NEI Comments on Advanced Non-Light Water Reactor Design Criteria

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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?	As discussed in the January 21, 2015 NRC public meeting (summary available at ML15044A081), the DOE confirmed that their proposed ARDC were generally applicable to six advanced reactor designs, Sodium-cooled Fast Reactors (SFRs), Lead Fast Reactors (LFRs), Gas-cooled Fast Reactors (GFRs), modular High Temperature Gas-cooled Reactors (HTGRs), Fluoride High Temperature Reactors (FHRs), and Molten Salt Reactors (MSRs), based on the information available at that time. It appears that NRC did consider much of the DOE input which was based on extensive outreach to advanced reactor developers. However, in the NRC's rationale for the ARDC provided for comment there is no discussion of why the DOE input was or was not used. For example, it it not clear why several of the NRC's proposed design criteria are so similar to the existing light water reactor (LWR) GDC. These proposed DC may not be appropriate for advanced non-light water reactors as they are significantly different from current LWRs. With incorporation of the specific comments that follow, the ARDC provide a starting point as adaptive guidance for advanced reactor developers to create their principal design criteria (PDC). We expect the need to continue to develop more technology specific design criteria similar to the SFR-DCs and mHTGR-DCs. Even for SFRs and mHTGRs where specific DCs have been recommended, this is another partial step closer to the PDC that developers will create. Based on the wide variety of	See comments on ARDC.

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	advanced reactor designs, it is expected that some developers will identify some ARDC, and possibly technology specific DC, as not applicable to their individual design as supported by their design's technical information. See further comments on ARDC that, if not adjusted, would likely be identified as not applicable to some advanced non-LWR designs.	
2. Should the current regulations that an applicant must address be incorporated into the ARDC? If so, which ones?	Appendix A of 10 CFR 50 does not contain a list of the current regulations that an applicant must address. Regulations that are not currently reflected in 10 CFR 50 Appendix A should similarly be excluded from the ARDC. It is noted that this same question was raised during an NRC public meeting held on January 21, 2015 (meeting summary available at ML15044A081). The NRC and DOE responded that this was beyond the scope of this initiative, but could be a future endeavor. As it is outside the scope established for this initiative, a list of the current regulations that an applicant must address should not be incorporated into the current regulatory guidance development effort for a number of reasons, including: a) The ARDC would then be inconsistent with the structure and content of the GDC, which do not contain a list of current regulations that an applicant must address; b) Doing so would be outside the scope of both this initiative and the "adaptation" language reflected in the introductory language in Appendix A;	Incorporation of current regulations into the ARDC is outside the scope of the current initiative and should not be pursued.

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	c) Rulemaking would likely be needed to align the GDC and ARDC; d) Incorporation of current regulations into the ARDC would require significant effort and likely a deferral of the planned schedule for Regulatory Guide issuance, extending the current state of regulatory uncertainty for advanced reactor stakeholders regarding design criteria guidance.	
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?	See response to question 1. With incorporation of the specific comments that follow, the ARDC provide a reasonable starting point as adaptive guidance for advanced reactor developers to create their PDC. Even for SFRs and mHTGRs where specific DCs have been recommended, this is another partial step closer to the PDC that developers will create. Based on the wide variety of advanced reactor designs, it is expected that some developers will identify some ARDC, and possibly technology specific DC, as not applicable to their individual design as supported by their design's technical information.	
4. There are several new approaches within the ARDC, SFR-DC, and mHTGR-DC, such as: • use of "functional containment" for mHTGR-DC,	• The approach to "functional containment" is not appropriately addressed, since NRC did not incorporate the concept into ARDC 16. This creates a disconnect between this overarching ARDC and the more technology specific mHTGR-DC 16 (i.e., mHTGR-DC 16 will not logically derive from ARDC 16.). The ARDC language proposed by DOE in the December 2014 report (ML14353A246 and	• The NRC should reflect the "functional containment" concept proposed by DOE in ARDC 16 and allow advanced reactor applicants to use this guidance as they create PDC for their designs. ARDC 16 should be worded in a manner consistent with the intent of the ARDC effort to maximize the suitability of the ARDC for various advanced non-LWR designs and to permit innovation. See specific comment on

