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Template=ADM-013
E-RIDS=ADM-03

ADD: Bridget Curran, Ahsan Sallman, Jim Steckel, Mary Neely
Comment (4)
Publication Date: 2/8/2022
Citation: 87 FR 7209

As of: 4/12/22 12:19 PM
Received: April 08, 2022
Status: Pending_Post
Tracking No. l1q-i6f7-w9hu
Comments Due: April 08, 2022
Submission Type: Web

Docket: NRC-2022-0036
Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident

Comment On: NRC-2022-0036-0001
Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident; Public Comment Period Extended

Document: NRC-2022-0036-DRAFT-0006
Comment on FR Doc # 2022-02562

Submitter Information

Email: atb@nei.org
Organization: Nuclear Energy Association

General Comment

See attached file(s)

Attachments

04-08-22_NRC_ Comment Submission on DG-1385

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04-08-22_NRC_ Comment Submission on DG-1385

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NUCLEAR ENERGY INSTITUTE

April 8, 2022

Office of Administration
Mail Stop: TWFN-7-A60M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attn: Program Management, Announcements and Editing Staff

Subject: Submission of Comments on Draft Regulatory Guide, DG-1385, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Docket ID NRC-2022-0036

Project Number: 689

Dear Program Management, Announcements and Editing Staff:

The Nuclear Energy Institute (NEI)[1], on behalf of its members, appreciates the opportunity to review and provide comments on Draft Regulatory Guide, DG-1385, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident."

The purpose of this letter is to provide the attached comments, most of which recommend minor updates to Appendix B of the draft regulatory guide. These minor comments include the use of 'CS' as an abbreviation for Containment Spray rather than Core Spray, validating that the non-propriety version of the BWROG topical report is referenced, ensuring that impeller blade erosion due to cavitation is properly referenced in the Appendix only, and to include the function of "Reduction of Fission Products" within the Containment Spray System.

There are some more specific comments that indicate the need for a discussion within the draft regulatory guide on alternate calculations that would be acceptable to the staff and how the updates to this document could impact those plants requesting life extension.

Please note that Attachment 2 provides additional details regarding Attachment 1, comments six and seven. These two comments are focused on the need to incorporate an uncertainty factor on

[1] The Nuclear Energy Institute (NEI) is responsible for establishing unified policy on behalf of its members relating to matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect and engineering firms, fuel cycle facilities, nuclear materials licensees, and other organizations involved in the nuclear energy industry.

required NPSH based on evaluations discussed in PWROG-15050-P and the fact that bounding tests have already been performed on the pumps to show that operation in the mode with NPSHa less than NPSHreff (DBA) is acceptable.

We appreciate the NRC's effort in developing this draft guidance and encourage your consideration of all stakeholder comments prior to finalizing this draft Regulatory Guide.

We trust that you will find these comments useful and informative as you finalize the draft, and we look forward to future engagement on this important matter. Please contact me at ras@nei.org or (612) 518-2850 with any questions or comments about the content of this letter or the attached comments.

Sincerely,

R. Stadtlander

Rick Stadtlander

Attachments

c: Mr. James Steckel, Office of Nuclear Regulatory Research

Attachment 1
Comments on Draft Regulatory Guide DG-1385, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"

