NTTF Recommendation 1
Industry Perspective

Tony Pietrangelo
Senior Vice President and Chief Nuclear Officer
January 10, 2014

Initial Observations

- Substantial safety benefits have been made since March 11, 2011
- All Tier 1 and most of Tier 2 recommendations are completed or are well underway
- The Commission decision to defer consideration of Recommendation 1 was the right thing to do

The Finding Behind Recommendation 1

- The fundamental observation was that issues characterized "beyond the design basis" had ad hoc regulatory treatment
- Industry conclusion:
  - Better definition of the regulatory treatment for issues beyond the design basis would enhance regulatory stability
  - A Commission Policy Statement could provide this stability

Improvement Activity 1 – Establish Design Basis Extension Category

- Agreement with general intent
- Disagreement with proposed "design-basis extension" terminology/category
- Why?
  - We are specifying boundary conditions (e.g. loss of all AC power, loss of ultimate heat sink), not new events
  - Discounts the operational nature of the response
  - Perpetuates design basis thinking

Contrasting Design Basis and Beyond Design Basis Treatment

Defined Event
Design Basis SSCs
All Safety Functions
Detailed Procedures
Rigid Validation
Qualified Personnel

Boundary Conditions
FLEX Equipment
Core Clg, Cnmt, SFP Clg
Guidelines & Playbooks
Practical & Reasonable
Capable Personnel

Industry Paper on Beyond Design Basis

Current Design Basis Requirements:

- Provide a high level of assurance of design capability to address a defined set of event conditions

Beyond Design Basis Requirements:

- Provide reasonable confidence in a flexible operational capability for responding to a, by definition, unbounded class of event conditions

A 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

This framework is very similar to the proposed risk management regulatory framework in NUREG 2150, Figure 4-1.

NEI

The Commission's Prerogative

- 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.

Improvement Activity 2 – Establish Defense-in-Depth Expectations

- Defense-in-Depth is a philosophy that permeates all aspects of plant design and operation
- Disagree with NTTF characterization seeking "appropriate balance of risk and defense-in-depth considerations"
- Similar to adequate protection: It's what the Commission says it is

Improvement Activity 3 – Clarify Role of Voluntary Industry Initiatives

- Industry initiatives are not a substitute for justified regulatory requirements
  - By definition, they do not meet threshold for regulation
- Regulatory analyses should not credit industry activities that are not docketed
  - Controlled under NRC-endorsed Commitment Management program

Conclusions

- Industry supports a Commission Policy Statement on beyond design basis principles
- Industry does not believe additional work on defense-in-depth has value in the context of Recommendation 1
- Industry does not support regulation of voluntary industry initiatives

Acronyms

NTTF = Near-Term Task Force

SSC = Structures, Systems and Components

FLEX = Flexible, Diverse Coping Capability

Clg = Cooling

Cnmt = Containment

SFP = Spent Fuel Pool

PRA = Probabilistic Risk Assessment

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Potential Impact of Recommended Improvement Initiatives on Operating Nuclear Power Plants

Roy Linthicum
Chairman
Risk Management Committee

PRESSURIZED WATER REACTOR OWNERS GROUP

PWR Owners Group Perspective

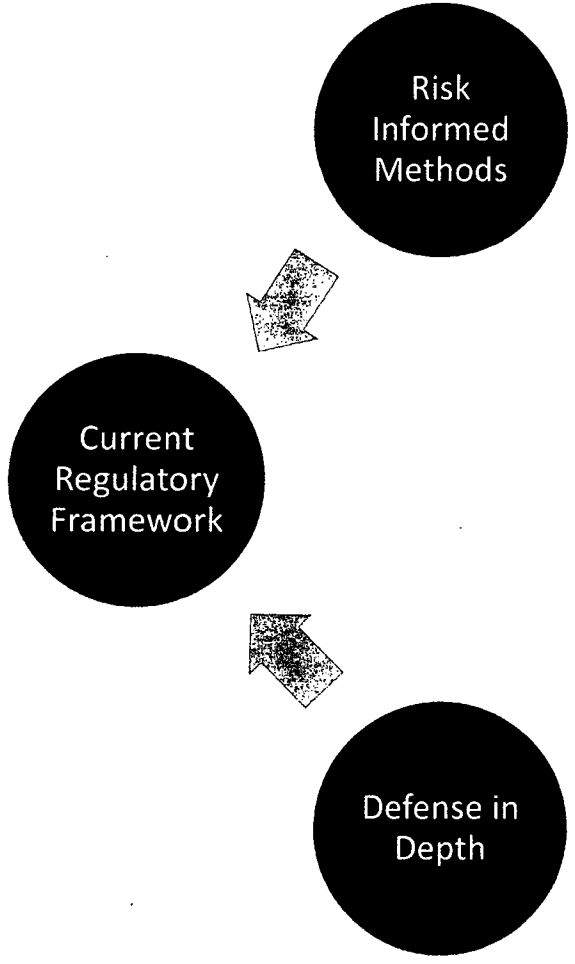
Recommendation 1 Concept

- A well implemented risk-informed regulatory framework will provide the greatest safety benefits

Current Recommendation 1 Proposal

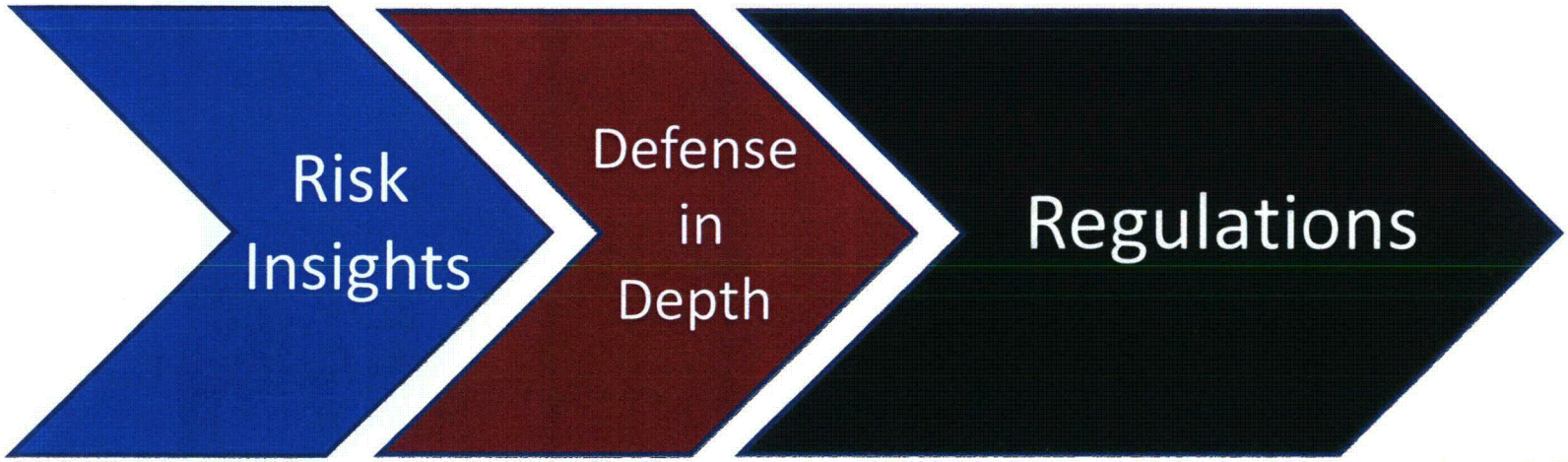
- Seeks to establish a risk-informed method but not clear on how risk insights will be used to inform design basis extension or defense in depth

Current Framework



The current regulatory framework uses Risk Informed and defense in depth concepts independently with the most conservative position typically being used in the final decision

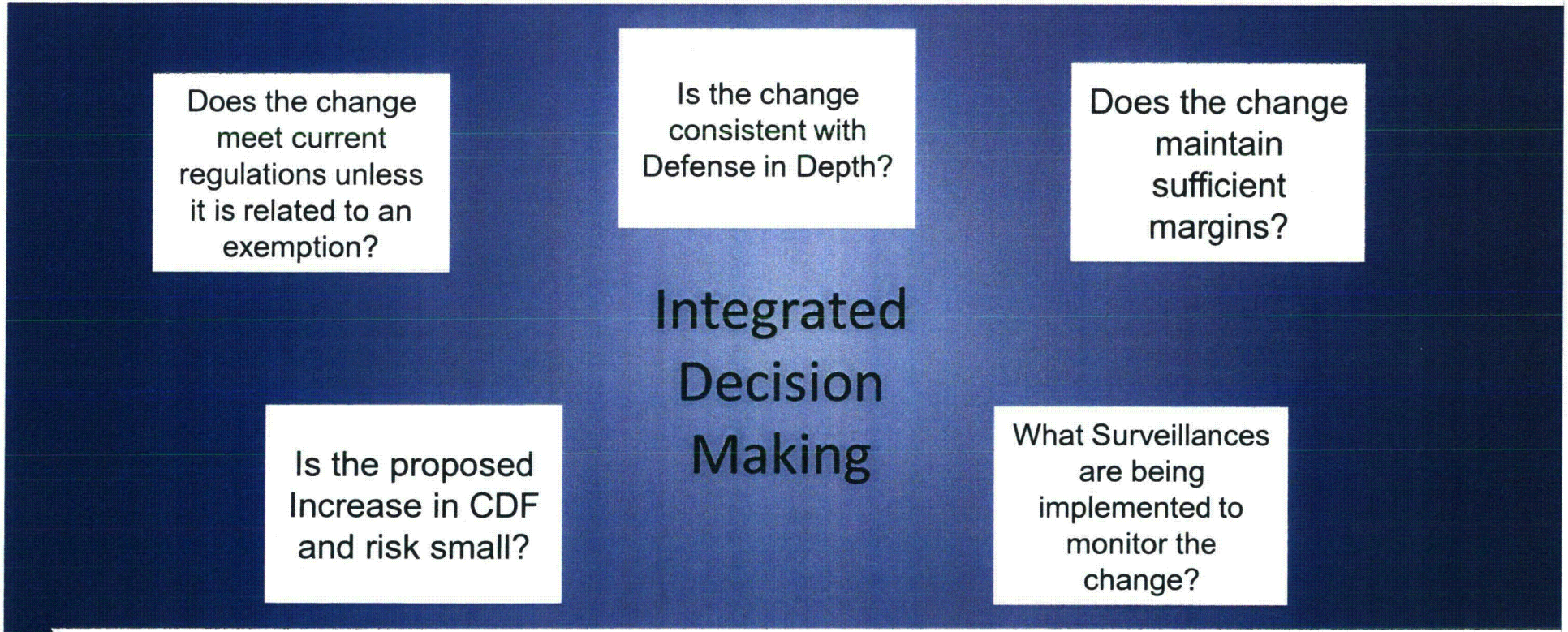
Risk Informed Framework



To appropriately risk inform regulatory activities, risk insights need to be integrated into defense-depth concepts