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• 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	ML14353A248) was intended to be sufficiently general to allow the other reactor technology versions of Criterion 16 to be the same as the ARDC with no further technology specific modifications. The language was chosen to encompass either a traditional containment structure that surrounds the reactor and its coolant system or a technology specific functional containment such as that used by the modular HTGR. It would be incumbent on the designer to demonstrate the suitability of their design for their reactor type and to demonstrate compliance with regulatory requirements for offsite dose. The more narrow ARDC language suggested by NRC does not provide for use of alternatives to traditional containment structures and, therefore, is not consistent with the Commission SRM issued in response to SECY-93-0092, the SRM issued in response to SECY-03-0047, and SECY-05-0006 that discuss the NRC's openness to options for containing radionuclides. The proposed NRC language removes flexibility and may dissuade future designers from pursuing technology specific functional containment concepts. • The use of specified acceptable radionuclide release design limits is a positive change more clearly focused on desired performance in a technology inclusive manner.	ARDC 16.

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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?	• ARDC 34 and 35 – As some designs will not rely on ECCS, suggest instead permitting the designer to show what cooling requirements are needed. Most designs will likely require some form of fuel cooling system. • See comment for ARDC 34, below. There is no need for SFR-DC 34 to differ from the ARDC or mHTGR-DC in this area.	
5. General, DOE-NRC Initiative	In the introduction to the document, the NRC clarifies how the use of "shall" and "must" should be interpreted, saying that: "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."	This clarification should also be included in the final version of the Regulatory Guide.
6. General, Process	It is encouraging that, although risk-informing the ARDC is not within the scope of the 2013 NRC and DOE joint initiative, the NRC "…intends to consider the extent to which risk-informing the ARDC… is possible given the level of design information and data available." The stated intent is consistent with NRC's stated openness "…to new opportunities to explore a risk-informed performance-based regulatory process" and the NRC's recognition of	First priority should be on completing the regulatory guide on the current ARDC effort. We recommend that NRC engage stakeholders within the next three months to discuss the scope and the timeline for risk-informing the ARDCs.

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	"…the benefits to risk informing the advanced non-LWR design criteria to the extent possible, depending on the design information and data available." This will enable implementation of some of our comments, including those on Criterion 24. We recognize that NRC's intent is also consistent with the NRC's willingness to consider adjusting future activities in response to external stakeholders' expressed interests as indicated by the NRC's plan to consider a "step-wise licensing strategy." To ensure that consideration of risk-informing the ARDC does not delay timely issuance of the near-term advanced non-LWR design criteria regulatory guide, it is necessary to engage the stakeholders in identifying criteria that can be readily adapted based on technology inclusive, performance-based, and risk-informed principles.	
7. General, Other Advanced Non-LWR Activities	NRC states that the staff is contemplating design considerations related to security requirements. Design considerations and associated regulatory requirements related to security are currently addressed outside of 10 CFR 50 Appendix A. This structure should be maintained, and design considerations related to security should not be incorporated into the advanced reactor design criteria.	Design considerations related to security should not be incorporated into the advanced reactor design criteria.
8. General, Application of "Important to Safety"	The ambiguity of the term "important to safety" in existing NRC regulation and guidance was identified during ARDC development. Proposed ARDC 3 is one example of the lack of clarity as to what NRC considers important to safety. On page 2 of the introductory material, NRC discusses important to safety, but it is not clear what the discussion	For consistency and clarity throughout the ARDC, all uses of the phrase "structures, systems, and components important to safety" should be removed and modified to state "safety-related structures, systems and components." We recognize that due to design differences and desire to move toward use of more risk-informed

