UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

November 22, 2022

Mr. Daniel H. Dorman
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REGULATORY GUIDE 1.82, "WATER SOURCES FOR LONG-TERM RECIRCULATION COOLING FOLLOWING A LOSS-OF-COOLANT ACCIDENT (LOCA)," REVISION 5

Dear Mr. Dorman:

During the 700th meeting of the Advisory Committee on Reactor Safeguards (ACRS), November 1-4, 2022, we completed our review of Revision 5 of Regulatory Guide (RG) 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-Of-Coolant Accident (LOCA)." Our Accident Analyses: Thermal Hydraulics subcommittee reviewed this matter on October 20, 2022. During these reviews, we also had the benefit of discussions with representatives of the staff and the referenced documents.

Our committee has issued four letters on the containment accident pressure (CAP) topic (March 18, 2009, May 19, 2010, February 17, 2011, and April 21, 2014). In addition, this topic has been considered in our reviews of one design certification application and several submittals for extended power uprate (EPU), maximum extended load line limit analysis plus (MELLLA+), and Generic Safety Issue (GSI)-191 for operating plants.

CONCLUSIONS AND RECOMMENDATION

1. Revision 5 of RG 1.82 provides adequate guidance to evaluate water sources for long-term recirculation cooling following design-basis accidents (DBAs), including methodologies to provide conservative estimates of the CAP credit, if necessary.

2. We continue to stand by our recommendations in prior CAP letters (see Appendix), especially our recommendation that licensees should provide plant-specific analyses of the increase in risk resulting from proposed modifications that require the use of CAP credit.

3. Eliminating the need for CAP credit, either through plant modifications or by design in new reactors, should be encouraged.

BACKGROUND

Regulatory Guide 1.82 defines an acceptable approach to meet the regulatory requirements for sumps and suppression pools that provide water sources for emergency core cooling, containment heat removal, or containment atmosphere cleanup systems. Revision 5 primarily updates the guide in two areas: it clarifies and amplifies information on certain characteristics of debris and its effects on long-term core cooling (commonly referred to as GSI-191); and it provides new guidance in a new Appendix B on calculating the net positive suction head (NPSH) margin with uncertainty for the pumps in the emergency core cooling system and the containment heat removal system.

NPSH margin is a measure of the pump's ability to avoid excessive cavitation so that it can perform its safety functions. In calculating NPSH margin during DBAs, the inclusion of some or all of the pressure developed in the containment during an accident is referred to as CAP credit. The amount and duration of CAP credited depend on pump and system characteristics, which vary from plant to plant. The new Appendix B defines methodologies acceptable to the staff for CAP calculations, including uncertainties.

DISCUSSION

Our concerns with crediting CAP during DBAs remain unchanged from our prior letters. This credit jeopardizes an important measure for ensuring the fundamental principle of defense in depth, the independence of two barriers (i.e., containment and fuel cladding) to prevent the release of radioactive materials.

While the guide imposes a new requirement to regularly monitor containment integrity when CAP credit is allowed, we caution against possible loss of containment isolation due to postulated operator errors or other internal or external events. Thus, minimizing the duration of CAP credit and evaluating the potential to reduce the risk should be considered. The staff should also ensure that any revision to severe accident guidance to address lessons learned from the events at Fukushima does not lead to early containment venting that adversely impacts NPSH.

Staff and their consultants have provided evidence indicating that pumps do not fail immediately after loss of NPSH and can continue to operate for extended periods of time with degraded performance. This may reduce the consequences in the event containment fails to hold sufficient pressure for some sequences.

Recent experience has shown that several operating reactors have found practicable and relatively simple plant modifications to avoid the need for CAP credit. This experience should be factored into the review of future CAP credit submittals, where plant modifications should be the preferred option.

Emergency core cooling system pump configurations, their NPSH needs, and containment designs vary greatly from plant to plant; thus, the risk associated with crediting CAP may be quite different for specific plants. In a regulatory environment where licensees routinely use risk arguments to demonstrate safety cases, it does not appear an undue burden to request that licensees provide analyses of the increase in risk resulting from proposed modifications that would require the use of CAP credit. These risk analyses need not necessarily involve full-scope probabilistic risk assessments; a simple bounding calculation may be sufficient to demonstrate that the risk increase is negligible.

SUMMARY

We continue to stand by our recommendations in prior CAP letters, especially our recommendation that licensees should provide plant-specific analyses of the increase in risk resulting from proposed modifications that require the use of CAP credit. Eliminating the need for CAP credit, either through plant modifications or by design in new reactors, should be encouraged.

Sincerely,

Signed by Rempe, Joy on 11/22/22

Joy L. Rempe
Chairman ACRS

Appendix:
Enclosed

REFERENCES

1. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.82, “Water Sources for Long-Term Recirculation Cooling Following a Loss-Of-Coolant Accident,” Revision 5, August 2022 (ML22152A114).

2. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.1, “Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps,” November 1970 (ML052440069).

3. U.S. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards Letter Report, “Crediting Containment Overpressure in Meeting the Net Positive Suction Head Required to Demonstrate That the Safety Systems Can Mitigate the Accidents as Designed,” March 18, 2009 (ML091120032).

4. U.S. Nuclear Regulatory Commission Letter, “March 18, 2009, Advisory Committee on Reactor Safeguards Letter on Using Containment Accident Pressure,” June 4, 2009 (ML091120032).

5. U.S. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards Letter Report, “Draft Guidance on Crediting Containment Accident Pressure in Meeting the Net Positive Suction Head Required to Demonstrate that Safety Systems Can Mitigate Accidents as Designed,” May 19, 2010 (ML101300332).

