NRC Regulatory Framework Panel: Design Basis and Beyond

Discussion of the NRC's Evaluation of Changes to the Regulatory Framework

NEI
NUCLEAR ENERGY INSTITUTE

Gary Holahan
Deputy Director, Office of New Reactors
Geary Mizuno
Special Counsel, Office of the General Counsel
U.S. Nuclear Regulatory Commission
Tony Pietrangelo
Sr. Vice President and Chief Nuclear Officer
Nuclear Energy Institute
Steve Frantz, Esq.
Partner
Morgan Lewis & Bockius
Jason Zorn, Esq.
Assistant General Counsel
Nuclear Energy Institute

NEI
NUCLEAR ENERGY INSTITUTE

Agenda

- Introduction/Background
- Current NRC Regulatory Framework
- Panel Presentations
- Panel Discussion
- Audience Questions

Background

Jason Zorn
Assistant General Counsel
Nuclear Energy Institute

NEI
NUCLEAR ENERGY INSTITUTE

Near-Term Task Force

- NRC establishes Fukushima Near-Term Task Force on March 23, 2011
  - "Senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction."
- Report to the Commission in 90 Days

Task Force Direction

- Commission Direction (March 23, 2011)
  - "Evaluate all technical and policy issues related to the event to identify…adjustments to the regulatory framework that should be conducted by the NRC."
- Task Force Charter (March 30, 2011)
  - Develop recommendations, as appropriate, for potential changes to NRC's regulatory requirements, programs, and processes, and recommend whether generic communications, orders, or other regulatory actions are needed.

NTTF Report: "Recommendations for Enhancing Reactor Safety in the 21st Century"

- Issued July 12, 2011 (SECY-11-0093)
- 12 Overall Recommendations
- Recommendation 1: The Task Force recommends establishing a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations.

Task Force Observations

- Current Framework:
  - "The current regulatory approach has served the Commission and the public well…"
  - "The Commission has come to rely on design-basis requirements and a patchwork of beyond-design-basis requirements and voluntary initiatives for maintaining safety."
- Future Framework:
  - "This framework … would provide a more coherent structure within the regulations to facilitate Commission decisions relating to what issues should be subject to NRC requirements and what those requirements ought to be."

Commission Direction (SRM-SECY-11-0097) (August 19, 2011)

- "Recommendation 1 should be pursued independent of any activities associated with the review of the other Task Force recommendations. Therefore, the staff should provide the Commission with a separate notation vote paper within 18 months of the issuance of this SRM. This notation vote paper should provide options and a staff recommendation to disposition this Task Force recommendation."

Recommendation 1 Working Group

- Three draft papers published: November 2, 2012, February 26, 2013, and May 14, 2013
- Three public meetings
- Comment period on latest draft ends August 15
- Two NEI comment letters (December and April)
- Commission paper due December 2013

Improvement Activities

- Improvement Activity 1: Establish "design basis extension" category of events
- Improvement Activity 2: Develop Commission policy statement on the use of defense-in-depth
- Improvement Activity 3: Develop Commission policy statement or guidance on regulation of voluntary industry initiatives that the staff believes are "important from both safety and regulatory perspectives, but do not themselves constitute matters of adequate protection."

Improvement Activity 1

- Establish new term “design basis extension” to replace “beyond design basis”
- Generically applicable (no site-specific PRAs)
- Prospective only
- No rulemaking – changes to internal policies, guidance, and procedures
- Adequate protection or cost-justified substantial safety enhancement
- Treatment requirements for DBEs
- All changes could be achieved in 2-4 years

NEI
NUCLEAR ENERGY INSTITUTE

Notable Staff Positions

- Acceptable from a safety standpoint to maintain existing regulatory processes, policy and framework
- Status quo is not a “do nothing” approach
  - E.g. Regulatory analysis guidelines modifications, establishing regulatory footprint over severe accidents.
- Staff expressed concerns with the cost-effectiveness of the approaches suggested by the NTTF and RMTF
  - Site specific PRAs “would not provide benefits commensurate with the substantial costs of developing” PRAs
- All activities prospective and generic

NEI
NUCLEAR ENERGY INSTITUTE

Morgan Lewis

NRC's Regulatory Treatment of Design Basis and Beyond Design Basis Events

NEI Lawyers Committee Meeting (June 20, 2013)

Steve Frantz

Issues

- Design Bases
- Design Basis Events (DBEs)
- Beyond Design Basis Events (BDBEs)
- Comparison of DBEs and BDBEs

Design Bases

- "Design Bases" is different from "Design Basis Event"
- 10 CFR 50.34 requires the Final Safety Analysis Report (FSAR) to identify the "design bases" of the facility
- 10 CFR 50.2 defines "design bases" as:

  > "the specific functions to be performed by a structure, system, or component [SSC] of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design."

