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United States Nuclear Regulatory Commission

Protecting People and the Environment

Performance-Based Approach for Licensing (an Adequate Protection Perspective)

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Key Messages

- A *performance-based* perspective is a proposed approach that establishes performance and results as the primary bases for meeting regulatory requirements, especially for new designs
  - To provide flexibility to determine how to meet the established performance criteria
  - Should address requirements holistically, NOT in isolation
  - **Guidance is one acceptable way to meet regulations, but not the only way**
    - Performance-Based Perspective can be used within existing guidance, or
    - To augment, supplement, or justify deviations from existing guidance
- Write application (e.g., PSAR for CP) from a Performance-Based Perspective
  - Three Key Levels (a layered approach to SAR development)
    - Performance Goals
    - Functions, Values, and Analyses to demonstrate Performance Goals are achieved
    - Description of Equipment and why it will perform as analyzed and not introduce new problems

Performance-Based vs. Compliance-Based Approach

- Compliance-Based Safety Analysis
  - Regulatory authority identifies acceptable way(s) to meet regulatory requirements and/or guidance
  - Applicant commits to following appropriate/applicable guidance
  - Regulatory reviewers evaluate application
  - Meeting the guidance, generally implies acceptance

- Performance-Based Safety Analysis
  - **Establish goals**
    - That, if accomplished, provides reasonable assurance of adequate safety
  - **Describe how goals are achieved (i.e., what is done in terms of functions and values)**
    - Usually supported by analyses in accordance with accepted practices
  - **Explain why the "how" is adequate**
  - **Ensure facility is constructed and operated accordingly**

Vision for Performance-Based Licensing

- Follow Performance-Based Regulatory Requirements for Licensing
  - 10 CFR 50.34(a)(2) – facility description and principal safety considerations
  - 10 CFR 50.34(a)(3)(i) – principal design criteria of the facility
  - 10 CFR 50.34(a)(3)(ii) – design bases and relation to principal design criteria
  - 10 CFR 50.34(a)(3)(iii) – design performs in accordance with design bases
- Document a performance-based approach is in SAR
- Operate the facility in accordance with the performance-based SAR

To ensure safety, one needs to identify the threats to safety.

§ 50.34 Contents of applications; technical information.
(a) Preliminary safety analysis report. …The minimum information to be included shall consist of the following:…

(a)(2) A summary description and discussion of the facility, with special attention to design and operating characteristics, unusual or novel design features, and principal safety considerations.

NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing…"

- Part 1 Section 1.2, "Summary and Conclusions on Principal Safety Considerations"
- Part 2 Section 1.2, "Summary and Conclusions on Principal Safety Considerations"

What performance goals would ensure safety?

§ 50.34(a)(3) The preliminary design of the facility including:

- (i) The principal design criteria for the facility. Appendix A, General Design Criteria … provides guidance to applicants for construction permits in establishing principal design criteria for other types of nuclear power units;

§ 50 Appendix A to Part 50—General Design Criteria for Nuclear Power Plants

- "The principal design criteria establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety; that is, structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public."

What functions and values ensure the performance goals are met?

- § 50.34(a)(3) The preliminary design of the facility including:…
  - (ii) The design bases and the relation of the design bases to the principal design criteria;
- § 50.2 Definitions.
  - Design bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted "state of the art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.
- § 50.59 Changes, tests and experiments.
  - (a)(1) Change means a modification or addition to, or removal from, the facility or procedures that affects a design function, method of performing or controlling the function, or an evaluation that demonstrates that intended functions will be accomplished.

Why do we have confidence that the equipment will perform the required functions?

§ 50.34 (a)(3) The preliminary design of the facility including:…

- (iii) Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety.

The application proposes how the facility will be designed, maintained, and operated (its not just regulatory burden).

§ 50.57 Issuance of operating license.

(a) …an operating license may be issued by the Commission…upon finding that:

- (1) Construction of the facility has been substantially completed, in conformity with the construction permit and the application as amended…
- (2) The facility will operate in conformity with the application as amended…

Performance-Based Approach Example
Ramp Reactivity Insertion

- **Facility Description:** Pool reactor with low enriched uranium fuel
- **Principal Safety Considerations:** Release radioactive materials to the unrestricted area
- **Principle Design Criteria (should be performance goals)**:
  - Design limits ensure: (1) no fuel melting, and (2) no cladding degradation
  - Neither normal operation nor hypothetical operational occurrences would cause design limits to be exceeded

Performance-Based Approach Example
Ramp Reactivity Insertion

Design Bases (functions and values):

Characterize hypothetical operational occurrences, e.g., ramp insertion from uncontrolled rod withdrawal

- —Assume a rate of reactivity insertion, e.g., based on rod worth and maximum rate of withdrawal
- —Use a method to identify that a ramp reactivity insertion event has occurred, e.g., via a measurement of high flux (or short period)
- —Use method(s) to address the occurrence, e.g., scram the reactor
- —Use an acceptable method of analysis to determine process parameters during and after occurrence, and demonstrate that the design bases will provide reasonable assurance of adequate safety

Performance-Based Approach Example
Ramp Reactivity Insertion

Describe Equipment & how it accomplishes the design bases, e.g., specify:

- Maximum control rod worth (e.g., TS limit)
- Control rod motor performance to limit maximum rate of rod withdrawal (SAR)
- Equipment to detect flux level (or period) to initiate scram (SAR Chapter 7)
- Control rod drop time (e.g., TS limit)

Challenges to applying the performance-based approach

- Focus on compliance and regulatory basis
- Lack of discussions about the change and why it is safe (too much focus on whether the guidance was followed)

Regulators can only use available means – Regulation

- Regulatory Requirements (e.g., conditions of license)
- Application, can be:
  - Compliance based (e.g., "The TS for experiments are in accordance with RG 2.2.")
  - Performance-based (e.g., safety is demonstrated in a layered approach)
- Guidance
  - Inherently compliance based (i.e., RG 2.2, "TS for experiments…")

Summary

- Generally, there is a safety-based reason for each GDC.
- Not all safety concerns are address by the GDC (e.g., chemical)
- For each underlying safety concern or "hazard and events",
  - Determine whether that concern exists for your facility
  - Determine what performance goals you want to have to address it
  - Determine what functions and values are needed to achieve goals
  - Ensure equipment will perform needed functions

Questions?