6. U.S. Nuclear Regulatory Commission Letter, “Draft Guidance on Crediting Containment Accident Pressure in Meeting the Net Positive Suction Head Required to Demonstrate that Safety Systems Can Mitigate Accidents as Designed,” June 10, 2010 (ML101470141).

7. U.S. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards Letter Report, SECY-11-0014, “Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents,” February 17, 2011 (ML110450555).

8. U.S. Nuclear Regulatory Commission Letter, SECY-11-0014, “Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents,” June 10, 2010 (ML110750406).

9. U.S. Nuclear Regulatory Commission, SECY-11-0014,“Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents,” January 31, 2011 (ML1025901961, Enclosure 1 - ML102110167, Enclosure 2 - ML102780592).

10. U.S. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards Letter Report, “Credit for Containment Accident Pressure to Ensure Operation of US-APWR Emergency Core Cooling System Pumps,” April 21, 2014 (ML14107A290).

11. U.S. Nuclear Regulatory Commission, “Credit for Containment Accident Pressure to Ensure Operation of US-APWR Emergency Core Cooling System Pumps,” June 25, 2014 (ML14126A399).

12. U.S. Nuclear Regulatory Commission, “GSI-191 Technical Assessment,” NUREG/CR-6762, Vols. 1-4, August 2002 (ML022470077 (package), ML022470093, ML022480182, and ML022480262).

13. Boiling Water Reactor Owners’ Group, “Containment Overpressure Credit for Net Positive Suction Head (NPSH),” NEDC-33347P-A, Rev. 2 (proprietary version), and NEDO-33347-A, Rev. 2 (non-proprietary version), March 2017 (ML17192A204 (package)).

APPENDIX

Our committee has issued four letters on the CAP topic (March 18, 2009, May 19, 2010, February 17, 2011, and April 21, 2014). In addition, this topic has been considered in our reviews of one design certification application and of several submittals for EPU, MELLLA+, and GSI-191 for operating plants.

Prior ACRS Recommendations and their Status

A summary of our main prior recommendations and their current status follows:

1. CAP credit is only acceptable if no practicable plant modifications can be implemented. Section 1.3 of the guide has incorporated this requirement, which should be emphasized during regulatory reviews.

2. CAP credit calculations must include a conservative treatment of uncertainties. Appendix B of the guide now describes methodologies acceptable to the staff to calculate the required CAP credit incorporating analysis and data uncertainty, as appropriate.

3. Deterministic NPSH analyses should be complemented by plant-specific probabilistic risk analyses of the impact of CAP credit to properly inform the risk. Following Commission instructions, the guide does not require plant-specific risk analyses. We stand by our recommendation.

4. CAP credit should not be accepted for new reactors without a thorough assessment of feasible design alternatives and a full understanding of the plant-specific risk. This guide addresses operating BWRs and PWRs, but it would be applicable to new reactors if licensed under Title 10 of the *Code of Federal Regulations* Parts 50 or 52. We stand by our recommendation that new reactor concepts have the flexibility to avoid the need for CAP credit in the design process and should do so.

Past ACRS Involvement

Our involvement in the CAP issue dates back to 1970, when the staff issued RG 1.1 based on our recommendation that the containment pressure used to determine NPSH margin should be limited to the pressure in containment before the accident. The RG 1.1 no-CAP credit requirement was carried over to RG 1.82, Revision 0, in 1974, although the guide recognized that “for some operating reactors, some credit for containment accident pressure may be necessary.” The new Revision 5 of RG 1.82 removes the no-CAP credit requirement and specifies methodologies to calculate NPSH margin and its uncertainty.

Our March 18, 2009, and May 19, 2010, letter reports addressed the topic of CAP credit. Our main conclusions were that CAP credit: should be limited in amount and duration; licensees should demonstrate that it is not practical to reduce or eliminate the need for CAP credit by hardware changes; the analyses should include results from detailed thermal hydraulic analyses, including uncertainties; and plant-specific probabilistic risk assessment results should be used to inform the regulatory decision.

As a follow up to our letters, SECY-11-0014 documented areas of agreement and disagreement between staff and ACRS on this topic. In our February 17, 2011, letter report on

SECY-11-0014, we continued to stand by our earlier recommendations regarding CAP credit. The main area of disagreement was the staff position that “there is no regulatory basis to request that licensees provide plant-specific risk information to help assess the challenge to defense in depth and support crediting CAP.”

The Commission evaluated both the staff position and ACRS recommendations. The staff requirements memorandum (SRM) dated March 15, 2011, directed the staff to update RG 1.82 to provide guidance for reviewing non-risk-informed applications (e.g., for EPU applications) and to include deterministic guidance based on recommendations of ACRS to include uncertainty and margins in CAP calculations. The SRM did not include a requirement to perform plant-specific risk assessments.

On April 21, 2014, we issued a fourth letter report during our review of the U.S. Advanced Pressurized Water Reactor (US-APWR) design. We stated our position that CAP credit should not be allowed for new reactors where modifications may be introduced, during the design process, to eliminate the need for CAP credit. The staff response noted that their approach “preserves the use of successive compensatory measures to prevent accidents or mitigate damage consistent with the principle of defense-in-depth.” Therefore, plant-specific CAP-credit risk analyses are not required.

In 2017, the Boiling Water Reactor Owners’ Group issued a report (NEDC-33347P-A/NEDO-33347-A, Revision 2) that proposed an alternate method of calculating the NPSH margin, in which the CAP uncertainty is determined by a Monte Carlo calculation. This method was reviewed and approved by the staff (without our involvement). This method is now incorporated in this guide as an option.

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