- This definition applies to SSCs that protect against BDBEs as well as DBEs
  - Even severe accident features have design bases

Design Bases

- There are numerous documents that identify the content of the design bases; e.g.:
  - NEI 97-04, Design Bases Program Guidelines (Rev. 1, Feb. 2001)
  - Regulatory Guide 1.186, Guidance and Examples for Identifying 10 CFR 50.2 Design Bases (Dec. 2000)
  - SECY-00-0212, Regulatory Guide Providing Guidance and Examples for Identifying 10 CFR 50.2 Design Bases (Oct. 25, 2000)

Design Basis Events

- 10 CFR Part 50 does not define the term “design basis event” or “design basis accident”
- NRC regulations seldom use those terms
- NRC regulations do not list design basis events
- A definition of “design basis events” is provided in SRP Section 15.0:

> Conditions of normal operation, including AOOs [Anticipated Operation Occurrences], design-basis accidents, external events, and natural phenomena, for which the plant must be designed to ensure functions of safety-related . . . equipment.

Design Basis Events

- AOOs mean those conditions of normal operation which are expected to occur one or more times during the life of the nuclear power unit
  - Probability of about 10E-2/per year or greater
- Design basis accidents (DBAs) are postulated accidents that are not expected to occur during the lifetime of the plant
  - SECY-05-0006 proposed that DBAs have a probability of less than 10E-2/per year and greater than 10E-5/per year
  - DBAs are used to set the design criteria and limits for the design and sizing of safety-related SSCs

Design Basis Events

- Natural phenomena – General Design Criterion (GDC) 2
  - SSCs important to safety shall be designed to withstand the effects of natural phenomena without loss of capability to perform their safety functions
  - Design must consider appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena

Attributes of Design Basis Events

- In general, a design basis event has the following attributes:
  - Postulated initiating event (e.g., LOCA)
  - A single failure of an active component (See GDC 17, 21, 34, 35, 38, 41, and GDC 44
  - Loss of Offsite Power (See GDC 17)
  - Consequential failures (Part 50, Appendix A)
  - Credit is only given to safety-related SSCs

Attributes of Design Basis Events

- SRP Section 15.0 states that DBEs can be grouped into seven types:
  - (1) Increase in heat removal by the secondary system;
  - (2) Decrease in heat removal by the secondary system;
  - (3) Decrease in Reactor Coolant System (RCS) flow rate;
  - (4) Reactivity and power distribution anomalies;
  - (5) Increase in reactor coolant inventory;
  - (6) Decrease in reactor coolant inventory; and
  - (7) Radioactive release from a subsystem or component

Attributes of Design Basis Events

- SRP Section 15.0 provides the following acceptance criteria for AOOs:
  - Pressure in the RCS and main steam systems should be maintained below 110% of ASME design values
  - Fuel cladding integrity shall be maintained
  - There is no possibility of initiating a postulated accident with the frequency of occurrence of an AOO
  - An AOO should not:
    - generate a postulated accident without other faults occurring independently, or
    - result in a consequential loss of function of the RCS or reactor containment barriers

Attributes of Design Basis Events

- SRP Section 15.0 provides the following acceptance criteria for DBAs:
  - Pressure in the RCS and main steam system should be maintained below acceptable design limits
  - Fuel cladding integrity will be maintained
  - The release of radioactive material shall not result in offsite doses in excess of the guidelines of 10 CFR Part 100
  - A postulated accident shall not, by itself, cause a consequential loss of required functions of systems needed to cope with the fault, including those of the RCS and the reactor containment system

Beyond Design Basis Events

- Regulations do not define BDBEs
- Conceptually, BDBEs consist of two types of events:

