POLICY ISSUE
INFORMATION

March 22, 2013 SECY-13-0029

FOR: The Commissioners

FROM: R. W. Borchardt */RA Mike Johnson for/*
Executive Director for Operations

SUBJECT: HISTORY OF THE USE AND CONSIDERATION OF THE LARGE RELEASE FREQUENCY METRIC BY THE U.S. NUCLEAR REGULATORY COMMISSION

PURPOSE:

In the staff requirements memorandum (SRM), dated October 22, 2012, on SECY-12-0081, "Risk-Informed Regulatory Framework for New Reactors," dated June 6, 2012, the Commission directed the staff to provide an information paper to the Commission, reviewing the history of the U.S. Nuclear Regulatory Commission's (NRC's) use and consideration of large release frequency (LRF). The Commission also directed the staff to provide pros and cons of requiring the use of LRF, possibly in addition to large early release frequency (LERF), for all operating reactors. This paper is the staff's response to the Commission's direction.

SUMMARY:

The NRC first established expectations related to the frequency of a large release of radioactive materials in its 1986 safety goal policy statement. The policy statement specified two qualitative safety goals and two quantitative health objectives (QHOs). The two QHOs are a prompt fatality QHO and a latent cancer fatality QHO. The policy statement discussed the need for specific guidelines to use as a basis for determining whether a level of safety ascribed to a plant is consistent with the safety goal policy. It further stated that the guidance to be developed should

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be based on a general performance guideline that the Commission proposed for further staff examination: the frequency of a large release of radioactive material to the environment should be less than 10^{-6} per reactor year.

The Commission acknowledged that analyses indicated that the cancer fatality QHO was not the more controlling objective and that, if the prompt fatality QHO is met, the cancer fatality risk generally would be much lower than the cancer fatality QHO. Recognizing that the prompt fatality QHO is more controlling, the staff worked to develop a large release definition that focused on LRF being a surrogate for the prompt fatality QHO. In 1993, the staff concluded that defining large release beyond a simple qualitative statement related to its 10^{-6} per reactor year release frequency (such as is currently contained in the safety goal policy statement) was neither practical nor required for regulatory or design purposes. The Commission approved the staff proposal to terminate further work on the development of a large release definition and magnitude.

As part of NRC and industry initiatives to expand the use of probabilistic risk assessment (PRA) for operating reactors, the NRC provided draft Regulatory Guide (RG) 1.174 for Commission review in 1997. Since then, for operating reactors, a LERF guideline of 10^{-5} per reactor year has been used as a surrogate for the prompt fatality QHO and a core damage frequency (CDF) guideline of 10^{-4} per reactor year has been used as a surrogate for the cancer fatality QHO. The staff has shown through calculations the appropriateness of these surrogates, and the Commission has continued to approve their use. These metrics have been applied to various aspects of reactor operation.

Because the NRC did not define which releases would be considered “large,” the definition was left open to interpretation. In their submittals, new reactor design certification applicants used definitions of large release that were more conservative than those the staff evaluated in its effort to define LRF.

The staff also considered the potential requirement of LRF for all operating reactors in the context of the safety goal policy statement. The staff’s view is that the objective of using LRF as a basis for determining whether a level of safety ascribed to a plant is consistent with the safety goal policy statement is fulfilled today by the use of LERF and CDF guidelines for operating reactors.

BACKGROUND:

While maintaining the overarching safety goals for all nuclear power plants, the Commission has established expectations that new reactor designs achieve a higher standard of severe accident safety performance[1] and provide increased margin before exceeding safety limits[2] through various means (e.g., severe accident mitigation features, diverse and simplified systems). As a result of these and other enhancements, risk estimates for new reactor designs are one or more orders of magnitude lower than for current operating reactor designs, based on consideration of quantified internal and external (excluding seismic) hazards. One method the staff uses to

[1]“Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants,” 50 *Federal Register* (FR) 32138; August 8, 1985.
[2]“Policy Statement on the Regulation of Advanced Reactors,” 73 FR 60612; October 14, 2008.

