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United States Nuclear Regulatory Commission
Protecting People and the Environment

Developing the Staff's Response to Fukushima Task Force Recommendation 1

Public Stakeholder Meeting

June 20, 2012

U.S. NRC Interoffice Working Group

Overview of Fukushima Task Force Recommendation 1

Public Stakeholder Meeting

June 20, 2012

Richard Dudley, NRR-Rulemaking Branch

Outline of Presentation

- Review Recommendation 1 and SRM direction
- Discuss staff’s approach to develop Commission paper
- Review actions taken to date
- Provide overview of framework options
- Discuss next steps

Acronyms

NRC – Nuclear Regulatory Commission
NRR – Office of Nuclear Reactor Regulation
SRM – Staff Requirements Memorandum
CFR – Code of Federal Regulations
IPE – Independent Plant Evaluation
IPEEE - Independent Plant Evaluation – External Events
CDF – Core Damage Frequency
LERF – Large Early Release Frequency
PRA – Probabilistic Risk Assessment
RES – Office of Nuclear Regulatory Research
OGC – Office of the General Counsel
NRO – Office of New Reactors
FSME – Office of Federal and State Materials and Environmental Management Programs
NMSS – Office of Nuclear Material Safety and Safeguards
NSIR – Office of Nuclear Security and Incident Response
RMTF - Risk Management Task Force

Acronyms (cont.)

ACRS – Advisory Committee on Reactor Safeguards
LWR – Light Water Reactor
NEPA – National Environmental Policy Act
SSCs – Systems, Structures, and Components
NTTF – (Fukushima) Near-Term Task Force
ATWS- Anticipated Transients Without Scram
SBO – Station Blackout
SAMGs – Severe Accident Management Guidelines
TSs – Technical Specifications
LBE – Licensing Basis Event
EP – Emergency Preparedness
F-C – Frequency-Consequence
RG – Regulatory Guide
EAB – Exclusion Area Boundary
TEDE – Total Effective Dose Equivalent
LPZ – Low Population Zone

Task Force Recommendation 1

- **Task Force findings:**
  - NRC now relies on combination of design-basis requirements and “patchwork” of beyond design-basis requirements and voluntary initiatives to maintain safety
  - NRC’s safety approach is incomplete without strong program for dealing with the unexpected, including severe accidents
  - Continued reliance on industry initiatives for a fundamental level of defense-in-depth would leave gaps in NRC’s regulatory approach
- **Task Force Recommendation 1:**
  - Establish a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations

NTTF Framework Recommendations

- Increase the level of adequate protection
- Draft a Commission policy statement
  - Articulate a risk-informed defense-in-depth framework
  - Include extended design-basis category of requirements as necessary for ensuring adequate protection
- Modify the Regulatory Analysis Guidelines
  - More effectively implement defense-in-depth philosophy
  - Consider some of the concepts presented in the technology-neutral framework (NUREG-1860) to integrate safety goals with defense-in-depth
- Initiate rulemaking to implement the policy
  - Separate 10 CFR Section or Appendix (replace patchwork)
  - Specify treatment requirements and § 50.59-like change process for new section

NTTF Framework Recommendations (cont.)

- Consider adding additional requirements:
  - Evaluate the insights from the IPE and IPEEE to identify generic or plant-specific requirements
  - Consider applying new reactor severe accident requirements to operating plants within reasonable bounds
- Voluntary initiatives:
  - Should not take the place of needed requirements
  - Use as mechanism for facilitating and standardizing implementation requirements (guidance)
- PRA role in new framework
  - Full-scope Level 1 PRA (CDF)
  - Containment performance Level 2 PRA (LERF)
  - Level 3 PRA may be needed for some alternatives
- No change to NRC's current approach to the issue of land contamination from reactor accidents

Commission SRM Direction

<u>SRM-11-0093</u>:

"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." (Due in February 2013)

Approach to Develop SECY Paper

- Formed inter-office Working Group (WG), led by NRR with support from RES, OGC, NRO, FSME, NMSS, NSIR, and a liaison with the Commissioner Apostolakis Risk Management Task Force (RMTF)
- Prepare Commission paper evaluating a wide range of possible options:
  - technical and policy issues
  - schedules
  - resource requirements
  - stakeholder concerns
  - pros and cons
- Include a recommended approach and basis for its selection
- External stakeholder involvement
  - 2 public stakeholder meetings
  - ACRS meetings

Basic Options

- Option 1 - Continue with existing regulatory processes (status quo) making occasional improvements in a non-integrated manner
- Option 2 - Coordinated effort to refine/improve portions of existing regulatory processes as approved by the Commission
- Option 3 - Develop revised regulatory framework

Next Steps

- Characterizing and evaluating specific framework options (technical/policy issues, resources, schedules)
- Late summer – Meet with ACRS subcommittee
- Fall 2012 – Public meeting to discuss specific options and pros/cons
- ACRS subcommittee in December/January
- ACRS full committee in February/March
- Commission paper due to EDO mid-February 2013

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NRC Staff Concept of Regulatory Framework

Richard Dudley, NRR/Rulemaking

Staff Thoughts on Criteria for Evaluating Framework Options

- To the extent possible each framework should:
  - Specify the process and criteria to more logically categorize regulated events, accidents, and proposed new requirements
  - Specify the processes/methods/criteria used to determine adequate protection and sufficient defense-in-depth
  - Specify the processes/methods/criteria used to promulgate requirements not required for adequate protection (safety enhancements)

Staff Thoughts on Criteria for Evaluating Framework Options (cont.)

