



Briefing on Alternative Risk Metrics for New Light-Water Reactors

**Bill Borchardt, EDO
October 14, 2010**

Speakers and Topics

Bill Borchardt, EDO: Introduction

**Mike Johnson, NRO: Agenda and
Opening Remarks**

**Charles Ader, NRO: Background,
Options, Staff's Recommendation**

**Fred Brown, NRR: Current Framework
for Regulatory Response**

**Mike Mayfield, NRO: Advanced
Reactors**

Agenda

- **Risk-informed guidance for new light-water reactors (LWRs)**
 - **Background**
 - **Options**
 - **Staff's recommendation and basis**
- **Progress on advanced reactor policy issues**

Background

NRC Staff white paper (2/2009)

- New plants estimated to have lower risk profiles**
- Current framework could allow large relative changes in risk**
- Several potential options identified**
- Intention to engage stakeholders**

Commission Policy: Expectations vs. Requirements

- **Safety Goals**
 - **Establishes acceptable level of risk**
- **Severe Reactor Accidents**
 - **Expects a higher standard of severe accident performance**

Commission Policy: Expectations vs. Requirements

- **Advanced Nuclear Power Plants**
 - **Expects enhanced margins of safety**
 - **Does not state that designs must be safer than current generation**
- **Design Certification Rulemakings**
 - **Expectations realized and codified in rulemakings**

ABWR Certification Final Rule

“The Commission will deny a request for an exemption . . . if it finds that the design change will result in a significant decrease in the level of safety otherwise provided by the design.” (Rule)

Expects that “the level of enhanced safety believed to be achieved with this design will be reasonably maintained” (SOC)

