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

November 8, 2012

The Honorable Allison M. Macfarlane
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: ACRS REVIEW OF STAFF'S DRAFT SECY PAPER ON CONSIDERATION OF ADDITIONAL REQUIREMENTS FOR CONTAINMENT VENTING SYSTEMS FOR BOILING WATER REACTORS WITH MARK I AND MARK II CONTAINMENT DESIGNS

Dear Chairman Mcfarlane:

During the 599th meeting of the Advisory Committee on Reactor Safeguards (ACRS), November 1-3, 2012, we reviewed the staff's draft SECY paper on Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors (BWRs) with Mark I and Mark II Containment Designs. Although the internal staff reviews of this document had not been completed, the Fukushima Steering Committee for this work has concurred with the staff's recommendation to develop Option 3. Our Fukushima Subcommittee also reviewed these and related matters on June 20, September 5, October 3, and October 31, 2012. 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), representatives of public interest groups, and members of the public. We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

1. Additional measures for accident source-term mitigation in Mark I and Mark II containments are not justified by risk-informed cost-benefit analyses that rely on the generic PRA models, risk metrics, estimates of averted costs, and uncertainties that were examined by the staff. Nevertheless, we agree with the staff that additional defense-in-depth measures should be considered to compensate for uncertainties in quantitative techniques to evaluate accident progression in reactors with small containments.

2. We recommend the implementation of Option 4, Performance-Based Approach, to reduce radioactive material releases as a needed defense-in-depth measure for BWR Mark I and Mark II containments.

3. Installation of external filtered vents (Option 3) may be one outcome of Option 4 to minimize the release of radioactive material to the environment.

4. Severe accident capable vents (Option 2) are an essential part of any controlled venting strategy.

BACKGROUND

On October 3, 2011, the staff issued SECY-11-0137, a notation vote paper with the proposed prioritization of the Fukushima Near-Term Task Force (NTTF) recommendations and on December 15, 2011, the Commission issued SRM to SECY-11-0137 approving the staff's proposed prioritization. In this SRM the Commission also directed the staff to shift the issue of "Filtration of Containment Vents" from the "additional issues" category and merge it with the Tier 1 issue of hardened vents for Mark I and Mark II containments such that the analysis and interaction with stakeholders, needed to inform a decision on whether filtered vents should be required, would be performed concurrently with the development of the technical bases, acceptance criteria, and design expectations for reliable hardened vents.

On March 12, 2012, the staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents (Effective Immediately)." This Order applies only to BWR facilities that have Mark I or Mark II containment structures. Mark I reactors must improve installed venting systems that help prevent or mitigate core damage in the event of a serious accident; Mark II reactors must install these venting systems.

The Order specifies that all holders of operating licenses issued under Part 50 with BWR Mark I and Mark II containment designs "shall, notwithstanding the provisions of any Commission regulation or license to the contrary, comply with the requirements except to the extent that a more stringent requirement is set forth in the license. These Licensees shall promptly start implementation of these requirements and shall complete full implementation no later than two (2) refueling cycles following the submittal of the overall integrated plan, as required in Condition C.1., or December 31, 2016, whichever comes first."

The staff is completing its work to deliver to the Commission a notation vote paper on filtered vents by the end of November 2012.

DISCUSSION

We recommend the implementation of Option 4, Performance-Based Approach, to reduce radioactive material releases as a needed defense-in-depth measure for BWR Mark I and Mark II containments. Option 4 will identify acceptable performance objectives and requirements for these containments so that their severe accident management response capabilities can be evaluated. Equipment additions and procedural enhancements, including filtered ventilation systems, would be evaluated and implemented to meet these objectives.

Because of their relatively small volumes, venting is important to severe accident management strategies for BWRs with Mark I and Mark II containments. Without venting there are severe accident scenarios, such as station blackout, where there is a high probability of containment failure due to overpressure with a resulting uncontrolled release. Venting from the drywell without effective filtration can lead to very large releases.

Currently, filtration of radioactive releases in the Mark I and II containments is provided by physical processes, scrubbing of releases from the wetwell vent by the suppression pool, and drywell sprays if they are available. This allows substantial radioactive material retention in containment.

Under station blackout conditions, the drywell sprays, even if powered by portable pumps under B.5.b or FLEX, can lose much of their effectiveness in the removal of radioactive materials from the containment atmosphere. Drywell flooding will ultimately fill the suppression pool air space within 12 to 24 hours. As the pool approaches full flooding, operators will vent from the drywell rather than from the wetwell. Without sprays this is an unscrubbed release of radioactive aerosol.

The staff argues that an improved filtering strategy can compensate for the loss of the containment barrier due to venting under a wider range of accident conditions including extended drywell flooding and that it improves confidence in taking action to depressurize containment to help address other severe accident challenges. The staff concludes that this provides a substantial improvement in containment performance and hence defense in depth that addresses uncertainties in the prevention, progression, and mitigation of severe accidents and in the effectiveness of emergency planning and evacuation. In their consideration of additional requirements for containment venting systems, the staff concluded that their recommended option, Option 3, would not meet a quantitative cost-benefit test based on current NRC regulatory analysis guidance. Based on several qualitative considerations including defense in depth, they recommend Option 3.

