DC or license application process..."

The above and other references identify considerable effort to license non-LWRs by requesting exemptions to existing regulations. This TR justifies an approach to alleviate the effort associated with licensing the UIUC MMR to regulations intended for LWRs and to satisfy Congressional direction in NEIMA without any reduction in the level of safety for the UIUC MMR.

5.4. EXCLUSION VS. EXEMPTION – ENTRY CONDITIONS OBVIATE EXEMPTIONS

As discussed in Section 4.1, NRC regulations already contain entry conditions to direct licensees regarding limited or generic applicability. Exemptions requested should be minimized for the following reasons:

- Focus attention during review on those matters where an applicant proposes to deviate from established requirements
- Reduce use of NRC staff resources on matters already addressed in the regulations
- Promote licensing consistency among similar designs
- Avoid the impression that the NRC is waiving/relaxing safety requirements (i.e., "regulating by exemption")
- Requiring an applicant to request exemptions from regulations explicitly labelled as applicable to other designs/activities is inconsistent with NRC's Principles of Good Regulation (Reference 23):
  - Efficiency: "...Where several effective alternatives are available, the option which minimizes the use of resources should be adopted..." Using an entry condition to identify regulations designated as not having applicability avoids the applicant and NRC staff effort to process an exemption to an already excluded condition.

- Clarity: "Regulations should be coherent, logical, and practical. There should be a clear nexus between regulations and agency goals and objectives whether explicitly or implicitly stated. Agency positions should be readily understood and easily applied." If regulations with entry conditions such as “For light-water cooled reactors” are not treated as written (i.e., plain language), applicants and the public will not be able to determine NRC staff expectations in advance of submittal of applications.

5.5. NRC STAFF POSITIONS ON EXEMPTION REQUESTS

NRC guidance discusses licensing non-LWRs to a regulatory framework that mostly assumes large, power LWRs. The process for exemption requests in 10 CFR 50.12 and elsewhere was expected to be used infrequently to accommodate individual design deviations from the regulations. As such, the process entails considerable effort and time from the applicant and the NRC staff. For advanced reactors, a large number of regulations would need permanent exemptions today because the accumulation of LWR-specific guidance without formally issued alternative HTGR criteria leaves a gap in regulatory direction. The NRC has conducted numerous evaluations and meetings regarding this situation, and proposed resolution continues to be a work in progress.

The draft staff white paper treatment of exemptions evolved from Reference 4 to Reference 12. Although marked as “draft,” “not for use,” “subject to change,” and “should not be interpreted as official agency positions,” to Reference 12 provides the most current, detailed, and broad assessment of applicability of extant regulations to non-LWRs. As the NRC has not yet issued official guidance, References 4 and 12 have been used to inform this UIUC MMR TR. The following describes substantive differences among drafts pertaining to the exemption request process.

5.5.1. Original September 2020 draft

The white paper (Reference 4) states that applicants may request exemptions on a case-by-case basis. Then, the NRC will determine if the proposed exemption is authorized by law.

- For a regulation generically not applicable to any non-LWR, the application does not need to include any further information.
  - TMI requirements per 10 CFR 50.34(f) are not applicable to 10 CFR 50 non-LWR applicants. However, Part 52 applicants must address 50.34(f) subject to some exceptions. NRC states that Part 50 applicants shall consider 50.34(f) as applicable in accordance with SECY-15-0002 (Reference 24), which was approved by Staff Requirements Memorandum (SRM) dated September 22, 2015.[4]
- For those regulations generically applicable to non-LWRs, then

[4] Although this SRM was issued in September 2015, the NRC regulations have not been revised to implement it. The NRC has taken the position that these regulations must be evaluated for non-LWRs licensed under Part 50 based on the SRM, pending rulemaking. They were included in the review, as shown in Attachment 1.

- Provide information in the application as to how the requirement is met.
- Table 1 lists areas where the NRC anticipates exemptions.
- If not met, the application must provide a technical justification if requesting an exemption as follows.
  - Identify specifically for what portions of the regulation that an exemption is being requested.
  - Identify at least one special circumstance per 10 CFR 50.12(a)(2) as part of justification for the exemption.
    - Exemption requests should be in their own section of the application.
    - Exemption requests need not repeat technical information presented elsewhere in the application (i.e., reference the relevant portion of the application). Exemption requests using the same technical justification can be bundled together into a single request at the applicant's discretion.
    - An exemption may not always be required, as non-LWR designs may meet a rule through design and application-specific implementations.
    - In other cases (e.g., 50.55a), the regulations may be applicable but not pose requirements
    - Each applicable exemption request will need to be included in the individual licensing action or design certification applications.

5.5.2. Revised July 2021 draft

This section identifies the more significant changes from the September 2020 draft. Note that the numbering of tables differs from the September 2020 draft. Also, an interim revision is not discussed.

- The NRC staff acknowledged that some regulations considered generically applicable may not serve a purpose for certain non-LWR designs.
- Applicants will be required to submit on the docket the information needed to support staff's determinations on the acceptability of each exemption request.
  - As the application will provide information regarding the overall safety of the design, some or all of the basis for exemptions from regulations may be addressed in the application without need for additional justification.
  - The justification for exemption requests will vary. As long as the administrative record demonstrates that the regulatory requirements are met and the exemption request is justified, the NRC considers it acceptable for the format and content of the exemption to differ.
  - In a few special cases, something other than a full exemption request may be appropriate.
  - For regulations inapplicable because of entry conditions already in the rule, applicants should document and support their claim that a requirement is inapplicable because of the entry condition.
  - The NRC will determine if the proposed exemption is authorized by law, which includes identifying at last one special circumstance per 10 CFR 50.12(a)(2).

- For requirements under 10 CFR 50.34(f) (i.e., Three Mile Island (TMI) requirements) regulations are considered not applicable if entry conditions are not met.
- Regulations listed in Table 5 are associated with three topical areas (fission product release, criticality, and RCPB). Although the underlying concern applies to all reactor designs, the regulations include provisions specific to LWR designs. The NRC staff anticipates non-LWR exemptions from these regulations, but the precise nature of each requested exemption will depend on the specific technology and how other regulations are being met. The NRC staff will afford applicants as much flexibility as possible in meeting the underlying purpose of these regulations.

In each of the draft versions, the staff repeatedly emphasizes the importance of early engagement on these topics to facilitate an efficient and effective review.

Note that the July 2021 draft gives more weight to use of entry conditions that are already present in the rule to determine applicability. In these cases, applicants are expected to document and support their claim that a requirement is inapplicable because of the entry condition. Previously, the NRC had espoused the position that not meeting a regulation with an entry condition that limited applicability to LWRs still required an exemption. However, the July 2021 version of the staff draft white paper acknowledges that when a regulation is clearly inapplicable because of conditions limiting its scope, documenting the basis for inapplicability is sufficient, and an exemption need not be requested (see Figure 4-1 of this TR, second row rightmost box and fourth row second box from left).

5.5.3. Interim Staff Guidance

The draft ISG (Reference 17) previously discussed in Section 4.2 identifies scenarios where a regulation may not be applicable and if an exemption request may be appropriate.

If a non-LWR design satisfies an applicable regulation via an alternative approach (e.g., rule of specific applicability), an exemption may not be required if the underlying safety requirement can be shown to be met and appropriately documented.

5.6. UIUC APPROACH

As stated previously, the draft NRC guidance discussed in the above sections provides the best available, albeit unofficial/draft, information on the NRC staff perspective on applicability of specific regulations to non-LWRs. The NRC subsequently approved the Kairos process for determining applicability, but for the UIUC MMR, the initial determination of regulatory applicability was made independently of the NRC draft guidance, which was then used to review the suitability of the rationale. As the UIUC MMR is a research reactor, an additional entry condition is considered. This results in regulations potentially applicable to a non-LWR being excluded.

The alignment between UIUC MMR RAG assignments and the draft NRC guidance can be summarized as:

- If an entry condition in a regulation or the heading of the regulation plainly states it is applicable to a LWR (or other similar terms such as water-cooled), PWR, or BWR, then it is RAG 1 N/A. No justification other than the MMR being an HTGR not meeting the entry condition is required. This RAG is also used to denote any regulation with an entry condition that does not include a utilization facility/reactor.
- If an entry condition in a regulation or the heading of the regulation plainly states it is applicable to a stationary power reactor or nuclear power reactor (or plant) or not applicable to a research reactor, then it is RAG 2 N/A to NPUF. No justification other than the UIUC reactor being a Class 104(c) research reactor not meeting the entry condition is required.
- If the regulation is not excluded by an entry condition and will be satisfied, it is in one of several subgroups to distinguish among several variations.
  - 3 Applicable as is – regulations that are relevant without further consideration
  - 3A Modified/partial – regulations that are not written in a manner suitable for application to the UIUC MMR
  - 3B Meets intent – although not applicable to a high temperature gas-cooled research reactor, the underlying requirement should be met
  - 3C Administrative – for efficiency, applicable requirements not relevant to design or technical aspects are grouped separately
  - 3D NRC, not applicant – some NRC regulations in Parts 1 to 199 of Title 10 pertain to operation of the NRC, not to applicants or licensees.
- If an excluded regulation contains guidance that is safety-significant but not addressed in other applicable regulations, then excluding it could leave a gap. Therefore, it is assigned to RAG 3B, and the CPA will discuss how the intent is met.
- Finally, for regulations not excluded by entry conditions and not planned to be met, exemptions must be requested, as noted by RAG 4.