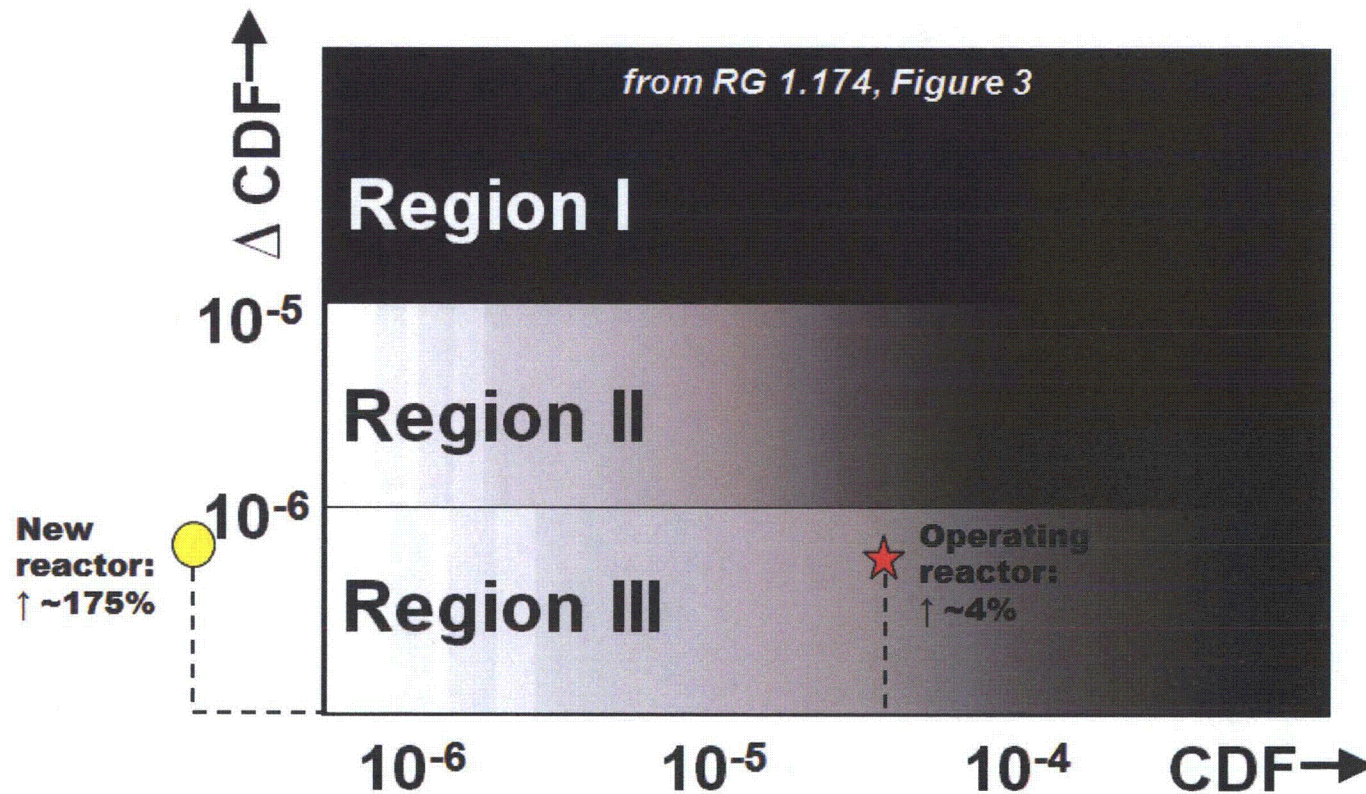
Current Risk-Informed Framework

- **Changes to licensing basis with NRC review and approval**
- **Changes to licensing basis allowed without prior NRC approval through 10 CFR 50.59**
- **Risk-informed regulations**
- **Reactor Oversight Process**

Changes To Licensing Basis With NRC Review and Approval

- **Current RG 1.174 provides basic framework for risk-informed guidance**
- **Includes qualitative and quantitative considerations**
- **Allows increases in risk that are small relative to safety goals**
- **Does not address enhanced severe accident features**

Example: Risk-Informed Licensing Basis Change



Changes To Licensing Basis Without Prior NRC Approval

- **Each Design Certification Rule (Section VIII) includes a “50.59 like process”**
 - **Includes a new change process for ex-vessel severe accident features**
- **Staff developing guidance for “50.59 like process”**

Risk-Informed Regulations

Guidance Derived from RG 1.174

Supports:

- **Maintenance rule - 50.65(a)(4)**
- **Risk-informed categorization and treatment of SSCs - 50.69**
- **LOCA technical requirements - 50.46a (proposed)**

Current Framework for Regulatory Response

Potential differences in response to:

- **Recurring equipment failures**
- **Operational events**
- **Performance degradation**
- **Passive safety system
performance**

Overview of Options Associated with Current Risk-Informed Framework

- 1) No changes to existing risk-informed guidance (status quo)**
- 2) Implement enhancements to existing guidance to prevent significant decrease in enhanced safety**
- 3) Develop lower numeric thresholds for new reactors**

Option 1 – Status Quo

Advantages

- **Provides greater operational and regulatory flexibility for safer designs**

Disadvantages

- **Would allow significant decrease in enhanced safety**

Implementation

- **Minimal resources**

Option 3 – Lower numeric thresholds

Advantages

- **Reaffirms and strengthens Commission's expectation of enhanced safety**

Disadvantages

- **Inconsistent with the underlying policy and technical basis of RG 1.174 (i.e., de facto new safety goals)**
- **Less operational and regulatory flexibility for safer designs**

Option 2 – Augment existing framework

Advantages

- **Reaffirms Commission's expectation on enhanced safety**
- **Acknowledges safety margins and defense in depth in addition to quantitative thresholds**

Disadvantages

- **Some stakeholders view any change to the thresholds in RG 1.174 as inconsistent with their underlying policy and technical basis**

Option 2 (cont.)

Implementation

- **Continue to engage stakeholders**
- **Modify guidance to prevent a significant decrease in safety**
- **Evaluate potential ROP changes**
- **Ensure no unintended consequences**

Staff Recommendation

The staff recommends Option 2.

- **Option 2 provides assurance that “the level of enhanced safety believed to be achieved with new reactors will be maintained”**
- **Preserves intent of Commission policy; margin and flexibility**
- **Endorsed by ACRS**

Summary

- **Near term considerations**
- **Considered stakeholder views when developing options**
- **Proceed consistent with Commission direction**
- **Continue to engage stakeholders**

Advanced Reactor Program

- **Update on identification & resolution of advanced reactor policy issues**
- **Ongoing interactions**
 - **Interoffice & interagency**
 - **Industry working groups (NEI)**
 - **ANS special committee**
 - **Vendors and other stakeholders**