confirm the adequacy of new reactor designs is comparing applicant-calculated LRF estimates against an LRF goal of less than 10^{-6} per reactor year, consistent with Commission direction for new light-water reactors.[3]

The lower risk estimates associated with new reactor designs raised questions on how—once new reactors become operational—to apply acceptance guidelines related to CDF and LERF for risk-informed requests to make changes to the licensing basis and for regulatory response in the Reactor Oversight Process (ROP). In 2010, the staff recommended identifying appropriate changes to the existing risk-informed guidance for changes to the licensing basis—including operational programs—and to the ROP to recognize the lower risk profiles of new reactors and prevent a significant decrease in the enhanced levels of safety that new reactors provide.[4] In response,[5] the Commission reaffirmed that the existing safety goals, safety performance expectations, subsidiary risk goals and associated risk guidance (e.g., the advanced-reactor policy statement and RG 1.174[6]), key principles, and quantitative metrics for implementing risk-informed decisionmaking, are sufficient for new reactors.

The Commission further directed the staff to engage external stakeholders in a series of tabletop exercises to test various realistic performance deficiencies, events, modifications, and licensing-basis changes against current NRC policy, regulations, and guidance that will be relevant to the licensing basis for new reactors. The purpose of the tabletop exercises was either to confirm the adequacy of those regulatory tools (and make the NRC aware of these potential scenarios such that commensurate regulatory oversight can be applied) or to identify areas for improvement, such as potential adjustments to the ROP.

The staff conducted a series of public workshops and meetings with stakeholders from May 4, 2011, through October 26, 2011. Based on the results of the tabletop exercises performed for licensing applications, the staff did not identify any potentially significant decreases in the enhanced safety margins for new reactors that would be caused by using the current operating reactor guidelines. As a result, in SECY-12-0081, the staff recommended that new reactors transition from LRF to LERF at or before initial fuel load.[7] In addition, the staff stated its intention to augment the existing discussion on long-term containment performance in

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[3]"SECY-89-102—Implementation of the Safety Goals," SRM-SECY-89-102, dated June 15, 1990 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML003707881) and "SECY-90-016—Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationships to Current Regulatory Requirements," SRM-SECY-90-016, dated June 26, 1990 (ADAMS Accession No. ML003707885).

[4]"Modifying the Risk-Informed Regulatory Guidance for New Reactors," SECY-10-0121, dated September 14, 2010 (ADAMS Accession No. ML102230076).

[5]"Staff Requirements—SECY-10-0121—Modifying the Risk-Informed Regulatory Guidance for New Reactors," SRM-SECY-10-0121, dated March 2, 2011 (ADAMS Accession No. ML110610166).

[6]"An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," RG 1.174, Revision 2, issued May 2011 (ADAMS Accession No. ML100910006).

[7]"Risk-Informed Regulatory Framework for New Reactors," SECY-12-0081, dated June 6, 2012 (ADAMS Accession No. ML12117A012).

Section 2.2 of RG 1.174 by referring to the deterministic containment performance objective for new reactors in SECY-90-016 and SECY-93-087.[8]

In the SRM on SECY-12-0081, the Commission approved the staff's recommendation and directed the staff to provide an information paper to the Commission reviewing the history of the NRC's use and consideration of LRF.[9] The Commission also directed the staff to provide pros and cons of requiring the use of LRF, possibly in addition to LERF, for all operating reactors.

DISCUSSION:

History of LRF

The NRC first established expectations related to the frequency of a large release of radioactive materials in the 1986 safety goal policy statement.[10] The policy statement, developed following the 1979 accident at Three Mile Island, defined an acceptable level of radiological risk for nuclear power plants. The policy statement established the following qualitative safety goals:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The policy statement also established the following QHOs for use in determining achievement of the qualitative safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities[11] that might result from reactor accidents should not exceed one-tenth of one percent of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

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[8]"Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," SECY-90-016, dated January 12, 1990 (ADAMS Accession No. ML003707849) and its associated SRM. In addition, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," SECY-93-087, dated April 2, 1993 (ADAMS Accession No. ML003708021) and its associated SRM, "SECY-93-087— Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," SRM-SECY-93-087, dated July 21, 1993 (ADAMS Accession No. ML003708056). The containment should maintain its role as a reliable, leak-tight barrier for approximately 24 hours following the onset of core damage under the more likely severe accident challenges and, following this period, the containment should continue to provide a barrier against the uncontrolled release of fission products.