Table 5-1 outlines the steps of the process used to assess regulation applicability. Attachment 1 of this TR is the results of the assignment of individual parts, sections, and paragraphs to specific RAGs and the rationale for determinations other than Applicable As-is or Administrative.

Table 5-1. Steps in Process to Evaluate NRC Regulation Applicability to UIUC MMR

Step	How Applicability of Regulations Evaluated	Remarks
1	Search 10 CFR 50 Parts 1 to 199 for key distinguishing terms such as "non-power," "NPUF," “power plant,” "water-cooled," "pressurized water," etc. to identify entry conditions to create a list of potentially excluded regulations.	Location of entry conditions varies (e.g., in title, in first sentence of paragraph, at end). Because of the complex organization of several parts, determining applicability involved considerable cross-checking of various parts.
2	Compare to Kairos TR test reactor list (Reference 13) and the NRC response (Reference 5) and reconcile differences.	Most differences result from distinction between test and research reactors
3	Compare to guidance in the NRC staff draft white paper (Reference 12) tables 1) 10 CFR 50 regulations potentially applicable to non-LWRs 3) Regulations other than 10 CFR 50 and 52 (NRC list usually does not distinguish below part level) 4) 10 CFR 50.34(f) TMI requirements 5) areas with anticipated exemptions Reconcile differences.	Most differences result from research reactor designation, some from HTGR technology (e.g., functional containment), and some from both (e.g. 10 CFR 50.46 and 10 CFR Appendix J are not applicable to non-power reactors or to HTGRs.
4	Compare to NUREG-1537 (Reference 6) App. A listing of regulations applicable to non-power reactors, including test reactors and reconcile differences.	For example, 10 CFR 37 had been identified as applicable but was not listed by NUREG-1537 App. A, which was based on 1995 CFR, whereas this Part was added in 2013.
5	For a few regulations where some question remained, review licensed research reactor safety analysis and evaluation reports and/or look for other NRC guidance.	Generally, the higher power research reactors were considered. Other NRC guidance included staff papers (SECYs), federal register rulemaking narratives, etc.

5.7. REQUESTING AND JUSTIFYING EXEMPTIONS

Means for documenting the basis for determination of applicability and need for an exemption are described in the NRC staff draft white paper (Reference 12):

- Although each exemption could be individually justified, applicants may provide information related to the overall safety of the design and, thereby, justify multiple exemptions. Exemption requests using the same technical justification can be bundled together into a single request at the applicant’s discretion.
- Exemption requests ideally should be in their own section of the application, although the exemption requests need not repeat technical information presented elsewhere in the application (the exemption request can reference the relevant portion of the application).

- Applicants will be required to submit on the docket the information needed to support staff's determinations on the acceptability of each exemption request.
- Exemption requests will vary both in content and complexity, and the amount of supporting information needed to justify the technical and regulatory criteria associated with a specific exemption request will vary accordingly. Provided the docketed information demonstrates that the regulatory requirements are met and provides appropriate justification, the format and content of the exemption may vary.

The NRC notes there may be instances where less than a full exemption request may be appropriate, such as entries in the definitions sections or lists of codes and standards which do not impose requirements unless they are referenced in other applicable regulations. Some exemption requests are straightforward enough that providing a basis for them requires little information beyond the description of the design in the final safety analysis report (FSAR) as technical justification.

5.8. NRC REVIEW OF EXEMPTION AND RECOMMENDATIONS FOR NON-APPLICABILITY

The most recent draft staff white paper (Reference 12) discusses NRC actions to process exemption requests. To review the propriety of exemptions, the NRC has identified some process requirements

- Applicants will be required to submit on the docket the information needed to support staff's determinations on the acceptability of each exemption request.
- While some NRC regulations are generically not applicable to non-LWRs, the NRC staff will review applications to ensure that any particular non-LWR design achieves the underlying safety purpose of each such regulation if needed for adequate protection of public health and safety or the common defense and security.
- Although not applicable to the UIUC MMR being licensed under Part 50, the most recent draft staff white paper (Reference 12) states that NRC will prepare and evaluate exemptions for Part 52 regulations that reference Part 50 regulations applicable only to LWRs, even when not requested by the applicant. The white paper notes that the staff reserves the right to request additional information from the applicant.

5.9. UIUC MMR EXEMPTION REQUESTS

Based upon the foregoing guidance and considerations, UIUC MMR exemption requests will be handled as follows:

- Where an exemption to an existing regulation is needed because it is neither excluded by an entry condition nor met for the UIUC MMR, the exemption request will be formally submitted to the NRC with accompanying justification.

- Exemption requests and their justifications will be consolidated in one section of the CPA and OLA, with reference to detailed supporting data elsewhere in the submittals.
- Exemptions will not be requested for those items where the UIUC MMR design meets the underlying intent of a regulation particular to LWRs. See Attachment 1 for regulations (e.g., 50.34(f)(2)(ii) Plant procedure improvement program) for which the MMR will meet the intent but not the particular method of implementation.

6.0 SUMMARY OF PLANNED APPROACH

The UIUC 10 CFR 50 CPA will take the following approach to identify and justify exclusions and exemptions from appropriate regulatory requirements for the non-LWR MMR technology and reactor design. Regardless of regulation applicability, the UIUC MMR will need to demonstrate that protection of the health and safety of site personnel and the public and protection of the environment are provided. The proposed approach is in recognition that justifying acceptability of not complying with regulations that are on the face applicable to other reactor technology is not only inefficient for the applicant and the NRC, but also distracts from evaluation of the safety basis.

In summary: the UIUC MMR approach identifies if an NRC regulation must be met by assessing each regulation as applicable or not on the basis of entry conditions. For those not applicable, the reason will be documented in a formal record. For those applicable, license submittals will detail the method of compliance. If the regulation is applicable but the prescription for compliance is not appropriate, the means and justification for meeting the intent or a suitable modification of the compliance details will be provided. For those found applicable where an alternative is needed, an exemption will be requested and the rationale provided in license submittals and supporting documents. In most cases, the special circumstances for the requested exemption will be differences between the UIUC MMR high temperature gas-cooled research reactor and long-standing LWR-based regulatory framework.

Because of the above criteria, few exemptions will need to be requested for the UIUC MMR, leading to a more efficient and timely review. The results of the regulatory assessment of individual regulations are provided in Attachment 1.

6.1. EXCPECTED EXEMPTIONS

As shown in Attachment 1, few exemptions have been found to be necessary. Use of the entry conditions pertaining to various types of water-cooled reactors and to power reactors excluded virtually all regulations that would have required exemptions, with the exception of the following.

6.1.1. Criticality Accident Requirements

Criticality safety regulations are specified in 10 CFR 50.68 and 70.24. Many power reactors have been granted an exemption to 70.24 requirements for a criticality monitoring system. SECY-97-0155 (Reference 25) discusses commercial nuclear power plant exemptions from 10 CFR 70.24. In particular, it states

> "*At a commercial nuclear power plant, there are only three locations where amounts of SNM sufficient to cause a criticality may be found: the reactor core, the fresh fuel storage area, and the spent fuel pool. SNM other than fuel, such as in fission chamber neutron detectors and in neutron sources, may also be found in some laboratory and storage locations of these plants, but an inadvertent criticality is not considered credible in these areas due to the amount and configuration of the SNM. The SNM that could be assembled into a critical mass at a commercial nuclear power plant is in the form of nuclear fuel. This fuel is not enriched beyond 5.0 weight percent (wt %) uranium-235 (U-235) and commercial nuclear plant licensees have procedures and design features that prevent inadvertent criticality. The inadvertent criticality with which 10 CFR 70.24 is concerned could only occur during fuel-handling operations*."

The SECY observes that fuel is enriched to no more than five percent ^{235}U and, therefore, cannot become critical without both a critical arrangement and moderator. Some of the plants with exemptions may request approval to raise allowable enrichment as part of seeking approval to operate fuel to higher burnup over the next few years.

The situation for the MMR is conceptually similar. Although MMR fuel uses HALEU that may be enriched above five percent and that is contained within graphite blocks that provide moderation, no fuel handling of fuel blocks will be performed at UIUC, except during initial core loading and during disassembly after final reactor shutdown. The PSAR/FSAR will describe the procedural and physical controls for handling the fuel blocks and storing them or describe use of a temporary criticality accident monitoring system. An exemption to 70.24 (or the 50.68 limit to five percent enrichment) will likely be submitted.

