Public Comment Sought - Advanced Non-Light Water Reactor Design Criteria

The NRC Regulatory Framework

In accordance with its mission, the U.S. Nuclear Regulatory Commission (NRC) protects the health and safety of the public and the environment by regulating the design, siting, construction, and operation of commercial nuclear power facilities. The NRC conducts its reactor licensing activities through a combination of regulatory requirements and regulatory guidance. The applicable regulatory requirements are found in Chapter I of Title 10, "Energy," of the Code of Federal Regulations (10 CFR). Chapter I is divided into Parts 1 through 199. Regulatory guidance is additional detailed information on specific acceptable means to meet the requirements in regulation. Guidance is provided in several forms such as in regulatory guides, interim staff guidance, standard review plans, office instructions, review standards, and Commission Policy Statements. These regulatory requirements and guidance represent the entirety of the regulatory framework that an applicant must consider when preparing an application for review by the NRC. A key part of the regulatory requirements is the "General Design Criteria for Nuclear Power Units," which are contained in 10 CFR Part 50 Appendix A. The General Design Criteria (GDC) provide high-level requirements to support the design of nuclear power plants and are addressed in 10 CFR Part 50.34, "Contents of applications; technical information." The current GDC are based on light water reactor technology. As discussed below, the attached non-light water reactor (non-LWR) design criteria were developed as guidance to more appropriately align with non-LWR technology. These non-LWR design criteria are the subject of this invitation for public comment.

The nuclear power plants presently operating in the United States were licensed under the process described in 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities." The NRC and its predecessor, the Atomic Energy Commission, approved construction of these plants between 1964 and 1978 and granted the most recent operating license under 10 CFR Part 50 in 2015. 10 CFR Part 50 evolved over the years to address specific safety issues discovered as a result of operating experience and industry events. Some examples include fire protection in 10 CFR 50.48, emergency plans in 10 CFR 50.47, and aircraft impact assessment in 10 CFR 50.150. Some of these new regulations were applied retroactively to operating reactors while others applied only to new reactors.

The NRC applied its experience in licensing the currently operating fleet of nuclear power plants to the development of 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," which was issued in 1989 and has been used for the most recent new nuclear power plant licensing reviews, reactor design certifications, and early site permits. The regulations in 10 CFR Part 52 are intended to apply lessons learned from licensing the current operating reactor fleet, provide an alternative licensing process to the licensing process described in 10 CFR Part 50, and increase standardization of the next generation of nuclear power plants. For many years, new nuclear power plant licensing and guidance development activities have focused on the licensing processes in 10 Part 52, rather than those in 10 CFR

Part 50. As a result, some Commission decisions regarding new nuclear power plant licensing issues have been incorporated into 10 CFR Part 52, without similar requirements consistently being incorporated into 10 CFR Part 50. For example, 10 CFR Part 52 includes requirements derived from the Commission "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants" (ML003711521), with explicit requirements related to the Three Mile Island items in 10 CFR 50.34(f), severe accidents, probabilistic risk assessment, and other topics, whereas no similar requirements have been incorporated for new 10 CFR Part 50 nuclear power plant applications. In response to recent industry interest in employing the 10 CFR Part 50 process for new designs, SECY 15-0002, "Proposed Updates of Licensing Policies Rules, and Guidance for Future New Reactor Applications" (ML13277A647), was written to request that the Commission confirm that its policies and requirements apply to all new nuclear power plant applications, regardless of the selected licensing approach. The Commission approved the staff's recommendation that the regulations in 10 CFR Part 50 be revised for new power reactor applications to more closely align with requirements in 10 CFR Part 52.

Role of the General Design Criteria in the Regulatory Framework

As mentioned above, the GDC are contained in 10 CFR Part 50 Appendix A, and are an important part of the NRC's regulatory framework. They help to serve as the basis for design, fabrication, construction, testing, and performance requirements for structures, systems, and components (SSCs) that are important to safety; that is, as stated in Appendix A, "SSCs that provide reasonable assurance that the nuclear power plant can be operated without undue risk to the health and safety of the public." The GDC serve as the fundamental criteria for the NRC staff when reviewing the SSCs that make up a nuclear power plant design. They establish the design basis in that they address normal operations, anticipated operational occurrences and postulated accidents. As mentioned earlier, the regulatory framework includes the entire collection of regulation and guidance, which also address severe and beyond design basis accidents.

NRC Policy on Advanced Reactors

The NRC's mission with respect to regulating nuclear power reactors, consistent with its legislative mandate, is to ensure adequate protection of public health and safety, the common defense and security, and the environment. From the NRC staff's regulatory perspective, the characteristics of an "advanced reactor" has evolved over time, and this evolution is expected to continue. For example, the passive features in the AP1000 design were advanced concepts when first introduced. On October 14, 2008, the Commission issued its most recent policy statement regarding advanced reactors and included items to be considered during the design of such reactors. The Commission's 2008 "Policy Statement on the Regulation of Advanced Reactors" (ML082750370), reinforced and updated the policy statements regarding advanced reactors previously published in 1986 and 1994. In part, the 2008 update to the policy states the following:

Regarding advanced reactors, the Commission expects, as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation light-water reactors [i.e., those licensed before 1997]. Furthermore, the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions.

The Advanced Reactor Policy Statement makes clear the Commission's expectations that advanced reactor designs will address all current regulations including those related to severe accidents, beyond design basis accidents, defense-in-depth, and probabilistic risk assessment requirements. Depending on the design attributes of the different non-LWR technologies, regulations and policies may be addressed in different manner than traditional LWRs.

Role of the General Design Criteria for Advanced Non-LWRs

The requirements at 10 CFR 50.34(a)(3), 52.47(a)(3)(i), 52.79(a)(4), 52.137(a)(3) and 52.157(a) state that an application for a construction permit, design certification, combined license, standard design approval, or manufacturing license respectively, must include the principal design criteria (PDC) for the facility. The PDC are derived from the GDC in 10 CFR Part 50 Appendix A. 10 CFR Part 50, Appendix A establishes the applicability of the GDCs to non-LWR designs:

These General Design Criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission. The General Design Criteria are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing the principal design criteria for such other units.

In other words, the current regulations in 10 CFR Part 50, Appendix A, recognize that different requirements may be necessary for non-LWR designs. The preliminary draft of the advanced non-LWR design criteria as developed by the NRC staff are intended to provide stakeholders with insight into the staff's current views on how the General Design Criteria could be interpreted to address non-light water reactor design features; however, these are not considered to be final or binding regarding what may eventually be required from a non-LWR applicant. It is the applicant's responsibility to develop the PDC for its facility based on the specifics of its unique design, using the GDC, advanced non-LWR design criteria, or other design criteria as the foundation. Further, the applicant is responsible for considering public safety matters and fundamental concepts, such as defense in depth, in the design of their specific facility and for identifying and satisfying necessary safety requirements.

The advanced non-LWR design criteria are an important first step to address the unique characteristics of advanced non-LWR technology. Ultimately, a risk–informed, performance-

based advanced non-LWR regulatory framework is envisioned. The NRC is open to new opportunities to explore a risk-informed performance-based regulatory process. The NRC recognizes the benefits to risk informing the advanced non-LWR design criteria to the extent possible, depending on the design information and data available.

DOE-NRC Initiative

In July 2013, the NRC and U.S. Department of Energy (DOE) established a joint initiative to address a key element in the regulatory framework that could apply to advanced, non-LWR technologies—specifically, addressing the existing GDC, which contain aspects that do not directly apply to non-LWR power plant designs. The purpose of the initiative is to assess the GDC to determine whether they apply to non-LWR designs and if not, to propose modifications to address the non-LWR design features. In each case, the underlying safety objective of the GDC still applies. These non-LWR design criteria are intended as regulatory guidance to assist the staff and future applicants. They are not regulatory requirements. 10 CFR Part 50.34(a)(3), "Contents of Applications; Technical Information," requires that an application for a design certification, combined license, standard design approval, or manufacturing license, include the principal design criteria (PDC) for a proposed facility. The non-LWR design criteria provide guidance intended to support the development of the PDC.

The assessment of the GDC with respect to non-LWR designs is being accomplished in two phases. Phase 1 was managed by a team including DOE representatives and its national laboratories, and consisted of reviews and evaluations of applicable technical information. The DOE team reviewed information related to six different types of non-light water reactor technologies (i.e., sodium-cooled fast reactors, lead fast reactors, gas-cooled fast reactors, modular high temperature gas-cooled reactors, fluoride high temperature reactors, and molten salt reactors). Using this information, the DOE then reviewed the existing NRC GDC to determine their applicability and whether they should be modified to reflect non-LWR designs.

The results of DOE's assessment are contained in a DOE report titled, "Guidance for Developing Principal Design Criteria for Advanced (Non-Light Water) Reactors." This report was submitted to the NRC for consideration in December 2014 and is publicly available (ML14353A246 and ML14353A248). In this report, DOE proposed a set of Advanced Reactor Design Criteria (ARDC), which could serve the same purpose for non-LWRs as the GDC serve for light water reactors. The ARDC are intended to be technology-neutral and, therefore, could potentially apply to any type of advanced non-LWR design.

In addition to the technology-neutral ARDC, DOE proposed two sets of technology-specific, non-LWR design criteria. These technology-specific design criteria are intended to apply to sodium fast reactors (SFRs) and modular high temperature gas reactors (mHTGRs), and are referred to as the SFR design criteria (SFR-DC) and the mHTGR design criteria (mHTGR-DC), respectively. During the review, the DOE determined that the safety objective for some of the current GDC were not applicable to SFR and mHTGR technologies so entirely new design

criteria were developed to address unique design features (see section VIIa. and VIIb. of the NRC Draft Advanced Reactor Design Criteria Table).

The NRC is currently undertaking Phase 2 of the initiative. After receipt of the DOE report in December 2014, a multi-disciplinary team from across the NRC was assembled to review the report and other pertinent references and NRC documents, such as NUREGs, reports, and white papers. Some examples include NUREG-1338, "Pre-application Safety Evaluation Report for Modular High Temperature Gas-Cooled Reactor (mHTGR)" (ML052780497); NUREG-1368, "Pre-application Safety Evaluation Report for PRISM LMR" (ML063410561); and "Next Generation Nuclear Plant – Assessment of Key Licensing Issues" (ML14174A626). The NRC held a public meeting on January 21, 2015, (meeting summary available at ML15044A081) to discuss the report with DOE and to describe NRC's plans to develop regulatory guidance for advanced reactor design criteria.

During its review, the NRC staff formulated questions and clarifications necessary to obtain a full understanding of design aspects of the non-LWR technologies and the reasoning that DOE employed in developing its proposal for the ARDC, SFR-DC, and mHTGR-DC. The NRC questions, and DOE responses to those questions, are publicly available at ADAMS Accession Numbers ML15154B575 and ML15223B331 (NRC letters), and ML15204A579 and ML15272A096 (DOE responses), respectively.

After consideration of the DOE report and other applicable information relevant to the NRC regulatory philosophy and current understanding of non-LWR designs, the NRC developed these draft safety ARDC, SFR-DC, and mHTGR-DC. It is important to note that the current GDC are regulations and therefore use the words "shall" and "must" that are appropriate for regulatory requirements. The proposed safety ARDC, SFR-DC, and mHTGR-DC also utilize the words "shall", and "must" for consistency, but any Regulatory Guide that ultimately incorporates these design criteria will be guidance and not regulatory requirements. The "shall" and "must" language will apply only to those applicants that commit to the use of the Regulatory Guide. The NRC is not currently planning a rulemaking to add these advanced reactor design criteria to 10 CFR 50.

Process

The NRC staff believes that obtaining public comments on this draft version under development will be beneficial. Therefore, the ARDC, SFR-DC, and mHTGR-DC, along with the NRC's initial rationale for each, are being made available on the NRC website for comment.

After receiving and considering comments, the NRC staff intends to develop a draft Regulatory Guide (RG) that will include revised ARDC, SFR-DC, and mHTGR-DC, as appropriate, and any related explanatory text. As part of the RG process, the draft RG will be made available for public comment through a federal register notice (FRN). After receiving and considering public comments on the draft RG, the NRC staff intends to issue a final RG that will provide guidance to non-LWR applicants when developing appropriate principal design criteria for their facilities.

While developing the final RG, the NRC intends to consider the extent to which risk-informing the ARDC, SFR-DC, and mHTGR-DC is possible given the level of design information and data available.

Other Advanced Non-LWR Activities

In addition to providing design criteria related to safety considerations, the staff is contemplating design considerations related to security requirements. This information is forthcoming and will be issued for comment separately.

The NRC is also considering a step-wise licensing strategy within the current NRC licensing framework in response to external stakeholders' expressed interest in finding an approach that will allow a potential applicant to address portions of a nuclear power plant design and applicable regulations as they are finalized. Agreed-upon portions of finalized design information would be submitted to gain regulatory feedback with the expectation that it is to support a future application. It is expected that proposed PDC for a non-LWR design will be a key early element to informing the content of future submittals.

Topics Open for Comment

The specific information on which the NRC is seeking comment is included in the Draft Advanced Reactor Design Criteria Table (Attachment 1). The table consists of eight sections (I –VII). The table in Sections I-VI has four columns. These ARDC, SFR-DC, and mHTGR-DC follow the existing GDC format:

Column 1 – Contains the current GDCs that are specified in 10 CFR Part 50, Appendix A. The NRC **is not seeking** comments on the information in this column because the requirements for light-water reactors are not being revised.

Column 2 - Contains the draft ARDC and the NRC's rationale for any adaptations from the current GDC. The NRC **is seeking** comments on the information in this column because this is new information.

Column 3 - Contains the draft SFR-DC and the NRC's rationale for the adaptations from the current GDC. The NRC **is seeking** comments on the information in this column because this is new information.

Column 4 - Contains the mHTGR-DC and the NRC's rationale for the adaptations from the GDC. The NRC **is seeking** comments on the information in this column because this is new information.

Section VII.a and VII.b contain additional SFR-DC and mHTGR-DC respectively. The NRC **is seeking** comments on the information in this column because this is new information.

In addition to the contents of the columns described above, the NRC is specifically seeking comments on the following:

- 1. Are the ARDC generally applicable to the different types of non-LWRs being developed by different companies? Are there any additional criterion that should be added?
- 2. Should the current regulations that an applicant must address be incorporated into the ARDC? If so, which ones?
- 3. Are the SFR-DC and mHTGR-DC generally applicable to the different designs of SFRs and mHTGRs being developed by different companies? Are there any additional criterion that should be added?
- 4. There are several new approaches within the ARDC, SFR-DC, and mHTGR-DC, such as:
 - use of "functional containment" for mHTGR-DC,
 - use of "specified acceptable radionuclide release design limits" (SARRDLs) in the mHTGR-DC in place of specified acceptable fuel design limits (SAFDLs),
 - incorporation of GDC 35, "Emergency core cooling system," with GDC 34, "Residual heat removal," as applicable, and
 - the role of the SFR residual heat removal system during postulated accidents.

Are these approaches appropriately addressed in the proposed criteria?

Commenting Instructions

Comments will be accepted for a 60 day period beginning on April 8, 2016, and ending June 8, 2016.

Comments can be made by using the <u>Comments Form</u>. Once you have completed entering your comments into the form, please click the "submit" button and the NRC will automatically receive your comments. Alternatively, you can email your comments to <u>AdvancedRxDCComments.Resource@nrc.gov</u>. Comments will not be responded to individually but will be considered by the NRC staff when developing the draft RG.

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
1	<i>Quality standards and records.</i> Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.	Same as GDC	Same as GDC	Same as GDC

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
2	Design bases for protection against natural phenomena. Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed.	Same as GDC	Same as GDC	Same as GDC

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
3	<i>Fire protection.</i> Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.	Fire protection. Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room with safetyrelated equipment or structures, systems, and or components important to safety. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components. Rationale The phrase containing examples where noncombustible and heat	Same as ARDC	Same as ARDC

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		resistant materials must be used has been broadened to apply to all advanced reactor designs.		

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
4	<i>Environmental and dynamic</i> <i>effects design bases.</i> Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of- coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.	Environmental and dynamic effects design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss of coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.	Same as ARDC	Same as ARDC

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		Rationale		
		This change removes the LWR emphasis on loss of cooling accidents (LOCAs) that may not apply to some designs. For example, helium is not needed in a mHTGR to remove heat from the core during postulated accidents and does not have the same importance as water does to LWR designs to assure that fuel integrity is maintained. Therefore, a specific reference to "loss of coolant accidents" is not applicable to all designs. LOCAs may still require analysis in conjunction with postulated accidents if relevant to the design. Reference to pipe whip may not be applicable to designs that operate at low pressure.		

