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

June 16, 1995

NRC INFORMATION NOTICE 94-66, SUPPLEMENT 1: OVERSPEED OF TURBINE-DRIVEN PUMPS CAUSED BY BINDING IN STEMS OF GOVERNOR VALVES

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 (IN) supplement to alert addressees to a potential problem with some licensee actions taken to prevent binding of the valve stems of turbine governor valves and the resulting overspeed trips of the associated turbine-driven pumps. 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 are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Licensees continue to experience failures of steam turbine-driven auxiliary feedwater pumps and reactor core isolation cooling pumps to start upon actual or test demand and continue operating. A number of information notices have been written on aspects of the problem. The most recently issued information notice, IN 94-66, "Overspeed of Turbine-Driven Pumps Caused by Governor Valve Stem Binding," describes sticking of the governor valve stem in the control system for the steam-driven turbine. Since IN 94-66 was issued, additional instances of overspeed turbine trips or stem binding have been reported at Calvert Cliffs Unit 2, Beaver Valley Unit 2, South Texas Unit 2, and, most recently, at Comanche Peak Unit 1.

Comanche Peak

On June 11, 1995, the Unit 1 turbine-driven auxiliary feedwater pump started and immediately tripped on overspeed when it automatically started during a plant transient. Inspection of the governor valve stem revealed signs of corrosion. The root cause of the overspeed trip has not yet been determined, but it appears that corrosion may have been a contributing factor. The liquid-nitrided 410 stainless steel (410 SS) stem had been in service for only 8 weeks.

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Calvert Cliffs

The governor valve on one of the two turbine-driven auxiliary feedwater pumps at Calvert Cliffs 2 first failed in November 1993. The licensee could not determine a root cause and decided to increase the test frequency. No further failures occurred until May 1994 when only small movement of the governor valve stem was observed prior to binding during a surveillance test.

Examination of the governor valve stem showed corrosion in the area where the stem interfaces with the packing gland. No excessive moisture was found. This stem was the original stem fabricated from a gas-nitrided type 410 stainless steel and had been in service for 17 years. The stem was replaced with one fabricated from liquid-nitrided 410 SS.

The governor valve failed again during a surveillance test in September 1994. Corrosion was found in the same area on the governor valve stem. The corroded stem was replaced with another liquid-nitrided 410 SS stem. The licensee began exercising the governor valve every four days following the failure in September. In December 1994, the exercise frequency was changed to once a week. In January 1995, the valve stem failed to move during weekly valve stroke testing and required the use of a rubber mallet to free it. Examination showed corrosion in the same area seen in the previous instances of binding.

Beaver Valley

On March 29, 1995, at the end of a refueling outage, the governor valve stem for the turbine-driven auxiliary feedwater pump at Beaver Valley 2 was replaced after only 18 months of service, when inspection found that it was pitted due to corrosion. The stem was fabricated from liquid-nitrided 410 SS. It was replaced with a similar liquid-nitrided 410 SS stem with the nitride layer machined off.

After 25 days (April 23, 1995), the replacement valve stem became bound during pull testing. The plant had been in cold shutdown throughout the period. Upon disassembly of the valve, a buildup of corrosion products and significant pitting of the stem was found. The licensee decided to supplement the monthly surveillance test with a regular pull test performed on a biweekly basis.

South Texas

The original gas-nitrided 410 stainless steel governor valve stem for the turbine-driven auxiliary feedwater pump was replaced with a liquid-nitrided 410 SS stem during maintenance in April 1994 after several years of satisfactory service with only minor corrosion evident. During a surveillance test in December 1994, the pump tripped on overspeed. The licensee determined that corrosion of the governor valve stem was the root cause. The stem was replaced with another liquid-nitrided 410 SS stem.

In April 1995, the same pump tripped on overspeed during a test following planned preventive maintenance unrelated to the governor valve. The licensee determined that corrosion of the governor valve stem, similar to the corrosion observed in December 1994, was the root cause.

Discussion

The visible cause of valve stem binding is corrosion product buildup on the valve stem. The corrosion product hinders movement of the valve stem within the surrounding packing assembly because of the small tolerances between the stem and surrounding stainless steel washers. However, the root cause has not been definitively determined. Corrosion may be initiated by a combination of moisture, heat, trace impurities in stem packing, materials used for the valve stem and washers, and mechanical factors.

At South Texas and Calvert Cliffs, a valve stem replacement was soon followed by additional failures. It appears that a change in valve stem material processing (i.e. from gaseous to liquid nitriding) in conjunction with conditions conducive to corrosion may lead to rapid failures.