  (1) severe accidents involving substantial core damage and release of radionuclides to the containment; and

  (2) events that involve assumptions that exceed those associated with DBEs (e.g., multiple independent failures)

  - » Station Blackout (SBO), which entails failures of multiple emergency diesel generators
  - » Anticipated Transient without Scram (ATWS), which entails multiple failures of the reactor protection system or control rod system
- BDBEs typically represent events with a frequency lower than design basis events
  - SECY-05-0006 proposed that beyond design basis accidents have a frequency between 10^{-5} and 10^{-7}/reactor year

Beyond Design Basis Events

- Examples of BDBEs in NRC regulations
  - Hydrogen control (10 CFR § 50.44);
  - SBO (10 CFR § 50.63)
  - ATWS (10 CFR § 50.62)
  - Loss of large areas of the plant due to fires and explosions (10 CFR § 50.54(hh)(2))
  - Protection against aircraft impacts (10 CFR § 50.150)
  - Severe accident features for challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass (10 CFR § 52.47(a)(23)
- Requirements for Individual Plant Examinations (IPE) and Probabilistic Risk Assessment (PRA)

Beyond Design Basis Events

- Fukushima Orders
  - FLEX to deal with extended loss of power
  - Venting of containment
  - Spent fuel pool instrumentation

Special Cases

- Containment
  - Postulate core damage
  - Required to meet other criteria for DBAs
- Fire Protection
  - Fires are not a design basis event
  - Frequent occurrence - - much more frequent than BDBEs
  - One train of safe shutdown equipment free of fire damage
  - Fire protection equipment
    - Generally need not be single failure proof
    - Fire water systems must withstand seismic events, especially in high seismic areas
    - Many quality assurance (QA) criteria are applicable

Comparison of DBEs and BDBEs

- Requirements for DBEs have largely been in place since 1970
  - DBEs essentially use uniform assumptions
- Requirements for BDBEs have developed incrementally, mostly following the TMI accident in 1979
  - Assumptions for BDBEs tend to vary from event to event

Comparison of DBEs and BDBEs

	Design Basis Events	Beyond Design Basis Events
Primary Source of Requirements	General Design Criteria in Appendix A to 10 CFR Part 50	Varies, *e.g.*, 10 CFR §§ 50.44, 50.54(hh)(2), 50.62, 50.63, 52.79(a)(38), 52.79(a)(46), 50.150 *See also* Policy Statement on Safety Goals; SECY 93-087 for new plants.
Location of Analysis of Events in FSAR	Chapter 15	Primarily in Chapter 19 for new plants Other FSAR chapters as applicable
Goal	*See* SRP Acceptance Criteria for AOOs and DBAs	Varies, depending upon the event

Comparison of DBEs and BDBEs

	Design Basis Events	Beyond Design Basis Events
General Analytical Assumptions	Deterministic	Varies; e.g., Deterministic, Performance Based, Probabilistic
General Analytical Assumptions	Conservative	Realistic
General Failure Assumptions	Single Failure Loss of Offsite Power No credit for non-safety systems	None beyond the initiating event itself

Comparison of DBEs and BDBEs

	Design Basis Events	Beyond Design Basis Events
Reliance on Non-Safety Systems	No	Yes
Classification of Components that Prevent or Mitigate Event	Safety-Related Quality-Related Seismic Category I Environmental Qualification (EQ)	Generally none Some components designed to withstand Safe Shutdown Earthquake Some EQ requirements in SECY 93-087
Protection of Components against Natural Phenomena	Yes	None beyond normal building codes (some exceptions)

Comparison of DBEs and BDBEs

	Design Basis Events	Beyond Design Basis Events
Treatment of Systems in Technical Specifications	Yes	Yes, if safety or risk significant
Special Treatment	Quality Assurance per Appendix B to 10 CFR Part 50 Maintenance Rule Inservice Testing and Inspection	Subset of Appendix B in some cases Maintenance Rule if component/system is safety significant Regulatory Treatment of Non-Safety Systems (RTNSS) for passive plants

Conclusions

- NRC has requirements for both DBEs and BDBEs
- Requirements for DBEs are uniform
- Requirements for BDBEs are appropriately tailored to the event
  - Specific requirements for particular types of events
  - IPEs and PRAs provide for comprehensive evaluation of low probability BDBEs

Panel Presentations

Near-Term Task Force Perspective

Gary Holahan
Deputy Director
Office of New Reactors
U.S. NRC

A Regulator's Legal Perspective

Geary Mizuno
Special Counsel, U.S. NRC

NTTF Recommendation 1

(from *Recommendations for Enhancing Reactor Safety in the 21st Century*)

The Task Force recommends establishing a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations.