	Section	Comment/Basis	Recommendation
1.	B-2 Subtitle Boiling-Water Reactor Pumps	The abbreviation, CS, is used for Core Spray in the first paragraph, but it is used for containment spray in the bullet items below. It is not obvious why a distinction is made between containment spray pumps and RHR pumps with respect to the NPSH, and why the RHR and containment spray are singled out rather than including all ECCS pumps here. Containment spray is a function of the RHR pumps. The title of Section B-4 correctly identifies the pumps in the scope of this guide as "ECCS and Containment Heat Removal Pumps"	Replace "residual heat removal (RHR) system and core spray (CS) pumps" by Emergency Core Cooling System (ECCS) and containment heat removal pumps at a minimum. However, this section is confusing in its entirety and the purpose of it is not clear. It is recommended that this subsection be rewritten.
2.	B-3 Uncertainty Analysis	Only the proprietary version of the BWROG topical report, NEDC-33476P-A is referenced. Public does not have access to this version of the report.	Replace "NEDC-33347P-A" by "NEDC-33347P-A/NEDO-33347-A, Revision 2"
3.	B-5	This section provides some information on impeller blade erosion due to cavitation. If this is a concern, it may look like it applies whether or not CAP is credited. However, if the reasoning of including this only in Appendix B is that there is already margin if CAP is not credited due to the higher pressure than credited in the NPSH calculation, this should be clarified.	Clarify the regulatory position regarding Section B-5 or remove this section from Appendix B.
4.	General	The report should include discussions on alternate calculations that would be acceptable to the staff. In particular, a section should be added that overviews the risk-informed methods that were used to resolve the suction strainer issues.	New Section added to Appendix B – "Acceptable Alternate Risk Informed Methodologies"
5.	Appendix B Page B-3 Pressurized-Water Reactor Pumps	Appendix B (page B-3) of the draft guidance states that the function of the Containment Spray (CS) System is to cool the containment. Some PWRs also use the CS system to reduce fission products from the containment atmosphere.	Reference the additional function of the CS system to reduce fission products from the containment atmosphere for some PWRs
6.	B-4	The NRC draft guidance for the use of Containment Accident Pressure (CAP) to determine the Net Positive Suction Head available (NPSHa) of safety-related pumps, is provided in Appendix B of the Draft Regulatory Guide DG-1385. The guidance indicates for Design Basis	Based on the evaluations discussed in PWROG-15050-P, the incorporation of an uncertainty factor on required NPSH of 21% is not required.

	Section	Comment/Basis	Recommendation
		Analyses (DBAs) that credit CAP should use a value of effective NSPH required (NPSHreff) that includes the uncertainty in the value of the required NPSH based on a 3% drop in pump head (NPSHr3%) based on vendor testing and installed operation. The effects of motor slip, suction piping configuration, and air content should be included.	See Attachment 2 for further detail.
7.	Appendix B Page B-18 Pressurized-Water Reactor Plants	The NRC draft guidance specifies that if the NPSHa is less than NPSHreff (DBA), operation in this mode is acceptable if appropriate tests are performed to demonstrate that the pump will continue to perform its safety function(s). The tests are to be performed on the actual pump, with the same mechanical shaft seal (including flush system), or at least on a pump of the same model, size, impeller diameter, materials of construction, and pump seal/flush system.	A sufficient set of bounding tests have been performed, and additional testing is not required. See Attachment 2 for further detail.

Attachment 2
Additional Basis information for comments 6 and 7on Draft Regulatory Guide DG-1385, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"

Comment 6

The NRC draft guidance for the use of Containment Accident Pressure (CAP) to determine the Net Positive Suction Head available (NPSHa) of safety-related pumps, is provided in Appendix B of the Draft Regulatory Guide DG-1385. The guidance specifies for Design Basis Analyses (DBAs) that credit CAP should use a value of effective NSPH (NPSHreff) that includes the uncertainty in the value of the NPSH based on a 3% drop in pump head (NPSHr3%) based on vendor testing and installed operation. The effects of motor slip, suction piping configuration, and air content should be included.

An earlier version of the NRC draft guidance was provided to the PWROG in 2010 (Reference 1). The earlier version of the draft guidance defined the uncertainty in NPSH as 21%. Based on Reference 1, the PWROG completed a project which resulted in topical report PWROG-15050-P (Reference 2), "Use of Containment Accident Pressure to Demonstrate Acceptable PWR Pump NPSH." PWROG letter OG-15-191 (Reference 3) transmitted PWROG-15050-P to the NRC for information only. The current draft guidance does not specify an uncertainty value; instead, it specifies that the uncertainty in NPSH will be identified. During preparation of this response, it was assumed that the uncertainty may be as high as the 21% identified in Reference 1.

