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Category 2 Public Meeting

Options for Proceeding with Future Level 3 Probabilistic Risk Assessment Activities

Dan Hudson
Office of Nuclear Regulatory Research
April 11, 2011

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Meeting Logistics

- Category 2 public meeting
- Attendance roster
- NRC public meeting feedback forms
- Emergency egress
- Restrooms
- Portable electronic devices

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Meeting Purpose

- To obtain external stakeholder views on options for proceeding with future Level 3 probabilistic risk assessment (PRA) activities.

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Expected Outcomes

- External stakeholders understand the basis for options developed by the NRC staff.
- NRC staff understands external stakeholder views on:
  - Future uses for Level 3 PRAs
  - Objectives, scope, technology, and site selection attributes for a proposed site Level 3 PRA

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Meeting Agenda

- NRC Staff's Approach (45 minutes)
- Open Discussion (45 minutes)
  - Perspectives on future uses for Level 3 PRAs
- Break (15 minutes)
- Open Discussion (45 minutes)
  - Objectives, scope, technology, and site selection attributes for a proposed site Level 3 PRA

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NRC Staff's Approach

Options for Proceeding with Future Level 3 Probabilistic Risk Assessment Activities

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Presentation Objectives

- To facilitate external stakeholder understanding of the basis for NRC staff-developed options for proceeding with future Level 3 PRA activities.

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Probabilistic Risk Assessment (PRA)

- A structured, analytical process that provides both *qualitative insights* and *quantitative estimates of risk* by:
  - Identifying potential initiating event scenarios that can challenge system operations;
  - Estimating the likelihood of event sequences that lead to an adverse event; and
  - Estimating the consequences associated with these "accident sequences."

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Scope of Nuclear Power Plant PRAs

Factor	Scoping Options for Commercial Nuclear Power Plant PRAs
Radiological hazards	Reactor core Spent nuclear fuel (spent fuel pool and dry cask storage) Other radioactive sources (e.g., fresh fuel and radiological wastes)
Population exposed to hazards	Onsite population Offsite population
Initiating event hazard groups	Internal events • Traditional internal events (transients, loss-of-coolant accidents) • Internal floods • Internal fires
	External events • Seismic events (earthquakes) • High winds • Other external hazards
Plant operating states	At-Power Low-Power/Shutdown
End state/Level of risk characterization	Level 1 PRA: Initiating event to onset of core damage or safe state Level 2 PRA: Onset of core damage to radioactive material release Level 3 PRA: Radioactive material release to offsite radiological consequences

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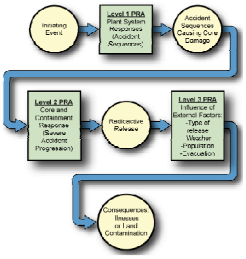
Significance of Level 3 PRAs



PRA End States
Level 1 PRA – Onset of core damage
Level 2 PRA – Radioactivity release
Level 3 PRA – Offsite consequences

Key Message:
A Level 3 PRA is required to quantitatively estimate the integrated risk to the public from all hazards.

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Historical Perspective

- **Prior studies estimating risk to public**
  - WASH-740 (March 1957)
  - WASH-1400 (October 1975) } **18 years**
  - NUREG-1150 (December 1990) } **15 years**
  - Present day } **20 years**
- **Safety Goal Policy Statement** (August 1986)
  - Two qualitative safety goals
  - Two quantitative health objectives (QHOs)
- **Generic Letter 88-20** (November 1988)
  - Initiated Individual Plant Examination (IPE) Program

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Historical Perspective

- **SECY-89-102** (June 1990)
  - Led to development and use of subsidiary numerical objectives that serve as surrogates for safety goal QHOs
- **PRA Policy Statement** (August 1995)
  - Increase use of PRA technology in all regulatory matters
  - Reduce unnecessary conservatism in regulatory requirements
  - PRAs should be as realistic as practicable
  - Safety goals and subsidiary numerical objectives are to be used with appropriate consideration of uncertainties

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Basis for New Site Level 3 PRA Initiative

- **Technical advances since NUREG-1150**
  - Modifications to enhance nuclear power plant safety and security
  - Advances in PRA technology
  - Updated seismic hazard data
- **Issues with current use of PRAs in risk-informed regulatory decision making**
  - Use of limited-scope PRAs for regulatory applications
  - Adequacy of CDF and LERF as surrogate risk metrics
  - Lack of consideration of multi-unit site effects
  - Lack of consideration of other site radiological hazards