The Task Force recommends that the Commission direct the staff to initiate action to enhance the NRC regulatory framework to encompass beyond-design-basis events and their oversight through the following steps:

1.1 Draft a Commission policy statement that articulates a risk-informed defense-in-depth framework that includes extended design-basis requirements in the NRC's regulations as essential elements for ensuring adequate protection.

1.2 Initiate rulemaking to implement a risk-informed, defense-in-depth frame framework consistent with the above recommended Commission policy statement.

1.3 Modify the Regulatory Analysis Guidelines to more effectively implement the defense-in-depth philosophy in balance with the current emphasis on risk-based guidelines.

The Task Force believes that the Regulatory Analysis Guidelines could be modified by implementing some of the concepts presented in the technology-neutral framework (NUREG-1860) to better integrate safety goals and defense-in-depth.

1.4 Evaluate the insights from the IPE and IPEEE efforts as summarized in NUREG-1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," issued December 1997, and NUREG-1742, "Perspectives Gained from the Individual Plant Examination of External Events (IPEEE) Program," issued April 2002, to identify potential generic regulations or plant-specific regulatory requirements.

NTTF's Underlying Concerns with NPP Regulatory Framework

- The complexity and difficulty of implementing a complex, unclear, unsystematic and incoherent regulatory framework

- The difficulty of explaining, to internal and external stakeholders*:*

  - the NRC's overarching regulatory principles governing the regulation and oversight of nuclear power reactors

  - the manner in which the NRC applies these principles in its regulatory activities

Current NRC Regulatory Framework-NPPs

<table>
<tr><td colspan="5">NRC Regulatory Interest (but not necessarily regulated)</td><td>No NRC Regulatory Interest</td></tr>
<tr><td colspan="4">Licensing Basis
NRC regulations, license conditions, orders
Closest analogy is current licensing basis under 10 CFR 54.3</td><td>Not in licensing basis
No NRC regulations, license conditions or orders</td><td rowspan="6">Type 3 industry initiatives</td></tr>
<tr><td colspan="3">Design Basis
10 CFR 50.2
10 CFR 50.34(a)(3)(ii)</td><td>Design Basis Extension (possible)</td><td colspan="2">Beyond Design Basis</td></tr>
<tr><td colspan="3">Design basis events

Closest analogy is 10 CFR 50.49(b)(1)(C)

GDC-2 max. historical natural phenomena
ECCS double guillotine break
Type 1 industry initiative (some)</td><td>Beyond design bases events and accidents <u>which are still in the design basis</u>

SBO
ATWS
AIA
Type 1 industry initiative (some)</td><td>Beyond design bases accidents whose prevention or mitigation from a <u>design</u> standpoint are not covered by any NRC regulations, license conditions or orders, but whose <u>mitigation from an operational standpoint may be addressed directly or indirectly by NRC regulations, license conditions or orders</u>

EP
Mitigating measures rule (possible)
Type 1 industry initiative (some)</td><td>Beyond design bases accidents whose prevention or mitigation are <u>not addressed in any manner by current NRC regulations, license conditions or orders</u>

Type 2 industry initiatives</td></tr>
<tr><td>Normal operation, anticipated operational occurrences</td><td>Upset & fault Conditi0ns</td><td>Design basis accident</td><td>(design basis extension events, as a term of art?)</td><td colspan="2">Region where severe accidents/Class 9 accidents are located</td></tr>
<tr><td colspan="2">Adequate protection</td><td>Adequate protection</td><td>Adequate protection or safety enhancement</td><td>Adequate protection or safety enhancement</td><td>Adequate protection or safety enhancement (potential)</td></tr>
</table>

NOTES: 1. Diagram only applies to radiological health and safety aspects of NRC regulatory framework for NPPs. It does not address common defense and security, economic consequences, environmental impacts, or other non-radiological considerations.

