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UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Status of Staff Efforts to Develop SECY that provides History of LRF and Staff's Views regarding Pros and Cons of Requiring LRF for all Operating Reactors

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Public Teleconference on Risk-Related Topics for New Reactors
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Background

- New reactors' lower risk estimates raised questions on how to apply operating reactor risk acceptance guidelines for licensing basis changes and the Reactor Oversight Process (SECY-10-0121)
  - Adequacy of new reactor designs confirmed by comparing against LRF of 10^{-6}/RY for design certification
  - Operating reactor risk acceptance guidelines based on LERF of 10^{-5}/RY
- Staff performed tabletop exercises to test various realistic performance deficiencies, events, modifications, and licensing basis changes against current NRC policy – per SRM-SECY-10-0121
- Staff did not identify potentially significant decreases in the enhanced safety margins for new reactors that would be caused by using the current operating reactor guidelines (SECY-12-0081)
- Staff recommended transitioning from LRF to LERF at or before initial fuel load (SECY-12-0081)

SRM-SECY-12-0081 dated October 22, 2012

- SRM approved transitioning from LRF to LERF at or before initial fuel load
- SRM requested an information paper that:
  - reviews the history of NRC's use and consideration of LRF
  - provides the staff's views regarding the pros and cons of requiring the use of LRF, possibly in addition to LERF, for all operating reactors
- Information paper due to Commission on March 22, 2013

Summary of Draft SECY

- History of NRC's use and consideration of LRF
  - Original intent of LRF was to be a surrogate for the two QHOs from the Safety Goal Policy Statement
  - Prompt fatality QHO is more limiting than the cancer fatality QHO
  - Staff effort to develop a definition of LRF focused on LRF being a surrogate for prompt fatality QHO
  - Currently, LERF is used as a surrogate for the prompt fatality QHO for operating reactors
  - In effect, both LRF and LERF served the same purpose (i.e., surrogate for the prompt fatality QHO)
- As a surrogate for the prompt fatality QHO, the original intent of using LRF for operating reactors is already being met

History of LRF

- **Safety Goal Policy Statement (1986)**
  - Defined an acceptable level of risk
    - Specified qualitative safety goals
    - Specified QHOs
    - Noted that prompt fatality QHO is more limiting than cancer fatality QHO
  - Discussed need for specific guidelines to use as basis for determining whether a level of safety ascribed to a plant is consistent with the safety goal policy
    - Stated that guidance would be based on the following general performance guideline which is proposed for further staff examination: LRF < 10^{-6}/RY

History of LRF (cont.)

- **Staff memo to Commission on safety goal implementation (January 1987)**
  - Large release definition should be reasonably consistent with QHOs
  - Recommended an approach to define the aggregate prompt fatality health effects from all large releases
- **ACRS letter (May 1987)**
  - Recommended a hierarchical structure of subsidiary safety goals
  - Each subordinate level in the hierarchy should be consistent with the level above, but should not be so conservative that it creates a *de facto* new safety goal
- **Commission SRM (November 1987)**
  - Supported ACRS recommendations
  - Reiterated that subordinate levels should not create *de facto* new safety goals

History of LRF (cont.)

- **SECY-89-102 (March 1989)**
  - Proposed hierarchy of objectives
    - Level 1 – qualitative safety goals
    - Level 2 – QHOs
    - Level 3 – LRF
    - Level 4 – CDF
  - Recommended developing large release definition where large release is defined as one that has potential for causing an offsite early fatality (surrogate for the prompt fatality QHO)
    - LRF < 10^{-6}/RY is inherently more conservative than the QHOs
    - Prompt fatality QHO is the more controlling objective of the QHOs

History of LRF (cont.)

- **SRM-SECY-89-102 (June 1990)**
  - Directed staff to evaluate and advise the Commission whether a general performance objective that focuses on release and eliminates site characteristics could be developed and how it would be useful
  - Acknowledged that LRF was within an order of magnitude more conservative than the QHO and provides a simple goal that has generally been accepted
  - Directed staff to formulate a new definition for large release consistent with this approach

History of LRF (cont.)

