

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

April 27, 2016

NRC INFORMATION NOTICE 2016-05: OPERATING EXPERIENCE REGARDING
COMPLICATIONS FROM A LOSS OF
INSTRUMENT AIR

ADDRESSEES

All holders of an operating license for a non-power reactor (research reactor, test reactor, or critical assembly) under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations.

All holders of an operating license or construction permit for a nuclear power reactor under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor combined license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of several reactor events during which operator response was complicated by a loss of instrument air. 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 IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Pilgrim Nuclear Power Station

On January 27, 2015, Pilgrim Nuclear Power Station experienced a loss of off-site power (LOOP) during a severe winter storm. A backup diesel-driven air compressor, installed to maintain instrument air system pressure during LOOP scenarios, failed to start on low instrument air pressure. The starting battery lacked the capacity to start the diesel-driven air compressor, and licensee testing did not include starting the compressor disconnected from its normal power source. As a result, the station experienced a sustained loss of instrument air. The letdown isolation valve in the reactor water cleanup system had, by design, failed in the closed position on the loss of instrument air. This challenged operator control of reactor

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pressure and reactor water level, and resulted in the safety relief valves cycling opened/closed 105 times in order to control reactor water pressure and level until a temporary air supply could be aligned to the letdown isolation valve. The loss of instrument air also impacted high pressure coolant injection (HPCI) system operability. Condensate in the systems that would normally be routed from the gland seal condenser through air-operated valves to the waste system following HPCI pump shutdown was trapped in the gland seal condenser and HPCI suction piping and began to leak from the gland seal blower.

The ability of operators to cope with, and recover from, the loss of instrument air was complicated by inadequate procedural guidance. Specifically, the loss of instrument air procedure did not identify contingencies in the event that the diesel-driven air compressor failed to operate. It also did not alert operators of the potential impact a loss of instrument air could have on the HPCI system and other systems relied upon by the operators to respond to various plant events. Further complicating matters, operators never received training on a sustained loss of instrument air scenario in the plant simulator.

The NRC chartered a Special Inspection Team to review this event. Further details are available in the NRC Special Inspection Report 05000293/2015007, dated May 27, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15147A412).

Millstone Power Station, Unit 3

On May 25, 2014, a fault on the off-site electrical grid resulted in a dual-unit LOOP at the Millstone station. The response at Unit 2 was uncomplicated, but at Unit 3 the recovery was complicated by a loss of instrument air. Although instrument air is a nonsafety-related system at the station, one of the instrument air compressors at Unit 3 is powered from a safety bus, and should have been able to be manually started from the control room after the emergency diesel generators had assumed electrical loads on the safety busses. The licensee later determined that a failed nonsafety-related start-permissive relay, which had been installed during plant construction, had prevented the compressor from being started from the control room.

The loss of instrument air meant that the reactor coolant system letdown isolation valves drifted shut as air pressure lowered, causing pressurizer level and pressure to rise. The LOOP caused a loss of reactor coolant pumps, which are powered from nonsafety-related busses, so normal pressurizer pressure reduction using pressurizer spray was also unavailable. Inadequate procedural guidance for responding to a loss of instrument air coincident with a LOOP challenged operators in the timely execution of the post-trip response. Pressurizer power-operated relief valves (PORVs) cycled six times automatically, and operators manually cycled a single PORV five additional times to maintain pressurizer pressure. To prevent filling the pressurizer solid, operators established a letdown path through the reactor vessel head vents to the pressurizer relief tank (PRT). The volume of water diverted to the tank caused the PRT rupture disc to rupture, diverting inventory from the reactor coolant system to containment.

The NRC dispatched a Special Inspection Team to review this event. Further details can be found in the Millstone Licensee Event Report 05000336/2014-006-00, dated July 24, 2014 (ADAMS Accession No. ML14211A526), and in NRC Special Inspection Report 05000335/2014011 and 05000423/2014011, dated August 28, 2014 (ADAMS Accession No. ML14240A006).

Turkey Point Nuclear Generating Station, Unit 3

On August 11, 2014, a non-licensed operator on rounds mistakenly unloaded the running instrument air compressor. As instrument air system pressure lowered, the two diesel-driven standby compressors started, but a latent software design flaw prevented them from loading. As operators attempted to restart and load the standby compressors, instrument air pressure on Unit 3 continued to lower, and operators inserted a reactor trip, as required by procedure. On Unit 4, operators were able to locally restart the standby compressors following an emergency stop, and system pressure was restored before system pressure reached the procedure setpoint for a reactor trip.

Immediately following the loss of instrument air, operators isolated instrument air to containment, following procedures to address an instrument air leak in containment. Although instrument air system pressure was restored within 10 minutes, instrument air to containment remained isolated for 2.5 hours while operators responded to indications of a leaking air valve. The resulting continued loss of instrument air to containment caused the loss of letdown flow, normal pressurizer pressure control, and pressurizer auxiliary spray. This resulted in automatic cycling of a pressurizer PORV (which operated on safety-related backup nitrogen pressure) to reduce pressurizer pressure. Operators attempted to cool down the plant, but neither the loss of instrument air abnormal operating procedure nor the reactor trip emergency operating procedure provided adequate guidance for the situation. A safety injection signal actuated on high differential pressure between the main steam line and one of the steam generators, causing the emergency diesel generators, residual heat removal pumps, and high head safety injection pumps to start. Because of plant conditions at the time, no injection to the reactor coolant system actually occurred.

Additional information appears in Turkey Point Licensee Event Report 05000250/2014-005-00, dated October 10, 2014 (ADAMS Accession No. ML14303A475), and NRC Integrated Inspection Report 05000250/2014005 and 05000251/2014005, dated January 30, 2015 (ADAMS Accession No. ML15030A278).

DISCUSSION

Instrument air systems are typically not safety-related, and are not required to meet single failure criteria or the rigorous design, testing, and maintenance requirements of safety-related equipment. However, failures of these systems can have an adverse impact on safety by challenging equipment and operator response during events. Safety-related components that require air pressure to function for event response typically have a safety-related supply of air (or gas), but this provides only a limited number of cycles. In addition, plant components respond to a loss of air in different ways, and may fail closed, open, or as-is. As this situation often impacts multiple systems simultaneously, a loss of instrument air can pose significant challenges for operators, both in the diagnosis of and response to the event.

Unit technical specifications require written procedures be established, implemented, and maintained for operations, including loss of instrument air, loss of power, and reactor trip. Plant operating procedures for a loss of instrument air provide guidance for responding to the basic event. Procedures that provide clear guidance regarding the potential impacts of a loss of instrument air, particularly on safety-related equipment and on reactor pressure and level control, as well as actions to be taken to bring a plant safely to cold shutdown in the event of a sustained loss of instrument air, minimize the challenges for operators facing these events. Well-vetted procedures help to reduce complications that can result during a loss of instrument

air event, particularly from excessive cycling of safety relief valves. Training scenarios incorporating a sustained loss of instrument air provide a valuable opportunity to verify the accuracy and completeness of procedures, and prepare operators, both in the control room and out in the plant, to respond to this complex event.

CONTACT

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

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