

December 22, 2003

Dr. Mario V. Bonaca, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: DRAFT FINAL REVISION 3 TO REGULATORY GUIDE 1.82, "WATER SOURCES FOR LONG-TERM RECIRCULATION COOLING FOLLOWING A LOSS-OF-COOLANT ACCIDENT"

Dear Dr. Bonaca:

Your letter to Chairman Diaz dated September 30, 2003, regarding the subject Regulatory Guide has been referred to me for response. In that letter you summarized the results of the review by the Advisory Committee on Reactor Safeguards (ACRS) of the draft final Regulatory Guide (RG) 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident (LOCA)." This regulatory guide is being revised to enhance guidance for the evaluation of blockage of emergency core cooling system (ECCS) sumps by LOCA-generated debris in pressurized water reactors (PWRs), and is associated with the resolution of Generic Safety Issue -191, "Assessment of Debris Accumulation on PWR Sump Performance." This RG was developed to provide high level guidance that a licensee could use in responding to the anticipated Nuclear Regulatory Commission (NRC) Generic Letter on this issue. RG 1.82 has evolved (i.e., Revisions 0, 1, 2 and now 3) as research has improved our understanding of the blockage phenomena and assessment methods. The issuance of Revision 3 represents a substantial improvement in the guidance relevant to PWR sump blockage concerns. The staff's response to your specific comments on draft final Regulatory Guide 1.82, Revision 3, are as follows.

Comment 1:

"Draft final Revision 3 to RG 1.82 should be issued in order to facilitate licensee response and the resolution of technical issues. In addition, the staff should carefully review implementing guidance being developed by the Nuclear Energy Institute (NEI) because of the issues identified, the complex phenomena involved, and the need for more accurate plant-specific assessments."

Response:

The staff appreciates the Committee's recommendation for the issuance of RG 1.82, Rev. 3. This RG was issued on November 19, 2003.

NEI issued draft implementation guidance, "PWR Containment Sump Evaluation Methodology," for review and comment by the industry and the NRC staff on October 31, 2003. In the transmittal letter of this guidance, NEI stated that revisions to this document are anticipated in order to address review comments and to include guidance currently under development.

Identified areas requiring further development include: (1) treatment of long-term chemical effects; (2) treatment of head-loss resulting from calcium silicate debris; and (3) guidance on identification and treatment of downstream effects. The staff intends to review NEI's implementing guidance thoroughly.

Comment 2:

"The knowledge base report (NUREG/CR-6808, February 2003) is a compendium of research results relevant to the problem, but it is confusing and it cannot be used directly as guidance for the analysis of sump blockage. Acceptable methods should be developed for use in satisfying the functional requirements described in RG 1.82."

Response:

The staff agrees with the Committee's comment that the knowledge base report is, indeed, a summary of available research relevant to the issue. It was not intended to provide a prescriptive approach for performing a PWR sump blockage assessment; rather, it was prepared to collect the entire knowledge base on this issue, without additional assessment. Results from previous NRC and industry research projects, as documented in numerous NUREG and industry reports collectively, can form the technical basis for the methodology that may be used to assess debris impact on PWR sump performance.

The staff anticipates that the implementation guidance being developed by NEI will provide guidance and acceptable methods for satisfying the functional requirements in Regulatory Guide 1.82.

Comment 3:

"An adequate technical basis should be developed to resolve the issue related to chemical reactions."

Response:

The staff agrees with this comment. In response to the chemical reaction concern raised by the Committee in February 2003, the staff has completed a limited-scope study to determine the effect of chemical precipitants on the head loss across a PWR sump screen. The study and its results are documented in a contractor report, LA-UR-03-6415. RES is currently discussing with the industry the conduct of integrated-effects chemical testing under realistic conditions expected in PWR containments. We expect the tests to be conducted in early 2004, in order to develop a timely technical basis to address the potential impact of chemical precipitants on ECCS recirculation performance.

Comment 4:

"The staff should consider the possibility that the uncertainties associated with the calculational methodology may be so large, or that strainers may prove to be so susceptible to debris blockage, that alternative solutions may be required to ensure long-term cooling. This might

involve, for example, changing the type of insulation used within containment or implementing diverse means of providing long-term cooling.”

Response:

The staff does not agree with the Committee’s view that the uncertainties associated with the calculational methodology are so large that alternative solutions are required to ensure long-term cooling. The staff recognizes that there are uncertainties associated with analytical modeling of this complex issue; therefore, experiments were conducted to reduce the level of uncertainties where possible. For areas where experimental results were not available, realistic conservatism was incorporated in the analyses to account for uncertainties. In addition, because almost all US PWR plants have unique features, plant-specific evaluations must be conducted to assess sump blockage for any specific plant. If a particular PWR sump screen proved to be susceptible to debris blockage, alternative solutions is one means to ensure long-term cooling. The RG encourages licensees to explore alternative solutions.

