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FINAL REPLY:

Said Abdel-Khalik, ACRS

TO:

Chairman Jaczko

FOR SIGNATURE OF : ** GRN ** CRC NO: 11-0072

Borchardt, EDO

DESC:

Current State of Licensee Efforts to Transition to National Fire Protection Association (NFPA) Standard 805 (EDATS: SECY-2011-0088)

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EDATS

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

February 17, 2011

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

SUBJECT: CURRENT STATE OF LICENSEE EFFORTS TO TRANSITION TO NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD 805

Dear Chairman Jaczko:

During the 580th meeting of the Advisory Committee on Reactor Safeguards (ACRS), February 10-12, 2011, we completed our review of the current state of licensee efforts to transition to risk-informed, performance-based fire protection programs that meet the requirements of 10 CFR 50.48(c) and the referenced 2001 Edition of National Fire Protection Association (NFPA) Standard 805. Our review was performed in response to a June 25, 2010, Staff Requirements Memorandum (SRM) in which the Commission stated that "the ACRS should conduct a review and report back to the Commission on the current state of licensee efforts to transition to National Fire Protection Association (NFPA) Standard 805. The review should include methodological and other issues that may be impeding the transition process, lessons learned from the pilot projects and recommendations to address any issues identified. The review should determine whether the level of conservatism of the methodology is appropriate and whether any adjustments should be considered. This review should not influence the staff's actions regarding the pilot projects or the pending license amendment reviews."

Our Reliability and Probabilistic Risk Assessment Subcommittee also reviewed this matter during its meetings on November 16, 2010, and December 13-14, 2010. During these reviews, we had the benefit of discussions with representatives of the NRC staff, the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), the National Institute of Standards and Technology (NIST), and individual licensees. We received written comments from NC Waste Awareness and Reduction Network, Beyond Nuclear, and the Union of Concerned Scientists. Our deliberations were also informed by a technical report that was prepared by ACRS Members, ACRS staff, and our consultant, which is attached to this Committee report. We also had the benefit of the documents referenced.

CONCLUSIONS

1. The methods and guidance in NUREG/CR-6850, supplemented by the clarifications and enhancements in NUREG/CR-6850 Supplement 1, provide a sound technical basis for the development of fire PRA models and analyses to support the transition to a risk-informed licensing framework in accordance with NFPA 805 and 10 CFR 50.48(c).

2. A determination of assurance that overall plant safety will be maintained under the risk-informed licensing framework can be made, despite retention of conservative simplifications and assumptions in the baseline fire PRA.

3. Sources of excessive analytical conservatism or large uncertainties that are not appropriately characterized may affect the quality of post-transition risk-informed decisions.

4. Additional research, testing, and development of improved databases are needed to bring the technology and analytical experience for fully integrated fire PRAs to a state that is comparable to that for internal events PRAs.

RECOMMENDATIONS

1. The staff should consider establishment of a mutually-agreed-upon firm schedule for sequential submittals of license amendment requests for transition to the risk-informed licensing framework under 10 CFR 50.48(c).

2. Uncertainties should be quantified and propagated through the fire PRA models according to current state-of-the-practice methods and guidance.

3. The quantified risks from fires and internal events should be combined to develop an overall plant risk profile. Post-transition analyses of the changes to the risk from fires, the risk from internal initiating events, and the overall plant risk should be made to provide a balanced assessment of these contributions.

4. The updated fire events database should consistently account for plant-to-plant variability in the available operating experience as a distinct contribution to uncertainties in the fire ignition frequencies. Efforts should be expedited to develop data for "component-level" fire ignition frequencies, rather than the currently applied "plant-level" frequencies.

5. Caution is warranted regarding expectations that in-progress efforts to enhance the industry fire events database will result in significant reductions in the quantified risk from electrical cabinet fires. Those efforts will improve the overall experience base and understanding of these fires, and they should continue to completion. However, other initiatives and research are needed to address this technical issue in a more integrated manner.

6. The general category of "electrical cabinets" in NUREG/CR-6850 should be subdivided into functional subgroups that can consistently account for fire ignition frequencies, potential fire severities, typical characteristics of plant locations, and potential risk consequences. Results and engineering insights from the completed pilot plant studies and in-progress PRAs should be used to guide the definitions of these groups.