Additional measures for accident source-term mitigation in Mark I and Mark II containments are not justified by risk-informed cost-benefit analyses that rely on the generic PRA models, risk metrics, estimates of averted costs, and uncertainties that were examined by the staff. Nevertheless, we agree with the staff that additional defense-in-depth measures should be considered to compensate for uncertainties in quantitative techniques to evaluate accident progression in reactors with small containments. We support the conclusion to proceed with options that augment Mark I and II containment function under severe accident conditions. Considering the limitations in the quantitative analyses, we are relying on qualitative factors, principally defense in depth for reactor facility designs with smaller containment volume and less margin compared to other reactors with similar thermal power, and uncertainties in severe accident progression, reactor response, and hydrogen control. We conclude this approach justifies containment improvement evaluation and is viable given the combinations of less margin and high conditional failure probabilities for these BWR containment systems.

At Fukushima Daiichi, the failure to operate systems as designed added substantially to the release of radioactive materials from the containments. The events at Fukushima called into question the reliability of current vent systems, especially under station blackout conditions. Reliability of the vent systems is currently being addressed under Order EA-12-050 for venting under design-basis accident conditions. Option 2 would address the reliability of vent systems under severe accident conditions. We agree with the staff that pursuit of this Option is an important near-term measure, but, unless a licensee plans to install an external filter, it should address reliability of the wetwell vent. We recommend Option 2 be implemented by issuing an Order or revising existing Order EA-12-050.

The staff and industry have completed studies of severe accident progression and containment releases for selected sequences and plants using the NRC severe accident analysis code (MELCOR) and the industry code (MAAP). Release estimates are used to calculate health consequence and offsite property damage assessment using the MELCOR Accident Consequence Code System, Version 2 (MACCS2). For certain accident sequences additional filtration systems reduced the cesium or iodine release from containment by a meaningful amount. For other sequences the existing filtration systems of the plant operated efficiently such that little additional radioactive material was removed by the external filter system.

We agree with the staff that an enhanced filtering strategy addresses the limitations of Mark I and Mark II containments under severe accident conditions and increases defense in depth. We do not support Option 3, Filtered Vents, as the sole course of action. We prefer Option 4 which allows more scope for innovation and may result in more effective solutions. We recognize that installation of an external filter (Option 3) may be one acceptable outcome of Option 4.

The staff has taken only limited steps to develop potential performance measures and other elements of a performance-based approach. In the development of a performance-based approach to a filtering strategy, it is important to consider the potential for unintended negative consequences. In addition to the effectiveness of a filtering strategy in preventing radioactive materials from being released from the containment, there are other characteristics of a performance-based approach that we think are important in reducing the likelihood of unintended negative consequences. For example the following strategies are preferred:

1. Strategies that can keep the loads on the containment well below design levels most of the time.
2. Strategies that rely primarily on passive components and reduce the need for manual actions or transportation of heavy pieces of equipment
3. Strategies that are compatible with actions to flood the drywell and mitigate the potential for overfilling the wetwell.
4. Strategies that rely on scrubbing by the suppression pool, which seek to keep the pool temperature well below the saturation temperature.
5. Strategies that preserve the integrity of the drywell head seal.
6. Strategies that address hydrogen control as well as radioactive releases.

We look forward to working with the staff on all important matters related to the Fukushima efforts.

Sincerely,

/RA/

J. Sam Armijo
Chairman

Additional Comments by ACRS Members Joy Rempe and Steve Schultz

As indicated in our letter, the staff evaluations considered results from MELCOR and MAACS calculations to assess the impact of filtration for selected sequences in a Mark I plant design. Although these tools are internationally recognized for their capabilities, information in the enclosures describing these calculations suggests that additional emphasis should be placed on evaluation efforts to support these and anticipated future post-Fukushima activities. Calculations should be performed with state-of-the-art versions of these analysis tools that contain models that are updated to incorporate insights from assessments against data from recent international programs in which the NRC collaborates. Uncertainties in the existing data base for these methods should be identified and reduced, where possible. The importance of remaining uncertainties should be carefully considered in evaluating analysis results. Because less BWR-specific severe accident data are available, a proactive effort should be established to consider insights from post-accident examinations at Daiichi as they become available. The efforts by the staff to address this and other Post-Fukushima actions are appreciated, and it is recognized that resources and schedules are limited. However, as the Commission moves forward with compliance decisions related to their selected option on this issue and with resolving other issues related to Fukushima, it is anticipated that the importance of MELCOR and MAACS analysis results will increase. Hence, it is recommended that actions be implemented now to improve the analysis and tools providing results for the basis on which such decisions are made.

REFERENCES

1. JLD Memorandum, “Draft Commission Paper Entitled ‘Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments’,” November 8, 2012 (ML12313A051)

2. Notation Vote SECY-11-0137, “Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,” October 3, 2011 (ML11272A111)

3. SRM to SECY-11-0137, “Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,” December 15, 2011 (ML113490055)

4. Order EA-12-050, “Order to Modify Licenses with Regard to Reliable Hardened Containment Vents,” March 12, 2012 (ML12054A694)

5. NEI Letter, “Containment Filtration Strategies for Mitigating Radiological Releases in Severe Accidents for BWR Mark I and Mark II Plants to Reduce the Risk of Land Contamination,” October 5, 2012 (ML12286A291)

6. EPRI Report 1026539, “Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents, BWR Mark I and Mark II Studies,” September 2012

7. Pilgrim Watch, “Comments with Regard to Reliable Hardened Containment Vents – Request Recommend Filters & Rupture Discs,” November 1, 2012 (ML12311A223)

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