Risk Informed Framework

A Risk informed Regulatory needs to be built on the basic principles outlined in Regulatory Guide 1.174



Impact of Improvement Activity 1

Design Basis Extension Category

Only Applies to New Regulations	Only Uses Generic Risk Insights	Requirement to Develop Full Scope PRAs	Certain Terms Need to be Better Defined
• To be valuable this category needs to apply to existing and new regulations	• Plant Specific insights should be incorporated so important safety enhancements are not overlooked	• This requirement only increases the resource burdens on the plants • If implemented appropriately plants should see building PRA models as cost effective	• "Significant safety concern" and "adequate protection" need to be defined to ensure consistency in decision making

Impact of Improvement Activity 2

Expectations of Defense-in-Depth

The Need for Full Scope PRA Models

- Although there is no written requirement in this activity for a full scope PRA model, it is inherently necessary for realistic implementation
- Though the purpose of recommendation 1 is to work with plant resource limitations to maximize safety, this necessity will only increase the resource burdens on plants

Risk Aggregation and Quantitative Criteria

- Levels of uncertainty vary widely between internal and external events model which leads to an unrealistic single aggregate value and ultimately ineffective identification of safety improvements
- Relative risk contributions from each hazard should be evaluated to provide better risk insights
- Estakeholder engagement is requested for any quantitative criteria development to identify potential issues

Impact of Improvement Activity 3

Role of Voluntary Initiatives

The RMSC supports the NEI recommendation that there is no need for any NRC initiative regarding voluntary initiatives.

- The NRC has *not identified any systematic, industry-wide problem that would suggest that the industry as a whole is not following through on its commitments to implement these voluntary safety enhancements.*

Costs of Developing Full Scope PRA Models

PRA Full Scope [a]	Development Cost [b]	Maintenance Cost [c]
Internal Events	$1500K	$150K
Internal Flood	$500K	$100K
Fire	$5000K	$500K
Seismic	$3000K	$300K
Other External Events	$500K	$50K
LPSD Internal Events & Flood	$1000K	$200K
LPSD Seismic & Other External Events	$500K	$50K
LPSD Fire	$2000K	$200K
Spent Fuel Pool	$500K	$50K
Level 2 PRA	$1000K	$100K
TOTAL	$15,500K	$1,700K

(a) LPSD, SFP, and Level 2 are not currently part of the PRA Standard (ASME/ANS PRA Standard RA-Sa-2009). For these technical areas, Standards have been drafted or are being considered.
(b) Development Costs: estimated costs for the "average" PRA, assuming starting from scratch.
(c) Maintenance Costs: estimated 10-year costs, assuming 3 Internal Events PRA updates of data and plant changes and 1 update of all other PRAs over 10 years.

Conclusions

The existing regulatory structure provides an adequate level of safety but is overly conservative with regard to some safety issues and for some plants

Risk-Informed regulation should be applied to both current and future regulations

Risk-Informed regulation should use generic risk insights to focus regulatory control

Allow a plant-specific option for PRA-specific insights to prioritize safety issues. This would allow utilities to leverage the large cost of developing and maintaining full scope PRAs

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Developments in Safety Requirements for NPP Design

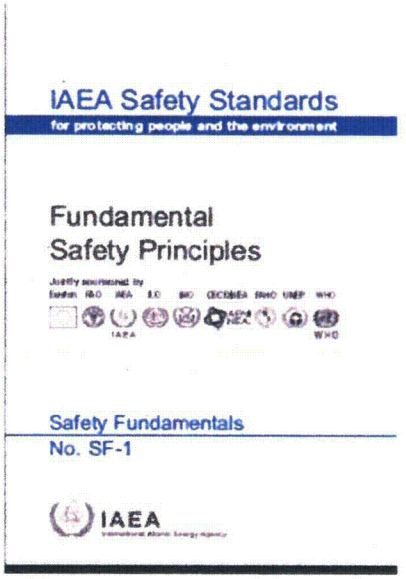
January 10, 2014

James E. Lyons

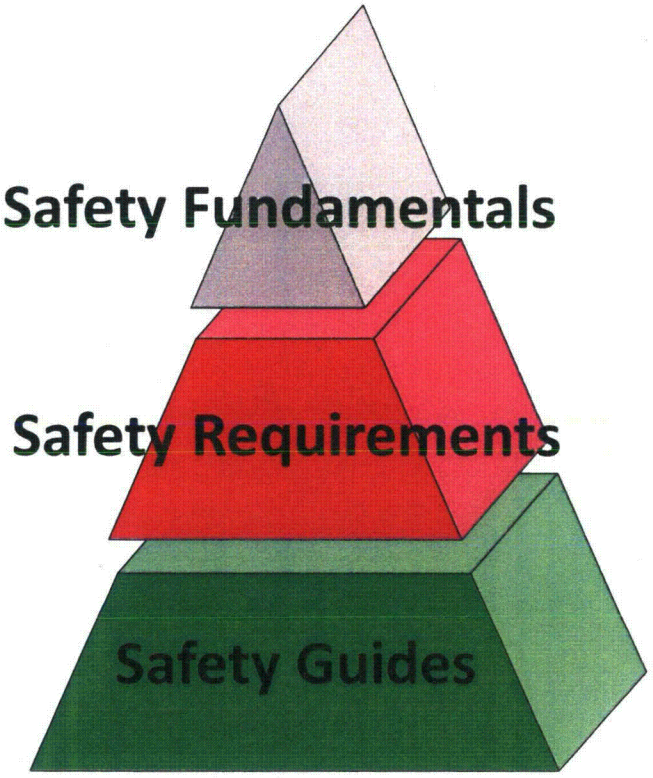
Director Nuclear Installation Safety

Department of Nuclear Safety and Security

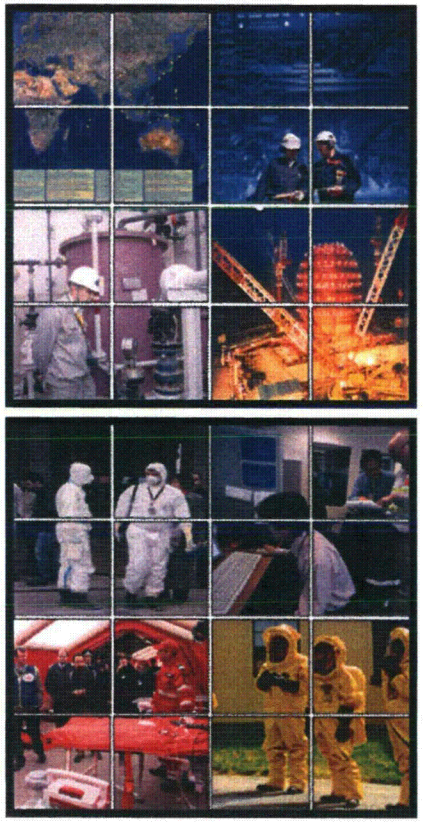
Safety Standards Hierarchy



Global reference point for a high level of nuclear safety

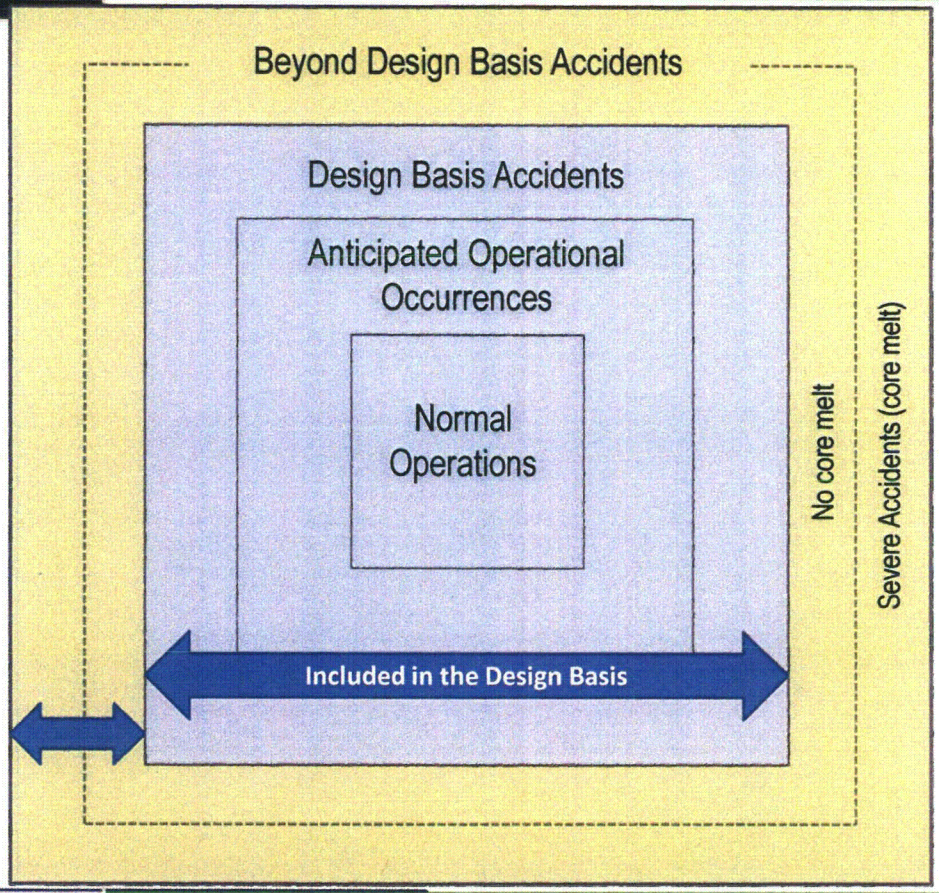


Defence in Depth



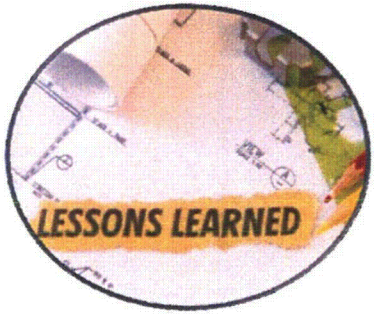
- *Defence in Depth in Nuclear Safety*, (INSAG-10, 1996)
- *Safety of Nuclear Power Plants: Design* (IAEA Nuclear Safety Requirements, No. NS-R-1, 2000)
- *Safety of Nuclear Power Plants: Design* (IAEA Specific Safety Requirements, No. SSR-2/1, 2012)