6.1.2. Backfitting

Although the publication of the final rulemaking in the Federal Register (53 FR 20610) had the title "Revision of Backfitting Process for Power Reactors," 10 CFR 50.109 Backfitting

contains no entry criteria that would restrict it from full applicability to NPUFs. SECY-19-0062 (Reference 31) states that Backfit Rule is not intended to apply to research and test reactors.[5]

The UIUC MMR is a non-power research reactor. As such, 10 CFR 50.109 does not apply, but the published 10 CFR 50.109 language is not definitive. Therefore, an exemption from 10 CFR 50.109 is planned.

6.1.3. Security and Safeguards

In 10 CFR 73 and 74, which are for physical protection of plants and materials and for material control and accountability, the NRC provides direction to protect against diversion of SNM and against radiological sabotage.

Based solely on the maximum enrichment and amount of ^{235}U in the MMR core, the UIUC facility will have SNM of moderate strategic significance. The MMR core is comprised of HALEU-containing TRISO particles bonded into silicon carbide FCM pellets that are, in turn, loaded into graphite blocks. The MMR core is assembled on-site prior to initial operation; once in the reactor vessel, the blocks are considered inaccessible. Therefore, individual blocks are accessible at the operating site for a short period of time, and even when they are, each block exceeds what an individual (or two) person can carry but contains a relatively small amount of SNM. This size and lack of access to individual blocks is considered to provide more than adequate protection of special nuclear material from theft or diversion.

The MMR plant is protected against external physical threats by several features:

- Fuel enrichment is below 20%.
- The entire nuclear plant is enclosed in a below ground concrete citadel.
- Radiation levels and temperatures in the reactor cavity after a short period of initial operation will be high enough to preclude access by adversaries.
- The core is not refueled, and the vessel is not opened for routine maintenance.
- The low power density simplifies decay heat removal so that no electrical power or SSCs vulnerable to active failures or sabotage serve as possible targets. Thus, the potential for malevolent attack to cause radiological release is low.
- Fuel damage with release of fission products will be shown not to occur for a rupture of the helium boundary and complete depressurization.
- The low power rating creates a small radionuclide source term, presenting a small risk to the health and safety of the public.

Therefore, the UIUC MMR is not a potential target of high risk of radiological consequences.

[5] SECY-19-0062 also includes a revision of the accident radiation exposure limits for research reactors that would raise the limit from the 10 CFR 20 value for normal operation to 1 rem, consistent with the safety basis of many operating non-power reactors. The timing of action on this final rulemaking is uncertain. If implemented, it will affect a few of the regulation applicability determinations in Attachment 1. Any changes will be addressed in the CPA or OLA. A change in the proposed rulemaking to the definition of an NPUF would not change the relevance or conclusions of this TR.

Reference 26 discusses evolution of NRC staff approach to safeguards against diversion of SNM. In place of an initial concept using multiple parameters to define SNM attractiveness, the staff focused on considering only dilution, which corresponds "to the difficulty of acquiring and processing SNM."

"Dilution factor" for solids would be defined as the weight of fissile material divided by the total weight of the SNM material and non-SNM materials which are not mechanically separable from the SNM.[6] For MMR fuel blocks, the dilution factor would be near the lower end of moderately dilute. Under the current draft criteria for categorization, a single block would be no more than a Category II quantity. However, there is only a short window of time when any fuel block would be on-site unirradiated and, once loaded, it would be inaccessible as part of the assembled core.

As proposed in the staff evaluation, the safeguards requirements for the UIUC MMR would be the second to lowest, called "Category II - moderately dilute." Reference 26 states that physical protection measures would be tailored for individual categories and attractiveness levels, which will allow adjusting for differences in material form, size, etc. Table 4-3 of Reference 26 summarizes the protective measures (e.g., access control point search, periodic patrols) but does not require a protected area with security detection nor armed security officers.

UIUC plans to request an exemption/relaxation of certain safeguards and security regulations to treat the largely inaccessible SNM as low strategic significance and to simplify physical security measures in 10 CFR 73.

In addition, as the core is not accessible and SNM is not stored outside the reactor vessel, simplified physical inventory actions will be proposed. The details of what deviations from specific regulations will be included in the CPA.

[6] Mechanically separable is defined as being accomplished by a simple mechanical operation that does not require specialized tools or processes and that does not considerably increase the adversary's mission timeline (time-on-target). In a case of a typical non-power reactor fuel element, SNM cannot be separated from the aluminum matrix of the fuel without chemical processing. Also, the fuel mixture is mechanically bonded to the aluminum cladding and it cannot be separated from the cladding without chemical and/or complex mechanical processing. In this example, SNM is not mechanically separable.

7.0 REFERENCES

1. U.S. Code of Federal Regulations, Title 10, Parts 1 to 199, Nuclear Regulatory Commission
2. NRC, “TR Process,” NRR Office Instruction LIC-500, Revision 9 [ML20247G279]
3. NRC, “DRAFT Pre-application Engagement to Optimize Advanced Reactors Application Reviews,” May 2021 [ML21145A106]
4. NRC, draft white paper, “Analysis of Applicability of NRC Regulations for Non-Light Water Reactors,” September 2020 [ML20241A017]
5. NRC, Kairos Power LLC - Safety Evaluation for, “Regulatory Analysis for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor,” Revision 4, dated May 26, 2022 [ML22159A358]
6. NRC “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors Standard Review Plan and Acceptance Criteria,” NUREG-1537, Part 1 and Part 2, February 1996
7. UIUC, “Proposed Contents of PSAR Using NUREG-1537 Guidance for the Micro Modular Reactor (MMR®)”
8. EPRI, Uranium Oxycarbide (UCO) Tristructural Isotropic (TRISO) Coated Particle Fuel Performance: Topical Report, EPRI-AR-1(NP), 3002015750, May 31, 2019.
9. NRC, “Final Safety Evaluation, Uranium Oxycarbide (UCO) Tristructural Isotropic (TRISO) Coated Particle Fuel Performance: TR EPRI-AR-1(NP) [ML20216A453]
10. NRC, Regulatory Guide 1.232 - “Guidance for Developing Principal Design Criteria for Non-Light Reactors,” Revision 0, April 2018 [ML17325A611]
11. NRC Staff, "Functional Containment Performance Criteria for Non-Light-Water-Reactors," SECY-18-0096, September 28, 2018 [ML18115A157]
12. NRC, draft white paper, “Analysis of Applicability of NRC Regulations for Non-Light Water Reactors, July 2021 [ML21175A287]
13. Kairos Power LLC, “Regulatory Analysis for the Kairos Power Fluoride Salt-Cooled High Temperature Reactor – TR,” Revision 4, Non-proprietary, January 2022 [ML22018A161]
14. NRC, “Applicability of Regulations,” letter from NRC to Oklo, November 17, 2020 [ML20300A593]
15. NRC, “Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design,” Volume 1 (Chapters 1 – 3), NUREG-1996, Volume 1, [ML14099A519]
16. GE Hitachi Nuclear Energy, “ESBWR Design Control Document Tier 2 Chapter 1 Introduction and General Description of Plant Appendices 1A-1D,” 26A6642AF, Revision 10, April 2014 [ML14100A501]
17. NRC, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap, Interim Staff Guidance,” DANU-ISG-YYYY-## [ML21336A702].
18. NRC, SECY-20-0093, “Policy and Licensing Considerations Related to Micro-Reactors,” October 6, 2020 [ML20129J985]

19. NRC, “NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness,” December 2016 [ML16356A670]

20. NRC, “Briefing on Advanced Reactors” (Public Meeting), April 24, 2018 [ML18117A463]

21. Brookhaven National Laboratory, NRC Regulatory History of Non-Light Water Reactors (1950-2019), BNL-211739-2019-INRE, June 10, 2019 [ML19282B504]

22. Government Accountability Office (GAO), “Nuclear Reactors - Status and challenges in development and deployment of new commercial concepts,” GAO-15-652. July 2015

23. NRC, “Principles of Good Regulation,” [ML14135A076]

24. NRC, SECY-15-0002, “Proposed Updates of Licensing Policies Rules, and Guidance for Future New Reactor Applications,” January 8, 2015 [ML13281A382]

25. NRC, “Staff’s Action Regarding Exemptions from 10 CFR 70.24 for Commercial Nuclear Power Plants,” SECY-97-155, dated July 21, 1997

26. NRC, “Rulemaking for Enhanced Security of Special Nuclear Material,” Docket ID: NRC-2014-0118, January 2015 [ML14321A007]

27. NRC, “Standard Review Plan for the Review and Evaluation of Emergency Plans for Research and Test Reactors,” NUREG-0849, October 1983

28. NUREG-1791 “Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m),” July 2005 [ML052080125]

29. NRC, “NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness,” December 2016 [ML16356A670]

30. NRC, Regulatory Guide 2.6, “Emergency Planning for Research and Test Reactors and other Non-Power Production and Utilization Facilities,” September 2017

31. NRC, “Final Rule: Non-Power Production or Utilization Facility License Renewal (RIN 3150-AI96, NRC-2011-0087),” June 17, 2019 [ML18031A001]