PWROG-15050-P summarizes an investigation into containment analyses to determine the minimum available NPSH for a representative W NSSS ice condenser containment, W NSSS sub-atmospheric containment, CE NSSS large-dry containment and W NSSS large-dry containment. An analysis of a B&W NSSS large-dry containment was also assessed; however, it was felt that these results were redundant because they were sufficiently similar to the CE NSSS large-dry containment example, with respect to the elements that are relevant to this work. PWROG-15050-P documents three investigations which are summarized as follows:

1. PWROG-15050-P Section 4.1 summarizes conservative deterministic containment analyses to determine the minimum available NPSH from the containment sump to the ECCS pumps. These results indicate that in all cases, the PWR designs have positive margin, and in most cases, this margin can offset the proposed 21% uncertainty in NPSHr.
2. PWROG-15050-P Section 4.2 summarizes an assessment of the impact of relaxing two very conservative assumptions in the containment analyses to determine NPSH margin.
    a. The conservative containment analysis assumed the saturated liquid portion of the mass and energy (M&E) exiting the break was discharged directly into the containment sump liquid inventory. A more realistic assumption was used in the evaluation contained in PWROG-15050-P, which modeled this portion of the M&E as discharging to the containment atmosphere. PWROG-15050-P demonstrates that reducing this assumption increases the minimum difference between the containment accident pressure and the

saturation pressure at the sump liquid temperature from 2.3 psi to 4.6 psi. This represents an increase in margin of 2.3 psi, which doubles the previous margin.

b. The conservative analyses assumed that all heat exchangers used to cool the sump inventory had zero fouling. A more realistic assumption was used in the evaluation contained in PWROG-15050-P, which models design fouling factors for these heat exchangers. PWROG-15050-P demonstrates that reducing this assumption increases the minimum difference between the containment accident pressure and the saturation pressure at sump liquid temperature from 2.3 psi to 3.4 psi. This represents an increase in margin of 1.1 psi.

Given that the 21% uncertainty in NPSH margin for a PWR ECCS pump is approximately 2 psi, the impact of relaxing the M&E conservative assumptions more than offsets the proposed NPSH uncertainty of 21%.

3. PWROG-15050-P Section 4.3 assessed the maximum potential time for which the PWR ECCS pumps could operate with an NPSHa deficit. PWROG-15050-P concludes that the times varied within the range from 0.1 to 1.1 hours. These times are much lower than the time required for cavitation damage of the pump to occur.

PWROG-15050-P Section 4.4 summarizes a pump evaluation performed by Flowserve, which investigated the impact of a postulated 21% NPSH deficit on the three models of ECCS pumps for the representative plants (RHR 8 x 20 WDF; LPSI 18-CKXH; and HPSI 3-HMTA7). The following sections summarize the key results documented in PWROG-15050-P.

1. Pump Operation with NPSHa<NPSHr with a Fixed System Resistance

   PWROG-15050-P Section 4.4.1 discusses that the nuclear safety pumps considered in the evaluation all operate in fixed systems (constant hydraulic resistance) at a flow rate greater than or equal to the best efficiency point (BEP) flow rate of the pump. This mode of operation is fundamentally different from the way an NPSH-suppression test is performed. In the NPSH test the system is not fixed; rather, a valve is opened enough to maintain the flow rate, as the NPSHa is decreased toward NPSHr. As the 97% head or break point is approached, cavitation instabilities in the form of pressure pulsations can occur, and these can be quite severe at flow rates substantially below the BEP flow rate, often resulting in an adverse mechanical response, such as extreme fluctuating axial and radial loads and/or excessive vibration – any or all of which can lead to stress-related failures, mechanical seal failures, etc., of the pump. These issues do not exist in the applications that were considered in PWROG-15050-P. If the pump supplying a fixed system loses suction pressure such that the NPSHa drops below the NPSHr with a flow greater than BEP, the pump can no longer deliver that high flow rate. Rather, it will deliver a lower flow rate through the same system, and in doing so, produces less head to move the smaller amount of fluid through the same system. For such a pump, then, both the flow rate and the head it produces are less.