Defence in Depth



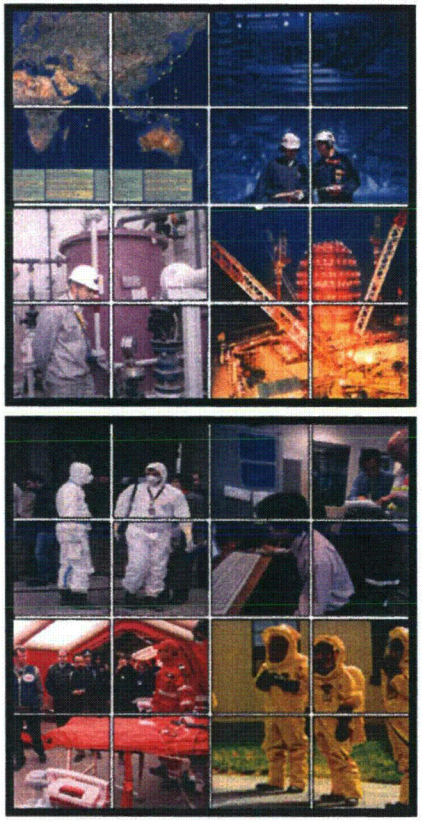
NS-R-1, 2000

Design Extension Conditions
SSR-2/1, 2012



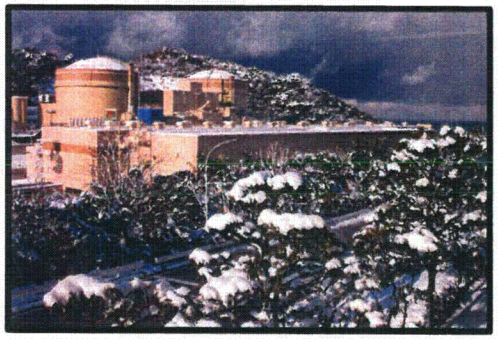
- Accidents that are either more severe than design basis accidents or that involve additional failures.
- Capable to withstand without unacceptable radiological consequences
- Derived on the basis of:
  - Engineering judgment
  - Deterministic assessments
  - Probabilistic assessments

Design Extension Conditions
SSR-2/1, 2012



- Identify the additional accident scenarios to be addressed in the design.
- Plan practicable provisions for the prevention of such accidents or
- Mitigation of their consequences if they do occur.

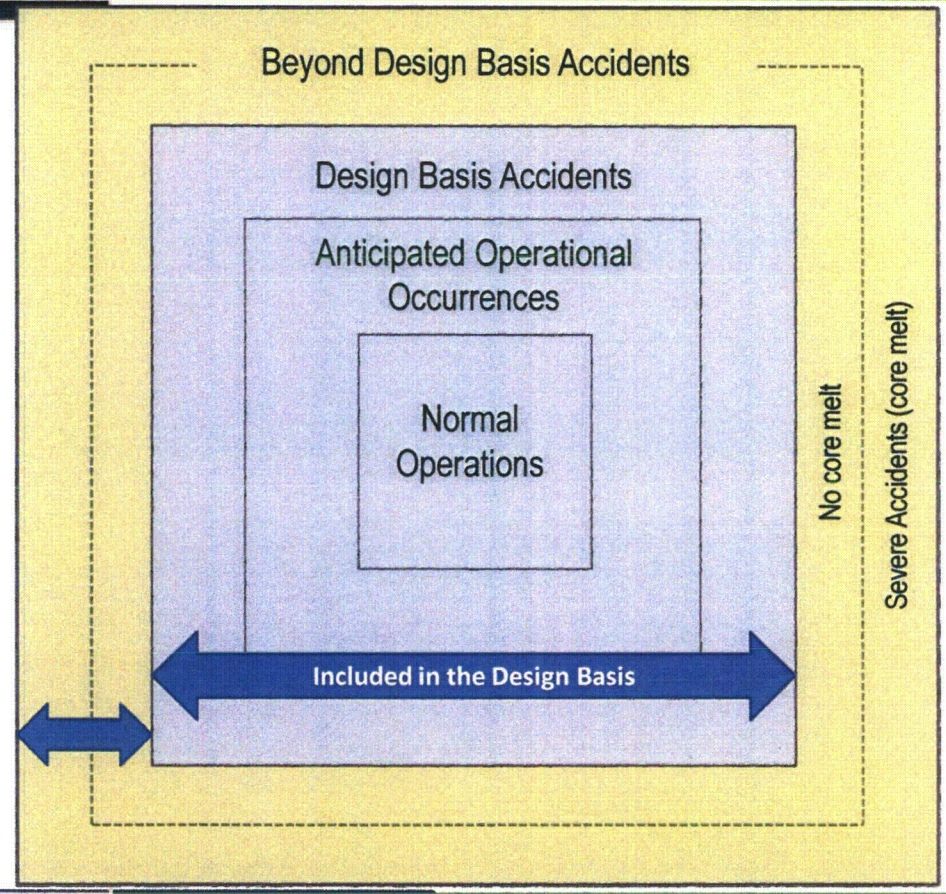
Design Extension Conditions
SSR-2/1, 2012



- Conditions that could lead to significant radioactive releases are practically eliminated
- If not practically eliminated
  - Only protective measures that are of limited scope in terms of area and time shall be necessary for protection of the public
  - Sufficient time shall be made available to implement these measures

