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

October 29, 2001

NRC INFORMATION NOTICE 2001-15: NON-CONSERVATIVE ERRORS IN MINIMUM CRITICAL POWER RATIO LIMITS

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform the addressees that NRC recently received reports of nonconservative errors affecting the minimum critical power ratio (MCPR) operating and safety limits. 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.

Background

Thermal limits on nuclear power plant operation are established to ensure that fuel cladding integrity is not lost because of overheating. Fuel cladding integrity provides one of the protections of public health and safety against uncontrolled release of radioactivity into the environment. One of these limits, the MCPR safety limit, is defined as the smallest allowed ratio of the critical bundle power (defined as that required to produce a critical stage of boiling called transition boiling somewhere in the bundle) to the actual bundle power. A higher value of this ratio may be used as an operating limit based on the single failure (operator error or equipment malfunction causing a transient) design basis requirement.

Description of Circumstances

In June 2001, the fuel vendor General Electric reported that licensees that implemented stability detect and suppress trip systems at their plants may be making nonconservative errors in their licensing calculations for reloads, resulting in inadequate MCPR safety limit protection (Part 21 Report 2001-23-0).

Optional stability solutions requiring these calculations are defined as Options I-D, II, and III in the vendor's document NEDO-32465-A, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," August 1996. This document gives two

generic so-called Delta CPR/Initial CPR Vs. Oscillation Magnitude (DIVOM) curves, one for core-wide mode oscillations and one for regional mode oscillations. The curves relate normalized critical power ratio to hot bundle oscillation magnitude.

In Option I-D, the generic core-wide curve is used to confirm that the flow-biased average power range monitor (APRM) flux trip provides adequate MCPR safety limit protection for a core-wide mode oscillation initiating on the rated flow control line.

Option II is not specifically addressed in the vendor's document, but the vendor states that the generic regional mode curve has been used at Nine Mile Point Unit 1 to confirm that the APRM trip gives adequate MCPR protection for a regional mode oscillation initiating on the rated flow control line.

In Option III, the generic regional mode oscillation curve is used to determine the setpoints for the implemented stability detect and suppress trip system used to provide adequate MCPR protection. Plants using this option sometimes call these systems oscillation power range monitors.

In recent evaluations, the vendor identified a nonconservative error in the high peak bundle power-to-flow ratios in the generic regional DIVOM curve and in the high core-average power-to-flow ratios in the generic core-wide DIVOM curve. The generic regional DIVOM curve overpredicts the Option III system trip setpoint, and the generic core-wide DIVOM curve overpredicts the flow-biased APRM flux trip setpoint.

The vendor stated that it had informed all affected nuclear power plants, including General Electric boiling water reactors (BWRs), and the industry BWR owners group. The vendor described compensatory actions taken by the Hatch licensee for both Units 1 and 2. The Perry, Nine Mile Point Unit 2, and Fermi Unit 2 licensees notified the NRC of their compensatory actions (Event Notifications 38099, 38106, and 38119 respectively).

The vendor provided updated generic DIVOM curves and a corresponding figure of merit to determine curve applicability in August 2001. The vendor expected to review applicable studies and, if necessary, develop new methodologies and obtain licensing approval for them by the end of 2002.

In March 2001, the fuel vendor Framatome ANP Richland reported having used an inappropriate reference temperature in establishing MCPR operating limits for several BWRs. The result was to overpredict the thermal conductivity of the fuel. The affected plants were Dresden Units 2 and 3, Quad Cities Units 1 and 2, LaSalle Units 1 and 2, and Susquehanna Units 1 and 2. The largest correction was to increase the previous MCPR limit by 0.02 for power less than 60-percent rated power (Part 21 Report 2001-14-0).

The vendor stated that it had demonstrated continued compliance with the overpressurization criteria of the American Society of Mechanical Engineers (ASME) code and had installed the appropriate reference temperature in the computer code used for the MCPR analysis.

In October 2000, Siemens Power, the predecessor of Framatome ANP Richland, reported a deviation in the pump model of the COTRANSA2 computer code, resulting in improper calculation of the flow resistance during a pump seizure event. The affected nuclear power plants were Dresden Units 2 and 3 and Susquehanna Units 1 and 2 (Part 21 Report 2000-23-0).