Advanced Reactor Program

- **Selected Policy Issues**
 - **Risk-Informed Licensing**
 - **NRC Annual Fees**
 - **Emergency Preparedness**
 - **Security**
 - **Multi-Module Facilities**
- **Future Commission Updates and Interactions**

List of Acronyms

- **ABWR** – **Advanced Boiling-Water Reactor**
- **ACRS** – **Advisory Committee on Reactor Safeguards**
- **ANS** – **American Nuclear Society**
- **CDF** – **Core Damage Frequency**
- **EDO** – **Executive Director for Operations**
- **ISI** – **In-service Inspection**
- **LOCA** – **Loss-of-coolant accident**
- **LWRs** – **Light-Water Reactors**

List of Acronyms (cont.)

- **NEI** – **Nuclear Energy Institute**
- **NRC** – **Nuclear Regulatory Commission**
- **RG** – **Regulatory Guide**
- **ROP** – **Reactor Oversight Process**
- **SOC** – **Statement of Considerations**
- **SSCs** – **Structures, Systems and Components**

***Vendor's Perspective on
the Options for Risk-
Informed Guidance for
New Reactors***

October 14, 2010

Gary Miller, Technical Leader

ESBWR PRA

GE Hitachi Nuclear Energy



imagination at work

Vendor Perspective

Regulatory credit should be given to passive plants because they pose less risk to the public.

Design focus is also applied to:

Reducing abnormal operating event frequencies, and

Controlling and limiting abnormal events if they occur.

Vendor Perspective, cont.

Measuring safety changes in passive plants should consider a tiered approach, similar to Regulatory Treatment of Non-Safety Systems (RTNSS).

Evaluate core damage frequency, etc., by not crediting passive systems and determine nonsafety related system risk importance.

Vendor Perspective, cont.

Consider evaluating core damage frequency, etc., by not crediting passive systems and determine nonsafety related system risk importance.

Measure safety changes relative to systems important for reducing abnormal operating event frequencies and controlling and limiting abnormal events if they occur.

Passive Safety Features

Reduce risk significantly, e.g., Gravity Driven Cooling or Passive Residual Heat Removal

Analogous to car airbags

However,

Plant design features should allow the control room to prevent the conditions that require passive actuations

Design for Operability

Plant operators cannot bank on the passive safety functions while neglecting prevention, control and limitation systems

Don't ignore the condition or use of seatbelts just because airbags might function to prevent injury

Design for Reliability

***Reliable performance of systems
and components that prevent,
control or limit abnormal events***

***Maintain the brakes, seatbelts
and good driving habits***

***Maintaining high availability =
fewer initiating event challenges***

Design for Reliability, cont.

RTNSS is applied to plant operational activities through the Design Reliability Assurance Program

Ensures that risk significant plant features in the design analysis are maintained throughout the life of the plant

Design for Prevention, Control and Limitation

Plant operational design considers similar concept: Design with passive systems, but focus on abnormal event prevention, control and limitation

Allows control room to use active systems to preempt automatic safety function actuations

Design for Prevention, Control and Limitation, cont.

***Use of active mitigation systems
provides more operator control of
plant conditions***

***Performance of important active
systems is monitored and controlled
by the Maintenance Rule process***

Conclusion

Passive plant safety should be measured against the absolute public safety goals.

Regulatory attention to active functions that prevent, control and limit abnormal events ensures acceptable performance.

***UCS Perspective on
Maintaining Enhanced
Safety for New Reactors***

October 14, 2010

Dr. Edwin S. Lyman

Senior Staff Scientist

Union of Concerned Scientists

Reactor Risks: New vs. Old

- ***Based on average CDF, and considering external events and low-power and shutdown risks, the current reactor fleet is not safe enough today:***
 - ***Fleet-wide core damage risk: ~0.5 to 1% per year.***
- ***New reactors should be significantly safer if the size of the fleet is going to increase.***

A Question

- ***Has the 1986 Advanced Reactor Policy Statement inhibited significant safety improvements, as Commissioner Asselstine warned in his dissent?***
 - ***“I do not believe that this ... statement provides the sound regulatory basis to support a new generation of nuclear power plants in this country. The policy statement encourages, but does not require, safety improvements in advanced reactor design.”***

On the One Hand ...