	I. Overall Requirements			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
5	Sharing of structures, systems, and components. Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.	Same as GDC	Same as GDC	Same as GDC

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
10	Reactor design. The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.	Same as GDC	Same as GDC	Reactor design. The reactor core-system and associated coolant heat removal, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel-core radionuclide release design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.
				Rationale The specified acceptable fuel design limits (SAFDL), which prevents additional fuel failures during AOOs, has been replaced with the concept of specified acceptable radionuclide release design limits (SARRDL), which limits the amount of radionuclide inventory that escapes the fuel and circulates within the helium coolant boundary under normal operations and AOO conditions. The TRISO fuel of the mHTGR design is the primary fission product barrier and is expected to have very

	II. Multiple Barriers			
Critorion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
onterion		Rationale for Modification	Rationale for Modification	Rationale for Modification
				low incremental fission product release during AOOs. As noted in NUREG-1338, "Pre- application Safety Evaluation Report for the Modular High- Temperature Gas-Cooled Reactor (mHTGR)", and in the NRC staff's feedback on the next generation nuclear plant (NGNP) project white papers "Office of New Reactors Summary Feedback on Four Key Licensing Issues NGNP(ADAMS Package ML14174A626)," the TRISO fuel fission product transport and retention behavior under all expected operating conditions is the key to meeting dose limits as traditional defense in depth design features may not be included in a mHTGR. The SARRDL concept allows for some small increase in circulating radionuclide inventory during an AOO. To ensure the SARRDL is not violated during an AOO, a normal operation radionuclide inventory limit must also be established (i.e., appropriate margin). The radionuclide activity circulating within the helium coolant boundary is continuously monitored such that the normal operation limits

Criterion Current GDC Language ARDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language/ Rationale for Modification Image: Comparison of the stress of
Childen Control of Canguage Rationale for Modification Rationale for Modificatio and SARRDL are not exceeded. The SARRDL will be established so that the most limiting license basis event does not exceed the siting regulatory dose limits criteria the exclusion area boundary (EAB) and low population azo (LPZ), and also so that the 1 CFR 20.1301 annualized do limits to the public are not exceeded at the EAB for normal operation and AOOs The concept of replacing SAFDL with SARRDL has no been reviewed or approved the TRSIO fuel being the primary fission product barrier is intertwined the concept of the TRSIO fuel being the primary fission product barrier is intertwined the concept of the TRSIO fuel being the primary fission product barrier is intertwined the concept of the TRSIO fuel being the primary fission product barrier is of the transitory of the components and base of the transitory of the transity of the transitory of the transitory of the transit
and SARRDL are not exceeded. The SARRDL will be established so that the most limiting license basis event does not exceed the siting regulatory dose limits criteria the exclusion area boundary (EAB) and low population zo (LPZ), and also so that the 1 CFR 20.1301 annualized do: limits to the public are not exceeded at the EAB for normal operation and AOOs The concept of replacing SAFDL with SARRDL has no been reviewed or approved i the NRC. The concept of the TRSIO fuel being the primaer fission product barrier is intertwined the concept of a functional containment for mHTGR technologies. See I rationale for mHTGR-DC 16 further information on the Commission's current positic The word "core" has been replaced with "system" to include the components and
internals of the mHTGR heliu pressure boundary. Design features within the reactor system, such as the helium purification system, must be

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
				during normal operations and AOOs. The word "coolant" has been replaced with "heat removal" as helium coolant inventory control for normal operation and AOOs is not necessary to meet the SARRDL due to the reactor system design. The word "core" has been replaced with "system" to denote that RCS design barriers exist for plate out and that systems such as the purification system contribute in meeting the specified acceptable core radionuclide release design limit (SARRDL). The word "coolant" has been replaced with "heat removal" as helium coolant inventory control for normal operation and AOOs is not necessary to meet the SARRDL due to the reactor system design.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
11	Reactor inherent protection. The reactor core and associated coolant systems shall be designed so that in the power operating range the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity.	Rationale for Modification Reactor inherent protection. The reactor core and associated coolant systems that contribute to reactivity feedback shall be designed so that in the power operating range the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity. Rationale The wording has been changed to broaden the applicability from "coolant systems" to additional factors (including structures or other fluids) that may contribute to reactivity feedback. These systems are to be designed to	Same as ARDC	Same as ARDC
		compensate for rapid reactivity increase.		

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
12	Suppression of reactor power	Suppression of reactor power	Same as ARDC	Suppression of reactor power
	oscillations.	oscillations.		oscillations.
	The reactor core and	The reactor core and		The reactor core and
	associated coolant, control,	associated <u>structures</u> , coolant,		associated coolant, control,
	and protection systems shall	control, and protection systems		and protection systems shall
	be designed to assure that	shall be designed to assure		be designed to assure that
	power oscillations which can	that power oscillations which		power oscillations which can
	result in conditions exceeding	can result in conditions		result in conditions exceeding
	specified acceptable fuel	exceeding specified		specified acceptable tuel core
	design limits are not possible	acceptable fuel design limits		radionuclide release design
	or can be reliably and readily	are not possible or can be		limits are not possible or can
	detected and suppressed.	reliably and readily detected		be reliably and readily detected
		and suppressed.		and suppressed.
		Rationale		Rationale
		The word "etructuree" wee		
		added because items such as		Helium in the mHTGR does
		reflectore which could be		not affect reactor core
		considered either outside or		susceptibility to coolant
		not part of the reactor part		induced power oscillations.
		mot part of the reactor core,		therefore a separate mHTGR
		core to power oscillations		specific DC is appropriate. The
		core to power oscillations.		word "coolant" was deleted
				and the SAFDLs were
				replaced by SARRDLs. The
				discussion regarding the
				SARRDL is given in mHTGR-
				DC 10.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
13	Instrumentation and control. Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges	Instrumentation and control. Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. Rationale "As appropriate" was removed to provide specificity to the criterion. "Reactor coolant pressure boundary" has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary	Instrumentation and control. Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor primary coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. Rationale "As appropriate" was removed to provide specificity to the criterion. "Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the	Instrumentation and control. Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, and the integrity of the reactor core, reactor helium coolant pressure boundary, and reactor core, the reactor coolant pressure boundary, and the containment and its associated systems functional containment. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. Rationale "As appropriate" was removed to provide specificity to the criterion. "Reactor coolant pressure
		without giving any implication of system operating pressure. As such, the term "reactor coolant boundary" is applicable	term "primary" indicates that the SFR-DC is applicable to the primary cooling system, not the intermediate cooling system.	boundary" has been relabeled as "reactor helium pressure boundary" to conform to standard terms used for mHTGRs.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		to non-LWRs that operate at either low or high pressure.		The criterion has been modified to reflect use of the modular HTGR functional containment. See mHTGR-DC 16 rationale.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
14	Reactor coolant pressure	Reactor coolant pressure	<u>Primary</u> coolant pressure	Reactor <u>helium</u> coolant
	boundary.	boundary.	boundary.	pressure boundary.
	The reactor coolant pressure	The reactor coolant pressure	The reactor primary coolant	The reactor heliumcoolant
	boundary shall be designed,	boundary shall be designed,	pressure boundary shall be	pressure boundary shall be
	tabricated, erected, and tested	tabricated, erected, and tested	designed, fabricated, erected,	designed, fabricated, erected,
	so as to have an extremely low	so as to have an extremely low	and tested so as to have an	and tested so as to have an
	probability of aphormal	probability of abnormal	extremely low probability of	extremely low probability of
	feiture and of group rupture	feiture and of group rupture	abnormal leakage, of rapidly	abnormal leakage, of rapidly
	failure, and of gross rupture.	failure, and of gross rupture.	propagating failure, and of	propagating failure, and of
		Pationale	gross rupture.	unaccentable ingress of air
		Rationale	Rationale	secondary coolant or other
		"Reactor coolant pressure	Rationale	fluids
		boundary" has been relabeled	"Reactor coolant pressure	
		as "reactor coolant boundary"	boundary" has been relabeled	Rationale
		to create a more broadly	as "primary coolant boundary"	
		applicable non-LWR term that	to conform to standard terms	"Reactor coolant pressure
		defines the boundary without	used in the LMR industry.	boundary" has been relabeled
		giving any implication of		as "reactor helium pressure
		system operating pressure. As	The use of the term "primary"	boundary" to conform to
		such, the term "reactor coolant	indicates that the SFR-DC is	standard terms used for
		boundary" is applicable to non-	applicable only to the primary	mHTGRs.
		LWRs that operate at either	cooling system, not the	
		low or high pressure.	intermediate cooling system.	The addition of unacceptable
			L	air and fluid ingress, which is
			The cover gas boundary is	unique and critical to the
			included as part of the primary	mHTGR design, warranted the
			coolant boundary (referred to	development of a mHIGR
			as RCPB by PRISM) per	aesign specific criterion for the
			NUREG-1368 (page 3-38).	reactor neilum pressure
				boundary.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
15	Reactor coolant system	Reactor coolant system	Reactor Primary coolant	Reactor <u>helium pressure</u>
	design.	design.	system design.	<u>boundary coolant system</u>
	The reactor coolant system	The reactor coolant system	The reactor primary coolant	design.
	and associated auxiliary,	and associated auxiliary,	system and associated	The reactor <u>helium pressure</u>
	control, and protection systems	control, and protection systems	auxiliary, control, and	boundary coolant system and
	shall be designed with	shall be designed with	protection systems shall be	associated auxiliary, control,
	sufficient margin to assure that	sufficient margin to assure that	designed with sufficient margin	and protection systems shall
	the design conditions of the	the design conditions of the	to assure that the design	be designed with sufficient
	reactor coolant pressure	reactor coolant pressure	conditions of the reactor	margin to assure that the
	boundary are not exceeded	boundary are not exceeded	primary coolant pressure	design conditions of the
	during any condition of normal	during any condition of normal	boundary are not exceeded	reactor <u>helium pressure</u>
	operation, including anticipated	operation, including anticipated	during any condition of normal	boundary coolant pressure
	operational occurrences.	operational occurrences.	operation, including anticipated	boundary are not exceeded
			operational occurrences.	during any condition of normal
		Rationale		operation, including anticipated
			Rationale	operational occurrences.
		Reactor coolant pressure		
		boundary has been relabeled	"Reactor coolant pressure	Rationale
		as "reactor coolant boundary"	boundary" has been relabeled	
		to create a more broadly	as "primary coolant boundary"	"Reactor coolant system" has
		applicable non-LWR term that	to conform to standard terms	been relabeled as "reactor
		defines the boundary without	used in the LMR industry.	helium pressure boundary" to
		giving any implication of		conform to standard terms
		system operating pressure. As	The use of the term "primary"	used for mHTGRs.
		such, the term "reactor coolant	indicated that the SFR-DC is	
		boundary" is applicable to non-	applicable only to the primary	
		LWRs that operate at either	cooling system, not the	
		low or high pressure.	intermediate cooling system.	
		<u> </u>		
			The cover gas boundary is	
			included as part of the primary	
			coolant boundary (referred to	
			as RCPB by PRISM) per	
		_	NUREG-1368 (page 3-38).	
1	1	1	1	1

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
16	Containment design.	Same as GDC	Containment design.	Containment design.
	Reactor containment and		A reactor containment	<u>A</u> reactor <u>functional</u>
	associated systems shall be	Rationale	consisting of a high strength,	containment, and associated
	provided to establish an		low leakage, pressure	systems consisting of a
	essentially leak-tight barrier	For non-LWR technologies	retaining structure surrounding	structure surrounding the
	against the uncontrolled	other than SFRs and	the reactor and associated its	reactor and its cooling system
	release of radioactivity to the	mHTGRs, designers should	cooling systems, shall be	or multiple barriers internal
	environment and to assure that	use the current GDC to	provided to establish an	and/or external to the reactor
	the containment design	develop applicable principal	essentially leak-tight barrier	and its cooling system, shall be
	conditions important to safety	design criteria.	against the uncontrolled	provided <u>to establish an</u>
	are not exceeded for as long		control the release of	essentially leak-tight barrier
	as postulated accident		radioactivity to the environment	against the uncontrolled
	conditions require.		and to assure that the reactor	control the release of
			containment design conditions	radioactivity to the environmen
			important to safety are not	and to assure that the
			exceeded for as long as	functional containment design
			postulated accident conditions	conditions important to safety
			require.	are not exceeded for as long
			The containment leakage shall	as postulated accident
			be restricted to be less than	conditions require.
			that needed to meet the	
			acceptable onsite and offsite	Rationale
			dose consequence limits as	
			specified in 10 CFR Part 50.34	I ne term "functional
			for postulated accidents.	containment" is applicable to
				advanced non-LVVRs without a
			Rationale	pressure retaining containmen
				structure. mHTGR-DC 16
			The Commission engraved the	states that the functional
1			The Commission approved the	containment:
			stan s recommendation to	
			restrict the leakage of the	
			that peopled to react the	the release of radioactivity to
			that needed to meet the	the environment and to assure
			acceptable onsite and offsite	that the functional containmen
			aose consequence limits [Ref.	design conditions important to
			SRM, SECY-93-092].	safety are not exceeded for as
			Therefore, the Commission	

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
			agreed that the containment leakage for advanced reactors, similar to and including PRISM, should not be required to meet the "essentially leaktight" statement in GDC 16. [Ref: NUREG-1368]. Also, ARDCs and SFR-DCs 38, 39, 40, 41, 42, 43, 50, 51, 52, 53, 54, 55, 56, and 57 in the DOE report refer to containment in the traditional sense in that these SFR-DCs specify traditional containment systems design, inspection, and testing (including leakage rate testing). Furthermore, all past, current, and planned SFR designs use a high strength, low leakage, pressure retaining containment concept which aims to provide a barrier to contain the fission products and other substances and to control the release of radioactivity to the environment.	long as postulated accident conditions require." The DOE Report defines functional containment as: A barrier, or set of barriers taken together, that effectively limit the physical transport and release of radionuclides to the environment across a full range of normal operating conditions, anticipated operational occurrences, and accident conditions. Functional containment is relied upon to ensure that dose at the site boundary as a consequence of postulated accidents meets regulatory limits. Traditional containment structures also provide the reactor and SSCs important to safety inside the containment structure protection against accidents related to external hazards (turbine missiles, flooding, aircraft, etc.). Protection against accidents related to external hazards for mHTGRs is addressed in mHTGR-DCs 70-72. The modular HTGR functional containment safety design objective is to meet 10 CFR 50.34, 52.79, 52.137, or 52.157 offsite dose requirements at the plant's

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
onterion	Current ODC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
				exclusion area boundary (EAB) with margins. The DOE report further clarifies functional containment in section 7.1.4:
				Modular HTGRs employ a functional containment that consists of an integrated set of five radionuclide retention barriers: 1) the coated fuel particle kernel, 2) the fuel particle coatings surrounding the particle kernel, 3) the carbonaceous matrix and graphite that surrounds the fuel particles, 4) the reactor helium pressure boundary, and 5) the reactor building.
				NRC staff has brought the issue of functional containment to the Commission, and the Commission has found it generally acceptable as indicated in the SRMs to SECY-93-092 and SECY-03- 0047. NRC staff also provided feedback to the DOE on this issue as part of the Next Generation Nuclear Plant project. However, approval of the proposed approach to functional containment for the modular HTGR concept, with its emphasis on passive safety features and radionuclide retention within the fuel over a broad spectrum of off-normal

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
				conditions, would necessitate that the required fuel particle performance capabilities be demonstrated with a high degree of certainty. See the NRC staff's "Summary Feedback on Four Licensing Issues NGNP" regarding functional containment and fuel development and qualification (ML14174A774). GDCs 38, 39, 40, 41, 42, 43, 50, 51, 52, 53, 55, 56, and 57 are not applicable to the mHTGR design since they address design criteria for pressure retaining containments in the traditional LWR sense. Requirements regarding the performance of the modular HTGR reactor building are addressed by new Criterion 71 (design basis) and Criterion 72 (provisions for periodic testing and inspection).

