UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

April 26, 2012

Mr. R. W. Borchardt
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: DRAFT COMMISSION PAPER, "RISK-INFORMED REGULATORY FRAMEWORK FOR NEW REACTORS"

Dear Mr. Borchardt:

During the 593rd meeting of the Advisory Committee on Reactor Safeguards, April 12-14, 2012, we completed our review of the Draft Commission Paper titled "Risk-Informed Regulatory Framework for New Reactors," dated February 3, 2012. Our Reliability and PRA Subcommittee also reviewed this matter during meetings held on September 20, 2011, and March 7, 2012. During these meetings, we had the benefit of discussions with representatives of the NRC staff, industry participants in selected tabletop exercises, and the Nuclear Energy Institute. We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

1. Approvals for the implementation of risk-informed licensing applications that address structures, systems, and components (SSCs) which do not have a unique design or different function from those in currently operating reactors should not require the compilation of additional new reactor operating experience as a prerequisite.

2. We concur with the staff's recommendation of Option 1B to close a potential gap in the reviews of changes to Tier 2 design certification information regarding SSCs for the mitigation of non-ex-vessel severe accidents.

3. We concur with the staff's recommendation of Option 2C for transition from use of the conditional containment failure probability (CCFP) and large release frequency (LRF) metrics to the use of only the large early release frequency (LERF) metric at or prior to initial fuel load.

4. The staff should assess what effort is necessary to ensure that the scope and level of detail in the Level 2 offsite release categories and Level 3 consequence categories from the evolving consensus PRA standards and their supporting methods are adequate to support metrics that address aspects of societal risk.

5. A fourth Option 3D should be developed for Commission consideration with regard to risk significance determinations to support the Reactor Oversight Process (ROP) and other risk-informed applications. That option should employ relative measures of the change in risk as a metric for safety significance, rather than absolute measures. Use of these relative measures should also be clarified in an update to Regulatory Guide 1.174.

BACKGROUND

This draft Commission paper was developed in response to the Staff Requirements Memorandum (SRM) on SECY-10-0121, "Modifying the Risk-informed Regulatory Guidance for New Reactors." In that SRM, the Commission stated:

> The Commission reaffirms that the existing safety goals, safety performance expectations, subsidiary risk goals and associated risk guidance (such as the Commission's 2008 Advanced Reactor Policy Statement and Regulatory Guide 1.174), key principles and quantitative metrics for implementing risk-informed decision making, are sufficient for new plants. Because new plant designs incorporate operating experience from current generation reactors, severe accident research, and risk insights from design probabilistic risk assessments, the Commission expects that the advanced technologies incorporated in new reactors will result in enhanced margins of safety. However, the Commission continues to expect (consistent with the 2008 Advanced Reactor Policy Statement), as a minimum, at least the same degree of protection of the public and the environment that is required for current-generation light water reactors. New reactors with these enhanced margins and safety features should have greater operational flexibility than current reactors. This flexibility will provide for a more efficient use of NRC resources and allow a fuller focus on issues of true safety significance.

The draft Commission paper summarizes results and insights from a series of public workshops and tabletop exercises that were conducted with stakeholder input to examine a variety of postulated practical risk-informed licensing applications for new reactors within the framework of current regulatory guidance, including the ROP. The paper develops options for possible changes to specific regulatory guidance and presents the staff's recommendations for each option.

DISCUSSION

The tabletop exercises and public workshops provide useful insights about the treatment of practical risk-informed licensing applications for new reactors within the current regulatory framework. The staff indicated that approvals for the implementation of some risk-informed applications (e.g., inservice inspections, Technical Specifications allowed outage times and surveillance frequencies, etc.) may be delayed until additional operating experience is available from the new reactors.

