



POLICY ISSUE **(Notation Vote)**

DATE: September 28, 2018 **SECY-18-0096**

FOR: The Commissioners

FROM: Margaret M. Doane
Executive Director for Operations

SUBJECT: FUNCTIONAL CONTAINMENT PERFORMANCE CRITERIA FOR
NON-LIGHT-WATER-REACTORS

PURPOSE:

The purpose of this paper is to seek Commission approval of the U.S. Nuclear Regulatory Commission (NRC) staff's proposed methodology for establishing functional containment performance criteria for non-light-water-reactors (non-LWRs). This paper does not address any new commitments or resource implications.

SUMMARY:

Historically, the NRC has expressed an openness to a functional containment concept. In 2006, via a staff requirements memorandum (SRM), the Commission indicated that performance criteria for functional containment was a policy matter that required a Commission decision prior to implementing. Recently, the staff has engaged with stakeholders to develop a proposed methodology that could be used by designers to define design-specific functional containment performance criteria, relying heavily on the identification and analyses of licensing-basis events. The staff is seeking the Commission's approval of this methodology at this time; such approval would provide a regulatory foundation that enables progress on interrelated activities associated with developing a framework for licensing non-LWR designs.

CONTACT: William D. Reckley, NRO/DSRA
301-415-7490

BACKGROUND:

One of the fundamental safety functions to be addressed for any nuclear reactor is limiting the release of radioactive materials from the facility. The NRC's existing regulations and guidance for nuclear reactors were primarily developed for LWRs and the specific events and phenomena related to zirconium clad fuel and water coolant. LWRs include protections against design-basis accidents that reflect the traditional approach for multiple barriers providing "defense in depth" to limit releases of radioactive material: fuel cladding, reactor coolant system pressure boundary, and containment. The containment structures for LWRs have been designed to control the leakage of radioactive materials following design-basis accidents that can damage the fuel cladding and pressure boundary. The performance criteria for LWR containments are defined as allowable leakage rates, which are determined from analyses performed to show that estimated radiation doses to members of the public resulting from a design basis accident are below the reference values cited by NRC regulations.

Non-LWR technologies have operating conditions, coolants, and fuel forms that differ from LWRs. These differences may allow or possibly require different approaches to fulfilling the safety function of limiting the release of radioactive materials. This has led to describing a "functional containment" as a barrier, or a set of barriers taken together, that effectively limits the physical transport of radioactive material to the environment. Non-LWRs in other countries and conceptual non-LWR designs in the U.S. have included barriers different than LWR-type containment structures. However, the last commercial reactor in the U.S. with barriers different from an LWR-type containment was licensed by the Atomic Energy Commission in 1973. In the past, and currently, the NRC has engaged in prelicensing interactions and developed some policies and guidance to support the potential licensing of non-LWR reactor technologies.

The Commission's openness to considering non-LWR type containments via a functional containment concept was documented in the SRM for SECY-93-092, "Issues Pertaining to the Advanced Reactor (PRISM, MHTGR, and PIUS) and CANDU 3 Designs and Their Relationship to Current Regulatory Requirements," dated July 30, 1993 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML003760774). The staff proposed an approach for functional containments in SECY-03-0047, "Policy Issues Related to Licensing Non-Light-Water Reactor Designs," dated March 28, 2003 (ADAMS Accession No. ML030160002). In SRM-SECY-03-0047 dated June 26, 2003 (ADAMS Accession No. ML031770124), the Commission signaled that they remained willing to consider functional containment concepts but deferred deciding on the staff's specific proposal. Instead, the Commission directed the staff to develop performance criteria and options for future consideration. Specifically, the Commission stated the following:¹

¹ The terminology in SECY-03-0047 of "Under what conditions can a plant be licensed without a pressure-retaining containment building (i.e., a confinement building instead of a containment)?" and the related SRM that stated "... At this time there is insufficient information for the Commission to prejudge the best options and make a decision on the viability of a confinement building. ..." have resulted in some uncertainty regarding the NRC's position on this issue. The challenges associated with the concept and terminology of confinement include possible perceptions that the approach involves a method of retaining fission products within a nuclear facility that is less robust than that provided by a LWR-type containment structure. The staff's recommendation in this paper is for the Commission to approve performance-based requirements instead of prescriptive or deterministic performance standards for a pressure-retaining or essentially leak-tight structure as the primary means of retaining fission products for advanced reactor designs. The staff's proposal for a technology-inclusive, risk-informed, performance-based methodology for establishing functional containment performance criteria is more fully described in Enclosure 2.