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	implies. The DOE December 2014 report (ML14353A246 and ML14353A248) provided a definition of the term "important to safety" to clarify and confirm its use, based on industry's understanding of its intended meaning within the context of 10 CFR 50 Appendix A. This term was further addressed in DOE's response to NRC Question 40 (ML15204A579). The need for this clarification was also discussed in an NRC public meeting on January 21, 2015 (meeting summary available at ML15044A081), with DOE indicating that the ARDC's could be heavily impacted if NRC's understanding of the use of the term within Appendix A is different from that provided in the clarifying definition. To avoid the ambiguity and confusion associated with use of the term "important to safety," we should make the most of this opportunity to ensure the clarity of ARDC as we move forward with development, review, and approval of advanced reactors.	methods in establishment of the licensing basis, the definition of "safety-related" for advanced non-light water reactors will eventually need some modification.
9. General, NRC should review and provide feedback on DOE proposed definitions.	The DOE report provided a series of Definitions (report Section 3.1) that are intended to confirm a common understanding of the use of certain terms within the context of 10 CFR 50 Appendix A, and to provide added clarity regarding the use of selected terms unique to DOE's proposed non-LWRs design criteria. These definitions were reviewed with the NRC staff in a public meeting on January 21, 2015 (meeting summary available at ML15044A081), but were not reflected in the material provided for public comment.	The DOE proposed definitions should be addressed and confirmed in the pending Regulatory Guide.

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	A common understanding of the Definitions in the DOE report is essential to a common understanding of the ARDC requirements and of the requirements associated with technology-specific examples of design criteria derived from the ARDCs.	
10. Criterion 3, *Fire Protection*	The term "safety related equipment" appears to be redundant to the term "structures, systems, and components important to safety" and potentially changes the applicability of the DC as stated in the first sentence. As written, this text makes a distinction between "safety related equipment" and "structures, systems, and components important to safety" that is made no place else in the design criteria. The ambiguity of the term "important to safety" in existing NRC regulation and guidance was identified during ARDC development. The understood meaning of important to safety was defined on page 7 of the DOE ARDC report as: "Important to Safety - Based on existing 10 CFR 50 Appendix A language, this designation refers to structures, systems, and components (SSCs) that provide reasonable assurance the facility can be operated without undue risk to the health and safety of the public. SSCs with this designation are safety related and are relied upon to remain functional during design basis accidents. Undue risk is associated with the inability to ensure the capability to prevent or mitigate the consequences of accidents which could result in	For consistency and clarity throughout the ARDC, all uses of the phrase "structures, systems, and components important to safety" should be removed and modified to state "safety-related structures, systems and components." See general comment on Application of "Important to Safety," above. We recognize that due to design differences and desire to move toward use of more risk-informed methods in establishment of the licensing basis, the definition of "safety-related" for advanced non-light water reactors will eventually need some modification.

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	offsite radiological consequences exceeding the limits set forth in 10 CFR 50.34 (or 10 CFR 52.79)." NRC's use of "important to safety" in ARDC 3 seems to deviate from that understanding.	
11. Criterion 4, *Environmental and dynamic effects design bases.*	For clarity, in the last sentence of this ARDC should indicate that the Commission considers gases such as helium a "fluid." The rationale for the change states "Reference to pipe whip may not be applicable to designs that operate at low pressure," but no markups are provided.	Clarify that gases are considered fluids. Revise ARDC 4 to include brackets around "[pipe whipping]" to identify a portion of the original GDC language where advanced designs that operate at low pressure may provide alternative descriptions to address underlying criterion requirements.
12. Criterion 10, *Reactor design.*	Many advanced reactors have a significantly different reactor design than current light water applications. The current wording for ARDC will not be applicable to all designs, as written. In the explanation of the rationale for the change, correct "TRSIO" to "TRISO." Also, in the explanation of the rationale for the change, the last part ("The word "coolant" has been replaced…reactor system design.") is repeated twice.	Revise ARDC 10 to state, "*Reactor design.* The reactor system and associated heat removal, 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." Correct "TRSIO" to "TRISO." Delete the repetition.

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13. Criterion 13, *Instrumentation and control.*	Proposed mHTGR-DC 13 states, "… *integrity of reactor core, and reactor helium pressure boundary…"* It is not clear what is meant by maintaining the integrity of the reactor core. We believe it is redundant to maintaining the integrity of functional containment which includes: fuel particle kernel, fuel particle coatings surrounding the kernel, graphite matrix (fuel compact/graphite fuel elements or pebbles), and the reactor helium pressure boundary.	Delete "…reactor core, and reactor helium pressure boundary…" from mHTGR-DC 13.
14. Criterion 16, *Containment design.*	DOE-proposed ARDC 16 language, in conjunction with the definition of "functional containment" as provided in the DOE report, is sufficient to address radiological containment for a wide variety of advanced reactors without incurring technology-specific modifications. DOE's proposed criterion text was crafted to encompass both traditional containment structures (and associated systems) and multi-barrier functional containment approaches. The DOE approach is consistent with the Commissioner's June 26, 2003 SRM on SECY-03-0047 which directed the staff to develop containment performance requirements and criteria working closely with industry and other stakeholders. Some advanced reactors may not rely on a containment structure or may need a significantly different containment configuration than what LWRs require. Suggest revising to reflect the DOE-proposed ARDC 16 language to allow a designer to show that there is no significant risk of uncontrolled release of radioactivity to the environment.	ARDC 16 should be revised to reflect the DOE proposal. Revise all DC to allow a designer to show that there is no significant risk of uncontrolled release of radioactivity to the environment.