Defence in Depth

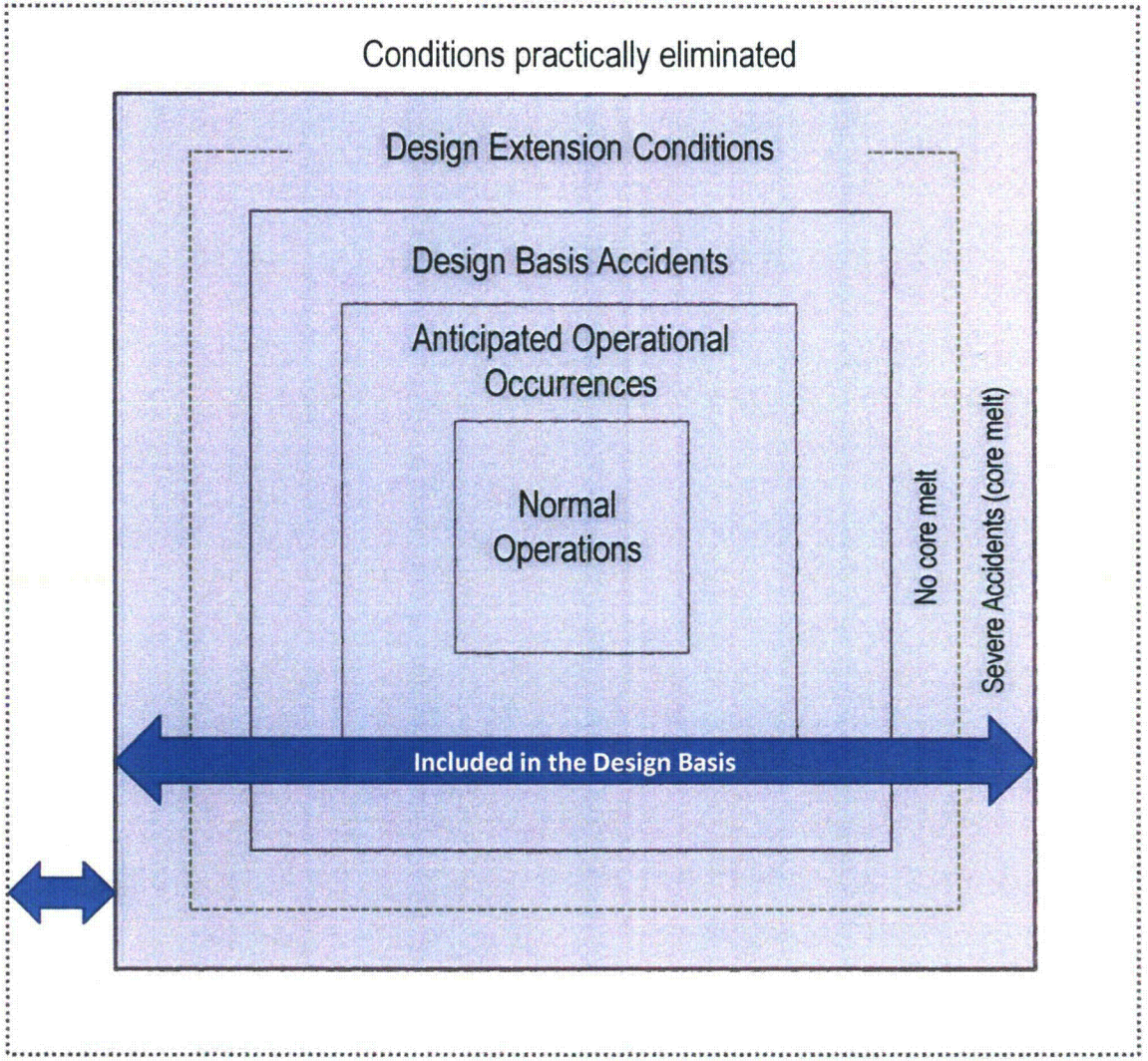
NS-R-1, 2000 versus SSR-2/1, 2012



NS-R-1, 2000

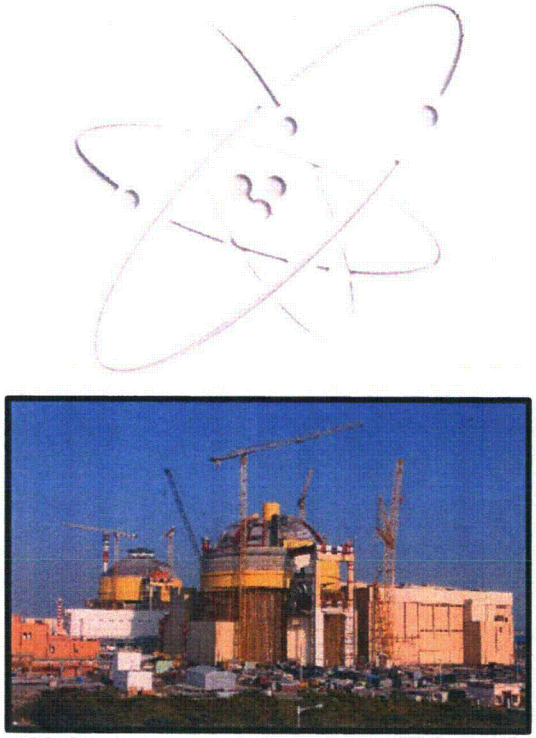
Defence in Depth

NS-R-1, 2000 versus **SSR-2/1, 2012**



SSR-2/1, 2012

Safety Features for Design Extension Conditions



- Capable of managing accident conditions in which there is a significant amount of radioactive material in the containment
- Plant shall be designed so that it can be brought into a controlled state and,
- Containment function can be maintained

Working to Protect People, Society and the Environment

UCS Views on NTTF Recommendation 1 and the NRC Staff Proposal

January 10, 2014

Dr. Edwin S. Lyman
Senior Scientist
Union of Concerned Scientists

UCS View on Severe Accidents

- **Vulnerability of the fleet to severe accidents remains unacceptably high**
- **Flawed risk and regulatory analyses have been used to paper over these problems**
- **The NRC has squandered multiple opportunities to address this problem over the decades**
  - **Post-TMI reforms**
  - **Severe Accident Policy Statement**
  - **IPE/IPEEE**
  - **License renewal**
- **After Fukushima, will the NRC once again avoid doing what needs to be done to protect public health and safety?**

NTTF Recommendation 1

- **A comprehensive overhaul of the flawed regulatory patchwork highlighted by the NTTF is needed**
- **UCS disagrees with the Staff's rejection of the comprehensive reforms proposed in NTTF Recommendation 1**

NTTF Recommendation 1

- **Staff's statement that maintaining the existing regulatory framework is a "viable and acceptable alternative" undermines the NTTF's conclusion that "the NRC's safety approach is incomplete without a strong program for dealing with the unexpected, including severe accidents"**
  - **Have resolutions of generic issues such as upstream dam failures been well-served by the current process?**

UCS View on Staff Proposal

- UCS disagrees with many aspects of the Staff proposal
- UCS supports a design-basis extension rule that would mandate retrospective, site-specific application of regulatory framework reforms
  - Otherwise the NRC will be merely "fighting the last war"
- NRC should provide additional resources so that this activity does not detract from programs that address known safety and risk issues

A Revised Framework

- **Revised regulatory guidance should**
  - **Regulate severe accidents more tightly – e.g. at the 95th percentile, not the mean**
  - **Increase geographical extent of accident consequences when appropriate**
  - **Consider qualitative aspects (e.g. land contamination)**
  - **Give more weight to defense-in-depth**
  - **Use risk analysis only when high-quality, full-scope PRAs are available and with appropriate consideration of uncertainty**
  - **Result in logical outcomes (e.g. mitigation equipment should be qualified to survive the event it is intended to mitigate)**

A Retrospective, Comprehensive, Site-Specific Review

- **New IPE/IPEEE program**
  - **Consistent methodology across the fleet**
- **New SAMA analyses using revised guidance**
  - **Every plant that has applied for license renewal already has a SAMA analysis**
  - **"Stress tests" to assess margins and identify cliff-edges**
  - **Required implementation of *all* safety improvements that the new analysis determines to be beneficial**

Improvement Activity #1

- **UCS disagrees with Staff that more comprehensive reform to fix the regulatory "patchwork" is not necessary given other post-Fukushima actions**
- **Staff claims that "site-specific vulnerabilities related to seismic and flooding events are being addressed by the post-Fukushima actions"**
  - **but not in a manner consistent with Recommendation 1**

Improvement Activity #1

- **Current approach may only add more patches**
  - **From NRC staff presentation, Aug 22, 2013:**
    - **"Audits ... revealed inconsistencies from site-to-site with respect to ... evaluation of APM" and "consideration of potentially significant safety consequences"**
    - **December 23, 2013 RAI went out to over 80% of licensees**
  - **Points of contention between staff and licensees on mitigating strategies integrated plans include 'identification of maintenance and testing programs for related equipment and procedures"**
- **Placing "adequate protection" and "safety enhancement" requirements in the same "design-basis extension" category may only increase confusion**

Improvement Activity #2

- **The balance has shifted too far toward reliance on the results of faulty risk calculations without appropriate consideration of uncertainty**
- **Regulatory analyses should systematically consider and give greater weight to defense-in-depth**
- **UCS agrees with ACRS that Improvement Activities #1 and #2 are fundamentally linked and should not be considered separately**
- **Would help make better decisions on issues including**
  - **Hydrogen control/mitigation**
  - **Filtered vents**
  - **Expedited spent fuel transfer**
  - **Emergency planning (e.g. expanded EPZs)**
  - **Security**

Improvement Activity #3

- **NRC should not credit voluntary industry initiatives to meet regulatory requirements**
  - **For protection against severe accidents in current framework**
  - **For protection against extended design-basis accidents in a revised framework**
- **NRC needs full inspection and enforcement authority to ensure compliance measures are properly implemented and maintained**
- **Situations like the so-called resolution of GI-189 should never be allowed to happen again**

Conclusions

- **Although the staff's proposals have merit, they address only certain pieces of the fundamental problem outlined by the NTTF and as such, likely will exacerbate the patchwork nature of NRC regulations**
- **A more comprehensive approach is needed to adequately address severe accident risks post-Fukushima: Staff should have provided such an option to the Commission**

Acronyms

- APM: Available Physical Margin
- EPZ: Emergency Planning Zone
- GI: Generic Issue
- IPE: Individual Plant Examination
- IPEEE: Individual Plant Examination of External Events
- NTTF: Near-Term Task Force
- PRA: Probabilistic Risk Assessment

Acronyms

- **SAMA: Severe Accident Mitigation Alternatives**
- **TMI: Three Mile Island**
- **UCS: Union of Concerned Scientists**

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Staff Recommendations to Disposition Fukushima Near-Term Task Force Recommendation 1

Improving NRC's Regulatory Framework

January 10, 2014

Agenda

1. Recommendation 1

- Background and Conclusions — Michael Johnson
- Overview of Improvement Activities — Jennifer Uhle
- Details of Improvement Activities — Richard Dudley
- Near-Term Task Force (NTTF) Perspective — Gary Holahan
- Next Steps — Michael Johnson

2. Status of Tier 1 Activities — Dave Skeen

3. Concluding Remarks — Mark Satorius

Background

- **Establish "a logical, systematic, and coherent regulatory framework"**
- **Pursue Recommendation 1 "independent of ... other Task Force recommendations"**
- **"[P]rovide options and a staff recommendation to *disposition*"**
- **Consensus was difficult**
- **Recommendations represent a balance of diverse views**

Staff Conclusions

- Current regulatory framework is robust and can maintain safety
- Can implement Fukushima lessons learned under current framework
- Some improvements to framework are warranted to enhance clarity, efficiency, and effectiveness of NRC's regulatory process

Process

- **Staff from all program offices; Oversight by Office Director Steering Committee**

- **Substantial public outreach**

Improvement Activities

1. Establish design-basis extension category of events and associated regulatory requirements
2. Establish Commission expectations for defense-in-depth
3. Clarify role of voluntary industry initiatives in NRC regulatory process

