



**U.S.NRC**

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

## **Public Meeting on the Status of Risk-Informed Regulatory Guidance for New Reactors**

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# Meeting Purpose

**Discussion on the status of risk-informed guidance for changes to the licensing basis, including operational programs, and to the Reactor Oversight Process (ROP) for new light-water reactors**

# Agenda

- **Risk-informed initiatives for new reactors**
- **Evolution of the staff's views**
- **Approaches considered**
- **Approach proposed by the staff**
- **Next steps**



# **Risk-Informed Initiatives for New Reactors**

- **In the near term, risk-informed applications have been proposed:**
  - **Risk-Managed Technical Specifications**
    - **Risk-informed completion times**
    - **Surveillance frequency control program**
- **Longer term initiatives (post-COL) may include:**
  - **EPRI research program on risk-informed inservice inspection of piping**
  - **Special treatment requirements (10CFR50.69)**

# **New Reactor Implementation Issues**

- **Review of these applications raised questions regarding the appropriate risk metric acceptance guidelines for implementation of risk-informed initiatives for new reactors, as well as thresholds in the ROP**

# Stakeholder Engagement

- **February 12, 2009 interoffice memorandum and white paper from Executive Director for Operations on options for risk metrics for new reactors (ADAMS ML090150636 and ML090160004)**
- **First public meeting, February 18, 2009, to engage stakeholders and obtain their feedback on the issues and potential options (ML090570356)**
- **2009 Regulatory Information Conference presentation**
- **Nuclear Energy Institute (NEI) white paper to the ACRS staff, March 27, 2009 (ML090900674).**
- **ACRS briefing on April 3, 2009 (ML091030667)**
- **ACRS Subcommittee on Reliability & PRA briefing on June 2, 2009, with views from industry representatives and the Union of Concerned Scientists (ML092040138)**
- **Second public meeting, September 29, 2009, that focused on the potential issues associated with the ROP (ML092780211)**
- **Staff presentation at American Nuclear Society 2009 embedded topical meeting, November 17, 2009**

# Evolution of Staff's Views

- **No early staff consensus on approach**
- **Initial staff concerns with risk acceptance guidelines for changes to the licensing basis (Regulatory Guide 1.174), and potential options (*relative* versus *absolute* change in core damage frequency (CDF) and large release frequency (LRF))**
- **More recently, less concern with numerical guidelines and more on**
  - **“Assuring that the level of enhanced safety believed to be achieved with this design will be reasonably maintained”**
  - **The implementation of 50.59-like process for new reactors**
- **Staff consensus on high-level approach across the agency including all regions**

# Staff Requirements

## Memorandum on SECY-90-377

- **The Commission approved a process similar to 10 CFR 50.59 for making changes to Tier 2 information between combined license (COL) issuance and authorization for operation**
- **The Commission stated that “the staff should ensure that this process requires **preservation of the severe accident, human factors, and operating experience insights** that are part of the certified design”**
- **Under Part 52, the process for changes and departures for each certified reactor design is found in Section VIII of the appendix that contains its design certification rule**

# Statement of Considerations for ABWR Design Certification

“The Commission recognizes that the ABWR design not only meets the Commission’s safety goals for internal events, but also offers a substantial overall enhancement in safety as compared, generally, with current generation of operating power reactors...The Commission recognizes that the safety enhancement is the result of many elements of the design, and that much but not all of it is reflected in the results of the probabilistic risk assessment (PRA) performed and documented for them. In adopting a rule that **the safety enhancement should not be eroded significantly by exemption requests**, the Commission recognizes and expects that this will require both careful analysis and sound judgment, especially considering uncertainties in the PRA and the lack of a precise, quantified definition of the enhancement which would be used as the standard.”