[9]"Staff Requirements—SECY-12-0081—Risk-Informed Regulatory Framework for New Reactors," SRM-SECY-12-0081, dated October 22, 2012 (ADAMS Accession No. ML12296A158).

[10]"Safety Goals for the Operations of Nuclear Power Plants; Policy Statement; Republication," 51 FR 30028; August 21, 1986.

[11]Prompt fatality risk refers to individual deaths that occur shortly (usually within a few weeks or months) after exposure to large doses of radiation.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent of the sum of cancer fatality risks resulting from other causes.

The policy statement discussed the need for specific guidelines to use as a basis for determining whether a level of safety ascribed to a plant is consistent with the safety goal. The policy statement stated that this guidance would be derived from additional studies conducted by the staff and resulting in recommendations to the Commission. The guidance would be based on the following general performance guideline proposed by the Commission for further staff examination:

> Consistent with the traditional defense-in-depth approach and the accident mitigation philosophy requiring reliable performance of containment systems, the overall mean frequency of a large release of radioactive materials to the environment from a reactor accident should be less than 1 in 1,000,000 per year of reactor operation.

The policy statement also stated that analyses indicate that the cancer fatality QHO will not be the controlling objective, and noted that, if the quantitative objective for prompt fatalities is met, the risk of cancer fatality would generally be much lower than the cancer fatality QHO.

Recognizing that the prompt fatality QHO was the more controlling objective, the staff worked to develop a definition of a large release that could be used as a surrogate for the prompt fatality QHO. In the late 1980s, the staff developed a recommended framework for safety goal implementation.[12] As part of its recommendations, the staff stated that the large release definition should be reasonably consistent with the QHOs and should cover the aggregate risk of prompt fatalities resulting from all large releases.

The Advisory Committee on Reactor Safeguards (ACRS) subsequently recommended formulating a hierarchical structure among the interrelated criteria in the overall safety goals that the Commission policy established.[13] The Committee recommended that each subordinate level in the hierarchy should be consistent with the level above, but it should be a more practical surrogate, representing a simplification or quantification of the previous level. It also recommended that each surrogate should not be so conservative that it creates a de facto new policy, and that each surrogate should provide a basis to ensure that the safety goal policy objectives are being met.

The Commission supported these ACRS recommendations.[14] The Commission reiterated that the subordinate levels in this hierarchical structure should not be so conservative that they create a de facto new policy. The Commission then directed the staff to submit an options

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[12]"Safety Goal Implementation Status," memorandum from the Executive Director for Operations (EDO) to the Commissioners, dated January 2, 1987, referred to in "Implementation of Safety Goal Policy," SECY-89-102, dated March 30, 1989.

[13]"ACRS Comments on an Implementation Plan for the Safety Goal Policy," letter from the ACRS to Chairman Zech, dated May 13, 1987.

[14]"Commission Guidance on Implementation of the NRC's Safety Goal Policy," memorandum from the Secretary of the Commission to the EDO, dated November 6, 1987.

paper addressing a range of definitions for a large release of radioactive materials, including defining a large release in terms of a quantity of fission products.

