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

June 15, 1988

NRC INFORMATION NOTICE NO. 88-39: LASALLE UNIT 2 LOSS OF RECIRCULATION PUMPS WITH POWER OSCILLATION EVENT

Addressees:

All holders of operating licenses or construction permits for boiling-water reactors (BWRs).

Purpose:

This information notice is being provided to alert addressees to potential problems resulting from the thermal hydraulic instability of BWR cores when the plant is operating at certain unstable power/flow regions. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Background:

BWR thermal hydraulic stability was the subject of Generic Issue B-19. Early BWRs were designed to maintain decay ratios (DRs) of neutron flux perturbations at less than 0.5 (DR = 1.0 corresponds to an undamped limit cycle oscillation). Later core designs tended toward DR of 1.0 because of higher power density cores and changing fuel design characteristics.

In the resolution of Generic Issue B-19, core designs that were potentially unstable (DR = 1.0) under natural circulation operating conditions were approved, provided that operating procedures would ensure that neutron flux oscillations indicative of core instability would be readily detected and suppressed as required by 10 CFR, Part 50, Appendix A, General Design Criterion 12, "Suppression of Reactor Power Oscillations." Licensees were informed by Generic Letter 86-02 that operating limitations must be implemented for new reload cores unless they could demonstrate by approved calculational methods that the core was stable throughout permissible operating regions of the power/flow map. A calculated core DR of less than 0.8 using General Electric (GE) methods was approved as acceptable evidence of core stability.

Description of Circumstances:

On March 9, 1988, LaSalle Unit 2 underwent a dual recirculation pump trip event. After the pump trip, the unit experienced an excessive neutron flux oscillation

while it was on natural circulation. A detailed description of the event is documented by the NRC augmented inspection team (AIT) in Inspection Report Nos. 50-373/88008 and 50-374/88008.

Before the event, the LaSalle Unit 2 reactor (a GE BWR-5) was operating at steady-state conditions at approximately 84 percent power, with 76 percent rated core flow using both recirculation pumps, and with the control rods withdrawn to the 99 percent flow control line (FCL).

The initiating transient was caused by an instrument maintenance technician who was performing a surveillance test of a wide range level instrument to check its reactor core isolation cooling initiation function. During the performance of this surveillance test, the technician opened a wrong valve. This produced a high "indicated" level signal to the feedwater control system, and the response eventually led to a trip of both recirculation pumps.

The trip of the recirculation pumps resulted in a flow decrease to natural circulation while the control rods remained in the 99 percent FCL position. The power-to-flow condition after the pump trip was known to be a susceptible condition for instabilities in some BWRs. In addition, as a result of the rapid power decrease, the feedwater heater level control system was unable to control the level in the feedwater heaters and began isolating extraction steam from the heaters. This resulted in a positive reactivity addition because cooler feedwater was being supplied to the reactor. It, in turn, caused an increase in power, further reducing the margin to instability.

Approximately 5 minutes after the recirculation pump trip, operators observed that the average power range monitor (APRM) indications were oscillating between 25 and 50 percent power (25 percent peak-to-peak) every 2 to 3 seconds, and the local power range monitor (LPRM) downscale alarms began to annunciate and clear. During this period, the operators recognized that they were in the region of core instability. They attempted to restart a recirculation pump in order to increase flow to prevent instability, but this action was unsuccessful as all of the pump start permissive conditions had not been satisfied. Approximately 7 minutes after the recirculation pump trip, as operators attempted to restore forced flow (but failed again) and were preparing to perform a manual scram, the reactor automatically scrammed on APRM neutron high flux (118 percent trip). The scram shut down the reactor and recovery from the scram proceeded normally.

The review performed after the event, from the STARTREC trace (a high-speed multi-channel recording system), revealed APRM peak-to-peak oscillations ranging from 20 percent to about 75 percent power. Extrapolation of the traces to the time of the scram indicated that the oscillations were at least 100 percent peak-to-peak when the scram occurred. The staff estimated that the peaking factor increased from 2.11 before the event to 2.65 at the time of the LPRM alarm. The magnitude of oscillation and the shifting in power peaking were unexpected on the basis of previous operating experience. Although the power oscillations were larger than expected, no fuel thermal or mechanical limits were exceeded during the event.