7. The NRC should encourage industry to expedite active engagement of the senior technical review and oversight group to facilitate consistent interpretation and application of focused modeling techniques or methods that have generic applicability to multiple plants. The staff should facilitate efficient reviews of departures from the guidance in NUREG/CR-6850 and communicate interim technical positions on issues that may have generic applicability.

8. The staff should continue current initiatives for collaboration and coordination of research. Research priorities should be established by demonstrated needs to support specific refinements to PRA methods, models, and data that have the most potential benefit for the largest number of stakeholders.

BACKGROUND

10 CFR 50.48(c) allows licensees to voluntarily adopt and maintain a fire protection program that meets the requirements of NFPA 805 as an alternative to meeting the requirements of 10 CFR 50.48(b), i.e., conformance with Appendix R to 10 CFR Part 50 for plants licensed to operate before January 1, 1979, or the approved fire protection license conditions for plants licensed to operate after January 1, 1979. NFPA 805 specifies the minimum fire protection requirements for existing light-water nuclear power plants during all phases of plant operations, including shutdown and decommissioning. NFPA 805 offers the choice of a "deterministic" or a "performance-based" methodology for determining fire protection features and demonstrating that nuclear safety performance criteria are met.

The transition process to 10 CFR 50.48(c) "brings forward" a significant portion of the existing licensing basis to the new NFPA 805-based licensing framework and adds some new requirements, such as investigating fires during non-power operational modes. After this transition phase, the performance-based option of NFPA 805 requires that any subsequent requests for changes to the approved fire protection program must be risk-informed. 10 CFR 50.48(c) permits license amendment requests that are not based on a fire PRA model. However, as stated in the Background Section of Regulatory Guide 1.205, "the NRC anticipates that licensees will develop a plant-specific fire PRA to fully realize the safety and cost benefits of making the transition to NFPA 805." A fire PRA also forms the basis for risk-informed changes to the fire protection program that can be made without prior NRC review and approval. In accordance with NFPA 805, the fire PRA used to perform the baseline fire risk analysis and the risk assessments for subsequent plant changes must be of sufficient technical adequacy to support the application. NFPA 805 also requires that the PRA approach, methods, and data must be acceptable to the authority having jurisdiction (i.e., NRC).

In 2005, the Office of Nuclear Regulatory Research and EPRI completed a cooperative program to consolidate prior fire PRA research and development activities into a single state-of-the-art methodology. The results, documented in NUREG/CR-6850 / EPRI 1011989, provide a structured framework for the overall analysis process, as well as recommended practices to address key aspects of specific analysis tasks. While the primary objective of the project was to consolidate and integrate existing state-of-the-art methods, in many areas new methods and approaches that represented a significant advancement over those previously documented were developed.

NFPA 805 allows fire modeling as a part of its performance-based requirements for regulatory applications. Fire modeling is also used in fire PRAs to determine the evolution and consequences of postulated fire scenarios. NFPA 805 defines a fire model as the "mathematical prediction of fire growth, environmental conditions, and potential effects on structures, systems, or components based on the conservation equations or empirical data." NFPA 805 requires that "only fire models that are acceptable to the authority having jurisdiction [NRC] shall be used in fire modeling calculations." NFPA 805 further requires that the fire models be verified and validated, and that the fire models only be applied within their limitations.

Two nuclear plants participated as pilot plants during the NUREG/CR-6850 development project and performed focused demonstrations of specific analysis tasks. However, neither of those plants completed a fully integrated fire PRA. As noted in our June 10, 2005, report on Draft Final NUREG/CR-6850, this represented "a missed opportunity to gain experience with the procedures and new approaches in NUREG/CR-6850." We also recommended that "full-scope pilot fire PRAs based on the procedures and methods in NUREG/CR-6850 should be completed, and the insights provided by these applications should be used to enhance the methodology."

In 2004, the NRC revised its Enforcement Policy to provide interim enforcement discretion during a period of transition to 10 CFR 50.48(c). The interim enforcement discretion policy includes provisions to address any non-compliances identified during the licensee's transition process and existing pre-transition non-compliances. The discretion period starts when the licensee informs the NRC of a transition start date in a Letter of Intent to transition to NFPA 805. The discretion period would remain in effect for up to two years for the licensee to submit to the NRC a license amendment request to transition to NFPA 805, and the discretion period would continue until the NRC disposition of the request. Revisions to the interim enforcement policy were made in 2006 and 2008 in response to industry requests. According to the current policy, the NRC may grant additional time extensions, depending on the progress the licensee has made in the transition effort. However, the additional period of discretion will end six months after the date of the safety evaluation approving the second pilot plant's license amendment request.

