United States
Nuclear Regulatory Commission

Pressurized Thermal Shock Rule (10CFR50.61) Re-Evaluation *Risk Acceptance Criteria – Status Report*

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Office of Nuclear Regulatory Research

Presented to
Advisory Committee on Reactor Safeguards
USNRC Headquarters • Rockville, MD • 10th July 2002

VG 1

Presentation Overview

- **Project overview and status**
- **PTS acceptance criteria – approach and issues**
- **Next steps**

Project Overview and Status

Current Rule

- **Focused on allowed degree of reactor pressure vessel (RPV) embrittlement**
- **Multi-level structure**
  - **Compare deterministically computed RPV embrittlement (RT_{PTS}) against screening criteria**
  - **If necessary, employ reasonably practicable flux reduction measures**
  - **If necessary, perform safety analysis (RG 1.154) to justify continued operation**
- **Use of risk information:**
  - **Risk implications of screening criteria explored as part of original technical basis**
  - **RG 1.154 acceptance criteria: TWCF of 5×10^{-6}/yr**

Project Objective

Reevaluate the technical basis for 10 CFR 50.61:

- **lessons learned in the application of 10 CFR 50.61 and RG 1.154, and**

- **research results developed since 1983**

Is there a technical basis for modifying the rule?

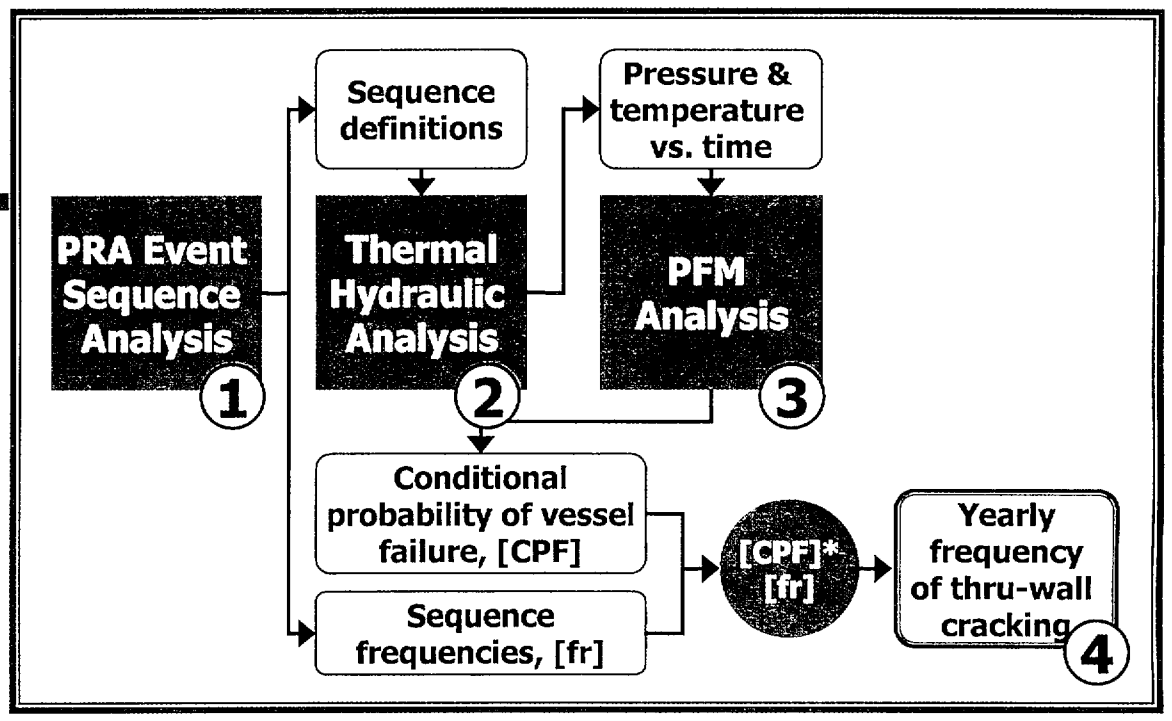
VG 5

Project Activities

- **Evaluation of frequency of PTS-induced RPV failures at pilot plants**
  - **Quantitative estimates including uncertainties**
  - **Key contributors to frequencies and uncertainties**
- **Extension to non-pilot plants**
- **Identification and evaluation of potential PTS risk acceptance metrics and criteria**

