U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Reactor Design MHTGR-DC 10

Jeff Schmidt
Senior Reactor Systems Engineer
Office of New Reactors

MHTGR-DC 10 Comment #43 and #44 DOE/Lab

<u>Comment:</u> Staff replaced "core" with "system" in the definition of specified acceptable system radionuclide release design limits (SARRDL). SARRDL is measure of particle fuel coating performance and hence the word "core" should be used in the definition.

<u>NRC Response:</u>

No change is proposed. Staff agrees that SARRDL is primarily an indicator of fuel coating performance but the limit should consider all sources which could be mobilized in the primary and connected systems which are not isolated, because the specific sources of radioactivity cannot be explicitly identified.

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Containment Design ARDC 16, SFR-DC 16, MHTGR-DC 16

Imtiaz Madni
Senior Reactor Systems Engineer
Office of New Reactors

ARDC 16 Comment # 52 Industry/NEI and Comment #53 DOE/Lab

Both comments recommended that the DOE version of ARDC 16 (functional containment) be adopted instead of using the current GDC 16 as proposed by the NRC.

- The current GDC 16 is intended for a pressure retaining light water reactor.
- Use of the current GDC limits the applicability of functional containment to applicable non-LWR designs and appears to be inconsistent with the Commissions position on alternatives to a leaktight containment (SECY 93-092).
- “ARDC 16 should be a high level technology neutral design criterion from which technology specific design criteria are derived.”

ARDC 16 Comment # 52 Industry/NEI and Comment #53 DOE/Lab (cont.)

<u>NRC Response</u>: The Commission may wish to assess the reactor technologies and possible approaches to functional containment that are different from those previously presented for MHTGRs.

- SECY paper is planned for early 2018 to discuss functional containment performance requirements for non-LWR designs.
- SECY paper will also address topics integral to functional containment such as the use of a specified acceptable system radionuclide release design limit.
- The Regulatory Guide will be modified to incorporate the Commission's position.

ARDC 16 Comment # 54 Industry/NEI

Comment: Clarify that use of ARDC 16 [per industry comment ##] for non-LWR designs other than MHTGRs may "be subject to a policy decision…" Making a justification, similar to that for research reactors and non-power reactors has basis in NRC policy and should not require a Commission-level policy decision.

Discussions of Commission policy decisions on functional containment need to be worded carefully. For the modular HTGR, a policy decision is not needed regarding general acceptability of applying a functional containment (radionuclide retention) approach that differs from a conventional LWR high-pressure, low-leakage structure.

ARDC 16 Comment # 54 Industry/NEI (cont.)

However, based on the SRM to SECY-03-0047, a policy decision is needed regarding the performance criteria to be applied to a functional containment. The information located in the MHTGR-DC 16 rationale correctly states that a policy decision regarding functional containment performance requirements and criteria will be needed. It’s noted that containment performance criteria for LWRs are provided in 10 CFR 50 Appendix J, rather than in the GDC of Appendix A.

ARDC 16 Comment # 54 Industry/NEI (cont.)

Industry's Suggested Change: Revise rationale to state,"…However, it is also recognized that characteristics of the coolants, fuels, and containments to be used in other non-LWR designs could share common features with SFRs and MHTGRs…Use of the ARDC 16 for non-LWR designs other than MHTGRs-DC 16 may be subject to a policy decision by the Commission. If a reactor is able to demonstrate safety margins and/or consequences on the order of those demonstrated by non-power and research reactors, a functional containment may be justified, and the reactor may be able to use ARDC 16 without a Commission level policy decision. ARDC 16 language should include technology neutral containment requirements which can be subsequently applied to a specific technology.

ARDC 16 Comment # 54 Industry/NEI (cont.)

<u>NRC Response</u>: If a reactor is able to demonstrate safety margins and/or consequences below regulatory limits using barriers other than an essentially leak-tight structure, a functional containment may be justified. However, the Commission may wish to assess the reactor technologies and possible approaches to functional containment that are different from those previously presented for MHTGRs. The staff expects to consider functional containment concepts and associated performance criteria within the broader development of a risk-informed, performance-based, technology-inclusive regulatory framework for non-LWRs. Those efforts will include making proposals and recommendations to the Commission, which will clarify the potential use of functional containment for various reactor technologies.

