



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 18, 2013

Mr. David A. Heacock
President and Chief Nuclear Officer
Dominion Nuclear Connecticut, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: MILLSTONE POWER STATION, UNIT NO. 2 - CLOSURE EVALUATION FOR
30-DAY REPORT FOR EMERGENCY CORE COOLING SYSTEM MODEL
CHANGES PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46
(TAC NO. ME7881)

Dear Mr. Heacock:

By letter dated January 25, 2012, as supplemented by letters dated November 1, 2012, and March 7, 2013, Dominion Nuclear Connecticut Inc. (Dominion), submitted a report describing cumulative errors and changes identified in the small break loss of coolant accident emergency core cooling system (ECCS) evaluation model, and an estimate of the effect of the changes on the predicted peak cladding temperature for Millstone Power Station Unit 2. This report was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 46 (10 CFR 50.46), paragraph (a)(3). A meeting was held between the Nuclear Regulatory Commission (NRC) staff and Dominion personnel along with their vendor, AREVA, on May 14, 2013 to discuss the sensitivity studies performed to support the review.

The NRC staff has evaluated the report, along with its supplemental information, and determined that it satisfies the reporting requirements of 10 CFR 50.46(a)(3), and also the intent of the reporting requirements, as discussed in the statement of considerations published on September 16, 1988, in the *Federal Register* (FR), for the realistic ECCS evaluations revision of 10 CFR 50.46 (53 FR 35996). The NRC staff's closure evaluation of the report is enclosed.

Please contact me at (301) 415-4125 if you have any questions on this issue.

Sincerely,

A handwritten signature in cursive script that reads "James Kim".

James Kim, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-336

Enclosure:
As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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CLOSURE EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DOMINION NUCLEAR CONNECTICUT, INC.

MILLSTONE POWER STATION UNIT 2

30-DAY REPORT FOR EMERGENCY CORE COOLING SYSTEM MODEL CHANGES

PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46

1.0 INTRODUCTION

By letter dated January 25, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12031A147), Dominion Nuclear Connecticut Inc. (Dominion), submitted a report describing cumulative errors and changes identified in the small break loss-of-coolant accident (SBLOCA) emergency core cooling system (ECCS) evaluation model, and an estimate of the effect of the changes on the predicted peak cladding temperature (PCT) for Millstone Power Station Unit 2. This report was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 46 (10 CFR 50.46), paragraph (a)(3). The report was supplemented by two additional letters dated November 1, 2012 (ADAMS Accession No. ML12311A029) and March 7, 2013 (ADAMS Accession No. ML13074A795). There was also a meeting held between the NRC staff and Dominion personnel along with their vendor, AREVA, on May 14, 2013 to discuss the sensitivity studies performed to support the review.

The Nuclear Regulatory Commission (NRC) staff has evaluated the report, along with its supplemental information, and determined that it satisfies the reporting requirements of 10 CFR 50.46(a)(3), and also the intent of the reporting requirements, as discussed in the statement of considerations published on September 16, 1988, in the *Federal Register* (FR), for the realistic ECCS evaluations revision of 10 CFR 50.46 (53 FR 35996). The staff review is discussed in the following sections of this closure evaluation.

2.0 REGULATORY EVALUATION

2.1 Requirements Contained in 10 CFR 50.46

Acceptance criteria for ECCS for light water nuclear power reactors are promulgated at 10 CFR 50.46. In particular, 10 CFR 50.46(a)(3)(i) requires licensees to estimate the effect of any change to, or error in, an acceptable evaluation model or in the application of such a model to determine if the change or error is significant. For the purpose of 10 CFR 50.46, a significant change or error is one which results in a calculated peak fuel cladding temperature different by more than 50 degrees Fahrenheit (°F) from the temperature calculated for the limiting transient using the last acceptable model, or is an accumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50 °F.

Enclosure

For each change to or error discovered in an acceptable evaluation model or in the application of such a model, paragraph (a)(3)(ii) to 10 CFR 50.46 requires the affected licensee to report the nature of the change or error and its estimated effect on the limiting ECCS analysis to the Commission at least annually. If the change or error is significant, the licensee is required to provide this report within 30 days and include with the report a proposed schedule for providing a re-analysis or taking other action as may be needed to show compliance with 10 CFR 50.46 requirements.

