OFFICE OF THE SECRETARY

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

March 31, 1995

Action: Russell, NRR/
Beckjord, RES
Cys: Taylor
Milhoan
Thompson
Blaha
MTaylor
Meyer, ADM
Shelton, IRM

MEMORANDUM TO: James M. Taylor
Executive Director for Operations

FROM: John C. Hoyle, Secretary

SUBJECT: SECY-94-225 - ISSUANCE OF PROPOSED RULEMAKING PACKAGE ON GI-23, "REACTOR COOLANT PUMP SEAL FAILURE"

The Commission (with all Commissioners agreeing) has disapproved issuance of the proposed rule for public comment. The Commission believes that there is insufficient basis for gains in safety and there may be some concerns with seal evaluation models. There is also a wide range of plant-specific considerations for PWRs, some of which would result in expending excessive resources without a commensurate benefit. In some cases, licensees appear to be planning to address the pump seal failure and other plant improvements identified under their IPE program including use of accident management strategies. The staff should communicate the foregoing decision to reactor licensees. (NRR/RES) 9200243

cc: The Chairman
Commissioner Rogers
Commissioner de Planque
OGC
OCA
OIG
Office Directors, Regions, ACRS, ACNW, ASLBP (via E-Mail)

SECY NOTE: THIS SRM, SECY-94-225, AND THE VOTE SHEETS OF ALL COMMISSIONERS WILL BE MADE PUBLICLY AVAILABLE 5 WORKING DAYS FROM THE DATE OF THIS SRM.

9933704B2

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

September 22, 1995

NRC INFORMATION NOTICE 95-42: COMMISSION DECISION ON THE RESOLUTION OF GENERIC ISSUE 23, "REACTOR COOLANT PUMP SEAL FAILURE"

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to notify addressees of the Commission's decision on Generic Issue (GI) 23, "Reactor Coolant Pump Seal Failure." This decision was documented in a staff requirements memorandum (SRM) from John C. Hoyle to James M. Taylor, dated March 31, 1995 (Accession Number 9504140300), written in response to SECY-94-225, "Issuance of Proposed Rulemaking Package on GI-23, 'Reactor Coolant Pump Seal Failure'." No specific action or written response is required as a result of this information notice.

Background

On April 19, 1991, the NRC published a *Federal Register* notice (56 FR 16130) requesting comments on the then-current understandings, findings, and potential recommendations regarding GI-23, together with a draft Regulatory Guide, DG-1008, "Reactor Coolant Pump Seals." On May 2, 1991, NRC issued Generic Letter (GL) 91-07, "GI-23, 'Reactor Coolant Pump Seal Failures' and Its Possible Effect on Station Blackout," which stated that preliminary results of NRC studies suggested that reactor coolant pump (RCP) seal leak rates could be substantially higher than those assumed in the coping analyses for implementation of the station blackout (SBO) issue. The generic letter reminded licensees that higher seal leak rates could affect licensee analyses and actions addressing conformance to the SBO rule.

Staff studies and analyses concerning RCP seal leakage are documented in Appendices A and B to NUREG/CR-5167, "Cost/Benefit Analysis for Generic Issue 23: Reactor Coolant Pump Seal Failure," April 1991, which contains the NRC model for RCP seal failure. The report identifies several modes of RCP seal leakage which may be in excess of that assumed in licensee coping analyses for implementing the requirements of 10 CFR 50.63, the SBO rule. GI-23 is related to a number of other generic issues: GI-65, "Component Cooling Water System Failure"; GI-130, "Essential Service Water (ESW) System Failure at Multiplant Sites"; GI-153, "Loss of Essential Service Water in LWRs"; GI-106, "Piping and the Use of Highly Combustible Gases in Vital Areas"; and Three Mile Island (TMI) Actions II.K.2.16 and II.K.3.25. In addition, the Individual Plant Evaluation (IPE) Program, as described in

GL 88-20, requests evaluation of plant vulnerabilities with respect to certain generic issues, including GI-23.

Discussion

The Commission considered the proposed rulemaking as a method to resolve GI-23. In SECY-94-225, dated August 26, 1994, a draft rule was proposed for public comment that would resolve GI-23.