Recently, a study performed for Calvert Cliffs reported that severe corrosion was known to have occurred at nine plants, and that all nine had valve stems made of 410 SS nitrided by using a liquid nitriding process. This nitriding process was first used in 1977, but product parts were not put into service until the late 1980s and early 1990s. Many of the original stems, which are still installed, were nitrided using a gas process, which gives a deeper layer of nitriding.

Independent studies of the effect of nitriding of stainless steel have shown that 410 SS with liquid nitriding has better surface corrosion resistance than 410 SS with gas nitriding. However, either type of nitriding is subject to galvanic attack when coupled to 410 SS without nitriding. If the layer of nitriding is mechanically damaged, the underlying 410 SS may cause galvanic corrosion of the nitrided layer.

As an interim solution, South Texas has replaced one stem with an Inconel 718 (Inconel) stem because of its superior corrosion resistance and has plans to make a similar replacement on the other governor valve. The licensee also plans to monitor starting times and governor valve temperatures during testing to get data on performance of the Inconel stem. The Inconel stem will be inspected at the end of a six-month period.

Calvert Cliffs replaced both Unit 2 governor valve stems for the turbine-driven auxiliary feedwater pumps with Inconel stems. The licensee plans to periodically exercise the Unit 1 stems until the next refueling outage, when installation of Inconel stems is planned. Beaver Valley installed a used stem from warehouse stock with the nitrided layer mechanically removed as an interim measure and plans to install an Inconel stem when one becomes available through the vendor, Dresser-Rand. Comanche Peak replaced the corroded stem with an Inconel stem.

The vendor, Dresser-Rand, has been investigating a solution involving Inconel as the stem material but has not completed qualification testing. The NRC continues to follow the efforts of the Terry Turbine Owner's Group, Dresser-Rand, and licensees to resolve this issue.

Related Generic Communications

Turbine-driven pump overspeed trip events attributed to various causes are described in the following NRC information notices:

- IN 93-51, "Repetitive Overspeed Tripping of Turbine-Driven Auxiliary Feedwater Pumps"
- IN 90-45, "Overspeed of the Turbine-Driven Auxiliary Feedwater Pumps and Overpressurization of the Associated Piping"
- IN 88-67, "PWR Auxiliary Feedwater Pump Turbine Overspeed Trip Failure"
- IN 86-14, Supplement 1, "Overspeed Trips of AFW, HPCI, and RCIC Turbines"

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.

Brian K. Grimes, Director
Division of Project Support
Office of Nuclear Reactor Regulation

Technical contacts: James Davis, NRR
(301) 415-2713

David Skeen, NRR
(301) 415-1174

Attachment: List of Recently Issued NRC Information Notices
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# LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

| Information Notice No. | Subject | Date of Issuance | Issued to |
|---|---|---|---|
| 95-29 | Oversight of Design and Fabrication Activities for Metal Components Used in Spent Fuel Dry Storage Systems | 06/07/95 | All holders of OLs or CPs for nuclear power reactors. |
| 95-28 | Emplacement of Support Pads for Spent Fuel Dry Storage Installations at Reactor Sites | 06/05/95 | All holders of OLs or CPs for nuclear power reactors. |
| 95-27 | NRC Review of Nuclear Energy Institute, "Thermo-Lag 330-1 Combustibility Evaluation Methodology Plant Screening Guide" | 05/31/95 | All holders of OLs or CPs for nuclear power plants. |
| 95-26 | Defect in Safety-Related Pump Parts due to Inadequate Heat Treatment | 05/31/95 | All holders of OLs or CPs for nuclear power reactors. |
| 94-61, Supp. 1 | Corrosion of William Power Gate Valve Disc Holders | 05/25/95 | All holders of OLs or CPs for nuclear power reactors. |
| 95-25 | Valve Failure during Patient Treatment with Gamma Stereotactic Radiosurgery Unit | 05/11/95 | All U.S. Nuclear Regulatory Commission Medical Licensees. |
| 95-24 | Summary of Licensed Operator Requalification Inspection Program Findings | 04/25/95 | All holders of OLs or CPs for nuclear power reactors. |
| 95-23 | Control Room Staffing Below Minimum Regulatory Requirements | 04/24/95 | All holders of OLs or CPs for nuclear power reactors and all licensed operators and senior operators at those reactors. |

OL = Operating License
CP = Construction Permit

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orig /s/'d by BKGrimes

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DOCUMENT NAME: S:\DOPS_SEC\IN94-66.SUP
*See previous concurrence
Note: Dresser-Rand (W. Sweeney) had no comments per telecon with R. Dennig on June 15, 1995

| OFC | OECB:DOPS | SC/OECB:DOPS | PUB:ADM | EMCB:DE |
|---|---|---|---|---|
| NAME | DSkeen* | RDennig* | Tech Ed* | JDavis* |
| DATE | 06/13/95 | 06/14/95 | 06/13/95 | 06/14/95 |

| OFC | C/EMCB:DOPS | D/DE | R-IV | R-IV |
|---|---|---|---|---|
| NAME | JStrosnider* | BSheron* | LSmith* | ECollins* |
| DATE | 06/14/95 | 06/14/95 | 06/14/95 | 06/14/95 |

| OFC | OECB:DOPS | C/OECB:DOPS | D/DOPS |
|---|---|---|---|
| NAME | RKiessel* | AChaffee* | BGrimes |
| DATE | 06/14/95 | 06/14/95 | 06/15/95 |