SFR-DC 16 Comment # 55 Industry/NEI

Current SFR-DC 16 Language: A reactor containment consisting of a high-strength, low-leakage, pressure-retaining structure surrounding the reactor and its primary cooling system shall be provided to control the release of radioactivity to the environment and to ensure that the reactor containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

The containment leakage shall be restricted to be less than that needed to meet the acceptable onsite and offsite dose consequence limits, as specified in 10 CFR 50.34 for postulated accidents.

SFR-DC 16 Comment # 55 Industry/NEI (cont.)

Comment: It is indicated that reactor containment is a pressure retaining structure surrounding reactor and its cooling systems. In case of SFR, it is possible to limit pressure loadings on containment structure in accident conditions. For Ex. rooms with sodium circuits can be designed so that effect of a sodium leak or fire would not result in significant pressure on containment structure and pressure effect could be limited to room where leak occurs. Also, reactor cooling systems could include secondary cooling systems which are partially outside containment structure…

Industry's Suggested Change: It is therefore proposed to modify the first sentence of the criterion to remove the term "pressure retaining" ..." Additionally, remove the phrase "and its primary cooling system."

SFR-DC 16 Comment # 55 Industry/NEI (cont.)

NRC Response: NRC staff considers that pressure retention is essential to accommodate impact of sodium reactions with air or water, etc. that could release significant energy inside the containment structure. The language in the rationale makes it clear that pressure retention is unlike an LWR containment. Several references have been cited in the NRC rationale to clarify this point. Also, Ref: SRM to SECY-03-0047 (ML031770124), and VR to SECY-03-0047 ((ML031770333) outline the Commission's view on pressure retaining containment.

The last paragraph of SFR-DC 16 clarifies the intent for pressure retaining characteristics of SFR designs.

The words in the first sentence of the criterion "and its primary cooling system" are appropriate and need not be changed or removed

MHTGR-DC 16 Comment # 57 DOE/Lab

Comment: The beginning part of this comment titled "Functional Containment Policy Issue," is identical to Comment # 53. Discussions of Commission policy decisions on functional containment need to be worded carefully. For the modular HTGR, a policy decision is not needed regarding the general acceptability of applying a functional containment (radionuclide retention) approach that differs from a conventional LWR high-pressure, low-leakage structure. However, based on the SRM to SECY-03-0047, a policy decision is needed regarding the performance criteria to be applied to a functional containment. The information located in the MHTGR-DC 16 rationale correctly states that a policy decision regarding functional containment performance requirements and criteria will be needed. It's noted that containment performance criteria for LWRs are provided in 10 CFR 50 Appendix J, rather than in the GDC of Appendix A. The last two sentences in the rationale for **ARDC 16** should be deleted.

MHTGR-DC 16 Comment # 57 DOE/Lab (cont.)

DOE/Lab Suggested Change: Reword the rationale to clarify what policy decisions have been made and what decisions need to be made. The last two sentences in the rationale for ARDC 16 should be deleted.

NRC Resolution: NRC does not agree that the rationale needs to be reworded to clarify the policy decisions that have been made and need to be made. It is clearly stated in the rationale that the Commission instructed the staff to, "…develop performance requirements and criteria working closely with industry experts (e.g., designers, EPRI, etc.) and other stakeholders regarding options in this area, taking into account such features as core, fuel, and cooling systems design," and directed the staff to submit options and recommendations to the Commission for a policy decision." This is language taken directly from the SRM to SECY 03-0047.

MHTGR-DC 16 Comment # 57 DOE/Lab (cont.)

<u>NRC Resolution (cont.):</u> The last two sentences of the rationale for ARDC 16 state, "Use of the MHTGR-DC 16 will be subject to a policy decision by the Commission. See rationale for MHTGR-DC 16 for further information on the policy decision." NRC agrees that the last sentence should be removed but does not plan to remove the sentence regarding the policy decision. This was covered during the ARDC Comment #54 discussion.

MHTGR-DC 16 Comment # 57 DOE/Lab (cont.)

<u>Additional NRC Modification:</u> NRC proposes to modify the second sentence of the second paragraph in the rationale for MHTGR-DC 16 as follows:

~~Traditional containment structures also provide the reactor and SSCs important to safety inside the containment.~~ If multiple barriers internal to the reactor and its cooling system are relied on for functional containment, the reactor building should provide the reactor and SSCs important to safety within its structure protection against accident related to external hazards (e.g., turbine missiles, flooding, aircraft). Reference: GDC 2 "Design bases for protection against natural phenomena."