Project Status

- Approach developed to assess the PTS risk
- Involves inputs from and models developed in three different technical areas
  - Probabilistic Risk Assessment (PRA)
  - Thermal Hydraulics (TH)
  - Probabilistic Fracture Mechanics (PFM)



Plant	① PRA	② TH	③ PFM	④ TWCF
Oconee	draft	draft	draft	draft
Palisades	Licensee revising	1st cut	1st cut	1st cut
Beaver	draft	1st cut	1st cut	1st cut
Calvert	Licensee revising	1st cut	--	--

PTS Acceptance Criteria

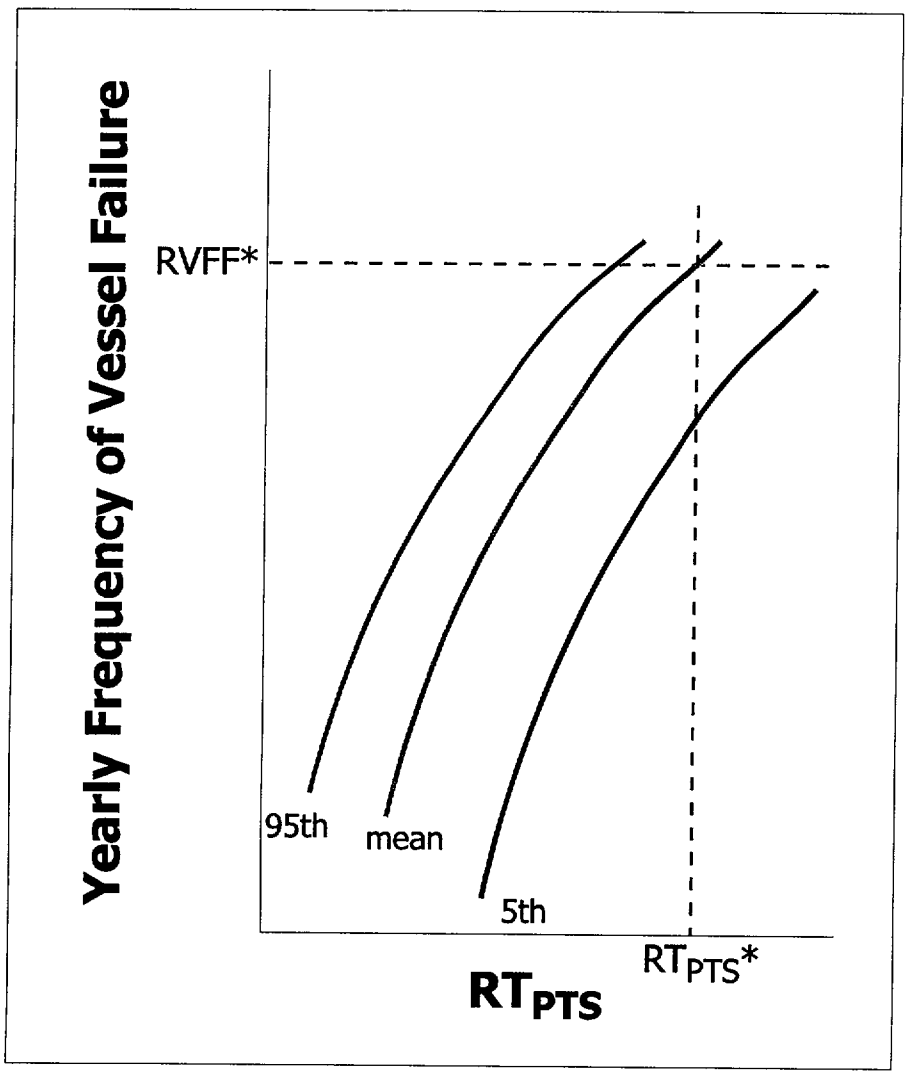
Acceptance Criteria Task

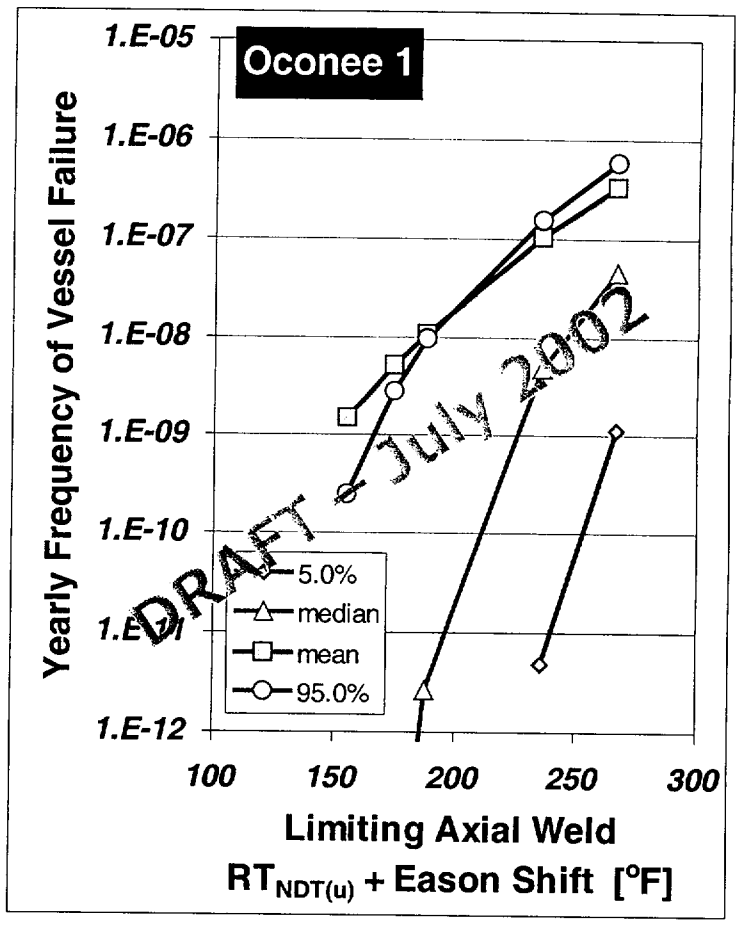
- **Objective: provide technical basis for risk-informed selection of PTS screening criteria**
- **Status report provided in SECY-02-0092 (May 30, 2002)**

Acceptance Criteria Task Assumptions

- **Key issue for rule and possible rule revisions: allowed degree of RPV embrittlement**
- **Allowed degree of embrittlement will be established in a risk-informed manner**
- **Reactor vessel failure frequency (RVFF) will be used as a key metric**
- **The criterion for RVFF will be established in a manner consistent with agency considerations of CDF and LERF in other risk-informed initiatives**

Conceptual Model for Developing PTS Acceptance Criteria





VG 11

Risk Acceptance Criteria
Principles in Developing Options

- **Consistency with intent of original rule**
  - **Low risk level**
  - **Low relative contribution**
- **Consistency with recent risk-informed initiatives**
  - **Risk metrics**
  - **Risk criteria**

Risk Acceptance Criteria
Qualitative and Quantitative Options

- **Definition of RVFF**
  - **RVFF = f(PTS-induced RPV failure)**
  - **RVFF = f(PTS-induced crack initiation)**
- **RVFF acceptance limits**
  - **RVFF* = 5 x 10^{-6}/ry**
  - **RVFF* = 1 x 10^{-5}/ry**
  - **RVFF* = 1 x 10^{-6}/ry**

Option Evaluation Issues

- **Uncertainties in pilot plant studies**
  - **Driving sources of uncertainty**
  - **Implications for additional work on gaps in knowledge regarding containment performance and source terms**
- **Uncertainties in extensions of pilot plant studies**
  - **External events**
  - **Non-pilot plants**
- **Application of defense-in-depth and safety margins considerations**