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| NAME | DSkeen | RDennig | Tech Ed | JDavis |
| DATE | 6/13/95 | 6/15/95 | 6/13/95 | 6/14/95 |

| OFC | C/EMCB:DOPS | D/DE | R-IV | R-IV |
|---|---|---|---|---|
| NAME | JStrosnider | BSheron | LSmith | ECollins |
| DATE | 6/19/95 | 6/14/95 | 6/14/95 | 6/14/95 |

| OFC | DOPS/D | C/OECB:DOPS | D/DOPS |
|---|---|---|---|
| NAME | RKiessel RJR | ACHaffee | BGrimes |
| DATE | 6/19/95 | 6/14/95 | /95 |

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| DATE | 6/13/95 | / /95 | 6/13/95 | 6/14/95 |

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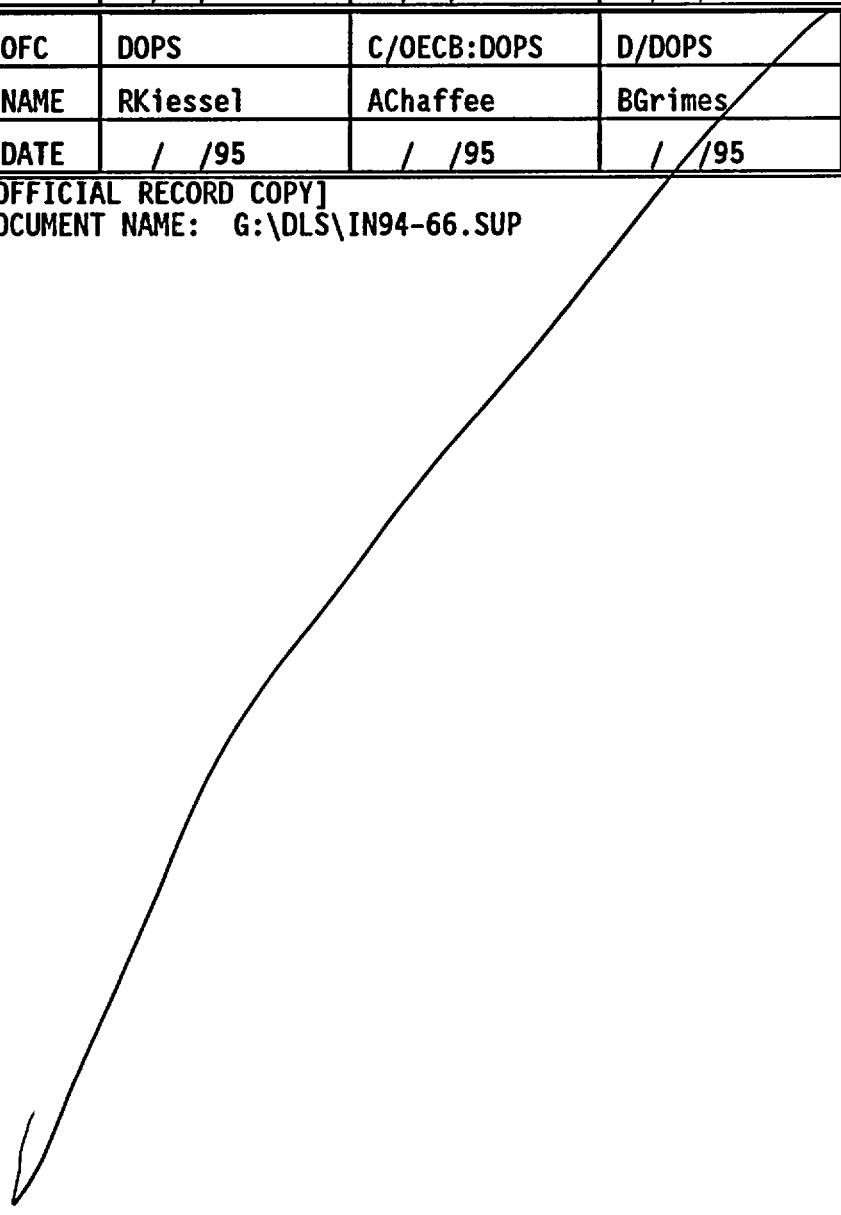

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