- Framework should incorporate:
  - performance-based regulation
  - risk-informed regulation
- Framework should:
  - Specify proper balance between defense-in-depth and risk considerations
  - Specify conditions upon which voluntary industry initiatives are acceptable
- Applicability of framework to various periods in life cycle of nuclear power plant must be clearly defined

Scope of a Regulatory Framework

- Framework limited to
  - operating power reactors and evolutionary new LWR designs
  - matters affecting radiological health and safety and NEPA compliance
  - initial licensing and operational stage (not reactor decommissioning)

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NRC Staff Concept of Defense-in-Depth

Mary Drouin, RES/DRA

Defense-in-Depth *and NTTF Recommendation 1*

- A more balanced application of the Commission’s defense-in-depth philosophy using risk insights
- Application of the defense-in-depth philosophy can be strengthened by including explicit requirements for beyond-design-basis events
- New insight regarding low-likelihood, high-consequence events that warrant enhancements to defense-in-depth on the basis of redefining the level of protection that is regard as adequate
- The defense-in-depth philosophy is useful and broadly applied concept; however, it is not susceptible to a rigid definition because it is a philosophy

Defense-in-Depth *and NTTF Recommendation 1 (cont.)*

- NTTF focused on the following application of the defense-in-depth concept:
  - Protection from external events that could lead to fuel damage
  - Mitigation of the consequences of such accidents should they occur, with a focus on preventing core and spent fuel damage and uncontrolled releases of radioactive material to the environment
  - Emergency preparedness to mitigate the effects of radiological releases to the public and the environment, should they occur

Defense-in-Depth – *Sources Reviewed*

- Over two dozen sources identified spanning a 45 year period
- Primarily regulatory sources reviewed:

• Joint Committee on Atomic Energy Hearings, 1967 • Internal Study Group, 1969 • ECCS Hearings, 1971 • WASH-1250, 1973 • 10 CFR Part 60 • Post TMI Definitions and Examples, 1981 • NUREG/CR-6042, 1994 • Commission Policy Statements, 1986, 1994, 1995 • NUREG-1537, 1996 • MIT Speech by Chairman Jackson, 1997 • Commission White Paper, 1999 • PSA '99 paper, 1999 • ACRS letters, 1999, 2000 • IAEA Documents (INSAG-3, 10, & 12, NP-T-2.2), 1988, 1996, 1999, 2000	• 10 CFR Part 50, Appendix R, 2000 • 10 CFR §50.69, 2004 • NEI 02-02, 2002 • Petition on Davis Besse, 2003 • Remarks by Chairman Diaz, 2004 • Digital Instrumentation and Controls (NUREG/CR-6303, RG 1.152, NUREG-0800 BTP HICB-91, NUREG-0800 SRP BTP 7-19, DI&C-ISG-02), 1994, 1996, 1997, 2007, 2009 • NUREG-1860, 2007 • INL NGNP report, 2009 • RG 1.174, 2012 • NRC glossary, 2012 • RMTF, 2012

Defense-in-Depth – ***Review Approach***

- Reviewed the sources to identify defense-in-depth positions regarding:
  - The need for defense-in-depth
  - The objective for defense-in-depth (what is it trying to accomplish)
  - The approach or strategy to defense-in-depth (how is it accomplishing the objective)
  - Criteria used to implement the approach or strategy
  - Criteria used for determining whether adequate defense-in-depth has been achieved

Defense-in-Depth – *Review Findings*

- Numerous common themes
- Differences primarily in how the themes are characterized
  - For example, one position may state the objective of defense-in-depth is to have multiple barriers, another may state multiple barriers is a strategy to achieve defense-in-depth, and another may state multiple barriers as criteria for determining adequate defense-in-depth
- Perspectives grouped by whether related to:
  - The need for defense-in-depth
  - The objective for defense-in-depth (what is it trying to accomplish)
  - The approach or strategy to defense-in-depth (how is it accomplishing the objective)
  - Criteria used to implement the approach or strategy
  - Criteria used for determining whether adequate defense-in-depth has been achieved

Review Findings: *Regarding the Need for Defense-in-Depth*

- Examples of various views on the need:
  - guard against unwanted events
  - compensating for uncertainty in probabilistic analyses
  - related to the issue of uncertainty
  - the aggregate of provisions made to compensate for uncertainty and incompleteness in the knowledge of accident initiation and progression
  - compensation for inadequacies, incompleteness, and omissions of risk analyses
  - a strategy to ensure public safety given the unquantified uncertainty in risk assessments
  - a strategy to ensure public safety given there exists both unquantified and unquantifiable uncertainty in engineering analyses (both deterministic and risk assessments)
  - application of deterministic design and operational features for events that have a high degree of uncertainty
  - ultimate purpose is to compensate for uncertainty (e.g., uncertainty due to lack of operational experience with new technologies and new design features, uncertainty in the type and magnitude of challenges to safety)
  - an element of NRC's safety philosophy that is used to address uncertainty
  - a safety philosophy intended to deliver a design that is tolerant to uncertainties in knowledge of plant behavior, component reliability, or operator performance that might compromise safety
  - to compensate for the recognized lack of knowledge of nuclear reactor operations and the consequences of potential accidents

Review Findings: ***Regarding the Need for Defense-in-Depth (cont.)***

- There does appear to be a general consensus regarding why defense-in-depth is needed.

- There is a common recognition that there is a lack of knowledge (or uncertainty) with regard to the design, construction, maintenance and operation of the facility.

Review Findings: *Regarding the Objective of Defense-in-Depth*

- Examples of various views on the objective:
  - to protect the plant, the plant operators, and the health and safety of the public
  - guarding against unwanted events
  - ensure the protection of public health and safety
  - reducing the potential for, and consequences of, severe accidents
  - to increase the degree of confidence in the results of the PRA or other analyses supporting the conclusion that adequate safety has been achieved
  - the probability of accidents must be acceptably low
  - to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs
  - if a failure should occur it would be compensated for or corrected without causing harm to individuals or the public at large
  - preventing the release of radioactive material to the environment
  - averting damage to the plant
  - the facility or system in question tends to be more tolerant of failures and external challenges
  - to provide several levels or echelons of defense to challenges to plant safety, such that failures in equipment and human error will not result in an undue threat to public safety
  - to designing and operating nuclear facilities that prevents and mitigates accidents that release radiation or hazardous materials
  - to prevent, contain, and mitigate exposure to radioactive material

Review Findings: ***Regarding the Objective of Defense-in-Depth (cont.)***

- There also appears to be a general consensus regarding the objective of defense-in-depth.
- There is a common recognition that the objective of defense-in-depth is to avert damage to the plant by preventing and mitigating accidents and thereby ensuring the protection of public health and safety while maintaining an acceptably low probability of accidents.