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Electric Power Systems ARDC 17 & 18

Bob Fitzpatrick
Electrical Engineer
Office of Nuclear Reactor Regulation

Comments on Electric Power Systems

Comment #	Essence	NRC Resolution
58	Suggested clarification	Added to Rationale
59, 61, 62	Single Switchyard	Deleted text
60	Clarification of safety and vital functions	Revised ARDC 17 and Rationale
64 & ACRS	Clarify 'systems' in first sentence	Revised ARDC 17 and Rationale
65	ARDC 18 Rationale	Revised Rationale

Staff's Proposed Modification to ARDC 17

An onsite electric power system~~s~~ and an additional power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each power system shall be to provide sufficient capacity, capability, and reliability to ensure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant boundary are not exceeded as a result of anticipated operational occurrences and (2) safety functions as well as vital functions that rely on electric power are maintained in the event of postulated accidents.

The onsite electric power system~~s~~ shall have a safety classification and sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure.

Staff's Proposed Modification to ARDC 17 Rationale

The overall electric ~~A reliable~~ power ~~system~~ supply scheme is required to provide reliable power for SSCs during postulated accident conditions when those SSCs' safety functions require electric power. Power systems shall be sufficient in capacity, capability, and reliability to ensure that safety functions as well as vital ~~safety~~ functions are maintained. The safety functions are established by the safety analyses. The vital functions may include: post-accident monitoring, control room habitability, emergency lighting, radiation monitoring, communications and or any others that may be deemed appropriate for the given design.

Staff's Proposed Modification to ARDC 17 Rationale (cont.)

Compared to GDC 17, more ~~The~~ emphasis is placed on requiring reliability of the overall power ~~sources~~ supply scheme rather than fully prescribing how such reliability can be attained. For example, reference to ~~onsite vs.~~ offsite electric power systems was deleted to provide for those reactor designs that do not depend on offsite power for the functioning of SSCs important to safety or do not connect to a power grid.

Staff's Proposed Modification to ARDC 17 Rationale (cont.)

- Text related to "…supplies, including batteries, and the onsite distribution system," was deleted to allow increased flexibility in the design of ~~offsite~~ onsite power systems for advanced reactor designs. ~~However, it is still expected that such onsite systems must remain capable of performing assigned safety functions during accidents as a condition of requisite reliability.~~

- ~~The existing single switchyard allowance remains available under ARDC 17. If a particular advanced design requires the use of GDC single switchyard allowance wording, the designer should look to GDC 17 for guidance when developing PDC.~~

Staff's Proposed Modification to ARDC 17 Rationale (cont.)

If electrical power is not required to permit functioning of SSCs important to safety, the onsite electric power system may not be ~~requirements~~ required to have a safety classification. ~~in the ARDC are not applicable to the design.~~ However, it is still expected that the onsite system must remain capable of supporting assigned vital functions during accidents as a condition of requisite reliability. In this case, the functionality of SSCs important to safety must be fully evaluated and documented in the design bases.

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Staff’s Proposed Modification to ARDC 17 Rationale (cont.)

“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.

SFR-DC 17 and MHTGR-DC 17

These two design criteria are the same as ARDC 17 except for the differences noted in DG-1330. The differences apply to reactor design differences not electric power.

ARDC 18 Inspection and Testing of Electric Power Systems

- No changes to ARDC 18
- SFR-DC 18 and MHTGR-DC 18 are the same as ARDC 18

Staff's Proposed Modification to ARDC 18 Rationale

- ~~GDC~~ ARDC 18 is a design-independent companion criterion to ~~GDC~~ ARDC 17.
- Wording pertaining to additional system examples has been deleted to allow increased flexibility associated with various designs. ~~The~~ Specifically, the text related to the nuclear power unit, offsite power system, and onsite power system was deleted to be consistent with ARDC 17.

Note: SFR-DC 18 and MHTGR-DC 18 rationale is the same as ARDC 18.

