



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

July 27, 2010

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: RISK-INFORMED REGULATORY GUIDANCE FOR NEW REACTORS

Dear Chairman Jaczko:

During the 574th meeting of the Advisory Committee on Reactor Safeguards, July 14-16, 2010, we completed our review of a draft Commission Paper on Modifying the Risk-Informed Regulatory Guidance for New Reactors. During our 573rd meeting, June 9-11, 2010, we met with representatives of the NRC staff to discuss this matter. Our Subcommittee on Reliability and Probabilistic Risk Assessment also met with the staff and representatives of the Nuclear Energy Institute and the Union of Concerned Scientists on June 2, 2009, to discuss preliminary options and proposals for the use of quantitative metrics in risk-informed applications for new reactors. We also had the benefit of the documents referenced.

RECOMMENDATIONS

1. We agree with the staff's position in the draft Commission Paper that the proposed framework should prevent significant decreases in the level of safety of the new reactor designs. The staff should continue to interact with internal and external stakeholders to develop guidance for an integrated risk-informed decision-making framework that consistently applies the principles of Regulatory Guide 1.174 for currently operating plants and new reactors. Pilot applications should be used to assess and refine details of the proposed framework.
2. The bases for risk significance determinations in the Reactor Oversight Process (ROP) should be consistent with the guidance for changes to the licensing basis.
3. The guidance should anticipate and account for plant-specific risk profiles that may be influenced significantly by external events such as severe earthquakes.
4. The staff should expedite the development of interim guidance for the use of numerical risk significance measures for selection of candidate structures, systems, and components (SSCs) in design certification and Combined License (COL) reliability assurance programs.

BACKGROUND

Quantitative metrics are used extensively to guide regulatory decisions regarding the risk significance of design, operations, testing, maintenance, and inspection issues that affect the

ROP and changes to the licensing basis for currently operating nuclear power plants. The specific metrics and their applications have evolved during the 15 years since the 1995 Commission Policy Statement on the use of Probabilistic Risk Assessment (PRA) methods in nuclear regulatory activities. Regulatory Guide 1.174 describes the key principles for implementing risk-informed decision making, and it contains guidance for the use of quantitative metrics to assess the measurable risk impacts from a proposed change.

Current guidance relies primarily on Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) as surrogate measures for the risk from nuclear power plant accidents. A modified metric, Large Release Frequency (LRF), is applied for new reactor designs to clarify the risk implications that are subsumed by the LERF metric. The CDF and LRF metrics are approximate pragmatic surrogates for a more complete assessment of risk that would be provided by a fully integrated Level 3 PRA. Our referenced reports contain extensive discussions about the complex relationships among the Commission Safety Goals, PRA scope and quality, efficacy of CDF and LERF as risk surrogates, and applied methods for measuring risk significance within the constraints of these metrics.

Regulatory pragmatism and the limitations of applied PRA technology have influenced the selection of these risk metrics and the guidance for their use. Current PRAs focus primarily on CDF (Level 1 PRA) with the most emphasis placed on internal initiating events that occur during full power operation. The scope of these PRAs typically includes limited assessments of the risk from internal plant fires, seismic events, other external events, or initiating events that may occur during low power and shutdown modes of operation. Most PRAs include only a limited evaluation of containment performance (Level 2 PRA) that is deemed sufficient to estimate the conditional probability of large (early) releases.

New plant designs have benefited substantially from the use of passive safety features and insights gained from PRAs for operating plants. Regulatory Guide 1.206 states that PRAs which are performed to support the certification of new reactor designs and COL applications “should be a Level 1 and Level 2 PRA that includes internal and external events and addresses all plant operating modes.” The scope and level of detail in the design certification and COL PRAs are typically more limited than many PRAs that are performed for operating plants. The resulting estimates for CDF and LRF are typically 10 to 1,000 times lower than CDF and LERF estimates for the current operating fleet. These substantial differences require reexamination of the types of metrics that are used to assess risk, the criteria that are used to measure risk significance on an absolute level, and the criteria that are used to measure the significance of departures from a particular plant's baseline risk profile.

DISCUSSION

The following three issues are most pertinent to the draft Commission Paper.

(1) What principles should apply in near-term risk-informed guidance for new reactors?

Pragmatic considerations must continue to guide the regulatory decision-making process. Those considerations favor retention of the basic principles that are currently applied for risk-informed licensing decisions as well as inspection and enforcement actions under the ROP. The foundations for those principles are elaborated in Regulatory Guide 1.174.

