

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

October 17, 1995

NRC BULLETIN 95-02: UNEXPECTED CLOGGING OF A RESIDUAL HEAT REMOVAL (RHR) PUMP
STRAINER WHILE OPERATING IN SUPPRESSION POOL COOLING MODE

Addressees

All holders of boiling-water reactor (BWR) operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this bulletin to accomplish the following:

- (1) Alert addressees to complications experienced during a recent event in which a licensee initiated suppression pool cooling in response to a stuck-open safety relief valve (SRV) and subsequently experienced clogging of one RHR pump suction strainer.
- (2) Request addressees to review the operability of their emergency core cooling system (ECCS) and other pumps which draw suction from the suppression pool while performing their safety function. The addressee's evaluation should be based on suppression pool cleanliness, suction strainer cleanliness, and the effectiveness of their foreign material exclusion (FME) practices. In addition, addressees are requested to implement appropriate procedural modifications and other actions (e.g., suppression pool cleaning), as necessary, to minimize foreign material in the suppression pool, drywell and containment. Addressees are requested to verify their operability evaluation through appropriate testing and inspection.
- (3) Require that addressees report to the NRC whether and to what extent they have complied with the requested actions. In addition, require a second report indicating completion of confirmatory test(s) and inspection(s) and providing the test results by addressees that have complied with the requested actions, or indicating completion of any proposed alternative course of action by addressees that have not complied with the requested actions.

PDR I+E Bulletin 95-002 951017

9510040059

updated bulletin

*DFOL
1/1*

Background

On September 11, 1995, Limerick Unit 1 was being operated at 100 percent power when control room personnel observed alarms and other indications that one safety relief valve ("M") was open. Emergency procedures were implemented. Attempts to close the valve were unsuccessful, and within 2 minutes a manual reactor scram was initiated. The main steam isolation valves were closed to reduce the cooldown rate of the reactor vessel. The maximum cooldown rate was 54°C/hr [130°F/hr].

Prior to the opening of the SRV, the licensee was running the "A" loop of suppression pool cooling to remove heat being released into the pool by leaking SRVs. Shortly after the manual scram, and with the SRV still open, the "B" loop of suppression pool cooling was started. Operators continued working to close the SRV and reduce the cooldown of the reactor vessel. Approximately 30 minutes later, fluctuating motor current and flow was observed on the "A" loop. Cavitation was believed to be the cause, and the loop was secured. After it was checked the "A" pump was restarted, but at a reduced flowrate of 8kl/m [$2,000\text{ gpm}$]. No problems were observed, so the flow rate was gradually increased back to 32kl/m [$8,500\text{ gpm}$], the full flowrate for the RHR pumps when operating in suppression pool cooling mode. Again, no problems were observed, so the pump continued to be operated at a constant flow. A pressure gauge located on the pump suction was observed to have a gradually lower reading, which was believed to be indicative of an increased pressure drop across the pump suction strainers located in the suppression pool. After about 30 minutes of additional operation, the suction pressure remained constant.

The rest of the reactor shutdown was routine, with no further complications.

Discussion

Limerick Unit 1 has been in commercial operation since 1986 without its suppression pool ever being cleaned. Cleaning was scheduled for the upcoming 1996 refueling outage. The pool of Unit 2 was cleaned during the last refueling outage in 1995.

At Limerick, each pump suction inlet is constructed in a "T" arrangement with two truncated cone-type strainers. The strainers are constructed of 0.95 cm [$3/8\text{ inch}$] thick perforated 304L stainless steel plate with 1.6 cm [$5/8\text{ inch}$] holes on 2.2 cm [$7/8\text{ inch}$] centers. All strainer surfaces are covered by a 12×12 316L stainless steel wire mesh. Because of the leaking SRVs, the "A" and "B" loops of RHR had typically been used for suppression pool cooling during the last few months before the event. Originally, the licensee only used the "A" loop for suppression pool cooling. Approximately 3 months before the event, the licensee changed its practice so that use of the "A" and "B" loops could be alternated.

