

**THE U.S. NUCLEAR REGULATORY COMMISSION (NRC) STAFF IS RELEASING THIS APPENDIX TO THE NRC STAFF DRAFT WHITE PAPER: ANALYSIS OF APPLICABILITY OF NRC REGULATIONS FOR NON-LIGHT WATER REACTORS (AGENCY WIDE DOCUMENTS ACCESS AND MANAGEMENT SYSTEM (ADAMS) ACCESSION NO. ML20241A017) TO SUPPORT AN UPCOMING ADVANCED REACTOR STAKEHOLDER MEETING. THE NRC STAFF INTENDS THIS DOCUMENT TO FACILITATE DISCUSSION AT THE MEETING, BUT IS NOT SOLICITING WRITTEN COMMENTS ON IT. THE CONTENTS OF THIS DOCUMENT ARE SUBJECT TO CHANGE AND SHOULD NOT BE INTERPRETED AS OFFICIAL AGENCY POSITIONS. FOLLOWING THE MEETING, THE NRC STAFF PLANS TO REVISE THE DRAFT WHITE PAPER, INCLUDING ADDING A REVISED VERSION OF THIS APPENDIX IN THE FORM OF A WHITE PAPER OR SOME OTHER DOCUMENT AND WILL CONSIDER OPTIONS FOR INVITING PUBLIC PARTICIPATION.**

**February 2021**

**Appendix to NRC Staff Draft White Paper: Analysis of Applicability of NRC Regulations for Non-Light Water Reactors**

A regulation with an “N” in the last column of Tables 3 and 5 of the Draft White Paper is generically not applicable to any non-Light Water Reactor (non-LWR) and the application need not include further information to address such a regulation. There is no expectation that applicants address regulations that are not applicable to any non-LWR on their face. Other regulations that have been deemed applicable may relate to structures, systems, and components that certain classes of non-LWRs don't have, but at this stage the staff is not prepared to declare them generically inapplicable because additional design information and a further stage of review is needed to determine whether they're relevant or whether an exemption is needed.

A regulation with an “Y” in the last column of Tables 3, 4, and 5 of the Draft White Paper is generically applicable to non-LWRs and applications will need to include information to demonstrate on a design-specific basis (1) the proposed design complies with the regulation in question or (2) the application provides technical justification for an exemption from the regulation. The staff has not provided application templates in this appendix. The application should contain information to address the regulations in whatever manner the applicant deems effective, and the NRC encourages interaction with the staff to align on any areas where information is not clear. Some examples of how non-LWR applicants might address specific regulations follows.

**Regulatory Compliance**

In most cases, the regulations are written in a way where any reactor applicant – LWR or non-LWR – will be able to provide a justification that the regulation in question is met. Often, this is clear; for other regulations, whether compliance is achieved versus the need for an exemption may be less clear. In order to provide additional clarity, NRC staff provides the following examples for the level of detail acceptable to the staff for justifying compliance with a set of regulations:

- 10 CFR 50.46a requires in part that:

“Each nuclear power reactor must be provided with high point vents for the reactor coolant system, for the reactor vessel head, and for other systems required to maintain adequate core cooling if the accumulation of noncondensable gases would cause the loss of function of these systems.”

By its plain text, the regulation is applicable to “each nuclear power reactor” regardless of reactor technology. However, high point vents for the reactor coolant system need only be supplied if the accumulation of noncondensable gases could cause the loss of function of the systems required to maintain adequate core cooling. Accordingly, to demonstrate compliance with this regulation, an applicant can either:

- Provide high point vents for the reactor coolant system, the reactor vessel head (if applicable), and other systems required to maintain adequate core cooling, or
  - Alternately, provide a justification that noncondensable gases cannot cause a loss of function for the above systems. For some non-LWR designs, this justification might be straightforward (e.g., those with a low pressure reactor coolant system and an external core cooling system not susceptible to gas binding) and therefore involve a simple statement in the application with a reference to the appropriate system technical description. For other non-LWR designs, this justification might be more involved and call for additional description in the application.
- 10 CFR 50.44 governs the requirements associated with combustible gas control. Sections 50.44(a) through (c) apply only to water-cooled reactor designs, but 10 CFR 50.44(d) also applies to non water-cooled reactor applicants and provides that applications subject to Section 50.44(d) must include:

“(1) Information addressing whether accidents involving combustible gases are technically relevant for their design, and

(2) If accidents involving combustible gases are found to be technically relevant, information (including a design-specific probabilistic risk assessment) demonstrating that the safety impacts of combustible gases during design-basis and significant beyond design-basis accidents have been addressed to ensure adequate protection of public health and safety and common defense and security.”

All non-LWR applications must contain information to address the technical relevance of accidents involving combustible gases to the safety of the design. The extent of this information will depend on the specific design. For some non-LWR designs, if combustible gases cannot be generated by any means, a short statement to that effect coupled with any necessary references to supporting technical material would be sufficient to address the regulation. As the relevance of combustible gases to the design increases, additional information becomes necessary to meet the regulation (up to safety and risk assessments associated with combustible gases during accident conditions).