- ***“CDF estimates for new reactors are typically 1 to 3 orders of magnitude lower than those for current designs when the contributions from external events that have been quantified ... are included.”***

--- NRC Staff White Paper, February 12, 2009

On the Other Hand ...

- ***“plants are required ... to develop PRAs ... which ... include internal events, fire, and external events including seismic ... the calculated risk metrics for new reactors are likely to increase and therefore be closer to current plants than being portrayed today. That is, the one to four orders of magnitude difference cited by the staff will decrease as other site-specific risk contributors, such as seismic, are more fully quantified.”***
- ***“Risk Metrics for Operating New Reactors,” NEI White Paper, March 27, 2009.***

Maintain Enhanced Safety

- ***It is not clear whether new designs now before the NRC really represent significant advances in safety ... but to the extent that they do, NRC should ensure that these advances will not be eroded over time. The public deserves better.***

Risk Metrics for New Reactors

- ***Risk-informed processes should***
 - ***Make sense and be useful for the intended application.***
 - ***Take into account all contributors to risk and all uncertainties.***
 - ***Ensure that risks to the public remain comparable to the risk profiles upon which the plants' approvals were based.***
- ***Corollary: If uncertainties are large, PRA is most useful in assessing relative, not absolute, risks.***

ROP

- ***The ROP is intended to provide timely indications of problems. We share the staff's concern that if the risk thresholds are too high compared to the CDF that the process will not be sensitive to significant declines in performance and will become ineffective.***
- ***Relative, not absolute, risk is the relevant parameter here.***

Risk-Informed LB Changes

- ***In an extreme scenario, maintaining current risk metrics for new reactors could allow some safety-significant systems to be taken out of service virtually forever.***
- ***NEI argues that “deterministic backstops” would prevent such absurd scenarios from taking place, eg. in RITS Initiative 4b.***
- ***But if the process drives all allowed outage times to deterministic backstops, this can hardly be called “risk-informed” regulation.***

UCS Preferred Option

- **SECY-10-0121 identifies three options:**
 - **Option 1: status quo**
 - **Option 3: reduce risk guidelines for new reactors**
 - **Option 2: keep thinking about it; develop application-specific changes**
- **UCS generally supports Option 2**
 - **Caveat: process must preserve new reactor safety enhancements; we believe that relative risk metrics will prove to make the most sense.**

Don't Rush the Process

- ***SECY-10-0121 says that a disadvantage of Option 2 is that the staff needs an answer soon to review risk-informed applications in current DCs and COLs (e.g. RITS for APWRs at Comanche Peak).***

Defer RITS for New Reactors

- ***The Commission should defer consideration of these requests for three reasons:***
 - 1. The analyses and pilot projects needed to develop sensible processes for new reactors will take time.***
 - 2. Risk-informed applications are not appropriate for new reactor designs that have not accumulated any operating experience to validate PRAs.***

Defer RITS for New Reactors

3. Risk evaluations should be based on the entire site-specific risk profile, including all external events and risks in modes other than full-power, where applicable. Ultimately, risk-informed processes should be based on full-scope, level 3 PRAs (see ACRS member Stetkar's comment).

Conclusions

- **UCS supports Option 2 but believes it will ultimately look more like Option 3.**
- **The staff's concern that Option 3 is inconsistent with the Advanced Reactor Policy Statement is misguided.**
- **UCS opposes consideration of RITS for new reactors until**
 - **A meaningful regulatory framework is in place.**
 - **New reactor PRAs are sufficiently developed and validated.**

Acronyms

- **ACRS: Advisory Committee on Reactor Safeguards**
- **APWR: Advanced Pressurized Water Reactor**
- **CDF: Core Damage Frequency**
- **COL: Combined Operating License**
- **DC: Design Certification**
- **LB: Licensing Basis**

Acronyms (cont.)