On March 31, 1995, the Commission voted against the publication of the proposed rule on the resolution of GI-23, "Reactor Coolant Pump Seal Failure." The Commission concluded that the proposed rule did not provide sufficient gain in safety to justify its issuance. The Commission was also concerned that inaccuracies in the NRC seal leakage evaluation model may exist. Further, the wide range of plant-specific considerations with regard to pressurized-water reactor (PWR) RCP seals would result in the spending of excessive resources by some licensees without commensurate safety benefits; also some licensees are addressing the issue by using the IPE program and accident management strategies. Therefore, the NRC will not proceed with the rulemaking effort described in SECY-94-225. The staff is currently exploring options to determine what, if any, further action will be taken regarding the final disposition of GI-23.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Dennis M. Crutchfield, Director
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

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(301) 415-1361

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
95-41	Degradation of Ventilation System Charcoal Resulting from Chemical Cleaning of Steam Generators	09/22/95	All holders of OLs or CPs for nuclear power reactors.
95-40	Supplemental Information to Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes"	09/20/95	All holders of OLs or CPs for nuclear power reactors.
95-39	Brachytherapy Incidents Involving Treatment Planning Errors	09/19/95	All U.S. Nuclear Regulatory Commission Medical Licensees.
95-38	Degradation of Boraflex Neutron Absorber in Spent Fuel Storage Racks	09/08/95	All holders of OLs or CPs for nuclear power reactors.
95-37	Inadequate Offsite Power System Voltages during Design-Basis Events	09/07/95	All holders of OLs or CPs for nuclear power reactors.
95-36	Potential Problems with Post-Fire Emergency Lighting	08/29/95	All holders of OLs or CPs for nuclear power reactors.
95-35	Degraded Ability of Steam Generators to Remove Decay Heat by Natural Circulation	08/28/95	All holders of OLs or CPs for pressurized water reactors (PWRs).
95-34	Air Actuator and Supply Air Regulator Problems in Copes-Vulcan Pressurizer Power-Operated Relief Valves	08/25/95	All holders of OLs or CPs for nuclear power reactors.
93-83, Supp. 1	Potential Loss of Spent Fuel Pool Cooling After a Loss-of-Coolant Accident or a Loss of Offsite Power	08/24/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

GL 88-20, requests evaluation of plant vulnerabilities with respect to certain generic issues, including GI-23.

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orig /s/'d by DMCrutchfield
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*See previous concurrence page DOCUMENT NAME: 95-42.IN

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DATE	9/05/95	8/25/95	9/06/95	09/08/95	09/19/95

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DATE	09/19/95	09/15/95	09/19/95	09/19/95	09/21/95

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Attachment 6

CONTRIBUTION TO THE CORE DAMAGE FREQUENCY FROM RCP SEAL LOCAs INDUCED BY LOSS OF CCW/ESW

1. INTRODUCTION

The purpose of the study was to determine, for selected plants, estimates of the core damage frequency (CDF) from reactor coolant pump (RCP) seal LOCAs induced by loss of essential service water (ESW) or loss of component cooling water (CCW), using the Rhodes model for RCP seal failures. The plants were chosen somewhat arbitrarily, but an effort was made to include plants from each of the three PWR vendors. In addition, a list of some other plants was developed where we believe the core damage frequency from loss of CCW/ESW induced RCP seal LOCAs is low, because of design features of the plant. The results give some indication of plant to plant differences in the core damage frequency from RCP seal LOCAs resulting from the loss of CCW or the loss of ESW initiators. It should be pointed out that in some cases the loss of CCW or loss of ESW could lead to loss of containment heat removal, leading to long term containment failure. This was not investigated as yet, but will be investigated in future work. Moreover, there was no consideration of "external" events, such as internal fires or seismic events, but this will also be investigated in the future.

The estimates obtained here are obtained with a specific model of RCP seal behavior on loss of seal cooling. This model is subject to revision, given more information, especially for plants with non-Westinghouse RCPs, where a conservative bounding model based on Westinghouse pumps was used.

The concern with regard to RCP LOCA on loss of CCW or loss of ESW comes from the fact that the loss of CCW or loss of ESW can, depending on the design of the plant, both fail RCP seal cooling, resulting in an RCP LOCA, and also fail the ability to mitigate the LOCA, if the high pressure injection (HPI) pumps are dependent on CCW or ESW for cooling.

