UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

March 26, 2018

Mr. Victor M. McCree
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REGULATORY GUIDE 1.232, "GUIDANCE FOR DEVELOPING PRINCIPAL DESIGN CRITERIA FOR NON-LIGHT-WATER REACTORS"

Dear Mr. McCree:

During the 651st meeting of the Advisory Committee on Reactor Safeguards (ACRS), March 8-9, 2018, we reviewed the draft final Regulatory Guide 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors." Our Future Plant Designs Subcommittee also reviewed this matter during a meeting on February 7, 2018. During these meetings we had the benefit of discussions with representatives of the NRC staff. We also had the benefit of the referenced documents.

CONCLUSION AND RECOMMENDATION

1. The draft final Regulatory Guide 1.232 should be issued.

2. The advanced reactor-, sodium-cooled fast reactor-, and modular high temperature gas-cooled reactor design criteria in the appendices to the regulatory guide may not be appropriate to a specific design (even if it is a variant of the sodium-cooled fast reactor or modular high temperature gas-cooled reactor) and compliance may be difficult to demonstrate, since there is limited operating experience.

BACKGROUND

As part of developing a non-light-water reactor (non-LWR) regulatory review process (Implementation Action Plan Strategy 3 of the staff's Non-LWR Vision & Strategy Document), the staff developed a draft regulatory guide, DG-1330, and issued it for public comment in February 2017. It described the NRC's proposed guidance on how the General Design Criteria (GDC) in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," should be used to establish principal design criteria for non-LWR designs. Our Future Plant Designs Subcommittee reviewed the initial design criteria in a public meeting on February 22, 2017, and the revised design criteria in draft final Regulatory Guide 1.232 at a second meeting on February 7, 2018.

DISCUSSION

Regulatory Guide 1.232 explains the current regulatory framework including the role of the GDC. The GDC provide high-level requirements to support the design of nuclear power plants. The current GDC are based on light-water reactor (LWR) technology. However, they recognize that different requirements may be necessary for non-LWR designs. The advanced reactor design criteria (ARDC) were developed as guidance to more appropriately align with non-LWR technologies. The regulatory guide includes technology-specific criteria for sodium-cooled fast reactors (SFR) and modular high temperature gas-cooled reactors (MHTGR), as well as general ARDC that the staff expects to be applicable to most other designs. Any of the sets of criteria may be used by applicants to support their choice of principal design criteria for newly designed plants.

In our March 2017 letter on the draft regulatory guide, we recommended that the staff should consider making a number of the design criteria more explicit. We raised specific issues regarding several of the design criteria in the body of the letter:

> MHTGR Design Criterion 10, as presently written, is cryptic. The term, 'specified acceptable system radionuclide release design limits' (SARRDLs), needs to be clearly defined. Replacing the GDC's specific acceptable fuel design limit (SAFDL) concept with the proposed SARRDL concept in the ARDCs is acceptable. However, during design, reactor designers will need to develop their own design-specific limits in order to characterize and evaluate their reactor design. The new SARRDL concept requires additional analysis that the staff will have to review and approve. Later, during operation, licensees will monitor both circulating activity and plate-out activity to ensure acceptable fuel performance, i.e., as evidence that the SARRDLs are being met.
>
> ARDC 16, the functional containment performance requirement, is vague and needs to be defined. For example, the phrases 'essentially leak tight' or 'low leakage' are not adequately defined. An examination for the possibility of reactor pressure boundary failure to induce containment failure should be included explicitly.
>
> The staff should improve the clarity of ARDC 17 with respect to the term 'vital functions.' Even if electric power is not needed for operational equipment, reliable power is still needed for monitoring plant status, habitability, lighting, and communications.
>
> ARDC 26 eliminated the GDC 26 requirement for controlling the rate of reactivity changes resulting from planned, normal power changes. For harder spectrum reactors, particularly for liquid fuel systems, control of the rate of reactivity insertion can be very important and should be retained.

