



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

June 16, 2015

Mr. Jack Stringfellow, PWROG
PWR Owners Group, Program Management Office
Westinghouse Electric Company, LLC
1000 Westinghouse Drive, Suite 380
Cranberry Township, PA 16066

Dear Mr. Stringfellow:

The U.S. Nuclear Regulatory Commission (NRC) staff has considered your request submitted on behalf of the Pressurized-Water Reactor Owners Group (PWROG) to endorse the Westinghouse report entitled PWROG-14064-P, "Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances," which was made available to the NRC staff by your letter dated September 26, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14276A099 (the enclosure is being withheld from public disclosure for proprietary reasons)). In addition, the NRC staff has further considered the scaling methodology outlined in PWROG-14027-P, Revision 3, "No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power, Task 3: Evaluation of Revised Seal Flow Rate on Time to Enter Reflux Cooling and Time at which the Core Uncovers." The PWROG submitted this report to the NRC staff for information only by letter dated April 24, 2015 (ADAMS Accession No. ML15120A069, enclosure also withheld from public disclosure for proprietary reasons), to support the staff's endorsement of PWROG-14064-P.

The NRC staff is performing evaluations of licensees' mitigation strategies required for compliance with NRC Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (ADAMS Accession No. ML12054A735). An important aspect of these evaluations is to determine whether licensees' determinations of the overall sequence of events, the timing of those events, and the phenomena affecting those events, are reasonable.

To comply with NRC Order EA-12-049, several licensees have submitted Overall Integrated Plans that credit generic analyses using the NOTRUMP thermal-hydraulic computer code. The NOTRUMP code and corresponding Appendix K-based evaluation model were originally submitted in the early 1980s as a method for performing licensing-basis safety analyses of small-break loss-of-coolant accidents for Westinghouse pressurized-water reactors (PWRs). The NRC staff had not previously examined NOTRUMP's technical adequacy for performing best-estimate simulations of beyond-design-basis extended loss of alternating current (ac) power (ELAP) events. Therefore, in support of our reviews of mitigation strategies where licensees credit thermal-hydraulic analysis with the NOTRUMP code, the NRC staff is evaluating the applicability of the NOTRUMP code and corresponding best-estimate ELAP evaluation model for the purpose of demonstrating compliance with Order EA 12-049.

To support the NRC staff's evaluation of the applicability of a NOTRUMP-based evaluation model to the ELAP event, the PWROG provided WCAP 17601-P, Revision 1, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion

Engineering and Babcock & Wilcox NSSS [Nuclear Steam Supply System] Designs," and WCAP-17792-P, "Emergency Procedure Development Strategies for the Extended Loss of AC Power Event for all Domestic Pressurized Water Reactor Designs," by letters dated January 30, 2013, and January 13, 2014, respectively.

By letter dated September 26, 2014, the PWROG provided PWROG-14064-P as its position paper on the use of the NOTRUMP code for analyzing the reactor coolant system response of a Westinghouse-designed reactor to an ELAP event. In its paper, the PWROG identified several significant issues that arose from interactions with the NRC staff on the applicability of WCAP 17601-P and WCAP-17792-P to licensees' thermal-hydraulic analyses in response to ELAP events. The PWROG summarized these issues as including code validation, boron mixing, reflux cooling, and reactor coolant pump (RCP) seal leakage, and provided its position on each of these issues in the paper.

As none of the PWROG submittals above requested a comprehensive technical review of the reports (i.e., topical report review), the NRC staff did not perform such a review to provide a generic conclusion on acceptability of the NOTRUMP code or the applicability of the generic analysis and evaluation model methods to individual plants or groups of plants. Therefore, PWR licensees who choose to credit an analysis using NOTRUMP to demonstrate compliance with Order EA 12-049 will need to be able to justify the technical basis for its use.

From its review of the PWROG-14064-P paper, the NRC staff endorses the following aspects for the use of NOTRUMP for beyond-design-basis ELAP events, as described in PWROG-14064-P:

