From:	SHAHROKHI Farshid (AREVA)
To:	AdvancedRxDCComments Resource
Subject:	[External_Sender] AREVA Comments for Draft Adv Rx Design Criteria
Date:	Monday, May 30, 2016 9:42:24 AM
Attachments:	AREVA SFR-DC comments.docx AREVA mHTGR-DC comments.docx

Hello,

AREVA is pleased to offer comments and recommendations in response to NRC public request for input and in support of NRC Advanced Reactor Design Criteria (ARDC) for tomorrow's reactors.

AREVA's comments are provided in the attached files. The first file includes our comments for mHTGR-DCs and the second file has our comments for the SFR-DCs.

Our licensing professionals have also worked with the NEI Advanced Reactor Regulatory Task Force (ARRTF) in preparation of the nuclear industry's comments. AREVA supports and concurs NEI's comments which will be submitted separately by NEI.

We also believe there is not enough technical information available to provide any meaningful comments for advanced reactors other than mHTGRs and SFRs.

As always we appreciate NRC's efforts in clarifying our nation's regulatory structure and framework to usher in advanced non-LWR based technologies.

Best Regards,

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"Having just the vision is no solution; everything depends on execution." Stephen Sondheim

AREVA Comments and Recommendations for SFR-DC

#	Comment	Recommendation
1	Criterion 3: Firefighting systems are required. In case of SFR, the main mitigation of sodium fire is provided by the draining of the leaking tank or pipe. The sodium firefighting systems (e.g., fire extinguishing powder) are not reliable.	We propose to modify the wording and to use “fire mitigation measures” instead of “firefighting systems”.
2	Criterion 4: This criterion is related to environmental and dynamic effects design bases. It is precisely indicated that the dynamic effects have to be considered.	In case of the SFR-DC, we recommend adding a passage at the end of the criterion: “Chemical consequences of accidents, such as sodium leakages, shall be appropriately considered for the design of structures, systems and components which have to be protected”
3	Criterion 14: The definition of the primary coolant boundary includes the cover gas boundary. Therefore, the criterion 14 requiring an extremely low probability of abnormal leakage could be not adequate for cover gas leakage. A cover gas leakage would lead very limited safety consequences (no impact on the fission process, no impact and limited radiological consequences). This allows for implementation of safety valves on the cover gas system needed for limiting abnormal pressure on the reactor vessel. On the other hand, the failure of the reactor vessel could have very severe consequences (e.g., reactivity insertion, failure of the core coolability).	For SFR-DC we propose modifying the wording and use “reactor vessel” instead of “primary coolant boundary”.
4	Criterion 16: It is indicated that the reactor containment is a pressure retaining structure surrounding the reactor and its cooling systems. In case of SFR, it is possible to limit the pressure loadings on	For SFR-DC we propose to modify the first sentence of the criterion as: “A reactor containment consisting of a high strength, low leakage, pressure retaining structure surrounding the reactor and its cooling systems shall be provided to control the release of radioactivity to the environment

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	the containment structure in accident conditions. Also, the reactor cooling systems could include secondary cooling systems which are partially outside the containment structure.	and to assure that the reactor containment design conditions important to safety are not exceeded for as long as postulated accident conditions require."
5	Criterion 17: Same comment as the one for Criterion 14	For SFR-DC we recommend using "reactor vessel" instead of "primary coolant boundary".
6	Control 19: In the SFR, the control room shall be adequately protected against radiological hazards and also chemical hazards, in particular against sodium aerosol which could be released in case of accidental sodium leakage and sodium fire.	For SFR-DC we propose adding: "Adequate protection against sodium aerosol shall be provided to permit access and occupancy of the control room under accident conditions."
7	Criterion 21: This Criterion requires "*periodic testing of* [the] *functioning* [of the protection system] *when the reactor is in operation*". Concerning the reactor shutdown systems of the SFR, the testing of the capability of each control rod to be inserted in the core (i.e., verification that there are no mechanical failures which could impact the insertion capability) could not be feasible in safe conditions during power operations.	For SFR-DC this Criterion should be limited to the I&C of the protection system and concerning the mechanical equipment, possibility to provide justification should be added if periodic testing in operation is not feasible. We propose modifying the sentence: "The I&C of 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 determines failures and losses of redundancy that may have occurred. The mechanical parts of the protection system should also be designed to permit periodic testing. If this is not feasible in safe conditions, justification shall be provided that any failure can be detected before the failure of the safety function occurred."