The Commission has disapproved the staff's recommendation...related to the requirement for a pressure retaining containment building. At this time there is insufficient information for the Commission to prejudge the best options and make a decision on the viability of a confinement building. The staff should develop performance requirements and criteria working closely with industry experts (e.g., designers, EPRI [Electric Power Research Institute], etc.) and other stakeholders regarding options in this area, taking into account such features as core, fuel, and cooling systems design. The staff should pursue the development of functional performance standards and then submit options and recommendations to the Commission on this important policy decision.

The staff has interacted with stakeholders as part of several programs related to non-LWR technologies since SRM-SECY-03-0047. For example, the NRC and the Department of Energy (DOE) participated in the Next Generation Nuclear Plant (NGNP) Program. Congress directed the NRC and DOE to develop and implement the NGNP Program as part of the Energy Policy Act of 2005 (Pub.L. 109–58). The staff addressed several key licensing issues related to the NGNP Program, including functional containment performance criteria, in a letter to DOE's Office of Nuclear Energy dated July 17, 2014 (ADAMS Accession No. ML14174A734).

The staff described efforts to prepare for possible licensing of non-LWR technologies in "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness," issued in December 2016 (ADAMS Accession No. ML16356A670). The staff developed implementation action plans (IAPs) to identify specific activities that the NRC will conduct in the near-term, mid-term, and long-term timeframes (ADAMS Accession Nos. ML17165A069 and ML17164A173). The IAPs describe resolving remaining questions on functional containment performance criteria as an important policy issue. Along those lines, the staff issued Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors," in April 2018 (ADAMS Accession No. ML17325A611). The RG discusses a technology-inclusive approach to functional containments and states that defining functional containment performance criteria is a policy issue that may require Commission review and approval.

DISCUSSION:

Proposed Methodology

Through interactions with stakeholders, the staff developed and is proposing a methodology that would be used by non-LWR designers to define functional containment performance criteria in a manner that is technology inclusive, risk informed, and performance based. The staff seeks the Commission's approval of that methodology in this paper. Enclosure 2 describes in more detail how the proposed methodology defines logical performance criteria for specific design features that have a role in limiting the release of radioactive material. The basic framework of the methodology is built around the identification and categorization of licensing-basis events. Similar to the framework that has evolved for operating reactors, event categories such as anticipated operational occurrences, design basis accidents, and beyond-design-basis events are selected considering factors such as estimated event frequencies.

The illustration below, Figure 1, provides a depiction of how the staff's proposed methodology would help designers establish performance criteria for plant features using accepted event categories and fundamental safety functions such as controlling reactivity and reactor power, removing heat, and limiting the release of radioactive materials from a reactor facility. For each

event category, plant-level performance criteria would be defined using the established correlations within NRC regulations, policy statements, and guidance, which call for lesser potential offsite consequences with increasing event frequencies. Designers would analyze event sequences to ensure the plant-level performance criteria are met and to identify those structures, systems, and components (SSCs) and programmatic controls needed to fulfill important safety functions as well as controlling parameters for the design and operation of risk-significant SSCs. This process serves to define the appropriate performance criteria for specific SSCs and programs for each event category. For example, for beyond-design-basis events, the barriers making up the functional containment for the event sequences in that category would be analyzed and be confirmed to maintain the consequences of accidents to a fraction of the NRC's safety goals as defined in the Commission's Policy Statement "Safety Goals for the Operations of Nuclear Power Plants" published on August 21, 1986 (51 FR 30028).

In terms of functional containment, a given SSC may have performance criteria associated with its role to limit effluent releases during normal operation and anticipated events as well as performance criteria associated with its role to retain radionuclides during design basis accidents or beyond-design-basis events. Another SSC may have a role in retaining radionuclides only during beyond-design-basis events. The design and related performance criteria for each SSC would be determined based on the aggregation of performance requirements from all event categories and fundamental safety functions, as well as other potential roles that a designer may choose for that SSC.