In 1989, the staff proposed to the Commission a revised plan for safety goal policy implementation.[15] Consistent with ACRS recommendations and Commission direction, the staff recommended the following hierarchy of objectives:

- Level 1: qualitative safety goals
- Level 2: QHOs
- Level 3: large release (potential for offsite early fatality)
- Level 4: CDF

The staff recommended developing a large release definition in which a large release is defined as a release that has the potential for causing an offsite early fatality as a surrogate for the prompt fatality QHO. In formulating this definition, the staff determined that there was no need to recommend a surrogate for the latent cancer QHO since the prompt fatality QHO was recognized as more controlling. Further, the staff noted that the large release guideline is inherently more conservative than either of the QHOs.[16] At an overall mean frequency of less than 10^{-6} per reactor year, any release definition for large release would result in an average individual risk of exposure to that release that is less than the QHOs. This is because (1) the cancer fatality QHO is already greater by a factor of 2 than the LRF guideline, and (2) following a large release, wind direction considerations alone would reduce the average risk of individual exposure to that release by substantially more than a factor of 2, well below the prompt fatality QHO. The average individual defined for the QHOs has a lower risk than an individual downwind.[17] Thus, alternative definitions of a large release threshold can reflect varying degrees of conservatism but will always be smaller than either QHO. Because the prompt fatality QHO was recognized as the more controlling objective, the staff worked to develop a large release definition that focused on LRF being a surrogate for the prompt fatality QHO.

The Commission, in response, directed the staff to evaluate whether a plant performance objective (i.e., LRF) that focuses on the release and eliminates site characteristics could be developed and implemented.[18] The Commission acknowledged that while a large release guideline of 10^{-6} per reactor year is inherently more conservative than either of the QHOs, this more conservative result is within an order of magnitude of the Commission's health objectives and provides a simple goal that has generally been accepted. The Commission further directed the staff to formulate a new definition for large release that focused on the release rather than site characteristics.

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[15]SECY-89-102.

[16]The prompt fatality QHO represents a $5x10^{-7}$ per year objective for an average individual within 1 mile. The cancer fatality QHO represents a $2x10^{-6}$ per year objective for an average individual within 10 miles. ("Safety Goals for Nuclear Power Plant Operation," NUREG-0880, Rev. 1, issued May 1983.)

[17]The average individual is defined as the average individual biologically and locationally who resides within 1 mile and 10 miles from the plant for prompt fatality risk and cancer fatality risk, respectively. In calculating the consequences for an average individual to compare against the QHOs, the radiological consequences for people downwind of the release and therefore potentially exposed to the radioactive plume are averaged with the radiological consequences for people not downwind of the release.

[18]SRM-SECY-89-102.

In 1990, the staff provided two alternative definitions for large release for Commission consideration and recommended that the Commission approve the second definition:[19]

(1) A release from an event involving severe core damage, reactor coolant system pressure boundary failure, and early failure or significant bypass of the containment.

(2) A release of radioactivity from the containment to the environment of a magnitude equal to or greater than: (An amount, to be determined by the staff, expressed in curies or fraction of the core inventory, which has the potential, based on representative site characteristics, for causing one or more prompt fatalities.)

The Commission approved the staff's recommendation and stated that the staff should keep in mind the following guidelines for subordinate levels of the safety goal hierarchy:[20]

- should be consistent with the level above
- should not be so conservative as to create a de facto new policy
- should represent a simplification of the previous level
- should provide a basis for assuring that the safety goal policy objectives are being met

In accordance with Commission direction, the staff performed analyses using the MELCOR Accident Consequence Code System (MACCS).[21] The staff used MACCS for a representative site to evaluate candidate large releases to identify those releases that would lead to a prompt fatality. The staff developed the representative site to encompass the consequences of any actual site, while staying within the envelope of a proposed revision to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 100, "Reactor Site Criteria." Using the range of releases developed for the five plants examined in NUREG-1150[22] and the LaSalle plant, the staff developed a set of candidate large releases to reflect a range of release characteristics, including timing, duration, energy, and composition (fractions of core inventory). The staff found that the proposed LRF goal was more conservative than previously understood.