2. METHODOLOGY AND ASSUMPTIONS

Modeling of the RCP pump LOCA on loss of RCP seal cooling

For all pump vendors, it was assumed that there was a 20% chance of the RCP seal "popping open", at about 10 minutes after loss of RCP seal cooling, with a leak rate of about 180 gpm per RCP. The 20% chance of pop open is an epistemic uncertainty, and, if one RCP seal leaks, all RCPs leak. The popping open of the seal refers to the increase in the opening between seal faces caused by a change in the balance of forces on the seal ring which is movable in the axial direction. This change in the balance of forces occurs when two phase fluid begins to pass between the seal faces, at about 10 minutes after loss of RCP seal cooling.

The estimate of 20% that the RCP seal will pop open is the estimate of David Rhodes, given in Appendix A to NUREG/CR-5167, for Westinghouse pumps. We are assuming that this estimate also applies to non-Westinghouse reactor coolant pumps, because of lack of knowledge to produce a better estimate for the non-Westinghouse RCPs.

For Westinghouse pumps, the assumption is made that O-rings made of the "old" material (Parker E515-80) will fail after two hours without RCP seal cooling. O-rings made of the new, qualified material are assumed not to fail on loss of RCP seal cooling, if the RCP seals have not

popped open. These assumptions are those made by David Rhodes, in Appendix A to NUREG/CR-5167. For non-Westinghouse pumps, the secondary seal elastomers are assumed not to fail.

Westinghouse pumps, and pumps in B&W reactors, have two means of cooling the RCP seals, RCP thermal barrier cooling (generally by the CCW system) and RCP seal injection, from the charging pumps. Reactor coolant pumps in Combustion Engineering plants, except for Maine Yankee and Palo Verde, cool the RCP seals only by thermal barrier cooling.

Sequence Delineation and Quantification

The frequencies of the loss of ESW and CCW were taken from the Individual Plant Examinations (IPEs), or revisions to the IPE. The probability of recovery of ESW or CCW in a short time were taken as given in the IPE. For example, a recovery action for loss of a CCW train may consist in starting the standby train, or aligning a swing CCW pump to a train of CCW pump and starting it.

The degree of dependence of the charging pumps and HPI pumps on lube oil cooling is taken from the IPE. Some of the plants cool the charging pumps and high pressure safety injection pumps by ESW and others by CCW. If the plants cool the charging pumps by ESW, and if the plants cool the RCP seals by both CCW and RCP seal injection (supplied by the charging pumps), then a loss of CCW does not lead to a RCP seal LOCA, since RCP seal injection can be maintained. However, for such plants, a loss of ESW will result in heating up the CCW (typically, in about a half hour) resulting in loss of cooling to the RCP thermal barrier, and will also result in loss of charging and HPI pumps, if they depend on ESW for cooling. This results in the loss of both means of cooling the RCP seals. If a RCP seal LOCA occurs then it may not be possible to mitigate it, if the charging or HPI pumps are required to mitigate it. For plants which cool the charging pumps and high pressure safety injection by CCW, then loss of CCW can result in loss of both means of cooling the seals, which may result in an RCP seal LOCA, and no means to mitigate it.

3. PLANT-SPECIFIC CONSIDERATIONS

The magnitude of the core damage frequency due to RCP seal LOCAs on loss of CCW or ESW depends on many plant-specific factors. These include:

1. Whether RCP seal injection is used, and, if it is used, whether the charging pumps are dependent on CCW or ESW. If the charging pumps do not depend on ESW or CCW (e.g., if they are air cooled), then RCP seal injection can be continued on loss of CCW or ESW, and the RCP seal LOCA will not occur. If the charging pumps are cooled by ESW, then loss of CCW will not cause loss of RCP seal injection, and the RCP seal LOCA will not occur on loss of CCW (but may occur on loss of ESW). In some plants there may be a backup system to supply cooling to the charging pumps from an alternate water supply system such as from the fire protection system.

2. For Westinghouse pumps, whether new or old O-rings are used.

3. The initiating event frequencies for loss of ESW and CCW, which depends on plant design features.

4. For two unit plants which use RCP seal injection, there may be the ability to cross-tie charging between the units; if this is the case, and the cross tie can be accomplished before the seals pop open, it may be possible to avoid the RCP seal LOCA, if the loss of CCW/ESW occurs at only one unit.

5. If a small LOCA can be mitigated by depressurizing the primary system and using the low pressure coolant injection system, if the low pressure injection pumps do not require cooling in the injection mode, and if there is means available to continue in the injection mode without going to the recirculation mode, then it may be possible to mitigate an RCP seal LOCA caused by loss of ESW or CCW. To continue in the injection mode, it would be necessary to refill the refueling water storage tank.