- ***NEI: Nuclear Energy Institute***
- ***PRA: Probabilistic Risk Assessment***
- ***RITS: Risk-Informed Technical Specifications***
- ***ROP: Reactor Oversight Process***
- ***UCS: Union of Concerned Scientists***

Risk-Informed Regulatory Guidance for New Reactors

Biff Bradley
Director, Risk Assessment
Nuclear Energy Institute

October 14, 2010



NRC's Risk-Informed Framework

- **Derived from the Commission Safety Goal Policy Statement and subsidiary objectives**
- **Regulatory Guide 1.174 provides integrated process for risk-informed decision making**
 - **Risk-informed versus risk-based**
 - **Meeting regulations, absolute and delta risk guidelines, defense in depth, safety margin, performance monitoring**
 - **Effectively used for many years without degradation of safety margins**



Industry Perspectives

- **Industry provided paper to NRC staff and ACRS in March 2009**
 - **Included in SECY-10-0121**
- **Industry believes Option 1 is sufficient to address NRC staff concern and preserve safety margins**
 - **With addition of new plant change control guidance through Appendix to NEI 96-07**



SECY Option 2

- **Identify and implement changes to the existing risk-informed guidance**
- **We have reviewed the guidance for several key risk applications:**
 - **Risk-Informed Technical Specifications**
 - **Maintenance Rule**
 - **Reactor Oversight Process**
 - **Mitigating Systems Performance Index**
 - **Significance Determination Process**



SECY Option 2

- **Current risk-informed guidance already includes many provisions that address the NRC concern (backstops, limits, defense in depth considerations)**
- **New plant change control guidance will address severe accident design features and other elements of Part 52 not applicable to operating plants**
 - **This guidance is thus more restrictive than that for operating plants**



Technical Specifications

- Risk informed technical specifications initiative 4B – flexible completion times
- Includes a 30 day deterministic backstop on equipment out of service regardless of low risk significance
- For a lower CDF new plant, this backstop is more restrictive than for an operating plant
- Also bounds Maintenance Rule configuration management (a)(4) assessments



Reactor Oversight Process

- **Mitigating Systems Performance Index**
 - Index is triggered by failures exceeding a performance based limit regardless of risk significance
 - For a new multi-train plant, this feature will be more restrictive than for operating plants due to lower risk significance of MSPI components



Reactor Oversight Process (Cont)

- **Significance Determination Process**
 - **Green findings require corrective action and receive NRC scrutiny**
 - **Safer plants will have fewer significant findings – it is a safety focused process**



Concerns with new metrics (Option 3)

- **Inconsistent with safety goal policy**
- **Undermines basic premise of risk-informed philosophy which is to focus resources based on safety significance**
- **Would penalize new plants**
- **Would create public perception problems**
- **Would act as a disincentive for new plant risk-informed applications**



Technical Issues with Option 3

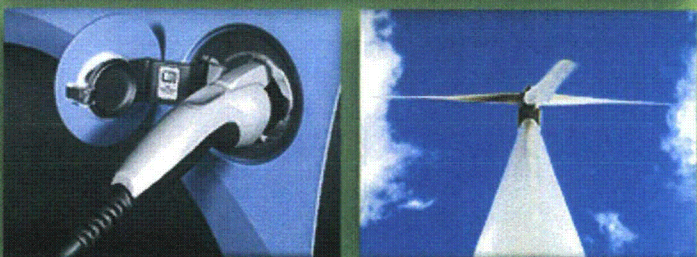
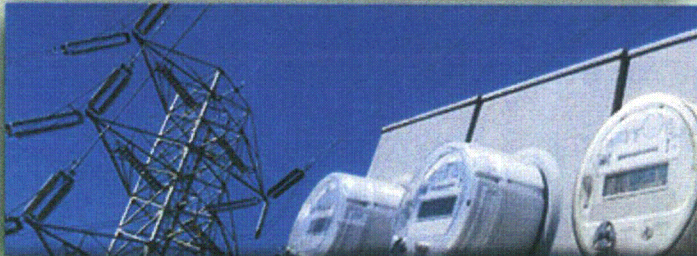
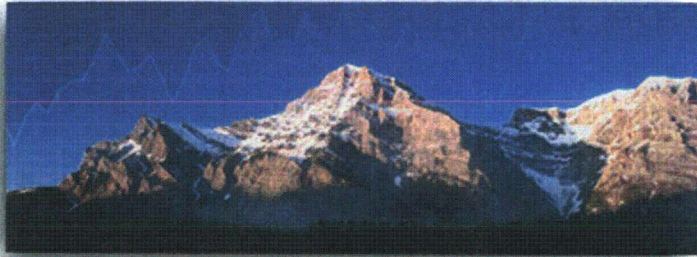
- Metrics could be well within PRA uncertainty bands
- Considerations are premature based on incomplete CDF profile for new plants
- Large release (used for DCD) is undefined in this context and should be replaced with Large Early Release as used in Regulatory Guide 1.174 for operating plants