Specifically, in SECY-93-138, the staff concluded that, given a large release at 10^{-6} per reactor year, any large release definition would result in a degree of conservatism several orders of magnitude more conservative than the QHOs. The staff further concluded that development of a large release definition and magnitude, beyond a simple qualitative statement related to the 10^{-6} per year release frequency (such as is contained in the safety goal policy statement), was not practical or required for regulatory or design purposes. Instead, the staff proposed using guidance for implementing the safety goal policy statement developed in parallel with the work evaluating a large release. For operating reactors, the staff proposed a framework for regulatory decisionmaking using CDF and conditional containment failure probability (CCFP) as

[19]"Formulation of a Large Release Definition and Supporting Rationale," SECY-90-405, dated December 14, 1990.
[20]"SECY-90-405—Formulation of a Large Release Definition and Supporting Rationale," SRM-SECY-90-405, dated March 21, 1991.
[21]"Recommendation on Large Release Definition," SECY-93-138, dated May 19, 1993.
[22]"Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, issued December 1990 (ADAMS Accession No. ML040140729).

the subsidiary safety goal objectives.[23] For new reactor design certification reviews, the staff proposed a CDF goal and a CCFP goal complemented by a deterministic containment performance goal.[24]

In June 1993, the Commission approved terminating the staff effort to define large release.[25]

Transition to LERF

By the time the Commission's policy statement on PRA was issued in 1995,[26] most operating reactor licensees had completed their individual plant examinations, which were intended to evaluate severe accident behavior and sequences, develop probabilities of core damage and fission product release, and, if necessary, reduce these probabilities through hardware and procedural modifications. Operating reactor licensees expected subsequent PRA applications to involve the assessment of changes to the plant operation, maintenance or design, or to involve a prioritization evaluation to help optimize the expenditure of resources. With these applications in mind, the Electric Power Research Institute (EPRI) issued its "PSA [Probabilistic Safety Assessment] Applications Guide" to provide utilities with guidance on the preparation, application, interpretation, and maintenance of plant-specific PRAs.[27]

The PSA Applications Guide introduced the term LERF and included the following definition for large early release:

- unscrubbed containment failure pathway of sufficient size to release the contents of the containment (i.e., one volume change) within 1 hour, which occurs before or within 4 hours of vessel breach; or

- unscrubbed containment bypass pathway occurring with core damage.

As part of NRC and industry initiatives to expand the use of PRA for operating reactors, the NRC provided draft RG 1.174 for Commission review in 1997.[28] The staff proposed using LERF and CDF in draft RG 1.174 as risk measures against which licensing-basis changes would be assessed instead of the QHOs themselves.

As discussed in SECY-97-077, the staff defined large early release as a significant unmitigated release from containment before effective evacuation of the close-in population such that there is a potential for prompt health effects. The staff proposed a LERF guideline of 10^{-5} per reactor

[23]"Interim Guidance on Staff Implementation of the Commission's Safety Goal Policy," SECY-91-270, dated August 27, 1991, and "Regulatory Analysis Guidelines for the U.S. Nuclear Regulatory Commission," SECY-93-043, dated February 22, 1993.
[24]SECY-90-016 and SECY-93-087.
[25]"SECY-93-138—Recommendation on Large Release Definition," SRM-SECY-93-138, dated June 10, 1993.
[26]"Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities," 60 FR 42622; dated August 16, 1995.
[27]"PSA Applications Guide," EPRI TR-105396, issued August 1995.
[28]"Draft Regulatory Guides, Standard Review Plans and NUREG Document in Support of Risk Informed Regulation for Power Reactors," SECY-97-077, dated April 8, 1997 (ADAMS Accession No. ML992920137).

