

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

January 26, 1989

NRC INFORMATION NOTICE NO. 89-08: PUMP DAMAGE CAUSED BY LOW-FLOW OPERATION

Addressees:

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

Purpose:

This information notice is being provided to alert addressees to potential problems that may result from operation of centrifugal pumps at flows that can cause severe pump component damage. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

Two events which resulted in pump damage are described below. Operations for extended periods at low-flow conditions apparently created hydraulic instability, resulting in pump damage from cavitation, pressure pulsation, and/or vibration. These events occurred at the Haddam Neck Plant and Susquehanna Steam Electric Station, Unit 1 (Susquehanna 1). The pump damage at the Haddam Neck plant was attributed to pressure pulsation and pump vibration, while at Susquehanna 1 it was the result of cavitation.

Haddam Neck Plant Event:

On February 4, 1988, an electric-driven fire pump was declared inoperable during a routine surveillance test when a high-amperage condition was noted. The normal indication of 200 amps initially increased to between 340 and 360 amps. The indication further increased to 1000 amps during a subsequent manual restart. The cause of the high amperage was attributed to physical damage to the stuffing box brass bushing in the upper shaft area. On the basis of the licensee's evaluation and its discussions with the manufacturer, the licensee concluded that prolonged operation of the pump at low flow may have caused the problem. Operation of the pump at or near the shut-off head had occurred during the containment integrated leak rate test. During the test, the fire pump operated in a low-flow mode, providing cooling water to the air compressors.

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Susquehanna 1 Event:

While the plant was operating at full power on May 22, 1986, an over-current alarm for an emergency service water (ESW) pump was received in the control room. The pump was declared inoperable, placing the plant in a limiting condition for operation. Subsequent disassembly of the pump revealed that the bottom portion of the pump suction bell had separated from the pump body and fallen into the pump pit. In addition, the pump's impeller vanes were eroded through. Similar, but less severe, damage was found on the three other ESW pumps. A subsequent inspection of the residual heat removal service water (RHRSW) pumps found similar damage. The licensee determined that the damage to the ESW and RHRSW pumps was caused by recirculation cavitation, caused by operation of the pumps at flows significantly below their design flow rates.

The ESW pumps are normally operated at 60 percent or less of their design flow of approximately 6,000 gallons per minute (gpm) per pump. When the loop supplying cooling water to the diesels is run with two operating pumps, each pump delivers approximately 3500 to 3900 gpm. The other loop, that does not serve the diesels is normally run with only one pump providing approximately 1000 to 1500 gpm. Operation at these conditions is believed by the pump vendor to cause recirculation cavitation. In addition, the RHRSW pumps are believed to have been operated at less than 50 percent of design flow most of the time. The licensee indicated that the cavitation damage can be avoided by operating the pumps at higher flows; specifically, operation at 75 to 100 percent of design flow is desirable.

Discussion:

These events illustrate that pump damage, caused by operating pumps at flows significantly below their design flow rates, has resulted, with slow deterioration of pump internals occurring over a long period. During the early phases of degradation, the pumps were still functional and remained operable. The pumps had to be disassembled before damage to the pump internals could be seen. Therefore, the routine pump surveillance tests, provided in the plant inservice test programs, may not be capable of detecting early component degradation. In addition, while operating the pumps in their normal, specified system operating ranges, plant personnel were not aware of a problem until actual failure of a pump occurred. It is most likely that pump degradation caused by low-flow operation will go undetected until total failure of the pump occurs, preventing the associated system from performing its safety function.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the technical contact listed below or the Regional Administrator of the appropriate regional office.

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

Technical Contact: Chuck Hsu, AEOD
(301) 492-4443

Attachment: List of Recently Issued NRC Information Notices

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The results of the review and recommendation for issuance of this draft information notice was transmitted to OGCB in a memorandum from M. Wayne Hodges dated November 17, 1988.

***SEE PREVIOUS CONCURRENCES**

D/DOEA-NRR	*C/OGCB:DOEA:NRR	*PPMB:ARM	*OGCB:DOEA:NRR	*AD/SAD:DEST:NRR
CERossi	CHBerlinger	TechEd	RJKiessel	ACThadani
01/19/89	01/11/89	12/22/88	12/06/88	12/09/88
*ROAB:DSP:AEOD	*ROAB:DSP:AEOD	*C/ROAB:DSP:AEOD	*DSP:AEOD	*D/DSP:AEOD
CHsu	MChirama1	JERosenthal	VBenoroya	TMNovak
10/18/88	10/18/88	10/18/88	10/18/88	10/18/88

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These events illustrate that pump damage, caused by operating pumps at flows significantly below their design flow rates, has resulted with slow deterioration of pump internals occurring over a long period. During the early phases of degradation, the pumps were still functional and remained operable. The pumps had to be disassembled before damage to the pump internals could be seen. Therefore, the routine pump surveillance tests, provided in the plant inservice test programs, may not be capable of detecting early component degradation. In addition, while operating the pumps in their normal, specified operating ranges, plant personnel were not aware of a problem until actual failure of the pump occurred. It is most likely that pump degradation caused by low-flow operation will go undetected until total failure of the pump occurs, preventing the associated system from performing its safety function.

The information herein is being provided as an early notification of a potentially significant matter that is under further consideration by the NRC staff. If NRC evaluation so indicates, further licensee action may be requested.

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during which the pumps were still functional and remained operable at early degradation. Damage indication on the pumps' internals can only be observed by disassembly of the pumps. The routine surveillance tests of the pumps provided in the plant inservice test programs may not be capable of detecting early component degradation. In addition, since the pumps operated in the specified operating ranges, the plants were not aware of the problem until the occurrences of pump failure. There is the potential that pump degradation due to low flow operation could go undetected until total failure of the pump occurs. Such failures could prevent the associated system from performing its safety function.

The information herein is being provided as an early notification of a possibly significant matter that is still under consideration by the NRC staff. Recipients should review the information for possible applicability to their facilities. If NRC evaluation so indicates, further licensee action may be requested.

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