Summary

- **Industry is engaged with NRC staff on new plant change control guidance**
- **Existing controls are sufficient for other risk applications, and have been effective in practice**
- **New reactors should transition to Regulatory Guide 1.174 risk metrics when operating**
- **Maintains consistent commission policy and rational regulatory framework**





EPRI

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Considerations for a Future Risk Informed Regulatory Framework

Ken Canavan

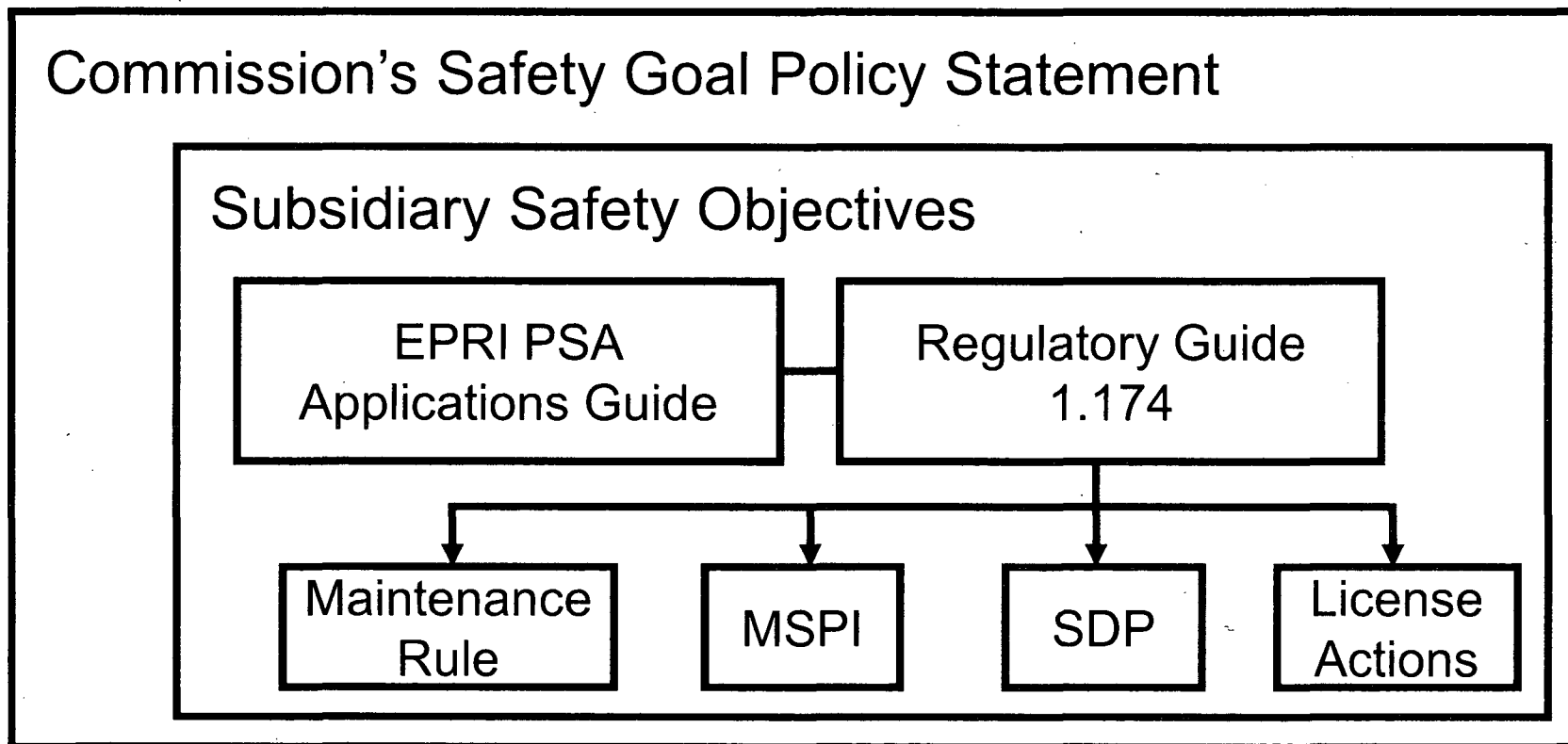
Director, Plant Technology

Nuclear Regulatory Commission Briefing

October 14th, 2010

Basis for Existing Metrics

Acceptable Level of Risk



Consistent application promotes safety & performance