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
onteriori		Rationale for Modification	Rationale for Modification	Rationale for Modification
17	Electric power systems.	Electric power systems.	Electric power systems.	Electric power systems.
	An onsite electric power			
	system and an offsite electric			
	power system shall be			
	provided to permit functioning			
	of structures, systems, and			
	components important to	components important to	components important to	components important to
	safety. The safety function for			
	each system (assuming the			
	other system is not functioning)			
	shall be to provide sufficient			
	capacity and capability to			
	assure that (1) specified			
	acceptable fuel design limits	acceptable fuel design limits	acceptable fuel design limits	acceptable fuel core
	and design conditions of the	and design conditions of the	and design conditions of the	radionuclide release design
	reactor coolant pressure	reactor coolant pressure	reactor primary -coolant	limits and design conditions of
	boundary are not exceeded as	boundary are not exceeded as	pressure boundary are not	the reactor <u>helium</u> coolant
	a result of anticipated	a result of anticipated	exceeded as a result of	pressure boundary are not
	operational occurrences and	operational occurrences and	anticipated operational	exceeded as a result of
	(2) the core is cooled and	(2) the core is cooled and	occurrences and (2) the core is	anticipated operational
	containment integrity and other	containment integrity and other	cooled and containment	occurrences and (2) the core is
	vital functions are maintained	vital functions are maintained	integrity and other vital	cooled and <u>functional</u>
	in the event of postulated	in the event of postulated	functions are maintained in the	containment integrity and other
	accidents.	accidents.	event of postulated accidents.	vital functions are maintained
	The excite states a success			In the event of postulated
	I ne onsite electric power	I ne onsite electric power	I ne onsite electric power	accidents.
	supplies, including the	supplies, including the	supplies, including the	The supplity of a trians and a
	batteries, and the onsite	batteries, and the onsite	batteries, and the onsite	I ne onsite electric power
	electric distribution system,	electric distribution system,	electric distribution system,	supplies, including the
		shall have sufficient	shall have sufficient	batteries, and the onsite
	independence, redundancy,	Independence, redundancy,	independence, redundancy,	electric distribution system,
	and testability to perform their	and testability to perform their	and testability to perform their	snall nave sufficient
	safety functions assuming a	safety functions assuming a	safety functions assuming a	independence, redundancy,
	single failure.	single failure.	single failure.	and testability to perform their
	Floatria nowar from the	Floatria now or from the	Floatric newer from the	salety functions assuming a
	Electric power from the	Electric power from the	Electric power from the	single tallure.
	transmission network to the	transmission network to the	transmission network to the	

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
onterion		Rationale for Modification	Rationale for Modification	Rationale for Modification
	onsite electric distribution	onsite electric distribution	onsite electric distribution	Electric power from the
	system shall be supplied by	system shall be supplied by	system shall be supplied by	transmission network to the
	two physically independent	two physically independent	two physically independent	onsite electric distribution
	circuits (not necessarily on	circuits (not necessarily on	circuits (not necessarily on	system shall be supplied by
	separate rights of way)	separate rights of way)	separate rights of way)	two physically independent
	designed and located so as to	designed and located so as to	designed and located so as to	circuits (not necessarily on
	minimize to the extent practical	minimize to the extent practical	minimize to the extent practical	separate rights of way)
	the likelihood of their	the likelihood of their	the likelihood of their	designed and located so as to
	simultaneous failure under	simultaneous failure under	simultaneous failure under	minimize to the extent practical
	operating and postulated	operating and postulated	operating and postulated	the likelihood of their
	accident and environmental	accident and environmental	accident and environmental	simultaneous failure under
	conditions. A switchyard	conditions. A switchyard	conditions. A switchyard	operating and postulated
	common to both circuits is	common to both circuits is	common to both circuits is	accident and environmental
	acceptable. Each of these	acceptable. Each of these	acceptable. Each of these	conditions. A switchyard
	circuits shall be designed to be	circuits shall be designed to be	circuits shall be designed to be	common to both circuits is
	available in sufficient time	available in sufficient time	available in sufficient time	acceptable. Each of these
	following a loss of all onsite	following a loss of all onsite	following a loss of all onsite	circuits shall be designed to be
	alternating current power	alternating current power	alternating current power	available in sufficient time
	supplies and the other offsite	supplies and the other offsite	supplies and the other offsite	following a loss of all onsite
	electric power circuit, to assure	electric power circuit, to assure	electric power circuit, to assure	alternating current power
	that specified acceptable fuel	that specified acceptable fuel	that specified acceptable fuel	supplies and the other offsite
	design limits and design	design limits and design	design limits and design	electric power circuit, to assure
	conditions of the reactor	conditions of the reactor	conditions of the reactor	that specified acceptable tuel
	coolant pressure boundary are	coolant pressure boundary are	primary coolant pressure	core radionuclide release
	not exceeded. One of these	not exceeded. One of these	boundary are not exceeded.	design limits and design
	circuits shall be designed to be	circuits shall be designed to be	One of these circuits shall be	conditions of the reactor
	available within a few seconds	available within a few seconds	designed to be available within	heliumcoolant pressure
	following a loss-of-coolant	following a postulated loss of	a few seconds following a	boundary are not exceeded.
	accident to assure that core	coolant accident to assure that	postulated loss-of-coolant	One of these circuits shall be
	cooling, containment integrity,	core cooling, containment	accident to assure that core	designed to be available within
	and other vital safety functions	integrity, and other vital safety	cooling, containment integrity,	a few seconds following a
	are maintained.	functions are maintained.	and other vital safety functions	postulated loss-of-coolant
	Descriptions also like in shade dife	Descriptions also like in shade data	are maintained.	accident to assure that core
	Provisions shall be included to	Provisions shall be included to	Devicione chall be included for	cooling, containment integrity,
	minimize the probability of	minimize the probability of	Provisions shall be included to	and other vital safety functions
	of the remaining evention any	of the new gining electric power from any	minimize the probability of	are maintained.
	of the remaining supplies as a	of the remaining supplies as a	losing electric power from any	Drevisions shall be instuded for
	result of, or coincident with, the	result of, or coincident with, the	of the remaining supplies as a	Provisions shall be included to

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
	loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.	loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.	result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.	minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.
		Rationale The requirements for offsite	Rationale The requirements for offsite	Rationale
		power are being retained for defense-in-depth considerations. This position was reinforced by a letter from the NRC to Dale Atkinson, Chief Operating Officer, NuScale Power, September 15, 2015 (ML15222A323). At the September 24, 2015 meeting of the Advisory Committee for Reactor Safeguards subcommittee on advanced reactor designs, this subject came up again and the subcommittee was supportive of keeping offsite power requirements in GDC 17 for the NuScale design. LWR emphasis on LOCAs may not apply to non-LWR designs. For example, helium is not needed in an HTGR to remove heat from the core during postulated accidents and does	power are being retained for defense-in-depth considerations. This position was reinforced by a letter from the NRC to Dale Atkinson, Chief Operating Officer, NuScale Power, September 15, 2015 (ML15222A323). At the September 24, 2015 meeting of the Advisory Committee for Reactor Safeguards subcommittee on advanced reactor designs, this subject came up again and the subcommittee was supportive of keeping offsite power requirements in GDC 17 for the NuScale design. "Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the term "primary"	The requirements for offsite power are being retained for defense-in-depth considerations. This position was reinforced by a letter from the NRC to Dale Atkinson, Chief Operating Officer, NuScale Power, September 15, 2015 (ML15222A323). At the September 24, 2015 meeting of the Advisory Committee for Reactor Safeguards subcommittee on advanced reactor designs, this subject came up again and the subcommittee was supportive of keeping offsite power requirements in GDC 17 for the NuScale design. "Reactor coolant pressure boundary" has been relabeled as "reactor helium pressure boundary" to conform to

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		not have the same importance as water does to LWR designs to assure that fuel integrity is maintained. LOCAs may still require analysis in conjunction with postulated accidents if relevant to the design. Reactor coolant pressure boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As such, the term "reactor coolant boundary" is applicable to non- LWRs that operate at either low or high pressure.	indicates that the SFR-DC is applicable to the primary cooling system, not the intermediate cooling system.	standard terms used for mHTGRs. The specified acceptable fuel design limits has been replaced with the specified acceptable core radionuclide release design limit. The discussion regarding the change to specified acceptable core radionuclide release design limit is given in GDC 10.

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
18	Inspection and testing of electric power systems.	Same as GDC	Same as GDC	Same as GDC
	important to safety shall be designed to permit appropriate	Rationale	Rationale	Rationale
	designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the	GDC 18 is a design- independent companion criterion to GDC 17.	GDC 18 is a design- independent companion criterion to GDC 17.	GDC 18 is a design- independent companion criterion to GDC 17.
	power system, and the onsite power system.			

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
Cinteriori		Rationale for Modification	Rationale for Modification	Rationale for Modification
19	Control room.	Control room.	Same as ARDC	Same as ARDC
	A control room shall be	A control room shall be		
	provided from which actions	provided from which actions		
	can be taken to operate the	can be taken to operate the		
	nuclear power unit safely	nuclear power unit safely		
	under normal conditions and to	under normal conditions and to		
	maintain it in a safe condition	maintain it in a safe condition		
	under accident conditions,	under accident		
	including loss-of-coolant	conditionsincluding loss-of-		
	accidents. Adequate radiation	coolant accidents. Adequate		
	protection shall be provided to	radiation protection shall be		
	permit access and occupancy	provided to permit access and		
	of the control room under	occupancy of the control room		
	accident conditions without	under accident conditions		
	personnel receiving radiation	without personnel receiving		
	exposures in excess of 5 rem	radiation exposures in excess		
	whole body, or its equivalent to	of 5 rem total effective dose		
	any part of the body, for the	equivalent (<u>IEDE</u>) whole body,		
	duration of the accident.	or its equivalent to any part of		
	Equipment at appropriate	the body, (TEDE) as defined in		
	locations outside the control	§ 50.2 for the duration of the		
	room shall be provided (1) with	accident.		
	a design capability for prompt			
	not shutdown of the reactor,	Adequate nabitability	· · · · · · · · · · · · · · · · · · ·	
	including necessary	measures shall be provided to		
	maintain the unit in a controls to	of the control room during		
	appdition during bot abutdown	or the control room during		
	and (2) with a notontial			
	capability for subsequent cold	accident conditions.		
	shutdown of the reactor	Equipment at appropriate		
	through the use of suitable	locations outside the control		
	procedures	room shall be provided (1) with		
		a design capability for prompt		
	Applicants for and holders of	hot shutdown of the reactor.		
	construction permits and	including necessary		
	operating licenses under this	instrumentation and controls to		
	part who apply on or after	maintain the unit in a safe		
	part who apply on or allor		1	

	II. Multiple Barriers			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
	January 10, 1997, applicants	condition during hot shutdown,		
	for design approvals or	and (2) with a potential		
	certifications under part 52 of	capability for subsequent cold		
	this chapter who apply on or	shutdown of the reactor		
	after January 10, 1997,	through the use of suitable		
	applicants for and holders of	procedures.		
	combined licenses or			
	manufacturing licenses under	Applicants for and holders of		
	part 52 of this chapter who do	construction permits and		
	not reference a standard	operating licenses under this		
	design approval or certification,	part who apply on or after		
	or holders of operating	January 10, 1997, applicants		
	licenses using an alternative	for design approvals or		
	source term under § 50.67,	certifications under part 52 of		
	shall meet the requirements of	this chapter who apply on or		
	this criterion, except that with	after January 10, 1997,		
	regard to control room access	applicants for and holders of		
	and occupancy, adequate	combined licenses or		
	radiation protection shall be	manufacturing licenses under		
	provided to ensure that	part 52 of this chapter who do		
	radiation exposures shall not	not reference a standard		
	exceed 0.05 SV (5 rem) total	aesign approval or certification,		
	(TEDE) as defined in \$ 50.2 for	OF HORDERS OF OPERAting		
	(TEDE) as defined in § 50.2 for	acures term under \$ 50.67		
	the duration of the accident.	source term under § 50.07,		
		this criterion, except that with		
		regard to control room access		
		and occupancy, adequate		
		radiation protection shall be		
		provided to ensure that		
		radiation exposures shall not		
		exceed 0.05 Sy (5 rem) total		
		effective dose equivalent		
		(TEDE) as defined in 8 50 2 for		
		the duration of the accident		
		the duration of the dooldent.		

	II. Multiple Barriers		8	^
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		Rationale The criterion was updated to remove specific emphasis on LOCA, which may be not appropriate for advanced designs such as the mHTGR. Reference to "whole body, or its equivalent to any part of the body" has been updated to the current TEDE standard as defined in § 50.2. Control room habitability requirement beyond that associated with radiation protection has been added to address concern that non-radionuclide accidents may also affect control room access and occupancy. The last paragraph of the GDC has been eliminated for the ARDC because it is not applicable to future applicants.		
	II. Multiple Barriers			
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Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
20	Protection system functions. The protection system shall be designed (1) to initiate	Same as GDC Rationale	Same as GDC	Protection system functions. The protection system shall be designed (1) to initiate
	automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety.	For non-LWR technologies other than mHTGRs designers should use the current GDC to develop applicable principal design criteria.		automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable-fuel-core <u>radionuclide release</u> design limit is not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety
				Rationale
				SAFDL has been replaced with SARRDL. The concept of using SARRDL is discussed for GDC 10. The quantitative value of the SARRDL will be design specific. The protection aspect of automatic operation and to protect normal operation and AOO limits and to sense accident conditions and initiate mitigating equipment has been preserved.

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
21	Protection system reliability	Same as GDC	Same as GDC	Same as GDC
	and testability.			
	The protection system shall be			
	designed for high functional			
	reliability and inservice			
	testability commensurate with			
	the safety functions to be			
	performed. Redundancy and			
	independence designed into			
	the protection system shall be			
	sufficient to assure that (1) no			
	single failure results in loss of			
	the protection function and (2)			
	removal from service of any			
	component or channel does			
	not result in loss of the			
	required minimum redundancy			
	unless the acceptable			
	reliability of operation of the			
	protection system can be			
	otherwise demonstrated. The			
	protection system shall be			
	designed to permit periodic			
	testing of its functioning when			
	the reactor is in operation,			
	including a capability to test			
	channels independently to			
	determine failures and losses			
	of redundancy that may have			
	occurred.			

ATTACHMENT 1 - DRAFT Advanced Non-LWR Design Criteria Table – April 2016 III. Reactivity Control MHTGR-DC Language/ Rationale for Modification riterion Current GDC Language ARDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language/ Rationale for Modification

Current GDC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
Protection system	Same as GDC	Same as GDC	Same as GDC
independence.			
The protection system shall be			
designed to assure that the			
effects of natural phenomena,			
and of normal operating,			
maintenance, testing, and			
postulated accident conditions			
on redundant channels do not			
result in loss of the protection			
function, or shall be			
demonstrated to be			
acceptable on some other			
techniques, such as functional			
diversity or diversity in			
component design and			
principles of operation shall			
be used to the extent practical			
to prevent loss of the			
protection function.			
	Current GDC Language Protection system independence. The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.	Current GDC LanguageARDC Language/ Rationale for ModificationProtection system independence.Same as GDCThe protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.	Current GDC LanguageARDC Language/ Rationale for ModificationSark-DC Language/ Rationale for ModificationProtection system independence.Same as GDCSame as GDCThe protection system shall be

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
23	Protection system failure	Same as GDC	Protection system failure modes	Same as GDC
	The protection system shall be designed to fail into a safe	Rationale	The protection system shall be designed to fail into a safe state	
	state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme	For non-LWR technologies other than SFRs, designers should use the current GDC to develop applicable principal design criteria.	or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, <u>sodium and</u>	
	heat or cold, fire, pressure, steam, water, and radiation) are experienced.		sodium reaction products, pressure, steam, water, and radiation) are experienced. Rationale	
			In NUREG-1368, Table 3.3 (page 3-21), (ML063410561) NRC staff recommended adding the phrase "sodium and sodium reaction products" to the list of postulated adverse environments in the GDC. Therefore, "sodium and sodium reaction products" are added to the second list of examples in parenthesis in SFR-DC 23.	

	III. Reactivity Control			
Criterior	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
24	Separation of protection and control systems. The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.	Same as GDC	Same as GDC	Same as GDC

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
25	Protection system	Protection system	Same as ARDC	Protection system
	requirements for reactivity	requirements for reactivity		requirements for reactivity
	control malfunctions.	control malfunctions.		control malfunctions.
	The protection system shall be	The protection system shall be		The protection system shall be
	designed to assure that	designed to assure that		designed to assure that
	specified acceptable fuel	specified acceptable fuel		specified acceptable tuel core
	design limits are not exceeded	design limits are not exceeded		radionuclide release design
	for any single malfunction of	during any anticipated		limits are not exceeded during
	the reactivity control systems,	operational occurrence		any anticipated operational
	such as accidental withdrawal	resulting from a for any single		occurrence resulting from a for
	(not ejection or aropout) of	main main of the reactivity		any single malfunction of the
	control rods.	control systems. , such as		reactivity control systems.
		accidental withdrawal (not		such as accidental withdrawal
		ejection of dropout) of control		(not ejection or aropout) or
		roas		Control rods.
		Rationale		Rationale
		Text has been added to clarify		Use ARDC except SAFDL is
		that the protection system is		replaced with SARRDL. The
		designed to protect the		concept of using SARRDLs is
		SAFDLs for AOOs in		discussed for GDC 10.
		combination with a single		
		failure; the protection system		
		does not have to protect the		
		SAFDLs during a postulated		
		accident in combination with a		
		single failure. The example		
		was deleted to make ARDC		
		technology neutral.		

