

## Some Thoughts on Safety Goals

**George Apostolakis**

**Former Commissioner, NRC**

**Former Member, ACRS**

**Director, Nuclear Risk Research Center**

**[apostola@mit.edu](mailto:apostola@mit.edu)**

**<http://criepi.denken.or.jp/en/nrrc/index.html>**

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## Changes over the years

**“safety goals are intended to be applied generically and are not for plant specific applications.”**

(Commission’s Policy Statement, 1995)

- Individual plant CDF and LERF are compared to the goals routinely.
- Informal upper limits are implemented.
  - CDFs greater than  $10^{-3}$  per ry prompt immediate action.

## Multi-Unit and Adjacent Sites

- **U.S.A.**
  - **Currently at most 3 units**
  - **Plant Vogtle will have 4**
  - **Geographically adjacent sites: Salem 1&2 (PWRs) and Hope Creek (BWRs 3 total, PSEG); Nine Mile Point 1&2 (BWRs Constellation Energy) and FitzPatrick (BWRs Entergy 3 total)**
- **Canada**
  - **Bruce Power: 8 units**
- **Japan**
  - **Kashiwazaki-Kariwa: 7 units**

## **Whole-Site Risk: Early Consideration**

- **In the early 1980s, the NRC staff proposed that Safety Goals be applied on a per-site basis**
- **Commission decided not to impose a “bias” against multi-unit sites**
- **Quantitative Health Objectives (NRC) are now interpreted on a per-reactor basis**

## How stable should the QHOs be?

- **The QHOs are a commitment to society.**
- **As such, they should be revised only when there is compelling evidence that they should be.**
- **One could argue that the Fukushima accident did not violate the NRC's QHOs.**
- **Is this a valid comparison?**
- **A Level 3 PRA prior to the accident would probably have shown that the goals were not met.**
- **There had been serious warnings that the tsunami height had been underestimated.**

## Some Proposals

- **“Our results suggest that the number of people relocated is a good proxy for societal disruption, and relatively straightforward to calculate.”** (Bier et al, PSAM 12, 2014)
- **“There should be no significant likelihood that a largescale, long-term evacuation will be needed as a result of a nuclear power plant accident.”** (Mubayi Youngblood, Nuclear Technology, 2021)

## **CNSC Technical Safety Objectives for New Plants**

- **Likelihood of accidents with serious radiological consequences should be extremely low.**
- **Potential radiological consequences from severe accidents limited to as far as practicable.**

Greg Rzentkowski, Presentation at 34th Annual Conference of Canadian Nuclear Society, Toronto, June 9-12, 2013

## CNSC Proposed Quantitative Safety Metrics for New Plants

- Frequency of severe core degradation (SCDF)  $< 10^{-5}$  per reactor year
- Frequency of release of  $10^{15}$  Bq of I-131 triggering evacuation  $< 10^{-5}$  per reactor year
- Frequency of release of  $10^{14}$  Bq of Cs-137 triggering long-term relocation  $< 10^{-6}$  per reactor year

**SCDF** “... the effects of adjacent units at multi-unit stations are considered and accounted for when calculating the Safety Goals for internal events sequences at the representative unit (generally, the lead unit).”

**LRF** “The assessment is done per reactor year with due account of the effects of adjacent units at multi-unit stations”

G. Rzentkowski, Y. Akl, and S. Yalaoui, Application of Probabilistic Safety Goals to Regulation of Nuclear Power Plants in Canada.



## ACRS Letter, April 2004 (1)

- **The Quantitative Health Objectives (QHOs) apply to the site as a whole. The sum of the contributions from each reactor on the site to acute and latent fatalities should be bounded by the QHOs.**
- **The Committee has not reached consensus on the approach that should be taken to determine the core damage frequency (CDF) goal. Two views are presented in the discussion below.**

## ACRS Letter, April 2004 (2)

- **Option 1**

- The site goal (e.g.,  $10^{-4}$  per ry) is divided by the number of units at the site.
- The risk from and the likelihood of a core damage accident at all sites cannot be precisely equal. However, there is the expectation that they be comparable.