Review Findings: *Regarding the Strategy for Defense-in-Depth*

- Examples of various views on the strategy:
  - three lines of defense: (1) prevention of accidents, (2) protective systems are provided to take corrective actions, and (3) engineered safety features to mitigate the consequences of postulated serious accidents
  - three successive protective barriers: (1) preventing initiation of incidents (conservative design margins, etc.), (2) capability to detect and terminate incidents, and (3) Protecting the public.
  - The key elements are accident prevention, safety systems, containment, accident management, and siting and emergency plans.
  - the strategy for defense in depth is two fold: first, to prevent accidents and, second, if prevention fails, to limit their potential consequences and prevent any evolution to more serious conditions.
  - three layers of defense against the consequences of an event at a nuclear facility. The three layers are (1) protection to prevent accidents from occurring, (2) mitigation of accidents if they occur, and (3) emergency preparedness to minimize the public health consequences of releases if they occur
  - maintaining multiple barriers against radiation release, and by reducing the potential for, and consequences of, severe accidents

Review Findings: ***Regarding the Strategy for Defense-in-Depth (cont.)***

- There also appears to be a general consensus regarding the strategy for defense-in-depth.

- There is a similar concept that can be found, which is there are basic protections which involve, at a high level, prevention of accidents and mitigation of accidents.
  - Prevention of accident can be defined as preventing the occurrence of an event to preventing the progression of accident sequences.
  - Mitigation of an accident can be defined from ending the progression of a severe accident, to containing the effects of a severe accident, to mitigating the consequences of a severe accident.

Review Findings: *Regarding the Implementation of Defense-in-Depth*

- Examples of various views on the implementation:
  - quality and quality assurance, independently and concurrently.
  - redundant elements, provision for periodic in-service testing, and other features to enhance performance and reliability
  - provide multiple barriers to the escape of radioactive material, from whatever cause, and to withstand the occurrences of natural forces . . . without compromising these barriers
  - selection of proper materials, quality controls in fabrication of components, rigorous systems of inspection and testing, appropriate techniques and controls in workmanship.
  - high standards of engineering practice in design for critical components and systems
  - regularly scheduled equipment checks and maintenance programs; prompt and thorough investigation and correction of abnormal events, failures or malfunctions.
  - the requirements of sound and well defined principles of good management in operation; a competent and well-trained staff, clearly assigned duties, written procedures, checks and balances in the procedures for revisions, periodic internal audits of operations, etc.
  - redundancy in controls and shutdown devices; emergency power from independent sources -sometimes in triplicate -and emergency cooling systems
  - containment building itself, building spray and washdown system, building cooling system . . ., and an internal filter-collection system
  - through requirements and processes that include design, construction, regulatory oversight and operating activities.
  - programmatic activities as compensatory measures; system redundancy, independence, and diversity
  - no key safety functions will depend on a single element (i.e., SSC or action) of design, construction, maintenance or operation.
  - appropriate safety margins
  - containment functional capability

Review Findings: ***Regarding the Implementation of Defense-in-Depth (cont.)***

- There also appears to be a general consensus regarding the implementation of defense-in-depth in terms of some of the specific criteria; these include, for example:
  - quality assurance, redundancy, independence, oversight, containment, emergency planning.
- There is no similarity with regard to a process in selecting the criteria for implementing defense-in-depth
  - Only a couple of sources provided a process which involved both deterministic and probabilistic criteria

Review Findings: *Regarding the Adequacy Criteria for Defense-in-Depth*

- Examples of various views on adequacy criteria:
  - Risk insights can make the elements of defense-in-depth more clear by quantifying them to the extent practicable
  - Decisions on the adequacy of or the necessity for elements of defense should reflect risk insights gained through identification of the individual performance of each defense system in relation to overall performance
  - The rationalist is: (1) establish quantitative acceptance criteria, such as the quantitative health objectives, core damage frequency and large early release frequency, (2) analyze the system using PRA methods to establish that the acceptance criteria are met, and (3) evaluate the uncertainties in the analysis, especially those due to model incompleteness, and determine what steps should be taken to compensate for those uncertainties
  - The various compensatory measures taken for the purposes of defense in depth can be graded according to the risk posed by the activity, the contribution of each compensatory measure to risk reduction, the uncertainties in the risk assessment, and the need to build stakeholders trust.
  - The ultimate objective is that any credible accident sequence, even considering the failures of lines of protection for the different levels of defense in depth, remain under the overall frequency consequence curve.
  - Defense-in-depth is adequate if the overall redundancy and diversity among the plant's systems and barriers is sufficient to ensure the risk acceptance guidelines discussed in . . . . are met
  - Assessing the adequacy via a process that uses a PRA to assess the acceptability of uncertainties and uses identified options (such as increasing performance monitoring) to determine the acceptability of the uncertainties or refine the design

Review Findings: ***Regarding the Adequacy Criteria for Defense-in-Depth (cont.)***

- There are no similarities regarding criteria for determining the adequacy of defense-in-depth
  - Most did not offer perspectives in this regard

- A few did touch on this topic
  - each proposed a process to be used
  - some relied strictly on probabilistic criteria, others deterministic criteria and other used a combination of deterministic and probabilistic criteria

Defense-in-Depth: *Status of Staff Review*

- Although there are common themes, the differences do indicate there is not a consensus regarding the implementation of defense-in-depth and determination whether sufficient defense-in-depth has been achieved

- Thus, should the staff make recommendations regarding:
  - Whether there should be a policy statement explicitly stating the Commission's expectations?
    - Stating the Commissions view regarding the need and objective of defense-in-depth the strategy for achieving defense-in-depth.
  - Whether a process (with associated guidance and criteria) should be developed on:
    - How defense-in-depth should be implemented?
    - How to determine if adequate defense-in-depth has been implemented?