III. Reactivity Control ARDC Language/ SFR-DC Language/ mHTGR-DC Language/ **Current GDC Language** Criterion **Rationale for Modification Rationale for Modification Rationale for Modification** Same as ARDC Reactivity control system Reactivity control system Reactivity control system 26 redundancy and capability. redundancy and capability. redundancy and capability. Two independent reactivity At least two independent At least two independent control systems of different reactivity control systems of reactivity control systems of design principles shall be different design principles different design principles provided. One of the systems shall be provided. One of the shall be provided. One of the systems shall use control shall use control rods. systems shall use control rods, preferably including a rods, preferably including a preferably including a positive means for inserting the rods, positive means for inserting positive means for inserting and shall be capable of the rods, and shall be capable the rods, and shall be capable reliably controlling reactivity of reliably controlling reactivity of reliably controlling reactivity changes to assure that under changes to assure that under changes to assure that under conditions of normal conditions of normal conditions of normal operation, including operation, including operation, including anticipated operational anticipated operational anticipated operational occurrences, and with occurrences, and with occurrences, and with appropriate margin for appropriate margin for appropriate margin for malfunctions such as stuck malfunctions such as stuck malfunctions such as stuck rods, specified acceptable fuel rods, specified acceptable fuel rods, specified acceptable fuel design limits are not design limits are not core radionuclide release exceeded. The second exceeded. The second design limits are not reactivity control system shall reactivity control system shall exceeded. The second be capable of reliably be capable of reliably reactivity control system shall controlling the rate of reactivity controlling the rate of reactivity be capable of reliably changes resulting from changes resulting from controlling the rate of reactivity planned, normal power planned, normal power changes resulting from changes (including xenon changes (including xenon planned, normal power burnout) to assure acceptable burnout) to assure acceptable changes (including xenon fuel design limits are not fuel design limits are not burnout) to assure acceptable exceeded. One of the systems fuel design limits are not exceeded. One of the systems shall be capable of holding the shall be capable of holding the exceeded. One of the systems shall be capable of holding the reactor core subcritical under reactor core subcritical under reactor core subcritical under cold conditions. cold conditions. cold conditions. Rationale Rationale

ATTACHMENT 1 - DRAFT Advanced Non-LWR Design Criteria Table – April 2016

"At least" was added to set a minimum number of

43

III. Reactivity Control SFR-DC Language/ ARDC Language/ mHTGR-DC Language/ **Current GDC Language** Criterion **Rationale for Modification Rationale for Modification Rationale for Modification** independent reactivity control Same rationale as the ARDC systems; it does not preclude but with the additional revision more than two systems. of replacing specified acceptable fuel design limits The parenthetical phrase with specified acceptable core radionuclide release design "including xenon burnout" has been deleted as it is already limits. The concept of using addressed by the statement specified acceptable core "...rate of reactivity changes radionuclide release design resulting from planned, normal limits is discussed for GDC 10. power changes."- In other words, the second reactivity control system must control the reactivity changes relevant to the specific design for normal plant power changes. This deletion makes the ARDC more technology neutral. For example, xenon burnout does not apply to fast reactor designs. "Cold conditions" remains but will have to be defined by a principal design criteria for the specific design.

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
ontenion		Rationale for Modification	Rationale for Modification	Rationale for Modification
27	Combined reactivity control	Combined reactivity control	Same as ARDC	Same as ARDC
	systems capability.	systems capability.		
	The reactivity control systems	The reactivity control systems		
	shall be designed to have a	shall be designed to have a		
	combined capability, in	combined capability , in		
	conjunction with poison	conjunction with poison		
	addition by the emergency	addition by the emergency		
	core cooling system, of	core cooling system, of		
	reliably controlling reactivity	reliably controlling reactivity		
	changes to assure that under	changes to assure that under		
	postulated accident conditions	postulated accident conditions		
	and with appropriate margin	and with appropriate margin		
	for stuck rods the capability to	for stuck rods the capability to		
	cool the core is maintained.	cool the core is maintained.		
		Detienale		
		Rationale		
		None of the educated per		
		WP designs evaluated in the		
		review utilized poison addition		
		via an ECCS		
		In addition ARDC 34		
		Residual heat removal		
		combines the ECCS		
		requirements in GDC 35 into		
		ARDC 34, because none of		
		the advanced non-LWR		
		designs evaluated utilized an		
		ECCS. Advanced non-LWR		
		designs that do use poison		
		addition or an ECCS will have		
		to look to GDC 27 and GDC		
		35 for guidance.		

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
28	Reactivity limits. The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition.	Reactivity limits. The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of [rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition].	Reactivity limits. The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the <u>primary reactor</u> coolant boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of [rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition].	Reactivity limits. The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor <u>heliumcoolant</u> pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor <u>pressure</u> vessel internals to impair significantly the capability to cool the core. <u>These postulated reactivity</u> accidents shall include <u>consideration of [rod ejection</u> (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition].
		Rationale	Rationale	Rationale
		Reactor coolant pressure boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As such, the term "reactor coolant	"Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the term "primary" indicates that the SFR-DC is applicable to the primary	 "Reactor coolant pressure boundary" has been relabeled as "reactor helium pressure boundary" to conform to standard terms used for mHTGRs. The list of "postulated reactivity accidents" has been

	III. Reactivity Control			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
Cinterion	Current GDC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
		boundary" is applicable to	cooling system, not the	deleted. Each design will have
		non-LWRs that operate at	intermediate cooling system.	to determine its postulated
		either low or high pressure.		reactivity accidents based on
			The list of "postulated reactivity	the specific design and
		The word "pressure" was	accidents" has been deleted.	associated risk evaluation.
		deleted when referring to the	Each design will have to	
		reactor vessel as some	determine its postulated	
		designs may not be	reactivity accidents based on	
		pressurized (SFR for	the specific design and	
		example).	associated risk evaluation.	
		The list of "postulated		
		reactivity accidents" has been		
		deleted to make the ARDC		
		technology neutral Each		
		design will have to determine		
		its postulated reactivity		
		accidents based on the		
		specific design and associated		
		risk evaluation.		
	III. Reactivity Control			
Critorian	Current CDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
Criterion	Current GDC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
29	Protection against anticipated	Same as GDC	Same as GDC	Same as GDC
	operational occurrences.			
	The protection and reactivity			
	control systems shall be			
	designed to assure an			
	extremely high probability of			
	accomplishing their safety			
	functions in the event of			
	anticipated operational			
	occurrences.			

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
30	pressure boundary. Components which are part of the reactor coolant pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.	Components which are part of the reactor coolant pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage. Rationale	<i>Coolant pressure-boundary.</i> Components which are part of the reactor primary coolant pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage.	heliumcoolant pressure boundary. Components which are part of the reactor helium coolant pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor heliumcoolant leakage. Rationale
		boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As such, the term "reactor coolant boundary" is applicable to non-LWRs that operate at either low or high pressure.	boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the term "primary" indicates that the SFR-DC is applicable only to the primary cooling system, not the intermediate cooling system. The cover gas boundary is included as part of the reactor primary coolant boundary (referred to as RCPB by PRISM) per NUREG-1368 (page 3-38).	"Reactor coolant pressure boundary" has been relabeled as "reactor helium pressure boundary" to conform to standard terms used for mHTGRs.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
31	Fracture prevention of reactor	Fracture prevention of reactor	Fracture prevention of reactor	Fracture prevention of reactor
	coolant pressure boundary.	coolant pressure b oundary.	<u>primary</u> coolant pressure	<u>helium coolant pressure</u>
	The reactor coolant pressure	The reactor coolant pressure	boundary.	boundary.
	boundary shall be designed	boundary shall be designed	The reactor primary coolant	The reactor helium coolant
	with sufficient margin to	with sufficient margin to	pressure boundary shall be	pressure boundary shall be
	assure that when stressed	assure that when stressed	designed with sufficient margin	designed with sufficient
	under operating, maintenance,	under operating, maintenance,	to assure that when stressed	margin to assure that when
	testing, and postulated	testing, and postulated	under operating, maintenance,	stressed under operating,
	accident conditions (1) the	accident conditions (1) the	testing, and postulated accident	maintenance, testing, and
	boundary behaves in a	boundary behaves in a	conditions (1) the boundary	postulated accident conditions
	nonbrittle manner and (2) the	nonbrittle manner and (2) the	behaves in a nonbrittle manner	(1) the boundary behaves in a
	probability of rapidly	probability of rapidly	and (2) the probability of rapidly	nonbrittle manner and (2) the
	propagating fracture is	propagating fracture is	propagating fracture is	probability of rapidly
	minimized. The design shall	minimized. The design shall	minimized. The design shall	propagating fracture is
	reflect consideration of service	reflect consideration of service	reflect consideration of service	minimized. The design shall
	temperatures and other	temperatures and other	temperatures and other	reflect consideration of service
	conditions of the boundary	conditions of the boundary	conditions of the boundary	temperatures and other
	material under operating,	material under operating,	material under operating,	conditions of the boundary
	natulated assident conditions	namenance, lesting, and	namenance, lesting, and	material under operating,
	and the uncertainties in	and the uncertainties in	and the uncertainties in	nostulated accident conditions
	determining (1) material	determining (1) material	determining (1) material	and the uncertainties in
	properties (2) the effects of	properties (2) the effects of	properties (2) the effects of	determining (1) material
	irradiation on material	irradiation on material	irradiation on material	properties (2) the effects of
	properties (3) residual steady	properties (3) residual steady	properties (3) residual steady	irradiation on material
	state and transient stresses	state and transient stresses	state and transient stresses	properties (3) residual steady
	and (4) size of flaws	and (4) size of flaws	and (4) size of flaws	state and transient stresses
				and (4) size of flaws.
		Rationale	Rationale	Detionala
		Reactor coolant pressure	"Reactor coolant pressure	Rationale
		houndary has been relabeled	houndary" has been relabeled	"Reactor coolant pressure
		as "reactor coolant houndary"	as "primary coolant boundary"	houndary" has been relabeled
		to create a more broadly	to conform to standard terms	as "reactor belium pressure
		applicable non-I WR term that	used in the LMR industry	boundary" to conform to
		defines the boundary without		standard terms used for
		giving any implication of	The use of the term "primary"	mHTGRs
		system operating pressure As	indicates that the SFR-DC is	
		Rationale Reactor coolant pressure boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As	Rationale "Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the term "primary" indicates that the SFR-DC is	and (4) size of flaws. Rationale "Reactor coolant pressure boundary" has been relabeled as "reactor helium pressure boundary" to conform to standard terms used for mHTGRs.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		such, the term "reactor coolant boundary" is applicable to non-LWRs that operate at either low or high pressure.	applicable only to the primary cooling system, not the intermediate cooling system.	
			The cover gas boundary is included as part of the reactor primary coolant boundary (referred to as RCPB by PRISM) per NUREG-1368 (page 3-38).	
	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
32	Inspection of reactor coolant pressure boundary. Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel.	Inspection of reactor coolant pressure-boundary. Components which are part of the reactor coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel.	Inspection of reactor-primary coolant pressure-boundary. Components which are part of the reactor-primary coolant pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel.	Inspection of reactor <u>heliumcoolant</u> pressure boundary. Components which are part of the reactor <u>heliumcoolant</u> pressure boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the
		Rationale	Rationale	Rationale
		Reactor coolant pressure boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As	"Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to conform to standard terms used in the LMR industry. The use of the term "primary" indicates that the SFR-DC is	"Reactor coolant pressure boundary" has been relabeled as "reactor helium pressure boundary" to conform to standard terms used for mHTGRs.

	IV. Fluid Systems			
Criterior	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		such, the term "reactor coolant boundary" is applicable to non-LWRs that operate at either low or high pressure. The staff modified the LWR GDC by replacing the term "reactor pressure vessel" with "reactor vessel", which staff believes is a more generically applicable term.	applicable only to the primary cooling system, not the intermediate cooling system. The cover gas boundary is included as part of the reactor primary coolant boundary (referred to as RCPB by PRISM) per NUREG-1368 (page 3-38). The staff modified the LWR GDC by replacing the term "reactor pressure vessel" with "reactor vessel", which staff believes is a more generically applicable term.	The staff modified the LWR GDC by replacing the term "reactor pressure vessel" with "reactor vessel", which staff believes is a more generically applicable term.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
33	Reactor coolant makeup.	Reactor coolant inventory	Reactor Primary coolant	Not applicable to modular
	A system to supply reactor	maintenance makeup .	inventory maintenancemakeup.	HTGR.
	coolant makeup for protection	A system to maintain supply	A system to maintain supply	
	against small breaks in the	reactor coolant inventory	reactor-primary coolant	Rationale
	reactor coolant pressure	makeup for protection against	inventory makeup for protection	
	boundary shall be provided.	small breaks in the reactor	against small breaks in the	The mHTGR does not require
	The system safety function	coolant pressure boundary	reactor primary coolant	reactor coolant inventory
	shall be to assure that	shall be provided <u>as</u>	pressure boundary shall be	maintenance for small leaks to
	specified acceptable fuel	necessary. The system safety	provided. The system safety	meet the SARRDLs, which
	design limits are not exceeded	function shall be to assure that	function shall be as necessary	replaces the concept of the
	as a result of reactor coolant	specified acceptable fuel	to assure that specified	SAFDLs as discussed in GDC
	loss due to leakage from the	design limits are not exceeded	acceptable fuel design limits	10. Therefore, ARDC 33 is not
	reactor coolant pressure	as a result of reactor coolant	are not exceeded as a result of	applicable to the mHTGR
	boundary and rupture of small	inventory loss due to leakage	reactor primary coolant	design.
	piping or other small	from the reactor coolant	inventory loss due to leakage	
	components which are part of	pressure boundary and	from the reactor primary	
	the boundary. The system	rupture of small piping or other	coolant pressure boundary and	
	shall be designed to assure	small components which are	rupture of small piping or other	
	that for onsite electric power	part of the boundary. The	small components which are	
	offeite neuror is not evoluble)	system shall be designed to	part of the boundary. The	
	and for officito alactric nowor	nower system operation	system shall be designed to	
	system operation (assuming	(assuming offsite power is not	nower system operation	
	onsite nower is not available)	available) and for offsite	(assuming offsite power is not	
	the system safety function can	electric nower system	available) and for offsite electric	
	be accomplished using the	operation (assuming onsite	nower system operation	
	piping pumps and valves	power is not available) the	(assuming onsite power is not	
	used to maintain coolant	system safety function can be	available) the system safety	
	inventory during normal	accomplished using the	function can be accomplished	
	reactor operation.	piping, pumps, and valves	using the piping, pumps, and	
		used to maintain coolant	valves used to maintain primary	
		inventory during normal	coolant inventory during normal	
		reactor operation.	reactor operation.	
1				

IV. Fluid Systems ARDC Language/ SFR-DC Language/ mHTGR-DC Language/ **Current GDC Language** Criterion **Rationale for Modification Rationale for Modification Rationale for Modification** Rationale Rationale Retitled with "inventory "Reactor coolant pressure maintenance" to provide more boundary" has been relabeled flexibility regarding advanced as "primary coolant boundary" to reflect that the SFR primary reactor designs. system operates at low-The term "...shall be provided pressure and to conform to as necessary to assure ... " has standard terms used in the been modified to recognize LMR industry. the inventory control system may be unnecessary for some The coolant boundary design requirements differ from the designs to maintain safety functions that assure fuel traditional LWR coolant design limits are not pressure boundary requirements. The effects of exceeded. low pressure design are Reactor coolant pressure acknowledged in NUREG-1368 boundary has been relabeled (page 3-28) (ML063410561) as "reactor coolant boundary" under discussion of GDC 4 and to create a more broadly on (page 3-30) under GDC 14. applicable non-LWR term that The use of the term "primary" implies the GDC is applicable defines the boundary without giving any implication of to the primary cooling system, system operating pressure. As not the intermediate cooling such, the term "reactor coolant | system. boundary" is applicable to Both pool- and loop-type SFR non-LWRs that operate at designs limit loss of primary either low or high pressure. Maintained the words "system coolant so that an inventory safety function" of GDC 33 as adequate to perform the safety reactor coolant inventory function of the residual heat maintenance may be removal system is maintained necessary in some designs to under operating, maintenance, support residual heat removal testing, and postulated accident which is a safety function. If conditions.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		not required for maintaining residual heat removal capability the qualifier "as necessary" in the first sentence would apply. For example, if all small breaks or leaks would result in reactor coolant inventory levels such that residual heat removal function would still be performed, and the fuel design limits met, no safety function would be associated with the inventory maintenance system.		