Caution is warranted for proposed changes that affect unique equipment or new functional applications (e.g., large squib valves, digital protection systems, safety-related gas turbines, etc.). However, the substantial available operating experience for most SSCs in the current operating fleet is equally applicable to new reactors. There is always component-to-component and plant-to-plant variability in that experience. Accrual of a few more years of new reactor operating experience does not substantially improve estimates for the reliability or availability of that equipment. As with each plant in the current operating fleet, the generic industry data will be updated periodically to account for the observed plant-specific operating experience. The justification for each risk-informed application will be reexamined if changes to the plant data do not continue to support the initial conclusions. Therefore, approvals for the implementation of risk-informed licensing applications that address SSCs which do not have a unique design or different function from those in currently operating reactors should not require the compilation of additional new reactor operating experience as a prerequisite.

The draft Commission paper presents options and recommendations for the following three regulatory issues that were identified during the tabletop exercises and workshops.

<u>Tier 2 Change Process</u>

The staff identified a potential gap in the change process for Tier 2 design certification information regarding SSCs that address severe accident conditions. In particular, certain design features (e.g., features to prevent containment bypass and containment hydrogen mitigation equipment such as igniters) do not specifically address "ex-vessel" conditions, as they are defined in the statement of considerations for 10 CFR Part 52. Unless a design feature specifically applies to the mitigation of "ex-vessel" phenomena, a proposed change to that feature does not require an evaluation against the severe accident criteria that are listed in Section VIII.B.5.c of each design certification rule. If the design feature also does not address the mitigation of design-basis accidents, a proposed change does not require an evaluation against the criteria in Section VIII.B.5.b. Therefore, changes to some severe accident mitigation design features could conceivably be made without prior NRC approval, according to the criteria in Section VIII.B.5.a.

The staff has recommended Commission approval of Option 1B to close this potential gap. That option ensures that sufficient details of all key severe accident design features are included in Tier 1. The change process in Section VIII of future design certification rulemakings would also be modified to require an evaluation of non-ex-vessel severe accident design features using criteria similar to those currently applied for ex-vessel severe accident design features under Section VIII.B.5.c. We concur with this recommendation.

<u>Transition from LRF to LERF</u>

Risk information that is developed during the design certification process uses conditional containment failure probability (CCFP) and large release frequency (LRF) as surrogate metrics for potential offsite releases and consequences. Current regulatory guidance for operating reactors and the ROP use large early release frequency (LERF) as the corresponding surrogate metric for decisions regarding risk-informed licensing changes and event significance determination. These differences introduce a discontinuity in the risk metric definitions and the risk significance quantification requirements when a new reactor transitions from the design phase to power operation.

The staff has recommended Commission approval of Option 2C to address this discontinuity. That option adopts the use of LERF as the applicable metric after issuance of the combined license and no later than initial fuel load, and discontinues the use of CCFP and LRF thereafter. It affords consistent licensee and regulatory understanding and applications of this metric for all operating reactors, regardless of their licensing basis. It is likely that a pending consensus standard for the performance of Level 2 PRAs will further clarify the process to consistently define and quantify LERF, circumventing the as-yet-to-be-defined LRF metric. Under Option 2C, the discussion of long-term containment performance in Regulatory Guide 1.174 would also be amended to include containment performance objectives that are similar to those applied during the design certification process. We concur with these recommendations.

LERF is a suitable metric to address early health effects within the context of the current Commission safety goals. However, LERF does not adequately evaluate other measures of societal risk such as land and water contamination, relocation of nearby populations, regional and national economic impacts, etc. Expansion of the current risk-informed regulatory framework may explicitly address these broader issues. That expanded perspective will require appropriately defined metrics to consistently assess these other elements of societal risk. The process to develop those metrics would benefit from a careful examination of the comprehensiveness and potential applicability of Level 2 offsite release categories and Level 3 consequence categories in the evolving consensus PRA standards and their supporting methods. The staff should assess what effort is necessary to ensure that the scope and level of detail in those methods are adequate to support metrics that address aspects of societal risk.