year for use in evaluating proposed risk-informed licensing-basis changes (i.e., plants with a LERF greater than 10^{-5} per reactor year would be expected to propose changes that decrease LERF or are neutral). The staff noted that the LERF guideline of 10^{-5} per reactor year corresponds to that value, estimated from existing PRA results, necessary to ensure that the prompt fatality QHO would be met without undue conservatism. The staff also proposed a CDF guideline of 10^{-4} per reactor year for use in evaluating proposed risk-informed licensing-basis changes (i.e., plants with a CDF greater than 10^{-4} per reactor year would be expected to propose changes that decrease CDF or are neutral). The staff later demonstrated that a LERF of 10^{-5} per reactor year is an acceptable surrogate for the prompt fatality QHO and a CDF of 10^{-4} per reactor year is an acceptable surrogate for the cancer fatality QHO.[29] In demonstrating that a CDF of 10^{-4} per reactor year was an acceptable surrogate for the cancer fatality QHO, the staff assumed an open containment. In effect, this would be equivalent to assuming an LRF of 10^{-4} per reactor year as an acceptable surrogate for the cancer fatality QHO.

The staff's recommendation and Commission's approval to publish draft RG 1.174[30] resulted in the transition from LRF to LERF and CDF as surrogates for the two QHOs for operating reactors.

In 2000, the staff recommended possible modifications to the safety goal policy statement, including incorporating subsidiary goals of a LERF of less than 10^{-5} per reactor year and a CDF of less than 10^{-4} per reactor year and deleting reference to the general performance guideline of an LRF of less than 10^{-6} per reactor year.[31] The staff noted that LERF and CDF goals would provide practical implementation guidance for the QHOs consistent with current practice.

Regarding its recommendations to delete reference to LRF and apply subsidiary goals of LERF and CDF, the staff stated that current regulatory practice would not change, but the policy would then provide a better foundation for the subsidiary objectives currently used. The Commission approved the staff's recommendation to modify the safety goal policy statement to include the use of LERF and CDF as surrogates for the QHOs.[32]

The staff subsequently recommended to the Commission a modified version of the safety goal policy statement that included the specific changes regarding CDF, LERF, and LRF discussed above.[33] In its response, the Commission disapproved issuance of the revised safety goal policy statement.[34] Instead, the Commission directed the staff to consult with the Commission

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[29]Appendix D to NUREG-1860, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing," NUREG-1860, issued December 2007 (ADAMS Accession No. ML073400800).

[30]"Staff Requirements—SECY-97-077—Draft Regulatory Guides, Standard Review Plans and NUREG Document in Support of Risk Informed Regulation for Power Reactors," SRM-SECY-97-077, dated June 5, 1997 (ADAMS Accession No. ML003752391).

[31]"Modifications to the Reactor Safety Goal Policy Statement," SECY-00-0077, dated March 30, 2000 (ADAMS Accession No. ML003694247).

[32]"Staff Requirements—SECY-00-0077—Modifications to the Reactor Safety Goal Policy Statement," SRM-SECY-00-0077, dated June 27, 2000 (ADAMS Accession No. ML003727206).

[33]"Modified Reactor Safety Goal Policy Statement," SECY-01-0009, dated January 22, 2001 (ADAMS Accession No. ML003779058).

[34]"Staff Requirements—SECY-01-0009—Modified Reactor Safety Goal Policy Statement," SRM-SECY-01-0009, dated April 16, 2001 (ADAMS Accession No. ML011060125).

on a more significant revision to the safety goal policy statement in the future, when further progress had been made on the agency's risk-informed initiatives. As a result of that Commission decision, the safety goal policy statement has not changed since it was issued in 1986.

Continued Use of LRF

LRF continues to be a useful screening criterion for judging whether new reactor design certification applicants fulfill the Commission's expectations that new reactors have a higher standard of severe accident safety performance and increased margin before exceeding safety limits.[35] Providing features for enhanced containment performance has been a successful approach at the design stage. New reactor designs can credit this enhanced containment performance in demonstrating an LRF of less than 10^{-6} per reactor year.

Because the NRC did not define which releases would be considered "large," new reactor design certification applicants used definitions of large release that were more conservative than those the staff evaluated in its effort to define LRF. For example, the first three designs certified under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (i.e., Advanced Boiling-Water Reactor (ABWR), System 80+, and AP600[36]), used the definition for LRF proposed by EPRI.[37] Furthermore, General Electric stated in its ABWR design control document that no attempt was made to define the term large release, but the dose threshold selected by General Electric was considered to be much less than large, so the large release goal is satisfied. The staff found this approach to addressing large release acceptable in these design certification reviews.