# Statement of Considerations for ABWR (cont.)

**“The Commission on its part also has a reasonable expectation that vendors and utilities will cooperate with the Commission in **assuring that the level of enhanced safety believed to be achieved with this design will be reasonably maintained for the period of the certification** (including renewal). This expectation that industry will cooperate with NRC in maintaining the safety level of the certified designs applies to design changes suggested by new information, to renewals, and to changes under section VIII.B.5 of the final rule. If this reasonable expectation is not realized, the Commission would carefully review the underlying reasons and, if the circumstances were sufficiently persuasive, consider the need to reexamine the backfitting and renewal standards in Part 52 and the criteria for Tier 2 changes under section VIII.B.5.”**



# **Current Regulatory Guidance for Risk-Informed Initiatives**

- **Regulatory guidance associated with risk-informed initiatives for currently operating reactors are based on Commission's Safety Goals (e.g., RG 1.174, 1.175, 1.177, 1.178, 1.201)**
- **A key principle of RG 1.174 is that “when proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement”**

# From RG 1.174

- **Five principles for making risk-informed decisions**
  - **The proposed change:**
    - Meets current **regulations** (unless exemption request)
    - Is consistent with the **defense-in-depth** philosophy
    - Maintains sufficient **safety margins**
    - Results in an increase in CDF or risk that is **small** and consistent with the intent of the Commission's Safety Goal Policy Statement
    - Will be monitored using **performance measurement** strategies.

# From RG 1.174

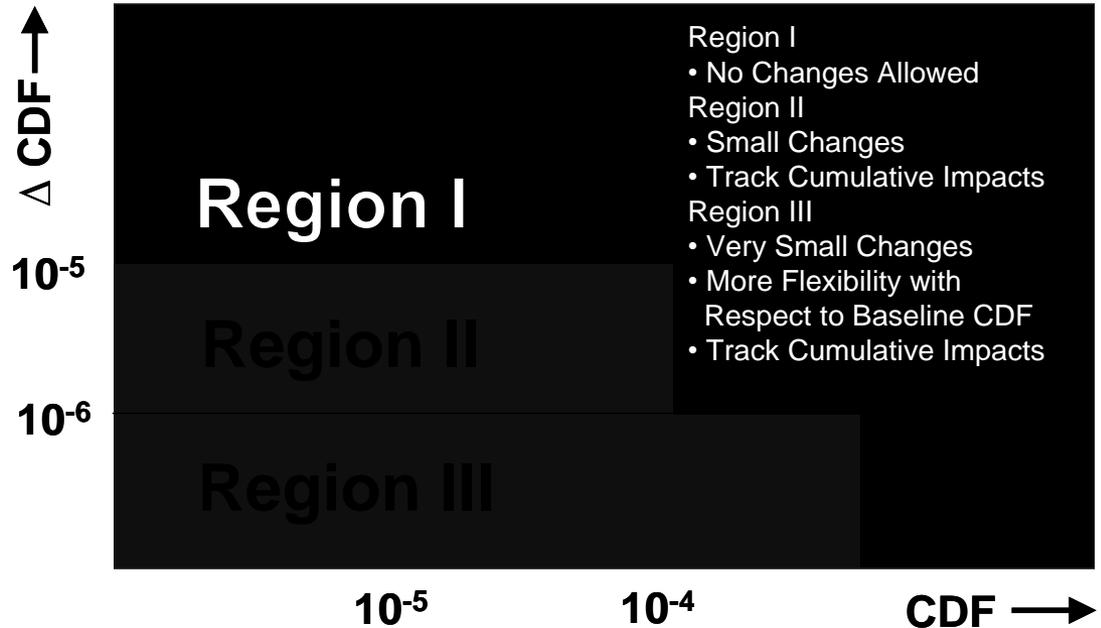


Figure 3. Acceptance Guidelines for Core Damage Frequency (CDF)