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Options 1 & 2

Steven Laur, NRR/DRA

Option 1 – ***Continue with existing regulatory processes***

- NRC would not change structure or operation of existing regulatory processes
- Regulatory actions/orders would be continue to be undertaken as issues warrant; e.g., as is currently being done in response to Fukushima event
- No new event categories would be developed
- NTTF noted that current processes have served us well in past

Option 2 – ***Optimize portions of existing regulatory processes***

- NRC staff would evaluate the need for improvements, e.g.:
  - Backfit rule guidance
  - Regulatory analysis guidelines
  - Criteria for reliance on voluntary initiatives
  - PRA policy statement
  - Safety margins for external hazards
  - Guidance for determining the adequacy of risk-informed defense-in-depth
  - Processes for evaluating new information impacting safety
- Selected improvements would be implemented under this option

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Option 3 – Develop New Regulatory Framework

Richard Dudley, NRR/Rulemaking

Option 3 - New Framework Alternatives

- Option 3.1 - Extended design basis framework described by NTTF (add new extended design basis category)
- Option 3.2 - Implement Commissioner Apostolakis' Risk Management Task Force framework approach
- Option 3.3 - Develop new category-based framework
  - re-categorize anticipated operational occurrences, design-basis accidents, and extended design-basis accidents based on initiating event frequency
  - specify different levels of mitigation/prevention required for each category
- Option 3.4 - Develop new framework using NUREG-1860 (technology-neutral approach)

Option 3.1 – ***Extended design basis framework***

- Eliminate “patchwork” by formally establishing new category in regulations for extended design basis requirements
- Category would include both adequate protection and safety enhancement rules
- Specify criteria for determining adequate protection and adequacy of defense-in-depth
- Specify criteria for determining necessary safety enhancements

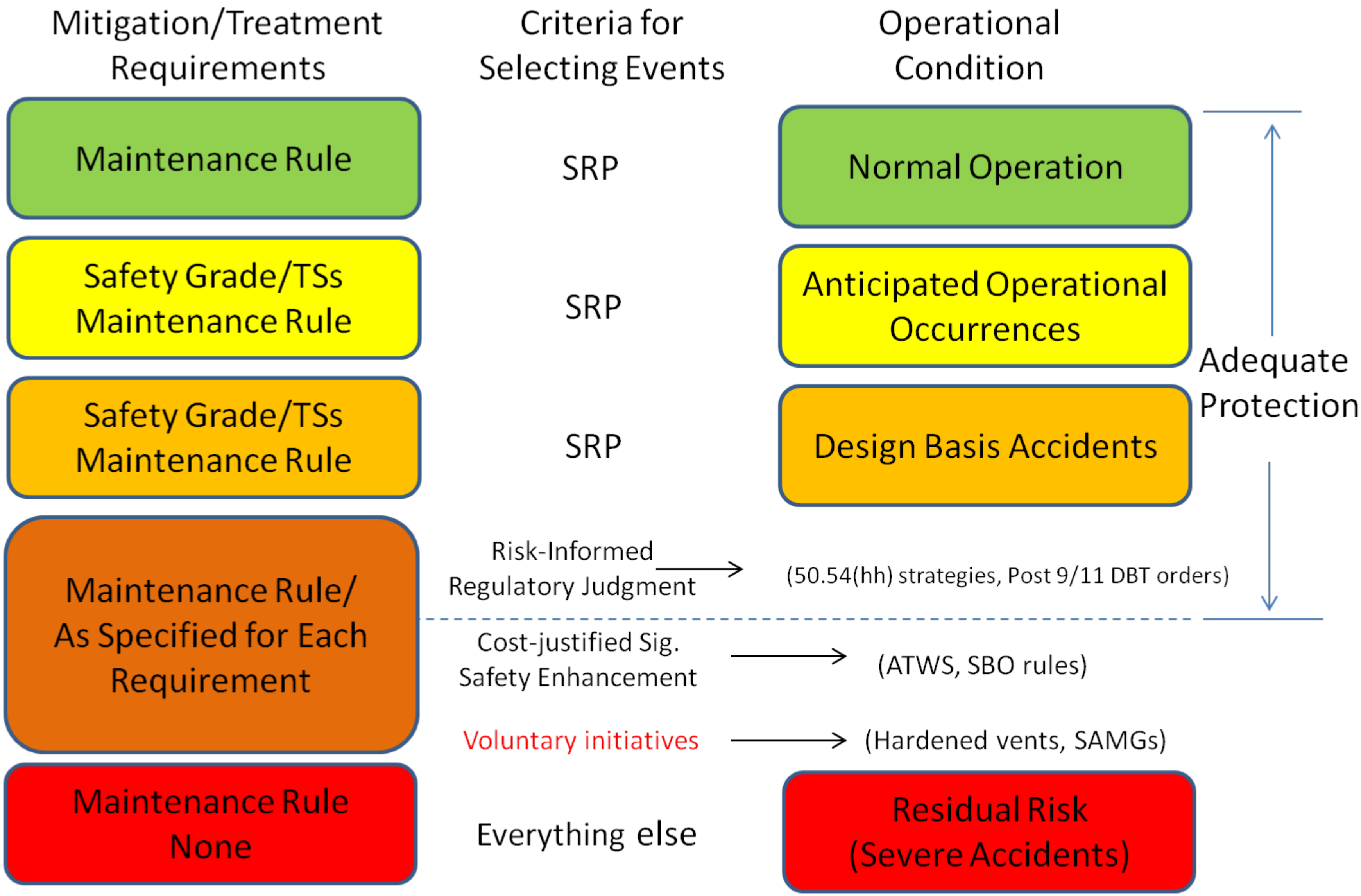
Option 3.1 – ***Extended design basis framework (cont.)***

- Similar to Option 2, evaluate the need for improvements in:
  - Backfit rule guidance
  - Regulatory analysis guidelines
  - Criteria for reliance on voluntary initiatives
  - PRA policy statement
  - Safety margins for external hazards
  - Guidance for determining the adequacy of risk-informed defense-in-depth
  - Processes for evaluating new information impacting safety