Next Steps

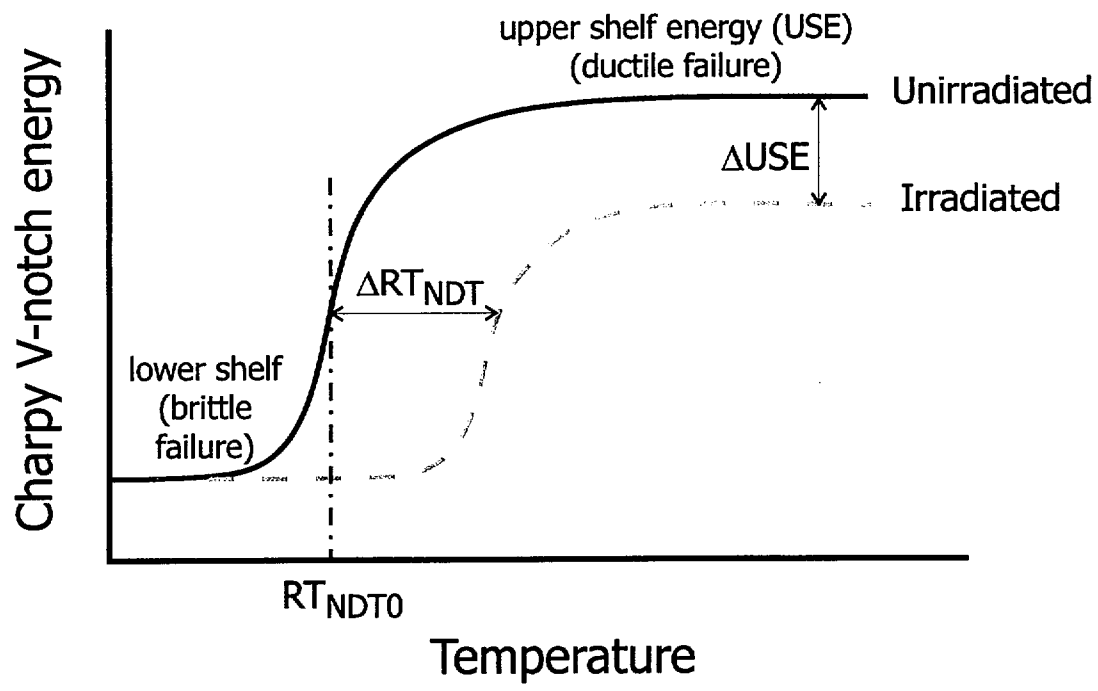
- **Complete pilot studies**
- **Address external events and extension to broader population**
- **Assess need for and feasibility of scoping study on post-RPV failure scenarios**
- **Continue interactions with international community**

Summary

- **Reevaluation of PTS rule technical basis (including recommendations) scheduled for completion in December 2002**
- **Reevaluation addresses**
  - **PTS risk at selected pilot plants (quantitative estimates including uncertainties + drivers of results)**
  - **Extension to non-pilot plants**
  - **Potential PTS risk acceptance criteria**
- **Risk acceptance criteria options have been identified and will be evaluated**
- **Defense-in-depth and safety margins considerations may play a leading role in recommendations**