Improvement Activities

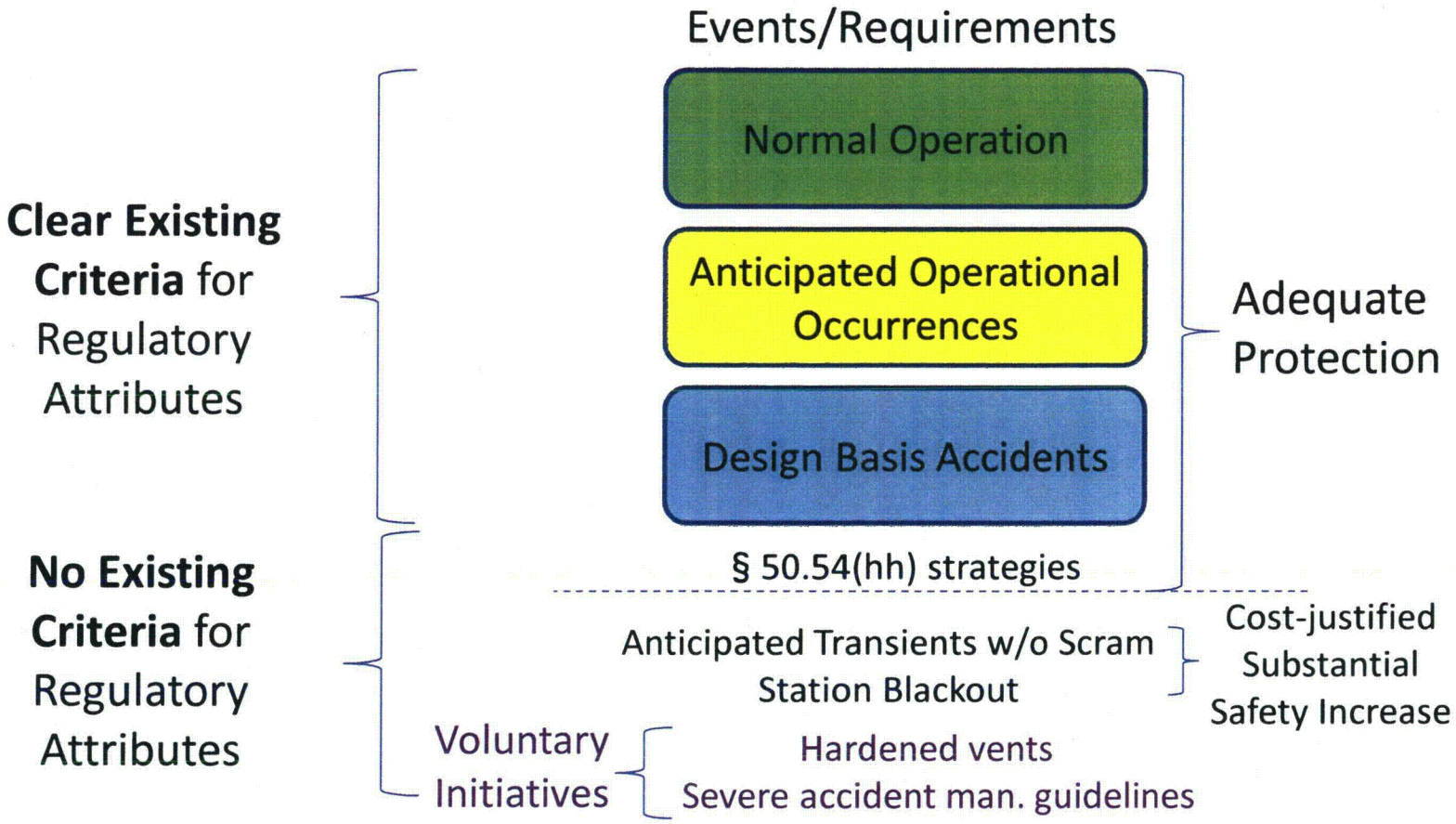
- **Not mutually exclusive options**
- **Maximize potential benefits while minimizing resource impacts**
- **Recommendations will likely result in modest safety enhancements**

Coordination with RMTF

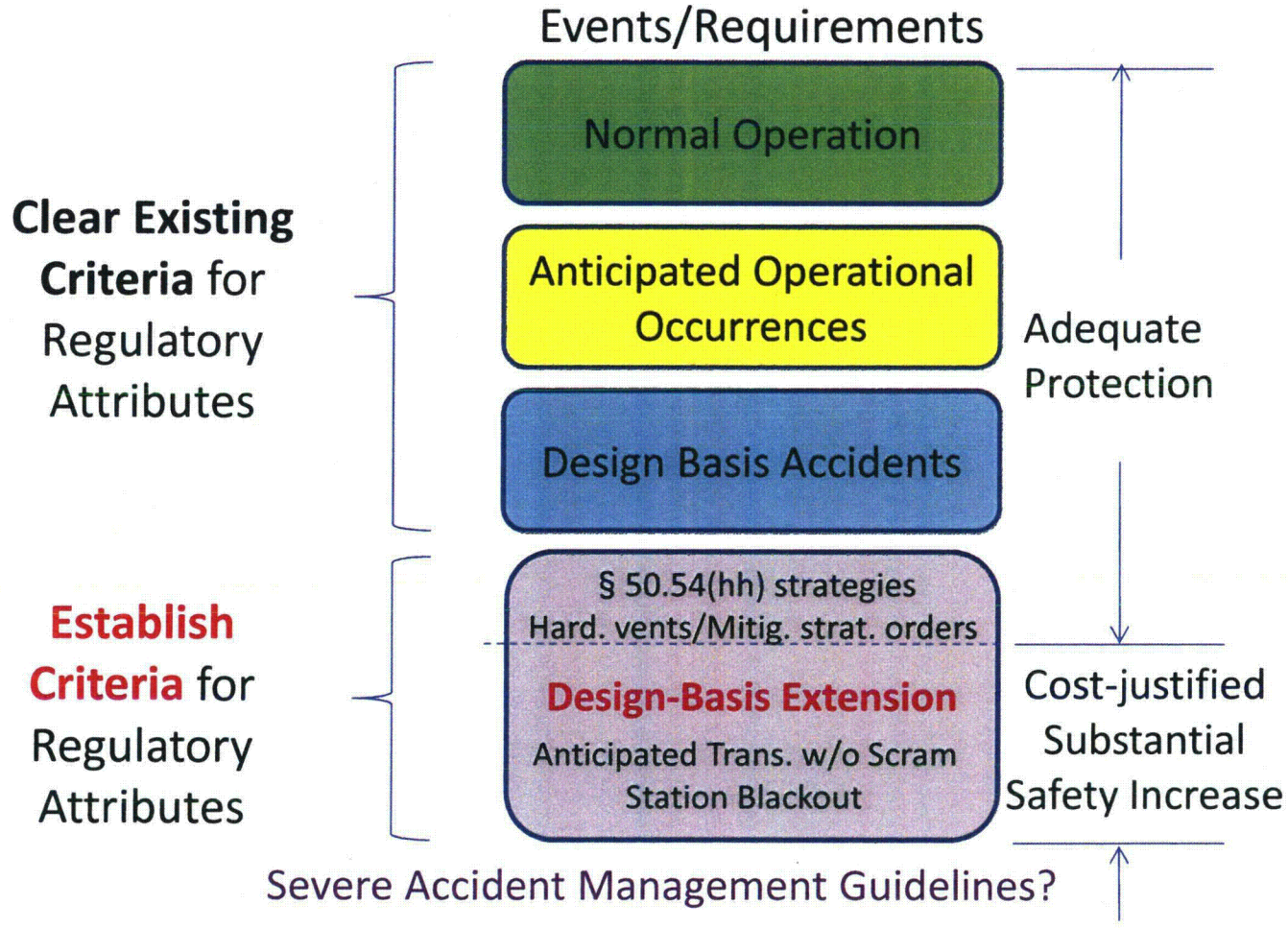
- Considered Risk Management Task Force (RMTF) framework recommendations for power reactors in NUREG-2150
- Commission direction on Recommendation 1 will be considered when staff addresses RMTF recommendations

Improvement Activity 1: Design-Basis Extension Category of Events and Associated Regulatory Requirements

Current Regulatory Structure



Design-Basis Extension Category



Design-Basis Extension Category

- Generic basis
- Adequate protection and cost-justified substantial safety enhancements
- Regulatory attribute guidance in NUREG
  - Treatment requirements, quality assurance, change process, Final Safety Analysis Report documentation, training, analysis methods, etc.
- Implement via internal staff guidance

Design-Basis Extension Category

- **Applies to current and future licensees/applicants**
- **Applies to new/additional design-basis extension requirements**

Identification of New Issues

- Use existing processes to identify and address candidates for this category, e.g. operating experience program, industry trends program, etc.
- Thus, no retroactive search for additional design-basis extension events is needed

Potential Benefits of the Design-Basis Extension Category

- **Promotes openness**
  - **Clarity and a common terminology**
  - **Consistent/complete approach to future requirements for all regulatory attributes**
  - **Aids the public's understanding**
- **Improves efficiency**
- **Increases alignment with international standards**

Improvement Activity 2: Establish Commission expectations for defense-in-depth

Defense-in-Depth (DID)

- **Improvement Activity 2 will develop**
  - **DID definition**
  - **DID structure**
  - **Set of DID principles**
  - **Set of levels of defense**
  - **DID decision process**
  - **Set of DID decision criteria**
    - **Include in Regulatory Analysis guidelines**
    - **Integrate with risk-based decision criteria**

Potential Benefits of the Defense-in-Depth Activity

- Promotes efforts to ensure safety
  - Uniform, technically-justified concept
  - Enhances risk-informed decisonmaking
- Promotes openness, clarity, reliability
  - More efficient, timely, predictable decisions
- Involves international community

Improvement Activity 3: Clarify the role of voluntary industry initiatives in the NRC regulatory process

Current NRC Policy

- Industry initiatives may not be used for adequate protection issues
- NUREG-BR-0058, Rev. 4
  - Supports reliance on industry initiatives
  - Credits them in decisionmaking
- No uniform review/acceptance process
- No formal verification process

Improvement Activity 3:

- **Re-affirm industry initiatives may not be used to address adequate protection issues**
- **Credit only when well-documented and highly likely to be maintained**
- **Develop oversight guidance**
- **Review existing initiatives; verify implementation as appropriate**

Potential Benefits of Activity 3 on Voluntary Initiatives

- **Safety benefits consistently maintained over time**
- **Improves clarity of NRC regulatory processes**
  - **Clear criteria on use of voluntary initiatives**
  - **Visibility to all stakeholders**
  - **Defines oversight of voluntary initiatives**

NTTF Tasking Memo

- **Called for the Task Force to:**
  - **"evaluate all technical and policy issues to identify...adjustments to the regulatory framework" and**
  - **"determine whether the agency should make additional improvement to our regulatory system and make recommendations to the Commission for its policy direction"**

Task Force Evaluation

- The current regulatory approach has served the Commission and the public well
- The NTTF also concluded that the regulatory system could and should be enhanced

NTTF Recommendation 1

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

... enhancing ... the NRC regulatory framework to encompass beyond-design-basis events

Task Force Envisioned:

1. Coherent risk-informed and defense-in-depth regulatory framework
2. Addressing safety-significant issues beyond the design-basis (including severe accidents)
3. Generic and plant-specific issues