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Commission Tasking

- **Staff requirements memorandum M100218**
  - Issued in response to February 2010 Commission Briefing on Research Programs, Performance, and Future Plans
  - Expressed conditional support for new Level 3 PRA activities
  - Directed the staff to:
    - Continue internal coordination efforts and **engage external stakeholders in formulating a plan and scope for future actions**
    - Provide the Commission with various options for proceeding which include costs and perspectives on future uses for Level 3 PRAs

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NRC Staff's Approach

- **Scoping Study**
- **Proposed Option for Proceeding**
- **Follow-on studies (as needed)**

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Scoping Study Objectives

- **Develop options for the following aspects of a potential site Level 3 PRA pilot study:**
  - Scope of the analysis and PRA technology to be used
  - Perspectives on future uses of results
  - Site selection attributes
  - Resource estimates
- **Determine feasibility of developed options**
- **Identify staff's recommendation for proceeding**
- **Obtain external stakeholder views and support**

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Scoping Study Activities

- **Internal Coordination Activities**
  - Workshops
  - Coordination meetings
  - Alignment meetings
- **External Stakeholder Engagement Activities**
  - Advisory Committee on Reactor Safeguards (ACRS) interactions
  - Regulatory Information Conference (RIC) presentations
  - Category 2 public meeting

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Perspectives on Future Uses

- Support potential future regulatory decision making
- Support specific risk-informed regulatory applications
- Develop and pilot test PRA technology
- Support PRA knowledge management
- Provide technical basis to support resolution of issues associated with future reactor designs

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Staff-Developed Options for Proceeding

Option 1: Maintain Status Quo – Continue Evolutionary Development of Risk Tools

Option 2: Conduct Focused Research to Address Identified Gaps Before Performing Future Level 3 PRAs

Option 3: Full-Scope Integrated Site Level 3 PRA Study – Operating Nuclear Power Plant Site

Option 4: Limited-Scope Integrated Site Level 3 PRA Study – Operating Nuclear Power Plant Site

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Option 1: Maintain Status Quo

Potential Objectives

- Continue ongoing and planned research to develop and improve upon existing analytical tools on a resource-available basis.

Advantages

- Supports current fiscal climate
- Focuses resources on existing mission critical work

Disadvantages

- Insights from a new site Level 3 PRA would not be realized
- Can result in inconsistent and potentially more costly treatment of emerging issues by developing the necessary analytical tools on an ad-hoc basis

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Option 2: Research to Address Gaps

Potential Objectives

- Conduct near-term focused research to address gaps in existing PRA technology to ensure future site Level 3 PRAs are of sufficient quality to support a wide variety of regulatory applications.

Scope (example research areas)

- Consequential (linked) multiple initiating event modeling
- Multi-unit modeling
- Post-core damage human reliability analysis modeling
- Updated seismic fragility curves for structures, systems, components
- Non-reactor PRA technology (e.g., spent fuel)

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Option 2: Research to Address Gaps

Advantages

- Focuses additional resources on needed research
- Enhances PRA capability

Disadvantages

- Insights from a new site Level 3 PRA would be delayed
- Potential loss of critical momentum and duplication of effort if a future Level 3 PRA study is planned

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Option 3: Full-Scope Site Level 3 PRA

Potential Objectives

- Update and improve understanding of site accident risk by:
  - Incorporating advances since NUREG-1150, and
  - Using a more integrated and consistent analysis approach
- Enhance PRA capability by integrating and bridging gaps between existing analytical tools and by developing risk analysis expertise
- Demonstrate feasibility of lower cost Level 3 PRAs by leveraging both existing analytical tools and relevant research
- Evaluate need for and scope of follow-on studies

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Option 3: Full-Scope Site Level 3 PRA

Scope

- All site radiological hazards (reactor core, spent fuel, other sources)
- All initiating event hazards (internal events, fires, flooding, seismic events, other site-specific external hazards)*
- All plant operating states (at-power, low-power/shutdown)
- Research identified in Option 2 would also be conducted in parallel with this option. (including multi-unit modeling)

*** Hazards specifically excluded from the scope:**
- **Deliberate malevolent acts (terrorism, sabotage)**
- **Offsite accidents involving spent fuel and waste transportation and disposal**

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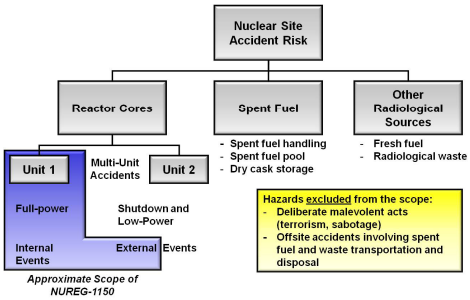
Option 3: Full-Scope Site Level 3 PRA



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Option 3: Full-Scope Site Level 3 PRA