- The use of NOTRUMP analysis can be an acceptable means to predict onset of reflux cooling in Westinghouse designed NSSS plants, provided that individual licensees can demonstrate the analysis is applicable to their plants.
- For the purpose of evaluating the ELAP event, the onset of reflux cooling is considered to occur when the one hour centered moving average of the steam generator U-bend flow quality has increased to a value of 0.1 in any one loop.
- The time criteria specified in Table 1 of PWROG-14064-P pertain to reference cases with specific assumptions for each (e.g., RCP seal leakage rates, reactor coolant system (RCS) coolant inventory, accumulator design parameters, and RCS cooldown end point). Licensees need to demonstrate appropriate scaling of parameters/assumptions as compared to those of the applicable reference case to derive plant-specific response times or to show that they are indeed bounding.
- Assurance of adequate boron mixing during an ELAP event is addressed separately in PWROG letter dated August 15, 2013 (ADAMS Accession No. ML13235A135), and NRC letter dated January 8, 2014 (ADAMS Accession No. ML13276A183).
- The NOTRUMP reference case results provided in Table 1 of PWROG-14064-P are based on an RCP seal leakage rate of 21 gpm at nominal post-trip conditions, whereas, individual licensees may have different RCP seal leakage rates. The technical basis for

each plant-specific leakage rate and its effect on the NOTRUMP results will be considered by the NRC staff on a case-by-case basis.

Based on its review of PWROG-14027-P, the NRC staff places the following additional clarifications and limitations on the PWROG's proposed methods for scaling the reference results from PWROG-14064-P:

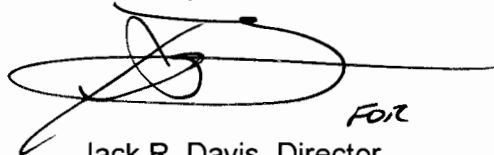
- Table 3-1 of PWROG-14027-P, Revision 3, recommends a simplified template for determining the applicability of the reference analysis to individual plants. Though Table 3-1 contains parameters that may typically be dominant, the staff noted that the simplified template does not contain all the parameters that may be necessary to demonstrate the applicability of the reference case to individual plants. Accordingly, individual licensees should confirm the applicability of the reference analysis according to the complete list of ELAP simulation parameters previously requested by the NRC staff via the mitigation strategies audit process and provide justification that the reference analysis parameters are conservative or representative in an overall sense for determining the coping time prior to the onset of reflux cooling for their plants.
- While the staff agrees that the PWROG has correctly identified the typically conservative direction for the parameters in Table 3-1, these simplified generic determinations may be subject to confirmatory review during mitigation strategy audits, as appropriate, based on plant-specific conditions.
- Regarding the process for determining plant-specific coping times prior to reflux, the NRC staff expects that the approximate mass-balance scaling method outlined in PWROG-14027-P, Revision 3, will generally provide an appropriate means for scaling the generic reference analyses described in PWROG-14064-P to support individual licensees' mitigation strategies. However, the NRC staff recognizes the potential for the approximate method to provide inaccurate estimates in cases where significant plant-specific deviations exist with respect to the reference analysis assumptions (e.g., major discrepancies with respect to plant design, seal leakage rate, or mitigation strategy). Therefore, the NRC staff will confirm the applicability of the scaling methodology during mitigation strategy audits.
- In Equation 3-3 from PWROG-14027-P, Revision 3, the staff does not endorse the PWROG's reliance on generic input values from Table 5-2 (i.e., initial RCS mass, injected accumulator mass at the onset of reflux cooling, and RCS mass at the onset of reflux cooling). In the NRC staff's experience, significant variation can exist with respect to these parameters, even among plants having the same nominal RCS configuration. Therefore, individual licensees should substitute applicable plant-specific values into Equation 3-3 in place of the generic values recommended by the PWROG or justify that the values from Table 5-2 are appropriate for plant-specific application.
- Licensees with emergency procedures that direct or allow accumulator isolation prior to the predicted onset of reflux cooling could experience reduced coping times relative to the reference analysis case. The coping time reduction under ELAP conditions could be especially significant if an additional, extended cooldown with accumulators isolated would be undertaken prior to establishing RCS makeup at a rate sufficient to offset the

cooldown-induced contraction of the RCS volume. Therefore, affected licensees should (1) justify that credit for accumulator injection is taken only to an extent that is consistent with emergency procedures regarding accumulator isolation and venting and (2) as applicable, justify that their coping strategies will remain successful if the coping time is reduced due to an additional, extended cooldown with the accumulators isolated.

- The NRC staff has not reviewed and does not endorse the method for calculating the time to core uncover.

If you have any questions concerning this letter, please contact Sheena Whaley of my staff at (301) 415-0213, or via email to Sheena.Whaley@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to be "J. Davis", written over a horizontal line.

For
Jack R. Davis, Director
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Cc: Mr. Joseph E. Pollock, Vice President
Nuclear Operations
Nuclear Energy Institute
1201 F Street NW, Suite 1100
Washington, DC 20004

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Sincerely,

/RA by Jeremy Bowen for/

Jack R. Davis, Director
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Cc: Mr. Joseph E. Pollock, Vice President
Nuclear Operations
Nuclear Energy Institute
1201 F Street NW, Suite 1100
Washington, DC 20004

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