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8	Criteria 25 and 26: These criteria concern both the reactivity control systems and the protection system. The definitions of these systems should be clarified. For SFR, the reactivity control systems are implemented for avoiding abnormal reactivity variations (in particular for avoiding spurious control rod withdrawal). The protection system initiates reactor shutdown by absorber elements insertion (e.g., control rod dropping).	For SFR-DC Criterion 26 seems to be relevant for the protection system. In Criterion 26, it is proposed to use "Protection system" instead of "Reactivity control system".
9	Criterion 30: Same comment as the one for Criterion 14	Use "reactor vessel" instead of "primary coolant boundary".
10	Criterion 32: Same comment as the one for Criterion 14	Use "reactor vessel" instead of "primary coolant boundary".
11	Criterion 33: There is no primary coolant inventory maintenance system implemented in SFR. In any case the reactor coolability by primary sodium must be maintained through adequate design (e.g., implementation of double envelope surrounding the primary circuit, limitation of the pressure of the cover gas). This is necessary because the sodium leakage could lead to unacceptable hazards.	It is proposed to delete Criterion 33 as it is written and replace it with a requirement for a design that maintains sufficient primary coolant inventory to achieve acceptable core coolability for any condition.
12	Criterion 36	Word missing: "The residual heat removal <u>system</u> shall be designed to permit…"
13	Criterion 37: The residual heat removal systems are not necessarily pressure systems.	For SFR-DC we propose to modify the first sentence: "The residual heat removal system shall be designed to permit periodic pressure and functional testing in adequate conditions representative of the accident conditions to assure…"

#	Comment	Recommendation
14	Criterion 41: In SFR hydrogen can be released in case of reaction between sodium and water.	Therefore, "hydrogen" could be kept in the beginning of the Criterion: "Systems to control fission products, hydrogen and other substances…" The word "other" should be deleted at the end of the Criterion: "… the concentration of other substances in the containment atmosphere…"
15	Criterion 43: The containment atmosphere cleanup system is generally not necessary in SFR for limiting the releases in the environment and the loading of the containment.	This could be indicated in the Criterion 41: "If containment atmosphere cleanup systems are implemented, they shall be designed to permit…"
16	Criterion 54: As indicated in the Rationale, in SFR the intermediate heat transport system penetrating the reactor containment needs no isolation (if justified).	This could be indicated in the Criterion 54: "Piping systems penetrating the reactor containment structure shall be provided with leak detection, isolation <u>if necessary</u> and containment capabilities…"
17	Criterion 70: In SFR an intermediate coolant system is implemented because severe chemical reaction occurred in case of leakage in the steam generator unit (i.e., sodium-water reaction). If a fluid chemically non-reactive with sodium is used in the energy conversion system (e.g., inert gas) the necessity of an intermediate circuit should be assessed.	It is proposed to modify the first sentence of the Criterion 70: "If necessary an intermediate cooling system shall be provided."
18	Criterion 72	For SFR-DC we propose modifying the last sentence of the Criterion 72: "… the temperature control <u>and the relevant corrective measures</u> associated with that line shall be considered important to safety."
19	Criterion 73: Mitigation of sodium leakage could be possible without implementation of special features (e.g., draining of the leaking tank or pipe could be sufficient).	For SFR-DC we propose modifying the last sentence: "<u>If necessary,</u> special features such as inerted enclosures or guard vessels shall be provided for system containing sodium."