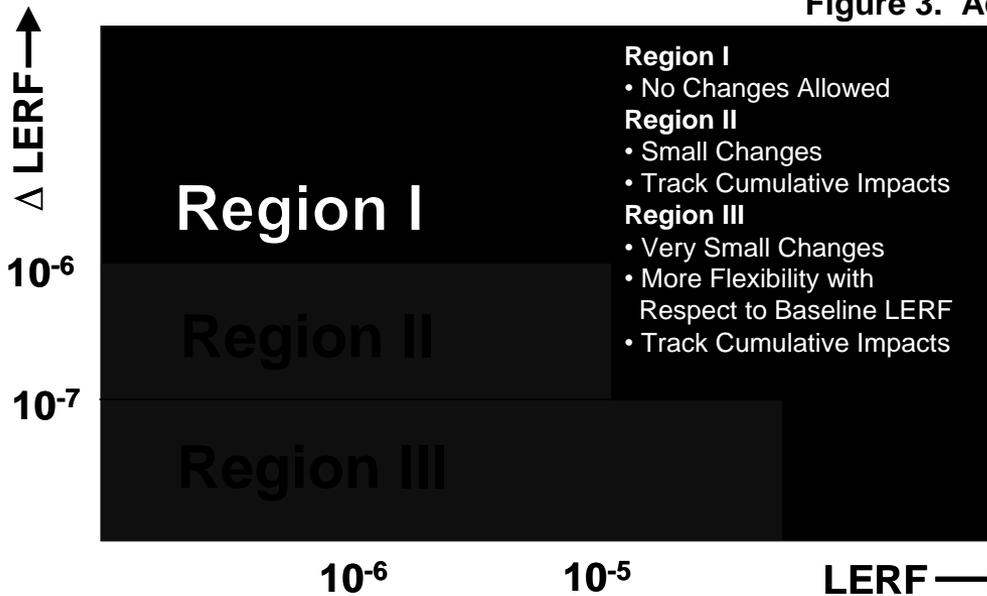


Figure 4. Acceptance Guidelines for Large Early Release Frequency (LERF)

# Current Regulatory Guidance for Risk-Informed Initiatives (cont.)

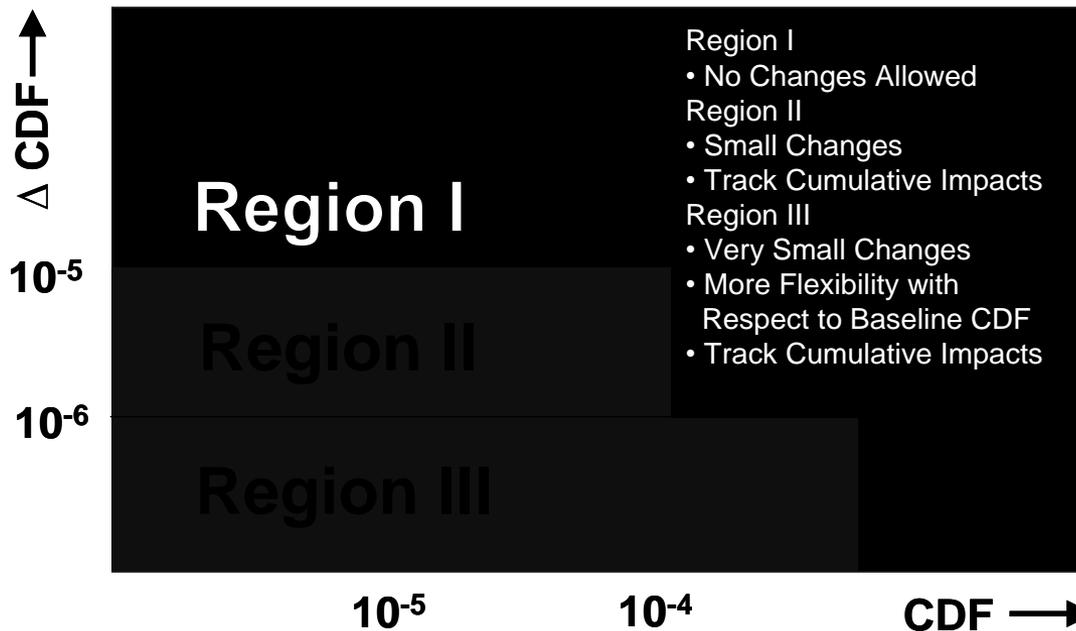
- **Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis”**
- **Risk-Acceptance Guidelines:**
  - **Baseline risk metrics of CDF and LERF**
  - AND**
  - **$\Delta$ CDF and  $\Delta$ LERF due to change**
- **Basis:**
  - **Increases should be limited to small increments**
  - **CDF threshold related to backfit regulatory analysis guidelines**
  - **$\Delta$ CDF limit based on *absolute* change and set close to limit of resolution of PRA models**