The draft Commission Paper summarizes three conceptual approaches for the assessment of acceptable risk margins for new reactors. One approach considered by the staff (denoted as

Option 1) involves no changes to the metrics in the current regulatory guidance. That approach uses the absolute risk measures for currently operating reactors as a basis for determining the significance of departures from a new reactor's baseline risk profile. In effect, under this proposal, risk increases would not be deemed "significant" until a new reactor's cumulative risk approaches the range of CDF and LRF estimates that apply for currently operating plants. If a new reactor had a very low overall baseline risk at the time of its COL issuance, successive plant changes under the regulatory framework of Option 1 could permit substantial erosion of its original risk margin. This is contrary to Commission expectations that a new reactor should maintain an enhanced level of safety throughout its operating life. We concur with the staff's conclusion that the principles of Option 1 are not appropriate for new reactor regulatory guidance.

Another approach considered by the staff (denoted as Option 3) would modify regulatory guidance to apply a "new risk metric" for new reactors. The staff explained that this approach would effectively use current numerical measures of relative risk significance as a basis for determining the acceptability of departures from a new reactor's baseline risk profile. The regulatory framework of Option 3 would permit only small relative increases in risk, regardless of a plant's original baseline risk profile. This approach could inappropriately constrain practical risk-informed applications for new reactors whose original baseline risk and updated risk profile remain substantially below the estimates for currently operating plants. These restrictions are also inconsistent with the principles and regulatory decision-making framework that are applied in Regulatory Guide 1.174.

The stated goals of the staff's recommended approach (denoted as Option 2) are to develop guidance for risk-informed licensing-basis changes that would prevent a significant decrease in the level of safety of a new reactor over its life and to develop risk-informed guidance for the ROP to provide meaningful regulatory oversight for all operating plants.

We concur with the general principle that the regulatory process should seek to prevent a significant decrease in the level of safety over the life of a plant. However, plants that have lower overall risk should be allowed more regulatory flexibility, compared with plants that have higher overall risk. For example, a conceivable regulatory framework under Option 2 could apply a variable determination of the acceptable level of cumulative risk increase as a function of a plant's baseline risk profile. New reactors with very low overall risk would be allowed a larger relative increase in that risk, provided that their total risk remains substantially below the estimates for currently operating plants. These concepts are consistent with Commission expectations for new reactor safety margins, our past recommendations, and the basic principles in Regulatory Guide 1.174. The staff has not yet developed substantive recommendations for implementation of Option 2. We encourage the staff to continue their interactions with internal and external stakeholders to develop more detailed guidance for that conceptual framework.

The staff has noted that different interpretations and applications of the risk metrics may be needed for risk-informed changes to the licensing basis and for evaluations of plant performance during the ROP. We reiterate our past recommendations on the need for a consistent basis for the determination of risk significance in all regulatory activities.

The staff noted that development of the guidance under Option 2 may benefit from pilot evaluations of changes to plant hardware, testing and maintenance programs, Technical Specifications, new reactor reliability assurance programs, and inspection findings within the context of a few actual reactor designs and their supporting PRAs. These evaluations would

provide valuable practical insights, experience, and mutual understanding that benefit the development of consistent regulatory guidance. We recommend that these types of pilot applications should be incorporated into the staff's deliberations and stakeholder discussions.

(2) How should applied regulatory guidance account for the plant-specific risk profile and its contributors?

The licensing process in 10 CFR Part 52 should ensure a high degree of design consistency among individual plants that reference the same design certification. However, there may be substantial differences in plant-specific risk profiles. For example, the PRAs that have been prepared for current design certification and COL applications typically do not quantify the risk from site-specific external events such as large earthquakes, high winds, tornadoes, and external floods. At many sites, it is likely that a complete assessment of these contributors may produce risk results that are substantially larger than the quantified CDF and LRF values that consider only internal initiating events. The current PRAs also include only limited assessments of the risk during plant low power and shutdown modes of operation. Experience has shown that the contributors to shutdown risk often depend strongly on plant-specific outage management plans and practices. Thus, it is likely that full-scope risk assessments of two nominally "identical" plant designs at two different sites with different operating and maintenance practices may display significantly different risk profiles. The risk-informed regulatory framework should not presume that all new plants referencing the same certified design will have similar risk profiles, and the guidance should account for expected site-specific plant-to-plant variability.

