SSINS No.: 6835
IN 87-46

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

September 30, 1987

NRC INFORMATION NOTICE NO. 87-46: UNDETECTED LOSS OF REACTOR COOLANT

Addressees:

All pressurized water reactor facilities holding an operating license or a construction permit.

Purpose:

This information notice is provided to alert recipients to potentially serious operational errors that may result in the inadvertent loss of reactor coolant system (RCS) inventory during abnormal system conditions. It is expected that recipients will review this information for applicability to their reactor facilities and consider actions, if appropriate, to prevent similar problems. Suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On June 21, 1987, the North Anna Unit 1 operators discovered that approximately 17,000 gallons of reactor coolant had been lost from the RCS while the unit was in cold shutdown. The delay in discovering the inventory loss resulted from (1) the use of pressurizer level as an indication of reactor coolant inventory, (2) failure to use all available indications, (3) and failure to perform a mass inventory balance.

On June 17, 1987, while making preparations to start up North Anna Unit 1 following a refueling outage, a problem developed with a reactor coolant pump motor, requiring removal of the motor. When the problem was discovered, the unit was at approximately 195°F, 325 psig, with a bubble in the pressurizer. In order to establish plant conditions for removal of the motor (which may involve leakage from the RCS), the plant would normally have been (1) cooled to less than 140°F, (2) drained to mid-nozzle, and (3) placed on the residual heat removal system. In order to expedite the work, the plant was cooled to 110°F, and the pressurizer was cooled by filling the pressurizer while venting via the power-operated relief valves (PORVs). The pressurizer level was lowered to 80% with the PORVs open. The PORVs were then shut because the vapor space temperature led the operators to believe a bubble still existed, and the level was further lowered to 20%. This was done using a procedure that was not specifically intended for draining the system. The operators did not realize that lowering the level with the PORVs shut -- and subsequently cooling the pressurizer -- caused a vacuum to form in the pressurizer, essentially holding the pressurizer level at 20%.

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On June 18, 1987, the pump motor was uncoupled and a small amount of expected leakage (estimated 2 gallons per minute) up the pump shaft was encountered. This leakage was relatively clean water from the seal injection line past the pump seals, which did not provide a tight seal when the motor was uncoupled. Makeup to the RCS was from the volume control tank (VCT). The VCT level was maintained with VCT pressure greater than reactor pressure. The operators believed that maintaining the pressurizer level and VCT level would maintain the reactor coolant inventory by making up for any losses by flow from the VCT to the RCS. Voids consisting of non-condensable gases and vapor formed in the RCS and collected in the system high points (reactor vessel head and steam generator tubes). The voids were not indicated by any decrease of the pressurizer level.

On June 21, 1987, a decision was made to reduce the pump shaft leakage by raising the pressurizer level, cycling the PORVs to vent the pressure, and, then lowering the pressurizer level to draw a slight vacuum in the pressurizer. This was a condition that already existed, but the operators were unaware of it. When the PORVs were cycled, the pressurizer relief tank pressure dropped, as well as the pressurizer level, indicating that a vacuum already existed in the pressurizer. The reactor vessel level indicating system (RVLIS) indication at this time was 79%; however, the operators were not monitoring this indication because the system had been modified during the previous outage and the operators thought it unreliable. Because of the recorder scale and the time span visible on the RVLIS trend recorder, the change in the level indication would only have been noticed (1) with a separate level plot or (2) by rolling the chart back 12 to 24 hours to compare it with the present indication. When the condition was discovered, the operators took action to make up to the RCS and vent the reactor vessel head, as well as to check other available information to account for the system inventory. A total of 17,000 gallons of borated water was required to reestablish the RCS inventory.

Discussion:

The principal error associated with this event is that the operator used only pressurizer level as an indication of RCS inventory. The operator relied on this single indication of inventory for an extended period with a known but unquantified leak from the RCS, rather than using other available indications to confirm reactor inventory.

The RVLIS level was available but was not used, as discussed previously. This system was not required to be operable while the reactor was shut down. Recorded RVLIS readings in the recorder viewing window did not show a downward trend in vessel level until the paper was removed from the recorder and evaluated for an extended period, because the level decrease was very gradual. Also, several work request stickers on the RVLIS display had not been removed following the modifications made during the outage. In addition, an inventory balance was not maintained to show how much water was being collected from the leak compared with the amount of water being added to the system.

The plant procedures were not adequate for monitoring the reactor coolant inventory. The procedure used to establish plant conditions for removing the motor did not contain appropriate instructions for monitoring and maintaining RCS inventory.

The licensee is changing the procedure to require (1) a review of reactor coolant system inventory and (2) routine surveillance of all available level indication, including RVLIS.