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
34	Residual heat removal.	Residual heat removal.	Residual heat removal.	Passive residual heat removal.
	A system to remove residual	A system to remove residual	A system to remove residual	A passive system to remove
	heat shall be provided. The	heat shall be provided. For	heat shall be provided. For	residual heat shall be
	system safety function shall be	normal operations and	normal operations and	provided. For normal
	to transfer fission product	anticipated operational	anticipated operational	operations and anticipated
	decay heat and other residual	occurrences, the The system	occurrences, the The system	operational occurrences, the
	heat from the reactor core at a	safety function shall be to	safety function shall be to	The system safety function
	rate such that specified	transfer fission product decay	transfer fission product decay	shall be to transfer fission
	acceptable fuel design limits	heat and other residual heat	heat and other residual heat	product decay heat and other
	and the design conditions of	from the reactor core to an	from the reactor core <u>to an</u>	residual heat from the reactor
	the reactor coolant pressure	ultimate heat sink at a rate	ultimate heat sink at a rate	core to an ultimate heat sink at
	boundary are not exceeded.	such that specified acceptable	such that specified acceptable	a rate such that specified
		fuel design limits and the	fuel design limits and the	acceptable fuel core
	Suitable redundancy in	design conditions of the	design conditions of the reactor	radionuclide release design
	components and features, and	reactor coolant pressure	primary coolant boundary are	limits and the design
	suitable interconnections, leak	boundary are not exceeded.	not exceeded.	conditions of the reactor
	detection, and isolation			heliumcoolant pressure
	capabilities shall be provided	During postulated accidents,	During postulated accidents,	boundary are not exceeded.
	to assure that for onsite	the system safety function	the system safety function shall	
	electric power system	shall provide continuous	transfer heat from the reactor	During postulated accidents,
	operation (assuming offsite	effective core cooling and to	core at a rate such that fuel and	the system safety function
	power is not available) and for	assure that the design	clad damage that could	shall be to provide continuous
	offsite electric power system	conditions of the reactor	interfere with continued	effective cooling and to assure
	operation (assuming onsite	coolant boundary are not	effective cooling is prevented,	that the design conditions of
	power is not available) the	exceeded.	sodium boiling is precluded,	the reactor helium pressure
	system safety function can be		and the design conditions of	boundary are not exceeded.
	accomplished, assuming a	Suitable redundancy in	the primary coolant boundary	
	single failure.	components and features, and	are not exceeded.	Suitable redundancy in
		suitable interconnections, leak		components and features, and
		detection, and isolation	Suitable redundancy in	suitable interconnections, leak
		capabilities shall be provided	components and features, and	detection, and isolation
		to assure that for onsite	suitable interconnections, leak	capabilities shall be provided
		electric power system	detection, and isolation	to assure that for onsite
		operation (assuming offsite	capabilities shall be provided to	electric power system
		power is not available) and for	assure that for onsite electric	operation (assuming offsite
		offsite electric power system	power system operation	power is not available) and for
		operation (assuming onsite	(assuming offsite power is not	offsite electric power system
		power is not available) the	available) and for offsite electric	operation (assuming onsite

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		system safety function can be	power system operation	power is not available) the
		accomplished, assuming a	(assuming onsite power is not	system safety function can be
		single failure.	available) the system safety	accomplished, assuming a
			function can be accomplished,	single failure.
		Rationale	assuming a single failure.	Batianala
		ARDC 34 incorporates the	A passive boundary shall	
		postulated accident residual	separate primary coolant from	mHTGR-DC 34 incorporates
		heat removal requirements	the working fluid of the residual	the postulated accident
		contained in GDC 35.	heat removal system and any	residual heat removal
			fluid in the residual heat	requirements contained in
		"Ultimate heat sink" has been	removal system that is	GDC 35.
		added to clarify that if ARDC	separated from the primary	
		44 is deemed not applicable to	coolant by a single passive	"Ultimate heat sink" has been
		the design, the RHR system is	barrier shall not be chemically	added to clarify that if
		then required to provide the	reactive with the primary	mHTGR-DC 44 is deemed not
		heat removal path to the	coolant. In addition, the working	applicable to the design, the
		ultimate heat sink.	fluid of residual heat removal	RHR system is then required
			system shall be at a higher	to provide the heat removal
		Reactor coolant pressure	pressure than the primary	path to the ultimate heat sink.
		boundary has been relabeled	coolant system.	
		as "reactor coolant boundary"	Detionals	I he word "passive" was added
		to create a more broadly	Rationale	based on the definition of a
		applicable non-LWR term that	CED DC 24 in corrected the	modular HIGR. In definitions
		defines the boundary without	SFR-DC 34 Incorporates the	Section 3.1 of INL/EXT-14-
		giving any implication of	bost removel requiremente	defined as having passive
		system operating pressure. As	approximation and a CDC 25	boat romoval due to a low
		boundary" is applicable to	contained in GDC 35.	newor donsity
		non LWPs that operate at	"I litimate heat sink" has been	"Peactor coolant pressure
		either low or high pressure	added to clarify that if SER-DC	boundary" has been relabeled
		entier low of high pressure.	A is deemed not applicable to	as "reactor belium pressure
		Text of first paragraph has	the design the RHR system is	boundary" to conform to
		been amended and the	then required to provide the	standard terms used for
		second paragraph added to	heat removal path to the	mHTGRs
		clarify requirements that are	ultimate heat sink	
		applicable following normal		The specified acceptable core
		operation including AOOs, and		radionuclide release design

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		during postulated accidents	"Reactor coolant pressure	limits replaces the ARDC
		following the precedent of	boundary" has been relabeled	specified acceptable fuel
		NUREG-1368, "Pre-	as "primary coolant boundary"	design limits as described in
		application SER for PRISM	to reflect that the SFR primary	rationale to mHTGR-DC 10.
		LMR."	system operates at low-	
			pressure and to conform to	The ARDC "core cooling" was
		The last phrase was added to	standard terms used in the	replaced with "cooling" in the
		the second paragraph to	LMR industry. The use of the	second paragraph to reflect
		assure that residual heat	term "primary" indicates that	that the core and integrity of
		removal capability is sufficient	the SFR-DC is applicable to the	reactor vessel must be
		to maintain the integrity of the	primary cooling system, not the	maintained by the residual
		reactor coolant boundary	intermediate cooling system.	heat removal system during
		during postulated accidents.		postulated accidentsThe last
		Maintaining the reactor	The second paragraph was	phrase was added to the
		coolant boundary is wording	added to clarify that the safety	second paragraph to assure
		not currently in GDC 35 as the	function of the residual heat	that residual heat removal
		limiting postulated accident is	removal system during	capability is sufficient to
		a LOCA where primary	postulated accidents is to	maintain the integrity of the
		coolant integrity is assumed	provide continuous effective	reactor helium pressure
		lost. In advanced designs	core cooling. For SFRs, that	boundary during postulated
		other accidents may be more	cooling is provided at a rate	accidents. Maintaining the
		limiting than a LOCA and	sufficient to prevent	reactor helium pressure
		hence the residual heat	propagation of fuel failures. The	boundary is wording not
		removal capability should be	last phrase was added to the	currently in GDC 35 as the
		designed to ensure the reactor	paragraph to assure that	limiting postulated accident is
		coolant boundary integrity is	residual neat removal capability	a LOCA where primary
		maintained.	is sufficient to maintain the	coolant integrity is assumed
		The third nergeroup	Integrity of the primary coolant	lost. In advanced designs
		addreeses BHD system	positionto	limiting then a LOCA and
		redundency ADDC 17	accidents.	honoo the residuel heat
		requires reliable power	A paragraph from NUIDEC	removal espekility should be
		systems for SSCs performing	A paragraph non NUREG-	designed to ensure the reactor
		vital safety functions and must	describing the characteristics of	belium pressure boundary
		be of adequate capacity and	the residual heat removal	integrity is maintained
		canability to operate during	working fluid and its associated	
		nostulated accidents. There	operating pressure A single	
		may be various combinations	nassive harrier is adequate	
		designed to ensure the reactor coolant boundary integrity is maintained. The third paragraph addresses RHR system redundancy. ARDC 17 requires reliable power systems for SSCs performing vital safety functions and must be of adequate capacity and capability to operate during postulated accidents. There may be various combinations	paragraph to assure that residual heat removal capability is sufficient to maintain the integrity of the primary coolant boundary during postulated accidents. A paragraph from NUREG- 1368 (page 3-41) was added describing the characteristics of the residual heat removal working fluid and its associated operating pressure. A single passive barrier is adequate	limiting postulated accident is a LOCA where primary coolant integrity is assumed lost. In advanced designs other accidents may be more limiting than a LOCA and hence the residual heat removal capability should be designed to ensure the reactor helium pressure boundary integrity is maintained.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		of power supply employed to address power reliability.	defense in depth when the residual heat removal working fluid is not chemically reactive with the primary coolant. If chemically reactive at least two passive barriers must separate the two systems. The higher pressure requirement is to ensure any leakage in the interface between the two systems does not result in a release of radioactive primary coolant to the non-radioactive part of the heat transport system.	

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
35	<i>Emergency core cooling.</i> A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.	Emergency core cooling. If the system as described in ARDC 34 does not provide continuous effective core cooling during postulated accidents and does not assure that the design conditions of the reactor coolant boundary are preserved; then a system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant such that continuous effective core cooling is maintained. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.	Same as ARDC	Same as ARDC

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		In most advanced reactor designs, residual heat removal is addressed by ARDC 34. If the design is such that ARDC 34 is not adequate to ensure residual heat removal under normal operations and postulated accidents then additional system(s) are required and would be addressed by this ARDC 35 to ensure continuous effective core cooling.		
	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
36	Inspection of emergency core cooling system. The emergency core cooling system shall be designed to permit appropriate periodic inspection of important components, such as spray rings in the reactor pressure vessel, water injection nozzles, and piping, to assure the integrity and capability of the system.	Inspection of emergency core cooling-residual heat removal system. The emergency core cooling system-residual heat removal shall be designed to permit appropriate periodic inspection of important components, such as spray rings in the reactor pressure vessel, water injection nozzles, and piping, to assure the integrity and capability of the system. Rationale Title has been renamed and GDC revised to provide for inspection of the residual heat removal systems as required for ARDC 34.	Same as ARDC	Inspection of <u>passive</u> <u>emergency core cooling</u> <u>residual heat removal</u> system. The <u>emergency core cooling</u> <u>system-passive residual heat</u> <u>removal</u> shall be designed to permit appropriate periodic inspection of important components , such as spray rings in the reactor pressure vessel, water injection nozzles, and piping, to assure the integrity and capability of the system. Rationale The word "passive" was added based on the definition of a mHTGR. In definitions Section 3.1 of INL/EXT-14-31179, the

	IV. Fluid Systems			
		ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
Criterion	Current GDC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
				mHTGR design is defined as
		The example list has been		having passive heat removal
		deleted because it applies to		due to a low power density.
		LWR designs and each		
		specific design will have		GDC 36 system is renamed
		different important		and revised to provide for
		components associated with		inspection of the residual heat
		residual heat removal. This		removal systems as required
		revision allows for a		for mHTGR-DC 34.
		technology neutral ARDC.		
				Deleted the example list as
		Review of the proposed DOE		they apply to LWR designs
		SFR and HTGR DCs found		and each specific design will
		that only SFR provided		have different important
		specific examples of important		components associated with
		components but were generic		residual neat removal.
		In nature and did not add any		
		significant additional guidance.		
	IV Eluid Systems			
			SEP_DC Languago/	mHTGP_DC Languago/
Criterion	Current GDC Language	Rationale for Modification	Bationale for Modification	Rationale for Modification
37	Testing of emergency core	Testing of residual heat	Same as ARDC	Testing of passive residual
57	cooling system	removal emergency core		heat removal emergency core
	The emergency core cooling	cooling_system		cooling_system
	system shall be designed to	The residual heat removal		The emergency core cooling
	permit appropriate periodic	emergency core cooling		passive residual heat removal
	pressure and functional testing	system shall be designed to		system shall be designed to
	to assure (1) the structural and	permit appropriate periodic		permit appropriate periodic
	leaktight integrity of its	pressure and-functional testing		pressure and functional testing
	components, (2) the	to assure (1) the structural and		to assure (1) the structural and
	operability and performance of	leaktight integrity of its		leaktight integrity of its
	the active components of the	components, (2) the		components, (2) the
	system, and (3) the operability	operability and performance of		operability and performance of
	of the system as a whole and,	the active system components		the active system
	under conditions as close to	of the system, and (3) the		components of the system,
	design as practical, the	operability of the system as a		and (3) the operability of the

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
		Rationale for Modification	Rationale for Modification	Rationale for Modification
	performance of the full	whole and, under conditions		system as a whole and, under
	operational sequence that	as close to design as practical,		conditions as close to design
	brings the system into	the performance of the full		as practical, the performance
	operation, including operation	operational sequence that		of the full operational
	of applicable portions of the	brings the system into		sequence that brings the
	protection system, the transfer	operation, including operation		system into operation,
	between normal and	of associated systems and		including operation of
	emergency power sources,	interfaces with an ultimate		associated systems and
	and the operation of the	heat sink including operation		interfaces with an ultimate
	associated cooling water	of applicable portions of the		heat sink and the transition
	system.	protection system, the transfer		from the active normal
		between normal and		operation mode to the passive
		emergency power sources,		operation mode relied upon
		and the operation of the		during postulated accidents
		associated cooling water		including operation of
		system.		applicable portions of the
				protection system, the transfer
		Rationale		between normal and
				emergency power sources,
		GDC 37 system has been		and the operation of the
		renamed and revised to		associated cooling water
		provide for testing of the		system.
		of ADDC 24		Detienele
		OF ARDC 34.		Rationale
		A aposific requirement for		Critorian 27 has been
		A specific requirement for		chileholi 37 has been
		pressure and leaking it testing		testing of the passive residuel
		future educated in the ARDC as		best removel evetem required
		ampley proceure retaining		heat removal system required
		PHD designs of the applicable		by modular HTGR-DC 34.
		system in the advanced		Section 2.3.4 of INIL/EVT 10
		dosign is not prossure		17007 "NCNP Mochanistic
		retaining then "poriodic		Source Terms White Dapar
		pressure testing" and		$\frac{1}{100} 2010 \text{ M} 102040260$
		Piessure resuring and		notes the passive PCCS
		removed in the specific design		(using oither air or water co
		critoria		host transfer fluid) contributes
		chiena.		neat transfer huid) contributes

Criterion Current GDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language/ Rationale for Modification ************************************	Criterion Current GDC Language ARDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language Rationale for Modification "Active" has been deleted in item (2) as appropriate operability and performance system component testing is required regardless of active or passive nature. to the modular HTGR safet basis and is subject to component integrity testing However, Section 6.1 of INL/EXT-11-22708, "Modu HTGR Safety Basis and Approach", Aug 2011, ML1251A169, indicates th RCCS performance does r require "leaktight" condition Reference to operation of applicable portions of the protection system, cooling water system, and power transfers is considered part of the more general "associated systems." Together with the ultimate heat sink, they are part of the operability testing Some modular HTGR reac cavity cooling system (RCC designs will provide continuous passive operati without need for a requirem to test the operation seque
Control Coole Language Rationale for Modification Rationale for Modification Rationale for Modification "Active" has been deleted in item (2) as appropriate operability and performance system component testing is required regardless of active or passive nature. to the modular HTGR safety basis and is subject to component integrity testing. However, Section 6.1 of INL/EXT-11-22708, "Modular HTGR Safety Basis and Approach", Aug 2011, ML11251A169, indicates that Reference to operation of applicable portions of the protection system, cooling water system, and power transfers is considered part of the more general "associated systems." Together with the ultimate heat sink, they are part of the operability testing of the system as a whole. Some modular HTGR reactor cavity cooling system into operation; "if applicable" is included to recognize this contingency. The criterion was modified to reflect the passive nature of the modular HTGR RCCS rom The criterion was modified to reflect the passive nature of the modular HTGR RCCS rom	Rationale for ModificationRationale for ModificationRationale for Modification"Active" has been deleted in item (2) as appropriate operability and performance system component testing is required regardless of active or passive nature.to the modular HTGR safer basis and is subject to component integrity testing However, Section 6.1 of INL/EXT-11-22708, "Modul HTGR Safety Basis and Approach", Aug 2011, ML11251A169, indicates th Reference to operation of applicable portions of the protection system, and power transfers is considered part of the more general "associated systems." Together with the ultimate heat sink, they are part of the operability testingSome modular HTGR reac cavity cooling system (RCC designs will provide continuous passive operati without need for a requiren to test the operation seque
"Active" has been deleted in item (2) as appropriate operability and performance system component testing is required regardless of active or passive nature.to the modular HTGR safety basis and is subject to component integrity testing. However, Section 6.1 of INL/EXT-11-22708, "Modular HTGR Safety Basis and Approach", Aug 2011, ML11251A169, indicates that Reference to operation of applicable portions of the protection system, cooling water system, and power transfers is considered part of the more general "associated systems." Together with the ultimate heat sink, they are part of the operability testing of the system as a whole.Some modular HTGR safety basis and is subject to component integrity testing to test the operation sequence that brings the system into operation; "if applicable" is included to recognize this contingency.The criterion was modified to reflect the passive nature of the modular HTGR RRCCS from the mede to verify ability to transition the RCCS from the need to verify ability to transition the RCCS from the mede to verify ability to transition the RCCS from the need to verify ability to transition the RCCS	"Active" has been deleted in item (2) as appropriate operability and performance system component testing is required regardless of active or passive nature.to the modular HTGR safet basis and is subject to component integrity testing However, Section 6.1 of INL/EXT-11-22708, "Modu HTGR Safety Basis and Approach", Aug 2011, ML11251A169, indicates th Reference to operation of applicable portions of the protection system, cooling water system, and power transfers is considered part of the more general "associated systems." Together with the ultimate heat sink, they are part of the operability testingSome modular HTGR safety basis and is subject to component integrity testing However, Section 6.1 of INL/EXT-11-22708, "Modu HTGR Safety Basis and Approach", Aug 2011, ML11251A169, indicates th RCCS performance does r require "leaktight" condition Some modular HTGR reac cavity cooling system (RCC designs will provide continuous passive operati without need for a requirem part of the operability testing
active mode (if present) to passive mode during	of the system as a whole. that brings the system into operation; "if applicable" is included to recognize this contingency. The criterion was modified reflect the passive nature of the modular HTGR RCCS the need to verify ability to transition the RCCS from active mode (if present) to passive mode during