After cooldown following the blowdown event, a diver was sent into the suppression pool at Unit 1 to inspect the condition of the strainers and the general cleanliness of the pool. Both suction strainers in the "A" loop of suppression pool cooling were found to be almost entirely covered with a thin

"mat" of material, consisting mostly of fibers and sludge. The "B" loop suction strainers had a similar covering, but to a lesser extent. One of the "B" loop suction strainers was approximately 75% covered by the mat. The other had only limited coverage. The other strainers in the pool were covered with a dusting of corrosion products (sludge). Debris was subsequently removed from the strainers and the suppression pool floor, and the water was cleaned by use of a temporary filtration system. The strainers were easily cleaned by brushing the material off the surface.

It is believed that during operation of the suppression pool cooling system, the strainer filtered out fibers that were in the pool water. The resulting mat of fibers improved the filtering action of the strainers, thereby collecting sludge and other material on the surface of the strainer. The licensee has concluded that the blowdown caused by the SRV opening did not significantly increase the rate of debris accumulation on the strainer. Following the event, the licensee removed about 635kg [1400 pounds] of debris from the pool of Unit 1. A similar amount of material had previously been removed from the Unit 2 pool.

Analysis showed that the sludge was primarily iron oxides and the fibers were of a polymeric nature. The source of the fibers has not been positively identified, but the licensee has determined that the fibers did not originate within the suppression pool. There was no trace of either fiberglass or asbestos fibers. In addition, other foreign material was found in the pool, such as pieces of wood, nails, and hose. In light of these findings, the licensee decided to modify their FME procedures to specifically address material control in the suppression pool and drywell.

Section 50.46 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.46) requires that licensees design their ECCSs so that the calculated cooling performance following a loss-of-coolant accident (LOCA) meets five criteria, one of which is to provide long-term cooling capability of sufficient duration following a successful system initiation so that the core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core. The ECCS is designed to meet this criterion, assuming the worst single active failure and only partially obstructed flow through the strainer. Experience gained from the Limerick event demonstrates that inadequate suppression pool cleanliness can lead to unacceptable buildup of foreign material, debris and corrosion products on the strainers during normal operation, which could prevent the ECCS from providing long-term cooling following a LOCA. The staff concludes, therefore, that licensees should take the actions discussed below to ensure that debris which is located in the suppression pool, or will accumulate in the suppression pool during normal operation, does not adversely impact ECCS capability during normal or transient operations or following a LOCA.

Prior to the Limerick event, the staff had issued a draft bulletin for public comment entitled, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors." The draft bulletin and associated draft regulatory guide provide the staff's proposed resolution to

the generic BWR strainer clogging issue. The issue covered by the draft bulletin, however, differs from the issue covered in this bulletin because the draft bulletin focuses on the potential for ECCS strainers to be clogged by debris generated by a LOCA. This bulletin has been issued to resolve a related issue, highlighted by the Limerick event, of the potential for ECCS suction strainers to be clogged during normal operations by debris which is presently in the suppression pool, or may accumulate in the suppression pool during normal operation. The draft bulletin was published in the *Federal Register* on July 31, 1995. The public comment period ended on October 2, 1995. The staff is currently involved in the review and disposition of the public comments as well as in resolving the open issues identified in the federal register notice.

Requested Actions

To ensure that unacceptable buildup of debris that could clog strainers does not occur during normal operation, all addressees are requested to take the following actions:

- 1) Verify the operability of all pumps which draw suction from the suppression pool when performing their safety functions (e.g., ECCS, containment spray, etc.), based on an evaluation of suppression pool and suction strainer cleanliness conditions. This evaluation should be based on the pool and strainer conditions during the last inspection or cleaning and an assessment of the potential for the introduction of debris or other materials that could clog the strainers since the pool was last cleaned.
- 2) The operability evaluation in requested action 1 above should be confirmed through appropriate test(s) and strainer inspection(s) within 120 days of the date of this bulletin.
- 3) Schedule a suppression pool cleaning. The schedule for cleaning the pool should be consistent with the operability evaluation in requested action 1 above. In addition, a program for periodic cleaning of the suppression pool should be established, including procedures for the cleaning of the pool, criteria for determining the appropriate cleaning frequency, and criteria for evaluating the adequacy of the pool cleanliness.
- 4) Review FME procedures and their implementation to determine whether adequate control of materials in the drywell, suppression pool, and systems that interface with the suppression pool exists. This review should determine if comprehensive FME controls have been established to prevent materials that could potentially impact ECCS operation from being introduced into the suppression pool, and whether workers are sufficiently aware of their responsibilities regarding FME. Any identified weaknesses should be corrected. In addition, the effectiveness of the FME controls since the last time the suppression pool was cleaned and the ECCS strainers inspected, and the impact that any weaknesses noted may have on the operability of the ECCS should be assessed.