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	Suggest that SFR and mHTGR have the same criteria. SFR containment designs surround only the primary cooling system. There is no need to require inclusion of the intermediate loop within the containment since this system will not contain radioactive materials. The SFR-DC contains an additional final sentence, "The containment leakage shall be restricted to be less than that needed….postulated accidents." It is not clear why such an addition should be specified for the SFR-DC as the onsite and offsite dose consequence limits of 10 CFR 50.34 are already applicable to all designs. Inclusion of this sentence creates questions on the design-specificity of onsite and offsite dose consequence limits.	Change SFR-DC 16 first sentence wording "its cooling systems" to "its primary cooling system" Delete the last sentence from the SFR-DC.
15. Criterion 17, *Electric power systems.*	NRC's proposed ARDC 17 is not performance-based, but rather is a preservation of prescriptive requirements for the electrical power system that are based upon the light water reactor designs from the 1970s, which bear little resemblance to future advanced non-LWR designs. As such, it is anticipated that all advanced reactor designs will need to take an exception to ARDC 17 in their applications for NRC approval. DOE's proposed ARDC 17 is performance-based in a manner that is inclusive of the advanced reactor designs that are anticipated to be submitted to the NRC for approval. The DOE's approach is flexible, focused, and aligned with guidance contained in the Commission's 2008 "Policy Statement on the Regulation of Advanced Reactors" (ML082750370). The DOE ARDC 17 language	NRC should adopt the DOE-proposed ARDC 17 language without modification, in order to accomplish the goal of being performance-based in its focus on ensuring that capability is provided to assure that safety-related functions are maintained. This will also better facilitate eventual risk-informing. The Rationale for Modification reference to the ACRS September 24 subcommittee meeting should be removed since the subcommittee was addressing the NuScale DSRS and requested the staff to remain flexible. Change to ARDC 17 will require extensive review and adaptation to ARDCs 18, 33, 34, 35, 37, 38,

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	focuses on the underlying purpose of GDC-17 by requiring the electric power necessary to ensure safety-related functions are performed when required. It also provides a performance-based approach to criteria for the electrical power system design, including consideration of the need for power supplied from off-site sources and the components and classification of the on-site power system, commensurate with the electrical power needs of those designs to successfully perform safety and other important plant functions. Consistent with the DOE ARDC, NEI submitted a paper to the NRC entitled "Offsite Power Requirements for Small Modular Reactors and Other New Technologies," which describes that the underlying purpose of GDC 17 "is to ensure the plant has sufficient power to accomplish safety functions." The NEI paper also describes how inherent assumptions, based upon early large LWR designs, have resulted in GDC-17's prescriptive requirements for the electric power system. Although the paper is focused on establishing acceptance criteria for designs that do not rely on an offsite power supply to provide adequate protection of the public health and safety, the paper also provides a basis for establishing a risk-informed performance-based DC-17 for advanced reactors and light water SMRs. This approach is technology inclusive, and permits the use of guidance to establish acceptance criteria on detailed aspects of the electric power system, such as the need for offsite power sources or specific components (such as batteries and onsite electric distribution systems) based upon design attributes, safety classifications, and performance characteristics. The	40, 41, 43, 44, and 46 to ensure consistency.