6. There exists the possibility that a plant may be able to use the high pressure systems in injection mode without cooling to the high pressure injection pumps, and may even be able to use them in the recirculation mode, provided that containment cooling is not lost when CCW is lost. This depends on the size of the RCP seal LOCA. Using the Rhodes model with a leak rate of 182 gpm per RCP when the seals pop open, no plant was identified where the high pressure injection pumps would not fail in the recirculation mode.

3. RESULTS

The core damage frequency from RCP seal LOCA sequences induced by loss of CCW or ESW was calculated only for cases where the loss of CCW or ESW caused loss of RCP seal cooling and also consequentially caused loss of cooling to the charging and high pressure injection pumps. (Of course, in some plants the charging and high pressure injection pumps are the same.) In addition, no recovery action, such as restoring cooling to the charging pumps from the fire water system was possible. Note that there may be RCP seal LOCA sequences initiated by loss of CCW or ESW which are not included in the above. For example, there may be isolation of CCW to the RCP seals in a plant which does not RCP seal injection. This may cause an RCP seal LOCA. The CCW to the high pressure injection pumps may not be lost, so that there is no consequential loss of the high pressure injection pumps. However, these pumps may fail from a cause independent of the loss of CCW. Also, a DC or AC bus can be lost, possibly isolating CCW to the RCP seals and partially degrading the high pressure injection system. These sequences were considered to have only a small contribution, relative to the case where the loss of CCW or ESW both caused loss of RCP seal cooling and loss of cooling to the high pressure injection pumps.

For cases where the loss of CCW causes consequential loss of all cooling to the RCP seals, and loss of the high pressure injection system, the frequency of core damage due to loss of CCW induced RCP seal LOCA is given by:

$$f(CD)=f(CCW)*P(S),$$

where f(CD) is the frequency of core damage from RCP seal LOCAs caused by loss of CCW, f(CCW) is the frequency of non-recovered loss of CCW, and P(S) is the probability of the RCP seal LOCA. Here, P(S)=1 for Westinghouse RCPs with old O-rings, and P(S)=0.2 for non-Westinghouse pumps or Westinghouse RCPs with new O-rings. The frequency of non-recovered loss of CCW was taken from the IPE. In some cases, the time for recovery in the IPE was about an hour, while it would be only 10 minutes for the pop-open mode in the Rhodes

model. However, this was judged not to have a significant effect on the results. A similar expression is used for the core damage frequency from RCP seal LOCA sequences initiated by loss of ESW.

The core damage frequency from RCP seal LOCAs induced by loss of ESW/CCW was estimated for 14 units (9 sites, some dual units). Estimates of the core damage frequency from the loss of ESW/CCW induced RCP seal LOCAs ranged from 1.4E-3 per year to below 1E-5 per year. As already noted, the initiating event frequencies were taken from the IPEs, and combined with the Rhodes model. The units chosen were not a random sample of units, but rather an attempt was made to select plants with a high contribution to the CDF from RCP seal LOCAs induced by loss of CCW/ESW, when the Rhodes model was used.

In addition to the quantitative estimates, plants were looked at qualitatively, using plant-specfic considerations such as given in section 2, to see if the design of the plants precluded a high contribution to the core damage frequency from RCP seal LOCAs induced by loss of ESW/CCW. Twenty-five units were identified where this was the case.

Attachment 7

Task Action Plan for Plant Specific Follow-up Related to GSI-23, RCP Seal Failures

Phase I (Screening Review)

-- An initial scoping review of 39 PWR plants for the loss of CCW/ESW sequence was conducted using conservative assumptions to identify those plants which would be reviewed in greater detail. Some plants (14) were looked at quantitatively, and other plants (25) were examined qualitatively. The quantitative analysis used RCP seal behavior based on the Rhodes Model (NUREG/CR-5167, Appendix A), but otherwise the assumptions used were those in the plant's IPE, including the initiating event frequencies for losses of ESW and CCW. The qualitative analysis was conducted if the staff judged the risk of loss of seal cooling was low, because of plant design. For example, plants which have RCP seal injection as a redundant means of RCP seal cooling from a source independent of CCW or ESW will have a lower probability of a RCP seal LOCA, given a loss of CCW or ESW. Twenty-five plants, which were analyzed qualitatively, were identified as having a low risk from RCP seal LOCA sequences initiated by loss of CCW or ESW. So far five plants were identified from this initial work for review in greater detail in Phase II.