The NRC recognized the first two licensees that filed a Letter of Intent to adopt a fire protection program based on 10 CFR 50.48(c) as NFPA 805 pilot plants. Progress Energy's single-unit Shearon Harris Nuclear Power Plant in North Carolina and Duke Energy's three-unit Oconee Nuclear Station in South Carolina were granted pilot status. Transition activities began in the

summer of 2005. In May 2008, Progress Energy submitted a license amendment request for Shearon Harris (first pilot) to adopt NFPA 805. Duke Energy submitted an initial license amendment request for Oconee (second pilot) in May 2008. Duke Energy then submitted a revised license amendment request in April 2010. The NRC issued the final safety evaluation for Shearon Harris in June 2010. The final safety evaluation for Oconee was issued in December 2010.

In addition to the two pilot plants, 30 other sites (50 nuclear units) have indicated their intent to transition to 10 CFR 50.48(c). Based on the December 29, 2010, date of the safety evaluation approving the Oconee license amendment, approximately 25 license amendment requests are currently expected to be submitted by June 29, 2011.

DISCUSSION

The following items briefly summarize our major observations. Additional background information and more detailed discussions of each issue are provided in the attached supplemental report.

Adequacy of Guidance in NUREG/CR-6850

The methods and guidance in NUREG/CR-6850, supplemented by the clarifications and enhancements in NUREG/CR-6850 Supplement 1, provide a sound technical basis for the development of fire PRA models and analyses to support the transition to a risk-informed licensing framework in accordance with NFPA 805 and 10 CFR 50.48(c). Analyses should take advantage of techniques provided in NUREG/CR-6850 to reduce unnecessary conservatism, for example, screening electrical cabinets when there is insufficient fuel loading to support fire propagation. Consistent application of the recommended methods provides confidence that the identified sources of fire risk are derived from plant-specific features and do not depend on significant analyst-to-analyst variations in basic modeling techniques or assumptions.

However, it is expected that focused departures from the guidance will be necessary to address some plant-specific issues. These departures should be justified by technical evaluations that are of comparable scope and quality to analyses that are typically performed to support departures from other licensing regulatory guidance. The PRA reports should appropriately differentiate between simplified modeling techniques and recommended bounding values that are applied during early screening analyses, but are retained in the final results, and best estimate models and values that are applied in more refined analyses.

An industry senior technical oversight and review group has been formed recently to evaluate substantial departures from the NUREG/CR-6850 methods, numerical values, and guidance that are identified during peer reviews. The NRC should encourage industry to expedite active engagement of this group to facilitate consistent interpretation and application of focused modeling techniques or methods that have generic applicability to multiple plants. The staff should facilitate efficient reviews of departures from the guidance in NUREG/CR-6850 and communicate interim technical positions on issues that may have generic applicability.

Sequential Licensing Submittals

The staff should consider establishment of a mutually-agreed-upon firm schedule for sequential submittals of license amendment requests for transition to the NFPA 805 risk-informed framework. The experience from a very successful similar process for plant license renewal applications has clearly demonstrated the technical benefits and mutual understanding that derive from each successive application and review. Specific staff technical concerns are clarified and documented once, avoiding inefficient parallel requests for duplicate information. The technical quality and consistency of subsequent license submittals benefit substantially from this experience, as the industry shares its understanding of the key generic issues and their resolution. Successive staff reviews focus more closely on plant-specific issues and problems, rather than common generic concerns. A sequential submittal process also facilitates effective pre-submittal performance of consistent, high quality, industry peer reviews, with adequate time for analysts to implement the necessary PRA model refinements.

The industry has had substantial time to address several key generic concerns during the pilot plant analyses and the Frequently Asked Question (FAQ) resolution process. Additional generic experience and insights are available from the Shearon Harris and Oconee license amendment reviews. It is likely that the most mature in-progress PRA models and analyses will require relatively minor adjustments to assure consistency with the technical scope and quality of the approved pilot plant submittals. Therefore, the first submittals under a sequential process may not be delayed substantially from the current schedule. Less mature analyses may require more substantial refinements. However, despite the industry's cited concerns or the need for additional research results, very protracted submittal extensions do not seem warranted.