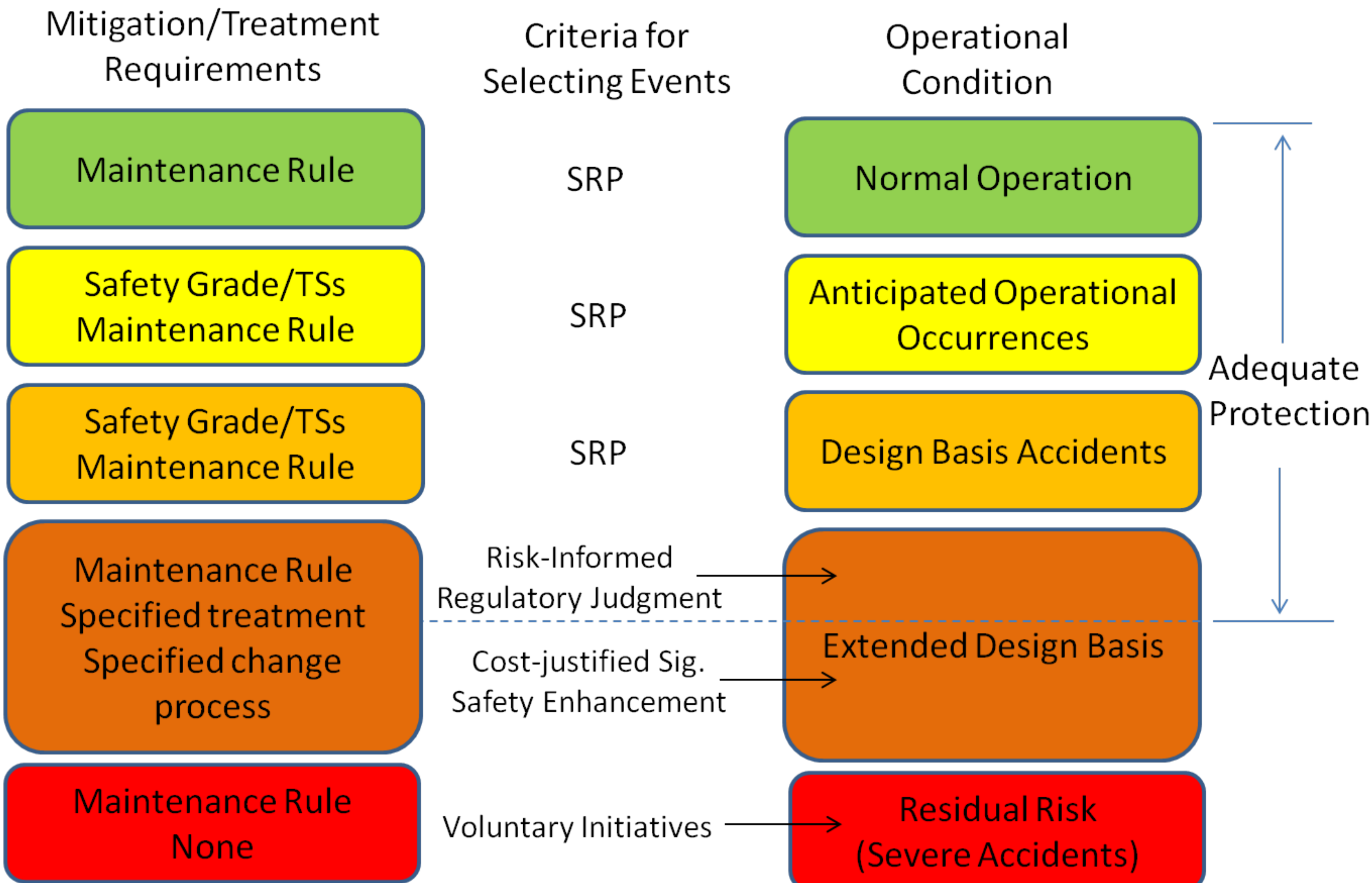
Option 3.1 – ***Extended design basis framework (cont.)***

- Undertake rulemaking to re-designate certain requirements into this category
- Evaluate treatment requirements for new category
- Evaluate change process similar to 10 CFR 50.59 with criteria for changing method of compliance without NRC review/approval

Existing Regulatory Framework



Extended Design Basis Regulatory Framework



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Option 3.2 – Risk Management Task Force (RMTF) Regulatory Framework