2.2 Additional Guidance

Additional clarification concerning the intent of the reporting requirements is discussed in the statement of considerations published on September 16, 1988, in the FR for the best estimate loss-of-coolant-accident (LOCA) revision of 10 CFR 50.46 (53 FR 35996):

[Paragraph (a)(3) of section 50.46] requires that all changes or errors in approved evaluation models be reported at least annually and does not require any further action by the licensee until the error is reported. Thereafter, although reanalysis is not required solely because of such minor error, any subsequent calculated evaluation of ECCS performance requires use of a model with such error, and any prior errors, corrected. The NRC needs to be apprised of even minor errors or changes in order to ensure that they agree with the applicant's or licensee's assessment of the significance of the error or change and to maintain cognizance of modifications made subsequent to NRC review of the evaluation model...

Significant errors require more timely attention since they may be important to the safe operation of the plant and raise questions as to the adequacy of the overall evaluation model... More timely reporting (30 days) is required for significant errors or changes... the final rule revision also allows the NRC to determine the schedule for reanalysis based on the importance to safety relative to other applicant or licensee requirements.

The NRC staff considered the discussion in the *Federal Register* in its evaluation of the changes in the report submitted by the licensee.

3.0 TECHNICAL EVALUATION

The report submitted by the licensee described the effects of changes in the SBLOCA ECCS evaluation model associated with the S-RELAP5 kinetics and heat conduction model changes and the Sleicher-Rouse single phase vapor heat transfer correlation.

Based on the nature of the reported changes, and on the magnitude of their effect on the PCT calculation, the NRC staff determined that a detailed technical review is necessary. Based on the regulatory evaluation discussed above, the staff's review was performed to ensure that the NRC staff agrees with the licensee's assessment of the significance of the changes, and to enable the staff to verify that the evaluation model, as a whole, remains adequate. Finally, the NRC staff's review also establishes that the licensee's proposed schedule for reanalysis is acceptable in light of the safety significance of the reported error.

3.1 Summary Of Technical Information In The Report

The licensee's report indicated that the effect of the model changes was 87 °F for Millstone Power Station Unit 2. The nature of the changes, and the method used to estimate its effect on the calculated peak fuel cladding temperature, are briefly discussed in the original report and significantly more detail is provided in the response to the NRC staff request for additional information dated January 25, 2012.

S-RELAP5 Kinetics and Heat Conduction Model Changes

Corrections to the coding of the point kinetics model in SRELAP-5 were previously provided by Idaho National Lab (INL) and incorporated into the code. The INL recently announced that the corrections were incorrect and that the recommended convergence criteria supplied with the corrections should be retained. The INL also announced that the heat conduction solution was incorrectly programmed. AREVA entered both of these items into their corrective action system.

The programming error in the heat conduction solution was associated with using the incorrect heat capacity when evaluating the right boundary mesh point, the code incorrectly used the next to last instead of the last mesh interval heat capacity. This error is minimized by the SBLOCA methodology guidelines requiring close mesh spacing.

The corrections for the two errors were installed into a new S-RELAP5 version and new evaluations were performed. The impact of the changes on PCT for Millstone Power Station Unit 2 was determined to be +4 °F.

Sleicher-Rouse Single Phase Vapor Heat Transfer Correlation

AREVA noticed that the behavior of the Sleicher-Rouse single phase vapor heat transfer correlation differed from other correlations while developing a boiling water reactor LOCA analysis methodology using S-RELAP5. It was discovered that the formulation of the correlation in S-RELAP5 differed from the formulation used in other industry codes. AREVA prepared a version of the code with the alternative formulation and found that it more closely agreed with the formulation used in other industry codes.

The results of the sample problems run with the corrected Sleicher-Rouse correlation indicate that the predicted SBLOCA PCT for Millstone Power Station Unit 2 should be increased 83 °F.

Reported Results

Following the changes to the S-RELAP5 models and the Sleicher-Rouse correlation, the current predicted PCT for Millstone Power Station Unit 2 is 1801 °F. The margin utilization table attached to the report also included RODEX2 thermal conductivity degradation. This error was reported to be a 0 °F change to PCT.

3.2 Summary of Staff Evaluation

In its evaluation, the NRC staff reviewed (1) the approach used to estimate the effects of the changes, (2) the estimated effect of the changes, and (3) the licensee's proposal for re-analysis in consideration of the approach used to estimate the effects of the changes. As discussed in

the following paragraphs, the NRC staff determined that the licensee's estimate and proposal for reanalysis are acceptable.

The changes proposed to the S-RELAP5 point kinetics and heat conduction models were simple, straight-forward corrections to errors reported by INL. The staff questioned the bundling of the errors and reporting a single value for the delta effect on the PCT. Dominion responded that none of the other changes and errors provided are bundles of more than one error or change and were reported separately to confirm to the staff that the errors did not offset each other and that the absolute value of the effects separately was not greater than the 4 °F delta reported. This also led the staff to question whether any of the magnitudes of the other changes reported to the analysis in the past had been bundled. Dominion confirmed that no other delta PCTs listed in the report were a bundle of multiple changes.

