OVERVIEW of NRC PSA APPLICATIONS

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PSA Applications

- Historical Perspective
- Progress toward Risk-Informed, Performance Based Regulation
- Ongoing Risk-Informed Activities

Development of Risk Informed Regulations

ORIGINS

- WASH-1400, Reactor Safety Study - 1975
  - Identified TMI-2 accident sequence as one of the more likely accident scenarios
  - NRC added many requirements after TMI-2 accident - but there were no tools available to measure the safety value of changes

Development of Risk Informed Regulations

- NRC Safety Goal Policy Statement (51 FR 28044) - 1986
  - Tried to address “How safe is safe enough?”
  - Addressed risks to public from nuclear power plant operations with the objective of establishing goals that broadly define a level of radiological risk that might be acceptable to the public as a result of nuclear power plant operation.
  - Commission approved use of qualitative safety goals, including use of the quantitative health effects objectives, in the regulatory decision making process.

Development of Risk Informed Regulations

- Commission established two qualitative objectives:
  - Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.
  - Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Development of Risk Informed Regulations

- Two quantitative objectives established in determining achievement of the above qualitative safety goals:
  - Risk of prompt fatality to an average individual in vicinity of a nuclear power plant that might result from reactor accidents should not exceed 1/10 of 1% of the sum of prompt fatality risks from other accidents to which the population is generally exposed.
  - Risk of cancer fatalities to population in area near a nuclear power plant that might result from operation should not exceed 1/10 of 1% of sum of cancer fatality risks from other causes.
- Subsidiary quantitative objectives were established later - 1990
  - CDF < 1E-4/year
  - LERF < 1E-5/year

Development of Risk Informed Regulations

Generic Letter (GL) 88-20, Required Individual Plant Examinations (IPE's) – 1988

- To identify plant specific vulnerabilities and "low cost improvements".
- Widespread application introduced nuclear community to concept of PSA-derived risk insights
- Numerous, cost-effective safety improvements identified
  - For BWR's most involved station blackout
  - PWR's included station blackout and RCP seal cooling

Development of Risk Informed Regulations

Regulatory Analysis Guidelines, NUREG-BR-0058, rev. 2, 1995

- Provided implementing guidance for the Backfitting Rule 10 CFR 50.109
- Tied safety goal evaluations and risk assessments to backfit criteria

Development of Risk Informed Regulations

- PRA Policy Statement (60 FR 42622) - 1995
  - Use of PSA insights should be increased in all regulatory matters and be used in a manner that complements the traditional deterministic approach and supports defense-in-depth
  - PSA technologies should be increased to the extent supported by the state of the art
  - PSA should be used to reduce unnecessary conservatism in NRC practices
  - PSA evaluations in support of decisions should be as realistic as practicable
  - Commission's safety goals and subsidiary numerical objectives should be appropriately considered when proposing backfitting new requirements
  - Insights and results derived from PSAs are used in combination with deterministic system & engineering analyses to focus attention on license and regulatory issues commensurate with their safety importance

Use of Risk Information in Regulatory Programs

OBJECTIVES

- Enhance Safety Decisions
- Efficient Use of NRC Resources
- Reduce Unnecessary Regulatory Burden
- Increase Public Confidence

NRC Uses of Risk-Informed Approaches

- Reactor Licensing
  - License amendments, e.g., extension of AOT's
  - Programmatic changes, e.g., IST, ISI
- Reactor Oversight
  - Assessment of licensee performance (inspection, Performance indicators, significance determination process)
  - Events assessment
- Rule-making
  - Special treatment requirements (10 CFR 50.69)
  - Changes to specific regulations (10 CFR 50.44, 10 CFR 50.46)
- Research programs and priorities
  - ASP program
  - Generic Safety Issues

Risk-Informed License Amendments Application Areas

- Technical specification allowed outage time extensions
- Integrated leak rate testing extensions
- In-service inspection scope changes
- In-service pump & valve testing extensions

Risk-Informed License Amendments Overview

- Implementation guidance established in RG 1.174, SRP Chapter 19 and application specific guides and SRPs

- Principles of risk-informed regulation established to guide applications:
  - meet current regulations unless application is exemption
  - be consistent with defense-in-depth philosophy
  - maintain sufficient safety margins
  - increases in risk should be small
  - impact of changes should be monitored

- Guidance documents specify acceptable techniques for evaluating potential changes from both a risk and deterministic perspective

- Updated guidance issued in November 2002 (RG 1.174 Rev. 1)
  - staff requests of licensees for risk information
  - ensuring quality of supporting risk analysis