# Fundamental Issue before the Staff

- **Current guidance could allow large relative changes to CDF and containment performance for new reactors**

# Hypothetical Example: Design Change

- A new reactor design has a baseline CDF of  $1 \times 10^{-7}$  /yr
- A proposed design change would render a system, that is credited in the PRA, unavailable for certain events. CDF could increase by  $7 \times 10^{-8}$  /yr (70% increase).



**X**

Figure 3. Acceptance Guidelines for Core Damage Frequency (CDF)

# Example: MD 8.3 Incident Investigation

Estimated Conditional Core Damage Probability (CCDP)				
CCDP < 1E-6	1E-6 – 1E-5	1E-5 – 1E-4	1E-4 – 1E-3	CCDP > 1E-3
No additional inspection				
	Special inspection			
		AIT		
			IIT	


  
**New Rx SGTR**      **Current SGTR**


  
**New Rx LOOP**                      **Current LOOP**

# Hypothetical Example: Significance Determination Process (SDP)

- **Assume a performance deficiency in a key valve with Risk Achievement Worth (RAW) of 5 for all initiators and a fault exposure time of 72 days (0.2 yr)**
- **For an operating reactor with CDF  $\sim 2 \times 10^{-5}$  /yr,**
  - **$\Delta$ CDF  $\sim 1.6 \times 10^{-5}$  (Yellow)**
- **For a new reactor with baseline CDF  $\sim 5 \times 10^{-7}$  /yr**
  - **$\Delta$ CDF  $\sim 4 \times 10^{-7}$  (Green)**
  - **Fault exposure time of  $\sim 6$  months to reach White**
  - **100-fold increase in CDF for 72 days needed to reach Yellow**
  - **1000-fold increase in CDF for 72 days to reach Red**

# Hypothetical Example: Maintenance Rule (a)(4)

**From NUMARC 93-01 Section 11.3.7.2:**

ICDP		ILERP
$> 10^{-5}$	- configuration should not normally be entered voluntarily	$> 10^{-6}$
$10^{-6} - 10^{-5}$	- assess nonquantifiable factors - establish risk management actions	$10^{-7} - 10^{-6}$
$< 10^{-6}$	- normal work controls	$< 10^{-7}$

- **Theoretically, this quantitative guidance if applied to some new reactors could allow normal work controls for an ICDP of high  $10^{-7}$  which would represent a significant fraction of or even several years' worth of integrated risk for baseline CDF of  $10^{-7}$  to  $10^{-6}$  /yr**
- **Staff exercised SPAR models for one plant and did find that technical specifications AOTs and investment protection short-term availability controls limited the ICDPs to reasonably low values for maintenance of key equipment for those cases evaluated**

# Approaches Considered

- **No changes to the current regulatory guidance, or *status quo***
  - **Provides incentive to build reactors with enhanced severe accident safety features**
  - **Applicants and licensees who invest in and maintain additional safety features have more flexibility to operate the plants with a reduction in regulatory interactions**
  - **The staff concluded, however, that this approach did not meet Commission expectations in that this approach may not prevent significant decrease in enhanced safety through changes to the licensing basis and plant operations over plant life**
  - **In addition, this approach may not provide for meaningful regulatory oversight that supports NRC's response and inspection**

