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

October 22, 1996

NRC INFORMATION NOTICE 96-56: PROBLEMS ASSOCIATED WITH TESTING, TUNING, OR RESETTING OF DIGITAL CONTROL SYSTEMS WHILE AT POWER

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to recent reactor transient events, reactor trips, and engineered safety feature actuations caused by testing, tuning, or resetting of digital control systems while at power. 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

Washington Nuclear Project 2 (WNP-2)

On July 20, 1996, the WNP-2 facility experienced a rapid change in power of 15 percent in a 40-second timeframe. Specifically, power dropped from 68 to 53 percent and returned to 68 percent. The licensee determined that the power transient resulted from testing of the recently installed digital adjustable speed drive modification to the reactor recirculation pumps. The adjustable speed drive provides the capability to change the speed of the reactor recirculation pump motors and eliminates the need for recirculation flow control valves.

Before the event, the licensee was preparing to increase reactor recirculation flow from 51 to 53 percent. As part of the preparation, a nonlicensed General Electric (GE) test engineer typed computer instructions that would return the reactor recirculation flow to 51 percent if electrical harmonics were experienced in the adjustable speed drive system during the reactor recirculation flow increase. Once these instructions were typed, a licensed reactor operator would verify the entry and only had to strike the "ENTER" key on the computer keyboard to execute the instruction. It was intended that the licensed operator would only hit the ENTER key and execute the instruction if the system started to experience electrical harmonics as reactor recirculation flow was increased. If there were no electrical harmonics, the instruction would not be executed. In this instance, the GE engineer typed an incorrect

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value (transposed numbers) and then mistakenly executed the instruction by striking the ENTER key. These actions caused reactor recirculation flow and reactor power to drop. Immediately after entering the data, the GE engineer recognized the error and corrected the instruction, thereby increasing reactor power. This event is discussed in NRC Inspection Report 50-397/96-16 dated September 12, 1996 (Accession No. 9609190275).

Dresden Unit 2

On May 31, 1996, while at approximately 45-percent power, Dresden Unit 2 experienced a loss of reactor feedwater control and a subsequent decrease in reactor vessel water level while performing an on-line configuration change to the recently installed Bailey Network 90 digital feedwater control system. Operators initiated a manual reactor scram as a result of the decrease in the reactor vessel water level.

Before the event, the licensee was performing startup testing of the Bailey Network 90 feedwater control system modification. During the startup testing, the test team determined that a minor software logic change was required to correct a problem associated with automatic transition from the 2B feedwater regulating valve to the 2A valve. An original equipment manufacturer representative indicated that the proposed software logic change could be completed with the control system on-line. The manufacturer representative indicated that the system would check the logic before going into the control mode and, as a result, there would be no impact on plant operation. The test team reviewed and approved the on-line logic change; however, the approval process was not documented per station procedure.

The new software logic configuration was inserted on the backup control module. Automatic diagnostic checks indicated a successful load into the control module. Upon placing the backup control module in the execute mode, the 2B feedwater regulating valve began to close, resulting in a sudden drop in feedwater flow and reactor vessel water level.

During a subsequent design review of the Bailey Network 90 feedwater control system, a logic execution sequence error was found in the original logic design of the Bailey Network 90 firmware. This error caused the 2B feedwater regulating valve to close when the backup control module attempted to take over process control from the primary module. It was determined that the execution sequence error would have resulted in the same process control failure any time the backup control module attempted to take control from the primary control module with the control system in the automatic mode. This event is discussed in NRC Inspection Report 50-237/96-06 dated August 22, 1996 (Accession No. 9609030142).

Browns Ferry Unit 2

On May 10, 1996, Browns Ferry Unit 2 experienced an automatic reactor scram on low reactor water level from full power. The low water level resulted from an unexpected runback of two of the three reactor feedwater pumps, which occurred while software parameter changes were being made in the recently installed digital feedwater control system. Specifically, the flow biasing of the feedwater pumps was being adjusted and the control system speed demand limit was being increased while at power in an effort to fine tune the system and thereby enhance system performance. When the software parameter changes were made active (saved) in the control system, a reinitialization sequence occurred within the control software block, which drove the feed pump speed demand signal to zero for a few seconds. Plant personnel were unaware that entering these new software parameters would cause the feedwater control system to reinitialize.