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Residual Heat Removal MHTGR-DC 34

Jeff Schmidt
Senior Reactor Systems Engineer
Office of New Reactors

MHTGR-DC 34 Comment # 87 DOE/Lab

Comment:

Revise rationale to allow active residual heat removal during normal operations and AOOs and passive during postulated accidents.

NRC Response:

AOOs assume a loss of offsite power and hence either a passive or an active cooling system supported by safety-related power is needed for residual heat removal.

MHTGR-DC 34 Comment # 87 DOE/Lab(cont.)

Comment:

Rationale includes a paragraph on fuel temperature limits not included under ARDC 34 or SFR-DC 34 and implies that a specific fuel temperature value is the limit

NRC Response:

Paragraph was added as limiting fuel temperature vs. time is key to meeting dose limits as TRISO fuel is expected to perform the majority of the fission product retention; this is not necessarily the case for other designs.

Rationale was rewritten to make it clear that time at temperature and not a specific, single value is the figure of merit.

ARDC 34-35, SFR-DC 34-35 Comment #'s 86 & 90 Industry/NEI

<u>Comments:</u> SFR-DC 34 deleted reference to postulated accidents (e.g. DBAs) without an explanation in the rationale section.

<u>NRC Response:</u> ARDC 34 and SFR-DC 34 address residual heat removal during normal operation and AOOs; ARDC 35 and SFR-DC 35 addresses heat removal during postulated accidents. Staff agrees that current ARDC 35 and SFR-DC 35 wording needs clarification.

ARDC 34-35, SFR-DC 34-35 Comment #'s 86 & 90 Industry/NEI (cont.)

Comment: ARDC 35 and SFR-DC 35 use the words "fuel damage is limited" which is not clearly defined and could be more restrictive than current GDC 35 wording

NRC Response: "Fuel damage is limited," was added to address the concern that local fuel damage could lead to reactivity events which could preclude effective core cooling. Staff agrees that ARDC 35 and SFR-DC 35 should be modified to address this concern

ARDC 34-35, SFR-DC 34-35 Comment #'s 86 & 90 Industry/NEI (cont.)

<u>NRC Response</u>: Staff proposes the following revision to the first paragraph of ARDC 35 and SFR-DC 35:

A system to assure sufficient ~~emergency~~ core cooling during postulated accidents and to remove residual heat following postulated accidents shall be provided. The system safety function shall be to transfer heat at a rate from the reactor core during and following postulated accidents such that fuel and clad damage that could interfere with continued effective core cooling is ~~maintained and fuel damage is limited~~ prevented.

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Reactivity Control ARDC 26

Jeff Schmidt
Senior Reactor Systems Engineer
Office of New Reactors

ARDC 26 Reactivity Control Systems DOE/Lab and NEI/Industry Comment #'s 69-76

- Reasons for proposed revision
  - Better define meaning of "reliably controlling reactivity changes" in GDCs 26 and 27
  - Rationale expanded to provide clarity on the role of safety-related equipment
  - Role of second reactivity control system

ARDC 26 Reactivity Control Systems DOE/Lab and NEI/Industry Comment #'s 69-76 (cont.)

- Reliably controlling reactivity changes
  - Current GDCs 26 and 27 do not clearly address if and when shutdown is required
    - AOOs and postulated accidents are typically broken into 3 phases.
    - Proposed revision provides guidance on shutdown for each phase.
    - Short term recriticality currently licensed for specific PWR cooldown transients (e.g., MSLB).
    - NRC has never licensed a plant which did not achieve shutdown in the long term (ML16116A083)

ARDC 26 Reactivity Control Systems DOE/Lab and NEI/Industry Comment #'s 69-76 (cont.)

- Basis for shutdown - 10 CFR 50.2 definition of safety-related equipment and SECY-94-084 definition applied to safe shutdown
  - 10 CFR 50.2, (2) "The capability to shut down the reactor and maintain it in a safe shutdown condition"
  - SECY 94-084, "… a safe shutdown state as long as reactor subcriticality, decay heat removal, radioactive materials containment are properly maintained for the long term."
  - Recent passive designs achieve and maintain shutdown

ARDC 26 Reactivity Control Systems DOE/Lab and NEI/Industry Comment #’s 69-76 (cont.)