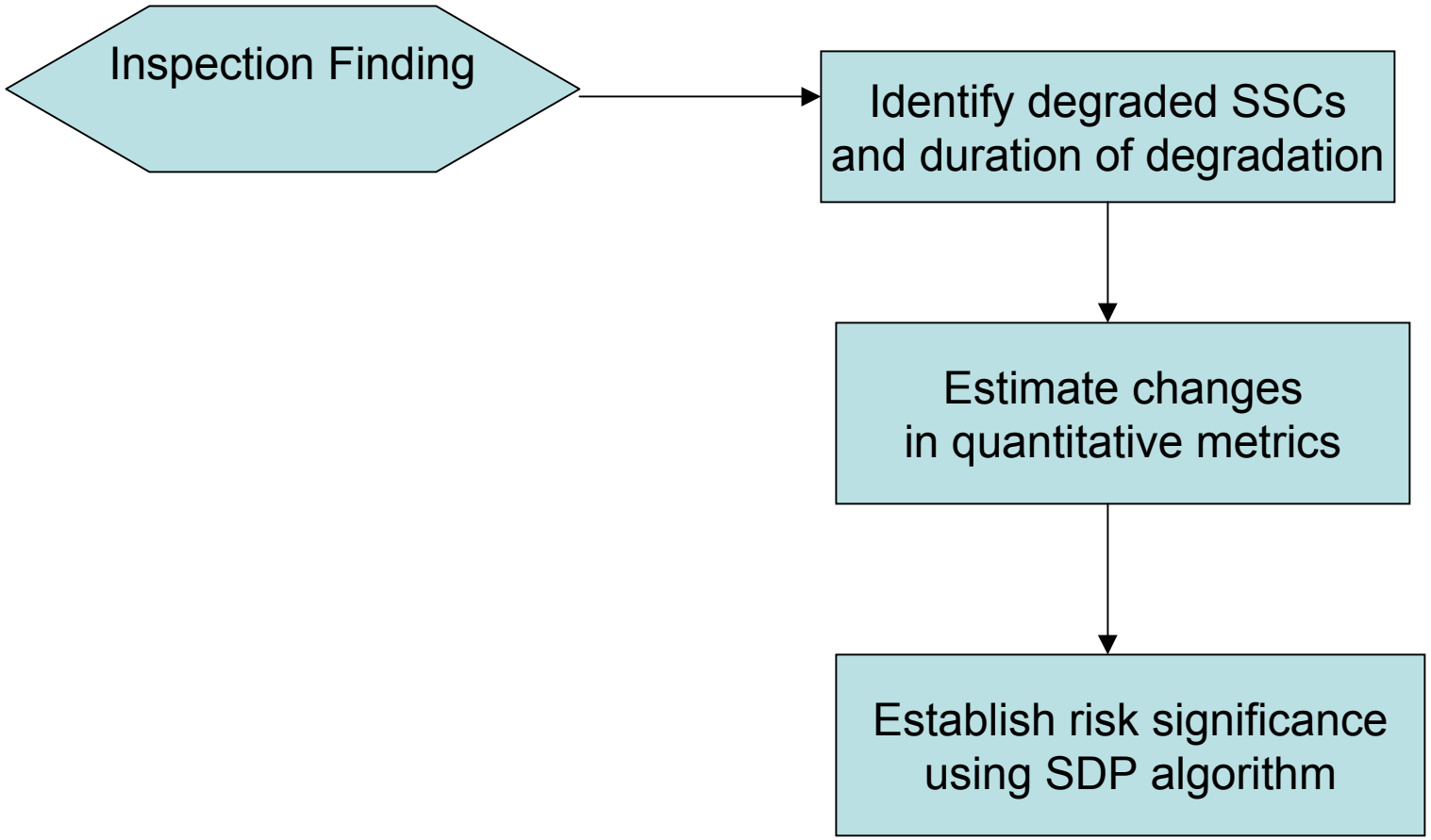
Reactor Oversight Process
Overview

- Process built on set of safety cornerstones that embodies concept of defense-in-depth
- Licensee performance assessed through performance indicators and inspections; both focus on plant features having greatest impact on safety and overall risk
- Different NRC response taken depending on risk significance
- Responses not ad hoc; established in response matrix

Reactor Oversight Process
Significance Determination Process

- Provides means of assessing risk significance of inspection findings
- Uses Quantitative metrics:
  - core damage frequency
  - large early release frequency
- Consists of plant-specific functional level accident sequences in tabular form, with rules for how to change credit given to mitigating functions to account for impact of inspection finding

Reactor Oversight Process
Significance Determination Process



Reactor Oversight Process

Risk Significance Based on ?CDF vs. ?LERF

Frequency Range/RY	Significance Based on ?CDF	Significance Based on ?LERF
" 10^{-4}	Red	Red
< 10^{-4} – 10^{-5}	Yellow	Red
< 10^{-5} – 10^{-6}	White	Yellow
< 10^{-6} – 10^{-7}	Green	White
< 10^{-7}	Green	Green

Existing Risk Informed Rules

- 10 CFR 50.65 - Requirements for monitoring the effectiveness of maintenance at nuclear power plants.

