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

July 2, 1981

IE Circular No. 81-10: STEAM VOIDING IN THE REACTOR COOLANT SYSTEM DURING
DECAY HEAT REMOVAL COOLDOWN

Description of Circumstances:

On April 21, 1981, Florida Power Corporation's Crystal River Unit 3 facility (a 2452 MWT Babcock & Wilcox reactor) was in Mode 5 (Cold Shutdown). The Decay Heat Removal (DHR) system was in operation taking a suction on the "B" hot leg and injecting cooled liquid back into the vessel downcomer. The Reactor Coolant System (RCS) water temperature was approximately 106°F as indicated by the DHR pump suction temperature. RCS pressure was about 50 psig and being maintained by use of pressurizer heaters and auxiliary spray from the DHR system.

The plant had been cooled down from 520°F to approximately 270°F (measured by the cold leg RTDs) over a 13 hour period, at which point DHR cooling was initiated and reactor coolant pumps (RCPs) were shut off. The plant was on DHR for 15 hours before the 106°F, 50 psig conditions were reached.

At this point, when the operators commenced spray of the pressurizer via the auxiliary spray line to decrease RCS pressure, the pressurizer level began to increase from about 82 inches to 180 inches indicating that a void of approximately 300 cu.ft. existed in the reactor coolant system. Upon seeing the level increase, the operator concluded there was a steam void in the system. He also noticed the "A" loop wide range hot leg RTDs were reading approximately 300°F, which is slightly above the 50 psig saturation temperature. Spray was terminated and emergency feedwater flow was initiated to the "A" Once Through Steam Generator (OTSG) cooling the "A" loop hot leg. About seven hours later sufficient cooling was achieved to drop pressurizer level. The plant depressurized without void formation.

On June 2, 1981, a similar event occurred at McGuire Unit 1. McGuire had not achieved criticality but had heated up using RCPs. While reducing RCS temperature and pressure to achieve a cold shutdown condition, a steam void was apparently formed in the reactor vessel head area when the system was vented.

The plant had initiated Residual Heat Removal (RHR) cooling and turned off RCPs at about 318°F. At a RCS loop temperature of 160°F and a pressure of 60 psig, the vessel head was vented. The operators observed a pressurizer level increase of three to four percent, indicating the presence of a steam void in the system. At this time, the reactor vessel upper internals showed a temperature of 250°F. Since the reactor had not achieved initial criticality,

there was no decay heat to drive natural circulation as there would have been for an operating plant. The system was repressurized, the reactor coolant pumps were restarted to uniformly cool the system and the plant was taken to cold shutdown.

Discussion:

These events were apparently caused by insufficient cooling of the large masses of hot metal in regions such as the reactor vessel head, upper "J" leg (B&W), steam generator walls, and reactor pressure vessel nozzles prior to initiating DHR cooling. Local stagnation and stratification of the fluid in the upper head region while on DHR cooling may also have contributed to the problem.

While the coolant passing through the core was being maintained relatively cool by the DHR system, coolant in the RCS hot legs and in the upper head region was essentially stagnant. This allowed the coolant to be heated to saturation temperature, or to remain at relatively high temperatures because of the stagnant conditions. This resulted in steam void formation when the system was depressurized. The operators correctly diagnosed the system voiding at both Crystal River 3 and McGuire 1 and took appropriate corrective actions to bring the plants to cold shutdown.

While these events were not a concern due to the availability of the DHR system at both Crystal River and McGuire and the lack of core heat production at McGuire, the NRC believes transmittal of this information is appropriate, since voiding in the RCS is a concern if operators fail to recognize this conditions. Also, normal natural-circulation flow is reduced by voids in hot legs and sufficiently large reactor vessel voids.

IE Circular No. 80-15, June 1980, and NRR Generic Letter No. 81-21, May 1981, were directed at the possibility of voids being formed in the reactor vessel head region during natural circulation cooldown. It is important that reactor operators recognize that voiding can occur in other portions of the RCS (e.g., in the "J-leg" of B&W reactors) and under conditions other than natural circulation cooldown so that timely and correct action is taken.

Recommended Actions for Holders of an Operating License and Near Term Operating Licensees (NTOL)*:

1. Review your operating procedures dealing with plant cooldown and emergency and/or abnormal procedures that address natural circulation to assure that sufficient information is available for operators to recognize the symptoms of RCS voiding and take appropriate actions to recover from a voided condition. Special attention should be directed to the information provided regarding the Crystal River and McGuire events in order to ascertain if they bring to light any conditions you did not consider during your review

*NTOL is defined, for the purpose of this circular, as a plant currently scheduled to receive an OL prior to January 1, 1983.

and revision of natural circulation and shutdown cooling procedures that were required in IE Circular 80-15, and NRR Generic Letter No. 81-21.

2. Each licensed operator should be informed of the matters discussed in this circular.
3. Consider including this information in your operator training and retraining classes.

No written response to this circular is required. If you need additional information with regard to this matter, contact the Director of the appropriate NRC Regional Office.

Attachment:
Recently issued IE Circulars

Attachment
IEC 81-10
July 2, 1981

RECENTLY ISSUED
IE CIRCULARS

Circular No.	Subject	Date of Issue	Issued to
81-08	Foundation Materials	5/29/81	All power reactor facilities with an OL or CP
81-07	Control of Radioactively Contaminated Material	5/14/81	All power reactor facilities with an OL or CP
81-06	Potential Deficiency Affecting Certain Foxboro 20 to 50 Milliampere Transmitters	4/14/81	All power reactor facilities with an OL or CP
81-05	Self-Aligning Rod End Bushings for Pipe Supports	3/31/81	All power reactor facilities with an OL or CP
81-04	The Role of Shift Technical Advisors and Importance of Reporting Operational Events	4/30/81	All power reactor facilities with an OL or near-term OL
81-03	Inoperable Seismic Monitoring Instrumentation	3/2/81	All power reactor facilities with an OL or CP
81-02	Performance of NRC-Licensed Individuals While on Duty	2/9/81	All power reactor facilities (research & test) with an OL or CP
81-01	Design Problems Involving Indicating Pushbutton Switches Manufactured by Honeywell Incorporated	1/23/81	All power reactor facilities with an OL or CP
80-25	Case Histories of Radiography Events	12/5/80	All radiography licensees
80-24	AECL Teletherapy Unit Malfunction	12/2/80	All teletherapy licensees

OL = Operating Licenses
CP = Construction Permit