NEI has proposed an initial staggered submittal schedule with the first license amendment requests planned for late June 2011 and subsequent submittals extended through June 2012. The proposal seems reasonable, based on our understanding of the key technical and practical issues. Further submittal extensions beyond June 2012 do not seem warranted. Any further extensions should be granted only if the staff and the licensee fully concur on a plant-specific justification.

Quantification of Uncertainty

Uncertainties were not quantified or propagated through the PRA models for the Shearon Harris and Oconee pilot plant license submittals. The cognizant PRA analysts also indicated that uncertainties have not been quantified for any of the relatively mature in-progress PRAs cited during our subcommittee meetings. The analysts indicated that limitations in the software used to develop these models preclude formal quantification and propagation of uncertainties. This assertion is quite surprising for any software that is currently being used for PRA model development and applications, especially regarding integrated quantification of parametric uncertainties. However, we did not have an opportunity to further examine the specific technical reasons for this fundamental deficiency.

Uncertainties should be quantified and propagated through the fire PRA models according to current state-of-the-practice methods and guidance. Quantification and documentation of the uncertainties and their contributors will improve understanding of the currently perceived degree of numerical conservatism in the overall fire risk results and its sources. Consistent quantification of the uncertainties will also afford better understanding of the relative risk contributions from various fire hazards, locations, and scenarios, and comparisons of the relative risks from fires and other initiating events.

Treatment of Post-Transition Risk-Informed Applications

Experience from the Shearon Harris and Oconee license amendment reviews indicates that retention of conservative simplifications and assumptions in the baseline fire PRA models and analyses may support a staff determination of assurance that overall plant safety will be maintained under the NFPA 805 risk-informed licensing framework. However, after transition to NFPA 805, known sources of conservatism or large uncertainties may affect the quality of decisions regarding proposed plant modifications that are informed by comparisons of absolute and relative changes in the baseline risk profile. This is especially true for licensee self-approved changes that do not require previous staff review and approval, and are based on a conclusion that the overall risk impact from the proposed change is minimal.

Elements of methods, modeling techniques, and data for the analyses of internal initiating events continue to evolve, 30 years after performance of the first full-scope plant-specific PRAs. It is likely that a similar evolution of fire analysis methods and data will continue through short-term (1-4 years) and longer-term research programs. However, the often-cited concerns regarding additional needed research should not preclude use of the fire PRA models for rational decision making.

The quantified risks from fires and internal events should be combined to develop an overall plant risk profile and a consistent enumeration of the contributors to that risk. Evaluations of proposed modifications to plant hardware or programs should appropriately characterize the quantified changes in risk, including the effects and sources of uncertainties, known conservatism, and possible optimism. Comparisons of the changes to the risk from fires, the risk from internal initiating events, and the overall plant risk should be made to provide a balanced perspective of these contributions. Staff reviews and applications of regulatory guidance should account for these comparative assessments in the context of each plant-specific PRA model and the proposed risk-informed decision.

Updates to Fire Events Database

The updated fire events database should consistently account for plant-to-plant variability in the available operating experience as a distinct contribution to the underlying uncertainties in the frequency of each fire event category. Inappropriate restriction of the data to include only a subset of the most recent operating experience will affect the computed uncertainties and the corresponding mean frequencies.

Some significant simplifications and approximations in NUREG/CR-6850 will not be addressed during the near-term industry database updates. In particular, "plant-level" fire frequencies will be retained, rather than "component-level" frequencies. This approach is reasonable, considering the lack of information about the actual population of each type of component at each operating reactor. However, the resulting allocation process can overestimate fire frequencies for plants that contain relatively small numbers of specific components, and it can underestimate fire frequencies for plants that contain a relatively large complement of equipment. The near-term database updates will also retain a single generic category of "electrical cabinet" fires. Efforts should be expedited to develop data for "component-level" fire ignition frequencies, rather than the currently applied "plant-level" frequencies.

The operating experience data in NUREG/CR-6850 were screened according to the assessed severity of each fire event. The corresponding parametric estimates for fire growth rates, peak heat release rates, detection, and suppression times account for those screening criteria. Therefore, the applied criteria for screening fire events in the augmented database cannot be modified in isolation. If different criteria are applied for the new data, or if the existing criteria are interpreted differently by the data analysts, there is a danger that some parametric values that are used in the fire growth, detection, suppression, and consequential damage analyses may be inconsistent with the characteristics of the fires that determine the ignition frequencies. Thus, the fire event screening evaluations should not be performed independently.

