UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

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NRC INFORMATION NOTICE 2015-05 INOPERABILITY OF AUXILIARY AND EMERGENCY FEEDWATER AUTO-START CIRCUITS ON LOSS OF MAIN FEEDWATER PUMPS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those that have permanently ceased operations and that have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor combined license, standard design approval, or manufacturing license under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of several instances between 2006 and 2012 where licensees operated their main feedwater systems in such a manner that the automatic initiation of auxiliary or emergency feedwater on loss of all main feedwater pumps was disabled. The operating experience referenced in this IN applies to pressurized-water nuclear power reactors with turbine-driven main feedwater pumps. The NRC expects that recipients will review the information for applicability to their facilities and will consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Oconee Nuclear Station

On December 17, 2009, Oconee Nuclear Station submitted Licensee Event Report (LER) 269/2009-02, "Automatic Initiation of Emergency Feedwater upon Loss of Main Feedwater," to the NRC. In this LER, the licensee explained that on 16 occasions between 2006 and 2009, Oconee technical specifications related to the emergency feedwater (EFW) system were not met during low-power operations when one main feedwater (MFW) pump was running and the second MFW pump was in reset. The EFW pumps at Oconee are designed to receive an automatic start signal on loss of MFW while in Mode 1 or 2. Each EFW pump has two loss of MFW pump instrumentation channels that determine if the pump should start automatically.

The EFW loss of MFW automatic start circuitry senses the presence of hydraulic oil on the pressure switches for the MFW pump turbines. If hydraulic oil pressure is present, the EFW auto-start circuitry senses a running MFW pump, and it will not receive an auto-start signal.

At Oconee, a MFW pump turbine can be in the reset condition (i.e., hydraulic oil pressure present on the pressure switches) but be neither running nor aligned as a source of MFW. Therefore, with one MFW pump running and one in reset, the running pump could trip offline and the logic for the auto-start circuitry for the EFW pumps would not be satisfied because the presence of hydraulic oil on the pressure switches for the pump in reset makes it appear as if the pump is running and supplying feedwater to the steam generators (SGs). This situation would render the EFW automatic initiation on loss of MFW function inoperable. Oconee Technical Specification (TS) 3.3.14 requires that with one or more loss of MFW instrumentation channels inoperable, the channel or channels should be placed in trip within one hour.

The licensee took corrective action to address this operability concern by changing the design documentation and associated procedures to provide the ability to isolate the loss of MFW circuit to provide a channel trip, as prescribed in TS 3.3.14 Condition A.

Watts Bar

In the August 7, 2008, quarterly NRC Inspection Report (IR 050000390-08-03), Watts Bar Unit 1 received a green non-cited violation for starting up the plant without an operable channel of auxiliary feedwater (AFW) set to automatically start on a trip of all MFW pumps as required by the TS. In the inspection report, the NRC determined that Watts Bar Unit 1 had been operating this way since the plant's initial startup. The plant was originally designed to supply water to the steam generators by using the motor-driven standby MFW pump during startup. A design change in 2006 caused the licensee to begin using the two motor-driven AFW (MDAFW) pumps for startup, but not the turbine-driven AFW (TDAFW) pump. There were concerns about the high flow rate from the TDAFW pump making reactivity control difficult at low power levels. In order to avoid automatic initiation of all three AFW pumps during startup, one of the turbine-driven MFW pumps was left in reset with hydraulic control oil present at its pressure switches during startup so it would be seen by the automatic AFW initiation circuitry as a running pump. Therefore, if the running turbine-driven MFW pump tripped offline, the licensee would avoid a situation where all three AFW pumps began pumping water into the SGs at low power.

Although the licensee's procedure was intended to avoid a potential overcooling or reactivity transient, it was nonetheless non-compliant with TS 3.3.2, Function 6.e, which requires one automatic initiation channel per AFW pump to be available on a trip of all MFW pumps while in Modes 1 or 2.

