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May 10, 1991

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: **Docket No. 50-206**
Volume Differences Identified in Accident Analyses
San Onofre Nuclear Generating Station, Unit 1

Reference: Letter, R. M. Rosenblum (SCE) to NRC Document Control Desk, "Underestimation of Refill Volume Assumed in Large Break LOCA Analysis," March 29, 1991.

The above reference documented our discovery that the reactor vessel refill volume used in the large break loss of coolant accident (LBLOCA) analysis for SONGS 1 was underestimated by Westinghouse. That letter 1) quantified the effect of the refill volume underestimation on the LBLOCA analysis, 2) described administrative controls instituted to assure continued safe plant operation, and 3) committed to include the provisions of those administrative controls in the SONGS 1 Technical Specifications via a future license amendment application. The NRC was also notified of the refill volume underestimation in Licensee Event Report (LER) No. 1-91-007, dated April 29, 1991.

Following the identification of the refill volume error, SCE initiated an independent effort to confirm the volume information utilized in other analyses performed by Westinghouse. Additional volume differences have recently been identified by that effort. Westinghouse has reviewed these differences and confirmed their existence (see Attachment). For conservatism, SCE is acting on assumption that these differences represent non-conservative errors. This letter describes the volume differences and the actions to be completed prior to restart from the current outage to confirm there is adequate margin in the affected accident analyses. Our preliminary evaluation is that sufficient margin is available in each of the affected accident analyses to compensate for the volume differences. A followup letter will be submitted prior to Mode 4 entry from the present outage to inform the NRC of the final evaluation results. We are unaware to what extent, if any, similar volume differences may exist at other Westinghouse plants and are currently evaluating the need for a 10 CFR 21 report.

BACKGROUND

On March 29, 1991, SCE notified the NRC that the refill volume used in the LBLOCA analysis was underestimated by approximately 182 ft^3 (total RCS

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volume is approximately 7200 ft^3). The underestimated refill volume translated into a conservatively forecast net PCT penalty of 188.5°F. We have established administrative controls on incore axial offset to compensate for this discrepancy. These restrictions on incore axial offset provided 237.5°F in additional PCT margin, more than enough to compensate for the underestimated refill volume.

AVAILABLE PCT MARGINS

Of the 237.5°F of available PCT margin obtained by limiting incore axial offset, 49°F were not required to offset the refill volume discrepancy. Therefore, 49°F of the PCT margin due to the axial offset limitations are available to compensate for additional volume discrepancies. Additionally, the following conservatisms in the PCT analysis were identified in the reference letter that could be credited to reduce calculated PCT: 1) 46°F PCT margin due to more realistic assumptions concerning the Safety Injection System mini-flow rate during a LBLOCA, 2) 64°F PCT margin due to operation at reduced power (i.e., 92%) vs. full power, and 3) 24°F PCT margin resulting from a decrease in the adiabatic heatup period due to the larger blowdown volume.

Subsequent to the reference letter, we have refined two of the above PCT margins that, although not presently credited, we identified were available and could be used to provide assurance that our existing analyses are conservative. First, the margin for operation at reduced power level is reduced to 56°F rather than 64°F to reflect operation up to 95% power (vs. 92% power assumed previously) for operational flexibility purposes. The 56°F margin is based on Westinghouse guidance that approximately 8°F reduction in PCT is realized for each 1% of power level reduction (assuming a 7% reduction from the 102% power used in the accident analyses). Second, we have concluded that the thermal hydraulic phenomena during the blowdown phase of a LOCA is sufficiently uncertain such that the 24°F margin listed above should not be credited unless confirmed by analysis. Therefore, the total available PCT margin is 151°F (i.e., 49°F due to axial offset, plus 46°F due to Safety Injection mini-flow, plus 56°F due to reduced power level).