- 10 CFR 52.79(a)(4)(i) requires that applicants provide principal design criteria (PDC) for the facility, and further states that Appendix A to Part 50, “General Design Criteria for Nuclear Power Plants,” provides guidance to applicants in establishing principal design

criteria for types of nuclear power units other than water-cooled reactor designs similar to those for which the Commission has previously issued a construction permit. 10 CFR Part 50, Appendix A states that the General Design Criteria (GDC) are also considered to be generally applicable to these other types of nuclear power units.

In satisfying the requirement that an application include PDC, applicants should consider the concepts the existing GDC in Appendix A as guidance noted in the regulation. One acceptable means of considering this guidance is through use of Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors." RG 1.232 is guidance, and as such represents only one means for satisfying the regulation. If an applicant elects not to consider RG 1.232 in developing its PDC, it should ensure it has adequately addressed the safety concepts described in 10 CFR Part 50, Appendix A, as applicable to the applicant's specific reactor technology. In particular, several of the existing GDC are not technology specific (i.e., Criteria 1-5, Protection by Multiple Fission Product Barriers, Protection and Reactivity Control Systems), and applicants should provide PDC that address these concepts.

- 10 CFR 52.79(a)(6) requires that the application contain a description and analysis of the fire protection design features for the reactor necessary to comply with 10 CFR Part 50, Appendix A, GDC 3, and 10 CFR 50.48. The requirements associated with Section 50.48 are applicable, and while compliance with GDC 3 itself is not a requirement, staff anticipates that applicants will provide a PDC that is representative of Criterion 3 or provide justification for not doing so (consistent with the discussion regarding PDC previously). Section 52.79(a)(41) does not require non-LWR applicants to evaluate the proposed facility against the Standard Review Plan (SRP) (NUREG-0800). Nonetheless, SRP Section 9.5.1 provides staff review guidance that is, in large part, technology neutral for helping the staff determine whether fire protection objectives are met. Accordingly, evaluation in the application of the proposed facility against SRP Section 9.5.1 and identification of differences in design features, analytical techniques and procedural measures proposed for a facility and the corresponding design features, analytical techniques, and procedural measures described in the SRP would assist the staff in its review.

### Exemptions

Exemption requests ideally should be in their own section of the application, although the exemption requests need not repeat technical information presented elsewhere in the application (the exemption request can reference the relevant portion of the application). Exemptions using the same technical justification can be bundled together into a single exemption at the applicant's discretion to reduce administrative burden, if the bundling makes logical sense.

Exemptions will vary both in content and complexity, and the amount of supporting information needed to justify the technical and regulatory criteria associated with a specific exemption request will vary accordingly. Staff expects some exemptions to be straightforward, with minimal information needed to meet the information requirements associated with the regulation. Other exemptions involving extensive technical justification are likely to have more

complex information requirements. As long as the regulatory requirements are met and the exemption request is justified, the format and content of the exemption may differ and remain acceptable.

In general, to support an exemption, the application should contain the following:

- A statement identifying the need for NRC approval or need for an exemption.
- The scope and summary of the requested exemption, including identification of the specific portion(s) of the regulation that the exemption is requested from;
- Relevant justification for the exemption, with references to regulatory guidance and/or requirements (as applicable);
- A technical and regulatory evaluation relative to the regulatory acceptance criteria associated with the request (e.g., Section 50.12); and
- An evaluation against the applicable exemption criteria.

Examples of what should be provided for three specific exemptions follows:

- For emergency response, emergency preparedness, and emergency planning zone regulations (e.g., those in 10 CFR 50.33(g), 50.47(b), 50.47(c)(2), and Appendix E), existing requirements may not account for design-specific features for some non-LWR designs. The specific portions of the regulations that an applicant will take an exemption from will not be provided for here (those will be up to an applicant to select and justify), but may include a reduced emergency planning zone, changes to offsite emergency response, or other specific exemptions from those regulations.

As part of ongoing regulatory efforts, because the NRC understands that the existing emergency planning regulations may not fully account for design features for new reactor technologies, the staff has undertaken a rulemaking entitled “Emergency Preparedness for Small Modular Reactors and Other New Technologies” (85 FR 28436, docket ID NRC-2015-0225). In Staff Requirements Memorandum for SECY-15-0077 “Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies” (ADAMS Accession No. ML15216A492) (SECY-15-0077 is available at ADAMS Accession No. ML15037A176), the Commission stated, “[f]or any small modular reactor [(SMR)] reviews conducted prior to the establishment of a rule, the staff should be prepared to adapt an approach to emergency planning zones for SMRs under existing exemption processes, in parallel with its rulemaking efforts.” Exemptions that conform to this proposed rule will be evaluated on a case-by-case basis, but use of the proposed rule to inform the exemption can streamline the exemption request process.

Accordingly, the staff expects many non-LWR applicants to apply for exemptions from portions of the current emergency preparedness regulations. In order to facilitate an efficient review of these exemptions, applicants should provide the following as part of their exemption requests (keeping in mind the general exemption content guidance above):

- Specifically identify what portions of the regulations the applicant is requesting an exemption from (either by citing regulatory text or striking through text that the proposed exemption is from).
- A description of how the exemption request satisfies the regulatory acceptance criteria associated with the request (e.g., Section 50.12).

