



U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

PSA Research and Development at the U.S. Nuclear Regulatory Commission

Nathan Siu, Martin Stutzke, John Monninger
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

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Objectives

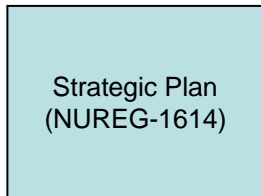
- To develop a PSA research and development plan focusing on advancements in PSA technologies (computational and modeling methods)
- Meet anticipated needs in licensing and regulating new systems (e.g., advanced reactors and fuel cycle facilities introducing challenges associated with human reliability analysis, digital I&C systems, passive systems)

NRC Strategic Plan FY2008-2013

- *Safety Goal:* Ensure adequate protection of public health and safety and the environment
 - Supporting Strategies
 - Improve the NRC’s regulatory programs and apply safety-focused research to anticipate and resolve safety issues
 - Use sound science and state-of-the-art methods to establish risk-informed and, where appropriate, performance-based regulations
 - Supporting Activities
 - Conduct research programs to identify, lead, and/or sponsor reviews that support the resolution of ongoing and future safety issues, including providing tools and expertise needed to support the NRC’s independent decision-making process
 - Evaluate domestic and international operating events and trends for risk significance and generic applicability in order to improve NRC programs

PRA R&D Plan: Role & Use

PLANNING

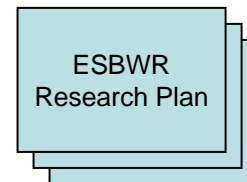
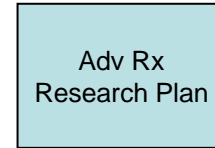


Strategies:

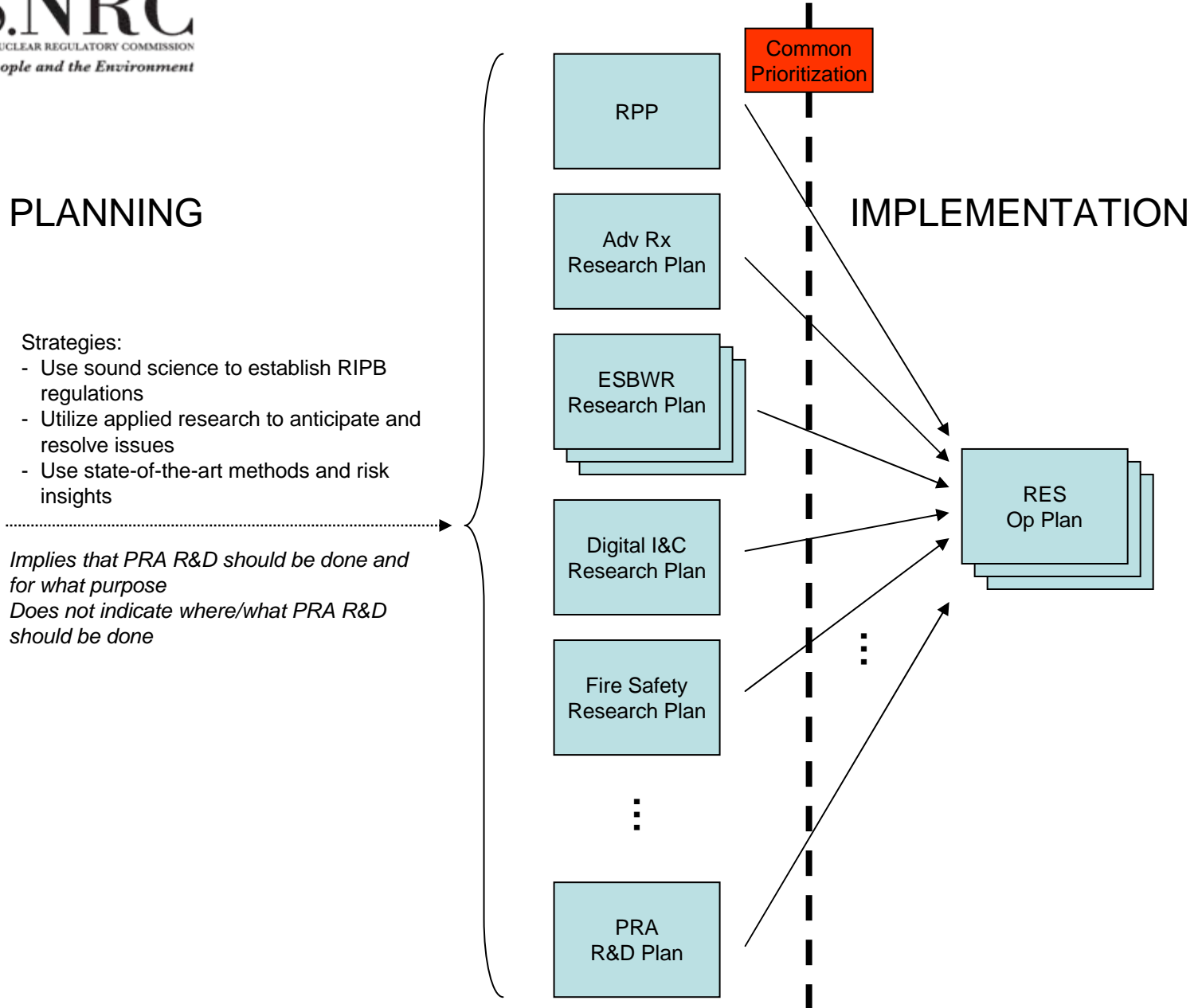
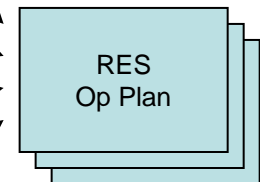
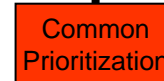
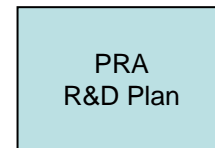
- Use sound science to establish RIPB regulations
- Utilize applied research to anticipate and resolve issues
- Use state-of-the-art methods and risk insights