The initial report contained a vague description of the changes made to the Sleicher-Rouse correlation in S-RELAP5. The staff requested that Dominion provide more information detailing the changes that were made to the correlation and how it was modified to more closely agree with other industry code formulations of the correlation. The S-RELAP5 form and the alternative form of the correlation were both provided to the staff. AREVA performed a comparison of the two formulations and the staff confirmed that the alternate form of the correlation that was implemented in S-RELAP5 more accurately models the temperature degradation factor.

Dominion reported, in the rack-up table, that the effect of the lack of thermal conductivity degradation consideration in the RODEX2 code produced a zero effect on SBLOCA PCT. A section of explanation was not provided in the report regarding this error. At the request of the NRC staff, Dominion provided a justification to support the reported estimate. The basis of the argument is that the PCT for SBLOCA does not occur until later in the transient, is therefore dependent on the decay heat versus heat transfer, and is not coupled to the initial stored energy within the fuel. The staff accepts the licensee's evaluation of thermal conductivity degradation with respect to SBLOCA.

Recent information gained through other reviews led the staff to question other aspects of the Millstone Power Station Unit 2 SBLOCA analysis. The specific areas of concern were with the coarseness of the break spectrum and the credit for the hot leg nozzle gaps and core barrel leakage path modeling in the S-RELAP5 nodalization. Dominion had AREVA perform thorough sensitivity studies to investigate the effects of the staff's concerns on the outcome of the SBLOCA analysis. The studies showed that the PCT reported in the Dominion letter dated January 25, 2012 remained conservative.

The staff also questioned the limiting break analysis which had multiple loop seal clearing behavior in the suction legs. Typically, PCT is maximized when only the broken loop seal clears due to the increased resistance of vapor flow through only one loop versus multiple venting loops. Because of these concerns, the staff requested the licensee to re-analyze the limiting break with credit for the leakage paths removed and with the constraint that only a single loop seal clear during the transient. The reanalysis demonstrated that the PCT was less than 1801 °F for the limiting break size of 0.083 ft². This current analysis of record showed that multiple loop seals partially cleared allowing vapor from the intact loop to entrain downcomer liquid and expel this liquid out the break. This caused the downcomer head of water to decrease, which increased the depth of core uncover and a higher PCT. The staff agrees that the multiple loop seal partial clearing produces a higher PCT than that for the case with only the

broken loop seal cleared. With vapor venting through only the broken loop, the potential for entraining downcomer liquid and expelling it out the break is precluded. The staff agrees that the current model with partial loop seal clearing produces a conservative PCT result for this limiting break. The staff further notes that the licensee should assure that this behavior remains dominant in all future analyses by comparison to the case where only one loop seal is allowed to clear for the limiting break.

In the supplemental letter dated November 1, 2012, Dominion proposed to submit a reanalysis of the SBLOCA event within one year of NRC approval of Supplement 1 to EMF-2328(P)(A). The NRC staff determines herewith, that the licensee's proposed schedule for reanalysis is acceptable and that the reanalysis requirement of 10 CFR 50.46 is presently satisfied.

In summary, the NRC staff reviewed the licensee's report estimating the effect of changes on the small break LOCA analyses for Millstone Power Station Unit 2. Based on the technical rigor employed by the licensee, which included performing significant sensitivity studies on the SBLOCA analysis, the NRC staff concluded that the change estimate was acceptable. Also, the NRC staff reviewed the licensee's proposed schedule for reanalysis and determined that the licensee satisfied the reanalysis requirement set forth in 10 CFR 50.46(a)(3)(ii).

4.0 CONCLUSION

Based on the considerations discussed above, the NRC staff finds that the report submitted pursuant to 10 CFR 50.46(a)(3), concerning multiple ECCS evaluation model errors, satisfies the intent of the 10 CFR 50.46 reporting requirements. The report and supplemental information enabled the staff to (1) determine that it agrees with the licensee's assessment of the significance of the error, (2) confirm that the evaluation model remains adequate, and (3) verify that the licensee continues to meet the PCT acceptance criterion promulgated by 10 CFR 50.46(b). The NRC staff concludes that the licensee's sensitivity studies and proposed schedule for reanalysis is acceptable and, therefore, the requirements of 10 CFR 50.46 are presently satisfied.

Principal Contributors: A. Proffitt
L. Ward

Date: July 18, 2013

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Mr. David A. Heacock
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Sincerely,
/ra/

James Kim, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-336

Enclosure:
As stated

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* See memo dated July 10, 2013

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