The cause of the event was attributed to inadequate design of the control system software. The digital feedwater control system is a Foxboro I/A distributed control system. The system software contains 380 software blocks, that is, logic functions performed by the computer. A design weakness existed in the installed system in that making software parameter changes in certain software blocks would cause the control system to automatically reinitialize to zero output. During its investigation, the licensee confirmed that for 5 of the 380 software blocks, a parameter change would result in a control system reinitialization. This characteristic of the software design was not known to the plant personnel. As part of its corrective actions, the licensee modified the five affected software blocks to eliminate the reinitialization problem. This event is discussed in NRC Inspection Report 50-260/96-05 dated June 19, 1996 (Accession No. 9607030386).

Comanche Peak Unit 2

On May 5, 1996, while in Mode 3, Comanche Peak Unit 2 experienced an auto-start of the motor-driven auxiliary feedwater pumps while personnel were resetting the central processing units in the digital main feedwater pump turbine control system. Before the event, the vendor representative for the newly installed main feedwater pump control system requested access to reset the central processing units following completion of system testing. The shift manager cautioned the vendor and nonlicensed utility instrumentation and controls personnel that two of the three processors were required to be in service to avoid a trip of the main feedwater pumps.

The instrumentation and controls personnel and the vendor representative planned to reset the three central processing units one at a time to avoid initiating a trip of the main feedwater pumps. The first two processors were rebooted. However, during the reset of the third processor, an inadvertent trip signal was generated for both main feedwater pumps. This signal caused an auto-start of the motor-driven auxiliary feedwater pumps (an engineered safety feature actuation). All four motor-driven auxiliary feedwater flow control valves shifted to auto and opened. Both motor-driven auxiliary feedwater pumps were operating and supplying the required flow to the steam generators before the event.

The licensee concluded that the personnel performing the rebooting task did not adequately verify that the second processor was properly restored and functional before rebooting the third processor. The main feedwater pump trip signal was generated because the system sensed that two of the three central processing units were not functional.

Discussion

In recent years, many licensees have chosen to replace outdated analog control systems with digital upgrades. Digital system retrofits are intended to improve system performance, reliability, flexibility, and operator interface characteristics. These systems also offer the capability to change software parameters, setpoints, or logic configurations or to reset processors while at power. However, as illustrated in the events previously described, resetting processors in digital control systems or performing on-line software manipulations as part of digital control system tuning or testing can result in unforeseen transients, reactor trips, and engineered safety feature actuations.

The events described herein highlight the importance of evaluating proposed changes and developing and implementing controls for performing any type of on-line manipulation of digital control systems to avoid reactor transients and plant trips. When it is deemed necessary to reset a processor or to perform on-line software changes, it is important to maintain control of these activities in order to minimize potential errors, and to be aware of the potential effect on plant operation if errors occur while performing such activities.

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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for Thomas T. Martin, Director
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Information Notice No.	Subject	Date of Issuance	Issued to
96-55	Inadequate Net Positive Suction Head of Emergency Core Cooling and Containment Heat Removal Pumps Under Design Basis Accident Conditions	10/22/96	All holders of OLs or CPs for nuclear power reactors
96-54	Vulnerability of Stainless Steel to Corrosion When Sensitized	10/17/96	All materials licensees
96-53	Retrofit to Amersham 660 Posilock Radiography Camera to Correct Inconsistency in 10 CFR Part 34 Compatibility	10/15/96	All industrial radiography licensees
95-04, Supp. 1	Excessive Cooldown and Depressurization of the Reactor Coolant System Following Loss of Offsite Power	10/11/96	All holders of OLs or CPs and vendors for nuclear power reactors
96-40, Supp. 1	Deficiencies in Material Dedication and Procurement Practices and in Audits of Vendors	10/07/96	All holders of OLs or CPs for nuclear power reactors
96-52	Cracked Insertion Rods on Troxler Model 3400 Series Portable Moisture Density Gauges	09/26/96	All U.S. Nuclear Regulatory Commission portable gauge licensees and vendors

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CP = Construction Permit

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original signed by D.B. Matthews
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