In September 2008, the licensee submitted a TS amendment request to modify the applicability of TS 3.3.2, Function 6.e and address the TS non-compliance. The amendment added a note to Table 3.3.2-1 in the TS to allow the licensee to operate in Mode 1 with an inoperable turbine-driven MFW pump trip channel for up to four hours while either placing the second turbine-driven MFW pump in service or removing one of the two turbine-driven MFW pumps from service. This note essentially delays the licensee's entry into TS 3.3.2 Condition J (one or more turbine-driven MFW pump trip channels inoperable) for up to four hours during startup or shutdown.

The amendment added a second note to TS Table 3.3.2-1 that applies to operation in Mode 2, with reactor power between 2 percent and 4 percent. The note states that the auto-start

channel for AFW does not need to be operable until after the first turbine-driven MFW pump has been placed in service. In other words, the licensee can place the anticipatory AFW auto-start channel in bypass for the non-operating turbine-driven MFW pump while the first pump is undergoing rollup trip testing and overspeed trip testing. This precaution prevents having an auto-start of all three AFW pumps at very low power, which could cause an over-cooling or reactivity transient. Once the first turbine-driven MFW pump is running and maintaining SG level, the AFW auto-start channel for the non-operating turbine-driven MFW pump is placed in the trip condition, and any operating AFW pumps are secured. The licensee also submitted LER 390/2008-003 in October 2008 describing this issue.

Callaway and Wolf Creek Generating Station

Callaway and Wolf Creek Generating Station have very similar designs. Both plants submitted LERs in spring 2010 summarizing a condition similar to what the licensees at Oconee and Watts Bar noted. After reviewing the operating experience from Oconee, both Wolf Creek Generating Station and Callaway put the issue into their corrective action programs. Both licensees were concerned about the design feature whereby a MFW pump in reset can provide indication that it is in service when it is not actually supplying water to the SG. In this condition, a trip of the running MFW pump while the second pump is in reset (hydraulic trip fluid present at the pressure switches to hold the MFW pump steam stop valves open) would not cause the motor driven AFW pumps to start because the circuitry that controls the anticipatory auto-start function of the motor driven AFW pumps would see the reset condition as a running MFW pump, and the two-out-of-two logic for AFW auto-start would not be satisfied. In LER 482/2010-001, the licensee for Wolf Creek Generating Station stated that this situation is created routinely during normal plant startup when one MFW pump is in operation but the other MFW pump is in reset to support maintenance or other operational activities.

Wolf Creek Generating Station and Callaway TS 3.3.2, “Engineered Safety Feature Actuation System (ESFAS) Instrumentation,” Table 3.3.2-1, Function 6.g, “Auxiliary Feedwater – Trip of all Main Feedwater Pumps,” requires two trip channels per MFW pump to be operable in Mode 1. At the time the LER was written, the TS for Wolf Creek Generating Station and Callaway had a condition, TS 3.3.2 Condition J, that stated, “One Main Feedwater Pump trip channel inoperable.” The Required Action J.1 was to “Place the channel in trip.” In the case of Wolf Creek Generating Station and Callaway, an MFW pump in reset would have two trip channels inoperable. Therefore, in order to meet the circuit’s one out of two taken twice logic and ensure proper auto-start of the AFW pumps should the running MFW trip, both channels on the reset pump would have to be placed in trip. Therefore, both licensees submitted license amendment requests to modify Condition J to read, “One *or more* Main Feedwater Pump trip channel*(s)* inoperable,” and modify Required Action J.1 to read, “Place channel*(s)* in trip.” These changes ensure that the affected channels will be placed in a safe condition, and the licensees will not be forced to enter limiting condition of operation (LCO) 3.0.3 each time an MFW pump is placed in a reset condition with one MFW pump in operation.

Comanche Peak

The licensee of Comanche Peak submitted LER 445/2010-002 in March 2010 (supplemented by LER 445/2010-002-01 in June 2010). The licensee noted it had reviewed the Oconee operating experience and discovered parallels between its design and that of Oconee. Of note, Comanche Peak is a Westinghouse 4-loop design, as are Watts Bar, Callaway, and Wolf Creek. After reviewing the Oconee operating experience, the licensee at Comanche Peak determined that, during low-power operations, with only one MFW pump operating and the second

MFW pump in reset (hydraulic trip fluid maintaining its steam stop valves open), the AFW auto-start circuit for loss of all MFW pumps would be inoperable. Just like the plants mentioned above, the reset condition of the second MFW pump would be seen by the trip circuit as a running pump in the event that the operating MFW pump tripped offline. Therefore, the associated MFW pump trip channel would be inoperable per Condition J of TS 3.3.2. Comanche Peak operators had not entered Condition J of TS 3.3.2 with the plant in this configuration since original plant startup in 1990, and consequently may not have met the required completion times for the actions associated with Condition J.