Current GDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language/ Rationale for Modification 38 Containment heat removal. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Containment pressure and temperature following any loss-of-coolant accident and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming of fistie power is not available) and for offiste electicic power system power is not available) the consomplished, assuming a single failure. Rationale for Modification Rationale failure. MHTGR-DC Language/ Rationale failure.		IV. Fluid Systems			
38 Containment heat removal. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Same as ARDC. Not applicable to modular HTGR. Suitable redundancy in components and features, detection, isolation, and containment operation offsite electric power system operation (assuming of single failure. Suitable redundancy in components and features, including electric power system operation (assuming a single failure. Not applicable to modular HTGR. 38 Containment heat removal. A system to remove heat from the reactor containment shall be provided as necessary. The consistent with the functioning of other associated systems, the containment pressure and temperature following any low levels. Not applicable to modular HTGR. Suitable redundancy in components and features, including electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure. Suitable redundancy in containment capabilities shall be provided to assure that for onsite electric power system operation (assuming a single failure. Not applicable to modular HTGR.	Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, attable interconnections, leak detection, isolation, and containment officite power is not available) and for officite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. HTGR. H	38	Containment heat removal.	Containment heat removal.	Same as ARDC	Not applicable to modular
the reactor containment shall be provided <u>as necessary</u> . The eystem safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure.		A system to remove heat from	A system to remove heat from		HTGR.
be provided. The system safety function shall be reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and consiste electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. Battonale		the reactor containment shall	the reactor containment shall		
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reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. This criterion is not applicable to modular HTGR. Modular the containment pressure and temperature within acceptable limits following fellewing any loss-of-coolant <u>ocstulated</u> accidents, and maintain them at acceptably low levels. Suitable redundancy in components and features, including electric <u>ower</u> systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for offsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. This criterion is not applicable to modular HTGR. Modular HTGR. Modular HTGR. Modular HTGR. Do ther associated systems, the containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. Rationale		safety function shall be to	system safety function shall be		
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associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. H1GRS designs do not have a "pressure retaining reactor containment succure", but limits following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure. Suitable redundancy in components and features, including electric power systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming a single failure. H1GRS designs do not have a "pressure retaining reactor containment succure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale. Suitable redundancy in components and features, including electric power operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure. Suitable redundancy in containment capabilities shall be provided to assure that for onsite electric power system operation (assuming a single failure. Offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available).the accomplished, assuming a single failure. II H CHS designs do not have a "pressure retaining reactor containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available).the accomplished, assuming a si		the functioning of other	consistent with the functioning		to modular HTGR. Modular
containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels. the containment pressure and temperature within acceptable limits following any loss-of-coolant accident and maintain them at acceptably low levels. "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) the system safety function cabe accomplished, assuming a single failure. Suitable redundancy in components and features, including electric power systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power sis not available) the system safety function cabe accomplished, assuming a single failure. Suitable redundancy in containment capabilities shall be provided to assure that for onsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. The appendent structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.		associated systems, the	of other associated systems,		HTGRs designs do not have a
temperature following any loss-of-coolant accident and maintain them at acceptably low levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure.		containment pressure and	the containment pressure and		"pressure retaining reactor
Ioss-of-coolant accident and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and maintain them at acceptably low levels. Initis following following any loss-of-coolant postulated accidents_and following any loss-of-coolant postulated power is not available) and for offsite electric power system operation (assuming onsite power is not available) and for offsite electric power system operation (assuming onsite power is not available). Initis following following any loss-of-coolant postulated power is not available). Initis following following any loss-of-coolant postulated power is not available). Initis following following following power is not available). Initis following following following following power is not available). Initis following following following power is not available). Initis following following following power is not available). Initis following following power is not available). Ini		temperature following any	temperature within acceptable		containment structure", but
maintain them at acceptably low levels. loss-of-coolant-postulated accidentsand maintain them at acceptably low levels. functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale. Suitable redundancy in components and features, and detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. Suitable redundancy in components and features, including electric power system safety function can be accomplished, assuming a single failure. Suitable redundancy in containment capabilities shall be provided to assure that for onsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. Suitable redundancy in containment capabilities power is not available) the system safety function can be accomplished, assuming a single failure.		loss-of-coolant accident and	limits following following any		instead rely on a multi-barrier
I ow levels. Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. I accident <u>s</u> , and maintain them at acceptably low levels. Suitable redundancy in components and features, including electric power systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. Rationale		maintain them at acceptably	loss-of-coolant-postulated		functional containment
Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming a single failure.		low levels.	accidents. and maintain them		configuration to control the
Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.			at acceptably low levels.		release of radionuclides. See
components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. Suitable redundancy in components and features, including electric power systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. Suitable redundancy in components and features, including electric power systems, and suitable power is not available) the system safety function can be accomplished, assuming a single failure.		Suitable redundancy in			mHTGR-DC 16 rationale.
suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.		components and features, and	Suitable redundancy in		
detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. including electric power systems, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) the system safety function can be accomplished, assuming a single failure. Rationale		suitable interconnections, leak	components and features,		
containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. Systems-, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) and for offsite electric power system operation (assuming onsite power is not available).the system safety function can be accomplished, assuming a single failure. Rationale		detection, isolation, and	including electric power		
be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.		containment capabilities shall	systems-, and suitable		
Onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available). operation assuming a single failure. Rationale		be provided to assure that for	interconnections, leak		
operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure. containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) and for offsite electric power system operation (assuming onsite power is not available)-the system safety function can be accomplished, assuming a single failure. Rationale "		onsite electric power system	detection, isolation, and		
be provided to assure that for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.		operation (assuming offsite	containment capabilities shall		
onsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.		power is not available) and for	be provided to assure that for		
operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.		onsite electric power system	onsite electric power system		
power is not available) the system safety function can be accomplished, assuming a single failure.		operation (assuming onsite	operation (assuming offsite		
system safety function can be accomplished, assuming a single failure.		power is not available) the	power is not available) and for		
single failure. Rationale		system safety function can be	onsite electric power system		
Rationale		accomplished, assuming a	operation (assuming onsite		
Rationale		single failure.	power is not available)-the		
Rationale			system safety function can be		
Rationale			accomplished, assuming a		
Rationale			single failure.		
" og poggager ("ig magnit			Rationale		
ae nacaeeany ile maani			" as necessary " is meant		
to condition ARDC 38			to condition ARDC 38		
application to designs			application to designs		

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		requiring heat removal for conventional containments which are found to require heat removal measures.		
		LOCA reference has been removed to provide for any postulated accident that might affect the containment structure.		
		Containment structure safety system redundancy is addressed in second paragraph.		

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
39	Inspection of containment heat removal system. The containment heat removal	<i>Inspection of containment heat removal system.</i> The containment heat removal	Same as ARDC	Not applicable to modular HTGR.
	system shall be designed to permit appropriate periodic inspection of important components, such as the torus, sumps, spray nozzles, and piping to assure the integrity and capability of the system.	system shall be designed to permit appropriate periodic inspection of important components , such as the torus, sumps, spray nozzles, and piping to assure the integrity and capability of the system. Rationale Examples were deleted to make the ARDC technology neutral		Rationale This criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
Criterion 40	Current GDC LanguageTesting of containment heat removal system.The containment heat removal system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole, and	ARDC Language/ Rationale for Modification <i>Testing of containment heat</i> <i>removal system.</i> The containment heat removal system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active system components of the system, and (3) the operability of the system as a	SFR-DC Language/ Rationale for Modification Same as ARDC	mHTGR-DC Language/ Rationale for ModificationNot applicable to modular HTGR.RationaleThis criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the
	of the system as a whole, and under conditions as close to the design as practical the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.	operability of the system as a whole, and under conditions as close to the design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system, including operation of associated systems. Rationale Specific mention of "pressure" testing has been removed yet remains a potential		configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.
		requirement should it be necessary as a component of "appropriate periodic functional testing" of cooling systems.		

IV. Fluid Systems ARDC Language/ SFR-DC Language/ mHTGR-DC Language/ Criterion Current GDC Language **Rationale for Modification Rationale for Modification Rationale for Modification** "Leaktight" integrity would be demonstrated through appropriate functional testing of system performance and operability. Reference to operation of applicable portions of the protection system, cooling water systems, and power transfers is considered part of the more general "associated systems" for operability testing of the system as a whole. **IV. Fluid Systems** SFR-DC Language/ ARDC Language/ mHTGR-DC Language/ Criterion Current GDC Language **Rationale for Modification Rationale for Modification Rationale for Modification** Containment atmosphere Containment atmosphere Same as ARDC Not applicable to modular 41 HTGR. cleanup. cleanup. Systems to control fission Systems to control fission products, hydrogen, oxygen, products hydrogen, oxygen Rationale and other substances which and other substances which may be released into the may be released into the This criterion is not applicable to modular HTGR. Modular reactor containment shall be reactor containment shall be provided as necessary to provided as necessary to HTGRs designs do not have a reduce, consistent with the reduce, consistent with the "pressure retaining reactor functioning of other associated functioning of other associated containment structure", but systems, the concentration systems, the concentration instead rely on a multi-barrier and quality of fission products and quality of fission products functional containment released to the environment released to the environment configuration to control the following postulated accidents, following postulated accidents, release of radionuclides. See and to control the and to control the mHTGR-DC 16 rationale. concentration of hydrogen or concentration of hydrogen or oxygen and other substances oxygen and other substances in the containment in the containment atmosphere following atmosphere following postulated accidents to assure postulated accidents to assure that containment integrity is

IV. Fluid Systems SFR-DC Language/ ARDC Language/ mHTGR-DC Language/ Criterion Current GDC Language **Rationale for Modification Rationale for Modification Rationale for Modification** that containment integrity is maintained. maintained. Each system shall have suitable redundancy in Each system shall have components and features, and suitable redundancy in suitable interconnections, leak components and features, detection, isolation, and including electric power containment capabilities to systems, and suitable assure that for onsite electric interconnections, leak power system operation detection, isolation, and (assuming offsite power is not containment capabilities to available) and for offsite assure that that for onsite electric power system electric power system operation (assuming offsite operation (assuming onsite power is not available) its power is not available) and for safety function can be offsite electric power system accomplished, assuming a operation (assuming onsite single failure. power is not available) its safety function can be accomplished, assuming a single failure. Rationale Advanced reactors offer potential for reaction product generation that is different from that associated with clad metal-water interactions. Therefore, the terms "hydrogen" and "oxygen" are removed while "other substances" is retained to allow for exceptions.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
42	Inspection of containment atmosphere cleanup systems. The containment atmosphere	Same as GDC	Same as GDC	Not applicable to modular HTGR.
	cleanup systems shall be designed to permit appropriate periodic inspection of important components, such as filter frames, ducts, and piping to assure the integrity and capability of the systems.			This criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
Criterion 43	IV. Fluid Systems Current GDC Language Testing of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation, including operation	ARDC Language/ Rationale for Modification <i>Testing of containment</i> <i>atmosphere cleanup systems.</i> The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leak-tight integrity of its components, (2) the operability and performance of the active system components, of the systems such as fans, filters, dampers, pumps, and valves and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into	SFR-DC Language/ Rationale for Modification Same as ARDC	mHTGR-DC Language/ Rationale for ModificationNot applicable to modular HTGR.RationaleThis criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.
	of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems.	operation, operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and including the operation of associated systems Rationale "Active" has been deleted in item (2) as appropriate operability and performance testing of system components is required regardless of active or passive nature, as are cited		

IV. Fluid Systems ARDC Language/ SFR-DC Language/ mHTGR-DC Language/ Criterion Current GDC Language **Rationale for Modification Rationale for Modification Rationale for Modification** examples of active system components. Examples of active systems under item (2) have been deleted both to conform to similar wording in ARDC 37 and 40 and ensure passive as well as active system components are considered. Specific mention of "pressure" testing has been removed yet remains a potential requirement should it be necessary as a component of "...appropriate periodic functional testing..." of cooling systems. "Leaktight" integrity would be demonstrated through appropriate functional testing of system performance and operability.
	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
44	Cooling water. A system to transfer heat from structures, systems, and components important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.	Rationale for ModificationStructural and equipmentcooling-Cooling water.In addition to the heatrejection capability of theresidual heat removal system,A-systems to transfer heatfrom structures, systems, andcomponents important tosafety, to an ultimate heat sinkshall be provided, asnecessary. The system safetyfunction shall be to transferthe combined heat load ofthese structures, systems, andcomponents under normaloperating and accidentconditions.Suitable redundancy incomponents and features, andsuitable interconnections, leakdetection, and isolationcapabilities shall be providedto assuming offsitepower is not available) and for <td>Rationale for Modification Same as ARDC</td> <td>Rationale for ModificationStructural and equipmentcooling. Cooling water.In addition to the heat rejectioncapability of the passiveresidual heat removal system.A-systems to transfer heatfrom structures, systems, andcomponents important tosafety, to an ultimate heat sinkshall be provided, asnecessary. The system safetyfunction shall beto transfer thecombined heat load of thesestructures, systems, andcomponents under normaloperating and accidentconditions.Suitable redundancy incomponents and features, andsuitable interconnections, leakdetection, and isolationcapabilities shall be providedto assure that for onsiteelectric power systemoperation (assuming offsitepower is not available) and foroffsite electric power systemoperation (assuming onsitepower is not available) thesystem safety function can beaccomplished, assuming asingle failure.RationaleInserted "passive" based on</td>	Rationale for Modification Same as ARDC	Rationale for ModificationStructural and equipmentcooling. Cooling water.In addition to the heat rejectioncapability of the passiveresidual heat removal system.A-systems to transfer heatfrom structures, systems, andcomponents important tosafety, to an ultimate heat sinkshall be provided, asnecessary. The system safetyfunction shall beto transfer thecombined heat load of thesestructures, systems, andcomponents under normaloperating and accidentconditions.Suitable redundancy incomponents and features, andsuitable interconnections, leakdetection, and isolationcapabilities shall be providedto assure that for onsiteelectric power systemoperation (assuming offsitepower is not available) and foroffsite electric power systemoperation (assuming onsitepower is not available) thesystem safety function can beaccomplished, assuming asingle failure.RationaleInserted "passive" based on
		for advanced reactor design		system design for residual

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		system differences to include safety-related cooling requirements for SSCs, if applicable; this ARDC does not address the residual heat removal system required under ARDC 34.		heat removal. If a specific mHTGR design can demonstrate that the reactor cavity cooling system (RCCS) provides indefinite core cooling capability, then structural and equipment cooling systems would not be needed.
	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
45	Inspection of cooling water system. The cooling water system shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the system.	Inspection of <u>structural and</u> <u>equipment</u> cooling water systems. The <u>cooling water structural</u> <u>and equipment cooling</u> systems shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the systems. Rationale This renamed ARDC accounts for advanced reactor system design differences to include possible safety-related cooling required for SSCs.	Same as ARDC	Same as ARDC

	IV. Fluid Systems			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
46	Testing of cooling water	Testing of <u>structural and</u>	Same as ARDC	Same as ARDC
	system.	<u>equipment</u> cooling_ . water		
	The cooling water system	systems.		
	shall be designed to permit	The structural and equipment		
	appropriate periodic pressure	cooling water systems shall be		
	and functional testing to	designed to permit appropriate		
	assure (1) the structural and	periodic pressure and		
	leaktight integrity of its	functional testing to assure (1)		
	components, (2) the	the structural and leaktight		
	operability and the	integrity of their its		
	performance of the active	components, (2) the		
	components of the system,	operability and the		
	and (3) the operability of the	performance of the active		
	system as a whole and, under	system components of the		
	conditions as close to design	system, and (3) the operability		
	as practical, the performance	of the system <u>s</u> as a whole		
	of the full operational	and, under conditions as close		
	sequence that brings the	to design as practical, the		
	system into operation for	performance of the full		
	reactor shutdown and for loss-	operational sequences that		
	of-coolant accidents, including	brings the systems into		
	operation of applicable	operation for reactor shutdown		
	portions of the protection	and postulated accidents,		
	system and the transfer	Including operation of		
	between normal and	associated systems, and for		
	emergency power sources.	loss-of-coolant accidents,		
		including operation of and		
		applicable portions of the		
		protection system and the		
		transfer between normal and		
		emergency power sources.		
		Rationale		
		This renamed ARDC accounts		
		for advanced reactor system		
		design differences to include		