PRA Technology

- Standardized Plant Analysis Risk (SPAR) Models
- Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE), Version 8
- Method for Estimation of Leakage and Consequence of Release (MELCOR) Code
- MELCOR Accident Consequence Code System, Version 2 (MACCS2)

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Option 3: Full-Scope Site Level 3 PRA

Site Selection Attributes

- Multi-Unit
- SPAR Model Capability
- National Fire Protection Association (NFPA) Standard 805 Transition
- MELCOR Input Decks
- Site-Specific Seismic Hazard
- Spent Nuclear Fuel Storage Configuration
- Independent Spent Fuel Storage Installations (ISFSIs)

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Option 3: Full-Scope Site Level 3 PRA

Advantages

- Provides near-term insights from updating and improving our understanding of nuclear site accident risk
- Provides near-term enhanced PRA capability
- More efficient use of resources by capitalizing on scoping study efforts and momentum

Disadvantages

- Relatively resource-intensive, requiring more resources than currently budgeted

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Option 4: Limited-Scope Site Level 3 PRA

Potential Objectives

- Use an integrated and consistent analysis approach to obtain quantitative estimates of the risk to the public associated with spent nuclear fuel and specific external initiating event hazards
- Enhance PRA capability by integrating and bridging gaps between existing analytical tools and by developing risk analysis expertise
- Demonstrate feasibility of lower cost Level 3 PRAs by leveraging both existing analytical tools and relevant research
- Evaluate need for and scope of follow-on studies

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Option 4: Limited-Scope Site Level 3 PRA

Scope

- Site radiological hazards: reactor core, spent fuel
- Initiating event hazards: internal events, seismic events, seismic-induced fires and floods
- Plant operating states: at-power, low-power/shutdown
- Research identified in Option 2 would also be conducted in parallel with this option. (including multi-unit modeling)

*** Hazards specifically excluded from the scope:**
- **Other site radiological sources (fresh fuel, radiological waste)**
- **Random internal fires and floods**
- **Other site-specific external hazards**
- **Deliberate malevolent acts (terrorism, sabotage)**
- **Offsite accidents involving spent fuel and waste transportation and disposal**

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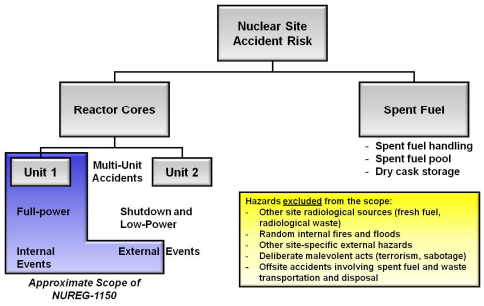
Option 4: Limited-Scope Site Level 3 PRA



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Option 4: Limited-Scope Site Level 3 PRA

PRA Technology

- Same as for Option 3

Site Selection Attributes

- Same as for Option 3

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Option 4: Limited-Scope Site Level 3 PRA

Advantages

- Focuses resources to obtain near-term insights into the relative importance of select, high-interest hazards(spent fuel pools and seismic events)
- Provides near-term enhanced PRA capability
- More efficient use of resources by capitalizing on scoping study efforts and momentum

Disadvantages

- Scope limitations precludes obtaining insights into the relative importance of the multitude of nuclear power plant site risk contributors, thereby potentially limiting the usefulness of results and insights.

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Review and Summary

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Questions?

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Open Discussion

Perspectives on Future Uses for Level 3 PRAs

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Questions to Consider

- How can stakeholders benefit from future Level 3 PRAs?
- How can the NRC benefit from future Level 3 PRAs?

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15 Minute Break

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Open Discussion

Options for a Proposed Site Level 3 PRA

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Questions to Consider

- Should the NRC sponsor a new site Level 3 PRA? Why or why not?
- If the NRC were to sponsor a new site Level 3 PRA:
  - Which objectives should be identified?
  - Which hazards should be included in the scope?
  - Which PRA technology (methods, models, tools, and data) should be used?
  - Which attributes should be considered for site selection?

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Acronyms and Abbreviations

ACRS	Advisory Committee on Reactor Safeguards
DRA	Division of Risk Analysis
IPE	Individual Plant Examination
MACCS2	MELCOR Accident Consequence Code System, Version 2
MELCOR	Method for Estimation of Leakage and Consequence of Release
NRC	U.S. Nuclear Regulatory Commission
PRA	Probabilistic Risk Assessment
QHO	Quantitative Health Objective
RES	Office of Nuclear Regulatory Research
RIC	Regulatory Information Conference
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluations
SECY	Office of the Secretary of the Commission
SPAR	Standardized Plant Analysis Risk

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