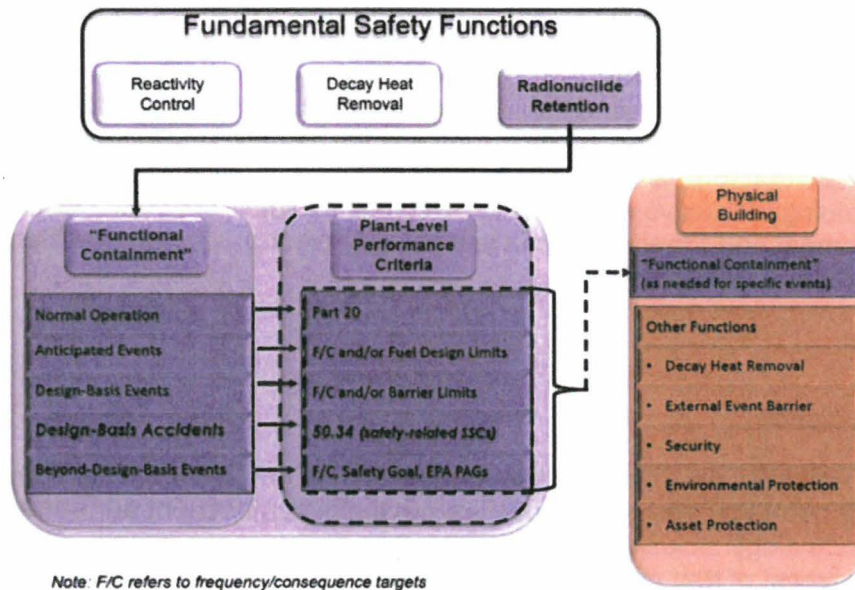


Figure 1 – Functional Containment Performance Criteria

Enclosure 2 discusses the possible role of the physical building that will enclose the reactor and primary coolant systems. As shown in Figure 1, the building may play a role in retaining radioactive materials for some event categories and would then become part of the functional containment for that design. Performance criteria would then be established to address the defined role of the building for those event categories or specific event sequences for which the building is needed to retain radioactive materials. If a design is able to retain radioactive materials by using other barriers, the building enclosing the reactor may not need to be part of the functional containment for some or all event categories.

Stakeholder Interactions

The NRC staff held numerous public meetings that included discussion of functional containment and related performance criteria during its interactions on the NGNP. More recently, the staff prepared and made publicly available draft papers on functional containment performance criteria (ADAMS Accession Nos. ML18010A516 and ML18010A721) to support public meetings and interactions with the Advisory Committee on Reactor Safeguards (ACRS). The meetings with the ACRS included presentations by industry representatives on how the proposed methodology would work for specific non-LWR designs.

The ACRS issued a letter dated May 10, 2018 (ADAMS Accession No. ML18108A404), providing its conclusions and recommendations. The ACRS stated that the staff paper provides a vision for setting licensing policy and developing functional containment performance criteria and recommended that a technology-inclusive, risk-informed, performance-based methodology be adopted for establishing performance criteria for SSCs serving as the functional containment for non-LWR designs. The ACRS cautioned that developing SSC-level performance criteria is not an easy task.

Relationship to other Non-LWR Priorities

Uncertainties associated with possible regulatory requirements for non-LWRs, including functional containments and related performance criteria, are limiting the ability of designers to assess features to prevent or mitigate plant transients and accidents. The staff is currently interacting with non-LWR stakeholders (e.g., DOE, designers) on a variety of policy and regulatory issues identified in the IAPs, and will provide recommendations for the Commission on those policy matters. For example, the staff is reviewing proposed approaches to identify and address plant internal and external events, exploring possible alternatives to current security requirements, assessing siting-related guidance, and developing a proposed rule with alternative requirements for emergency planning zones for Commission approval. These activities are interrelated and have a nexus to proposed design features such as functional containments and the associated performance criteria. An integrated approach is needed for resolving issues and developing a regulatory framework for non-LWRs; that integrated approach is being developed as part of the activities established in the IAPs. The staff is also preparing additional guidance related to the design and licensing of non-LWR technologies as described in the IAPs. The guidance to inform the design process and the related content of applications for licenses, certifications, and approvals for non-LWRs depends on resolving the issues on functional containment performance criteria, as described in this paper.

Next Steps

Pending the Commission's approval, the staff will incorporate the proposed methodology for functional containment performance criteria in ongoing activities such as preparing draft regulatory guide (DG) 1353, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Approach to Inform the Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors," future revisions of RG 1.232, and interactions with specific designers.

RECOMMENDATION:

The staff recommends that the Commission approve the proposed methodology for functional containment performance criteria for all non-LWRs.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection.

The staff also considered its interactions with the ACRS in finalizing this paper.

A handwritten signature in black ink, reading "Margaret M. Doane". The signature is fluid and cursive, with the first name "Margaret" being more prominent than the last name "Doane".

Margaret M. Doane
Executive Director
for Operations

Enclosures:

1. Background
2. Technology-Inclusive, Risk-Informed,
Performance-Based Approach

SECY PAPER "FUNCTIONAL CONTAINMENT PERFORMANCE CRITERIA FOR NON-LIGHT
WATER REACTOR DESIGNS" - DATED _____

ADAMS Accession No: ML18114A546 (Pkg)

*via e-mail

SECY-012

OFFICE	NRO/DSRA	QTE*	NRO/DSRA	NRO/DSRA
NAME	WReckley	JDougherty	JSegala	JMonninger
DATE	04/17/18	04/10/18	04/19/18	06/04/18
OFFICE	OGC*	NRO	EDO	
NAME	MCarpentier (NLO)	FBrown	MDoane	
DATE	06/15/18	07/09/18	9/28/18	

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