   PWROG-15050-P Section 4.4.1 also includes the results of testing conducted with the Ingersoll Rand 3-HMTA7 used in the CE NSSS and a 16,000 HP (12 MW) Ingersoll Rand 95-CHTA feed pump at values of NPSHa significantly less than 79% of NPSHr (corresponding to a 21% NPSH deficit). These tests confirmed that these pumps operated smoothly in a fixed system when the NPSHa was reduced to significantly less than 79% of NPSHr; the 12 MW pump was tested at NPSHa values as low as 59% of NPSHr. This is very significant, because, if a 12 MW multistage pump can operate smoothly at a significantly greater NPSHa reduction as a percent of NPSHr than is specified for the evaluation of nuclear safety pumps, all of which operate at less than half a megawatt, then it can be concluded that an adverse mechanical response of any kind will be insignificant for the nuclear safety pumps.

2. Minimum Calculated Life in Resistance to Cavitation Erosion

   PWROG-15050-P Section 4.4.3 summarizes an assessment of the impact on the estimated pump life due to impeller erosion. As discussed above, PWROG-15050-P Section 4.3 concluded that the pump operating time with an NPSHa deficit varied between 0.1 hour and 1.1 hour. The cavitation life varies from a minimum of 2,600 hours (0.2 hours cavitation deficit) to 4,900 hours (1.1 hour cavitation deficit). The ratio of the estimated life to the maximum possible time (operating at an NPSH deficit of at least 21%) is greater than 4,000 in all cases. Therefore, the impact of cavitation is negligible.

3. Mechanical Performance

   PWROG-15050-P Section 4.4.4 summarizes the expected mechanical performance of the pumps under the postulated reduced NPSH conditions. It was concluded that minimum flow-related instabilities are not experienced to occur unless the impeller is full of liquid (that is, NPSHa > NPSHr) at a low flow rate relative to the BEP flow. All of the pumps evaluated in PWROG-15050-P operate in a fixed system through which the DBA pump flow rates are greater than the BEP flow rates when there is adequate NPSHa and the impellers are full of liquid. In such systems, the application of the NPSHa lower than the NPSHr needed for these high flow system flow rates relative to pump flow capability results in partially filled impellers with a vapor core and a surrounding liquid ring that is incapable of sending backflow into the entry region of the impeller; therefore, the pump runs smoothly. PWROG-15050-P discusses that the high-energy 95-CHTA test pump ran smoothly when the NPSHa was less than NPSHr and this further supports the conclusion that the low-energy nuclear safety pumps are expected to run smoothly, without any adverse mechanical response and with minimal cavitation damage.

Based on the evaluations discussed in PWROG-15050-P, the incorporation of an uncertainty factor on NPSH is not specified for the following reasons:

a. PWROG-15050-P Section 4.2 demonstrates that the containment analyses used to define the available NPSH utilize conservative assumptions which more than offset an NPSH uncertainty of 21%. Therefore, the conservatism in the containment analyses obviates the need to explicitly consider an uncertainty in NPSH.

b. Ignoring the conservatism in the containment analyses, if a 21% penalty on the available NPSH for ECCS pumps is applied, PWROG-15050-P Section 4.3 demonstrates that the maximum time the ECCS pumps would operate at an NPSH deficit is 1.1 hours. PWROG-15050-P Section 4.4.3 demonstrates that the pump erosion lifetime corresponding to this scenario is 4,900 hours. Therefore, the substantial erosion margin eliminates the need to consider an uncertainty in NPSH.