The Comanche Peak licensee addressed the situation with procedure changes that add two caution notes to its plant startup procedure to ensure compliance with TS 3.3.2 and Table 3.3.2-1 Function 6.g. The procedural changes essentially remind operators to comply with TS 3.3.2 and ensure that, in Mode 1 or 2, the non-operating MFW pump remains tripped or has its trip oil pressure switches isolated. The licensee for Comanche Peak is still considering options for potential TS changes to address this issue.

Three Mile Island

When the licensee of Three Mile Island (TMI) reviewed the Oconee operating experience, it realized that TMI had the same vulnerability with regard to a MFW pump in reset being seen by the EFW auto-start logic as a running pump based on the presence of hydraulic control oil at the pressure switches. An additional concern existed at TMI. Specifically, with a single MFW pump in reset and the other MFW pump providing feedwater flow while reactor power was greater than 7 percent, a loss of the running MFW pump would not result in an anticipatory reactor trip. Like Oconee, TMI is a Babcock and Wilcox pressurized-water reactor. TMI has custom technical specifications, and TS 3.5.1.9.1 requires that when one Heat Sink Protection System actuation logic train is inoperable, the logic train shall be restored to operable or placed in an actuated (tripped) state within 72 hours. If this action is not completed within the specified time frame, then the TS requires the plant to be in hot shutdown within the next 12 hours. Additionally, the TS requires that when both Heat Sink Protection System actuation logic trains are inoperable, one train must be restored to operable within one hour or the plant must be in hot shutdown within the next six hours.

The licensee corrective actions resulting from the LER were to: (1) revise operating procedures to recognize entry into the TS Limiting Condition for Operation; (2) evaluate possible design modifications to preclude entry into the identified condition; (3) evaluate operator and technical training needs to correct deficiencies; and (4) evaluate potential improvements to the TS and TS Bases.

DISCUSSION

For pressurized-water reactors, the AFW system (EFW system on Babcock and Wilcox designs) provides a secondary side heat sink for the reactor by supplying water to the SGs in the event that the MFW system is not available. The system normally has two motor-driven pumps and one turbine-driven pump, making it available during normal operation, loss of alternating current (AC) power, loss of MFW, or a feedwater system pipe break. The normal source of water for the AFW system is the condensate storage tank, and the backup suction source is the safety-related essential service water system. The AFW system is aligned so that upon a pump start, flow is initiated to the respective SGs immediately.

A turbine driven MFW pump is typically equipped with two pressure switches on the control air/oil line for the speed control system. A low-pressure signal from either of these pressure switches indicates a trip of the MFW pump. Two operable channels per pump satisfy redundancy requirements with one-out-of-two taken twice logic. A trip of all MFW pumps starts the motor-driven and turbine-driven AFW pumps to ensure that at least one SG is available with water to act as a heat sink for the reactor. (Note: Plants with motor-driven MFW pumps sense the position of the pump's supply breaker to determine whether the pump is running.)

AFW flow can be initiated manually to facilitate plant startup, shutdown, or in the event of an emergency. Automatic AFW system initiation occurs on plant conditions that include low SG water level, trip of all MFW pumps, reactor coolant pump under voltage, loss of offsite power, and a safety injection signal. Plants may have additional automatic AFW system initiation signals based on their specific designs.

Although the issues described all have low safety significance and did not challenge any safety systems, each issue includes aspects of either TS non-compliance on the part of the licensee, inadequate TS, or a plant design and/or operating procedures that did not ensure compliance with TS. Licensees are encouraged to review their MFW pump startup procedures and affected TS, and make any necessary revisions to maintain TS compliance.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or to the appropriate Office of Nuclear Reactor Regulation project manager in the Division of Operating Reactor Licensing.

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