32. NEI, “NEI Input on Analysis of Applicability of NRC Regulations for Non-Light Water Reactors,” October 30, 2020 [ML20308A660]

Attachment 1

Assignment of NRC Regulations to UIUC-MMR Regulation Applicability Groups

The Regulation Applicability Group column is formatted to help distinguish different categorizations of regulations. Generally, a dark color with white italics font is used for any regulation deemed not applicable (e.g., because of entry conditions). Specifically, the format key is:

Group	Basis
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 (see Section 4.1) 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 D_2O • Specific time frame: applications submitted prior to 2023 • Specific license application: those that reference a specific project • Application type: other than Part 50 construction permit and OL
2 N/A to NPUF	NPUFs do not need to meet regulations that have entry conditions pertaining to "power reactor." Based upon UIUC qualifying for a Class 104(c) license, which is a non-power reactor, the power reactor regulations are not applicable.
3 Applicable as is	Regulation applies, but portions within down to the paragraph level may not be applicable and would be so noted as exceptions in the subsequent row(s).
3A Modified/partial	Regulation applies subject to specific modifications or only in part, which are not considered to be significant deviations that require an exemption.
3B Meets intent	The underlying safety basis is relevant and must be addressed, but an alternative approach would be more appropriate for the MMR design. Justification to be provided in PSAR and FSAR.
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 will materially deviate from the regulation. UIUC plans to request an exemption.

Explanation of RAG table columns

Part No.	**Title 10 Regulation Topic** **Paragraph hierarchy: Title/Chapter/Part (Subpart)/Section/Paragraph** **Paragraph levels: (a)(1)(i)(A)***(1)(i)*	**UIUC MMR Regulation Applicability Group (RAG)**	**Rationale/Justification/Comment (no entry required for 3, 3C, or 3D responses)**	**NUREG-1537 Part 1 Appendix A**
Parts 1 to 199	Identifying number and title of regulation Rows split up individual Parts (Chapters) of NRC regulations down to the lowest paragraph level to ensure than requirements are properly characterized: - In some cases a whole Part can be assigned to a single RAG - A Part may have all in one RAG with the exception of a few regulations - In some instances, individual paragraphs must be listed to capture entry condition differences	See table key on previous page	Provides clarifying notes to explain reason for assignment to a RAG, differences from NUREG-1537 Appendix A, Kairos topical report, etc.	Entries from reference 6 for regulations applicable to non-power (research OR test) reactors as of 1995

Assignment to UIUC MMR RAGs

Part No.	Title 10 Regulation Topic Paragraph hierarchy: Title/Chapter/Part (Subpart)/Section/Paragraph Paragraph levels: (a)(1)(i)(A)*(1)(i)*	UIUC MMR Regulatory Applicability Group	Rationale/Justification/Comment (no entry required for 3A, 3B responses)	NUREG-1537 Part 1 Appendix A
1	Statement of organization and general information	*3D NRC, not applicant*	NRC organizational information	
2	Agency Rules of Practice and Procedure	3C Administrative		
4	Nondiscrimination in Federally assisted programs or activities receiving Federal financial assistance from the Commission	*3D NRC, not applicant*	NRC administrative procedures	
5	Nondiscrimination on the basis of sex in education programs or activities receiving Federal financial assistance	3C Administrative		
7	Advisory committees	*3D NRC, not applicant*	NRC organizational information	
9	Public records	3C Administrative		
10	Criteria and procedures for determining eligibility for access to restricted data or national security information or an employment clearance	*3D NRC, not applicant*	NRC administrative procedures	
11	Criteria and procedures for determining eligibility for access to or control over special nuclear material	*2 N/A to NPUF*	11.11(a) specifies non-power reactor facilities and storage of fuel thereto are excluded 11.13 excludes non-power reactors from transport regulations by reference to 10 CFR 72.20, 245, 26, and 27. N/A to NPUF is consistent with NUREG-1537 App. A	
12	Implementation of the Equal Access to Justice Act in agency proceedings	*3D NRC, not applicant*	NRC administrative procedures	
13	Program fraud civil remedies	3C Administrative		
14	Administrative claims under Federal Tort Claims Act	3C Administrative		
15	Debt collection procedures	3C Administrative		
16	Salary offset procedures for collecting debts owed by Federal employees to the Federal government	*3D NRC, not applicant*	NRC administrative procedures	
19	Notices, instructions and reports to workers: inspection and investigations	3C Administrative		Y
20	Standards for protection against radiation including appendices, except	3 Applicable as is		Y
	20.1301(e) EPA 40 CFR 190 radiation standards	*2 N/A to NPUF*	Differs from NUREG-1537: 40 CFR 190 limited to power production for public use	Y
	20.1406(b)	*2 N/A to NPUF*	Applicants under part 52; instead use (a)	
	20.2004(b)(1) incineration of waste on-site	*2 N/A to NPUF*	Power reactor licensed under Part 50	

	20.1905(g)	3 Applicable as is	Note that non-power reactors are prohibited from using labeling exemption allowed by paragraph	Y
	20.2201(b)(2)(i) Written reporting	*2 N/A to NPUF*	Holders of an OL for a nuclear power plant; instead use (b)(ii)	
	20.2203(c)	*2 N/A to NPUF*	Holders of an OL for a nuclear power plant; instead use (d)	
21	Reporting of defects and noncompliance, except	3 Applicable as is		
	21.3 Definitions: basic component, commercial grade item, dedication	*2 N/A to NPUF*	When applied to nuclear power plants licensed pursuant to 10 CFR part 50; instead use subsequent paragraph	
	21.3 Definitions: critical characteristics, dedicating entity	*2 N/A to NPUF*	When applied to nuclear power plants licensed pursuant to 10 CFR part 50; no alternative given	
25	Access authorization	3C Administrative		
26	Fitness for duty programs	3B Meet intent	26.3(e) This part does not apply to ...non-power reactor licensees who possess, use, or transport formula quantities of irradiated SNM. UIUC will implement alternative security measures with suitable access authorization provisions per 10 CFR 37 subpart B.	
30	Rules of general applicability to domestic licensing of byproduct material, except	3 Applicable as is	NUREG-1537, App. A states: "Non-power reactor licenses issued under 10 CFR Part 50 contain authorization to receive, possess, and use byproduct material pursuant to 10 CFR Part 30. The Part 50 license states that the receipt, possession, and use of byproduct materials as authorized by the license will be in accordance with the Commission's regulations in 10 CFR Part 30 including Section 30.33."	Y
	Appendix D	*2 N/A to NPUF*	App. D is not applicable per NUREG-1537; App. E also N/A per 1537 but retained as specifically applicable to universities	
31	General domestic licenses for byproduct material	3 Applicable as is		
32	Specific domestic licenses to manufacture or transfer certain items containing byproduct material	*1 N/A*	Application for specific license not required for reactors.	
33	Specific domestic licenses of broad scope for byproduct material	*1 N/A*	Application for specific license not required for reactors.	
34	Licenses for industrial radiography and radiation safety requirements for industrial radiographic operations	*1 N/A*	Radiography be performed by licensed subcontractor	
35	Medical use of byproduct material	*1 N/A*	UIUC MMR is NPUF but has no use for production of radioisotopes for medical or other purposes.	
36	Licenses and radiation safety requirements for irradiators	*1 N/A*	UIUC MMR is NPUF and will not be used as an irradiator	

37	Physical protection of category 1 and category 2 quantities of radioactive material; Subpart A General Provisions, except	3C Administrative	Part 37 was added by 78 FR 17007, Federal Register / Vol. 78, No. 53 / Tuesday, March 19, 2013. Therefore, it is not listed in NUREG-1537 App. A, which was based on 1995 CFR.	*Y* (see Rationale)
	Subpart B, 37.21 to 37.33 - Background Investigations and Access Authorization Program Subpart C, 37.41 to 37.57 - Physical Protection Requirements During Use	*1 N/A*	10 CFR 37.11(b) exempts activities under subparts B & C included in security plan required by Part 73.	
	37.73 Physical protection in transit	*1 N/A*	Applies to shipping licensee (i.e., transporter)	
39	Licenses and radiation safety requirements for well logging	*1 N/A*	Not applicable to reactors	
40	Domestic licensing of source material	*1 N/A*	Not applicable to reactors	
50	Domestic licensing of production and utilization facilities	3A Modified/partial	See breakdown below.	
	50.1 Basis, purpose, and procedures applicable.	3C Administrative	Applicable as is or 3C Administrative, except as noted	Y
	50.2 Definitions.	3B Meet intent	Some definitions may require clarification (e.g., Safety-related structures, reactor coolant pressure boundary, basic component); these will be identified in PSAR	Y
	50.3 Interpretations.	3C Administrative		Y
	50.4 Written communications.	3C Administrative	UIUC MMR is 50.21(c) research reactor; address applications for 50.21(b) or § 50.22	Y, except 50.4(b)(2)(ii)
	50.5 Deliberate misconduct.	3C Administrative		Y
	50.7 Employee protection.	3C Administrative		Y
	50.8 Information collection requirements: OMB approval.	3C Administrative		Y
	50.9 Completeness and accuracy of information.	3C Administrative		Y
	50.10 License required; limited work authorization.	3 Applicable as is	UIUC does not currently plan to request a LWA or ESP	Y
	50.11 Exceptions and exemptions from licensing requirements.	*1 N/A*	Differs from NUREG-1537: UIUC is not an organization to which this is applicable	Y
	50.12 Specific exemptions.	3C Administrative	Process for determining need for exemptions and to justify them is described in TR Section 5.	Y
	50.13 Attacks and destructive acts by enemies of the United States; and defense activities.	3 Applicable as is		Y
	50.20 Two classes of licenses.	3C Administrative		Y
	50.21 Class 104 licenses; for medical therapy and research and development facilities.	3 Applicable as is	UIUC MMR qualifies for Class 104(c) license research reactor	Y, except 50.21(b)
	50.22 Class 103 licenses; for commercial and industrial facilities.	3 Applicable as is	See 50.21	Y