AREVA Comments and Recommendations for SFR-DC

#	Comment	Recommendation
20	Criterion 74: The energy conversion system does not necessarily use steam generator. Inert gas can also be used.	For SFR-DC we propose modifying the last sentence of Criterion 74: "If steam-water is used for energy conversion, to prevent loss of any plant safety function, the sodium-steam generator system shall be designed to detect…"

AREVA Comments and Recommendations for mHTGR-DCs

#	Comment	Recommendation
1	Criterion 4 ARDC- In this ARDC does the Commission considers gases such as helium a "fluid"? We recommend it be so.	Gases / fluids wording should be inter-changeable in this context.
2	Criterion 13 mHTGR-DC *"… integrity of reactor core, reactor helium pressure boundary, and functional containment…"* It is not clear what is meant by maintaining the integrity of the reactor core. We consider this redundant to the maintaining the integrity of functional containment (in mHTGR-DC 16). Functional containment includes: fuel kernel, particle fuel coatings, fuel compact graphitic matrix, graphite fuel assembly, and the reactor helium pressure boundary.	We recommend deleting the "*reactor core, and reactor helium pressure boundary"* as such instrumentation meets the intent of GDC 13 for mHTGRs.
3	Criterion 17 mHTGR-DC mHTGRs have fully passive decay heat removal systems as such they do not rely on internal or external AC power to remove decay heat or to begin operation. Decay heat is removed by redundant and passive mode of the RCCS systems for seven day or any number of days depending on the final size of the RCCS water reservoir tank. In addition there is no action (passive or active) required to start the RCCS passive mode system. RCCS system is always in operation in its non-safety mode. In a total station blackout or when non-safety related secondary RCCS circuit is not operational, the system continues operation in its passive mode and continues to remove decay heat.	This criterion does not apply to mHTGR designs.

#	Comment	Recommendation
	As a DID measure in a total failure of RCCS which is already passive and redundant (i.e. beyond design bases scenario) decay heat is passively (conduction, convection, and radiation heat transfer) rejected to the ground surrounding the reactor cavity maintaining fuel acceptable radionuclides release limits. The RCCS or any other mHTGR systems have no important to safety functions that rely on internal or external AC power for design basis or beyond design basis accident mitigation.	
4	Criterion 18 mHTGR-DC	In light of our comments on mHTGR-DC-17, the requirement for transfer of "offsite power system" requirement should be eliminated for mHTGRs This is because for mHTGR designs no important to safety SSCs require AC power.
5	Criterion 21 mHTGR-DC It should be designer's decision to choose redundancy to achieve the required level of safety. This gives the designers the option to innovate instead of forcing redundancy as the sole solution.	For mHTGRs, we recommend eliminating the "single failure" requirement and rely on designer to provide the required level of safety and defense in depth.
6	Criterion 24 mHTGR-DC If the designer chooses redundancy to achieve the required level of safety so be it. This gives the designers the option to innovate instead of design choices dictated by the regulation.	For mHTGRs, we recommend eliminating the "single failure and redundancy" requirement and rely on designer to provide the required level of safety and defense in depth.

#	Comment	Recommendation
7	Criterion 27 mHTGR-DC For mHTGR it is anticipated that although there are two independent and diverse reactivity control and reactor shutdown systems provided for normal control and reactor shut down. These systems include control rods and a diverse reactor shutdown spheres system. Neither system is required to allow reactor shutdown for public safety. During normal operation power maneuvering and reactor shutdown is accomplished by the control rods. If the control rods are not available Born spheres are introduced into the core for reactor shutdown. In case both reactivity control systems are not operating the core is naturally shuts down by highly negative core temperature coefficient. The core material and design combination provides for a natural reactor shutdown as core temperature increases without fuel damage. The core cooling and decay heat removal is normally provided by two active systems: 1) active core cooling through steam generators and 2) active core cooling through a diverse shutdown cooling system (SCS). In case both non-safety active core cooling systems fail to operate the safety related, redundant, and passive reactor cavity cooling system (RCCS) removes the decay heat and cools the core. In the case of a beyond design bases event where the safety related, redundant and passive RCCS systems fail to operate the decay heat is transferred to the ground	We recommend this criterion is not necessary for mHTGRs and should not be required.

