

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

January 15, 1985

IE INFORMATION NOTICE NO. 85-03: SEPARATION OF PRIMARY REACTOR
COOLANT PUMP SHAFT AND IMPELLER

Addressees:

All pressurized water power reactor facilities holding an operating license (OL) or construction permit (CP).

Purpose:

This information notice is provided to alert recipients of an event involving primary reactor coolant pump impeller separation from the pump shaft. It is expected that recipients will review the information for applicability to their facilities and consider actions, if appropriate, to preclude similar problems occurring at their facilities. However, suggestions contained in this information notice do not constitute NRC requirements and, therefore, no specific action or written response is required.

Description:

On September 16, 1984, the Palisades Nuclear Plant had been operating for approximately three days in the process of initial power ascension following a refueling outage. The plant was at approximately 57 percent power. At 3:45 a.m. (EDT), reactor coolant pump (RCP) seal cavity pressures indicated that the first (lower) and second (middle) seals had failed simultaneously, and an orderly shutdown was commenced. At 5:20 a.m., the third (upper) seal failed. The reactor was taken off-line and, at approximately the same time, the pump vibration level reached the "danger" level (10 mils). The pump was then secured. In the 3-hour period prior to securing the pump, the electric current to the pump had increased by approximately 10 to 15 percent. During the event, the flow in the loop driven by the affected pump remained normal.

During the examination to determine the extent of the seal failure and to evaluate required repair, major damage to pump components was discovered. The bolts and guide pins that secure the impeller to the shaft had been severely damaged. Unexpected wear on the pump impeller/shaft assembly and pump internals was found. The impeller is normally fastened to the shaft by eight cap screws and four guide pins. However, when the pump was examined, all eight cap screws and two of the four guide pins were found broken. The impeller had been kept in rotation by the two guide pins that had remained intact. Stationary pump parts showed unexpected wear in 360 degrees of arc; rotating pump parts showed wear in 180 degrees of arc.

The RCP at Palisades is a Byron Jackson 850 rpm, single stage, centrifugal pump with a 42-inch diameter impeller and a 4,000-hp Allis-Chalmers motor. The pump has four seal stages with controlled bleed off (and no seal injection) for cooling. Because an impeller was damaged during 1983 by an apparently unrelated failure, another impeller and pump shaft assembly was installed as a unit in February 1984. Procedures prescribed by the pump manufacturer were followed for the installation of the impeller/shaft assembly; however, no manufacturer's representative was present when the installation took place. This assembly had been stored horizontally in the plant store room for approximately 12 years after it had been used in the 1972 time-frame during initial hot functional testing. It is this impeller/shaft assembly that failed on September 16, 1984, after the pump had accumulated approximately 1,300 hours running time before the event.


The analysis of the failure of the eight cap screws and the two guide pins indicated that failures resulted from fatigue and impact loading. The two out of four guide pins that did not fail were bent, which caused the pump shaft to be forced upward and the impeller to be forced downward. No bolt corrosion was found. Although a sheared RCP shaft occurred at Surry 1 in November 1973 as a result of a manufacturing defect, the event described here is the first involving the potential separation of a primary coolant pump impeller from its shaft.

Discussion:

Events leading to the pump impeller/shaft failure cannot be precisely determined; however, examinations of the cap screws indicate that abnormal stress caused them to fail. It is believed that the pump impeller/shaft assembly caused the abnormal cap screw stresses that ultimately led to the failure. It is now believed that the improper torquing of the pump screws was the root cause.

The event and the above conclusion regarding the cause of the failure raise three issues which should be emphasized. (1) Disassembly and reassembly of primary reactor coolant pumps is an operation which should be done in a rigorous manner employing manufacturer's recommendations and proper procedures. (2) The nearly simultaneous failure of the two seal stages is indicative of the seal package under abnormal stress. This stress, concurrent with high pump vibration is indicative of possible severe pump damage. Operator response to these indications led to the pump being shut down before the final two guide pins failed, thus, preventing a more severe event. This action was a prudent response to the situation. (3) Although the event described here is apparently isolated, it demonstrates the credibility of a pump failure event which could lead to a rapid flow decrease transient of the type expected with a sheared shaft event. Most PWRs have a licensing basis analysis for that event or the similar seized rotor event. These analyses generally assume an automatic response of the plant's reactor protection system which generates a reactor trip as a result of low reactor coolant flow.

Plants which sense primary flow by pump shaft rotation rather than a fluid flow measurement for this automatic trip function are cautioned to the vulnerability of the protective system to a failure of the pump impeller. No specific action or written response to this information notice is required. If you need additional information about this matter, please contact the Regional Administrator of the appropriate NRC regional office or this office.


Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

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Attachment: List of Recently Issued IE Information Notices

Attachment
IN 85-03
January 15, 1985

LIST OF RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
85-02	Improper Installation And Testing Of Differential Pressure Transmitters	1/15/85	All power reactor facilities holding an OL or CP
85-01	Continuous Supervision Of Irradiators	1/10/85	All material licensees possessing irradiators that are not self-shielded and contain more than 10,000 curies of radioactive material
84-94	Reconcentration Of Radionuclides Involving Discharges Into Sanitary Sewage Systems Permitted Under 10 CFR 20.303	12/21/84	All NRC materials licensees other than licensees that use sealed sources only
84-93	Potential For Loss Of Water From The Refueling Cavity	12/17/84	All power reactor facilities holding an OL or CP
84-92	Cracking Of Flywheel On Cummins Fire Pump Diesel Engines	12/17/84	All power reactor facilities holding an OL or CP
84-91	Quality Control Problem Of Meteorological Measurements Problems	12/10/84	All power reactor facilities holding an OL or CP
84-90	Main Steam Line Break Effect On Environmental Qualification Of Equipment	12/7/84	All pressurized water reactor and gas cooled power facilities holding an OL or CP
84-89	Stress Corrosion Cracking In Nonsensitized 316 Stainless Steel	12/7/84	All boiling water reactor facilities holding an OL or CP
84-88	Standby Gas Treatment System Problems	12/3/84	All boiling water reactor facilities holding an OL or CP

OL = Operating License
CP = Construction Permit