50.23 Construction permits.	3 Applicable as is	UIUC will submit applications for CP per 10 CFR 50	Y
50.30 Filing of applications for licenses; oath or affirmation.	3C Administrative		Y, except 50.30(a)(4) & (5)
50.31 Combining applications.	3C Administrative		Y
50.32 Elimination of repetition.	3C Administrative		Y
50.33 Contents of applications; general information, except as noted	3 Applicable as is		Y, except 50.33(g), (i)
(f)(3) Info required for Part 52 COLA	*1 N/A*	Differs from NUREG-1537: applies to COL under Part 52	Y
50.34 Contents of applications; technical information, see below.	3A Modified/partial	3A because of individual regulation variation shown below	
(a)(1)(i)	3 Applicable as is		Y
(a)(1)(ii) Stationary power reactor applicants after 1996	*2 N/A to NPUF*	Differs from NUREG-1537: applicable after 1537 written	Y: Timing
(a)(2) Summary description of facility	3 Applicable as is		
(a)(3)(i) App A General Design Criteria for Nuclear Power Plants	3B Meet intent	UIUC MMR is research HTGR, GDC and RG 1.232 apply to power reactors. Differs from NUREG-1537: RG 1.232 issued 2018 for use for non-LWRs without need for exemption. UIUC MMR design will consider RG 1.232 App. C relevance for research reactor.	Y: Timing
(a)(3)(ii) Design basis and fuel design info	3 Applicable as is		Y
(a)(4) Preliminary analysis of design and performance, including 50.46 and 50.46a.	3A Modified/partial	MMR is HTGR - 50.46 not applicable (see 50.46)	Y
(a)(6) Preliminary plan for organization, training, and operations	3 Applicable as is		Y
(a)(7) Description of QA plan	3A Modified/partial	UIUC MMR is research reactor, 10 CFR 50 App B N/A	Y
(a)(8) SSCs requiring R&D	3 Applicable as is		Y
(a)(9) Technical qualifications of applicant	3 Applicable as is		Y
(a)(10) Preliminary plan for emergencies	3 Applicable as is		Y
(a)(11) Applicants for CPs on multiunit sites	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(a)(12) Stationary power reactor CPA comply with App S	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(a)(13) Power reactor applicants submit 50.150(b) info	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(b) FSAR	3A Modified/partial	UIUC MMR is non-power research reactor	
(b)(1) to (2)	3 Applicable as is		Y, except 50.34(b)(2)(ii)
(b)(3)	3 Applicable as is		Y

(b)(4) Final analysis per (a)(4), including 50.46	3A Modified/partial	MMR is HTGR - 50.46 not applicable (see 50.46)	Y
(b)(5)	3 Applicable as is		Y
(b)(6) to (6)(vi)	3 Applicable as is		Y
(b)(6)(vii) OLA at multiunit sites	*1 N/A*	UIUC site is single reactor	
(b)(7) and (8)	3 Applicable as is		Y
(b)(9) Protection against pressurized thermal shock per 50.61 & 50.61a	*1 N/A*	MMR is HTGR - 50.61 & 50.61a N/A (see 50.61 & 50.61a)	
(b)(10) Stationary power reactor OLA comply with App S	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(b)(11) Stationary power reactor OLA provide info per 50.34(a)(1)(ii)	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(b)(12) Power reactor applicants submit 50.150(b) info	*2 N/A to NPUF*	UIUC MMR is non-power research reactor	
(c) Physical Security Plan - OLA subject to §§ 73.55 or 73.50 and 73.60	*2 N/A to NPUF*	Differs from NUREG-1537: 73.50 & 73.60 do not apply (see 73.50, 73.55 & 73.60)	Y
(d) Safeguards contingency plan - OLA subject to §§ 73.55 or 73.50 and 73.60	*2 N/A to NPUF*	Differs from NUREG-1537: 73.50 & 73.60 do not apply (see 73.50, 73.55 & 73.60)	Y
(e) Protection against unauthorized disclosure	3 Applicable as is		Y, see also 10 CFR 73.60
(f) Additional TMI-related requirements - light-water-reactor CPA pending as of 1982 meet (f)(1) to (3)	3B Meet intent	MMR is HTGR; also N/A per NUREG-1537 App. A, but evaluate individually	
(f)(1)(ii) AFWS	*1 N/A*	UIUC MMR is HTGR - no AFWS	
(f)(1)(iii) RCP seal	*1 N/A*	UIUC MMR is HTGR - no RCPs	
(f)(1)(ii) and (iv) to (xii) AFWS, stuck PORV, HPCI/RCIC separation…	*1 N/A*	UIUC MMR is HTGR - no AWFS, HPSI, RCIC, ADS, etc.	
(f)(2)(i) Control room simulator	3B Meet intent	UIUC MMR is NPUF HTGR with no safety-related operator response required, but procedure development and training will use a plant computer model	
(f)(2)(ii) Plant procedure improvement program	3B Meet intent	UIUC MMR is new design with new procedures; will track need for improvement	
(f)(2)(iii) Control room human factors	*1 N/A*	UIUC MMR is HTGR	
(f)(2)(iv) Safety parameter display panel	3B Meet intent	UIUC MMR is NPUF HTGR with no safety-related operator response required, safety parameter display panel capability will be integrated into control room displays	
(f)(2)(v) Automatic indication of status of safety systems	3 Applicable as is	UIUC MMR is NPUF HTGR with no active safety systems; status of safety related functions will be incorporated into I&C	
(f)(2)(vi) High point venting of RCS	*1 N/A*	UIUC MMR is HTGR	
(f)(2)(vii) Radiation shielding design review	*1 N/A*	UIUC MMR is HTGR w/very limited release from fuel; source term considered in shield design	

(f)(2)(viii) Post accident sampling	*1 N/A*	UIUC MMR is HTGR - no RCS or containment to sample
(f)(2)(ix) Hydrogen control system	*1 N/A*	UIUC MMR is HTGR - no Zr; H from graphite reactions considered
(f)(2)(x) Relief & safety valves	*1 N/A*	UIUC MMR is HTGR NPUF: PWRs only
(f)(2)(xi) Relief & safety valves	3B Meet intent	Gas pressure relief valve
(f)(2)(xii) Automatic and manual AFWS initiation	*1 N/A*	UIUC MMR is HTGR NPUF: PWRs only
(f)(2)(xiii) Pressurizer heater power	*1 N/A*	UIUC MMR is HTGR NPUF: PWRs only
(f)(2)(xiv) Containment isolation	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(2)(xv) Containment purging	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(2)(xvi) B&W designs only	*1 N/A*	UIUC MMR not B&W PWR
(f)(2)(xvii) Control room instrumentation for containment functions	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(2)(xviii) Coolant instrumentation	3B Meet intent	HTGR monitoring of different parameters
(f)(2)(xix) Post-accident monitoring	3B Meet intent	HTGR monitoring of different parameters
(f)(2)(xx) Power supplies for PORVs, etc.	*1 N/A*	UIUC MMR is HTGR
(f)(2)(xxi) Auxiliary heat removal works without feedwater	*1 N/A*	UIUC MMR is HTGR - no AFWS
(f)(2)(xxii) B&W designs only	*1 N/A*	UIUC MMR is HTGR
(f)(2)(xxiii) B&W designs only	*1 N/A*	UIUC MMR is HTGR
(f)(2)(xxiv) BWRs only	*1 N/A*	UIUC MMR is HTGR
(f)(2)(xxv) Provide onsite Technical Support Center, etc.	3B Meet intent	UIUC MMR is NPUF HTGR and no active safety systems
(f)(2)(xxvi) Leakage control outside containment	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(2)(xxvii) In-plant radiation monitoring	3B Meet intent	UIUC MMR is NPUF HTGR
(f)(2)(xxviii) Control room habitability during accidents	3B Meet intent	UIUC MMR is NPUF HTGR only passive safety systems
(f)(3)(i) Industry experience	3B Meet intent	UIUC MMR is NPUF HTGR, limited operating experience
(f)(3)(ii) QA list includes all SSCs important to safety	3B Meet intent	App B N/A but equivalent safety-related SSC list will exist
(f)(3)(iii) QA program	3B Meet intent	App B N/A but will implement ISO 9001
(f)(3)(iv) Dedicated containment penetrations	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(3)(v) Preliminary design information	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232
(f)(3)(vi) External recombiners	*1 N/A*	UIUC MMR is HTGR - no recombiners
(f)(3)(vii) Management plan for design and construction activities	3C Administrative	