Backup Slides

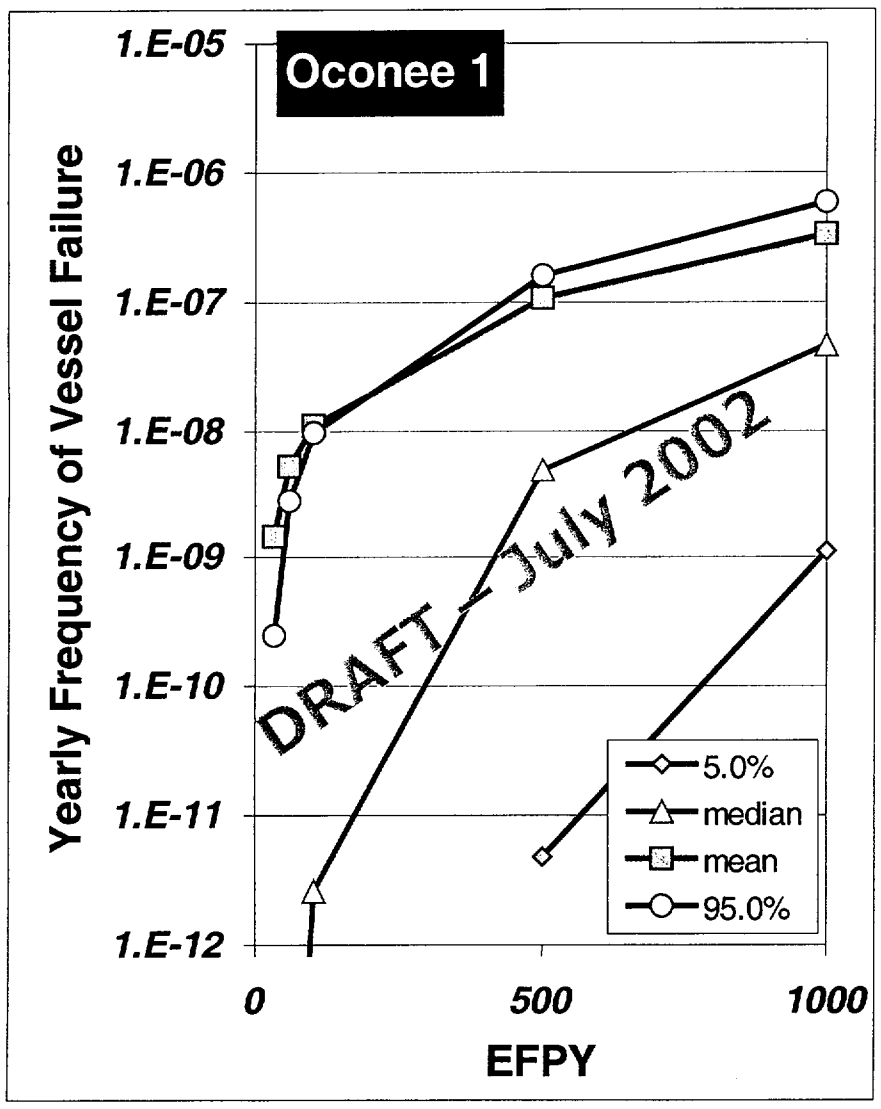
Irradiation and Embrittlement

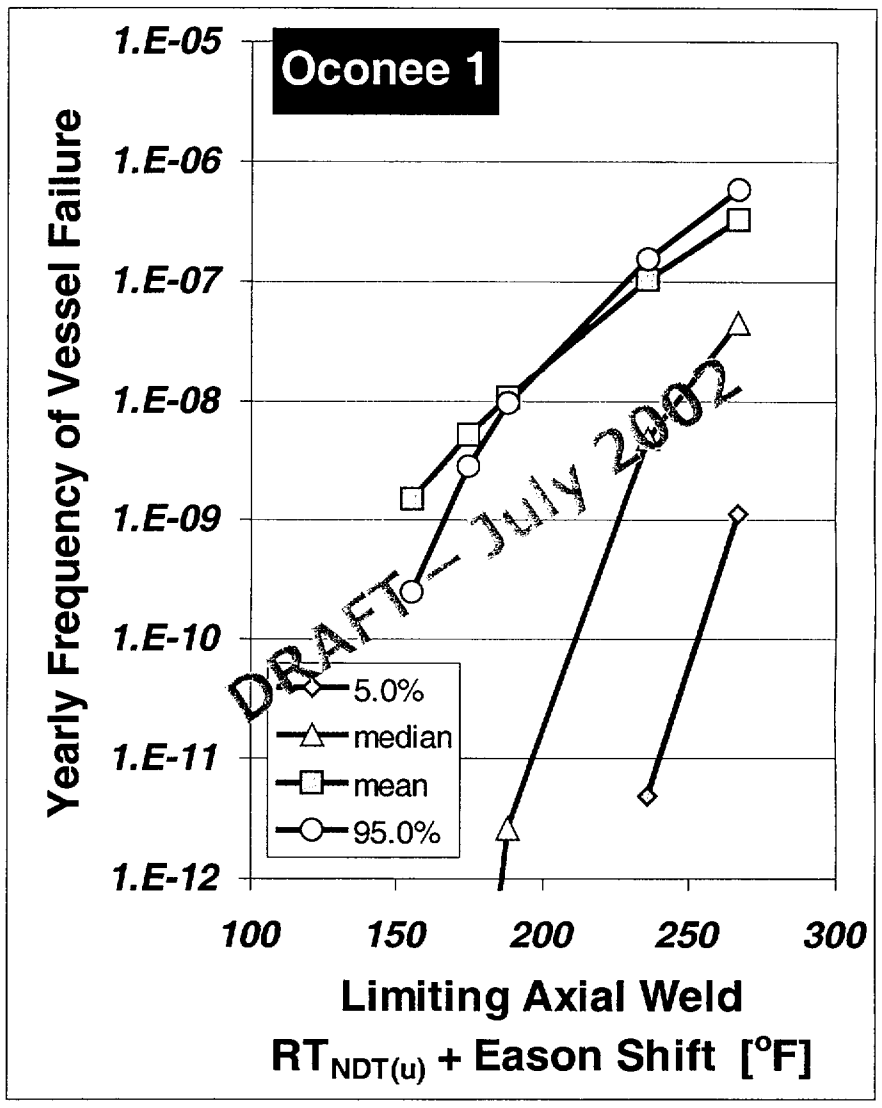


VG 18

Oconee 1

(Current Draft Results, July '02)