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	ARDC-17 proposed by DOE and the approach in the NEI paper, in contrast to the NRC's proposed ARDC-17, are consistent with the Commission's 2008 "Policy Statement on the Regulation of Advanced Reactors" (ML082750370) which summarizes its expectation 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. NRC's proposed content for ARDC 17 appears to be in conflict with this Commission expectation since the offsite power requirements typically associated with plants that rely on active safety systems are retained. This apparently conflicting ARDC content may discourage advanced reactor designers from pursuing the Commission's policy expectations regarding reduced reliance on active safety systems, since they'd then need to pursue a departure or exemption from this ARDC during the license application review process. The defense-in-depth (DID) rationale given by NRC to justify retaining prescriptive GDC 17 power requirements is based on LWR-derived design features that do not exist in advanced reactor designs. Advanced reactors will incorporate passive safety features that do not require electric power to function, which provide additional levels of DID not included in the LWR designs on which the existing GDC-17 is based. The NRC has previously recognized the ability of passive safety systems to provide an equivalent level of DID to some of the prescriptive electric power system requirements in GDC-17 in their approval of the AP1000 design. Consistent with the NRC Advanced Reactor Policy Statement, ARDC 17 should	

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	reflect the expectation that advanced reactors will further enhance their ability to perform safety functions through passive features thereby decreasing, or even eliminating, the reliance on electrical power, and should accommodate these advancements in design without the need for exemptions. Many of these designs may also be able to start up, operate and maintain in shutdown mode all reactors at the plant through an on-site preferred power source, without the need for off-site power. mHTGRs are passive plants and as such they do not rely on external DC or AC power to remove decay heat. Decay heat is removed by a redundant and fully passive reactor cavity cooling system (RCCS). Furthermore, there is no action required (passive or active) to start the RCCS. This system is always operating in a non-safety mode during both normal operation and AOOs. As a DID measure, in a total loss of RCCS, i.e., a beyond design bases scenario, decay heat is passively rejected to the ground surrounding the reactor cavity as long as the functional containment is maintained. There is no important to safety electrical equipment that relies on AC power for accident mitigation functions.	Revise mHTGR-DC to indicate Criterion 17 is not applicable.
16. Criterion 18, *Inspection and testing of electric power systems.*	In light of our comments on ARDC 17, the transfer of "offsite power system" requirement should be eliminated for ARDC 18.	Change ARDC 18 to ensure consistency with resolution of comments on ARDC 17. NRC should adopt the DOE-proposed ARDC 18 language without modification.
17. Criterion 21,	The regulations for advanced reactors should rely on	Change ARDC 21 to eliminate the "single failure"

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Protection system reliability and testability.	systematic risk-informing and performance-based methodology. This encourages designers to innovate and achieve enhanced levels of safety consistent with Commission Policy. The designer may choose redundancy to achieve the required level of safety, but it should not be prescribed.	requirement and rely on systematic risk-informing and performance-based methodology to provide the required level of safety.
18. Criterion 23, *Protection system failure modes.*	Instead of changing the SFR DC with the addition of "sodium and sodium reaction products," consider changing the ARDC by including, in the list of "postulated adverse environments," a mention of "chemicals eventually generated during postulated events that can result in an adverse environment." In this way, the applicability of ARDC would be extended to other technologies, e.g. SFRs, and the SFR-DC could be left as "Same as ARDC."	Change the ARDC by including, in the list of "postulated adverse environments," a mention of "chemicals eventually generated during postulated events that can result in an adverse environment."
19. Criterion 24, *Separation of protection and control systems.*	The regulations for advanced reactors should rely on systematic risk-informing and performance-based methodology. This encourages designers to innovate and achieve enhanced levels of safety consistent with Commission Policy. The designer may choose redundancy to achieve the required level of safety, but it should not be prescribed.	Change ARDC 24 to eliminate the "single failure and redundancy" requirement and rely on systematic risk-informing and performance-based methodology to provide the required level of safety.
20. Criterion 26, *Reactivity control system redundancy and capability.*	Control rods may not be included and may not even be possible with some advanced non-light water reactor designs. To extend the applicability of this ARDC to multiple advanced reactor designs, remove the requirement for one of these reactivity control systems to necessarily consist of control rods. The designer should be given freedom of choice in control system design. Rather, it is suggested to emphasize the need for at least two of	Remove the requirement for one of the reactivity control systems to necessarily consist of control rods.