(g) Combustible gas control - CPA after 2003 provide analyses IAW 50.44	3B Meet intent	UIUC MMR is a RTR - 50.44 is limited to power reactors. MMR does not generate significant H_2 during normal operation. For a LWR severe accident, cladding exothermic reaction with water and cladding release large amounts of hydrogen. Reactions of hot graphite with water may liberate CO or H_2 and will be assessed.	
(h)(i) Conformance with SRP - light water OLA after 1982 use SRP revision in effect 6 mo. prior to docketing	*1 N/A*	UIUC MMR is a research NPUF; apply NUREG-1537 SRP revision in effect 6 mo. prior to docketing	
(h)(ii) Conformance with SRP - light water CPA after 1982 use SRP revision in effect 6 mo. prior to docketing	*1 N/A*	UIUC MMR is a research NPUF; apply NUREG-1537 SRP revision in effect 6 mo. prior to docketing	
(i) Mitigation of beyond-design-basis events - power reactors apply 50.155	*2 N/A to NPUF*	UIUC MMR is a research NPUF HTGR	
50.34a Design objectives for equipment to control releases of radioactive material in effluents— nuclear power reactors.	*2 N/A to NPUF*	UIUC MMR is research NPUF	
50.35 Issuance of construction permits.	3C Administrative		Y
50.36 Technical specifications, except	3 Applicable as is	Will apply to OL	
(a)(2) Applicants under Part 52	*1 N/A*	Differs from NUREG-1537: UIUC MMR is under Part 50	Y
(c)(1)(i)(A) and (ii)(A) Safety limits and settings	3 Applicable as is	104 license under 50.21(c): LER retention for 3 yr.	Y
(c)(1)(i)(B) and (ii)(B) Fuel reprocessing plants	*1 N/A*	UIUC MMR is NPUF HTGR, not fuel reprocessing plant	
(c)(2)(ii)(A) Reactor coolant pressure boundary	3B Meet intent	Reactor coolant pressure boundary N/A	Y
(c)(2)(iii)	*1 N/A*	Differs from NUREG-1537: licenses prior to 1995	Y: Timing
(c)(6) Decommissioning - power reactors & NPUF not authorized to operate	*1 N/A*	Differs from NUREG-1537: UIUC MMR will be licensed to operate	Y: Timing
(d) Tech Specs - OL or CP prior to 1969	*1 N/A*	Differs from NUREG-1537: limited to licenses prior to 1969	Y: Timing
50.36a Technical specifications on effluents from nuclear power reactors.	*2 N/A to NPUF*	UIUC MMR is NPUF	
50.36b Environmental conditions.	3 Applicable as is		
50.37 Agreement limiting access to Classified Information.	3C Administrative		Y
50.38 Ineligibility of certain applicants.	3C Administrative		Y
50.39 Public inspection of applications.	3C Administrative		Y
50.40 Common standards.	3C Administrative		
50.41 Additional standards for class 104 licenses, except	3C Administrative		
(a) Medical therapy use	*1 N/A*	Differs from NUREG-1537: UIUC MMR is research reactor, but no medical use	Y: Medical

50.42 Additional standard for class 103 licenses and certifications for commercial power	*2 N/A to NPUF*	UIUC MMR is Class 104(c) research reactor (see 50.21)	
50.43 Additional standards and provisions affecting class 103 licenses and certifications for commercial power.	*2 N/A to NPUF*	UIUC MMR is Class 104(c) research reactor (see 50.21)	
50.44 Combustible gas control for nuclear power reactors.	*2 N/A to NPUF*	UIUC MMR is NPUF	
50.45 Standards for construction permits, operating licenses, and combined licenses, except	3 Applicable as is		Y
(b) COL holder	*1 N/A*	Differs from NUREG-1537: UIUC licensing pathway is Part 50	Y: Part 52
50.46 Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors.	*2 N/A to NPUF*	UIUC is NPUF HTGR	
50.46a Acceptance criteria for reactor coolant system venting systems, for each nuclear power reactor	*1 N/A*	UIUC is NPUF HTGR using non-G138condensible helium, also N/A per NUREG-1537 App. A	
50.47 Emergency plans.	*2 N/A to NPUF*	RIS 2005-02, Rev 1 [ML100340545] states "Section 10 CFR 50.54(q) and Appendix E to Part 50 establish requirements related to emergency plans for research and test reactors."	
50.48 Fire protection	*2 N/A to NPUF*	MHTGR-DC 3 of RG 1.232 applies. NUREG-1537: N/A per App. A and Section 9.3 states a description should be provided of how the facility meets all local building and fire codes. Apply ANSI/ANS 15.17 guidance.	
50.49 Environmental qualification of electric equipment important to safety for nuclear power plants.	3B Meet intent	UIUC MMR is NPUF. Although applicable only to power reactors, evaluate MMR per RG 1.232 MHTGR-DC 4. Note RG 1.97 for accident monitoring is also only applicable to power plants.	
50.50 Issuance of licenses and construction permits.	3C Administrative	No requirements	Y
50.51 Continuation of license.	3C Administrative	Applies after OL issued	Y
50.52 Combining licenses.	3C Administrative		Y
50.53 Jurisdictional limitations.	3C Administrative		Y

50.54 Conditions of licenses, except	3 Applicable as is	UIUC MMR is research reactor to be licensed per Part 52 -50.54 limits to power reactors and Part 52 -50.54(a)(1) limits to licensees subject to 10 CFR 50 App. B, which is N/A to research reactors -Multiple paragraphs limit to licenses in (a)(1): (a)(2) & (3) for power -Paragraphs of this section, except (r) & (gg) and applicable requirements of 50.55a are conditions in every nuclear power reactor operating license. (r) is Reserved; (gg) imposes emergency planning requirements.	Y except
(a), (m)(2) & (3), (o), (s)(2), (t), (w), (z), (bb), and (ff) to (jj)	*2 N/A to NPUF*	NUREG-1537, Part 1, App. A includes all except (a), (m)(2) & (3), (o), (s)(2), (t), (w), (z), (bb), and (ff) to (jj). Determination is made based on NUREG-1537	
50.55 Conditions of construction permits, early site permits, combined licenses, and manufacturing licenses, except	3 Applicable as is		Y
(e)(3)(iii)(C)	3B Meet intent	UIUC MMR is NPUF not subject to App. B. Breakdowns in QA program will be reported IAW approved program.	Y
(f) to (h)	*2 N/A to NPUF*	UIUC MMR is NPUF with CPA submittal after 1983	
50.55a(a) Codes and standards, except	3 Applicable as is	UIUC MMR is NPUF HTGR. Lists codes and standards approved for incorporation by reference, most of which apply to LWRs, but are not mandatory	Y, except 50.55a(a)(2), (b)(2)(iii)
(a)(2) and (b)(2(iii)	*1 N/A*	UIUC MMR is NPUF HTGR	
(b) to (g) for boiling or pressurized water-cooled reactors	*1 N/A*	Differs from NUREG-1537; UIUC MMR is NPUF HTGR	Y
(h) for nuclear power plant	*2 N/A to NPUF*	UIUC MMR is NPUF	Y, timing
(z) Alternatives to codes and standards requirements in 50.55a(b) to (h)	3 Applicable as is	UIUC MMR is NPUF HTGR; (b) to (h) do not apply	
50.57 Issuance of operating license.	3C Administrative		Y
50.58 Hearings and report of the Advisory Committee on Reactor Safeguards.	*2 N/A to NPUF*	(a) requires ACRS review for test reactors	
50.59 Changes, tests and experiments.	3 Applicable as is	See RG 2.8 for further guidance	Y
50.60 Acceptance criteria for fracture prevention measures for lightwater nuclear power reactors for normal operation.	3B Meet intent	UIUC MMR is HTGR NPUF; although N/A to non-LWRs, MMR must be shown to have margin to failure	
50.61 Fracture toughness requirements for protection against pressurized thermal shock events.	*1 N/A*	UIUC MR is HTGR NPUF: a(a)(2) limits to PWRs; HTGR not subject to pressurize thermal shock transients	
50.61a Alternate fracture toughness requirements for protection against pressurized thermal shock events.	*1 N/A*	Same as 50.61	