Michael Snodderly, NRR/DRA

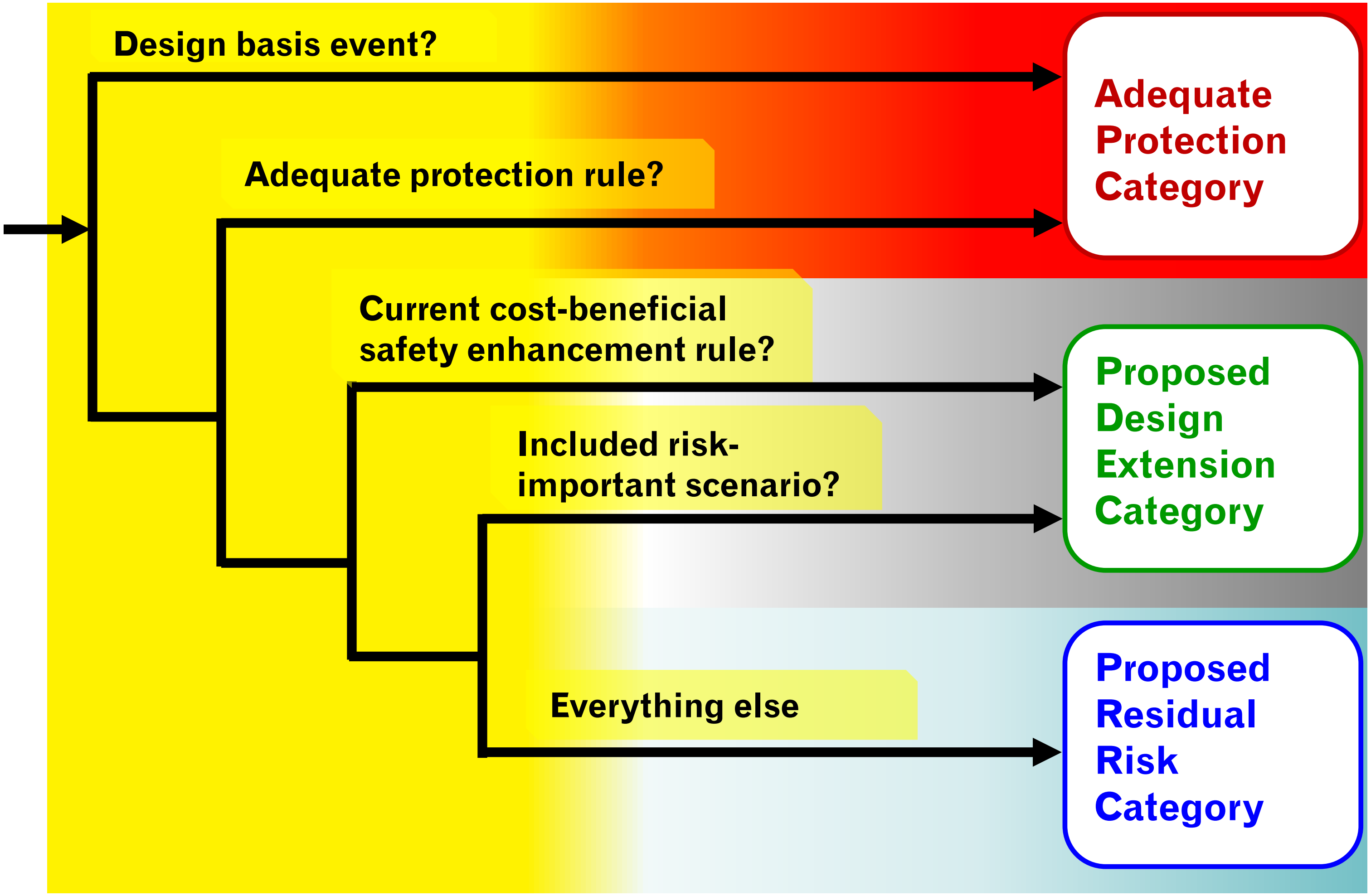
Option 3.2 – ***RMTF regulatory framework***

- Proposed risk management framework documented in NUREG-2150 (April 2012)
- Preservation of design basis accident supplemented with the creation of an enhanced design basis category via rulemaking

Option 3.2 – ***RMTF regulatory framework (cont.)***

- The RMTF recommended that the design enhancement category should:
  - Use risk as a safety measure
  - Be performance based
  - Include consideration of costs
  - Be implemented on a site-specific basis
  - Include treatment of associated structures, systems and components based on the frequency of initiating events

Risk Management Task Force - Proposed Regulatory Framework: Power Reactors



Option 3.2 – ***RMTF regulatory framework (cont.)***

- NUREG-2150, Appendix H provided three possible alternatives to creating the design enhancement category based on the following three questions:
  - Who decides which scenarios are included
  - What criteria are used for inclusion of events in the design enhancement category
  - What acceptance criteria are established for events in the design enhancement category
- All three alternatives would require development of a definition of defense-in-depth

Option 3.2 – ***RMTF Alternative 1***

- NRC staff would identify initiating events, define design-enhancement events and acceptance criteria
- Licensees would perform a facility specific implementation analysis for the NRC defined event and acceptance criteria
- NRC would either –
- review and approve analyses or,
- issue detailed guidance and rely on inspections (more performance-based)

Option 3.2 – *RMTF Alternative 2*

- NRC would define the threshold for events falling within the design-enhancement category
- Licensees would be required to perform periodic reviews and analyses to identify relevant scenarios and determine appropriate actions
- Regulatory analysis guidelines would be updated to ensure an effective cost-benefit analysis is performed by licensees when considering ways to address design-enhancement events
- A summary of the assessment and related actions would be provided to the NRC, similar to FSAR update requirement
- Risk management functions would continue to be supported by technical specifications, maintenance rule, and other programs

Option 3.2 – *RMTF Alternative 3*

- Would replace the “as low as reasonably achievable” principle with more definitive acceptance criteria
- Would require periodic site-specific risk assessments and additional reporting of related risk-reduction efforts
- Would emphasize acceptance criteria over cost considerations compared to Alternative 2

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Option 3.3 – Category-Based Regulatory Framework

Richard Dudley, NRR/Rulemaking

Option 3.3 – *Category-based regulatory framework*

- Framework contains three high level layers of defense against the consequences of an event at a nuclear facility:
  - (1) protection to prevent accidents from occurring
  - (2) mitigation of accidents if they occur, and
  - (3) emergency preparedness to minimize the public health consequences of releases of radioactivity if they occur

Option 3.3 - Prevention of Internal Events and Protection for External Events – Layer 1

- Maintain requirements and policy the following areas:
  - Conservative approaches for site selection and, facility design, manufacturing, construction, operation and maintenance
  - Assurance of quality in facility design, manufacturing, construction and operation
  - Use of national consensus standards and international standards for facility design, manufacturing, construction and operation
  - Use of state-of-the art probabilistic risk assessment to identify and evaluate potential design features and address plant operational vulnerabilities
  - A program for evaluating and addressing the root cause of experiences during plant operation to avoid repetition of reactor events, specific equipment malfunctions and human errors

Option 3.3 - Mitigation of Internal and External Events – Layer 2

- Define the following categories of licensing basis events (LBE) in the regulations
  - Anticipated Operational Occurrences
  - Postulated Accidents
  - Extended Design Basis Events
- Extend Part 52 requirement for a Level 1 & 2 PRA to Part 50 licensees and applicants
- Use operating experience, PRA and defense-in-depth considerations (to account for uncertainty) to identify events and establish their expected frequency
- Define category boundaries based on event frequency

Option 3.3 - Mitigation of Internal and External Events – Layer 2 (cont.)