- **SECY-90-405 (December 1990)**
  - Provided two options and recommended the second option
    - A release from an event involving severe core damage, RCS failure, and early failure or significant bypass of containment
    - A release of radioactivity of a magnitude equal to or greater than: (An amount, to be determined by the staff, expressed in curies or fraction of core inventory, which has the potential based on representative site characteristics to cause one or more prompt fatalities)
- **SRM-SECY-90-405 (March 1991)**
  - Approved staff's recommendation
  - Reiterated the following guidelines for subordinate levels of the safety goal hierarchy
    - 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 objectives are being met

History of LRF (cont.)

- **SECY-93-138 (May 1993)**
  - Documented staff effort to define LRF
  - Recommended terminating effort to define LRF
    - Given a LRF of 10^{-6}/RY, any large release definition would result in a degree of conservatism several orders of magnitude more conservative than the QHOs resulting in a *de facto* new safety goal
  - Recommended instead using guidance developed in parallel with effort to define LRF
    - Operating reactors – framework for regulatory decision making using CDF and CCFP as subsidiary safety goal objectives (SECY-91-270, SECY-93-043)
    - New reactors – CDF, CCFP, deterministic containment performance criteria (SECY-90-016, SECY-93-087)
- **SRM-SECY-93-138 (June 1993)**
  - Approved terminating staff effort to define LRF

Transition to LERF

- **EPRI *PSA Applications Guide* (August 1995)**
  - First use staff found of LERF
  - Qualitative definition of LERF
    - Unscrubbed containment failure pathway of sufficient size to release the contents of the containment (i.e., one volume change) within one hour, which occurs before or within 4 hours of vessel breach
    - Unscrubbed containment bypass pathway occurring with core damage

Transition to LERF (cont.)

- **SECY-97-077 (April 1997)** forwarded draft Regulatory Guide 1.174 for Commission review
  - Proposed using CDF and LERF as risk measures against which licensing-basis changes will be assessed in lieu of the QHOs themselves
    - Defined LERF as a significant unmitigated release from containment prior to effective evacuation of the close-in population such that there is a potential for early health effects
    - Noted that LERF of 10^{-5}/RY corresponds to that value, estimated from existing PRA results, necessary to ensure the prompt fatality QHO is met without undue conservatism
  - Although not discussed in SECY-97-077, NUREG-1860, Appendix D, later confirmed that CDF of 10^{-4}/RY is an acceptable surrogate for the latent cancer QHO
- The staff's recommendation and Commission's approval to publish draft Regulatory Guide 1.174, in effect, transitioned from LRF to LERF as surrogate for prompt fatality QHO for operating reactors

Transition to LERF (cont.)

- **SECY-00-0077 (March 2000)** recommended and Commission later approved changes to the safety goal policy statement
  - Deleting reference to general performance guideline of LRF < 10^{-6}/RY
  - Incorporating a subsidiary goal of LERF < 10^{-5}/RY
- **SECY-01-0009 (January 2001)** subsequently provided a modified safety goal policy statement incorporating these changes
- **SRM-SECY-01-0009 (April 2001)** deferred issuing the modified statement until further progress is made on the agency's risk-informed initiatives

Continued use of LRF

- Because NRC did not define “large” within the context of LRF, the definition was left open to interpretation
- New reactor applicants used definitions of LRF more conservative than the original intent of LRF (i.e., surrogate for the two QHOs)
  - For example, the first three designs that were certified (ABWR, System 80+, and AP600) used the definition of LRF proposed in EPRI’s *Advanced Light Water Reactor Utility Requirements Document*
    - Cumulative frequency of all sequences with a dose greater than 25 rem whole body at a distance of a half mile from the reactor for 24 hours after the start of core damage

Continued use of LRF (cont.)

- LRF continues to be a useful metric for judging whether new reactor design applicants fulfill the Commission's expectations that their designs:
  - "achieve a higher standard of severe accident safety performance than their prior designs"
  - have increased margin prior to exceeding safety limits through enhancements such as severe accident mitigation features and diverse and simplified systems

Abbreviations

CCFP	conditional containment failure probability
CDF	core damage frequency
LERF	large early release frequency
LRF	large release frequency
QHO	quantitative health objective
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
RCS	reactor coolant system
RY	reactor year