50.62 Requirements for reduction of risk from anticipated transients without scram (ATWS) events for light- water-cooled nuclear power plants.	*1 N/A*	§ (a) states applicability is LWRs.	
50.63 Loss of all alternating current power.	*1 N/A*	§ (a) states applicability is LWRs. MMR does not have safety-related ac power.	
50.64 Limitations on the use of highly enriched uranium (HEU) in domestic non-power reactors.	3C Administrative	UIUC MMR uses HALEU	Y
50.65 Requirements for monitoring the effectiveness of maintenance at nuclear power plants.	3 Applicable as is	UIUC MMR is HTGR NPUF	
50.66 Requirements for thermal annealing of the reactor pressure vessel, for lightwater reactors.	*1 N/A*	UIUC MMR is HTGR NPUF	
50.67 Accident source term.	*1 N/A*	Applicable to pre-1997 licenses. UIUC MMR-specific source term will be justified.	
50.68 Criticality accident requirements, for power reactors	*2 N/A to NPUF*	UIUC MR is HTGR NPUF. UIUC MMR fresh fuel will be shipped assembled, and no refueling is necessary during the 15-year core life. Therefore, no fuel storage racks are included in the design	
(b)(7) Maximum enrichment 5%.	4 Request exemption	Although 50.68 applies to power reactors, an exemption request may be submitted, as discussed in 70.24 and TR Section 6.1.1.	
50.69 Risk-informed categorization and treatment of structures, systems and components for nuclear power reactors.	*2 N/A to NPUF*	UIUC MMR is a NPUF and not using risk-informed approach.	
50.70 Inspections, except	3 Applicable as is		Y, except (b)(2) & (4)
(b)(2) & (b)(4)	*2 N/A to NPUF*	UIUC MMR is single unit NPUF	
50.71 Maintenance of records, making of reports, except	3C Administrative	Exceptions for 50.22(c) licenses and items applicable to only nuclear power reactors and Part 52 licensees	Y
(b) and (e) to (h)	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.72 Immediate notification requirements for operating nuclear power reactors.	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.73 License event report system.	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.74 Notification of change in operator or senior operator status.	3 Applicable as is		Y
50.75 Reporting and recordkeeping for decommissioning planning, except	3 Applicable as is	UIUC MMUIUC MMR is NPUF, N/A per NUREG-1537 App. AR is HTGR.	Y, except (b), (c), (e)(3)
(b), (c), (e)(1)(iv), (e)(3), (f)(1) to (3)	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.76. Licensee's change of status; financial qualifications.	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A, and UIUC is not an electric utility.	

50.78 Facility information and verification.	3C Administrative		Y
50.80 Transfer of licenses.	3 Applicable as is		
50.81 Creditor regulations.	3C Administrative		
50.82 Termination of license, except	3C Administrative		
(a) For power reactor licensees	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.83 Release of part of a power reactor facility or site for unrestricted use.	*2 N/A to NPUF*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A	
50.90 Application for amendment of license, construction permit, or early site permit.	3C Administrative		
50.91 Notice for public comment; State consultation.	3C Administrative	Introduction states applies to test reactors.	
50.92 Issuance of amendment.	3C Administrative		
50.100 Revocation, suspension, modification of licenses, permits, and approvals for cause.	3C Administrative		
50.101 Retaking possession of special nuclear material.	3C Administrative		
50.102 Commission order for operation after revocation.	3C Administrative		
50.103 Suspension and operation in war or national emergency.	3 Applicable as is		
50.109 Backfitting.	4 Request exemption	UIUC MMR is NPUF, N/A per NUREG-1537 App. A but no relevant entry conditions. See TR Section 6.1.2.	
50.110 Violations.	3C Administrative		
50.111 Criminal penalties.	3C Administrative		
50.120 Training and qualification of nuclear power plant personnel.	3B Meet intent		
50.150 Aircraft impact assessment.	*2 N/A to NPUF*	UIUC MMR is NPUF.	
50.155 Mitigation of beyond-design-basis events.	*2 N/A to NPUF*	UIUC MMR is NPUF.	
Appendix A to Part 50—General Design Criteria for Nuclear Power Plants	*1 N/A*	RG 1.232 is used instead, per RG no exemption required	
Appendix B to Part 50—Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants	*2 N/A to NPUF*	UIUC MMR is RTR	
Appendix C to Part 50—A Guide for the Financial Data and Related Information Required To Establish Financial Qualifications for Construction Permits and Combined Licenses	3C Administrative	First paragraph includes test reactors in scope.	

Appendix E to Part 50—Emergency Planning and Preparedness for Production and Utilization Facilities, except	3A Modified/partial	UIUC MMR is HTGR research reactor with functional containment: - I.3 states "Consequently, the size of Emergency Planning Zones (EPZs) for facilities other than power reactors and the degree to which compliance with the requirements of this section and sections II, III, IV, and V of this appendix as necessary will be determined on a case-by-case basis.[2]" and footnote 2 reads "[2]Regulatory Guide 2.6 will be used as guidance for the acceptability of research and test reactor emergency response plans. See also 85 FR 28436, "Emergency Preparedness for Small Modular Reactors and Other New Technologies." - UIUC MMR is NPUF. NUREG-1537 App. A states subsections I to V are applicable but does not distinguish lower level applicability.	Y, except Subsections V and VI
Appendix F to Part 50—Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities	*1 N/A*	UIUC MMR is NPUF.	
Appendix G to Part 50—Fracture Toughness Requirements	*1 N/A*	UIUC MMR is NPUF HTGR, N/A per NUREG-1537 App. A.	
Appendix H to Part 50—Reactor Vessel Material Surveillance Program Requirements	*1 N/A*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A.	
Appendix I to Part 50—Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents	*1 N/A*	UIUC MMR is NPUF, N/A per NUREG-1537 App. A.	
Appendix J to Part 50—Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors	*1 N/A*	UIUC MMR is HTGR w/functional containment; see RG 1.232	
Appendix K to Part 50—ECCS Evaluation Models	*1 N/A*	UIUC MMR is HTGR NPUF, no ECCS 50.46 and App. K for power reactors, N/A per NUREG-1537 App. A	
Appendix L to Part 50 [Reserved]	*1 N/A*	Reserved	
Appendix M to Part 50 [Reserved]	*1 N/A*	Reserved	
Appendix N to Part 50—Standardization of Nuclear Power Plant Designs: Permits To Construct and Licenses To Operate Nuclear Power Reactors of Identical Design at Multiple Sites	3 Applicable as is		
Appendix O to Part 50 [Reserved]	*1 N/A*	Reserved	
Appendix P to Part 50 [Reserved]	*1 N/A*	Reserved	

	Appendix Q to Part 50—Pre-application Early Review of Site Suitability Issues	*1 N/A*	UIUC MMR is research reactor: 3rd paragraph of Introduction states scope is for power reactors
	Appendix R to Part 50—Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979	*1 N/A*	New reactor
	Appendix S to Part 50—Earthquake Engineering Criteria for Nuclear Power Plants	*2 N/A to NPUF*	UIUC MMR is NPUF: Applicable to power reactors only
51	Environmental protection regulations for domestic licensing and related regulatory functions, except:	3A Modified/partial	Exceptions noted below
	51.1, 51.2, 51.3, 51.4, 51.5, 51.6, 51.10, 51.12 to 17, 51.20 to 22, 51.26 to 30, 51.32 to 35, 51.40, 51.41, 51.45, 51.49, 51.50, 51.53, 51.68, 51.70 to 77, 51.90 to 95, 51.100 to 106, 51.116 to 125, Appendix A	3C Administrative	General environmental info and process.
	51.23 Environmental impacts of continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor.	3 Applicable as is	No ISFSI planned; MMR core will be removed after end of life under DOE Lease and Takeback Program
	51.31	*2 N/A to NPUF*	UIUC MMR is NPUF.
	51.51 Environmental fuel cycle data	*2 N/A to NPUF*	UIUC MMR is NPUF.
	51.52 Environmental effects of transport of fuel & waste	*2 N/A to NPUF*	Applicable to LWRs
	51.54 Environmental Report - Manufacturing License	*1 N/A*	Applicable to manufacturing license, not Part 50 CP or OL
	51.55 Environmental Report - Standard Design Certification	*1 N/A*	Applicable to Part 52 DC, not Part 50 CP or OL
	51.60 Environmental Report - Materials Licenses	*1 N/A*	Applicable to Material Licenses not associated with reactor license
	51.61 Environmental Report – ISFSI or Monitored Retrievable Storage Installation License	*1 N/A*	No ISFSI planned; MMR core will be removed after end of life under DOE Lease and Takeback Program
	51.62 Environmental Report - Land Disposal of Radioactive Waste Licensed Under 10 CFR Part 61	*1 N/A*	UIUC MMR is NPUF HTGR.
	51.66 Environmental Report - Distribution	*1 N/A*	Applicable to Material Licenses not associated with reactor license
	51.67 Environmental information concerning geologic repositories	*1 N/A*	UIUC MMR is NPUF HTGR.
	51.80 & 51.81 Draft EIS - Materials Licenses	*1 N/A*	Applicable to Material Licenses without reactor license.
	51.85 & 51.86 Drafts EISs - Rulemaking	*3D NRC, not applicant*	
	51.88 - Draft EISs - Proposals for Legislation	*3D NRC, not applicant*	
	51.97 Final EISs - Materials Licenses	*1 N/A*	No ISFSI planned; MMR core will be removed after end of life under DOE Lease and Takeback Program
	51.105a Public Hearings, Manufacturing Licenses	*1 N/A*	UIUC MMR is using Part 50 pathway.
	51.107 Public Hearings, combined licenses and limited work authorizations	3A Modified/partial	UIUC MMR is NPUF using Part 50 pathway