Refinement of Electrical Cabinet Fire Analyses

Caution is warranted regarding expectations that in-progress efforts to enhance the industry fire events database will result in significant reductions in the quantified risk from electrical cabinet fires. Those efforts will certainly improve the overall experience base and understanding of these fires, and they should continue to completion. However, other initiatives and research are needed to address this technical issue in a more integrated manner.

The general category of "electrical cabinets" in NUREG/CR-6850 should be subdivided into functional subgroups that can consistently account for fire ignition frequencies, potential fire severities, typical characteristics of plant locations, and potential risk consequences. For example, possible subgroups might contain switchgear and load centers, motor control centers, DC buses, AC and DC power distribution panels, protection and control signal cabinets, etc. Results and engineering insights from the completed pilot plant studies and in-progress PRAs should be used to guide the definitions of these groups.

Efforts to compile fire ignition frequency data, test programs to measure rates of fire growth and peak heat release rates, and refinements to fire dynamics models should be coordinated to consistently address analysis issues within the context of these functional groups.

Research Programs

The staff should continue current initiatives for collaboration and coordination of research. These initiatives have effectively applied limited resources to investigate several difficult issues, and they have generally avoided inefficient duplication of effort. Research priorities should be established by the demonstrated needs to support specific refinements to PRA methods, models, and data that have the most potential benefit to the largest number of stakeholders.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

Attachment: As stated

REFERENCES

1. 10 CFR Part 50, Section 48, "Fire Protection"

2. National Fire Protection Association (NFPA) Standard 805, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants," 2001 Edition, National Fire Protection Association, Quincy, MA

3. Staff Requirements Memorandum (SRM), "Meeting with the Advisory Committee on Reactor Safeguards (ACRS)", M100609B, U.S. Nuclear Regulatory Commission, June 5, 2010 (ML101760054)

4. Letter from John D. Runkle, Attorney at Law, Subject: "Deficiencies in NFPA 805", dated November 10, 2010 (ML103230162)

5. "The Current State of Transition to Risk-Informed Performance-Based Fire Protection Programs," prepared by the Advisory Committee on Reactor Safeguards, dated February 4, 2011. (ML110430035)

6. NUREG/CR-6850, EPRI 1011989, "EPRI / NRC-RES Fire PRA Methodology for Nuclear Power Facilities", U.S. Nuclear Regulatory Commission and Electric Power Research Institute, Final Report, dated September 2005.

7. NUREG/CR-6850 Supplement 1, EPRI 1019259, "Fire Probabilistic Risk Assessment Methods Enhancements", U.S. Nuclear Regulatory Commission and Electric Power Research Institute, Technical Report, dated September 2010.

8. NRC Enforcement Policy, A Notice by the Nuclear Regulatory Commission, 69 FR 33684, dated June 16, 2004

9. Shearon Harris Nuclear Power Plant, Unit 1 - Issuance of Amendment Regarding Adoption of National Fire Protection Association Standard 805, "Performance-Based Standard For Fire Protection For Light Water Reactor Electric Generating Plants", dated June 28, 2010 (ML101750602)

10. Oconee Nuclear Station, Units 1, 2, And 3, Issuance of Amendments Regarding Transition to a Risk-Informed, Performance-Based Fire Protection Program in Accordance with 10 CFR 50.48(c), dated December 29, 2010 (ML103630612)

11. NUREG-1824, EPRI 1011999, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," U.S. Nuclear Regulatory Commission and Electric Power Research Institute Final Report, dated May 2007

12. Nuclear Energy Institute Letter, Transmittal of NEI Report, "Roadmap for Attaining Realism in Fire PRAs - December 2010", Nuclear Energy Institute, dated December 6, 2010 (ML103430372)

13. Nuclear Energy Institute Letter, "Successful Transition of Plants Implementing NFPA-805 to Meet 10 CFR 50.48 (c)", Nuclear Energy Institute, dated November 15, 2010 (ML103360406)

14. Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," Rev. 1, dated December 2009. (ML092730314)

ML110430035

The Current State of Transition to Risk-Informed Performance-Based Fire Protection Programs

Prepared by: John W. Stetkar, William J. Shack, and Hossein P. Nourbakhsh

February 2011

Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001