- Establish mitigation capability necessary to meet specified acceptance criteria for each event category
  - Equipment
  - Procedures
  - Trained personnel
- Perform safety and risk analyses, as appropriate, to demonstrate acceptance criteria are met
- Describe mitigation capability for each LBE category in the FSAR
- Develop guidelines for determining adequate protection and sufficient defense-in-depth related to mitigation capability
- Establish a graded level of treatment of mitigation capabilities based on whether a specific capability is required for adequate protection or is a safety enhancement; decision criteria are risk-informed and allow for defense-in-depth considerations

Option 3.3 - Treatment Programs for Maintaining an Adequate Mitigation Capability

- Availability of systems structures and components (SSCs)
  - Technical specifications
  - Availability Controls (administrative)
- Reliability of SSCs
  - Design
  - Maintenance
  - Testing
  - Performance Monitoring
- Qualification of SSCs for accident conditions
- Quality Assurance
- Training for event mitigation
  - Abnormal Operating Procedures
  - Emergency Operating Procedures
  - Severe Accident Management Guidelines
  - Extensive Damage Mitigation Guidelines

Option 3.3 - Emergency Preparedness – Layer 3

- Develop and maintain Emergency Preparedness (EP) plans that meet comprehensive NRC EP requirements

- Plans must address emergency conditions in a single nuclear power plant unit site and emergency conditions when more than one nuclear power plant unit is affected by an accident at the facility site, such as an extended loss of all electrical power, an earthquake or extensive flooding of the facilities at the site

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Option 3.4 – Technology-Neutral Regulatory Framework (NUREG-1860)

Mary Drouin, RES/DSRA

Option 3.4 – *Technology-neutral regulatory framework (NUREG-1860)*

- In this approach, a single category of events for which the plant is licensed is defined and referred to as licensing basis events.
  - This category encompasses the traditional anticipated operational occurrences, design basis accidents, design basis events and new proposed categories referred to beyond design basis events or design enhancement events.
- NUREG-1860 describes a framework similar to Alternative 3 from the RMTF for achieving adequate protection of the public without undue burden on NRC licensees.
- The implementation of this option is built on the principles of defense-in-depth and allows for the use of risk information.

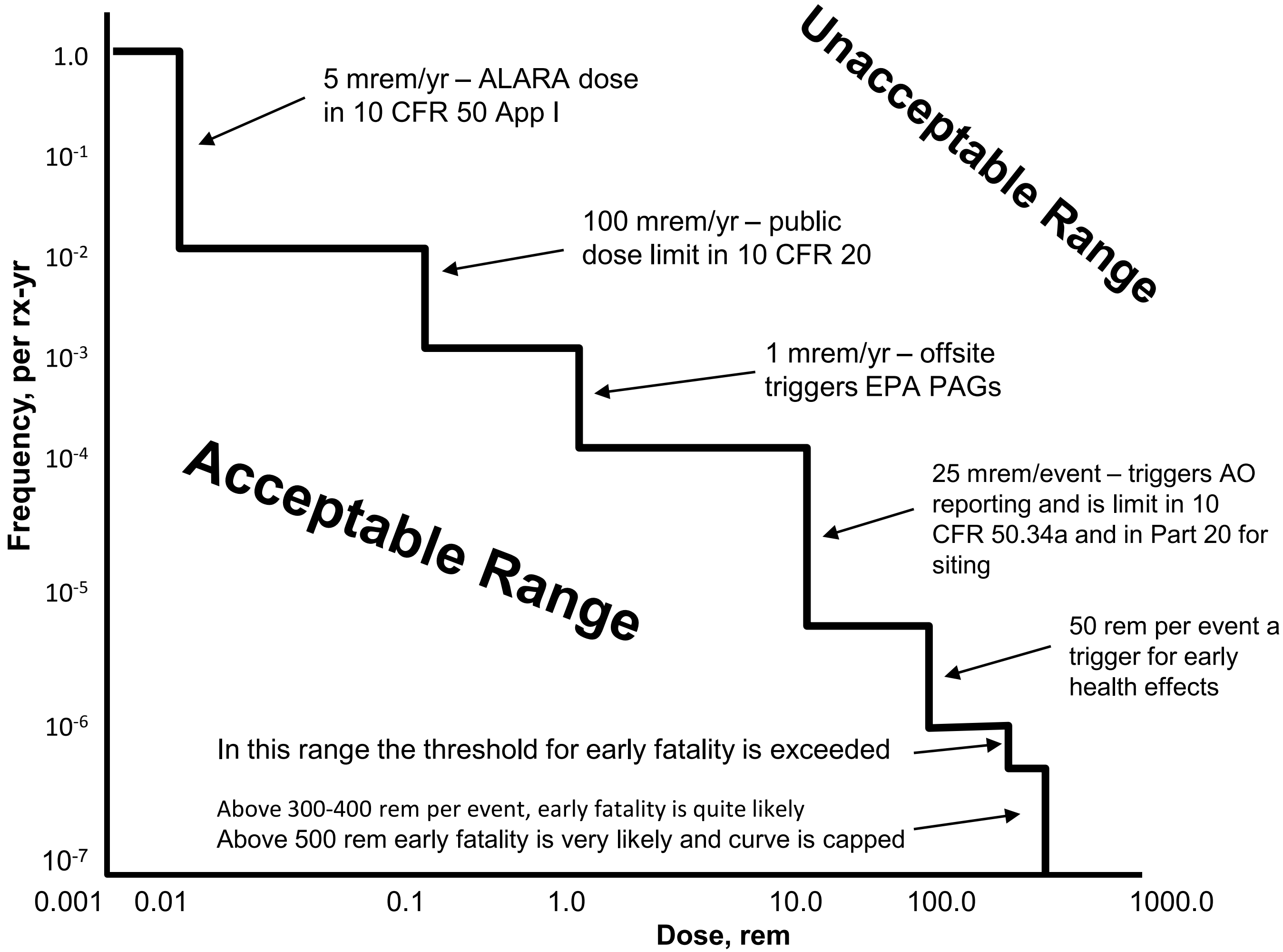
Option 3.4 *– Technology-neutral regulatory framework (cont.)*

