

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

March 4, 1997

NRC INFORMATION NOTICE 97-06: WEAKNESSES IN PLANT-SPECIFIC EMERGENCY OPERATING PROCEDURES FOR REFILLING THE SECONDARY SIDE OF DRY ONCE-THROUGH STEAM GENERATORS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors with once-through steam generators (OTSGs).

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to a potential need for guidance in plant-specific emergency operating procedures (EOPs) regarding the refilling of dried-out OTSGs. 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

On May 19, 1996, the reactor at Arkansas Nuclear One, Unit 1 (ANO-1) tripped as a result of circuitry problems in the main feedwater control system. The reactor trip was complicated by a main steam safety valve (MSSV) which opened, as designed, in response to an increase in pressure in the associated OTSG, but failed to reseal after the steam generator depressurized. Consequently, the steam generator boiled dry and the reactor coolant system (RCS) cooled down rapidly. The MSSV was later gagged shut.

Operators had been trained to respond to this type of event and, therefore, were familiar with the generic guidance to refill the dried-out steam generator. However, the plant-specific "overcooling" EOP (the EOP that addresses situations in which the RCS experiences such a cooldown) contained no guidance for refilling the steam generator. Operators consulted with their support staff who then drafted a modification to the "overcooling" procedure to provide guidance on refilling the steam generator. After obtaining concurrence on the modification from the OTSG vendor and approval of the revised procedure from the ANO-1 plant safety committee, the licensee implemented the procedure. Operators used the revised procedure to refill the dried-out steam generator and proceeded to stabilize the plant in the hot-shutdown mode of operation.

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Generic guidelines for mitigating overcooling events in nuclear power reactors designed by the Babcock & Wilcox Company (B&W) have been provided by the B&W Owners Group.¹ Section III.D, Step 7, of the Generic Emergency Operating Guidelines (Volume 1) provides guidance for refilling a dried-out steam generator during events that result in overcooling of the RCS. In addition, Section III.G of the Bases (Volume 3) discusses steam generator tube axial load concerns associated with cooldown scenarios. Items 3.6 and 3.8 of Section III.G provide tensile and compressive tube-to-shell temperature difference limits and strategies for minimizing tube compressive and tensile stresses during transients. At the time of the May 19, 1996 event, the ANO-1 licensee was in the process of revising the plant's "overcooling" EOP to bring it into agreement with the guidance document. In addition, lessons learned from a similar event that occurred at Oconee Unit 3 on August 10, 1994, were also being incorporated into this revision. Had these changes been completed, operators would have had the guidance necessary to refill the steam generator and would not have had to wait for the procedure to be revised.

Discussion

During normal operation, the water and steam in a steam generator provide thermal communication between the shell and the tubes. When a steam generator becomes dry, the thermal communication between the shell and the tubes is lost. Therefore, temperature changes in the RCS (including the steam generator tubes) are not transferred to the shell of the steam generator, allowing the temperatures to diverge rapidly. The resultant tube-to-shell temperature difference, and consequent differential thermal expansion between the tubes and the shell, can place unacceptable stresses on the tubes. These stresses can be either tensile or compressive during the dry-out /refill event. The loads are of a tensile nature when the tubes are cooled faster than the shell and of a compressive nature when the shell is cooled faster than the tubes. The differential pressure across the tube wall and the preload at fabrication also contribute to the tube axial loads.

The results of an analysis to determine the response of a dry, pressurized OTSG to refill under various conditions were used to develop plant operating procedures and guidance for refilling a dry OTSG. Various combinations of initial OTSG tube temperatures and auxiliary feedwater (AFW) flow rates were analyzed and the thermal-hydraulic results were used to determine acceptable AFW refill flow rates for various tube-to-shell temperature differences and initial tube temperatures. The allowable normal operating tube loads were established using NRC-developed minimum wall thicknesses for degraded tubes and the acceptance criteria provided in NRC Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes" and the ASME Boiler and Pressure Vessel Code.

¹ B&W Owners Group, Emergency Operating Procedures Technical Bases Document, December 16, 1996; NRC Accession Number 9612310074

B&W analyses have demonstrated that the steam generator tube loads are bounded by loads occurring during routine plant heatup and cooldown. Therefore, if up-to-date procedures and guidelines are adhered to during the dry-out/refill event, there should be no increase in the likelihood of a tube failure. During the ANO event, the tube-to-shell temperature difference exceeded the allowable limits and, therefore, the loads imposed by the event were analyzed to ensure continued operability of the steam generator.

As a result of recent operating experiences, the B&W Owners Group is currently reviewing the present guidance on refilling dried-out OTSGs. Generic guidelines and plant-specific EOPs are intended to reflect operating experience and the lessons learned from such experience. Therefore, the generic guidelines may change after the B&W Owners Group completes its review.

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.

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Information Notice No.	Subject	Date of Issuance	Issued to
91-85, Rev. 1	Potential Failures of Thermostatic Control Valves or Diesel Generator Jacket Cooling Water	02/27/97	All holders of OLs or CPs for nuclear power reactors
97-05	Offsite Notification Capabilities	02/27/97	All holders of OLs or CPs for nuclear power reactors and test and research reactors
97-04	Implementation of a New Constraint on Radioactive Air Effluents	02/24/97	All materials, fuel cycle, and non-power reactor licensees
97-03	Defacing of Labels to Comply with 10 CFR 20.1904(b)	02/20/97	All material licensees involved with disposal of medical waste
97-02	Cracks Found in Jet Pump Riser Assembly Elbows at Boiling Water Reactors	02/06/97	All holders of OLs or CPs for boiling water nuclear power reactors models 3, 4, 5 and 6, except those licenses that have been amended to possession-only status
97-01	Improper Electrical Ground- ing Results in Simultaneous Fires in the Control Room and the Safe-Shutdown Equip- ment Room	01/08/97	All holders of OLs or CPs for nuclear power reactors

OL = Operating License
CP = Construction Permit

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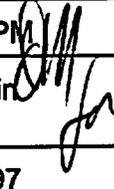
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event, such parameters as the average tube temperatures and primary and secondary pressures need to be recorded and the specific event needs to be evaluated.

In the B&W Owners Group's Emergency Operating Procedures Technical Bases Document, Volume 3, Bases, Section III.G, "Cooldown Methods," Items 3.6 and 3.8 discuss these concerns about tube axial loads. Tensile and compressive tube-to-shell temperature difference limits are established, and strategies for minimizing tube compressive and tensile stresses during transients are discussed. However, as a result of recent operating experiences, the B&W Owners Group is currently reviewing the present guidance on refilling dried-out OTSGs. Generic guidelines and plant-specific EOPs are intended to reflect operating experience and the lessons learned from such experience. Therefore, the generic guidelines may change after the B&W Owners Group completes its review.

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B&W Owners Group guidance states that, if the tube-to-shell temperature difference exceeds the bounds of the allowable limits, as represented in the reference curves, during the dry-out event, such parameters as the average tube temperatures and primary and secondary pressures need to be recorded and the specific event needs to be evaluated.

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