In October 2000, the Hope Creek licensee was doing surveillance testing of a recirculation pump motor-generator set. The licensee reported finding that the scoop tube mechanical and electrical stop overspeed setpoints were nonconservatively high (less than or equal to 109 percent for the mechanical stop and less than or equal to 107 percent for the electrical stop). If the analyzed reactor recirculation pump "runaway" transient occurs, the flow-dependent MCPR may be exceeded (Event Notification 37418).

In September 2000, the Grand Gulf licensee reported that a main generator partial load rejection can actuate a control circuit that may not always activate a reactor scram or recirculation pump downshift as assumed in the analysis. This condition could adversely affect MCPR limits (Event Notification 37342).

In July 2000, the Fitzpatrick licensee reported finding the mechanical stops to limit speed of both recirculation pumps were set at values exceeding those assumed in the calculated flow-dependent MCPR in the core operating limit report. Assuming initial low flow, this error could result in exceeding the MCPR safety limit under postulated runaway recirculation flow (Event Notification 37196).

In January 1999, the fuel vendor Asea Brown Boveri-Combustion Engineering (ABB-CE) reported that BWR MCPR analyses using the BISON fast-transient analysis code could be nonconservative because the code incorrectly models the reactor vessel lower plenum volume (Part 21 Report 1999-07-0).

Also in January 1999, ABB-CE reported a potential nonconservative critical power ratio correlation (XL-S96) for SVEA-96 BWR fuel. This correlation is based on a cosine axial power shape, which could lead to nonconservative MCPR operating limits and nonconservatively monitored critical power ratios for top-peaked axial power shapes. This error affected WNP-2 for Cycle 14 after 5,600 MWD/MTU fuel exposure (Part 21 Report 1999-08-0).

In November 1998, ABB-CE reported that a defect in modeling radial power in the BWR fast-transient analysis code BISON-SLAVE could lead to nonconservative MCPR operating limits. The defect involves an input option that was incorrectly described in the code user manual and not the program coding itself. The affected nuclear power plants were WNP-2 and Susquehanna Unit 1 (Part 21 Report 1998-69-0).

In September 1998, the fuel vendor Siemens Power reported that BWR MCPR operating limits were nonconservative because in determining gap heat transfer coefficients used by the RODEX2 code for BWR transient analyses, fuel cladding was assumed to be cold-worked instead of annealed. The affected nuclear power plants were LaSalle Unit 2 for Cycle 8 and Quad Cities Unit 2 for Cycle 15 (Part 21 Report 1998-55-0).

In April 1998, the fuel vendor Siemens Power reported that additive constants used by the core monitoring system to determine MCPR for Atrium-9B fuel were nonconservative and more uncertain than previously estimated. The affected nuclear power plants were Dresden Unit 3 and Quad Cities Unit 2 (Part 21 Report 1998-33-0).

Discussion

All of these 11 events involved BWRs. They may be categorized as follows:

- 6 thermal modeling errors
- 2 other modeling errors
- 2 incorrect settings
- 1 control circuit modeling error

Each category represents a shortcoming in quality control measures. Individually, the events had little safety significance. Collectively, a significant number of similar events in a relatively short time may indicate a trend of deteriorating quality control of the MCPR safety parameter.

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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LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
2001-14	Problems with incorrectly-Installed Swing-Check Valves	10/03/01	All holders of operating licenses for nuclear power reactors, except those who have ceased operations and have certified that fuel has been permanently removed from the reactor vessel
2001-13	Inadequate Standby Liquid Control System Relief Valve Margin	08/10/01	All holders of operating licenses for boiling water reactors
2001-12 (ERRATA)	Hydrogen Fire at Nuclear Power Stations	8/08/01	All holders of operating licenses or construction permits for nuclear power reactors except those who have ceased operations and have certified that fuel has been permanently removed from the reactor vessel
2001-12	Hydrogen Fire at Nuclear Power Stations	7/13/01	All holders of operating licenses or construction permits for nuclear power reactors except those who have ceased operations and have certified that fuel has been permanently removed from the reactor vessel
2001-11	Thefts of Portable Gauges	07/13/01	All portable gauge licensees
2001-10	Failure of Central Sprinkler Company Model GB Series Fire Sprinkler Heads	06/28/01	All holders of licenses for nuclear power, research, and test reactors and fuel cycle facilities
2001-09	Main Feedwater System Degradation in Safety-Related ASME Code Class 2 Piping Inside the Containment of a Pressurized Water Reactor	06/12/01	All holders of operating licenses for pressurized water nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel

OL = Operating License
CP = Construction Permit