Task Force Envisioned:

4. Requiring plant-specific PRAs
5. Increased clarity of the role of defense-in-depth in integrated regulatory decision-making
6. Increased clarity and oversight of voluntary initiatives

Proposed Activities:

- Positive and practical steps toward a clearer, more risk-informed regulatory process
- More can and should be done:
  - consistent with PRA Policy
  - consistent with NTTF vision
  - consistent with ACRS views
  - embracing Risk Management and other PRA initiatives

Recommendation 1
Next Steps

- **Staff will provide implementation plans 6 mo. after SRM on Recommendation 1**
- **Recommendation 1 implementation plans will be integrated with plans for addressing the Risk Management Task Force recommendations**

Overview

- **Implementation of lessons-learned is progressing at all plants**
- **Plants are better prepared for beyond design-basis events today than they were 3 years ago and will be even more prepared by the end of 2016**
- **Still a lot of work to do over the next 3 years**

Status of Tier 1 Activities

- **Orders**
  - **Mitigation strategies for beyond design basis external events**
  - **Containment venting system for Mark I and II containments**
  - **Spent fuel pool water level instrumentation**

Status of Tier 1 Activities

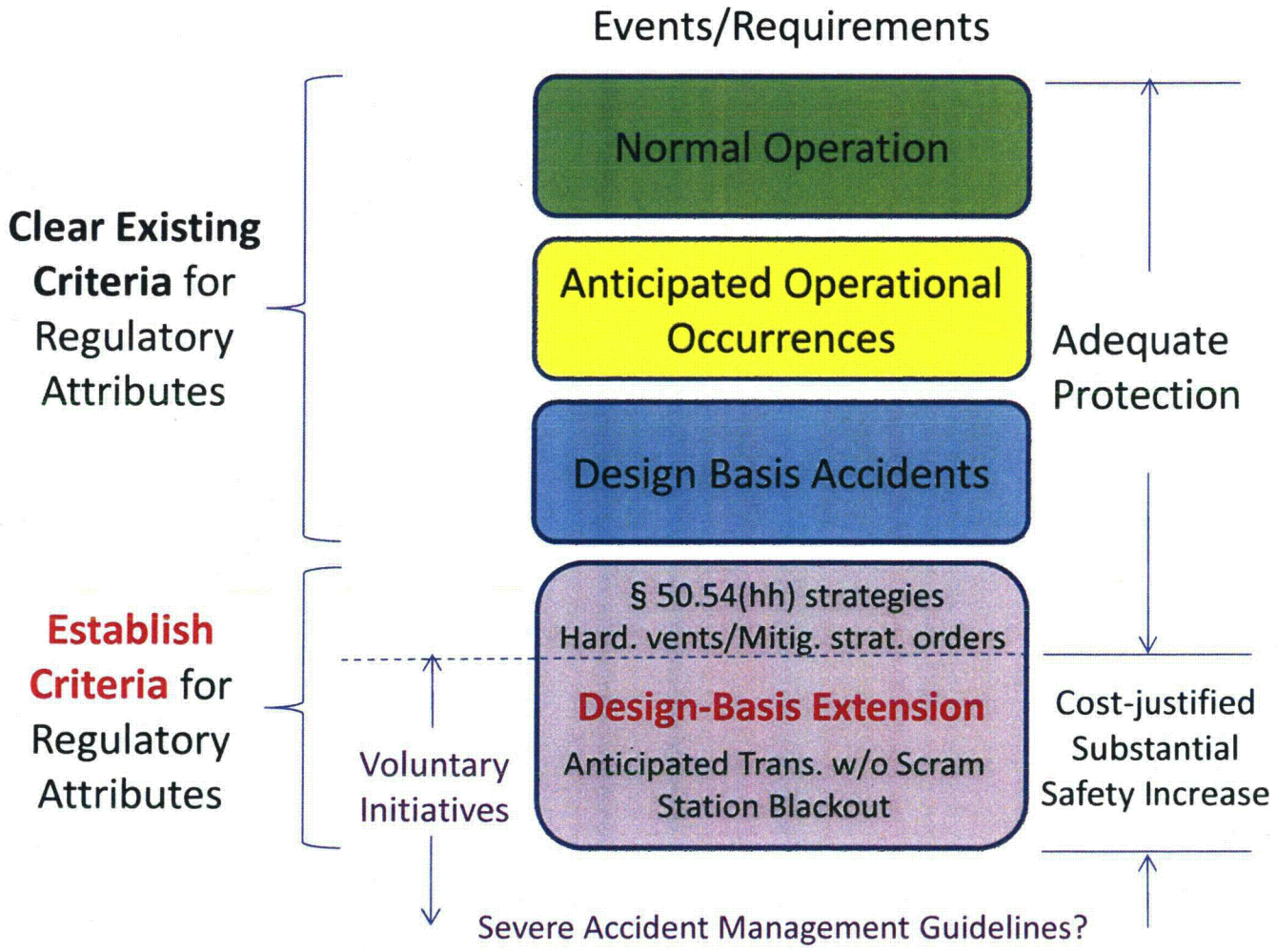
- **Request for Information**
  - **Seismic and flooding walkdowns (completed Nov. 2012)**
  - **Seismic and flooding hazard reevaluations**
  - **Emergency Preparedness staffing and communications**

Status of Tier 1 Activities

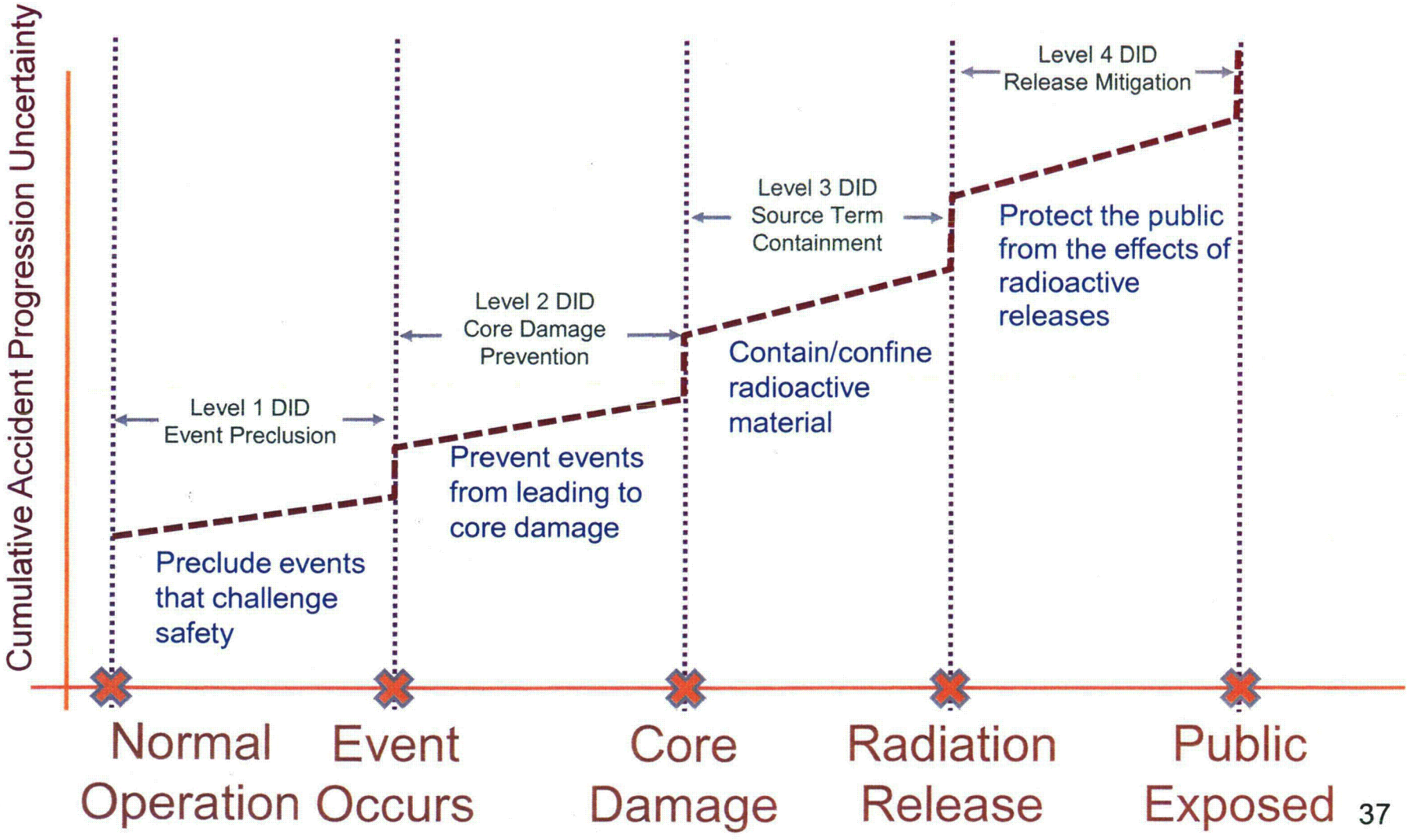
- **Rulemakings**
  - **Station Blackout Mitigation Strategies (SBOMS)**
  - **Onsite Emergency Response Capabilities**
  - **Filtering Strategies**

Backup Slides

Design-Basis Extension Category



Nuclear Power Reactor Defense-in-Depth May Consist of Four Levels



NRCExecSec Resource

From:	Bob Budnitz <budnitz@pacbell.net>
Sent:	Monday, December 30, 2013 4:26 PM
To:	NRCExecSec Resource
Subject:	Robert Budnitz letter to NRC on SECY-13-0132 (Dec. 30, 2013)
Attachments:	Robert Budnitz letter to NRC on SECY-13-0132 (Dec. 30 2013).pdf

TO:
Annette L. Vietti-Cook
Secretary, US Nuclear Regulatory Commission

FROM:
Robert J. Budnitz
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Attached as a PDF file is a letter that I am submitting to you as a public comment on SECY-13-0132, "Staff Recommendation for the Disposition of Recommendation 1 of the Near Term Task Force Report." I am directing this to the Commissioners, and will also send a copy to Mark Satorius (EDO) for his information.