- **Option 2**

- CDF is an accident prevention goal and its value should be the same for each reactor at every site.
- Requiring each module to have a CDF value given by the overall CDF goal divided by the number of modules introduces a new Safety Goal concept, a site CDF. Such a concept was never intended to be part of the Safety Goals.

## Part 53 Metrics

- **The total frequency of exceeding a site boundary dose of 100 millirem (mrem) from all LBEs shall not exceed 1/plant-year.**
- **The average individual risk of early fatality within 1 mile of the exclusion area boundary from all LBEs shall not exceed  $5 \times 10^{-7}$ /plant-year.**
- **The average individual risk of latent cancer fatalities within 10 miles of the exclusion area boundary from all LBEs shall not exceed  $2 \times 10^{-6}$ /plant-year.**

## NEI (Nov. 5, 2021)

- **it is unclear why the NRC believes the QHOs must be in the rule at all, rather than relying on the long-standing implementation of QHOs through the NRC's Safety Goal Policy.**
- **If the QHOs are in the rule, they must be met for legal compliance, and since the PRA is the basis for meeting the QHOs, more, if not all, of the PRA will need to be submitted on the docket and would be subject to contention.**
- **It is recognized that regardless of whether the QHOs are in the Safety Goal Policy or Rule Language, the design, analysis, and licensing approach that would be taken by an applicant, and the NRC scope of review would be the same.**

## NEI (Nov. 5, 2021)

- **There is at least one member of industry that believes QHOs must be in the rule to provide regulatory predictability by avoiding the need to develop surrogate metrics for the QHOs.**
- **Therefore, more discussion on the benefits and disadvantages of the options of how to address QHOs in a way that achieves both predictability and flexibility would be beneficial.**

## PRA

- **If applicable, the PRA should include event sequences involving two or more reactor modules as well as two or more sources of radioactive material, which could include waste processing and storage systems. (NRC staff)**
- **A standard exists: ASME/ANS RA-S-1.4-2021, Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants**

## NRC Staff (1)

- **Risk-informed performance standards, including the QHOs, provide a fixed cumulative risk standard for licensing events ranging from anticipated event sequences to very unlikely event sequences.**
- **Without these cumulative risk standards in Framework A, including the QHOs, there would be no equivalent to the collective effects of the prescriptive requirements in Parts 50 and 52 that provide reasonable assurance of adequate protection of public health and safety.**

## NRC Staff (2)

- **compliance with the existing totality of NRC (prescriptive) regulations provides reasonable assurance that adequate protection is maintained.**
- **Framework A proposes to support the adequate protection finding with a collective set of function-oriented and performance-based requirements. These requirements are intended to ensure that the proposed new regulations provide a level of safety comparable to that required by the existing regulations in Parts 50 and 52.**



## NEI 21-07, Rev. 1, February 2022

- **The PRA information included in Chapter 2 of the SAR should be at a summary level only as described below. It should address the requirement in 10 CFR Part 52 that the SAR includes a description of the PRA and its results.**
- **The applicant maintains complete PRA documentation in its plant records.**
- **The supporting methods, data, and detailed information used in the PRA will not be included in the SAR but will be available for NRC audit.**

## Conclusions

- **The issue of major societal disruption should be investigated further for possible inclusion in the safety goals. Comparisons with Fukushima should be reevaluated.**
- **The QHOs should be included in Part 53.**
- **Doing a credible PRA for all sources of radioactivity at the site will be challenging, even with the existence of the JCNRM Standard.**
- **The NRC staff should provide additional help perhaps using insights from the PRA Level 3 project.**
- **The license application should include a PRA summary and insights only. PRA details should be available to the NRC staff,**