The options suggested by the Committee were also available for the resolution of the boiling water reactor (BWR) strainer blockage issue (summarized in Section 8 of NUREG/CR-6808). For example, the self-cleaning strainer option was available. Plants also have the option of changing out more problematic insulation types for less problematic types, as already has been done by some licensees.

Comment 5:

“The staff should investigate a risk-informed approach to sump screen blockage.”

Response:

The staff agrees that a risk-informed approach for analyzing the sump blockage issue should be used, as appropriate. The Committee’s comment seems to indicate that leak-before-break be considered for debris generation. As directed by the Commission, the staff is conducting a comprehensive review of the ECCS evaluation models which include the LOCA pipe break size and locations. Industry has also submitted proposals for leak-before-break and fracture mechanics for debris generation, and they are currently under evaluation by the staff. In the meantime, the staff will continue to explore opportunities to improve the methodology for assessing the sump blockage issue by utilizing data from realistic test conditions, best estimate analytical models and risk information.

Comment 6:

“The technical basis for analyzing the phenomena described in RG 1.82 is not mature, the available information is inconsistent, and the knowledge base is evolving. Therefore, it is likely that the licensees’ responses will be disparate and difficult to evaluate unless more consistent guidance is developed.”

Response:

The basic approach has been successfully implemented in resolving the similar BWR strainer issue. The objective of Regulatory Guide 1.82 is to provide guidance on acceptable methods for assessing the debris impact on PWR sump performance, not to provide detailed analytical procedures for calculating debris generation, transport, and head loss across PWR sump screens. For this purpose, we believe the technical content in Regulatory Guide 1.82 is mature and sound. Although the knowledge base report is not the technical basis for RG 1.82, the staff agrees with the Committee that the knowledge base is evolving and will continue to conduct planned research as well as following other domestic and international research programs to gain additional updated insights on this issue. The staff expects that most licensees will use the NEI implementation guidance for their plant specific evaluation, and this will result in a more uniform evaluation of the issue by licensees.

Comment 7:

“The zone of influence (ZOI) models need revision and resolution of inconsistencies.”

Response:

The staff recognizes that the conflicting ZOI information resulted from insufficient discussion of this topic in the knowledge base report and will consider revising and clarifying the knowledge base report at the conclusion of the current series of planned experiments. The ZOI model was based on the model previously endorsed by the ACRS for use in the BWR suction strainer clogging calculations. It was modified to account for PWR system characteristics and to include realistic conservatism. To use this approach properly, the size and shape of the ZOI should be supported by analysis and experiment for the assumed plant-specific break and realistic debris candidates. It is important to apply appropriate thermal hydraulic conditions to the various break scenarios.

Comment 8:

“Neither RG 1.82 nor the knowledge base report gives adequate consideration to chemical reactions.”

Response:

The staff agrees and fully recognizes that the potential chemical effects represent an emerging concern. While it is not the technical basis for Regulatory Guide 1.82, the Committee is correct in noting that the knowledge base report does not provide sufficient treatment of potential chemical reactions inside a post LOCA containment. The knowledge base report was published prior to the ACRS meeting in February 2003 when the chemical effects concern was raised. The level of understanding of chemical effects and their potential impacts on sump screen blockage has not matured sufficiently to develop detailed guidance for incorporation into Regulatory Guide 1.82. Based on the findings of the limited-scope Office of Nuclear Regulatory Research (RES) study of the chemical effects, NRC cautioned licensees in RG 1.82 that chemical effects are plausible and should be considered. Results from the limited scope study are published in contractor report LA-UR- 03-6415. RES is currently in discussion with the

industry regarding the conduct of integrated-effects chemical testing under realistic conditions expected in PWR containments.

Comment 9:

“Knowledge about the head loss to be expected on sump screens is evolving, with recognition that the combination of fibrous and particulate materials can produce unusual effects. Again, this knowledge base needs to be consolidated into a form that is less susceptible to misinterpretation by readers. For instance, page 7-6 of the knowledge based report states that the NUREG/CR-6224 correlation will need considerable modification, whereas page 7-29 appears to endorse the same correlation with the statement that its predictions were within $\pm 25\%$ of the test data. There is also a need to synthesize this information into practical methods of prediction. The forthcoming NEI guidance should help in this regard.”

Response:

Although the knowledge base report is not the technical basis for RG 1.82, the staff agrees with the Committee that the updated knowledge base should be consolidated and organized so that it is less susceptible to misinterpretation by readers. The staff will consider revising and clarifying the knowledge base report at the conclusion of the current series of planned experiments. Furthermore, the staff intends to review NEI’s implementing guidance for the purpose of providing practical methods of assessing debris generation, transport, and its impact on head loss.

In summary, we appreciate the Committee’s effort in reviewing the draft final RG 1.82, Revision 3. I trust that this letter appropriately responds to the comments in your letter to Chairman Diaz dated September 30, 2003.

Sincerely,

/RA/

William D. Travers
Executive Director
for Operations

CC: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield

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RES-2003226 EDO-20030597

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