- Rather than defining different category of events, such as design basis events and beyond design basis events, NUREG-1860 defines a single category of events: licensing basis events (LBEs).
- The LBEs are grouped into 3 classes:
  - Frequent: 10-2/ry, includes all event sequences expected to occur at least once in lifetime of a plant assuming a lifetime of 60 years
  - Infrequent: < 10-2/ry to ≤10-5/ry, includes all event sequences expected to occur at least once in lifetime of population of plants assuming a population of 1000 reactors
  - Rare: <10-5/ry to ≤10-7/ry, includes event sequences not expected to occur in the lifetime of the plant population, but needed to assess Commission's safety goals
- For defense-in-depth purposes, additional deterministic criteria are imposed on the LBEs.
  - These additional criteria reflect some of the considerations that are found in the General Design Criteria of Appendix A to 10 CFR 50 for the current reactors.
  - The additional deterministic criteria imposed on the LBEs vary with the frequency range.

Option 3.4 *– The Most Important Features Regarding Frequency-Consequence (FC) Curve*

- The purpose of F-C curve is as a tool for selecting LBEs in a risk-informed manner and to provide a criteria for LBE acceptability.
- To meet the purpose of LBE selection, the F-C curve is a ‘per event’ curve, not a cumulative measure of total risk.
- The FC has some anchor points based on existing dose requirements in the regulations, but the existing regulations do not relate these doses to frequencies.
  - Engineering judgment is used to relate specific dose ranges to specific frequency ranges in the proposed curve.
- Other variations of the F-C curve could be proposed with similar arguments. A single ‘per event’ curve could be replaced by two curves:
  - one in the high-frequency-low consequence range, based on cumulative (annual) requirements in the current regulations, which plots rem/yr vs probability, and
  - a curve in the lower frequency-higher consequence range, based on dose limits for individual accidents in the current regulations.

Option 3.4 – *Example of a Proposed Frequency-Consequence Curve*



Option 3.4 – *Licensing Basis Event Selection and Criteria*

- The LBEs are selected in a risk-informed manner from the PRA sequences, and the LBEs need to meet the proposed F-C curve.
- Each LBE represents a class of PRA sequences, and each LBE bounds the sequences in its class in terms of frequency and consequence.
- Collectively, LBEs bound the individual PRA sequences in frequency and consequences.
- In the high-frequency-low dose range, LBEs may have to be chosen based on judgement rather than PRA results.
- In addition to conforming to the F-C curve, some other criteria are imposed on the LBEs. These criteria involve (1) additional deterministic criteria, and (2) additional dose criteria. The severity of these additional requirements depends on the frequency range the LBEs fall into. Some criteria on initiating events are also imposed.
- The LBEs need to meet the F-C curve and the additional criteria using only the credited safety-significant SSCs.
- As a defense-in-depth provision, a deterministic LBE is added that ensures each design can establish a controlled low-leakage barrier if plant conditions result in the release of radioactive material from the fuel and reactor coolant system in excess of anticipated conditions. This event should be agreed upon between the applicant and the NRC consistent with the technology and safety characteristics of the design.

Option 3.4 – *Summary of the Criteria Imposed on the Probabilistically Selected LBEs*

Frequency Category	Additional acceptance criteria for LBEs (demonstrated with calculations at the 95% probability value* with success criteria that meet adequate regulatory margin,
frequent ($\leq 10^{-2}$)	• no barrier failure (beyond the initiating event) • no impact on fuel integrity or lifetime and safety analysis assumptions • redundant means for reactor shutdown and decay heat removal remain functional • annual dose to a receptor at the EAB # 5mrem TEDE
infrequent ($< 10^{-2}$ to $\leq 10^{-5}$)	• maintain containment functional capability • a coolable geometry is maintained • at least one means of reactor shutdown and decay heat removal remains functional • for LBEs with frequency > 1E-3 annual dose to a receptor at the EAB # 100mrem TEDE • for LBEs with frequency < 1E-3 the worst two-hour dose at the EAB, and the dose from the duration of the accident at the outer boundary of the LPZ, meet the F-C curve
rare ($< 10^{-5}$ to $\leq 10^{-7}$)	• the worst two-hour dose at the EAB, and the dose from the duration of the accident at the outer boundary of the LPZ, meet the F-C curve
Note: With the exception of the source term, realistic calculations are carried out to obtain the mean and uncertainty distribution of the important parameters for estimating frequency and consequences. Source Term calculations use the 95% probability value* of the amount of radionuclides released, obtained from a mechanistic calculation, based on validated analytical tools. Dose calculations use RG 1.145 or the equivalent for calculating atmospheric dispersion.	

Option 3.4 – ***In Summary,***

- To differentiate between those requirements needed for adequate protection and those pursued for additional safety, this option would emphasize differences in analysis techniques and special treatment requirements for credited equipment and procedures.
- Adequate protection would be addressed primarily through
  - existing specific rules,
  - frequent events (similar to traditional design-basis accidents),
  - safety-related equipment, and well established procedures (e.g., emergency operating procedures).
- Infrequent events (similar to design-enhancement events) would involve best-estimate risk assessments, reliable but not necessarily safety-related equipment, and response guidelines for severe accidents and extreme damage conditions.

Future Stakeholder Interactions

- Late summer – Meet with ACRS subcommittee
- Fall 2012 – Public meeting to discuss options - pros/cons
- ACRS subcommittee in December/January
- ACRS full committee in February/March
- NRR_JLD.Resource@nrc.gov email address
  - All input regarding additional framework options must be received by July 15, 2012
  - Please clearly indicate that input is related to Recommendation 1
  - Also note that input will be reviewed but not formally addressed as are rulemaking public comments

Backup Slides

Task Force 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.***
- *Initiate action 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 framework consistent with the above recommended Commission policy statement.*

Task Force Recommendation 1 (cont.)

- *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.*