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	these systems to be independent and diversified and thus not be subjected to common cause failures (CCFs). If the need to require differences in "design principles" is maintained, the rationale for these differences should be made clear. Hypothetically, one could propose two rod-based systems, arguing that the "design principle" is different and thus satisfying the requirement. There should not be ambiguity in the interpretation of this requirement. If the requirement for one control system to necessarily be in the form of rods is maintained, clarify what "positive means for inserting the rods" requires.	
21. Criterion 27, *Combined reactivity control systems capability.*	ARDC 27 should be performance-based with acceptable performance to be demonstrated by the designer. For example, for mHTGR it is anticipated that although there are two independent and diverse reactivity control systems provided, neither is required to allow plant cooling or shutdown. If the reactivity control system is not available, the reactor shutdown is accomplished by a highly negative core temperature coefficient. Core cooling, i.e., decay heat removal, is provided by the active core flow provided by the circulators and the steam generators, backed by the active shutdown cooling system (SCS), and, in case of failure of both of those non-safety systems, the passive, safety-related, and redundant RCCS will cool the plant. In the beyond design bases event of RCCS failure, the decay heat is naturally transferred to the ground surrounding the reactor cavity.	Revise ARDC 27 to delete "for stuck rods" and ensure consistency with resolution of comments on ARDC 26. Revise mHTGR-DC to indicate Criterion 27 is not applicable.

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22. Criterion 29, *Protection against anticipated operational occurrences.*	Per the mHTGR example described for Criterion 27, the mHTGR reactivity control system does not have any safety function.	Revise mHTGR-DC to indicate Criterion 29 is not applicable.
23. Criterion 33, *Reactor coolant makeup.*	Some designs will utilize a method of draining primary coolant/fuel for accident scenarios and would not desire to makeup inventory.	Revise ARDC and SFR DC to reflect a range of designs including those that are intended to not use makeup inventory. Change ARDC 33 to ensure consistency with resolution of comments on ARDC 17.
24. Criterion 34, *Residual heat removal.*	Previous reviews of the content and structure of the existing General Design Criteria included in Appendix A of 10 CFR 50, have determined that various criteria (such as GDC's 4, 14, and 31) address the aspects of reactor coolant boundary integrity during postulated accidents. The underlying bases established in those criteria are retained in the adaptations previously proposed in the submitted DOE report for the corresponding ARDC's. It is also noted that a revised proposal for ARDC 34 content that provides further clarity was submitted by DOE on September 15, 2015 (ML15272A096). During SFR postulated accidents, localized boiling may occur, and is acceptable, under the definition of continued effective core cooling. There is no need for SFR-DC 34 to differ from the ARDC or mHTGR-DC in this area. Requiring that the RHRS coolant shall be chemically	ARDC 34 should not include text that specifically addresses pressure boundary integrity, since that topic is addressed elsewhere. ARDC 34 should be updated to reflect DOE's September 15, 2015 (ML15272A096) proposed revised format and content. Revise SFR-DC 34 paragraph, "During postulated accidents…," to be consistent with the ARDC and mHTGR-DC in this area. The phrase "sodium boiling is precluded" should be removed from the SFR-DC. In the fourth paragraph of the SFR-DC, the phrase

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	nonreactive with sodium can be open to misinterpretation. Instead, requiring that RHRS coolant to be chemically compatible with sodium is more appropriate. For example, NaK (a possible RHRS coolant) is chemically compatible with sodium; however, it is not chemically nonreactive with sodium.	"…shall not be chemically reactive with the primary coolant…" should be replaced with the phrase "…shall be chemically compatible with the primary coolant…"
	The water-cooled version of the mHTGR Reactor Cavity Cooling System (RCCS) responsible for post-accident decay heat removal is a dual function system: a) in normal operation and AOO conditions it performs its non-safety related function to remove parasitic heat from the reactor cavity which requires an active and non-safety related secondary heat removal circuit, and b) in postulated accident conditions it removes the core decay heat passively and does not rely on its secondary circuit. The air-cooled version of the RCCS has no active components and does not require electrical power. Therefore, as recommended in our comment on Criterion 17 above, no safety related off-site power or safety related AC power is needed by the RCCS for its residual or decay heat removal function during accident conditions. In beyond design bases conditions, where the dual RCCS is assumed not to be available, the decay heat is passively rejected to the ground surrounding the reactor cavity and the SARRDs are maintained.	For the mHTGR-DC, eliminate the following sentence, "For normal operations and anticipated operational occurrences, the…" to the end of the paragraph. Also, remove the any reference to electrical power or offsite power in the last paragraph. Change ARDC 34 to ensure consistency with resolution of comments on ARDC 17.
	In the NRC's mHTGR-DC rationale for modification it states, "the mHTGR design is defined as having passive heat removal **due to** a low power density." [emphasis added] To be clear, the mHTGR design has passive heat	Revise rationale to be clear that the mHTGR design has passive heat removal **and** a low power density.