c. PWROG-15050-P Section 4.4.1 demonstrates the PWR ECCS pumps operate in a fixed resistance manner when taking suction from the containment sump. Therefore, a deficit in the NPSH does not result in a mechanical problem, and only results in a reduction in pump flow rate and developed head proportional to the NPSH deficit. PWROG-15050-P Section 4.4.1 documents the results of testing conducted with a 16,000 HP (12 MW) Ingersoll Rand 95-CHTA feed pump at NPSHa values significantly less than 79% of the NPSHr (corresponding to a 21% NPSH deficit). These tests confirmed that these pumps operated smoothly in a fixed system, when the NPSHa was lowered much below 79% the NPSHr; the 12 MW pump was tested at NPSHa values as low as 59% of NPSHr. This is very significant, because, if a 12 MW multistage pump can operate smoothly at a significantly greater NPSHa reduction as a percentage of the NPSHr than is specified, for the nuclear safety pumps evaluated in PWROG-15050-P, all of which operate at less than half a megawatt, it can be concluded that an adverse mechanical response of any kind will be insignificant for the nuclear safety pumps.

d. PWROG-15050-P Section 4.4.4 concluded that the PWR ECCS pump impeller is protected by a vapor core that precludes mechanical instabilities, because the pump operates at a flow rate greater than the BEP flow rate when suction is taken from the pump.

Comment 7

The NRC draft guidance states that if the NPSHa is less than NPSHreff (DBA), operation in this mode is acceptable if appropriate tests are performed to demonstrate that the pump will continue to perform its safety function(s). The tests are to be performed on the actual pump, with the same mechanical shaft seal (including flush system), or at least on a pump of the same model, size, impeller diameter, materials of construction, and pump seal/flush system.

The performance of these tests would be extremely costly, and this testing is not needed based on the following:

a. PWROG-15050-P Section 4.4.1 demonstrates that the PWR ECCS pumps operate in a fixed resistance manner when taking suction from the containment sump. As a result, the flow is not held constant as the available NPSH decreases, causing the pump to operate at an available NPSH much less than the specified NPSH at that flow rate. Rather, a deficit in available NPSH relative to the specified NPSH only results in a reduction in pump flow rate and developed head that is proportional to the NPSH deficit. PWROG-15050-P Section 4.4 documents that many non-nuclear pump applications require the pump to continually operate in this mode where the system flow rate is controlled by the available NPSH.

b. PWROG-15050-P Section 4.4.1 also documents the results of testing performed on a 16,000 HP (12 MW) Ingersoll Rand 95-CHTA feed pump at values of NPSHa significantly less than 79% of NPSHr (corresponding to a 21% NPSH deficit). These tests confirmed that these pumps operated smoothly in a fixed system when the NPSHa was lowered significantly less than 79% of NPSHr; the 12 MW pump was tested at NPSHa values as low as 59% of NPSHr.

This is significant, because, if a 12 MW multistage pump can operate smoothly at a significantly greater NPSHa reduction as a percent of NPSHr than is specified in the evaluation of nuclear safety pumps, all of which operate at less than half a megawatt, then an adverse mechanical response of any kind will be insignificant on the nuclear safety pump.

c. PWROG-15050-P Section 4.3 demonstrates that the maximum time that the ECCS pumps would operate at an NPSH deficit is 1.1 hours. PWROG-15050-P Section 4.4.3 demonstrates that the pump erosion lifetime corresponding to this situation is 4,900 hours. Therefore, the substantial erosion margin eliminates the need to consider a 21% uncertainty in the specified NPSH.

Based on these above, a sufficient set of bounding tests have been performed, and additional testing is not needed.

References

1. "NRC Draft Guidance for the Use of Containment Accident Pressure in Determining the NPSH [Net Positive Suction Head] Margin of ECCS and Containment Heat Removal Pumps," Agencywide Document Access and Management System under Accession Number ML100550869.
2. PWROG-15050-P, Rev. 0, "Use of Containment Accident Pressure to Demonstrate Acceptable PWR Pump NPSH," May 2015.
3. Letter OG-15-191, "Transmittal of PWROG-15050-P: "Containment Accident Pressure for PWR Pump NPSH," For Information Only (PA-SEE-0929-R1)," May 2015.