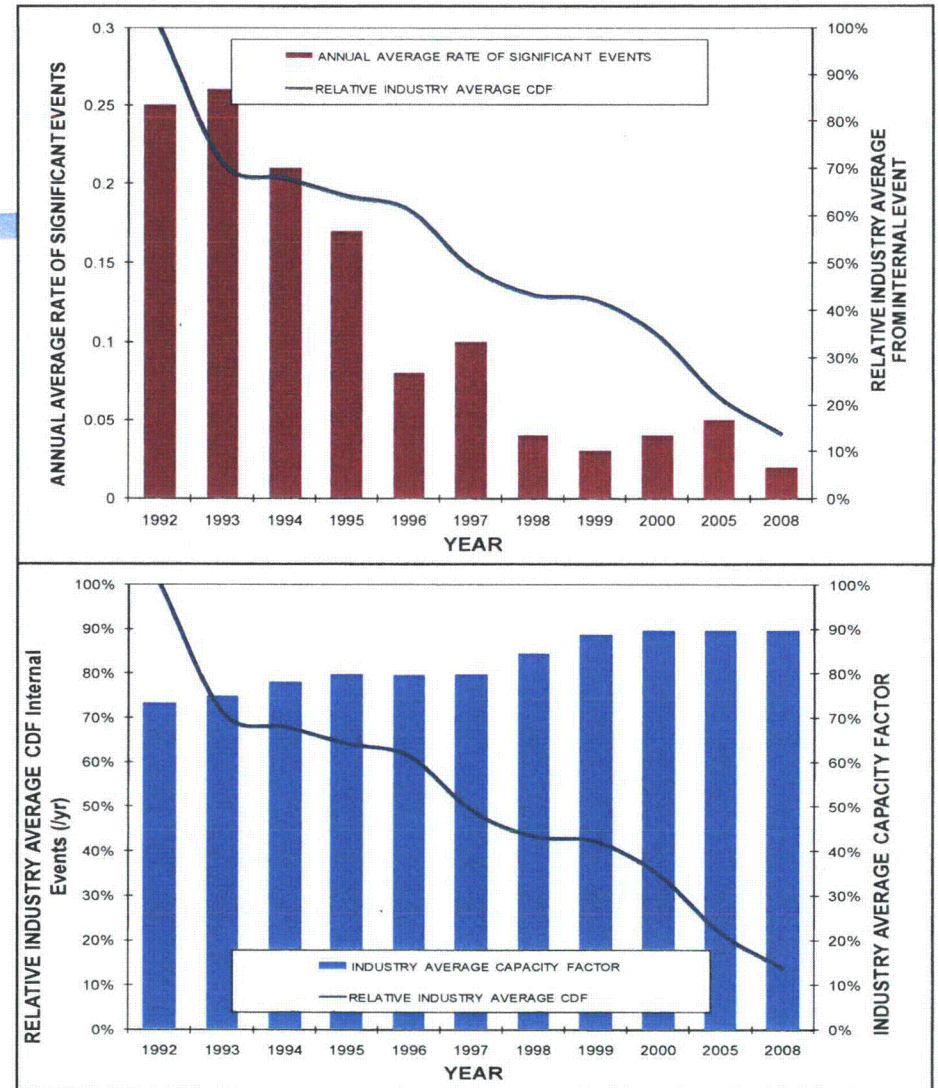
Actual Risk Profile of New Plants

- Design PRAs are necessarily incomplete
 - No operating experience
 - Field routing
 - Seismic risk and other hazards require as-built information
- Most new plant applications did not risk-inform technical specifications or other operational programs

Experience with As-Built, As-Operated Plants
Needed to Address Risk Metrics

Win – Win – Win

- Existing plant risk metrics are very successful
- Metrics developed following understanding of “risk picture”
- Metrics have:
 - Encouraged increased margin – permanent
 - Granted increased flexibility – rarely used
- Operators, regulator and public – all winners