	51.108 Public Hearings, ITAAC	*1 N/A*	UIUC MMR is using Part 50 pathway.	
	51.109 Public Hearings for geologic repository	*1 N/A*	UIUC MMR is NPUF HTGR.	
	51 Appendix B	*2 N/A to NPUF*	UIUC MMR is NPUF being licensed for first time.	
52	Licenses, certifications, and approvals for nuclear power plants	*1 N/A*	UIUC MMR is NPUF HTGR per 50.21(c) licensed per Part 50	
54	Requirements for renewal of operating licenses for nuclear power plants	*2 N/A to NPUF*	UIUC MMR is NPUF HTGR.	
55	Operators' licenses except	3 Applicable as is		
	55.5(b)(1) through end of 55.5	*2 N/A to NPUF*	UIUC MMR is NPUF HTGR.	
60	Disposal of high-level radioactive wastes in geologic repositories	*1 N/A*	UIUC MMR is NPUF HTGR.	
61	Licensing requirements for land disposal of radioactive waste	*1 N/A*	UIUC MMR is NPUF HTGR.	
62	Criteria and procedures for emergency access to non-federal and regional low-level waste disposal facilities	*1 N/A*	UIUC MMR is NPUF HTGR.	
63	Disposal of high-level radioactive wastes in a geologic repository at Yucca Mountain, Nevada	*1 N/A*	UIUC MMR is NPUF HTGR.	
70	Domestic licensing of special nuclear material, except	3 Applicable as is	Per NUREG-1537 App. A, SNM license normally part of Part 50 application. 70.24(c) exempts reactors under part 50 from 70.24(b)	
	70.11 DOE and NRC contractors; 70.12 Carriers; 70.13 DoD; 70.14 Foreign military aircraft	*1 N/A*	UIUC is US public education institution; differs from NUREG-1537 App. A	Y
	70.24 Criticality Accident Requirements	4 Request exemption	UIUC MMR fuel is HALEU, but individual fuel blocks will not be handled outside reactor except for initial fuel load and spent fuel transfer into canisters after final shutdown. Prevention of criticality will be justified in exemption submitted with CPA. See 50.68 and TR Section 6.1.1.	
	70.1(b) to (e), 70.13, 70.20b, 70.21(a)(1) and (g), 70.22(b), 70.22(f), 70.22(h), 70.22(k), 70.22(m), 70.23(a)(8) and (10) to (12), 70.23a, 70.31(e), 70.32(k), 70.39, 70.55(c)(1) & (2), 70.59, 70.64.	*2 N/A to NPUF*	UIUC MMR is a research reactor, N/A per NUREG-1537 App. A.	
71	Packaging and transportation of radioactive material	*2 N/A to NPUF*	71.4 defines spent nuclear fuel as being used in a power reactor. Other radioactive material requirements apply.	
72	Licensing requirements for the independent storage of spent nuclear fuel and high-level radioactive waste, and reactor-related greater than Class C waste	*2 N/A to NPUF*	UIUC MMR is NPUF.	
73	Physical protection of plants and materials, except:	3 Applicable as is		
73	73.6 Exemptions 73.20, 73.25, 73.26, 73.27, 73.45, 73.46, 73.70, & 73.72 not applicable: (a) if uranium enrichment <20% (e) SNM at non-power reactors	*2 N/A to NPUF*	UIUC MMR uses HALEU (enrichment >5% to <20%) and is a NPUF, meeting 73.6 on two criteria. Note that 73.21 defines >10 kg of U-235 enriched between 10 and 20% as of moderate strategic significance.	

	73.20, 73.25, 73.26, 73.27, 73.45, 73.46, 73.70, and 73.72.	*2 N/A to NPUF*	Exempt per 73.6
	73.21(a)(i) Protection of Safeguards Information for power reactors	*2 N/A to NPUF*	UIUC MMR is NPUF.
	73.21(a)(1)(ii) Protection of Safeguards Information for research and test reactors	3C Administrative	Applies to NPUF having SNM of moderate or low strategic significance.
	73.23 Safeguards Information - Modified Handling rules	3C Administrative	UIUC MMR meets 72.21(a)(1)(ii)
	Subpart D—Special Nuclear Material of Moderate Strategic Significance	3 Applicable as is	UIUC MMR will use HALEU enriched < 20%.
	73.45(a) to (f), 73.46(c), (e), and (f)	*2 N/A to NPUF*	UIUC MMR is NPUF exempted by 73.6.
	73.50 Requirements for physical protection of licensed activities	*1 N/A*	UIUC MMR will be licensed under Part 50
	73.51 Physical protection of stored spent nuclear fuel and high-level radioactive waste	*1 N/A*	As the core and plant life are the same and no provisions are made for storage of spent nuclear fuel or high-level radioactive waste, the UIUC MMR facility does not meet any of the applicability criteria of 73.51(a).
	73.54, 73.55, 73.77	*2 N/A to NPUF*	UIUC MMR is NPUF.
	73.56, 73.58	*2 N/A to NPUF*	UIUC MMR is NPUF.
	73.60 Additional requirements for physical protection at nonpower reactors possessing ^{235}U enriched to ≥ 20%	*1 N/A*	UIUC MMR will use HALEU enriched < 20%.
	73.67 Fixed site and in-transit requirements for physical protection of SNM of moderate or low strategic significance	4 Request exemption	UIUC MMR has SNM of moderate strategic significance (>10 kg of HALEU), but all contained in prefabricated TRISO particles encased in an FCM matrix pellet loaded into graphite blocks. The fuel blocks are unattractive targets and remain within the reactor vessel throughout the entire operating life. See TR Section 6.1.3.
74	Material control and accounting of special nuclear material	4 Request exemption	UIUC MMR is not refueled, see TR Section 6.1.3.
	74.1, 74.2, 74.4 to 8, 74.11, 74.13, 74.15, 74.17, 74.19, 74.81 to 84	*2 N/A to NPUF*	UIUC MMR is NPUF.
	Subpart C—SNM of Low Strategic Significance - 74.51 to 59	*2 N/A to NPUF*	UIUC MMR SNM is enriched<20%; it is of moderate significance
	74.41, 74.43, 74.45	*1 N/A*	UIUC MMR is NPUF.
	74.31 Nuclear MC&A for SNM of low strategic significance.	3B Meet intent	
	74.33 Nuclear MC&A for uranium enrichment facilities.	*1 N/A*	UIUC MMR is NPUF.
	Subpart D—Special Nuclear Material of Moderate Strategic Significance	3 Applicable as is	
	Subpart E - Formula quantities of SNM	*2 N/A to NPUF*	UIUC MMR is NPUF to be licensed to Part 50
75	Safeguards on nuclear material—implementation of safeguards agreements between the United States and the International Atomic Energy Agency	3 Applicable as is	

76	Certification of gaseous diffusion plants	*1 N/A*	UIUC MMR is NPUF, not an enrichment plant.
81	Standard specifications for the granting of patent licenses	*3D NRC, not applicant*	
95	Facility security clearance and safeguarding of national security information and restricted data	3C Administrative	
100	Reactor site criteria	*2 N/A to NPUF*	UIUC MMR is NPUF research reactor.
110	Export and import of nuclear equipment and material	3C Administrative	
140	Financial protection requirements and indemnity agreements	3C Administrative	UIUC MMR is research reactor; therefore, 140.11(3) applies.
150	Exemptions and continued regulatory authority in Agreement States and in offshore waters under Section 274	*1 N/A*	UIUC MMR is NPUF to be licensed per Part 50.
160	Trespassing on Commission property	*3D NRC, not applicant*	
170	Fees for facilities, materials, import and export licenses, and other regulatory services under the Atomic Energy Act of 1954, as amended	3C Administrative	UIUC is a non-profit educational institution, and the UIUC MMR is NPUF: (a)(4) No application fees, license fees, etc.
171	Annual fees for reactor licenses and fuel cycle licenses and materials licenses, including holders of certificates of compliance, registrations, and quality assurance program approvals and government agencies licensed by the NRC	3C Administrative	171.11 Exemptions. (b) An annual fee is not required for (1) A construction permit or license applied for by, or issued to, a nonprofit educational institution for a production or utilization facility, other than a power reactor, …" UIUC is a non-profit educational institution, and the UIUC MMR NPUF.
	171.1 Annual fees	3C Administrative	
172	Parts 172 through 199 are [RESERVED]	*1 N/A*	