- 5) Consider additional measures such as suppression pool water sampling and trending of pump suction pressure to detect clogging of ECCS suction strainers.

By letter dated September 29, 1995, (serial BWROG-95083), the BWR Owners Group (BWROG) Executive Oversight Committee (EOC) provided to the BWROG Executive Committee their recommended utility interim actions in response to the recent ECCS suction strainer plugging event at Limerick, Unit 1. The letter also provides additional guidance on the BWROG recommended method for evaluating pool cleanliness and on demonstrating adequate pool cleanliness.

Required Response

All addressees are required to submit the following written reports:

- (1) Within 30 days of the date of this bulletin, a report indicating to what extent the licensee intends to comply with the requested actions in this bulletin. In the report, licensees that intend to comply should provide a detailed description of their actions, the results of their evaluations, any corrective actions they have taken, and a description of the licensee's planned test(s) and inspection(s) for confirming their operability evaluation. In addition, licensees should include their schedule for pool cleaning, the basis for the cleaning schedule, and a summary of any additional measures taken to detect and prevent clogging of the ECCS strainers. If a licensee does not intend to comply with these requested actions, its report should contain a detailed description of any proposed alternative course of action, its schedule for completing this alternative course of action, and the safety basis for its having determined the acceptability of the planned alternative course of action.
- (2) If not addressed in the report discussed above by licensees that intend to comply with the requested actions, within 10 days of the completion of confirmatory tests and inspections or completion of proposed alternative actions, a second report confirming the completion of all pump operability testing and inspection and providing a description of the test/inspection results. Licensees who do not intend to comply with the requested actions should provide a second report indicating the completion of any proposed alternative actions within 10 days of completing the alternative actions.

Address the required written reports to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555-0001, under oath or affirmation under the provisions of Section 182a, the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f). In addition, submit a copy of the reports to the appropriate regional administrator.

Related Generic Communications

Recent instances of problems with strainer clogging are described in the following generic communications:

- NRC Information Notice 95-47: "Unexpected Opening of a Safety/Relief Valve and Complications Involving Suppression Pool Cooling Strainer Blockage"
- NRC Information Notice 95-06: "Potential Blockage of Safety-Related Strainers by Material Brought Inside Containment"
- NRC Information Notice 93-34 and Supplement 1: "Potential for Loss of Emergency Core Cooling Function due to a Combination of Operational and Post-LOCA Debris in Containment"
- NRC Bulletin 93-02 and Supplement 1: "Debris Plugging of Emergency Core Cooling Suction Strainers"
- NRC Information Notice 92-85: "Potential Failures of Emergency Core Cooling Systems caused by Foreign Material Blockage"
- NRC Information Notice 92-71: "Partial Plugging of Suppression Pool Strainers at a Foreign BWR"

Backfit Discussion

The actions requested by this bulletin, if required, would be backfits in accordance with NRC procedures and are necessary to ensure that licensees are in compliance with existing NRC rules and regulations. Specifically, 10 CFR 50.46 requires that the ECCS be designed so that it is calculated to provide adequate flow capability to maintain the core temperature at an acceptably low value and to remove decay heat for the extended period of time required by the long-lived radioactivity remaining in the core following a LOCA. The Limerick event has demonstrated that suppression pool cleanliness can adversely impact ECCS performance and could prevent the ECCS from performing its safety function of long-term decay heat removal following a LOCA. Therefore, this bulletin is being issued as if the requested actions were compliance backfits under the terms of 10 CFR 50.109(a)(4)(i). A full backfit analysis was not performed. An evaluation was performed in accordance with NRC procedures. A statement of the objectives of and the reasons for the requested actions and the basis for invoking the compliance exception if the requested actions were to be required, has been included. A copy of this evaluation will be made available in the NRC Public Document Room.

Paperwork Reduction Act Statement

This Bulletin contains information collections that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget, approval number 3150-0011, which expires July 31, 1997.

The public reporting burden for this collection of information is estimated to average 240 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The U.S. Nuclear Regulatory Commission is seeking public comment on the potential impact of the collection of information contained in the (Bulletin, etc.) and on the following issues:


1. Is the proposed collection of information necessary for the proper performance of the functions of the NRC, including whether the information will have practical utility?
2. Is the estimate of burden accurate?
3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?
4. How can the burden of the collection of information be minimized, including the use of automated collection techniques?

Send comments on any aspect of this collection of information, including suggestions for reducing the burden, to the Information and Records

Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 10555-0001, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0012), Office of Management and Budget, Washington, DC 20503.

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number.

If you have any questions about this matter, please contact the technical contact 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

Technical contact: Robert Elliott, NRR
(301) 415-1397

Lead project manager: Robert M. Latta, NRR
(301) 415-1314

Attachment:
List of Recently Issued NRC Bulletins

LIST OF RECENTLY ISSUED
NRC BULLETINS

Bulletin No.	Subject	Date of Issuance	Issued to
95-01	Quality Assurance Program for Transportation of Radioactive Material	01/13/95	<u>For Action</u> - All radiography rahy licensees <u>For Information</u> - None
94-02	Corrosion Problems in Certain Stainless Steel Packagings Used to Transport Uranium Hexafluoride	11/14/94	<u>For Action</u> - Registered users of Model Nos. NCI-21PF-1 and GE-21PF-1 uranium hexafluoride transportation packages
94-01	Potential Fuel Pool Draindown Caused by Inadequate Maintenance Practices at Dresden Unit 1	04/1/94	<u>For Action</u> - All holders of licenses for nuclear power reactors that are permanently shut down with spent fuel in the spent fuel pool (except Shoreham). [Humboldt Bay, Indian Point 1, LaCrosse, Rancho Seco, San Onofre 1, Trojan, Yankee Rowe, and Dresden 1]. <u>For Information</u> - All holders of OLs or CPs for nuclear power reactors and all fuel cycle and materials licensees authorized to possess spent fuel.
93-02, Supp. 1	Debris Plugging of Emergency Core Cooling Suction Strainers	02/18/94	All holders of OLs or CPs for boiling-water reactors All holders of OLs or CPs for pressurized-water reactors

OL = Operating License
CP = Construction Permit

1. Is the proposed collection of information necessary for the proper performance of the functions of the NRC, including whether the information will have practical utility?
2. Is the estimate of burden accurate?
3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?
4. How can the burden of the collection of information be minimized, including the use of automated collection techniques?

Send comments on any aspect of this collection of information, including suggestions for reducing the burden, to the Information and Records

Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 10555-0001, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0012), Office of Management and Budget, Washington, DC 20503.

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

orig /s/ld by DMCrutchfield

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

Technical contact: Robert Elliott, NRR
(301) 415-1397

Lead project manager: Robert M. Latta, NRR
(301) 415-1314

Attachment:
List of Recently Issued NRC Bulletins

DOCUMENT NAME: 95-02.BL Document reviewed by TechEd on 10/04/95

To receive a copy of this document, indicate in the box C=Copy w/o attachment/enclosure E=Copy with attachment/enclosure M = No copy

OFFICE	PECB:DRPM	C/PECB:DRPM	D/DRPM
NAME	JCarter	AEChaffee	DMCrutchfield
DATE	10/13/95	10/13/95	10/13/95

OFFICIAL RECORD COPY

1. Is the proposed collection of information necessary for the proper performance of the functions of the NRC, including whether the information will have practical utility?
2. Is the estimate of burden accurate?
3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?
4. How can the burden of the collection of information be minimized, including the use of automated collection techniques?

Send comments on any aspect of this collection of information, including suggestions for reducing the burden, to the Information and Records

Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 10555-0001, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0012), Office of Management and Budget, Washington, DC 20503.