#	Comment	Recommendation
	surrounding the reactor cavity by natural forces of convection, conduction and radiation heat transfer.	
8	Criterion 29 mHTGR-DC	In light recommendation for Criterion 27 the mHTGR reactivity control system does not have any safety function therefore this criterion is not applicable to mHTGRs.
9	Criterion 34 mHTGR-DC The 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 and dissipates the core decay heat passively. It does not rely on its secondary non-safety circuit or any AC or DC power system for control, actuation or operation.	We recommend eliminating the following sentence "*for normal operations and anticipated operational occurrences, the ……..to the end of the paragraph*". Therefore as recommended in Comment # 3 (mHTGR-DC 17) above no safety related off-site power or safety related AC power is needed by the RCCS system to perform its residual and decay heat removal function during design basis or beyond design basis accident conditions. In a beyond design bases condition where the redundant safety related RCCS system is assumed to fail the decay heat is passively rejected to the ground surrounding the reactor cavity. All specified acceptable radionuclides release design limits (SARRDLs) are maintained. Also remove the any reference to electrical power or offsite power in the last paragraph.
10	Criterion 34 mHTGR-DC We believe there are some issues and inconsistencies on NRC's mHTGR-DC 34 proposal. - NRC ties mHTGR passive cooling requirement to normal operations, which doesn't align with the reactor cavity cooling system (RCCS) designs being considered	So, it's not clear that the design of RCCS is fully understood. For clarification - The water cooled RCCS uses an active non-safety related secondary system during normal operation. - In an emergency or accident situations the non-safety system is

#	Comment	Recommendation
	(water cooled or air cooled) - In the bases, NRC indicates that "the mHTGR design is defined as having passive heat removal due to a low power density".	assumed to not operate so the RCCS will operate passively and removes the decay heat for over seven days without any human or electrical intervention to start or operate. - After seven days the RCCS reservoir tank is depleted. The tank can be refilled with water from an external connection by a fire hose. - mHTGRs are designed with a low power density AND passive heat removal.
11	Criterion 35 mHTGR-DC mHTGRs do not have and do not need an Emergency Core Cooling System. This because of the massive solid ceramic core structural graphite that provides heat sink following loss of all active core heat removal systems.	Remove "reactor coolant boundary" from the first sentence. The RCCS in mHTGR-DC 34 is a redundant and passive system that removes decay and residual heat and does not rely on the pressure retention function of the reactor helium pressure boundary.
12	Criterion 37 mHTGR-DC	Delete the last part of the last sentence "…., *the transfer between normal and emergency power sources, and the operation of the associated cooling system*" The Residual Heat Removal System for mHTGRs i.e. the RCCS, is designed as a passive system. It does not require AC power to be switch on or off for it to function. The operation of the RCCS heat transfer medium (i.e. water) is gravity driven, redundant, and passive.
13	Criterion 44 mHTGR-DC For mHTGRs there are no important to safety SSCs that require cooling water.	Delete the requirement and replace it with not applicable to mHTGRs.

#	Comment	Recommendation
14	Criterion 45 mHTGR-DC For mHTGRs there are no important to safety SSCs that require cooling water.	Delete the requirement and replace it with not applicable to mHTGRs.
15	Criterion 46 mHTGR-DC For mHTGRs there are no important to safety SSCs that require cooling water.	Delete the requirement and replace it with not applicable to mHTGRs.
16	Criterion 54 mHTGR-DC In light of the mHTGR-DC 16 the modular HTGRs have multiple and diverse radionuclides barriers collectively called functional containment instead of a fixed structural containment. This makes the reactor building a non-pressure retaining structure and pressure retention of any piping penetration unnecessary.	Delete the requirement and replace it with not applicable to mHTGRs.

In addition to the comments and recommendations above, the NRC is specifically seeking comments on the following:

#	NRC Question	AREVA Response
A	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?	In the absence of enough technical information for non-LWRs (except for SFRs and mHTGRs) the ARDCs are sufficient as a guide. Once technical information sufficient for licensing decision making are developed developed, design specific DCs may be necessary similar to SFR-DCs and mHTGR-DCs.
B	Should the current regulations that an applicant must address be incorporated into the ARDC? If so, which ones?	No. It is not clear to what regulations the NRC is referring. If the NRC eventually develops a technology neutral (or technology inclusive) regulatory framework and structure, this point becomes moot.
C	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?	For mHTGRs the answer is yes. Also please consider specific comments and recommendations provided for mHTGR-DCs.
D	There are several new approaches within the ARDC, SFR-DC, and mHTGR-DC, such as: Are these approaches appropriately addressed in the proposed criteria? • 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	For mHTGRs our answers are as follows: - Yes. - Yes

#	NRC Question	AREVA Response
	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.	- See our comment #s 9, 10 and 11 - See AREVA comments on SFR-DC submitted separately.