Criterion Current GDC Language ARDC Language/ Rationale for Modification SFR-DC Language/ Rationale for Modification mHTGR-DC Language/ Rationale for Modification possible safety-related cooling required for SSCs. Possifter safety-related cooling required for SSCS.	lage/ ation
Rationale for Modification Rationale for Modification Rationale for Modification Rationale for Modification possible safety-related cooling required for SSCs. Possible safety and the set for SSCs. Possifier safety and the set for SSCs. <td< th=""><th>ation</th></td<>	ation
possible safety-related cooling required for SSCs.	
required for SSCs.	
On a rifin manufactor of "manufactor"	
Specific mention of "pressure	
testing has been removed yet	
remains a potential	
requirement should it be	
" enprenriete periodie	
functional testing " of cooling	
Systems.	
"Leaktight" integrity would be	
demonstrated through	
appropriate functional testing	
of system performance and	
operability.	
"Active" has been deleted in	
item (2) as appropriate	
operability and performance	
system component testing is	
required regardless of active	
or passive nature.	
LOCA reference has been	
neetulated assident that might	
affect subject SSCs	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
50	Containment design basis.	Containment design basis.	Same as ARDC	Not applicable to modular
	The reactor containment	The reactor containment		HTGR.
	structure, including access	structure, including access		
	openings, penetrations, and	openings, penetrations, and		Rationale
	the containment heat removal	the containment heat removal		
	system shall be designed so	system shall be designed so		This criterion is not applicable
	that the containment structure	that the containment structure		to modular HTGR. Modular
	and its internal compartments	and its internal compartments		HTGRs designs do not have a
	can accommodate, without	can accommodate, without		"pressure retaining reactor
	exceeding the design leakage	exceeding the design leakage		containment structure", but
	rate and with sufficient margin,	rate and with sufficient margin,		instead rely on a multi-barrier
	the calculated pressure and	the calculated pressure and		functional containment
	temperature conditions	temperature conditions		configuration to control the
	resulting from any loss-of-	resulting from postulated		release of radionuclides. See
	coolant accident. This margin	accidents. any loss of coolant		mHTGR-DC 16 rationale.
	shall reflect consideration of	accident. This margin shall		
	(1) the effects of potential	reflect consideration of (1) the		
	energy sources which have	effects of potential energy		
	not been included in the	sources which have not been		
	determination of the peak	included in the determination		
	conditions, such as energy in	of the peak conditions, such		
	steam generators and as	as fission products, potential		
	required by § 50.44 energy	spray or aerosol formation,		
	from metal-water and other	and potential exothermic		
	chemical reactions that may	chemical reactions energy in		
	result from degradation but not	steam generators and as		
	total failure of emergency core	required by § 50.44 energy		
	cooling functioning, (2) the	trom metal-water and other		
	limited experience and	cnemical reactions that may		
	experimental data available for	result from degradation but not		
	defining accident phenomena	total failure of emergency core		
	and containment responses,	cooling tunctioning, (2) the		
	and (3) the conservatism of	limited experience and		
	the calculational model and	experimental data available for		
	input parameters.	defining accident phenomena		
		and containment responses,		
		and (3) the conservatism of		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		the calculational model and input parameters. Rationale		
		ARDC-50 specifically addresses a containment structure in the opening sentence and ARDCs 51-57 support the containment structure's design basis. Therefore, ARDC 51 – 57 are modified by adding the word "structure" to highlight the containment structure-specific criteria. The phrase "loss of coolant accident" is LWR-specific because this is understood to be the limiting containment structure accident for an LWR design. It is replaced by the phrase "postulated accident" to allow for consideration of the design-specific containment structure limiting accident for advanced non- LWR designs. The example at the end of subpart 1 of the ARDC is		
		LWR-specific and therefore deleted.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
51	Fracture prevention of containment pressure boundary. The reactor containment	<i>Fracture prevention of containment pressure boundary.</i> The reactor containment	Same as ARDC	Not applicable to modular HTGR. Rationale
	boundary shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the containment boundary material during operation, maintenance, testing, and postulated accident conditions, and the uncertainties in determining (1) material properties, (2) residual, steady state, and transient stresses, and (3) size of flaws.	boundary <u>of the reactor</u> <u>containment structure</u> shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic-materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the containment boundary materials during operation, maintenance, testing, and postulated accident conditions, and the uncertainties in determining (1) material properties, (2) residual, steady state, and transient stresses, and (3) size of flaws. Rationale ARDCs 51-57 support ARDC- 50, which specifically applies to advanced non-LWR designs that utilize a fixed containment structure. Therefore, the word "structure"		This criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		ARDCs to clearly convey the understanding that this criterion applies to designs employing containment structures. In some cases, the word "the" was also added to make the phrase grammatically correct. The term "ferritic" was removed in order to not limit the scope of the criterion to ferritic materials. With this revision, the staff believes that this criterion is generically applicable to all non-LWR designs.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
Criterion 52	Current GDC Language Capability for containment leakage rate testing. The reactor containment and other equipment which may be subjected to containment test conditions shall be designed so that periodic integrated leakage rate testing can be conducted at containment design pressure.	ARDC Language/ Rationale for Modification Capability for containment leakage rate testing. The reactor containment structure and other equipment which may be subjected to containment test conditions shall be designed so that periodic integrated leakage rate testing can be conducted at containment design pressure. Rationale ARDCs 51-57 support ARDC 50, which specifically applies to advanced non-LWR designs that utilize a fixed containment structure. Therefore, the word "structure" is added to each of these ARDCs to clearly convey the understanding that this criterion applies to designs employing containment structures. In some cases, the	SFR-DC Language/ Rationale for Modification Same as ARDC	mHTGR-DC Language/ Rationale for Modification Not applicable to modular HTGR. Rationale This criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.
		criterion applies to designs employing containment structures. In some cases, the word "the" was also added to make the phrase grammatically correct.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
Cinterion	Current GDC Language	Rationale for Modification	Rationale for Modification	Rationale for Modification
53	Provisions for containment	Provisions for containment	Same as ARDC	Not applicable to modular
	testing and inspection.	testing and inspection.		HTGR.
	The reactor containment shall	The reactor containment		
	be designed to permit (1)	structure shall be designed to		Rationale
	appropriate periodic inspection	permit (1) appropriate periodic		
	of all important areas, such as	inspection of all important		This criterion is not applicable
	penetrations, (2) an	areas, such as penetrations,		to modular HTGR. Modular
	appropriate surveillance	(2) an appropriate surveillance		HTGRs designs do not have a
	program, and (3) periodic	program, and (3) periodic		"pressure retaining reactor
	testing at containment design	testing at containment design		containment structure", but
	pressure of the leaktightness	pressure of the leak-tightness		instead rely on a multi-barrier
	of penetrations which have	of penetrations which have		functional containment
	resilient seals and expansion	resilient seals and expansion		configuration to control the
	bellows.	bellows.		release of radionuclides. See
		Detienale		maigr-DC 16 rationale.
		Rationale		
		APDCs 51 57 support APDC		
		50 which specifically applies		
		to advanced non-I WR		
		designs that utilize a fixed		
		containment structure		
		Therefore the word "structure"		
		is added to each of these		
		ARDCs to clearly convey the		
		understanding that this		
		criterion applies to designs		
		employing containment		
		structures. In some cases, the		
		word "the" was also added to		
		make the phrase		
		grammatically correct.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
54	Piping systems penetrating	Piping systems penetrating	Piping systems penetrating	Same as ARDC
	containment.	containment.	containment.	
	Piping systems penetrating	Piping systems penetrating	Piping systems penetrating the	Rationale
	primary reactor containment	the primary reactor	primary reactor containment	
	shall be provided with leak	containment <u>structure</u> shall be	structure shall be provided with	In that the specific design
	detection, isolation, and	provided with leak detection,	leak detection, isolation, and	details of each mHIGR is
	containment capabilities	isolation, and containment	containment capabilities naving	Unknown at this time, ARDC
	naving redundancy, reliability,	redundency reliability and	nedundancy, reliability, and	54 Should continue to apply to
	which reflect the importance to	performance capabilities	performance capabilities	applicant could indicate in its
	safety of isolating these pining	which reflect the importance to	containment safety function	application that its specific
	systems. Such nining systems	safety of isolating these pining	and which reflect the	mHTGR design makes this
	shall be designed with a	systems Such Ppining	importance to safety of	GDC not applicable
	capability to test periodically	systems shall be designed	preventing radioactivity	
	the operability of the isolation	with the a-capability to verify	releases from containment	
	valves and associated	by testing periodically the	through-isolating these piping	
	apparatus and to determine if	operability of the operational	systems. Such piping Piping	
	valve leakage is within	readiness of any isolation	systems shall be designed with	
	acceptable limits.	valves and associated	a the capability to verify by	
		apparatus periodically, and to	testing periodically the	
		determine if and to confirm	operability of the operational	
		that valve leakage is within	readiness of any isolation	
		acceptable limits.	valves and associated	
			apparatus <u>periodically</u> , and to	
		Rationale	determine if and to confirm that	
			valve leakage is within	
		ARDUS 51-57 Support ARDU	acceptable limits.	
		to advanced non LWP	Batianala	
		designs that utilize a fixed	Rationale	
		containment structure	The word "structure" was	
		Therefore the word "structure"	added to this SFR-DC to clearly	
		is added to each of these	convey the understanding that	
		ARDCs to clearly convey the	this criterion only applies to	
		understanding that this ARDC	designs employing containment	
		only applies to designs	structures. In some cases, the	
		employing containment	word "the" was also added to	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/	SFR-DC Language/	mHTGR-DC Language/
	0.0	Rationale for Modification	Rationale for Modification	Rationale for Modification
		structures. In some cases, the	make the phrase grammatically	
		word "the" was also added to	correct.	
		make the phrase		
		grammatically correct. The	Not all penetrations will provide	
		adjustment to the last	a release path to the	
		sentence enhances the clarity	atmosphere. Piping that may	
		of the sentence with respect to	be of interest in the case of an	
		the latest terminology used for	SFR design is for the	
		valve periodic verification and	intermediate neat transport	
		operational readiness.	system (IHIS) and the passive	
		The ASME Operation and	residual neat removal system.	
		Maintenance of Nuclear	Based on stakenoider input, a	
		Power Plants, Division 1: ON	designer may be able to	
		Code: Section IST (ASME OW	satisfactorily demonstrate that	
		Code) defines operational	containment isolation valves	
		readiness as the ability of a	design This rewarding for the	
		component to perform its	CER DC provides a designer	
		Specified functions. The	SFR-DC provides a designer	
		ASINE ON CODE IS	asfety asso without	
		the NPC regulations in 10	salety case without	
		CEP 50 552 including the	and associated pood for	
		definition of operational	testing Otherwise NUREC	
		readiness for pumps, valves	1368 (MI 063/10561) (page 3-	
		and dynamic restraints	51) indicated that GDC 54 was	
		and dynamic restraints.	applicable as written	
			applicable as written.	
			ANSI/ANS-54 1-1989	
			recommended revising the	
			phrase " containment	
			capabilities having redundancy	
			reliability and performance	
			capabilities which reflect the	
		_	importance to safety of isolating	
			these piping systems." to	
			"containment capabilities as	
			required to perform the	
			containment safety function "	

	V. Reactor Containment		8	•
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
			The adjustment to the last sentence enhances the clarity of the sentence with respect to the latest terminology used for valve periodic verification and operational readiness. It also removes the introductory statement, as the definition of "required" could be confusing— the designer will present the safety case for what is necessary, and the NRC staff will review it. The ASME Operation and Maintenance of Nuclear Power Plants, Division 1: OM Code: Section IST (ASME OM Code) defines operational readiness as the ability of a component to perform its specified functions. The ASME OM Code is incorporated by reference in the NRC regulations in 10 CFR 50.55a, including the definition of operational readiness for pumps, valves, and dynamic restraints.	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
55	Reactor coolant pressure	Reactor coolant pressure	Reactor Primary coolant	Not applicable to modular
	boundary penetrating	boundary penetrating	pressure boundary penetrating	HTGR.
	containment.	containment.	containment	
	Each line that is part of the	Each line that is part of the	Each line that is part of the	Rationale
	reactor coolant pressure	reactor coolant pressure	reactor primary coolant	
	boundary and that penetrates	boundary and that penetrates	pressure boundary and that	Lines that form a portion of the
	primary reactor containment	the primary reactor	penetrates the primary reactor	reactor coolant pressure
	shall be provided with	containment <u>structure</u> shall be	containment structure shall be	boundary do not penetrate the
	containment isolation valves	provided with containment	provided with containment	reactor building. Therefore,
	as follows, unless it can be	isolation valves as follows,	isolation valves as follows,	this criterion does not apply.
	demonstrated that the	unless it can be demonstrated	unless it can be demonstrated	
	containment isolation	that the containment isolation	that the containment isolation	
	provisions for a specific class	provisions for a specific class	provisions for a specific class of	
	of lines, such as instrument	of lines, such as instrument	lines, such as instrument lines,	
	lines, are acceptable on some	lines, are acceptable on some	are acceptable on some other	
	other defined basis:	other defined basis:	defined basis:	
	(1) One locked closed	(1) One locked closed	(1) One locked closed isolation	
	isolation valve inside and one	isolation valve inside and one	valve inside and one locked	
	locked closed isolation valve	locked closed isolation valve	closed isolation valve outside	
	outside containment; or	outside containment; or	containment; or	
	(2) One automatic isolation	(2) One automatic isolation	(2) One automatic isolation	
	valve inside and one locked	valve inside and one locked	valve inside and one locked	
	closed isolation valve outside	closed isolation valve outside	closed isolation valve outside	
	containment; or	containment; or	containment; or	
	(3) One locked closed	(3) One locked closed	(3) One locked closed isolation	
	isolation valve inside and one	isolation valve inside and one	valve inside and one automatic	
	automatic isolation valve	automatic isolation valve	isolation valve outside	
	outside containment. A simple	outside containment. A simple	containment. A simple check	
	check valve may not be used	check valve may not be used	valve may not be used as the	
	as the automatic isolation	as the automatic isolation	automatic isolation valve	
	valve outside containment; or	valve outside containment; or	outside containment; or	
	(4) One automatic isolation	(4) One automatic isolation	(4) One automatic isolation	
	valve inside and one	valve inside and one	valve inside and one automatic	
	automatic isolation valve	automatic isolation valve	isolation valve outside	
	outside containment. A simple	outside containment. A simple	containment. A simple check	
	check valve may not be used	check valve may not be used	valve may not be used as the	
	as the automatic isolation	as the automatic isolation	automatic isolation valve	

V	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
V	valve outside containment.	valve outside containment.	outside containment.	
a c a p a is d t	solation valves outside containment shall be located as close to containment as oractical and upon loss of actuating power, automatic solation valves shall be designed to take the position that provides greater safety.	containment shall be located as close to containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.	containment shall be located as close to containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.	
ר ק ק ק ק ק ק ק ק ק ק ק ק ק ק ק ק ק ק ק	Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these ines or of lines connected to them shall be provided as necessary to assure adequate safety. Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for inservice nspection, protection against more severe natural phenomena, and additional solation valves and containment, shall include consideration of the population density, use characteristics, and physical characteristics of the site environs.	Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these lines or of lines connected to them shall be provided as necessary to assure adequate safety. Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for inservice inspection, protection against more severe natural phenomena, and additional isolation valves and containment, shall include consideration of the population density, use characteristics, and physical characteristics of the site environs.	Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these lines or of lines connected to them shall be provided as necessary to assure adequate safety. Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for inservice inspection, protection against more severe natural phenomena, and additional isolation valves and containment, shall include consideration of the population density, use characteristics, and physical characteristics of the site environs.	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		Rationale	Rationale	
		Rationale ARDCs 51-57 support ARDC 50, which specifically applies to advanced non-LWR designs that utilize a fixed containment structure. Therefore, the word "structure" is added to each of these ARDCs to clearly convey the understanding that this ARDC only applies to designs employing containment structures. In some cases, the word "the" was also added to make the phrase grammatically correct. Reactor coolant pressure boundary has been relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As such, the term "reactor coolant boundary" is applicable to non-LWRs that operate at either low or high pressure.	Rationale The word "structure" was added to this SFR-DC to clearly convey the understanding that this criterion only applies to designs employing containment structures. In some cases, the word "the" was also added to make the phrase grammatically correct. The title of SFR-DC 55 is the <i>"Primary coolant boundary</i> <i>penetrating containment.</i> " The SFR intermediate loop is a separate closed system that does not allow any direct mixing of intermediate fluid with the primary coolant sodium. The tubing of the IHX and associated intermediate loop piping inside the RV are a part of the primary coolant boundary. SFR-DC 57, <i>"Closed</i> <i>system isolation valves,"</i> addresses closed systems that penetrate containment and would be the appropriate place to address a closed system, such as an intermediate loop, that penetrates containment and is not part of the primary	
		non-LWRs that operate at either low or high pressure.	would be the appropriate place to address a closed system, such as an intermediate loop, that penetrates containment and is not part of the primary coolant boundary (in its entirety). This is similar to the treatment of the main steam	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
			system and the steam generator in a PWR. "Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to reflect that the SFR primary system operates at low- pressure and to conform to standard terms used in the LMR industry. The use of the term "primary" implies the SFR- DC is applicable to the primary cooling system, not the intermediate cooling system.	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
Criterion 56	 V. Reactor containment Current GDC Language Primary containment isolation. Each line that connects directly to the containment atmosphere and penetrates primary reactor containment shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis: (1) One locked closed isolation valve inside and one locked closed isolation valve outside containment; or (2) One automatic isolation valve inside and one locked closed isolation valve outside containment; or (3) One locked closed isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve inside and one automatic isolation valve outside containment; or (4) One automatic isolation valve inside and one automatic isolation valve outside containment; or (4) One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment. A simple check valve may not be used 	ARDC Language/ Rationale for Modification Primary-Containment isolation. Each line that connects directly to the containment atmosphere and penetrates the primary-reactor containment structure shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis: (1) One locked closed isolation valve inside and one locked closed isolation valve outside containment; or (2) One automatic isolation valve inside and one locked closed isolation valve outside containment; or (3) One locked closed isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment; or (4) One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment; or (4) One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment. A simple check valve may not be used	SFR-DC Language/ Rationale for Modification Same as ARDC	mHTGR-DC Language/ Rationale for Modification Not applicable to modular HTGR. Rationale This criterion is not applicable to modular HTGR. Modular HTGRs designs do not have a "pressure retaining reactor containment structure", but instead rely on a multi-barrier functional containment configuration to control the release of radionuclides. See mHTGR-DC 16 rationale.
	valve outside containment.	valve outside containment.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
	containment shall be located as close to the containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.	containment shall be located as close to the containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety. Rationale		
		ARDCs 51-57 support ARDC 50, which specifically applies to advanced non-LWR designs that utilize a fixed containment structure. Therefore, the word "structure" is added to each of these ARDCs to clearly convey the understanding that this criterion applies to designs employing containment structures. In some cases, the word "the" was also added to make the phrase grammatically correct.		