Reactor Oversight Process (ROP)

The ROP tabletop exercises and workshops identified a number of situations in which the applied quantitative metrics and guidance may not provide adequate discrimination for enhanced regulatory oversight of new reactors. The current significance determination process (SDP) assigns a greater-than-green finding if the absolute change in core damage frequency (CDF) is more than 1.0×10^{-6} event per year, or if the absolute change in LERF is more than 1.0×10^{-7} event per year. As demonstrated by the tabletop exercises, it is difficult to exceed these absolute numerical thresholds if a plant's baseline risk is very low. It was noted that use of these metrics would not result in greater-than-green findings for several tabletop exercise conditions which the staff concluded should merit increased regulatory attention.

The staff developed three options to address this identified issue. They have recommended Commission approval of Option 3B. That option revises the current significance determination guidance and augments the quantitative criteria with changes that would:

(1) Develop deterministic backstops or other qualitative considerations for characterizing the significance of inspection findings in the reactor safety cornerstones to compensate for shortfalls noted during the tabletop exercises and allow for a transparent and predictable process for determining the appropriate regulatory response to address performance issues.

(2) Modify the contribution of existing deterministic criteria or develop new deterministic criteria for initiating a reactive inspection for events or degraded conditions at new reactor facilities, to provide a transparent and predictable process for determining the appropriate regulatory response to plant events.

We disagree with this recommendation. Applications of the proposed approach may not consistently balance the two Commission directions for advanced reactors: first, that there is an expectation of a greater level of safety for these reactors and second, that they should have increased operational flexibility. It implies that quantitative risk measures are not adequate to provide a consistent, unbiased, and reproducible determination of the significance of unusual events, equipment failures, or other conditions that occur at an operating nuclear power plant. It also introduces additional deterministic criteria and qualitative decisions that are contrary to the demonstrated success of the current risk-informed regulatory process.

We recommend that the staff should include a fourth Option 3D for Commission consideration to address these issues. In particular, we recommend that relative measures of the change in risk should be used to determine safety significance, rather than the absolute measures that were applied in the tabletop exercises. Such relative measures would maintain a regulatory framework that is consistently informed by quantitative evaluations of reactor safety, and they would provide an explicit expression of the Commission expectations for increased safety and operational flexibility.

The staff cited a literal interpretation of the SRM on SECY-10-0121 as the basis for their use of absolute measures for risk significance determination. Other possible numerical metrics or alternate significance determination methods were not considered in the proposed options, because the current regulatory guidance specifically cites the applied absolute values for CDF and LERF.

Relative measures of significance and the associated regulatory decision criteria can be developed and applied in a manner that preserves the Commission's stated intent to maintain the enhanced safety margins of new reactors, while providing greater operational flexibility than current reactors. No additional risk calculations are needed to develop these relative measures, beyond those already performed for the SDP and other risk-informed applications.

The use of relative measures to quantify risk significance is not a new concept. For example, two relative numerical measures (i.e., Fussell-Vesely Importance and Risk Achievement Worth) are used to determine the risk significance of SSCs as an input to the Regulatory Treatment of Non-Safety Systems (RTNSS) and Design Reliability Assurance Program (DRAP) evaluations for new reactors. These same relative metrics are used for significance determinations in the risk-informed categorization of SSCs under 10 CFR 50.69. The notion that significance is characterized by the relative change in risk, compared to a baseline measure of that risk, is also consistent with the fundamental decision framework in Regulatory Guide 1.174.

A rigid application of relative risk measures would not address the Commission direction to provide greater operational flexibility for reactors with increased margins of safety. Figure 1 is a conceptual framework in which the permitted relative change in CDF is dependent on the baseline CDF. The logarithmic scales for this metric accomplish the stated desire to provide increased operational flexibility as the absolute safety margin increases. The numerical values for the vertical scale can be selected to preserve the SDP metrics that are currently applied for operating reactors and to provide appropriate numerical discrimination for reactor oversight and other regulatory decisions for new reactors.