If Risk Margins Have Value, They Will Be Maintained or Increased

Future Risk Metrics

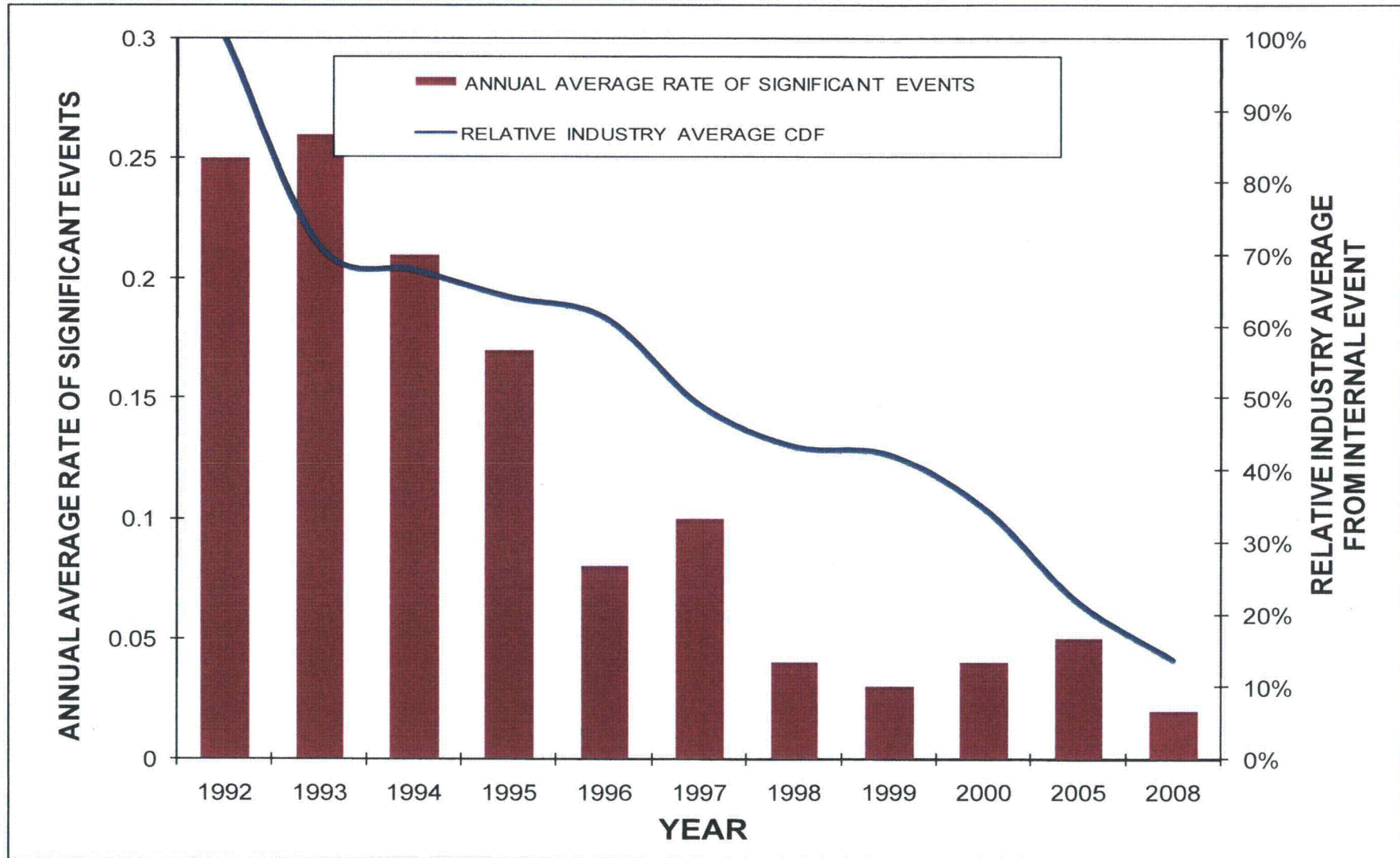
- Any future risk metric
 - Should preserve the “win – win – win” established by previous metrics
 - Should encourage the ability to react in the margin and correct declining trends
 - Should provide continued focus on significant issues
- The current risk metrics have these attributes

In the Absence of Contravening Data,
Current Risk Metrics are Adequate



Backup Material

Annual Average Significant Events and Internal Events CDF



Annual Average Internal Events and Capacity Factor