METHOD OF DISCOVERY OF VOLUME DISCREPANCIES

The refill volume discrepancy reported in our March 29, 1991 letter was discovered by SCE personnel during the performance of engineering design work related to the Cycle 12 modifications. As part of that design work, reactor coolant system (RCS) nodal volumes used in the SBLOCA NOTRUMP analysis were crosschecked with the corresponding nodal volumes used in the LBLOCA analysis completed by Westinghouse. SBLOCA analyses were recently completed using the NOTRUMP computer code. These analyses were performed by Westinghouse with extensive SCE involvement. We have high confidence in the NOTRUMP analysis due to our extensive involvement, particularly in the verification of input data, and were concerned when we discovered differences between values

used for the refill volume in the two analyses. The difference in the volumes was reviewed by Westinghouse and it was confirmed that the LBLOCA refill volume had been underestimated by 182 ft^3.

As a follow-on effort to the discovery of the refill volume discrepancy, we undertook an independent effort to compare the total RCS volumes utilized in other SONGS 1 Westinghouse analyses to that calculated in the recent NOTRUMP analysis. Although some variance would be expected due to modeling differences, this review identified differences that are larger than those considered by SCE to be appropriate. Concurrently, we requested Westinghouse to continue investigating the possibility of other differences in the volumetric inputs for the SONGS 1 accident analyses. This effort has identified additional volume differences in the LBLOCA/PCT, LBLOCA/mass and energy release, and non-LOCA analyses.

LBLOCA PCT ANALYSES

A comparison of the total RCS volume, as originally calculated, with more recently verified values, indicates an overall difference of approximately 550 ft^3, or approximately 8.6% of the total RCS volume. This total volume differences is comprised of: 1) the 182 ft^3 refill volume discrepancy previously identified, 2) 150 ft^3 in the core baffle region (where the volume between the reactor vessel baffle and core barrel was not modeled), and 3) small volume differences in the other areas of the system. Westinghouse has suggested that the lack of a barrel/baffle region volume in the SONGS 1 analyses may have been a specific analysis assumption due to the simplicity of the model. The other smaller differences appear to result from differences in calculational approach. As previously stated, we are conservatively acting on the assumption that these differences represent non-conservative errors.

An assessment of the LBLOCA analysis for SONGS 1 Cycle 11 is ongoing to determine the impact of the volume differences. This assessment is considering all three phases of the LBLOCA transient (i.e., blowdown, refill, and reflood). We will provide a detailed assessment of these differences prior to entry into Mode 4 from the current outage. Our preliminary assessment is that the differences are adequately offset by the available margin.

LOCA CONTAINMENT MASS AND ENERGY ANALYSIS

Volume differences also appear in the Westinghouse LBLOCA mass and energy analyses. The total RCS volume used in the LBLOCA containment mass and energy design basis analyses was determined to be approximately 300 ft^3 less than the volume utilized in the recent NOTRUMP analysis. This volume discrepancy includes the previously discovered 182 ft^3 in the lower plenum and other differences in various areas of the RCS. Assuming these differences represent non-conservative errors, the lower total volume results in an underestimate of the RCS mass and energy released during the LBLOCA. However, our preliminary

evaluation shows that this volume differences is offset by the margin available due to plant operation at a reduced RCS average coolant temperature. We will confirm that adequate margin exists to offset these volume differences prior to Mode 4 entry.

NON-LOCA ANALYSES

We are also evaluating the impact of the identified volume differences on all non-LOCA design basis accidents. SCE and Westinghouse will verify that correct volumes were used for non-LOCA analyses using digital computer codes in which volume is a modeled parameter. Our evaluation does not include transient analyses performed using analog simulation techniques because they are non-limiting, small volume differences are not considered significant, and little documentation is available for these analyses performed in the late 1960's. The results of this confirmatory effort will be included in our letter transmitting the final evaluation results.

At this time, our review of non-LOCA transients has determined that a volume differences of 366 ft^3 exists in the modeling of the LOFTRAN computer code. Our preliminary evaluation of the impact of this differences shows that LOFTRAN results are not sensitive to small changes in RCS volumes. Our final evaluation will be submitted prior to Mode 4 entry from the present outage.