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	removal **and** a low power density. As it reads now, ARDC 34 requires that the residual heat removal system "shall provide continuous effective core cooling and assure that the design conditions of the reactor coolant boundary are not exceeded." This "shall" becomes "should" because of how ARDC 35 is worded, i.e., "If the system as described in ARDC 34 does not provide continuous effective…." It is therefore suggested to merge ARDC 34 and 35, and to have ARDC 35 removed.	ARDC 34 and 35 should be merged in a single criterion.
25. Criterion 35, *Emergency core cooling.*	DOE did not propose ARDC content, but instead proposed that; "If a separate ECCS system is required for an advanced reactor, the PDC process for that reactor must look directly to GDC 35 for guidance." This does not suggest an advanced reactor design equivalent to GDC 35 is needed as ARDC 35. If a system described in ARDC 34 does not provide continuous effective core cooling during postulated accidents (which is required), the system is improperly designed and subject to revision to meet the ARDC 34 requirement. A "contingency" system should not be assumed as an arbitrary design option. Criterion 35 is obsolete and not applicable to advanced non-LWRs. mHTGRs do not have and do not need an Emergency Core Cooling System.	Delete proposed ARDC 35.
26. Criterion 36, *Inspection of residual heat removal ~~emergency~~*	In the NRC's mHTGR-DC rationale for modification it states, "the mHTGR design is defined as having passive heat removal **due to** a low power density." [emphasis added] To be clear, the mHTGR design has passive heat	Revise rationale to be clear that the mHTGR design has passive heat removal **and** a low power density.

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~~*core cooling*~~ *system.*	removal **and** a low power density.	
27. Criterion 37, *Testing of residual heat removal* ~~*emergency core cooling*~~ *system.*	The Residual Heat Removal System for mHTGRs, i.e., the RCCS, is a passive system. It does not require AC power to be switched on or off for it to function. The operation of the associated cooling water system is also gravity driven and passive in water-based RCCS configurations.	NRC should adopt the DOE-proposed ARDC 37 language and ensure consistency with resolution of comments on ARDC 17.
28. Criterion 38, *Containment heat removal.*	The basis for adding "…including electric power systems" to criteria 38 and 41 is unclear and not addressed in the rationale. Electric power systems are included under components and features, thereby making the new text unnecessary. New text for items already addressed should be avoided and technology neutrality maintained.	Delete new text and change ARDC 38 to ensure consistency with resolution of comments on ARDC 17.
29. Criteria 38, 39, 40, 41, 42, 43, 44, 45, 46, 50, 51, 52, 53, 54, 55, 56, 57	These criteria may apply if a containment is required for the design.	Revise ARDC to indicate they are not applicable to designs that do not have a "pressure retaining reactor containment structure."
30. Criterion 40, *Testing of containment heat removal system.*	See comments on Criterion 17.	Change ARDC 40 to ensure consistency with resolution of comments on ARDC 17.
31. Criterion 41, *Containment atmosphere cleanup.*	See comments on Criterion 17.	Change ARDC 41 to ensure consistency with resolution of comments on ARDC 17.
32. Criterion 43, *Testing of containment atmosphere cleanup systems.*	See comments on Criterion 17.	Change ARDC 43 to ensure consistency with resolution of comments on ARDC 17.
33. Criterion 44, ~~*Cooling water.*~~ *Structural and equipment cooling.*	See comments on Criterion 17. If a modular HTGR design cannot demonstrate that the	NRC should adopt the DOE-proposed ARDC 44 language and ensure consistency with resolution of comments on ARDC 17.