This description would need to include a description of how the exemption is authorized by law, will not present an undue risk to public health and safety, and is consistent with the common defense and security. Further, special circumstances must be present; of the listed special circumstances, staff expects most applicants to cite that “[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.”

- For exemption requests of this nature, applicants should provide a consequence- and risk-oriented justification, including a quantitative assessment of the dose at the proposed emergency planning zone boundary.
- Current NRC regulations include definitions that align with LWR technology, and some non-LWR designs may have (or not have) design features that do not align with current regulatory definitions or are distinct in terms of safety importance from similar features in LWRs. One example is in the definition of safety-related structures, systems and components, part (1), the integrity of the reactor coolant pressure boundary. Some non-LWRs do not have a reactor coolant pressure boundary, while others have a coolant pressure boundary that does not or only partially performs any safety function. Applicants for licenses for these designs will need to request exemptions from this definition.

Because the definition itself does not directly impose any regulatory requirements, an exemption from the definition is complex. In the case of the definition of “safety-related” SSCs, an applicant has another option besides requesting an exemption: the applicant could follow the process laid out in 10 CFR 50.69 to classify the system as Risk-Informed Safety Class 3, safety-related but performing low safety significant functions. Alternately, in taking an exemption from this definition, an applicant should (continuing to consider the general exemption content guidance above):

- Clearly define the precise scope of the requested exemption – evaluate what portions of the definition do or do not apply to the design, then provide a revised definition that will apply. Cite any technical references to relevant portions of the application.
- Evaluate how changing the definition affects regulatory requirements that apply to the design. In this case, as an example reviewing 10 CFR Part 50, the safety-related SSC definition affects the following:
  - Section 50.10, Limited work authorizations
  - Section 50.49, Environmental qualification of electric equipment
  - Section 50.55a, Codes and standards
  - Section 50.65, Maintenance rule
  - Section 50.69, Risk-informed categorization of SSCs
  - Section 50.72, Immediate notification requirements
  - Section 50.73, License event report system
  - Appendix B
  - Appendix S

These may or may not all apply to a given application – applicants should review all applicable regulations (not just Part 50) for impact on their application. If they do apply, an applicant should evaluate how changing the definition of “safety-related SSC” affects the requirements of each regulation. If the requirements are changed, the application should justify an exemption from the affected regulations.

- Provide a description of how the exemption request satisfies the regulatory acceptance criteria associated with the request (e.g., Section 50.12), considering both the definition and any of the regulations mentioned above (e.g., by justifying how application of the regulation in the particular circumstances associated with the design would not serve the underlying purpose of the rule).
  - Finally, provide a technical and regulatory evaluation relative to the safety significance of the proposed changes. In this case, demonstrate how the proposed exemption is justified for the design, by either demonstrating the safety significance of the reactor coolant boundary is sufficiently low considering the other portions of the safety-related definition and any of the affected regulations, or providing alternate acceptable reasoning for the exemption (i.e., that the design in question does not have a reactor coolant system with a pressure boundary).
- In some cases, non-LWR designs may have such margins of safety that they can address specific event-based regulatory requirements without providing for additional design features beyond those incorporated into the design. An example of where this might be relevant is 10 CFR 50.155(b)(2), which requires in part that each applicant or licensee shall develop, implement, and maintain strategies and guidelines to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant impacted by the event, due to explosions or fire, including firefighting, operations to mitigate fuel damage, and actions to minimize radiological release.

In the case of this specific regulation, an applicant would have the option of compliance through implementing a relatively simple set of strategies and guidelines that demonstrate core cooling, containment, and spent fuel pool cooling capabilities are maintained. Although the NRC staff does not necessarily anticipate exemption requests of this nature, an applicant could instead request exemption from this regulation. Staff anticipates an exemption request to this effect would include the following:

- A clear exemption request, with the application providing the portions of the regulation which are applicable and which the exemption request applies to. Staff anticipates an exemption request of this nature would involve substantial technical justification, though not necessarily as part of the exemption itself – any exemption to this effect would be inextricably tied to the overall safety of the design and thus would reference other portions of the application.
- A description of how the exemption request satisfies the regulatory acceptance criteria associated with the request (e.g., Section 50.12). Staff anticipates that the special circumstance cited would be to demonstrate application of the regulation in the particular circumstances associated with the design would not serve the underlying purpose of the rule.

- In citing this special circumstance, staff envisions a technical and regulatory evaluation justification that would demonstrate that strategies and guidelines are not necessary for the loss of large areas because either:
  - a) no fuel damage or radiological release is possible as a result of a loss of large area prescribed by the rule because the safety features are sufficiently simple, capable, and robust that they continue to perform their core cooling, containment, and spent fuel cooling functions despite the loss of large areas of plant contemplated in the rule, with a corresponding technical justification to that effect, or
  - b) that the consequences of a loss of large areas of the plant on the functions identified in the regulation (and the preceding bullet) are bounded by an analysis already conducted for another event, with appropriate justification and reference to that event.

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