CONCLUSION

We are continuing our investigation of this matter and will complete our assessment prior to Mode 4 entry from the current outage. Based on our preliminary evaluations, we expect that sufficient margin remains in each of the accident analyses to compensate for the identified volume differences. We will transmit our final evaluation results prior to Mode 4 entry from the present outage and provide a supplement to LER 1-91-007 by June 15, 1991. In addition, SCE is committed to re-perform all of the UFSAR Chapter 15 design basis accident analyses prior to Cycle 12 operation. That analytical effort will use independently verified volumetric input data.

Very truly yours,

R M Rosenblum

Enclosure

cc: George Kalman, NRC Project Manager, San Onofre Unit 1
J. B. Martin, Regional Administrator, NRC Region V
C. W. Caldwell, NRC Senior Resident Inspector, San Onofre Units 1, 2 & 3
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SCE-91-550

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May 9, 1991

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SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1
ASSESSMENT OF SAFETY ANALYSIS VOLUME DIFFERENCES

Ref. 1) SCE-91-528, "Large Break LOCA Lower Plenum Volume Discrepancy", Letter From H. C. Calton (Westinghouse) to J. T. Reilly (Southern California Edison Company), Dated March 28, 1991.

Ref. 2) SCE-91-533, "Integrated Assessment for Refill Volume Discrepancy", Letter From S. A. Pujadas (Westinghouse) to B. Carlisle (Southern California Edison Company), Dated April 24, 1991.

Dear Mr. Reilly:

Attached is an assessment by Westinghouse of the volume differences found in the safety analyses for the San Onofre Nuclear Generating Station Unit 1 (SONGS-1). The differences result from a comparison of the volume inputs used in the safety analyses, and the volumes which would be calculated using current analysis methods and standards. The effect of the large break LOCA analysis refill volume difference was previously addressed in SCE-91-528. Additional information regarding volume differences for other safety analyses within Westinghouse scope was provided in SCE-91-533. The attachment presents a current summary of the Westinghouse assessment of the volume differences.

If you have any questions or comments, please contact me or Mr. Michael Young of the Nuclear Safety Department.

Very truly yours,

J. M. Cully for C. J. Caso

C. Caso, General Manager
Nuclear and Advanced Technology Division

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ATTACHMENT TO
SCE-91-550

On March 26, 1991, SCE observed a discrepancy between the SONGS-1 refill volume assumed in the Westinghouse IAC (Interim Acceptance Criteria) large break LOCA analysis and the recently completed small break LOCA analysis using the NOTRUMP computer code. The original input calculations for the SONGS-I large break LOCA analysis were performed in 1970 and 1971. As part of the NOTRUMP small break LOCA analysis performed to support increases in safety injection (SI) miniflow, all small break analysis assumptions were reviewed with respect to the current plant configuration. Generation of the small break LOCA analysis volumes indicated a lower plenum volume of 611 ft^3 to the bottom of the active fuel inside the core barrel. An additional 61 ft^3 represents the downcomer volume from the bottom of the core barrel to the bottom of the active fuel elevation. Together, this 672 ft^3 volume comprises what can be termed "refill volume" with respect to the IAC large break evaluation model (EM).

Review of the SONGS-1 vessel drawings indicates that, using the current methods and processes, the refill volume used in the large break LOCA analysis was underestimated. Use of the refill volume as calculated using current methods and practices will result in an increase in calculated Peak Cladding Temperature (PCT). A review of available documentation has determined that the inputs used in the current SONGS-1 analysis were calculated by Westinghouse in 1971, and submitted to SCE for review and approval. However, information is not available to determine the basis for the original calculation of the lower plenum volume.

In view of the importance of the refill volume to the results of the SONGS-1 analysis, it was concluded that the lower plenum volume used for the refill period should be made consistent with current methods and standards. The lack of documentation to support the basis for the refill volume in the original SONGS-1 analysis is the result of the design documentation procedures in place for application of the Interim Acceptance Criteria LOCA codes in the late 1960's. Current practices require documentation and independent review of the calculations.