-- For each plant not already reviewed, estimates of the core damage frequency from loss of CCW/ESW induced RCP seal LOCAs must be obtained, or the plant must be eliminated as a possible high risk plant because of plant design features. These estimates will be obtained by combining the frequency of non-recovered loss of ESW/CCW as given in the IPE with the RCP seal failure probabilities and leak rates as given by the Rhodes model.

Estimated Work Effort: About 30 additional plants, 2 person-days per plant, or 60 person-days in all, including write-up

Phase II (Plant Specific Reviews)

The analysis that will be conducted to determine if plant specific backfits are appropriate will include a variety of issues. These issues will be determined in part, by items such as plant specific design information. Other issues which will be included in the plant specific backfit analysis include:

-- Plants identified in Phase I as having a high contribution to core damage will be reviewed in greater detail to determine if plant specific information or data will result in lower risk. This may involve interactions with licensees.

-- For plants where credit is given for restoration of RCP seal injection, the procedures must be reviewed to see if RCP seal cooling can be reasonably assumed to be restored within about 15 minutes after its loss. (There is evidence that the 10 minute time to pop open is somewhat conservative. In the Sizewell B RCP Test with loss of seal cooling, the seal leakoff flow did not begin to increase rapidly until about 16 minutes after loss of seal cooling. See the Sept. 17, 1999 letter from Liberatori, Westinghouse Owners Group, to Sher Bahadur and Jared Wermiel, OG-99-086.)

Estimated Work Effort: Probably only a few plants, where the procedure is used and there is question about whether it can be completed in time. Get NRR assistance, or contact the resident inspector at the plant. 5 person-days.

-- Obtain information from Westinghouse plants as to which plants have high temperature O-rings, for those Westinghouse plants where the risk from RCP seal LOCAs induced by loss of ESW/CCW appears significant.

Estimated Work Effort: Only a few plants would be important. Work together with NRR, and/or the resident inspectors. 2 person-days.

-- Note: The risk for loss of CCW/ESW initiated by external events (and internal floods) will be addressed in coordination with IPEEE reviews, and using the Rhodes Model.

Phase III (Plant Specific Backfits)

-- Containment performance aspects must be addressed. The containment performance section of the IPE shall be reviewed, for plants with appreciable core damage frequencies from RCP seal LOCAs after loss of RCP seal cooling. The dependency of containment heat removal systems on CCW/ESW will need to be identified, for these plants. The dependence of containment heat removal systems on CCW/ESW can likely be obtained from dependency tables in the IPE. This task need only be performed for those plants with significant core damage frequencies from RCP seal LOCAs induced by loss of CCW/ESW. The timing and mode of containment failure for the pertinent sequences can likely be obtained from the IPE.

Estimated Work Effort: Since the work need be done for only perhaps three or four plants, and the work consists primarily of extracting information from the IPE, about 5 person-days, including write-up.

-- The initial evaluation of the core damage frequencies from loss of CCW/ESW has used our own RCP seal model, but have otherwise used information from the IPE without review. In particular, the initiating event frequencies for loss of CCW/ESW have been taken from the IPEs. This information taken from the IPE should be reviewed before decisions are made as to whether a plant specific modification is necessary. Comparisons between plants of similar design would be useful. Also, the IPE should be checked as to whether there were "missed sequences", from loss of an electrical bus, loss of room cooling, etc., which can cause loss of seal cooling.

Estimated work effort: 60 person-days

-- The uncertainties in the results, especially with regard to the magnitude and likelihood of various RCP seal rates will be calculated, for all PWRs, or assessed as not changing the decision with respect to possible backfit, for particular plants. Probably only a few plants where this would affect the decision as to whether a backfit should be made.

Estimated work effort: Using bounding calculations, for only a few plants, 10 person-days

-- The work product will receive internal peer-review. The end product of this work will be modified, as necessary, as a result of the peer review and forwarded to NRR for action.

Total Estimated effort: About 1 person-year.

-- For the plants with significant calculated CDFs possible cost-beneficial backfits will be explored. Where cost beneficial backfits are identified, a supporting regulatory analysis will be prepared in accordance the appropriate backfit procedures and NRR Office Letter No. 901, "Procedures for Managing Plant-Specific Backfits and 10 CFR 50.54(f) Information Requests." The end product of this work will be a list of plant-specific backfits with supporting regulatory analysis.

Estimated effort: TBD