VG 19

Status of Regulatory Guide 1.174

Advisory Committee on Reactor Safeguards

Mary Drouin
John Lane

ACRS Full Committee Meeting
July 10, 2002

PURPOSE OF PRESENTATION

- Provide status on final version of Revision 1 to Regulatory Guide 1.174
- Request ACRS concurrence in publication of Rev. 1

BACKGROUND

- Regulatory Guide 1.174 is intended to be periodically updated
  - Lessons learned from ongoing issues, such as those at Davis-Besse will be considered in future revisions

- Issued draft Revision 1 to Regulatory Guide 1.174 and SRP Chapter 19 in June 2001 with 90-day comment period

- Staff presentation to ACRS (2-5-02) on final changes to Revision 1
  - no issues raised by ACRS
  - staff recommendations unchanged

INITIAL PROPOSED CHANGES

1. Risk-related information may now be requested if new, unforeseen hazards or a substantially greater prospect for a known hazard emerges
   –Reporting responsibilities not explicitly stated or defined
   –ACRS, CRGR and Commission approval received

2. Increases in power level, fuel burnup rates and the use of mixed oxide fuel may effect plant risk profiles, and consequently current risk parameters, such as LERF, may need to be re-evaluated

3. Identification and description of scope and minimal technical attributes comprising a PRA based upon SECY-00-0162, Attachment 1

4. Example provided of the use of risk insights in the decision making process

COMMENT REVIEW

Comments received from:

Individuals

Nuclear industry – utilities, industry groups

Comment Summary:

1. Risk-related information–no comments received
2. Increases in power level, fuel burnup uprates, and use of mixed-oxide fuel
   - No basis or justification since power level increase requests already exceed 3800 MWt
   - Additional staff guidance should be provided as to whether burnup rates pertain to core average, bundle average or peak rod exposure
3. Additions from SECY-00-0162
   - Inadequate explanation as to their purpose and use
   - Inappropriate document to include the information
4. Risk-informed example-no comments

STAFF RECOMMENDATION FOR REVISION 1 CHANGES

- Issue Revision 1 to Reg Guide 1.174 with:
  - Risk-related information–no change from draft (Attachment 1)
  - Increase in power level, fuel burnup rates and use of mixed oxide fuel–add cautionary note that the staff is evaluating their impact on LERF (Attachment 2)
- Rather than include information from SECY-00-0162 and staff endorsements of consensus standards and industry peer review process in Reg Guide 1.174, incorporate in separate regulatory guide
  - under development
- Risk insights examples–add additional ones to new regulatory guide

SUMMARY

- Staff requests ACRS letter recommending publication of Revision 1 to Regulatory Guide 1.174
  - Revision 1 adds appropriate guidance regarding staff requests for risk related information for new, unforeseen hazards or when a substantially greater prospect for a known hazard emerges
  - Revision 1 appropriately notes that the staff is evaluating the impact on LERF of increases in power level, fuel burnup rates and the use of mixed-oxide fuel
- Periodic updates to the reg guide will address on-going lessons learned

ATTACHMENT 1

Licensee-initiated LB changes that are consistent with currently approved staff positions (e.g., regulatory guides, standard review plans, branch technical positions, or the Standard Technical Specifications) are normally evaluated by the staff using traditional engineering analyses. A licensee generally would not be expected to submit risk information in support of the proposed change.

Licensee-initiated LB change requests that go beyond current staff positions may be evaluated by the staff using traditional engineering analyses as well as the risk-informed approach set forth in this regulatory guide. A licensee may be requested to submit supplemental risk information if such information is not submitted by the licensee. If risk information on the proposed LB change is not provided to the staff, the staff will review the information provided by the licensee to determine whether the application can be approved. Based on the information provided, using traditional methods, the NRC staff will either approve or reject the application.

However, licensees should be aware that special circumstances may arise in which new information reveals an unforeseen hazard or a substantially greater potential for a known hazard to occur, such as the identification of an issue related to the requested LB change that may substantially increase risk. In such circumstances, the NRC has the statutory authority to require licensee action above and beyond existing regulations and may request an analysis of the change in risk related to the requested LB change to demonstrate that the level of protection necessary to avoid undue risk to public health and safety (i.e., "adequate protection") would be maintained upon approval of the requested LB change.