Example values are shown on Figure 1 to illustrate how this concept could be implemented in practice. If the baseline CDF were 1.0×10^{-4} event per year, a White significance finding would be triggered if the CDF increases by 1%. This is equivalent to the current SDP threshold absolute increase of 1.0×10^{-6} event per year. If the baseline CDF were 1.0×10^{-8} event per year, a White significance finding would be triggered if the CDF increases by a factor of approximately 10. This is equivalent to an absolute increase of 1.0×10^{-7} event per year. As intended, the corresponding significance determination appropriately maintains the enhanced level of overall plant safety, supports improved decisions for increased regulatory oversight, and provides substantially increased operational flexibility, compared to current reactors.

This concept should be implemented by consistently extending the decision framework of Regulatory Guide 1.174. Appropriate values for these metrics, the shapes, and the slopes of the significance determination transitions would be developed through stakeholder interactions, informed by the available tabletop exercises or an expanded set of case studies.

In the decision framework of Regulatory Guide 1.174 and the risk quantification for new reactors, the Baseline CDF metric is intended to account for all contributions from internal events and external events during all plant operating modes. However, alternate definitions of the Baseline CDF metric may be needed for specific risk-informed applications. For example, the overall risk for some new reactors may be dominated by seismic events which are relatively insensitive to changes in the availability or configuration of specific SSCs. Since risk-informed decisions under the ROP are concerned primarily with the significance of operational events, equipment failures, and abnormal plant alignments, it could be more appropriate to focus those ROP applications on changes in the CDF from internal events, internal fires, and internal floods. More comprehensive risk-informed changes to the overall plant design or licensing basis may require an evaluation of all risk contributors. Definitions of the contributors to the Baseline CDF should be clearly elaborated in more fully integrated guidance to assure consistent and predictable regulatory decisions across the complete spectrum of reactor types and risk profiles.

We look forward to continuing our dialogue with the staff to address these important issues.