  "The Maintenance Rule"

- 10 CFR 50.44 - Standards for combustible gas control in light water cooled power reactors.

The Maintenance Rule

- 10CFR50.65 (a)(4) requires risk assessment prior to taking equipment out of service for maintenance
- 10CFR50.65 (a)(4) requires risk assessment of emergent plant conditions
- Risk assessment is used to plan equipment out-of-service (OOS) schedules
- Risk assessment is used as input to contingency plans and compensatory actions

Combustible Gas Control

- Eliminates the design basis accident as a source of significant combustible gas
- Eliminates the need for recombiners and/or purge/repressurization systems
- Eliminates the need for oxygen and hydrogen monitors and other combustible gas control systems to be safety grade

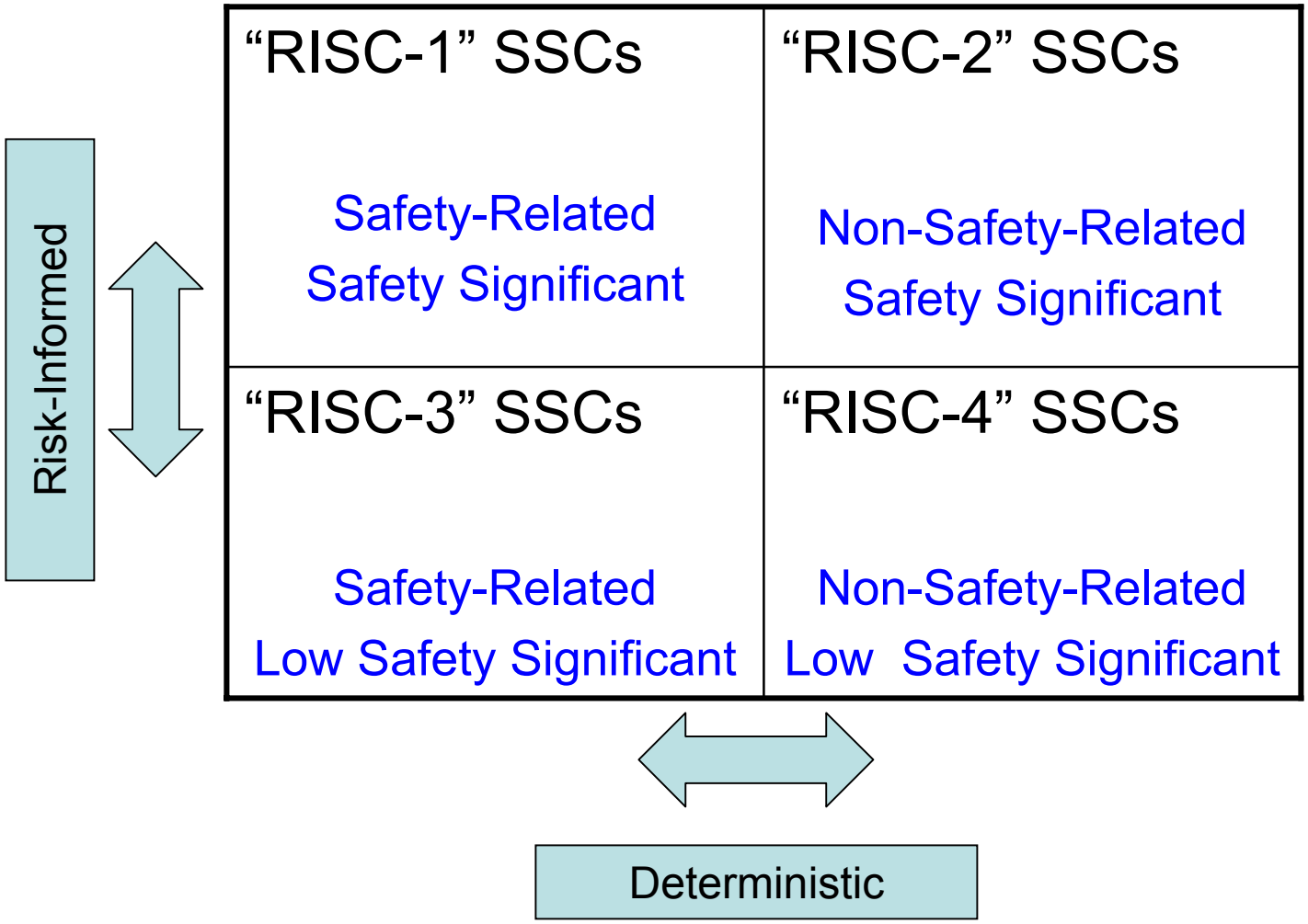
Ongoing Activities

- Requirements for special treatment of systems, structures and components (SSCs) (10 CFR 50.69)
- Risk-informing ECCS acceptance requirements (10 CFR 50.46)
- Fire protection rule (10 CFR 50.48)
- Technical specification initiatives
- Guidance for assessing PRA adequacy

Ongoing Rulemaking
Risk-Informed Treatment Of SSCs
(10 CFR 50.69)

- NRC proposing new requirements that may be adopted voluntarily by licensees or applicants
- Allow use of a risk-informed process to categorize SSCs according to their safety significance
- Allow removal of SSCs of low safety significance from the scope of certain identified special treatment requirements
- Existing requirements are retained for SSCs of safety significance

Risk-Informed Treatment Of SSCs
SSC Categories



Ongoing Rulemaking

Risk-informing ECCS requirements

(10 CFR 50.46)

Commission Directives for Proposed Rule

- Break Size Redefinition
  - Provide a comprehensive “LOCA failure analysis and frequency estimation”
  - Allow for a risk informed alternative to the present maximum LOCA break size
- ECCS Acceptance Criteria
  - Provide performance-based acceptance criteria for fuel rod integrity, maintenance of core coolable geometry and long term core cooling
- ECCS Reliability
  - As an option, replace LOCA/LOOP requirements with functional ECCS reliability requirements commensurate with the LOCA frequency
  - Include the need for a high quality PRA
- ECCS Evaluation Model
  - Any changes that redefine the design basis LB LOCA should use best estimate codes

Ongoing Rulemaking

Amending Fire Protection Requirements

(10 CFR 50.48)

- Proposed voluntary rule issued for comment
- Rule allows licensees to adopt requirements from National Fire Protection Association Standard 805