*Implies that PRA R&D should be done and for what purpose
 Does not indicate where/what PRA R&D should be done*

IMPLEMENTATION



⋮



Representative PSA Research Activities

- Reactors – Level 1, 2, & 3; low power and shutdown operations; operational data; event analysis; generic safety issues; performance indicators and thresholds; new reactors; advanced reactors
- Non-Reactor Facilities – High level waste; mixed oxide fuel fabrication facility; byproduct materials
- Special Topics – Human reliability analysis; digital I&C systems; common-cause failure; fire safety; seismic; external events
- General Systems Analysis Methods – PSA software; treatment of uncertainties; dynamic PSA methods
- Implementation / Application – PSA standards; technology neutral framework for future reactors

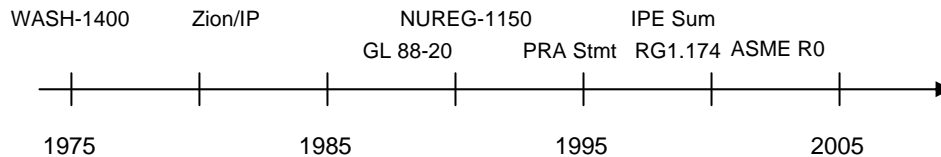
Reviews of NRC's PSA Research Program

- NRC's Advisory Committee on Reactor Safeguards
 - NUREG-1635, Vol. 7, 2006: "... NRC should not allow its work in such a crucial technology as risk assessments to become totally devoted to the support of line activities. Methods development is still important."
 - May 16, 2007 letter on Integrated Long-Term Regulatory Research Plan: "It is essential that NRC not allow development of PRA methods to stagnate."
- NRC's Advisory Committee on Nuclear Waste and Materials
 - August 10, 2007 letter on Integrated Long-Term Regulatory Research Plan: "The Committee has previously commented ... on the need for quantitative risk assessment for fuel cycle facilities... The best risk tools available should be applied..."

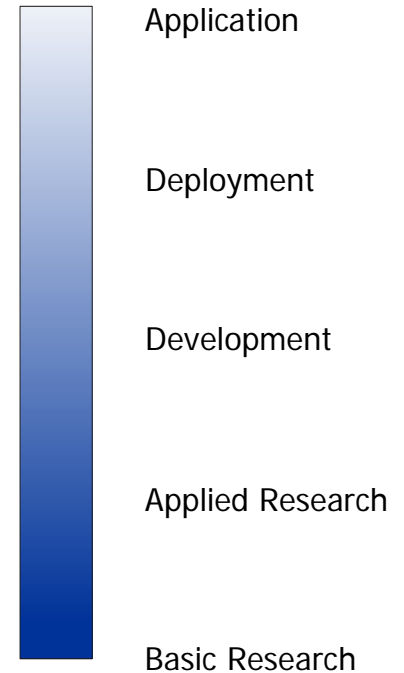
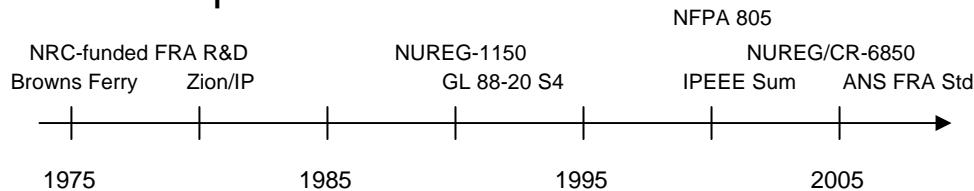
On NRC PSA Research and Development

- Purpose: methods, tools, information to support regulatory decision-making
- Wide range of activities
- Potentially long time to maturity and implementation

– PRA Example 1: WASH-1400



– PRA Example 2: Fire



- Often has side benefits
 - Unforeseen uses
 - Training/development

PRA R&D Plan: Development Approach

- Information gathering
 - Conferences, workshops, etc.
 - Contracted reviews (SNL, BNL)
 - Other R&D plans (NRC, industry, international)
 - Stakeholder feedback (ACRS, ACNW&M, RMT, user needs...)
- Initial gap analysis
 - Uncertainties
 - Decision support needs
 - Feasibility of improvements
- Develop input (with basis) to support budget process
- Finalize initial plan

Advanced Computational and Modeling Methods

- Enable the more accurate and/or efficient solution of existing problems
- Binary decision diagrams
 - Quantifying PSA models without the numerical approximations
- Advanced sensitivity analysis methods
 - Evaluating multivariate problems (e.g., external events and Level 2 analyses)
 - Integrated, simulation-based approach to the treatment of key phenomena
- Integrate the modeling of key phenomena directly in a PSA (e.g., dynamic PSA)
- Advanced modeling techniques for Level 2/3 PSA
- Simulation-based methods (e.g., human reliability analysis, external event analysis, passive system analysis)
- Probabilistic network modeling (e.g., Bayesian Belief Networks and dynamic flowgraphs)

Conclusions

- Broad range of PSA regulatory research activities are underway
- Advanced PSA computational and modeling methods research is in the initial stages and being conducted on a limited scale
- Results will support decisions on where in-depth research should be pursued to improve the ability to more accurately and/or efficiently address issues