The current version of the regulatory guide has adequately addressed these issues except our suggestion that examination for the possibility of reactor pressure boundary failure to induce containment failure should be included explicitly. The staff suggests that the rationale for the associated SFR design criterion (SFR-DC) 16 and MHTGR design criterion (MHTGR-DC) 16

adequately address this issue. We would offer a caveat to future applicants to ensure they have considered this possibility. SFR-DC 16 contains an excellent description of the high-level principle for the containment function, i.e., leakage shall be restricted to less than that needed to meet the acceptable onsite and offsite dose consequence limits, as specified in 10 CFR 50.34 for postulated accidents. We suggest the same language should be used in all three sets of criteria.

We also discussed with the staff our sense that having multiple definitions of containment in each set of design criteria in Appendices A, B, and C is logically inconsistent. The staff is separately sending a policy issue paper on functional containment to the Commission. It is the staff's intent to reconcile and integrate the containment sections of the three sets of design criteria, if the Commission approves the functional containment policy. We would caution potential applicants that selection of a functional containment requires the development of scenario-specific mechanistic source terms. For MHGTRs, where quantities of dust-entrained fission products and a plate-out release fraction are possible, meeting the associated release requirements may be difficult and costly.

Finally we note the nexus between fuel quality vis-à-vis barrier (functional containment) effectiveness. Full-scale production of fuel with demonstrated quality will be necessary to convince the staff that reduced barriers can be tolerated.

We had extensive discussions among ourselves and with the staff concerning the wisdom of including 'design-specific' design criteria for incompletely specified SFR and MHGTR designs in Appendices B and C. They do demonstrate that, with some design information, it is possible to reduce uncertainty in the design criteria and identify technical policy issues for Commission consideration. They also satisfy strong needs of SFR and MHTGR developers. However, they could be misapplied to variants of the associated 'design-specific' concepts. Therefore, we would offer another caveat that future applicants should remain aware that the design criteria in Appendices B and C might not be appropriate to their specific designs, even if they are variants of the SFR and MHTGR concepts, and compliance may be difficult to demonstrate, since there is limited operating experience. It is the applicant's responsibility to use the regulatory guide appropriately as they develop their actual design-specific principle design criteria.

In our letter of March 2017 on the draft regulatory guide, we recommended early initiation of Implementation Action Plan Strategy 3, Contributing Activity 3.2, which develops approaches to licensing bases and will determine licensing bases for non-LWR technologies. Design-specific licensing basis events need to be developed to ensure that the associated design criteria are complete. The ARDC are being resolved in advance of other initiatives on which they depend (e.g., Licensing Modernization Project, two policy issues [emergency planning and functional containment], and selection of licensing basis events). Therefore, the results of these other activities must be factored into the development of the principal design criteria for each application.

The new design criteria in Regulatory Guide 1.232 are well developed and presented. Although individual ACRS members would prefer certain specific changes, the overall product is sound. We especially appreciate that the regulatory guide memorializes staff rationale for each

ARDC/SFR-DC/MHTGR-DC within the body of the guide. This will be invaluable to future applicants and regulators. The draft final Regulatory Guide 1.232 should be issued.

Sincerely,

/RA/

Michael L. Corradini
Chairman

REFERENCES

1. U.S. Nuclear Regulatory Commission, Draft Final Regulatory Guide 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors," January 2018 (ML18011A659).

2. U.S. Nuclear Regulatory Commission, "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy Staff Report: Near-Term Implementation Action Plans: Volume 2 – Detailed Information," Draft, November 2016 (ML163324A495).

3. U.S. Nuclear Regulatory Commission, "Response to Public Comments on Draft Regulatory Guide DG-1330, 'Guidance for Developing Principal Design Criteria for Non-Light Water Reactors,' Proposed Revision 0 of Regulatory Guide 1.232," January 2018 (ML18011A662).

4. Advisory Committee on Reactor Safeguards, "NRC Non-Light Water Reactor Vision & Strategy – Near-Term Implementation Action Plans and Advanced Reactor Design Criteria," March 21, 2017 (ML17079A100).

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4. Advisory Committee on Reactor Safeguards, "NRC Non-Light Water Reactor Vision & Strategy – Near-Term Implementation Action Plans and Advanced Reactor Design Criteria," March 21, 2017 (ML17079A100).

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