- The Standard includes objective criteria for plant changes which are consistent with the principles of risk-informed regulation in RG 1.174
- Allows fire protection program changes performed with a risk assessment without prior NRC approval

Technical Specifications
Risk-informed Initiatives

- End States - allow repair time in hot shutdown instead of requiring transition to cold shutdown
- Missed Surveillance - allow up to one surveillance interval to make-up inadvertent missed/incomplete surveillance
- Mode Flexibility - allow mode transition up in power with inoperable equipment, relying on compliance with TS actions in higher mode

Technical Specifications Risk-informed Initiatives

- Flexible Completion Times - extend completion time from a nominal value up to a max value ("backstop") using configuration risk management
- Relocate Test Frequency - surveillance test frequency adjusted outside TS in licensee program using approved risk-informed methods
- Shutdown Time Requirements - risk inform shutdown completion times for loss of function within LCO

Technical Specifications Risk-informed Initiatives

- Risk-Informing Support Equipment Impact - allow TS train to be operable up to max time with degraded non-TS design support features
- Risk-Informing Ts Scope - relocate LCOs not meeting any 50.36 criteria and limit scope of TS to risk-significant systems, structures and components

Related Activities

Ensuring Technical Adequacy of PRAs

- Additional guidance on use of PRA in regulatory decision making (extends RG 1.174)

- Draft Regulatory Guide DG-1122 purpose:
  - Provide guidance on determining the quality of PRA analysis
  - Provide guidance on the technical adequacy of PRA results
  - Provide the NRC position on consensus PRA standards and industry PRA program documents

- Documentation of the process must be accurate and complete for the particular application

- Guide will be issued for trial use early in December 2003

- Pilot applications will guide early implementation of the guidance

Challenges to Risk-Informed Regulation

- Incomplete Coverage Of Contributors To Risk
  - Many PSAs do not address external events, shutdown/transition risk, uncertainties, etc.
- For Same Designs/Operations PSA Results Vary
  - Due to different assumptions, level of detail, different human reliability analysis (HRA) approaches, different thermal hydraulic codes
- Development of Risk Insights Can Be Resource Intensive
- Staff Expertise And Acceptance
  - Transition from solely deterministic thinking by incorporating PSA methods and results in decision making (How much are the risk numbers worth?)