## Approaches (cont.)

- **Modify the risk-informed guidance to include a new lower risk metric for the ROP and changes to the licensing basis**
  - Supports the Commission’s expectation that new plants have enhanced severe accident safety performance and that advanced reactors provide enhanced margins of safety
  - Approach goes beyond the Commission’s expectation by essentially *requiring* the continued maintenance of the enhanced margin of safety
  - Approach may be inconsistent with the Commission’s statement on the Regulation of Advanced Reactors in 2008 that the “policy statement does not state that advanced reactor designs must be safer than the current generation of reactors”
  - Would create a risk-informed framework that is, in effect, inconsistent with the underlying technical basis for the current thresholds that are derived from the Commission Safety Goals and implemented in RG 1.174
  - Could have unintended consequences in that new reactors with enhanced safety features would have less operational flexibility than the current fleet of reactors

# Approach Proposed by Staff

- **Identify specific changes to the risk-informed guidance for changes to the licensing basis that would prevent a significant decrease in the level of safety of the new reactor over its life**
- **Identify specific changes to the risk-informed guidance for the ROP to provide for meaningful regulatory oversight**

## ***For changes to the licensing basis and operational programs***

- **Evaluate how to modify the risk-informed guidance to prevent a significant decrease in the level of safety provided by certified designs**
- **Evaluate how to supplement the CDF and LERF acceptance guidelines to recognize the lower risk profiles of new reactors, including revisiting what would constitute a “small” change when implementing RG 1.174**
- **Utilize stakeholder involvement in the evaluation and development of detailed changes to risk-informed regulatory guidance**
- **Evaluate the merits of developing additional criteria (e.g., deterministic, defense in depth) to support the change process**
- **Evaluate proposed changes to guidance to ensure that the changes do not create unintended consequences such as creating disincentives for safer designs on the one hand, or allowing degradation of passive safety system performance on the other hand**
- **Develop guidance to implement Section VIII.B.5.c of the design certification rules**

## ***For changes to the ROP***

- **Utilize stakeholder involvement in the evaluation and development of changes to the guidance**
- **Evaluate the criteria for plant placement in the action matrix to assess whether the current process would ensure that operational performance that results in significant reductions in the level of safety provided by the certified design is fully understood by the licensee and NRC and is effectively corrected**
- **Evaluate the merits of developing additional criteria (e.g., deterministic, change in risk) to support NRC's response to findings and performance trends**
- **Evaluate any potential ROP changes to avoid unintended consequences such as creating disincentives for safer designs on the one hand; or allowing degradation of passive safety system performance on the other hand; or diverting the attention of NRC inspectors from issues of higher safety significance on currently operating reactors**

## ***For changes to the ROP (cont.)***

- **Consider the need to risk-weight or otherwise weight findings associated with passive systems to reflect the difficulty of recognizing the degradation of passive systems**
- **Continue to independently assess licensee performance in the area of safety culture since safety culture addresses common underlying factors that affect plant safety**
- **Evaluate maintaining or changing the current thresholds for green, white, yellow, red risk-significant findings and performance indicators, given that low-risk designs may rarely if ever cross the current white threshold**
- **Consider the advantages and disadvantages of applying any potential changes to the ROP to currently operating reactors**

## Summary

- **Early staff concern with risk metrics for changes to licensing basis and ROP thresholds**
- **Staff's concerns have evolved to those of how to**
  - **assure enhanced level of severe accident capability is maintained**
  - **implement a 50.59-like process**
- **Staff prepared to engage stakeholders to develop appropriate guidance**

## Next Steps

- **ACRS brief June 10, 2010**
- **Issue final Commission Paper**
- **Staff to continue to engage stakeholders regarding specific changes to industry and NRC guidance documents**
- **Staff to proceed with evaluation of applications for risk-informed initiatives for new reactors**
- **Parallel but extended effort to address ROP issues**

# Tasks for Next Stakeholders Public Meeting

- **Identification of key issues**
- **Identification of key players**
- **Development of framework**
- **Identification of regulatory and industry guidance needing change**
- **Time frame for next public meeting**