I have written this as a private citizen, as the introductory paragraph of the letter explains. Can you please acknowledge receipt? An email reply wold be sufficient.

Sincerely,
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30 December 2013

TO: Annette L. Vietti-Cook
Secretary, US. Nuclear Regulatory Commission
(sent by email to NRCExecSec@nrc.gov and intended for the Commissioners)

COPY TO: Mark Satorius, NRC Executive Director of Operations

SUBJECT: Individual public comment on SECY-13-0132 (December 6, 2013), "Staff Recommendation for the Disposition of Recommendation 1 of the Near Term Task Force Report"

INTRODUCTION and BACKGROUND

I am writing this as a private citizen. This note is intended to provide my personal input to assist the NRC Commission as it deliberates on the staff recommendations in SECY-13-0132 concerning Recommendation One of the NTTF Report.

I am employed at the University of California's Lawrence Berkeley National Laboratory (LBNL), one of the DOE national laboratories. However, I am not a stranger to the NRC -- I was once (1979-1980, a long time ago) the Director of NRC's Office of Nuclear Regulatory Research (RES), and in the intervening years, after leaving the NRC staff in 1980, I have worked as a contractor on a wide variety of NRC projects, mostly for RES but a few for NRR and recently NRO. Most of these projects have been technical (that is, research to develop new knowledge or new methods), but a few have been more directly related to improving a specific regulatory approach or assisting the NRC staff in reviewing an applicant's or licensee's submittal. For decades, and based in part on my early experience as RES Director, I have had a special interest in seeing that the NRC is well focused on fulfilling its safety mission, and that it carries out its work effectively and efficiently. This note is being written with that as a motivation.

For 5-plus years, I have been the Principal Investigator on a set of several interlocking LBNL projects funded by NRC-RES (Office of Nuclear Regulatory Research), all related in one way or another to the issue of the seismic safety of LWRs. One of these projects, NRC-RES Project V6159, underway since August 2010, is called "*Technology-Neutral Framework for Performance-Based and Risk-Informed Approaches for Structural and Seismic Safety.*"

In the course of this NRC-supported work over the past few years, I have developed a set of ideas about how to improve the way the NRC regulations and other regulatory positions deal with the seismic safety of large LWRs. These ideas have led me to the technical proposals that I will write about below, but I need to insist that this is a letter from a private citizen, not endorsed by anybody else, and not necessarily what will emerge at the end of my current NRC-supported project in this same area.

However, I would be remiss if I didn't note that, in the course of the NRC project noted above, I have written a draft report that will perhaps be published as a NUREG/CR report, if and when it gets through the NRC staff review process. The draft report is entitled, "*Toward a More Risk-Informed and Performance-Based Framework for the Regulation of the Seismic Safety of Nuclear Power Plants.*" It lays out an approach for a rather thorough revisiting of the way NRC regulates the seismic safety of LWRs, based on risk-informed and performance-based ideas.

And that is the idea that I wish to advance here. (See below.) My specific ideas about how to revisit the way seismic safety of LWRs is regulated are intended to be an example of how to approach the larger issue of revisiting the body of LWR safety regulations more generally – I therefore proffer the issue of seismic-safety regulation of large LWRs to the Commission as an example or as a "case study."

NTTF RECOMMENDATION ONE

The reason for this note is that I am very disappointed with the NRC staff response in SECY-13-0132 to the NTTF Report's Recommendation One. I will explain why, and will make recommendations about what different course might be taken to alleviate my disappointment. I will concentrate exclusively on the safety regulation of large LWRs.

When I studied the NTTF report two years ago, I was very much struck by NTTF Recommendation One, which says that the NRC ought to establish a "*logical, systematic and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations.*"

I thought (and still think) that this was intended to be a potential vehicle for a broad-based and fundamental revisiting of the framework of regulation, to incorporate a range of risk considerations into NRC's reactor-safety regulations in a way that is not present now, or at least is only present sporadically rather than consistently in those regulations. Specifically, while the current NRC regulations for LWR safety do a pretty good job of incorporating defense-in-depth ideas, they do only a sporadic and inconsistent job of using risk considerations in the regulations. Compared to what I think should be the approach vis-à-vis Recommendation One, the staff in SECY-13-0132 recommends a much more limited set of actions to achieve a much more limited set of objectives. These actions and objectives are all worthy, but in my personal view they are far from what could be accomplished by taking a broader view.

In the technical area I'm addressing here, the seismic safety of LWRs, I believe that a fundamental revisiting of the way NRC regulates has great promise of achieving a number of important endpoints. I believe that, if guided by appropriate NRC Commission policies, there is a good prospect that the community of experts (both on

the NRC staff and in the affected industry, and with input from the broader public) can produce a set of regulations (and Regulatory Guides, Standard Review Plan sections, other staff positions, inspection modules, etc.) that in this technical area would represent a more rational basis for regulation, would use staff resources more effectively, would be a basis for more effective use of industry resources to meet the regulations, would make the safety of our LWRs more understandable, would save lots of industry and NRC money, and most importantly would improve safety (although the safety achieved today in this area is generally more than adequate in my view.) That list of potential benefits sounds like "too good to be true," but in my view it is certainly within reach in this technical area. I can't prove it, but realizing each of those benefits seems more than plausible to me: it seems obvious, albeit in different measures for different situations.

Given the above, I have been hoping first that the Commission (in response to NTTF Recommendation One) would set in place policies to encourage (perhaps even require) revisiting the LWR safety regulations systematically. I have further been hoping that, if this were to occur, the staff might choose the seismic-safety area as one "case study" to examine how much could be accomplished, how, and why. My disappointment is because I see almost nothing even close to being that expansive in my reading of SECY-13-0132. I am very much disappointed in how narrowly the SECY paper interprets what I read into Recommendation One, and I want to try to affect the agency's deliberations. Hence this note.

THE TECHNICAL BASIS FOR MY RECOMMENDATIONS

My technical argument in the seismic-safety area goes as follows. Here I will only touch on the highlights, will leave out some elements of my overall recommended approach, and will only explain the most fundamental reasons why revisiting the seismic-safety regulations makes sense. (Further details are in the draft report mentioned above, but that report is still in draft form awaiting review, and I don't want to rely on it here. This is a letter from me acting as a private citizen.)

My argument has the following elements:

o When the current seismic-safety regulatory positions (CFR, SRP, Reg Guides, staff positions, etc.) was put in place, mostly in the 1960s-1970s-1980s time frame, nobody could do realistic analysis of how the plants actually behave in large earthquakes. Hence, nobody could quantify the "margins," nor understand the major "risk contributors," nor know "how safe the plants are" against a figure of merit like the annual core-damage frequency (CDF), nor know where there might be leverage for changes to improve things.

o Today we can do that realistic analysis – so we can quantify the "margins" (albeit with some uncertainty), we can and do understand on a plant-specific basis the major contributors to the seismic part of the overall risk profile, we can compare our understanding to figures of merit like CDF, and we can ascertain where today's regulations can be improved, even though they already lead to plants that are "adequately safe."

o The improvements in our knowledge have occurred in several different technical areas: we understand the seismic hazard better; we understand how to analyze the seismic capacity of our structures and components better; we can do better systems analysis to understand how the safety of the whole emerges from and depends on the "parts"; and we have an NRC-endorsed consensus-based American National Standard (the ASME-ANS PRA standard) that guides how this analysis is to be done properly. We therefore have a basis for "rationalizing" the seismic regulations using risk-informed and performance-based insights that we didn't have even a decade ago.

o However, there is much more to it. Let me explain starting with the issue of the various code committees. When the AEC and early NRC were putting together the NRC's seismic-safety regulations and the Reg Guides etc. for LWRs, they asked the various consensus code committees to take then-current (non-nuclear) codes and standards for seismic-safety design and analysis and convert them to "nuclear" codes and standards – there was to be more margin, embedded QA, better and more prescribed analysis, better review and inspection, and so on. Each code committee complied, with of course lots of AEC/NRC staff input. These consensus codes have been updated over the years, but this early work (and especially the philosophy embedded in the codes at that time) is still essentially still in place, and it provides the fundamental basis for today's NRC regulation of seismic safety of LWRs. Thus, concrete in NRC-regulated LWRs is to be designed and analyzed for seismic safety according to ACI codes; mechanical equipment according to ASME codes; structures according to ASCE codes; electric equipment (transformers, DC buses, etc.) according to IEEE codes, and so on, based on hazard inputs take in part from ANS standards. [1]

o Of course, each code committee embedded "margins" in their codes, as is necessary, but each did it (appropriately) with different technical issues in mind. Crucially, each did their work independently of the others.

o Let me give a stylized example: Imagine an LWR heat exchanger whose tank is designed and qualified for seismic safety under ASME, sitting on a concrete pad designed under ACI, connected to an electrical bus done under IEEE, inside an auxiliary building done according to ASCE, and so on. All of the designers have used the NRC's design-basis-earthquakes (the SSE, the safe-shutdown-earthquake, and the OBE, the operating basis earthquake) as the prescribed input earthquake motions. What is the item's seismic "margin," in the sense of asking how much extra seismic motion above the design basis can that heat exchanger resist before it gets into trouble in terms of performing its safety function? Well, a realistic analysis can tell us, relying where appropriate in part on test data or earthquake-experience data, and we now know how to do that analysis. However, no such realistic analysis is required by regulation. Meeting the design codes and analysis codes is sufficient. But the various design and analysis codes represent quite a mixture of very different technical considerations – each of them entirely sensible if viewed one-by-one, but an odd (perhaps even incommensurable) set of requirements when taken together. To meet NRC regulations, a "regulatory analysis" must be done and is done to meet the Standard Review Plan, checking against the

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[1] ACI is the American Concrete Institute. ASME is the American Society of Mechanical Engineers. ASCE is the American Society of Civil Engineers. IEEE is the Institute of Electrical and Electronics Engineers. ANS is the American Nuclear Society.

design basis, and if all is OK the item's safety is found to be "adequate," and hence the item is licensable. But today, while that is true, this seems highly unsatisfactory, given that we can really know so much more, but do not choose to ask!

o But there is more! Each structure or component is designed and analyzed individually to show that it meets the NRC regulations. No account is taken of the fact that various structures and components need to "work together" to make the plant adequately safe against earthquakes. It is assumed that if each item is acceptable then the system is acceptably safe. And in my judgment this is so. But the overall design is not coordinated, and this represents a waste of resources, industry resources and regulatory resources both, because the overall plant design is very much suboptimized (actually, hardly optimized at all.) Further, this represents a major lost opportunity, because of the suboptimality, and also because neither the regulator nor the industry (nor the public!) understands the overall seismic safety achieved as well as they could. Today the technical community knows how to take into account the interaction aspects of a complex design like that of a large LWR in responding to large earthquakes, by using systems-analysis methods, in both design and analysis. However, nobody requires it, and it has not generally been done.

The analyses done in the seismic PRAs bear out the observation that some items have much more seismic "margin" than others, so savings could ensue without compromising safety if things were more rationally balanced. Furthermore, if the analyses that are feasible today were used more fully in regulation, regulatory emphasis could be directed more toward those items and issues which "matter more" to seismic safety. This is the philosophy underlying the NRC's Reactor Oversight Process today, but this approach isn't used fully in the seismic-safety area, in part because not all plants have the analyses and many of those that do don't use them.

o There is still more! The "regulatory analysis" deals with the "design basis" – the NRC's design basis earthquakes (the so-called Safe Shutdown Earthquake and Operating Basis Earthquake.) Fine. However, today no full account is taken in regulatory decision-making of how the individual structures and components perform their individual safety function(s) at various beyond-design-basis earthquake loads (and furthermore, even if so, knowing individual performance wouldn't account for the behavior of the systems and functions in which these items are embedded.) Yet today we can do that analysis too. To support regulatory decisions, however, we don't.

o Still more! Today's seismic PRAs reveal that, while the plants are "adequately safe," their seismic "risk profile" is often dominated by the seismic failure of a single structure or component, albeit the dominant risk arises for earthquakes well beyond the design basis. For many operating LWRs, this seismic risk profile looks very much "out of balance" if examined carefully – a more "balanced" risk profile would not have almost all of the seismic risk of CDF dominated by a single failure. But this imbalance has generally not been accounted for in the design phase, and there has never been a mechanism with regulatory underpinnings to encourage (or require) an LWR designer to make some changes to "spread out the seismic risk" across a broader base of structural or component failures. Yet for newly designed plants, those not yet licensed and built, this is easy to accomplish if a requirement were in place to do so. The risk would be more evenly spread, the plant would be more robust, and hence the plant would be "safer" somehow.

I hesitate to call this a "defense-in-depth" issue, because those words are so "loaded," but I will: If the seismic safety (the "seismic risk profile") of an LWR relies so heavily on the performance of a single item (a structure or component), then if I suppose that that single item is somehow "weaker" than we think (because we've made an unknown error), the entire seismic risk profile of that plant would be concomitantly "less safe", and we wouldn't know it. Said another way, if we suppose that the seismic risk profile "looks fine" to the NRC as analyzed, but that the error I've just postulated exists, then isn't the NRC's understanding of the seismic risk profile in error, and aren't we all unknowingly more confident than we should be? Isn't "defense-in-depth" supposed to assure that something like this does not occur? That is, isn't such a plant relying too heavily on our understanding of that single item to keep its seismic risk profile in line?

o One other technical issue is worth discussing. Specifically, in the library of seismic PRAs on my shelf, a couple dozen in number, many of the important seismic accident sequences involve non-seismic failures or human errors as well as earthquake-caused failures. That is, some sequences involve only earthquake-caused failures, while others (perhaps a third or a half of them) require a non-seismic failure or a human error too before the sequence would lead to a core-damage accident. This observation – this "fact" -- has been known for 30 years. Yet no account is taken of this fact in how the NRC regulates seismic safety of LWRs. NRC's regulations generally address the seismic adequacy of one structure or component at a time – period. Admittedly, the seismic PRAs have generally found that the seismic CDF of our operating LWRs is in an acceptable range. But still – no regulatory requirements address this "fact" or do anything with it directly. The closest one might come is that, in a regulatory action for an operating LWR that invokes Reg. Guide 1.174, one might observe that the best way to improve the safety of a given accident sequence is to improve the non-seismic-failure or human-error aspect of that accident sequence. But that is indirect, not addressed head-on, and almost a "back-door" acknowledgment of the fact I've cited. A second way this fact might enter into seismic safety regulation is when a new design needs to meet the NRC requirement (in the SRM attached to SECY 93-087 in 1993) that the plant-level HCLPF seismic capacity meet or exceed 1.67 times the SSE. I won't devote space here to explaining why this link is also sort of a "back door" link, but that is how I see it.

In my view, although framing a set of regulatory positions to account for this fact will not be easy, and addressing it will require risk-informed thinking, leaving it permanently unaddressed, as it is now, seems to me to be unsatisfactory.

MY BOTTOM LINE

First, in my opinion advances like those I seek in the seismic-safety area will not likely occur without the NRC being "at the front of the charge." To be sure, the NRC cannot do this alone. Crucially, the consensus code committees play a vital role (and appropriately so!), but in my view not enough progress will happen without the NRC playing a leadership role. This means that the Commission needs to set in place the right set of policies, and the staff needs to devote its resources to the effort (meaning staff expertise in NRR and NRO as well as in RES, funds to help support the code committees, and funds for research projects to develop specific technical bases.)

Also, because this is fundamentally an issue of revising regulations and supporting regulatory positions, the leadership in this area needs, in my view, to come from NRR

and NRO, with RES playing a supporting role as needed. If the Commission turns this over to RES, without requiring NRR and NRO to be intimately involved from the top, it will likely "get lost." I know – I was once the Director of RES. And this is not casting aspersions on the RES leadership, whom I greatly admire.

Specific to the seismic-safety technical area, I recommend that the "community" of reactor-seismic-safety experts, working in part through the code committees and with strong NRC involvement, establish a 5-to-10-year program to address each of the technical issues I've raised above, one-by-one but beginning all-at-once. The goal is to come up, some years hence, with a much more rationalized approach to regulating seismic-safety design and analysis. Because current NRC regulatory positions lean so heavily on the consensus industry codes and standards (and appropriately so!), working though the code committees, as best I can figure, is the only way to get this program of work done.

o The outcome would be, in the reactor-seismic-safety area, a new set of regulatory positions that address head-on the issues that led the NTTF Task Force to write NTTF Recommendation One. The work would also – and not by accident – address head-on part of what the NRC's Risk Management Task Force seems to be seeking to do in NUREG-2150. I did not write "not by accident" because I used NUREG-2150 as a basis – far from it, because I had this whole set of ideas mostly framed in my mind before NUREG-2150 was published. This is "not by accident" because I am by no means alone in trying to think through how to make our seismic safety regulations more rational, more understandable, less expensive for regulators and licensees, and also able to achieve safety advances more rationally too.

o One other issue is very much worth mentioning, and that is my opinion on how difficult this work might be. In my opinion, bringing NRC regulations in seismic safety more in line with the thinking above would not be breaking totally new ground. To its credit, the U.S. Department of Energy's regulatory approach in this technical area has been miles ahead of NRC for a long while. Their DOE Standard 1020 has for many years (since 1994, revised in 2002) been using many (not all, but many) of these risk-informed and performance-based concepts for both design and evaluation, so as to assure adequate seismic safety of DOE's own nuclear facilities. Furthermore, at least one of the relevant code committees has gone a long way down the right path – specifically, the American Society of Civil Engineers Standard ASCE 43-05 (2005) embeds a lot of very forward thinking on this set of subjects in the area of seismic design criteria for nuclear facilities. In Reg Guide 1-208, the NRC staff has endorsed selected parts (but by no means the bulk) of ASCE 43-05's thinking on risk-informed, performance-based seismic design.

MY RECOMMENDATIONS

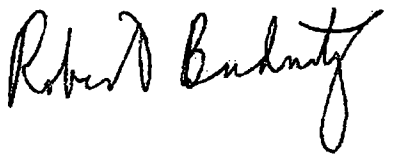
As I wrote at the top of this note, I am deeply disappointed that SECY-13-0132 stops so far short of what I had hoped it would recommend, in terms of a long-term set of agency actions, initiatives, and research projects. I am writing this letter to try to influence the Commission's (and the staff's) deliberations to change that.

Although I believe that the major recommendations in SECY-13-0132 are excellent and should be endorsed by the Commission, (1) I recommend that the Commission should

ask the staff to take seriously what I think are the key underlying reasons why the NTTF wrote Recommendation One to begin with. This means that (2) I recommend that the Commission should reject SECY-13-0132's delineation of the "problem statement" on page 4 of the SECY paper. That "problem statement" is, in my view, much too limited in vision and scope. Instead, (3) I recommend that the Commission should task the staff with developing a plan for a more fundamental long-term set of agency actions, initiatives, and research projects, leading ultimately to re-visiting (in each relevant technical safety area) the body of regulations, so as to take fully into account up-to-date methods of design, analysis, and evaluation, which rely in part on modern advances in engineering and on risk perspectives -- so as thereby to gain the benefits agency-wide that are like those I've outlined above in the seismic safety area for LWRs.

This will not be quick and it will not be easy. In the seismic-safety area, this is likely to be a 5- to 10-year effort. The effort can start with the consensus code committees, in parallel with work by the staff (and ultimately the Commission) on the issues embedded in the current SECY-13-0132 paper, namely issues about defense-in-depth, and about what to do in regulation to address accidents beyond today's design basis. I also believe that the seismic-safety area is likely an ideal "case study" topic, in large part because so much thinking has already been done in that area (DOE is a giant-step ahead of the NRC already), and also because the community of experts is very much "ripe" for this set of advances.

Sincerely,



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