The potential risk contributions from external hazards introduce another layer of conceptual complexity in the regulatory framework for new reactors. For example, a full-scope risk assessment may conclude that seismic events account for 80 percent of the plant-specific baseline risk, and all other contributors account collectively for the remaining 20 percent. The risk-informed regulatory framework should explicitly anticipate and account for this condition. Thus, it is important to decide whether the applied regulatory risk acceptance guidelines pertain to the total plant risk (i.e., including the seismic contribution) or to only a fraction of that risk (e.g., without the seismic contribution). Different guidance for acceptable risk increases may be appropriate for proposed changes to the licensing basis, which is concerned primarily with absolute risk, and regulatory actions under the ROP, which primarily address operational departures that involve equipment malfunctions, maintenance activities, and human performance.

(3) How should risk significance be determined for current design certifications and COL applications?

Quantitative risk metrics are being used to support licensing decisions for current design certifications and COL applications. In particular, numerical measures of risk significance are used to identify candidate non safety-related SSCs for inclusion in the Design Reliability Assurance Program (DRAP). The DRAP is developed during design certification, is adopted by the COL applicant, and is revised, as necessary, to include additional risk-significant site-specific SSCs.

Most applicants currently apply the numerical risk significance guidance that is endorsed in Regulatory Guide 1.200 and Regulatory Guide 1.201 (i.e., Fussell-Vesely Importance ≥ 0.005 or Risk Achievement Worth ≥ 2). Some applicants apply less restrictive selection criteria (e.g., Fussell-Vesely Importance ≥ 0.010 or Risk Achievement Worth ≥ 5), citing their low overall risk

values as justification. The former applicants effectively apply the principles of Option 3 discussed above, pending more explicit guidance on the applicable metrics. The latter applicants effectively apply a particular interpretation of Option 2.

While we endorse the conceptual principles of Option 2, we are concerned that the staff's approval of design-specific departures from Option 3 during current certification and COL licensing decisions could establish a precedent for "acceptable" measures of absolute and relative risk that may not be fully consistent with the eventual resolution of those quantitative metrics. Clear interim guidance should be developed expeditiously for the use of numerical risk significance measures to select candidate SSCs for design certification and COL reliability assurance programs.

We look forward to our continuing interactions with the staff to resolve these significant technical issues.

Additional comments by ACRS member John Stetkar are presented below.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

Additional Comments from ACRS Member John W. Stetkar

I concur fully with the content and recommendations in this letter. Consideration of these additional comments should not interrupt the staff's proposed approach in the draft Commission Paper. It is important to maintain consistency in the regulatory guidance for operating reactors and near-term new reactor applications. However, the investigation and development of risk metrics that will be applied for new reactors provide a valuable opportunity to judiciously consider a key issue that is not mentioned in the letter.

Are CDF and LRF the most appropriate metrics for risk-informed regulatory decision making?

Despite the general acceptance of these metrics, they are only surrogates that do not accurately assess the actual risk to a member of the public who resides near a particular nuclear power plant. An assessment of that risk can be made only by the performance of a full-scope Level 3 PRA that evaluates internal events and external hazards during all operating modes. Risk is measured by the integrated evaluation of the potential hazards, their likelihoods, the effectiveness of plant features to prevent core damage, the effectiveness of containment features and accident management plans to mitigate offsite releases, the local site meteorology and demography, the effectiveness of offsite emergency planning, and a consistent assessment of the uncertainties that are associated with each of these elements. Partial evaluations of CDF and LRF do not provide this integrated understanding of the risk and its contributors. Regulatory processes that focus too strongly on only these surrogate measures may not provide balanced decisions that are fully informed by an understanding of the actual risks.

Consideration of this issue is very timely. Insights from preliminary analyses of new reactor designs indicate that the most important contributors to their risk may involve hazards such as fires, floods, and severe seismic events that affect all elements of an integrated risk assessment. Thus, perceived distinctions among the contributors to core damage, containment failure, and offsite releases for new plants may be much less clear than those identified historically for operating plants with risks that are influenced strongly by internal events such as equipment failures.

It is conceivable that insights from plant-specific Level 3 PRAs may identify metrics other than CDF and LRF that are more appropriate representations of integrated risk. Those metrics would provide an improved rationale for regulatory decisions that are concerned primarily with potential effects on public health and safety.

With these observations in mind, I believe that the continuing evolution of risk-informed regulatory guidance and its applied metrics should encourage the extension of PRA technology to include full-scope Level 3 assessments that provide more complete estimates of actual public health risk and its contributors.

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