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

September 3, 1992

NRC INFORMATION NOTICE 92-65: SAFETY SYSTEM PROBLEMS CAUSED BY MODIFICATIONS THAT WERE NOT ADEQUATELY REVIEWED AND TESTED

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 problems caused by inadequate review and testing of safety system modifications. 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

The following describes two examples of safety system design errors that went undetected since construction, because design changes were not thoroughly reviewed and tested.

On October 10, 1991, during post overhaul testing, personnel at Arkansas Nuclear One, Unit 1, observed that one of the high-pressure safety injection (HPSI) pumps was losing its lubricating oil at a rate of more than 15 gallons per hour as a result of oil spraying from the bearings. The licensee found that the oil would always leak at this rate during emergency operation because of excessive oil pressure caused by the simultaneous operation of two oil pumps that served the HPSI pump. This condition had existed since the plant began operation.

The bearings for each of the HPSI pumps are supplied with lubricating oil by two oil pumps, one attached directly to the HPSI pump itself and the other a separate electric backup pump. Originally the electric oil pumps were intended to be used during start up of a HPSI pump or to replace a malfunctioning attached oil pump. The electric oil pumps could be started manually and would start automatically when the oil pressure decreased below a certain point. The licensee continues to use this method of control when the HPSI pumps are used for normal reactor water makeup. However, during construction, the licensee decided that the HPSI pumps would be more reliable if the electric lubricating oil pumps ran continuously during emergency operation. Consequently, the licensee modified the emergency controls to keep

the electric oil pumps operating whenever an emergency safety features actuation system (ESFAS) signal was present. Anticipating that the simultaneous operation of both oil pumps could cause excessive oil pressure, the licensee added an oil pressure relief valve to the oil system. However, the relief valve settings were not appropriately selected to prevent oil spraying from the bearings.

In September 1991, the Gulf States Utilities Company, licensee for the River Bend Station, discovered that the outlet valves for the hydrogen mixing system would immediately close if an operator attempted to start up the system by opening these valves when a loss-of-coolant accident (LOCA) signal was present. An interlock prevented the mixing system fans from operating with the outlet valves closed. Consequently, the hydrogen mixing system would have been inoperable if a LOCA signal were present. This condition had existed since the plant was constructed.

The River Bend Station is a boiling water reactor with a Mark III containment structure. This containment structure consists of two chambers, a large outer primary containment and a drywell which is inside the primary containment and surrounds the reactor vessel. This system suppresses the steam pressure released during a LOCA by directing the steam through the suppression pool water into the primary containment. After the initial pressure suppression is complete following a LOCA, hydrogen created by the zirconium-water reaction would be mainly concentrated in the drywell. The hydrogen mixing system is provided to reduce the concentration of the hydrogen in the drywell by moving it into the primary containment where it is diluted and reduced in concentration by the hydrogen recombiners.

The redundant hydrogen mixing systems each have two lines penetrating the drywell; an outlet line having a recirculating fan to draw suction from the drywell and an inlet line that allows diluted air to reenter the drywell. Each of these lines has two isolation valves which are normally closed during plant operation. In 1983, during construction, the licensee added a LOCA interlock to the hydrogen mixing system that would automatically close all eight of the mixing system valves upon receiving a LOCA signal. In 1984, the licensee revised the control logic for the mixing system valves to automatically override a LOCA signal when the operator opened the drywell inlet valves. However, the licensee did not provide this LOCA override capability for the outlet line valves.

Discussion

In both of these cases, the licensee changed the design with the intention of increasing the reliability of safety systems. However, because the licensees did not adequately review and test the designs, these changes introduced errors that could have prevented the systems from performing their safety functions as intended.

At Arkansas Nuclear One, the licensee intended to increase the reliability of the HPSI system by causing both HPSI oil pumps to operate simultaneously when an ESFAS signal was present. However, the oil pumps had apparently never been run simultaneously for any extended period until the recent overhaul test.

The licensee routinely conducted the required periodic pump surveillance tests with the HPSI operating in the normal reactor makeup mode with only one oil pump running at a time. The licensee tested the effectiveness of the ESFAS signal during each refueling outage. However, the test only required verification that the test signal would actuate the HPSI system and did not result in the simultaneous operation of the two oil pumps for an extended time. As a result, neither of these tests revealed the oil leakage problem. The licensee estimated that a HPSI pump would have performed satisfactorily for only 80 minutes without operator action to replenish the oil or to stop the electric oil pumps. With an ESFAS signal present, the electric oil pumps cannot be stopped from the control room, but must be stopped by opening local power supply breakers.

The licensee has modified the oil pressure relief valve settings to minimize the oil leakage. Procedures were established that instruct the operators to stop the electric oil pumps 15 minutes after an ESFAS actuation of the pumps.

At River Bend, the control logic to automatically close all of the mixing system valves was provided to ensure that the drywell integrity would be restored if a LOCA occurred during a mixing system test with the valves open. Apparently, the LOCA override for the inlet valves was provided later to permit the drywell to be depressurized to clear a false LOCA signal that might be caused by a loss of offsite power. The false LOCA signal could be generated by the drywell pressure rise that would accompany a loss of drywell cooling. Since the drywell could be depressurized without opening the outlet valves, the LOCA override was not provided for these valves. The need to open the outlet to operate the hydrogen mixing was apparently not considered for this change. Normal surveillance testing did not reveal this design error because it was never conducted with a LOCA signal present.

When the licensee discovered this design error, it declared both hydrogen mixing trains inoperable and commenced shutting down the reactor. The licensee then developed a LOCA bypass procedure for the hydrogen mixing system.

These events highlight the importance of thoroughly reviewing any safety-related design change, including considering the effect of the change on all related systems. The events also show the need for completely testing the systems affected by the design change under conditions that simulate as nearly as possible those conditions that are expected to exist when the systems are needed.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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

Technical contact: Thomas F. Westerman, RIV
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Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
92-64	Nozzle Ring Settings on Low Pressure Water-Relief Valves	08/28/92	All holders of OLs or CPs for nuclear power reactors.
92-63	Cracked Insulators in ASL Dry Type Transformers Manufactured by Westing-house Electric Corporation	08/26/92	All holders of OLs or CPs for nuclear power reactors.
92-62	Emergency Response Information Require-ments for Radioactive Material Shipments	08/24/92	All U.S. Nuclear Regulatory Commission licensees.
92-61	Loss of High Head Safety Injection	08/20/92	All holders of OLs or CPs for nuclear power reactors.
60	Valve Stem Failure Caused by Embrittlement	08/20/92	All holders of OLs or CPs for pressurized water reactors (PWRs).
92-59	Horizontally-Installed Motor-Operated Gate Valves	08/18/92	All holders of OLs or CPs for nuclear power reactors.
92-58	Uranium Hexafluoride Cylinders - Deviations in Coupling Welds	08/12/92	All Fuel Cycle Licensees.
92-57	Radial Cracking of Shroud Support Access Hole Cover Welds	08/11/92	All holders of OLs or CPs for boiling water reactors (BWRs).
92-56	Counterfeit Valves in the Commercial Grade Supply System	08/06/92	All holders of OLs or CPs for nuclear power reactors.
92-55	Current Fire Endurance Test Results for Thermo-Lag Fire Barrier Material	07/27/92	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit