

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

May 5, 1988

NRC BULLETIN NO. 88-04: POTENTIAL SAFETY-RELATED PUMP LOSS

Addressees:

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

Purpose:

The purpose of this bulletin is to request all licensees to investigate and correct as applicable two miniflow design concerns. The first concern involves the potential for the dead-heading of one or more pumps in safety-related systems that have a miniflow line common to two or more pumps or other piping configurations that do not preclude pump-to-pump interaction during miniflow operation. A second concern is whether or not the installed miniflow capacity is adequate for even a single pump in operation.

Description of Circumstances:

Westinghouse Electric Corporation recently notified all utilities with Westinghouse-designed nuclear steam supply systems (NSSS) of the two concerns noted above. NRC Information Notice 87-59 forwarded a summary of these concerns to all holders of operating licenses or construction permits for nuclear power reactors and indicated that further staff evaluation might result in a request for specific licensee actions. Several licensees have confirmed the existence of these concerns in their plants (Turkey Point, H. B. Robinson, Vermont Yankee). This bulletin is the result of the staff's evaluation.

Discussion:

When two centrifugal pumps operate in parallel and one of the pumps is stronger than the other (i.e., has a higher developed head for the same flow), the weaker pump may be dead-headed when the pumps are operating in the minimum flow mode. The phenomenon is manifested at low flow rates because of the flatness of the pump characteristic curve in this range. The head difference is not a problem at moderate to high flow conditions because of the shape of the pump characteristic curve in these regions.

Traditionally, the required miniflow for these pumps was established solely on the basis of pumped fluid temperature rise. Today, however, it is generally

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understood that temperature rise is not the only factor influencing safe continuous minimum flow operation. Centrifugal pumps will demonstrate a flow condition that has been described as hydraulic instability or impeller recirculation at some point below the best efficiency point (BEP) on their characteristic curve. These unsteady flow phenomena become progressively more pronounced as the flow is further decreased and can result in pump damage from pump vibration, excessive forces on the impeller, and cavitation. It is now generally recommended that the limitations associated with these hydraulic phenomena be considered when specifying minimum flow capacity.

The first potential problem involves parallel pump operation with both pumps recirculating through a common miniflow recirculation line or with a piping configuration that does not preclude pump-to-pump interaction during miniflow operation. The problem was identified on a plant whose licensee requested that Westinghouse determine if parallel operation while on miniflow is acceptable. Westinghouse reviewed the plant's residual heat removal (RHR) system configuration. The review determined that the potential exists for the stronger pump to dead-head the weaker pump during low flow, parallel pump operating conditions while on miniflow only. In addition, it was determined that even without pump interaction the recirculation flow available was not adequate to ensure continuous operation of even a single RHR pump on miniflow. Although these issues are based on an evaluation of RHR pumps at a particular plant, the first concern may exist at other plants configured with a common pump recirculation flow path and the second concern may also exist at other plants independent of whether or not there is a common recirculation pump flow path.

The NRC staff believes that these issues may be relevant to all water-cooled reactor designs, regardless of the pump application or the NSSS manufacturer. This is based on the belief that miniflow lines have traditionally been designed for only 5% to 15% of pump design flow. Some pump manufacturers now are advising that their pumps should have minimum flow capacities of 25% to more than 50% of best efficiency flow for extended operation to protect against hydraulic instability or impeller recirculation problems.

Actions Requested:

All addressees are requested to do the following:

1. Promptly determine whether or not its facility has any safety-related system with a pump and piping system configuration that does not preclude pump-to-pump interaction during miniflow operation and could therefore result in dead-heading of one or more of the pumps.
2. If the situation described in Item 1 exists, evaluate the system for flow division taking into consideration (a) the actual line and component resistances for the as-built configuration of the identified system; (b) the head versus flow characteristics of the installed pumps, including actual test data for "strong" and "weak" pump flows; (c) the effect of test instrument error and reading error; and (d) the worst case allowances for deviation of pump test parameters as allowed by the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Paragraph IWP-3100.

3. Evaluate the adequacy of the minimum flow bypass lines for safety-related centrifugal pumps with respect to damage resulting from operation and testing in the minimum flow mode. This evaluation should include consideration of the effects of cumulative operating hours in the minimum flow mode over the lifetime of the plant and during the postulated accident scenario involving the largest time spent in this mode. The evaluation should be based on best current estimates of potential pump damage from operation of the specific pump models involved, derived from pertinent test data and field experience on pump damage. The evaluation should also include verification from the pump suppliers that current miniflow rates (or any proposed modifications to miniflow systems) are sufficient to ensure that there will be no pump damage from low flow operation. If the test data do not justify the existing capacity of the bypass lines (e.g., if the data do not come from flows comparable to the current capacity) or if the pump supplier does not verify the adequacy of the current miniflow capacity, the licensee should provide a plan to obtain additional test data and/or modify the miniflow capacity as needed.
4. Within 60 days of receipt of this bulletin, provide a written response that (a) summarizes the problems and the systems affected, (b) identifies the short-term and long-term modifications to plant operating procedures or hardware that have been or are being implemented to ensure safe plant operations, (c) identifies an appropriate schedule for long-term resolution of this and/or other significant problems that are identified as a result of this bulletin, and (d) provides justification for continued operation particularly with regard to General Design Criterion 35 of Appendix A to Title 10 of the Code of Federal Regulations (10 CFR 50), "Emergency Core Cooling" and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling System for Light Water Nuclear Power Reactors."
5. Within 30 days of completion of the long-term resolution actions, provide a written response describing the actions taken.
6. An evaluation of your actions in response to this bulletin should be documented and maintained at the plant site for a minimum of two (2) years. That evaluation should, as a minimum, address the piping system configuration in accordance with Item 1 above, each of the four factors discussed in Item 2, pertinent test data and field experience on minimum flow operation, and verification of the adequacy of current miniflow capacity by the pump manufacturer.

The written reports, required above, shall be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555, under oath or affirmation under the provisions of Section 182a, Atomic Energy Act of 1954, as amended. In addition, a copy shall be submitted to the appropriate Regional Administrator.

This requirement for information was approved by the Office of Management and Budget under clearance number 3150-0011. Comments on burden and duplication should be directed to the Office of Management and Budget, Reports Management, Room 3208, New Executive Office Building, Washington, D.C. 20503.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate NRR project manager.



Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: T. Collins, NRR
(301) 492-0897

Attachment: List of Recently Issued NRC Bulletins

LIST OF RECENTLY ISSUED
 NRC BULLETINS

Bulletin No.	Subject	Date of Issuance	Issued to
85-03, Supplement 1	Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings	4/27/88	All holders of OLs or CPs for BWRs.
87-02, Supplement 1	Fastener Testing to Determine Conformance with Applicable Material Specifications	4/22/88	All holders of OLs or CPs for nuclear power reactors.
88-03	Inadequate Latch Engagement in HFA Type Latching Relays Manufactured by General Electric (GE) Company	3/10/88	All holders of OLs or CPs for nuclear power reactors.
88-02	Rapidly Propagating Fatigue Cracks in Steam Generator Tubes	2/5/88	All holders of OLs or CPs for W-designed nuclear power reactors with steam generators having carbon steel support plates.
88-01	Defects in Westinghouse Circuit Breakers	2/5/88	All holders of OLs or CPs for nuclear power reactors.
87-02	Fastener Testing to Determine Conformance with Applicable Material Specifications	11/6/87	All holders of OLs or CPs for nuclear power reactors.
87-01	Thinning of Pipe Walls in Nuclear Power Plants	7/9/87	All licensees for nuclear power plants holding an OL or CP.
86-04	Defective Teletherapy Timer That May Not Terminate Dose	10/29/86	All NRC licensees authorized to use cobalt-60 teletherapy units.

OL = Operating License
 CP = Construction Permit

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Reviewed by CRGR in the meeting on 4/27/88. In a telephone conversation on 4/29/88 Cheryl Sakenas confirmed that the CRGR staff had reviewed the changes to the bulletin and confirmed that the changes reflect the CRGR comments.
E. Rossi

*SEE PREVIOUS CONCURRENCES

*OGCB:DOEA:NRR
RJKiesel
03/21/88

*SRXB:DEST:NRR
MMcCoy
12/17/87

*SRXB:DEST:NRR
TCollins
12/17/87

*C/SRXB:DEST:NRR
MWHodges
12/17/87

*C/OGCB:DOEA:NRR
CHBerlinger
04/01/88
*PPMB:ARM
TechEd
03/ /88

*to 4/29/88
concurrent
in Serial*

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*OGCB:DOEA:NRR	*SRXB:DEST:NRR	*SRXB:DEST:NRR	D/DOEA:NRR CEROS 04/9/88	*C/OGCB:DOEA:NRR CHBerlinger 04/01/88
RJKiesel 03/21/88	MMcCoy 12/17/87	TCollins 12/17/87	*C/SRXB:DEST:NRR MWHodges 12/17/87	*PPMB:ARM TechEd 03/ /88

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Although no specific request or requirement is intended, the following information would be helpful to the NRC in evaluating the cost of complying with this bulletin:

- (1) staff time to perform requested inspections, corrective actions, and associated operability testing
- (2) staff time to prepare requested documentation
- (3) additional cost incurred as a result of the inspection findings (e.g., costs of corrective actions, costs of down time)

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<i>AMK</i>			D/DOEA:NRR	<i>CNB</i>
			CERossi	C/OGCB:DOEA:NRR
			03/ /88	CHBerlinger
OGCB:DOEA:NRR	*SRXB:DEST:NRR	*SRXB:DEST:NRR	*C/SRXB:DEST:NRR	04/01/88
RJKiessel	MMcCoy	TCollins	MWHodges	*PPMB:ARM
03/ /88	12/17/87	12/17/87	12/17/87	TechEd
				03/ /88