This regulatory guide describes an acceptable method for the licensee and NRC staff to use in assessing the nature and impact of LB changes when the licensee chooses to support or is requested by the staff to support the changes with risk information. The NRC staff would review these LB changes by considering engineering issues and applying risk insights. Licensees who submit risk information (whether on their own initiative or at the request of the staff) should address each of the principles of risk-informed regulation discussed in this regulatory guide. Licensees should identify how their chosen approaches and methods (whether quantitative or qualitative, deterministic or probabilistic), data, and criteria for considering risk are appropriate for the decision to be made.

Additional guidance is provided to the NRC staff (in Appendix D to Chapter 19 of the Standard Review Plan, Ref. 3) regarding the circumstances and process under which NRC staff reviewers would request and use risk information in the review of non-risk-informed license amendment requests.

The guidance provided in this regulatory guide does not preclude other approaches for requesting changes to the LB. Rather, this regulatory guide is intended to improve consistency in regulatory decisions in areas in which the results of risk analyses are used to help justify regulatory action. As such, the principles, process, and approach discussed herein also provide useful guidance for the application of risk information to a broader set of activities than plant-specific changes to a plant's LB (i.e., generic activities), and licensees are encouraged to use this guidance in that regard.

ATTACHMENT 2

Current LERF guidelines are based on assumptions of reactor power level, fuel burnup rates, and extent of the use of mixed oxide fuel. The staff is undertaking an evaluation of the impact, if any, of increases in these parameter on LERF.

The technical review that relates to the risk evaluation will address the scope, level of detail, and technical acceptability of the analysis, including consideration of uncertainties as discussed in the next section. Aspects covered by the management review are discussed in Section 2.2.6, Integrated Decisionmaking, and include factors that are not amenable to PRA evaluation.

2.2.5 Comparison of PRA Results with the Acceptance Guidelines

This section provides guidance on comparing the results of the PRA with the acceptance guidelines described in Section 2.2.4. In the context of integrated decisionmaking, the acceptance guidelines should not be interpreted as being overly prescriptive. They are intended to provide an indication, in numerical terms, of what is considered acceptable. As such, the numerical values associated with defining the regions in Figures 3 and 4 of this regulatory guide are approximate values that provide an indication of the changes that are generally acceptable. Furthermore, the state-of-knowledge, or epistemic, uncertainties associated with PRA calculations preclude a definitive decision with respect to which region the application belongs in based purely on the numerical results.

The intent of comparing the PRA results with the acceptance guidelines is to demonstrate with reasonable assurance that Principle 4, discussed in Section 2, is being met. This decision must be based on a full understanding of the contributors to the PRA results and the impacts of the uncertainties, both those that are explicitly accounted for in the results and those that are not. This is a somewhat subjective process, and the reasoning behind the decisions must be well documented. Guidance on what should be addressed follows in Section 2.2.5.4; but first, the types of uncertainty that impact PRA results and methods typically used for their analysis are briefly discussed. More information can be found in some of the publications in the Bibliography.

2.2.5.1 Types of Uncertainty and Methods of Analysis

There are two facets to uncertainty that, because of their natures, must be treated differently when creating models of complex systems. They have recently been termed aleatory and epistemic uncertainty. The aleatory uncertainty is that addressed when the events or phenomena being modeled are characterized as occurring in a "random" or "stochastic" manner, and probabilistic models are adopted to describe their occurrences. It is this aspect of uncertainty that gives PRA the probabilistic part of its name. The epistemic uncertainty is that associated with the analyst's confidence in the predictions of the PRA model itself, and it reflects the analyst's assessment of how well the PRA model represents the actual system being modeled. This has been referred to as state-of-knowledge uncertainty. In this section, it is the epistemic uncertainty that is discussed; the aleatory uncertainty is built into the structure of the PRA model itself.

Because they are generally characterized and treated differently, it is useful to identify three classes of uncertainty that are addressed in and impact the results of PRAs: parameter uncertainty, model uncertainty, and completeness uncertainty. Completeness uncertainty can be regarded as one aspect of model uncertainty, but because of its importance, it is discussed separately. The

Risk-Informed Regulation Implementation Plan

Presentation to ACRS

July 10, 2002

Overview of Presentation

- Introduction & 10 CFR 50.46 Rulemaking Activities
  - Mark Cunningham, RES
- Plan for Improving Coherence Among Risk-Informed Activities
  - Michael Johnson, NRR
- Risk-Management Technical Specifications
  - William Beckner, NRR
- Upcoming Items of Interest
  - Chris Grimes, NRR & Mark Cunningham, RES

