



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
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December 22, 2017

Dr. Dennis C. Bley, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

**SUBJECT: RESPONSE TO NOVEMBER 16, 2017, LETTER FROM THE ADVISORY
COMMITTEE ON REACTOR SAFEGUARDS REGARDING "STATE-OF-THE-
ART REACTOR CONSEQUENCE ANALYSIS PROJECT: SEQUOYAH
INTEGRATED DETERMINISTIC AND UNCERTAINTY ANALYSES"**

Dear Dr. Bley:

This letter provides the U.S. Nuclear Regulatory Commission (NRC) staff's response to your letter dated November 16, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17319A667), in which the Advisory Committee on Reactor Safeguards (ACRS) reported on its review of the NRC staff's draft NUREG/CR report, "State-of-the-Art Reactor Consequence Analysis (SOARCA) Project: Sequoyah Integrated Deterministic and Uncertainty Analyses."

ACRS Conclusion and Recommendation 1

The Sequoyah SOARCA study has significantly advanced the understanding of severe accident progression in a pressurized-water reactor (PWR) with an ice condenser containment. It demonstrates the importance of an integrated assessment of uncertainties that accounts for the best available knowledge about equipment performance, thermal-hydraulic phenomena, and emergency planning.

Staff Response to ACRS Conclusion and Recommendation 1

The staff agrees with this conclusion and recommendation.

ACRS Conclusion and Recommendation 2

This study evaluates the conditional site-specific consequences from a short-term and a long-term station blackout scenario, which are tailored to examine the effects from hydrogen generation, ignition, and containment failure vulnerability. It does not examine other scenarios that may be important for containment failure or bypass and it does not account for accident mitigation equipment and strategies that have been implemented at Sequoyah. The results from this study should not be extrapolated to other PWRs with ice condenser containments at other sites.

Staff Response to ACRS Conclusion and Recommendation 2

The staff agrees with this conclusion and recommendation. The SOARCA Sequoyah report highlights the detailed site-specific and plant-specific information used in the analyses. Both the executive summary and the end of Section 7, Conclusions, caution the reader that "additional

work would be needed to consider differences in plant-specific designs and site-specific characteristics” to determine applicability of insights from the Sequoyah study for other PWRs with ice condenser containments.

ACRS Conclusion and Recommendation 3

The Sequoyah SOARCA report should be published after the staff more clearly documents the following issues and additional research needed for their resolution: potentially important modeling uncertainties, justification for safety valve failure rates, and MELCOR failures to complete some simulations involving an early stuck-open pressurizer safety valve.

Staff Response to ACRS Conclusion and Recommendation 3

The staff agrees with this conclusion and recommendation, has started the final publication process and anticipates publication in 2018.

The staff added a discussion to the executive summary (ADAMS Accession No. ML17340B209), noting that model uncertainty was outside the scope of this uncertainty analysis and that a systematic evaluation of model uncertainties could reveal additional important uncertainties that were not captured within this study. The staff also added discussion on safety valve failure rates under a new sub-heading in the executive summary. This discussion notes that supporting data are sparse and that no established expert consensus exists on the best way to model safety valve failure-to-close.

Following the November 2, 2017, brief to the ACRS full committee, the staff completed additional analysis of the MELCOR simulations in the overall uncertainty analysis within the small sample space that had the potential for early containment failure (where 13 runs did not complete out of the 36 possible realizations). Almost all of the incomplete MELCOR simulations (11 realizations) ran through the time of the initial hydrogen deflagration (none had an early containment failure). The two MELCOR simulations that did not were re-started with convergence criteria adjustments that allowed completion through the time of initial hydrogen deflagration (only one of the two indicated an early containment failure). The additional analysis adds confidence that no insights were missing with regard to the potential for early containment failure, which remains a very low probability dominated by the safety valve behavior. Section 4.2 documents the new analysis, which is summarized in the executive summary under a new sub-heading.

ACRS Conclusion and Recommendation 4

The staff should examine and resolve the issues regarding safety valve failure rates and MELCOR performance before further enhancements are made to the SOARCA studies.

Staff Response to ACRS Conclusion and Recommendation 4

The staff understands the ACRS recommendation and will continue to gather accessible information on the operational experience that forms the basis for safety valve failure modeling in the SOARCA Surry Uncertainty Analysis. The safety valve failure rate is important in the Surry short-term station blackout because of its influence on the probability of inducing a steam-generator tube rupture. If the staff conducted additional investigation, it would delay the completion of the Surry Uncertainty Analysis and it is uncertain whether the investigation would yield a stronger technical basis. Nonetheless, the staff recognizes the importance of attempting to further develop the underlying technical basis and to increase confidence, given the important influence of the safety valve failure-to-close rate in the Surry study.

On April 18, 2017, the NRC's Office of Nuclear Regulatory Research staff and Sandia National Laboratories made a separate presentation on the overall MELCOR performance and insights relevant to SOARCA to the ACRS subcommittee on thermal-hydraulics. As discussed above in staff response to ACRS Conclusion and Recommendation 3, Section 4.2 documents the causes and the investigation of the few MELCOR incomplete runs. We will use the insights from these investigations in our future work.

The NRC staff appreciates the ACRS's review of this report. We thank the ACRS for its valuable feedback.

Sincerely,

/RA Michael R. Johnson Acting for/

Victor M. McCree
Executive Director
for Operations

cc: Chairman Svinicki
Commissioner Baran
Commissioner Burns
SECY

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