Discussion:

The event indicated the following:

(1) Decay Ratio

The predicted DR for LaSalle licensing conditions was 0.60, yet limit cycles were observed in this event. In response to NRC questions, GE performed the thermal hydraulic stability analysis again on the basis of the actual plant data recorded during the event. The analysis showed a strong sensitivity to modeling and input conditions, especially the modeling of power distributions, and transient conditions of power/flow and subcooling. This reanalysis result indicates that the DR determined by the licensing calculations is not a reliable indicator that a core will be stable under all operating conditions during a fuel cycle.

(2) Instrumentation

Instrumentation on many BWRs make detection and suppression of neutron flux oscillations difficult.

(3) Operating Procedures

In 1984, GE issued Service Information Letter (SIL) 380, Revision 1, containing recommendations regarding BWR core thermal hydraulic stability. This document discusses recirculation pump trip and recommends: "Immediately reduce power by inserting control rods to or below the 80 percent FCL using the plant's prescribed control rod shutdown insertion-sequence." Further, the SIL recommends that the operation of restarting recirculation pumps should be performed below the 80 percent FCL. However, because the LaSalle-calculated DR was low and the perception of margin to instability was substantial, these recommendations were not incorporated into the LaSalle abnormal operating procedures. Since the event, these recommendations have been incorporated. In addition, some improvements to the existing procedures were made:

High-worth "CRAM" rods have been designated for immediate insertion after recirculation pump(s) trip from power levels above the 80 percent FCL. Control rods in the CRAM array are preselected to achieve a 10 percent reduction in the rod line while minimizing the effect on power distribution and future rod movement. In addition, APRM/LPRM signals will be monitored concurrently. The reactor is to be tripped if instability is suspected.

CRAM rods are immediately inserted, followed by insertion of rods in sequence to get below the 80 percent FCL, if instability is indicated while operating in a stability surveillance region with one or two pumps. APRM/LPRM signals are concurrently monitored and the reactor is scrammed if the instability has not been terminated within two minutes.

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

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

Technical Contacts: Laurence E. Phillips, NRR
(301) 492-3235

Peter C. Wen, NRR
(301) 492-1172

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
88-38	Failure of Undervoltage Trip Attachment on General Electric Circuit Breakers	6/15/88	All holders of OLs or CPs for nuclear power reactors.
88-37	Flow Blockage of Cooling Water to Safety System Components	6/14/88	All holders of OLs or CPs for nuclear power reactors.
88-36	Possible Sudden Loss of RCS Inventory During Low Coolant Level Operation	6/8/88	All holders of OLs or CPs for PWRs.
88-35	Inadequate Licensee Performed Vendor Audits	6/3/88	All holders of OLs or CPs for nuclear power reactors.
88-34	Nuclear Material Control and Accountability of Non-Fuel Special Nuclear Material at Power Reactors	5/31/88	All holders of OLs or CPs for nuclear power reactors.
87-61, Supplement 1	Failure of Westinghouse W-2-Type Circuit Breaker Cell Switches	5/31/88	All holders of OLs or CPs for nuclear power reactors.
88-33	Recent Problems Involving the Model Spec 2-T Radiographic Exposure Device	5/27/88	All Agreement States and NRC licensees authorized to manufacture, distribute or operate radiographic exposure devices and source changers.
88-32	Promptly Reporting to NRC of Significant Incidents Involving Radioactive Material	5/25/88	All NRC material licensees.

OL = Operating License
CP = Construction Permit

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*OGCB:DOEA:NRR	*SRXB:DEST:NRR	*C/SRXB:DEST:NRR	*SAD/DEST:NRR	*PPMB:ARM
PCWen	LEPhillips	MWHodges	ACThadani	TechEd
06/10/88	06/10/88	06/10/88	06/10/88	06/10/88

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* CRAM rods are immediately inserted, followed by insertion of rods in sequence to get below the 80 percent FCL, if stability is indicated while operating in a stability surveillance region (see Figure 1) with one or two pumps. APRM/LPRM are concurrently monitored and the reactor is scrammed if the instability has not been terminated within two minutes.

Several additional concerns with regard to TS adequacy and the validity of previous safety analyses were reviewed by the NRC. The staff will consider the need for an additional Generic Letter on this matter to strengthen the implementation of core stability detection and suppression provisions for operating BWRs.

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06/10/88	06/10/88	06/10/88	06/10/88	06/10/88