- Safety-related and important to safety
  - Safety-related is a subset of important to safety
  - ARDCs can be satisfied by important to safety equipment/systems
  - Rationale provides guidance on safety classification on structures systems and components to meet the proposed criteria
  - AOOs and postulated accidents are prevented or mitigated using safety-related equipment
    - Proposed ARDC 26 rationale states at least one, or some combination of, safety-related systems/mechanisms are needed to control reactivity
    - The second means, which is independent and diverse from the first means, is an important to safety system/mechanisms
    - At least two systems/ mechanisms are necessary to satisfy ARDC 26

ARDC 26 Reactivity Control Systems
DOE/Lab and NEI/Industry Comment #'s 69-76 (cont.)

- Role of second reactivity control system
  - Staff has reverted back to the language similar to GDC 26
  - Safety benefit of the second, independent means is to minimize challenges to the protection system preserving the SAFDLs

ARDC 26 Reactivity Control Systems
DOE/Lab and NEI/Industry Comment #'s 69-76 (cont.)

- Based on public comments staff proposes the following ARDC 26 language:

A minimum of two reactivity control systems or means shall be provided.

(1) A means of inserting negative reactivity <u>at a sufficient rate and amount</u> to assure, with appropriate margin for malfunctions, that the design limits for fission product barriers are not exceeded and <u>safe shutdown is</u> achieved during normal operation, including anticipated operational occurrences shall be provided.

(2) The second means, which is <u>independent and diverse from the other(s</u>), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure fission product barriers are not exceeded.

(3) A means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition <u>following</u> an AOO and postulated accident, with appropriate margin for malfunctions, shall be provided.

(4) A system for holding the reactor shutdown under conditions which allow for interventions such as fuel loading, inspection and repair shall be provided.

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Reactor Helium Pressure Boundary, Leaktightness, and Intermediate Coolant System

Andrew Yeshnik

Materials Engineer

Office of New Reactors

Outline

- Reactor Helium Pressure Boundary (RHPB)
- Use of the word “leaktight”
- Sodium Fast Reactor (SFR) Intermediate Coolant System (ICS)
- Other items to discuss?

Background Reactor Helium Pressure Boundary

- MHTGR-DC 14, “Reactor helium pressure boundary”
  - The reactor helium pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, of gross rupture, and of unacceptable ingress of moisture, air, secondary coolant, or other fluids.
- MHTGR-DC 30, “Quality of reactor helium pressure boundary”
  - Components that are part of the reactor helium 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 helium leakage. Means shall be provided for detecting ingress of moisture, air, secondary coolant, or other fluids to within the reactor helium pressure boundary.

Background Reactor Helium Pressure Boundary (cont.)

- MHTGR-DC 31, “Fracture prevention of reactor helium pressure boundary”
  - The reactor helium pressure boundary shall be designed with sufficient margin to ensure 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, service degradation of material properties, creep, fatigue, stress rupture, 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 and coolant chemistry on material properties, (3) residual, steady-state, and transient stresses, and (4) size of flaws.
- MHTGR-DC 32, “Inspection of reactor helium pressure boundary”
  - Components that are part of the reactor helium pressure boundary shall be designed to permit (1) periodic inspection and functional testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor vessel.

Reactor Helium Pressure Boundary - Public Comments

- Revise the MHTGR-DCs to de-emphasize the pressure retention function of the RHPB
  - Quality and leaktightness are important for commercial operation, not important to safety
- Focus on seismic and geometric stability
  - Addressed by MHTGR-DC 70

Reactor Helium Pressure Boundary – Proposed Staff Response

In general, the staff disagrees:

- While helium (and inventory makeup) are not important for the heat transfer. These MHTGR-DCs focus on the function of a radiological barrier.
- RHPB may be part of the functional containment concept and credited for radionuclide isolation.
- A vendor can provide justification that pressure retention is not a radiological safety function. However, a pressure retaining system would add defense-in-depth.
- As written, ASME Code components will be subject to pressure testing

Background - Leaktight

- Impacts multiple comments and ARDCs, SFR-DCs, and MHTGR-DCs.
- Therefore, not listing any specific design criteria.

Leaktight – Public Comments

- The inclusion of the words “and leaktight” in the criterion is not necessary when “structural integrity” is sufficient to describe the requirement. The allowable leak rate for a given design should be one of the acceptance criteria for the test for “structural integrity.”
- “Leaktight” standards may not be necessary for certain advanced reactor SSCs, but keeping this word in the criterion infers expectation of leaktight capability. Determination of the degree to which a system is “leaktight” should be subject to acceptance criteria that are appropriate for each reactor technology.