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

orig /s/'d by DMCrutchfield

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

Technical contact: Robert Elliott, NRR
(301) 415-1397

Lead project manager: Robert M. Latta, NRR
(301) 415-1314

Attachment:
List of Recently Issued NRC Bulletins

DOCUMENT NAME: 95-02.BL Document reviewed by TechEd on 10/04/95

To receive a copy of this document, indicate in the box C=Copy w/o attachment/enclosure E=Copy with attachment/enclosure N = No copy

OFFICE	PECB:DRPM	C/PECB:DRPM	D/DRPM	
NAME	JCarter	AEChaffee	DMCrutchfield	
DATE	10/17/95	10/19/95	10/13/95	

OFFICIAL RECORD COPY

The Commissioners

- 2 -

The operability of the ECCS suction for recirculation is required to meet the requirements of 10 CFR 50.46. The actions requested in the attached bulletin are considered necessary to ensure compliance with existing regulations and need to be taken expeditiously.

A notice of opportunity for public comment on the proposed bulletin was not published in the Federal Register because of the need to take prompt action in response to emergent operational experience with ECCS suction strainer clogging. The proposed bulletin will be published in the Federal Register when it is issued.

The proposed bulletin was endorsed by the Committee to Review Generic Requirements (CRGR) during its meeting number 278 on October 11, 1995. The staff has incorporated all comments provided by CRGR in that meeting.

The Office of the General Counsel reviewed this bulletin and has no legal objections.

The staff intends to issue this bulletin on October 17, 1995.

Original signed by
James M. Taylor

James M. Taylor
Executive Director
for Operations

Attachment:

Proposed Bulletin Titled "Unexpected
Clogging of Residual Heat Removal
(RHR) Pump Strainer While Operating
in Suppression Pool Cooling Mode"

*SEE PREVIOUS CONCURRENCES

DOCUMENT NAME: A:\COMM.MEM

To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure "E" = Copy with attachment/enclosure "N" = No copy

OFFICE	SCSB/DSSA	BC/SCSB/DSSA	D/DSSA	D/DRPM	OGC
NAME	RElliott:pmm*	CBerlinger*	GMHolahan*	DCrutchfield*	JCutchin*
DATE	10/12/95	10/12/95	10/12/95	10/13/95	10/13/95
OFFICE	D/NRR	EDO			
NAME	WTRussell*	JMTaylor			
DATE	10/13 /95	10/ /95			

OFFICIAL DOCUMENT COPY

The Commissioners

- 2 -

The operability of the ECCS suction for recirculation is required to meet the requirements of 10 CFR 50.46. The actions requested in the attached bulletin are considered necessary to ensure compliance with existing regulations and need to be taken expeditiously.

A notice of opportunity for public comment on the proposed bulletin was not published in the Federal Register because of the need to take prompt action in response to emergent operational experience with ECCS suction strainer clogging. The proposed bulletin will be published in the Federal Register when it is issued.

The proposed bulletin was endorsed by the Committee to Review Generic Requirements (CRGR) during its meeting number 278 on October 11, 1995. The staff has incorporated all comments provided by CRGR in that meeting.

The Office of the General Counsel reviewed this bulletin and has no legal objections.

The staff intends to issue this bulletin on October 13, 1995.

James M. Taylor
Executive Director
for Operations

Attachment:

Proposed Bulletin Titled "Unexpected
Clogging of Residual Heat Removal
(RHR) Pump Strainer While Operating
in Suppression Pool Cooling Mode"

No legal objections
subject to changes
to be made

DOCUMENT NAME: G:\FRONT\COMM.MEM

To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure "E" = Copy with attachment/enclosure "N" = No copy

OFFICE	SCSB/DSSA <i>26</i>	<input checked="" type="checkbox"/> BC/SCSB/DSSA	D/DSSA <i>26</i>	D/DRPM <i>BS</i>	OGC <i>26</i>
NAME	PElliott:pmm	CBerlinger	GMHolahan <i>WV</i>	DCrutchfield	<i>26</i>
DATE	10/12/95	10/12/95	10/12/95	10/ /95	10/12/95
OFFICE	D/NRR <i>26</i>	EDO			
NAME	WTRussell	JMTaylor			
DATE	10/13/95	10/ /95			

OFFICIAL DOCUMENT COPY