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
57	Closed system isolation	Closed system isolation	Closed system isolation valves.	Not applicable to modular
	valves.	valves.	Each line that penetrates the	HTGR.
	Each line that penetrates	Each line that penetrates the	primary reactor containment	
	primary reactor containment	primary reactor containment	structure and is neither part of	Rationale
	and is neither part of the	structure and is neither part of	the reactor primary coolant	
	reactor coolant pressure	the reactor coolant pressure	pressure boundary nor	This criterion is not applicable
	boundary nor connected	boundary nor connected	connected directly to the	to modular HTGR. Modular
	directly to the containment	directly to the containment	containment atmosphere shall	HTGRs designs do not have a
	atmosphere shall have at least	atmosphere shall have at least	have at least one containment	"pressure retaining reactor
	one containment isolation	one containment isolation	isolation valve which unless it	containment structure", but
	valve which shall be either	valve which shall be either	can be demonstrated that the	instead rely on a multi-barrier
	automatic, or locked closed, or	automatic, or locked closed, or	containment safety function can	functional containment
	capable of remote manual	capable of remote manual	be met without an isolation	configuration to control the
	operation. This valve shall be	operation. This valve shall be	valve and assuming failure of a	release of radionuclides. See
	outside containment and	outside containment and	single active component. The	mHTGR-DC 16 rationale.
	located as close to the	located as close to the	isolation valve, if which shall	
	containment as practical. A	containment as practical. A	required, shall be either	
	simple check valve may not be	simple check valve may not be	automatic, or locked closed, or	
	used as the automatic	used as the automatic	capable of remote manual	
	isolation valve.	isolation valve.	operation. This valve shall be	
			outside containment and	
		Rationale	located as close to the	
			containment as practical. A	
		ARDCs 51-57 support ARDC	simple check valve may not be	
		50, which specifically applies	used as the automatic isolation	
		to advanced non-LWR	valve.	
		designs that utilize a fixed		
		containment structure.	Rationale	
		Therefore, the word "structure"		
		is added to each of these	The word "structure" was	
		ARDCs to clearly convey the	added to this SFR-DC to clearly	
		understanding that this	convey the understanding that	
		criterion applies to designs	this criterion applies to designs	
		employing containment	employing containment	
		structures. In some cases, the	structures. In some cases, the	
		word "the" was also added to	word "the" was also added to	
		make the phrase	make the phrase grammatically	
		grammatically correct.	correct.	

	V. Reactor Containment			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		Reactor coolant pressure boundary is relabeled as "reactor coolant boundary" to create a more broadly applicable non-LWR term that defines the boundary without giving any implication of system operating pressure. As such, the term "reactor coolant boundary" is applicable to non-LWRs that operate at either low or high pressure.	Reactor coolant pressure boundary" has been relabeled as "primary coolant boundary" to reflect that the SFR primary system operates at low- pressure and to conform to standard terms used in the LMR industry. The use of the term "primary" implies the SFR- DC is applicable to the primary cooling system, not the intermediate cooling system.	
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	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
60	Control of releases of radioactive materials to the environment. The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.	Same as GDC	Same as GDC	Same as GDC

	VI. Fuel and Radioactivity			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
61	Fuel storage and handling and radioactivity control. The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions.	Fuel storage and handling and radioactivity control. The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory cooling under accident conditions. Rationale The underlying concept of establishing functional requirements for radioactivity control in fuel storage and fuel handling systems is independent of the design of	Same as ARDC	Same as ARDC

	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
		non-LWR advanced reactors. However, some advanced designs may use dry fuel storage that incorporates cooling jackets that can be liquid-cooled or air-cooled to remove heat. This modification to this GDC allows for both liquid and air-cooling of the dry fuel storage containers.		
	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
62	Prevention of criticality in fuel storage and handling. Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.	Same as GDC	Same as GDC	Same as GDC

	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
63	Monitoring fuel and waste storage. Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.	Same as GDC	Same as GDC	Same as GDC

	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
64	Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.	Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.	Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of- coolant accident fluids-primary system sodium and cover gas cleanup and processing, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational	Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment building atmosphere, spaces containing components for recirculation of loss of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.
		Rationale The phrase "spaces containing components for recirculation of loss of coolant accident fluids" was removed to allow for plant designs that do not have loss-of-coolant accident fluids, but may have other similar equipment that exist in spaces where radioactivity should be monitored.	Rationale In NUREG-1368, Table 3.3 (page 3-25) (ML063410561) NRC staff recommended deleting the GDC-64 phrase "spaces containing components for recirculation of loss-of- coolant accident fluids." Otherwise, the NRC staff noted that criterion requirements are independent of the design of SFRs (page 3-55). Text was added to identify other SFR plant areas that should also be included to maintain consideration of all	Rationale The underlying concept of monitoring radioactivity releases from the modular HTGR particle fuel to the reactor building, effluent discharge paths, and the plant environs applies. High radioactivity in the reactor building provides input to the plant protection system. In addition, the reactor building atmosphere is monitored for personnel protection. Recirculation of loss-of- coolant fluids (i.e., water) does not apply to the modular HTGR.

	VI. Fuel and Radioactivity Control			
Criterion	Current GDC Language	ARDC Language/ Rationale for Modification	SFR-DC Language/ Rationale for Modification	mHTGR-DC Language/ Rationale for Modification
			potential discharge paths and areas subject to monitoring. Therefore, primary system sodium and cover gas cleanup systems that may be outside containment and effluent processing systems are considered in place of the current text.	The descriptions of the associated atmospheres and spaces that are required to be monitored are revised to reflect the modular HTGR's different design configuration and functional containment arrangement.

SFR-DC Language/ Rationale for Modification		
Overarching Rationale for all Additional SFR-DC		
10 CFR Part 50 Appendix A does not have a GDC corresponding to these SFR specific DC. NRC staff is considering the addition of SFR-DC 70 -77.		
Intermediate coolant system. An intermediate cooling system shall be provided. A single passive barrier shall separate intermediate coolant from primary coolant; at least a single passive barrier shall separate the energy conversion system coolant from intermediate coolant. The intermediate coolant shall be chemically nonreactive with sodium. A pressure differential shall be maintained across the primary to intermediate barrier such that any coolant barrier leakage would flow from the intermediate coolant system to the primary coolant system. The intermediate coolant boundary shall be designed to permit the conduct of a surveillance program and inspection in areas where intermediate coolant leakage out of the intermediate coolant system, or energy conversion system coolant leakage into the intermediate coolant system, may hinder or prevent a structure, system, or component from performing any of its intended safety functions.		
Rationale		
NRC considered the DOE's proposed SFR-DC 70 and made changes based on the "Response to NRC Staff Questions on the U.S. Department of Energy Report, "Guidance for Developing Principal Design Criteria for Advanced Non-Light Water Reactors" (ML15204A579) (pages 8-11) NUREG-1368 (page 3-57) (ML063410561) Section 3.2.4.5 suggested the need for a separate criterion for the intermediate coolant system. Also separate criteria were included in NUREG-0968 (ML082381008) (Criterion 31–		

	VII.a. Additional SFR-DC		
Criterion	SFR-DC Language/ Rationale for Modification		
71 Primary coolant & cover gas purity control. Systems shall be provided as necessary to maintain the purity of primary coolant sodium and cover gas specified design limits. These limits shall be based on consideration of (1) chemical attack, (2) fouling a passages, and (3) radionuclide concentrations.			
	Rationale		
	NRC considered the DOE's proposed SFR-DC 71 and made changes based on the "Response to NRC Staff Questions on the U.S. Department of Energy Report, "Guidance for Developing Principal Design Criteria for Advanced Non-Light Water		
	Reactors" (ML15204A579) (pages 12-13) NUREG-1368 (page 3-57) (ML063410561) Section 3.2.4.6 suggested the need for a separate criterion for sodium and cover gas purity control. Also a separate criterion was included in NUREG-0968 (ML082381008) (Criterion 34– Reactor and intermediate coolant and cover gas purity control).		
72	Sodium heating systems. Heating systems shall be provided for systems and components important to safety, which contain or could be required to contain sodium. These heating systems and their controls shall be appropriately designed to assure that the temperature distribution and rate of change of temperature in systems and components containing sodium are maintained within design limits assuming a single failure. If plugging of any cover gas line due to condensation or plate out of sodium aerosol or vapor could prevent accomplishing a safety function, the temperature control associated with that line shall be considered important to safety.		
	Rationale		
	NRC considered the DOE's proposed SFR-DC 72 and made changes based on the "Response to NRC Staff Questions on the U.S. Department of Energy Report, "Guidance for Developing Principal Design Criteria for Advanced Non-Light Water Reactors" (ML15204A579) (pages 13-14)		
	NUREG-1368 (page 3-56) (ML063410561) Section 3.2.4.2 suggested the need for a separate criterion for sodium heating system. Also, a separate criterion was included in NUREG-0968 (ML082381008) (Criterion–7 Sodium Heating Systems).		

	VII.a. Additional SFR-DC		
Criterion	SFR-DC Language/ Rationale for Modification		
73	3 Sodium leakage detection and reaction prevention and mitigation. Means to detect sodium leakage and to limit and control the extent of sodium-air and sodium-concrete reactions a to extinguish fires resulting from these sodium-air and sodium-concrete reactions shall be provided to assure that safety functions of structures, systems and components important to safety are maintained. Special features such inerted enclosures or guard vessels shall be provided for systems containing sodium.		
	Rationale		
	NRC considered the DOE's proposed SFR-DC 73 and made changes based on the "Response to NRC Staff Questions on the U.S. Department of Energy Report, "Guidance for Developing Principal Design Criteria for Advanced Non-Light Water Reactors" (ML15204A579) (pages 15-16).		
	NUREG-1368 (page 3-56) (ML063410561) Section 3.2.4.1 suggested the need for a separate criterion for protection against sodium reactions. Also, a separate criterion was included in NUREG-0968 (ML082381008) (Criterion–4 Protection against Sodium and NaK reactions).		
74	Sodium/water reaction prevention/mitigation. Structures, systems, and components containing sodium shall be designed and located to limit the adverse effects of chemical reactions between sodium and water on the capability of any structure, system, or component to perform any of its intended safety functions. Means shall be provided to limit contact between sodium and water such that chemical reactions between sodium and water will not affect the capability of any structure, system, or component to perform any of its intended safety functions.		
	To prevent loss of any plant safety function, the sodium-steam generator system shall be designed to detect and contain sodium-water reactions and limit the effects of the energy and reaction products released by such reactions, as well as to extinguish a fire as a result of such reactions.		
	Rationale		
	NRC considered the DOE's proposed SFR-DC 74 and made changes based on the "Response to NRC Staff Questions on the U.S. Department of Energy Report, "Guidance for Developing Principal Design Criteria for Advanced Non-Light Water Reactors" (ML15204A579) (pages 16-18) NUREG-1368 (page 3-56) (ML063410561) Section 3.2.4.1 suggested the need for a separate criterion for protection against sodium reactions. Also, a separate criterion was included in NUREG-0968 (ML082381008) (Criterion–4 Protection against Sodium and NaK reactions). Fire considerations are added for consistency with SFR-DC 73.		

	VII.a. Additional SFR-DC		
Criterion	SFR-DC Language/ Rationale for Modification		
75	Quality of the intermediate coolant boundary. Components which are part of the intermediate coolant boundary shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.		
	Rationale		
	This criterion is unique to the SFR design because, based on the information available to the staff, it is the only nuclear plant design for which there is an intermediate coolant loop. This criterion is identical to GDC 30 in 10 CFR 50, Appendix A, and is intended to ensure that, similar to the reactor coolant pressure boundary, the intermediate coolant boundary is designed, fabricated, and tested using quality standards and controls sufficient to ensure that failure of the intermediate system would be unlikely.		
76	<i>Fracture prevention of the intermediate coolant boundary.</i> The intermediate coolant boundary shall be designed with sufficient margin to assure that when stressed under operating, maintenance, testing, and postulated accident conditions (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation on material properties, (3) residual, steady state and transient stresses, and (4) size of flaws.		
	Rationale		
	This criterion is unique to the SFR design because, based on the information available to the staff, it is the only nuclear plant design for which there is an intermediate coolant loop. This criterion is identical to GDC 31 in 10 CFR 50, Appendix A, and is intended to ensure that, similar to the reactor coolant pressure boundary, the intermediate coolant boundary is designed to avoid brittle and rapidly propagating facture modes.		
77	Inspection of the intermediate coolant boundary. Components which are part of the intermediate coolant boundary shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the intermediate coolant boundary. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of coolant leakage.		
	Rationale		
	This criterion is unique to the SFR design because, based on the information available to the staff, it is the only nuclear plant design for which there is an intermediate coolant loop. This criterion is identical to GDC 32 in 10 CFR 50, Appendix A, and is intended to ensure that, similar to the reactor coolant pressure boundary, the intermediate coolant boundary is designed to avoid brittle and rapidly propagating facture modes.		

	VII.b. Additional mHTGR-DC			
Criterion	mHTGR-DC Language/ Rationale for Modification			
	Overarching Rationale for all Additional mHTGR-DC			
	10 CFR Part 50 Appendix A does not have a GDC corresponding to this mHTGR specific DC. NRC staff is considering the addition of mHTGR-DC 70-72.			
70	Reactor vessel and reactor system structural design basis. The design of the reactor vessel and reactor system shall be such that their integrity is maintained during postulated accidents (1) to ensure the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and (2) to permit sufficient insertion of the neutron absorbers to provide for reactor shutdown.			
	Rationale			
	New modular HTGR design-specific GDC is necessary to assure reactor vessel and reactor system (including the fuel, reflector, control rods, core barrel, and structural supports) integrity is preserved for passive heat removal and for insertion of neutron absorbers.			
71	Reactor building design basis. The design of the reactor building shall be such that during postulated accidents it structurally protects the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and provides a pathway for release of reactor helium from the building in the event of depressurization accidents.			
	Rationale			
	The reactor building functions are to protect and maintain passive cooling geometry and to provide a pathway for the release of helium from the building in the case of a line break in the reactor coolant pressure boundary. This newly established criterion assures that these safety functions are provided. It is noted that the reactor building is not relied upon to meet the offsite dose requirements of 10 CFR 50.34 (10 CFR 52.79).			
72	<i>Provisions for periodic reactor building inspection.</i> The reactor building shall be designed to permit (1) appropriate periodic inspection of all important structural areas and the depressurization pathway, and (2) an appropriate surveillance program.			
	Rationale			
	This newly established criterion regarding periodic inspection and surveillance provides assurance that the reactor building will perform its safety functions of protecting and maintaining the configuration needed for passive cooling and providing a discharge pathway for helium depressurization events.			