Immediately after the discovery of the lower plenum refill discrepancy, Westinghouse and SCE performed a safety assessment of the impact of the volume discrepancy. As a result, constraints on the axial offset limits were recommended to provide a reasonable assurance of safe operation within the SONGS-1 licensing basis.

After the initial safety assessment, a more complete review of the lower plenum fluid volumes used in the safety analyses for SONGS-1 was performed. In the LOCA area, this included a review of the SATAN blowdown code, the refill calculation, and the reflood calculation code called CCNDES. In the containment mass and energy release area, the SATAN code used to calculate blowdown mass and energy release was reviewed. In the non LOCA area, the LOFTRAN code was reviewed. Other codes are used in the safety analyses, but they do not use fluid volume as input. For example, LOCTA-R2 and FACTRAN are the fuel rod codes used in the LOCA and non LOCA analysis, respectively. The lower plenum volume discrepancy was found only to exist in the SATAN code input.

At Southern California Edison's request, the review was extended to all the volumes in the RCS. Differences were found between several of the volumes used in the SONGS-1 safety analyses, and those which would be calculated using the current methods and practice by the LOCA plant component databases. It was concluded that, due to the complexity of the reactor vessel internals, several geometrical approximations must be made which could easily result in slightly different calculated volumes. Furthermore, some fluid volumes were not modeled in the SONGS-1 LOCA analysis. Given the simplicity of the Interim Acceptance Criteria LOCA model, and the level of knowledge of the LOCA at the time, it would have been reasonable to not model some of the fluid regions in the analysis. It has been concluded that these differences are not errors, but result from changes in design methods and practices as the LOCA analysis methodology advanced.

The overall RCS volume differences between the current licensing analyses and the recently calculated RCS volumes for the NOTRUMP analysis are summarized below:

Large Break LOCA	550 FT3
LOCA M/E	300 FT3
Non-LOCA	366 FT3

Westinghouse is performing a thorough review of all safety analyses potentially impacted by volume discrepancies. Of the volume discrepancies noted, Westinghouse has concluded that only the lower plenum volume in the LOCA analysis is significant and must be corrected. It is Westinghouse judgement that past operation of SONGS-1 did not pose a threat to the public health and safety as a result of the refill volume discrepancy. Sufficient margin is available to allow SONGS-1 to resume operation, although with some peaking factor constraints. This judgement is based upon the following:

1) The plant specific measurements for axial offset indicates that the total peaking factor would have maintained compliance with the Interim Acceptance Criteria limit of 2300°F. Reductions in peaking factor to offset the effect of the volume discrepancy in the LOCA analysis appear small enough to allow full power operation.

2) Comparison of the SONGS-1 analysis results to the results of calculations performed for another plant which used the Westinghouse Interim Acceptance Criteria ECCS Evaluation Model indicate consistent results during the blowdown phase.

3) Comparison of the analysis results to applicable full length emergency core cooling heat transfer (FLECHT) tests indicate consistent results during the reflood phase.

4) The discrepancies found in the Non-LOCA analyses do not affect the conclusion of the current licensing basis analyses.

5) The discrepancies found in the LOCA mass and energy release analysis can be offset by margin available due to plant operation at reduced RCS average coolant temperature.

Planned Actions

An additional analysis is planned to confirm the effect of the volume differences on the large break LOCA blowdown and reflood transients. The SONGS-1 blowdown model will be modified to include an additional 550 cubic feet in the fluid volumes. All other input will remain unchanged for this calculation. As stated previously, neglecting the barrel-baffle region appears to have been a reasonable assumption for the LOCA model used for SONGS-1. Nevertheless, this region will now be included in the analysis. In addition, a reflood calculation will be performed which takes this volume into account. The effect of this change will be calculated by performing the hot rod heatup calculation using the new blowdown and reflood results. This analysis will be completed by May 17, 1991.

In the Non-LOCA area, a safety evaluation has been performed for those transients which used the LOFTRAN code, and confirms that the volume discrepancies do not adversely affect the safety analysis results. The details of this evaluation will be provided by May 17, 1991.

The final Westinghouse assessment of the impact of the volume discrepancies will be provided in a letter report on May 17, 1991.