Requiring the Use of LRF for All Operating Reactors

In addition to directing the staff to provide a history of LRF, in its SRM on SECY-12-0081, the Commission directed the staff to provide pros and cons of requiring the use of LRF, possibly in addition to LERF, for all operating reactors. The staff considered such a guideline in the context of the safety goal policy statement.[38]

[35]"Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants" and "Policy Statement on the Regulation of Advanced Reactors."

[36]The NRC certified ABWR, System 80+, and AP600 on June 11, 1997, June 20, 1997, and January 24, 2000, respectively.

[37]"Advanced Light Water Reactor Utility Requirements Document," TR-016780, issued March 1999. EPRI defined LRF as the cumulative frequency of all sequences with a dose greater than 25 rem whole body at a distance of a half mile from the reactor assuming exposure to the plume for the first 24 hours after core damage begins.

[38]Potential additional requirements related to economic consequences were considered in a separate effort. "Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission's Regulatory Framework," SECY-12-0110, dated August 14, 2012 (ADAMS Accession No. ML12173A478).

Advantages of Implementing an LRF Guideline

- An LRF guideline could provide the NRC with an additional means of judging the overall performance of containment systems for operating reactors.

- Use of LRF would communicate more clearly an expectation regarding containment performance—in effect, that releases above a certain magnitude should be avoided regardless of their timing.

Disadvantages of Implementing an LRF Guideline

- One previous function of LRF was to determine whether a level of safety ascribed to a plant is consistent with the safety goal policy. LERF and CDF guidelines today fulfill this function for operating reactors. The LERF guideline of 10^{-5} per reactor year has been shown to be an appropriate surrogate for the prompt fatality QHO. The CDF guideline of 10^{-4} per reactor year has been shown to be an appropriate surrogate for the cancer fatality QHO.[39] An LRF guideline used as a surrogate for the QHOs would be redundant.

- Without additional Commission guidance, the staff would face the same technical and policy challenges as in the original attempt to define a large release and to integrate it into NRC regulatory decisionmaking. For example, application of an LRF guideline at 10^{-6} per reactor year would be considerably more conservative than either of the two QHOs, which is inconsistent with previous Commission guidance not to create a de facto new safety goal. Implementation of an LRF guideline at 10^{-5} per reactor year would be consistent with the current LERF guideline but would still be considerably more conservative than the cancer fatality QHO.

- There are currently no regulatory requirements for operating reactors to develop or maintain a PRA, though new reactors are bound by such requirements in 10 CFR 50.71(h). Instead, operating reactor licensees use PRA in voluntary risk-informed applications such as requests for licensing-basis changes guided by RG 1.174. Implementing a requirement for operating reactors related to PRA, and specifically to require LRF, would be a fundamental departure from the previous regulatory approach.

- To implement an LRF guideline, the staff would need to revise not only RG 1.174, but also other risk-informed regulatory guides, inspection guidance, and standard review plan sections. Industry standards, or at least the NRC's endorsement thereof, would also need revision. Such changes to the risk-informed regulatory approach would undermine the regulatory stability achieved in this area over the past two decades, as well as requiring significant staff and industry resources.

[39]Ongoing staff efforts to develop a full-scope site Level 3 PRA will provide additional insights into the use of LERF and CDF as surrogates for the QHOs. "Update on Staff Plans to Apply the Full-Scope Site Level 3 PRA Project Results to the NRC's Regulatory Framework," SECY-12-0123, dated September 13, 2012 (ADAMS Accession No. ML12202B170).

Use of LRF for new reactors has evolved to be a concept that is useful for reviewing design certification applications. The staff plans to continue to use an LRF as a screening criterion to inform the staff whether new reactor design applicants are meeting the Commission's expectations for a higher standard of severe accident safety performance and increased margin before exceeding safety limits.

COORDINATION:

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

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