Sincerely,

/RA/

J. Sam Armijo
Chairman

Attachment:
Figure 1

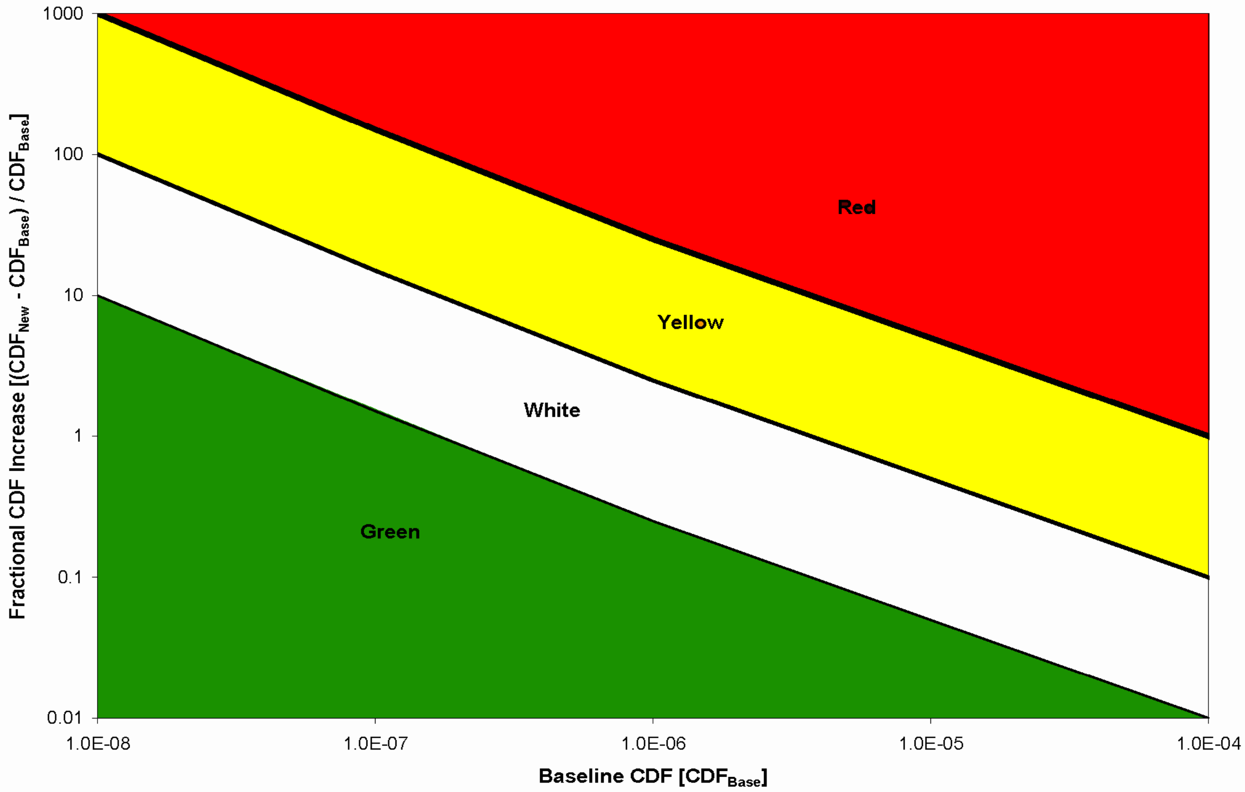

Figure 1. Relative Risk Significance Concept

REFERENCES

1. Memorandum to Edwin M. Hackett, “Transmittal of Draft Commission Paper on Risk-informed Regulatory Framework for New Reactors," February 3, 2012 (ML12011A191)

2. SRM on SECY-10-0121 “Modifying the Risk-informed Regulatory Guidance for New Reactors,” March 2, 2011(ML110610166)

3. SECY-10-0121, "Modifying the Risk-informed Regulatory Guidance for New Reactors," September 14, 2010 (ML102230076)

4. ACRS Letter, "Risk-informed Regulatory Guidance for New Reactors," July 27, 2010 (ML102000422)

5. Summary of Public Meeting to Discuss Changes During Construction, Draft ISG-025 and NEI 96-07, Appendix C on November 15, 2011, dated November 28, 2011 (ML113320197)

6. Summary of Public Meeting to Further Discuss Key Points from Tabletop Exercises for New Reactor Risk Application in ROP on October 26, 2011, dated November 4, 2011 (ML11308A542)

7. Summary of Public Meeting to Perform Tabletop Exercises to Complete Licensing Issues and to Discuss the ROP for New Reactors on October 5, 2011, dated October 18, 2011 (ML11291A076)

8. Summary of Public Meeting to Perform Tabletop Exercises Regarding Guidance on 50.69 and Draft NEI 96-07 Appendix C Related to Ex-Vessel Severe Accident (EVSA) Features for New Reactors, Summary Package on 08/09/2011, dated August 17, 2011 (ML112290891)

9. Risk-informed Technical Specifications, Initiative 5b (RITS 5b) Public Meeting Summary Package, dated July 6, 2011 (ML11182A976)

10. Risk-informed Technical Specifications, Initiative 4b (RITS 4b) Second Public Meeting Summary Package, dated June 22, 2011(ML111650341)

11. Risk-informed Technical Specifications, Initiative 4b (RITS 4b) Public Meeting Summary Package, dated June 21, 2011(ML111721655)

12. Risk-Informed Inservice Inspection of Piping (RI-ISI) Public Meeting Summary Package, dated May 12, 2011(ML111330381)

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1. Memorandum to Edwin M. Hackett, "Transmittal of Draft Commission Paper on Risk-informed Regulatory Framework for New Reactors," February 3, 2012 (ML12011A191)

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Letter to R.W. Borchardt, EDO, from J. Sam Armijo, ACRS Chairman, dated April 26, 2012

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