2

Introduction & 10 CFR 50.46 Rulemaking Activities

Mark Cunningham, RES

Overview of June 2002 RIRIP

- Summary of Upcoming Activities - Reactor Safety Arena
  - Special Treatment Requirements (10 CFR 50.69)
  - Risk-Informing Part 50 (10 CFR 50.44 & 50.46)
  - Fire Protection Rule Revision
  - Improve Coherence Among Risk-Informed Activities
  - Risk-Informed Environment Initiative
  - Risk-Management Technical Specification Initiatives
  - Develop Regulatory Guide and Standard Review Plan to assess PRA adequacy
  - Pressurized Thermal Shock

4

Overview of June 2002 RIRIP

- Summary of Upcoming Activities - Waste Safety and Materials Safety Arenas
  - Amending Regulations – medical use of byproduct material
  - High-Level radioactive waste disposal at Yucca Mountain
  - Revision of Inspection Manual
  - Decommissioning policy and guidance documents

5

Overview of June 2002 RIRIP

- New Activities
  - Waste Safety and Materials Safety Arenas
    - Develop Guide for Performing Risk Analyses
    - Develop Safety Goals
    - Evaluate Low-Level Source Material (thorium and/or uranium)
    - Amend Part 63
    - Cross Cutting Risk Assessment of Spent Fuel Management
- Accomplishments
- More Detailed Descriptions of activities and milestones

6

Identifying possible changes to NRC's reactor safety requirements

Changing 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors"

- Suggested changes to 10 CFR 50.46
  - Replace current requirements with a performance-based requirement
  - Revise requirements for ECCS evaluation model
    - Allow for more realistic analyses
  - Propose a risk-informed voluntary alternative to 10 CFR 50.46 for ECCS reliability

7

Recent and Upcoming Activities

- Evaluation of plant-specific approach for reliability evaluation (April 2002)
- Evaluation of changes to acceptance criterion and evaluation model (June 2002)
- Evaluation of generic approach for reliability evaluation (July 2002)

8

PLAN FOR IMPROVING COHERENCE AMONG RISK-INFORMED ACTIVITIES

Michael Johnson, NRR
Stu Magruder, NRR
Mary Drouin, RES

Background

- SRM: for current reactors –
  - "provide its plan for moving forward with risk-informed regulation to address regulatory structure convergence with our risk-informed processes"
- Stakeholders believe we are inconsistent
- NRC staff is often frustrated

10

Goals

- Develop a common understanding of risk-informed regulatory objectives
- Staff and stakeholder buy-in

11

Need to Develop Plan That Will:

- Utilize ongoing efforts
- Identify goals and associated end products
- Identify approach for achieving goals
- Approach will identify:
  - Inefficiencies
  - Unnecessary regulatory burden
  - Safety concerns
  - Interface with advanced reactors

12

Next Steps

- Outline in RIRIP, June 2002
- Briefing for Commission TAs
- Interact with stakeholders to solicit input
  - Public meetings/workshop
  - ACRS
- Develop detailed plan

13

Risk-Management Technical Specifications

William Beckner, NRR

Overview

- Staff and industry briefed ACRS 4/28/00
- Eight initiatives developed by owners groups through NEI task force
- Major objective:
  - Bring 10 CFR 50.65(a)(4) risk assessment process into configuration management under technical specifications

15

Status Highlights

- Initiative 2 – Missed Surveillance
  - Manage risk of missed surveillance
  - Offered for adoption 9/28/01
  - 34 applications for 57 units
- Initiative 3 – Mode Change Flexibility
  - Permit upward mode change
  - Model safety evaluation nearing completion

16

Status Highlights (cont.)

- Initiative 1 – TS Actions End States
  - Permit repair in hot shutdown
  - Safety evaluations complete (CEOG, BWROG)
- Initiative 4 – Completion Times From Configuration Risk Management Program
  - Major reliance on 50.65(a)(4) to control completion times
  - Initial concept developed

17

Initiatives

1. TS Actions End States
2. Missed Surveillance
3. Mode Change Flexibility
4. Completion Times from CRMP
5. STI Methodology
6. LCO 3.0.3 Actions and Times
7. Non-TS Support Features
8. Scope of TS

18

Upcoming Items of Interest

Chris Grimes, NRR
Mark Cunningham, RES

Upcoming Items of Interest

- 10 CFR 50.69 (Special Treatment)
- RG on PRA Standards & Industry Guidance
- Draft Guidance on Performance-Based Regulation
- Advanced Reactors

20