Leaktight – Proposed Staff Response

In general, the staff disagrees:

- There is no current industry definition of “structural integrity” of a piping system.
- Defense-in-Depth (similar to previous MHTGR slides).
- Current LWRs have allowable leakage which is controlled by Technical Specifications. However, in current LWRs the expectation that the system will be returned to leak-tight conditions during the next outage (ASME Code).
- Moisture (or other fluid) ingress concerns.

Background - SFR Intermediate Coolant System

- SFR-DC 70, "Intermediate coolant system"
  - If an intermediate coolant system is provided, then the system shall be designed ~~to transport heat from the primary coolant system to the energy conversion system as required. The intermediate coolant system shall be designed~~ with sufficient margin to assure that (1) the design conditions of the intermediate coolant boundary are not exceeded during normal operations, including anticipated occupational occurrences, and (2) the integrity of the primary coolant boundary is maintained during intermediate coolant system accidents.

Background - SFR Intermediate Coolant System (cont.)

- SFR-DC 75, "Quality of the intermediate coolant boundary"
  - Components that 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.
- SFR-DC 76, "Fracture prevention of the intermediate coolant boundary"
  - The intermediate coolant boundary shall be designed with sufficient margin to ensure 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.

Background SFR Intermediate Coolant System (cont.)

- SFR-DC 77, “Inspection of the intermediate coolant boundary”
  - Components that are part of the intermediate coolant boundary shall be designed to permit (1) periodic inspection and functional testing of important areas and features to assess their structural and leaktight integrity commensurate with the system’s importance to safety, 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.

Intermediate Coolant System – Formal Public Comments

- SFR-DCs 75, 76, and 77 are superfluous when evaluated in combination with SFR-DC 70
- If the ICS provides safety-related heat removal capability, then SFR-DC 34-37 contain the requirements
- Recommend deleting SFR-DCs 75, 76, and 77

Intermediate Coolant System – Proposed Staff Response

In general, the staff disagrees:

- SFR-DCs (and ARDC in general) discuss safety related and important to safety systems
- SFR-DC 70 is written so a failure of the intermediate system does not impact the primary system, however there could be impact on other aspects (post accident recovery)
- SFR-DC 76 does not include the statement “important to safety” because the intermediate system should be designed to prevent fracture during all conditions

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PUBLIC MEETING
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Cooling Water MHTGR-DC 44-46

Chang Li
Senior Reactor Systems Engineer
Office of New Reactors

MHTGR-DC 44, 45, 46 Cooling Water

Comments: These criteria are "not applicable for MHTGR" because the reactor cavity cooling system (RCCS), by definition, of modular HTGR is sufficient for core cooling.

NRC Response: NRC does not agree with this comment because the proposed wording of MHTGR-DC 44 is consistent with the wording for ARDC 44 and SFR-DC 44, and provides sufficient flexibility for an applicant of a design certification to justify the applicability and for NRC to review the adequacy. Whether the capability of RCCS is sufficient without additional cooling water is subject to NRC review, and MHTGR-DC 44 criterion is needed for this review.

The applicability of MHTGR-DC 45 and 46 is tied to MHTGR-DC 44.

PUBLIC MEETING
Non-LWR Design Criteria
August 24, 2017
Human Factors Considerations of ARDC 19 Control Room

Brian Green
Materials Engineer
Office of New Reactors

Proposed Modification ARDC 19 Control Room

A control room, that reflects state-of-the-art human factors principles, shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent as defined in § 50.2 for the duration of the accident.

Adequate habitability measures shall be provided to permit access and occupancy of the control room during normal operations and under accident conditions. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

Summary of Comments ARDC 19 Control Room

- **ACRS: Concern about how operators <u>know/understand</u> status of plant**
  - Addition of human factors principles address this directly.
  - Consistent with 10 CFR 50.34 (f)(2)(iii)
    - Stating in ARDC is more useful to designers
- **Industry: Presumption that a control room is necessary**
  - Human factors principles could be used to support an alternate control paradigm that doesn't use a traditional control room.