2. Horizontal axis is NOT intended to represent probability or pure risk. It is intended to represent a risk-informed spectrum of safety.

SUMMARY

- The lack of a logical, systematic and coherent regulatory framework is not a safety issue, unless confusion results in future NRC actions which are inadequate.

- This is a good opportunity for the NRC to evaluate whether it can take action to significantly enhance our ability to:

    - Explain to all NRC stakeholders, in a consistent and easily comprehensible manner, our conceptual approach to regulation of nuclear power plants

    - Consistently implement and - as needed - revise or extend our regulatory framework for nuclear power plants in a timely and cost-effective manner.

- The key issue: Can NRC do so without great resource burdens on both the NRC and the industry, without diverting significant attention and resources of the NRC and licensee away from safety issues, while maintaining public confidence in the independence and effectiveness of the NRC as a regulator?

NEI's Perspective on the Regulatory Framework

Tony Pietrangelo
Senior Vice President and Chief Nuclear Officer, NEI

Regulatory Framework

Licensing Basis

No cost-benefit analysis	**Perform cost-benefit analysis**	**Licensee discretion**
Adequate protection	**Is cost-beneficial, i.e. provides substantial additional protection**	**Is not cost-beneficial; may have other benefits**
Design Basis	**Beyond Design Basis**	**Residual Risk**

PRA

Informs (provides risk insights) across spectrum

Note: New information (e.g. operating experience, changes to external hazards) will pose questions as to whether a new or changed requirement is needed, and is it considered adequate protection or is cost-benefit analysis necessary. That is a commission decision on a case-by-case basis.

NEI

Proposed BDB Philosophy

- **Current Design Basis**
  - Provide a high level of assurance of design capability to address a defined set of event conditions
- **Beyond Design Basis**
  - Provide reasonable confidence of operational flexibility for responding to an unbounded set of event conditions

Morgan Lewis

NRC Fukushima Recommendation 1

NEI Lawyers Committee Meeting (June 20, 2013)

Steve Frantz

Task Force Recommendation 1

- Recommendation 1 - Establish a logical, systematic, and coherent regulatory framework for adequate protection balancing defense-in-depth and risk considerations
  - Eliminate “patchwork of regulatory requirements”
  - Establish a new category of “extended design basis” events”
  - Based on PRAs and defense in depth
  - Separate quality standards
  - Presumably, separate and uniform requirements for special treatment and environmental qualification

Benefits

- In theory, Recommendation 1 is sound and intellectually attractive
  - Logical and consistent
  - Easy to understand
  - Provides a high level of safety
  - Eliminates gaps
- If NRC were working with a blank slate, it would be desirable

Problems

- NRC is not working on a blank slate
  - 100 operating reactors (and decreasing due to costs)
  - 4 reactors under construction
  - Numerous design certifications and design certification applications
  - Numerous combined license applications
- Substantial NRC and industry costs
  - to change Part 50 and existing NRC guidance
  - to evaluate existing design and procedures against new requirements and guidance
  - to backfit existing plants

Minimal or No Improvement in Safety

- Existing plants are safe
- Existing plants have already performed IPEs/PRAs
  - Plants have substantially improved safety since that time
- NRC has not identified any significant improvements in safety as a result of Recommendation 1
  - Existing requirements for beyond design basis events are appropriately tailored to the event in question
  - It is unlikely that uniformity of requirements would result in any significant improvement in safety
- As Chairman Jaczko stated:

  Quilts are made up of patchwork. That doesn't necessarily mean that the quilt won't keep you warm.

Draft NRC Working Group Evaluation

- Work Group Conclusions:
  - Recommendation 1 is not cost effective
  - Establish “design basis extension” category
  - Apply the category to future changes
  - No requirement for existing plants to have a PRA
  - No backfits
- Work Group conclusions are reasonable
  - Not burdensome to NRC or the industry
  - Would apply a more structured approach to future changes

Conclusions

- Recommendation 1 is intellectual attractive but is highly flawed in practice
- High costs associated with restructuring the regulatory system
- No significant improvement in safety from wholesale changes
- NRC Working Group conclusions are reasonable

Panel Questions

Audience Questions