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	reactor cavity cooling system (RCCS) provides an indefinite core cooling capability, then the design is inadequate and needs to be redesigned to keep the facility consistent with the definition of a modular HTGR. GDCs 44, 45, and 46 address safety systems that are not present in a properly designed modular HTGR and are therefore not applicable on that basis.	Delete mHTGR-DCs 44, 45, and 46 and replace with "not applicable to mHTGRs."
34. Criterion 45, *Inspection of structural and equipment cooling ~~water~~ systems.*	See comments on Criterion 44. There is no technical basis for applying Criterion 45 to the modular HTGR.	Delete mHTGR-DC 45 and replace it with "not applicable to mHTGRs."
35. Criterion 46, *Testing of structural and equipment cooling ~~water~~ systems.*	See comments on Criterion 17. See comments on Criterion 44. There is no technical basis for applying Criterion 46 to the modular HTGR.	Change ARDC 46 to ensure consistency with resolution of comments on ARDC 17. Delete mHTGR-DC 46 and replace it with "not applicable to mHTGRs."
36. Criterion 50, *Containment design basis.*	The criterion reads: "This margin shall reflect consideration of (1) the effects of potential energy sources which have not been included in the determination of the peak conditions, such as fission products, potential spray or aerosol formation, and potential exothermic chemical reactions…" It is not clear how "fission products, potential spray or aerosol formation" can act as energy sources.	Revise ARDC 50 to delete the list of potential energy sources beginning with "such as…"
37. Criterion 54, *Piping systems penetrating containment.*	In light of mHTGR-DC 16, the modular HTGRs have functional containments instead of a fixed containment. This makes the reactor building a non-pressure retaining structure and pressure retention of any piping penetration unnecessary.	Delete mHTGR-DC 54 and replace it with "not applicable to mHTGRs."

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38. Criterion 57, *Closed system isolation valves.*	The change currently incorporated in the corresponding SFR-DC, i.e., "unless it can be demonstrated…if required, shall," should be incorporated in the ARDC as well to allow all advanced reactor developers to show what requirements are needed for their design.	Revise the ARDC to incorporate "unless it can be demonstrated…if required, shall," as added to the SFR-DC.
39. Criterion 70, *Intermediate coolant system.*	Rather than imposing the specific engineering solution to adopt, i.e., the use of an intermediate circuit, the criterion should require the designer to ensure that acceptable fuel design limits are not exceeded upon events involving a breach of the power conversion system boundary at the interface with the primary system, and require an intermediate cooling system ONLY IF the power conversion system fluid is water, or another fluid which exothermically reacts with sodium. If the power conversion system fluid is chemically compatible with sodium, the designer should have freedom to decide whether to adopt an intermediate circuit or to incorporate engineering solutions to prevent or mitigate the consequences of potential leaks of power conversion system fluid into primary sodium. The NRC's technical review will determine whether the designer's choices are adequate to protect the public and the environment from these events.	Revise the criterion to require the designer to ensure that acceptable fuel design limits are not exceeded upon events involving a breach of the power conversion system boundary at the interface with the primary system, and require an intermediate cooling system ONLY IF the power conversion system fluid is water, or another fluid which exothermically reacts with sodium.
40. Criterion 75, *Quality of the intermediate coolant boundary.*	Proposed SFR-DC 75, 76, and 77 appear to elevate the importance of the intermediate coolant system as a safety grade system. With a non-radioactive coolant, maintaining the integrity of the intermediate coolant system boundary is an operational concern, not a safety issue. Quality of the intermediate coolant boundary within the context of a leakage that may prevent a structure, system, or	The proposed new criteria 75, 76, and 77 should be removed.

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	component from performing any of its intended safety functions is already addressed in SFR-DC 70. More general considerations for sodium leakage detection, reaction prevention and mitigation are also captured in SFR-DC 73. If, for some designs, the intermediate coolant system is also utilized as a path for decay heat removal, then the quality of its boundary is covered in SFR-DC 34, 36, and 37.	
41. Criterion 76, *Fracture prevention of the intermediate coolant boundary.*	See comments on SFR-DC 75.	The proposed new criterion 76 should be removed.
42. Criterion 77, *Inspection of the intermediate coolant boundary.*	See comments on SFR-DC 75.	The proposed new criterion 77 should be removed.