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

Charles E. Rossi

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

Technical Contacts: R. Croteau, RII
(404) 242-4668

Sam MacKay, NRR
(301) 492-8394

Attachment: List of Recently Issued NRC Information Notices

Attachment
IN 87-46
September 30, 1987

LIST OF RECENTLY ISSUED
INFORMATION NOTICES 1987

Information Notice No.	Subject	Date of Issuance	Issued to
87-45	Recent Safety-Related Violations of NRC Requirements by Industrial Radiography Licensees	9/25/87	All NRC licensees authorized to possess and use sealed sources for industrial radiography.
87-44	Thimble Tube Thinning in Westinghouse Reactors	9/16/87	All PWR facilities employing a W nuclear steam supply system holding an OL or CP.
87-43	Gaps in Neutron-Absorbing Material in High-Density Spent Fuel Storage Racks	9/8/87	All nuclear power reactor facilities holding an OL or CP.
87-42	Diesel Generator Fuse Contacts	9/4/87	All nuclear power reactor facilities holding an OL or CP.
87-41	Failures of Certain Brown Boveri Electric Circuit Breakers	8/31/87	All nuclear power reactor facilities holding an OL or CP.
87-40	Backseating Valves Routinely to Prevent Packing Leakage	8/31/87	All nuclear power reactor facilities holding an OL or CP.
87-39	Control of Hot Particle Contamination at Nuclear Power Plants	8/21/87	All nuclear power reactor facilities and spent fuel storage facilities holding an NRC license or CP.
87-38	Inadequate or Inadvertent Blocking of Valve Movement	8/17/87	All nuclear power reactor facilities holding an OL or CP.

OL = Operating License
CP = Construction Permit

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D/DOEA:NRR	*C/OGCB:DOEA:NRR	*PPMB:ARM	*OGCB:DOEA:NRR	*RII
CERossi	CHBerlinger	TechEd	SDMacKay	MErnst
09/24/87	09/21/87	08/28/87	08/27/87	07/28/87
*RII	*RII	*RII	*RII	*RII
RCroteau	FCantrell	TPeebles	VBrownlee	LReyes
07/22/87	07/24/87	07/24/87	07/24/87	07/24/87

The plant procedures were not adequate for monitoring the reactor coolant inventory. The procedure used to establish plant conditions for removing the motor did not contain appropriate instructions for monitoring and maintaining RCS inventory.

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07/22/87 reconcur by phone 9/8/87	07/24/87 reconcur by phone 9/8/87	07/24/87	07/24/87	07/24/87

situation degraded, RHR suction may have been lost. Had water level decreased below the nozzles, the water in the pressurizer may have burped out to the vessel, providing water for the RHR suction and indicating to the operators that a problem existed.

The RVLIS level was available but was not used, as discussed previously. This system was not required to be operable in modes 4, 5, and 6 by the Technical Specifications. Recorded RVLIS readings in the recorder viewing window did not show a downward trend in vessel level until the paper was removed from the recorder and evaluated for an extended period since the level decrease was very gradual. Also, several work request stickers on the RVLIS display had not been removed following the modifications made during the outage.

In addition, an inventory balance was not maintained that showed how much water was being collected from the leak compared to the amount of water being added to the system.

The procedure used to establish plant conditions for removing the motor was not adequate and did not contain appropriate instructions for monitoring and maintaining RCS inventory. The procedure was not written to establish the conditions for which it was used in this case. Pressurizer level was the sole means being used by the operators for RCS inventory indication.

The licensee is changing the procedure to require (1) a review of reactor coolant system inventory and (2) routine surveillance of all available level indication, including RVLIS. As stated in IN-87-23, the NRC is currently considering generic action on the issue of loss of decay heat removal during reduced water level operations.

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lost. Had water level decreased below the nozzles, the water in the pressurizer may have burped out to the vessel providing water for RHR suction and indication to the operators that a problem existed.

RVLIS level was available but not used as discussed previously. This system was not required to be operable in modes 4, 5, and 6 by the Technical Specifications. Recorded RVLIS readings in the recorder viewing window did not show a downward trend in vessel level until the paper was removed from the recorder and evaluated for an extended period since the level decrease was very gradual. Also, several work request stickers on the RVLIS display had not been removed following the modifications made during the outage.

In addition, an inventory balance was not maintained showing how much water was being collected from the leak compared to the amount of water being added to the system.

The procedure used to establish plant conditions for removing the motor was not adequate and did not contain appropriate instructions for monitoring and maintaining reactor coolant system inventory. The procedure utilized was not written to establish the conditions for which it was used in this case. Pressurizer level was the sole means being used by the operators for reactor coolant system inventory indication.

The licensee is changing the procedure to require (1) a review of reactor coolant system inventory and (2) routine surveillance of all available level indication including RVLIS. As stated in IN-87-23, the NRC is currently considering generic action on the issue of loss of decay heat removal during reduced water level operations.

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The procedure used to establish plant conditions for removing the motor was not adequate and did not contain appropriate instructions for monitoring and maintaining reactor coolant system inventory. The procedure utilized was not written to establish the conditions for which it was used in this case. Pressurizer level was the sole means being used by the operators for reactor coolant system inventory indication.

Following this event, the licensee is changing the procedure used to require (1) a review of reactor coolant system makeup and loss inventory and (2) routine surveillance of all available level indication including RVLIS. As stated in IN-87-23, the NRC is currently considering generic action on the issue of loss of decay heat removal during reduced level evolutions.

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