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

May 9, 1988

NRC INFORMATION NOTICE NO. 88-21: INADVERTENT CRITICALITY EVENTS AT OSKARSHAMN AND AT U.S. NUCLEAR POWER PLANTS

Addressees:

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

Purpose:

This information notice is being provided to alert addressees to undesirable procedural practices that could lead to inadvertent criticality events in nuclear power plants. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On July 30, 1987, an unplanned criticality event occurred at Oskarshamn Unit 3, a boiling water reactor (BWR) in Sweden, during routine control rod shutdown margin testing. A night shift team, consisting of a shift supervisor, a physicist, and an operator, had decided to proceed with shutdown margin testing, even though they knew that the fast-acting hydraulic scram system was inoperable. A slower acting electric rod insertion system and the boron injection system remained operational.

Upon partial withdrawal of the first control rod, the core unexpectedly went critical. Although the flux rise was indicated on the instrument panels, the team was not immediately aware that the reactor was critical. However, the control logic for the electric system was initiated by the high flux signal, blocking further withdrawal and reinserting the control rod.

The team then reset the electric control system and continued the test on a second control rod without further incident. The night shift was in the process of testing a third control rod when they were relieved by the day shift. The night shift apparently failed to inform the day shift of the

inoperable fast-acting hydraulic scram system. The day shift had completed testing the third rod and had started testing the fourth rod when they discovered that the hydraulic scram was inoperable. They then stopped further testing and reported the situation to their supervisors.

Several unplanned criticality events have occurred at nuclear power plants in the United States, although none have been reported in which the crew deliberately withdrew rods with an inoperable scram system.

On November 7, 1973, an inadvertent criticality event occurred at the Vermont Yankee nuclear power plant when an operator withdrew a control rod with the adjacent rod already in the fully withdrawn position. At the time of the event, the reactor was shut down with the reactor vessel and primary containment heads removed, and the refueling cavity above the reactor vessel flooded. Control rod friction tests and core verification procedures were in progress simultaneously. To allow traversing of the television camera mounted on the fuel grapple while rods were being withdrawn for the friction tests, the operators used jumpers to defeat the refueling interlock of the manual control system for the control rods. Contrary to the normal refueling condition, this action permitted the withdrawal of more than one rod at a time.

As the rod testing progressed, the rod in position 30-23 was inadvertently left in the fully withdrawn position. Meanwhile, the core verification procedure was completed, but the interlock jumpers were not immediately removed. The reactor operator conducting the rod testing failed to observe that rod 30-23 was still withdrawn and withdrew an adjacent rod in position 26-23. At about rod notch position 16, the reactor went critical. Somewhere between notch positions 20 and 26, the operator saw the power rising on the nuclear instruments and attempted to insert the rod. However, a full scram was initiated by the high-high flux signals on the intermediate-range monitors.

Because the scram system remained operational and terminated the power rise, the event did not cause any serious consequences. The dosimeter readings of the personnel working on the refueling floor were normal. Five fuel assemblies in the affected area were removed for inspection and testing, and no damage was found.

On November 12, 1976, an inadvertent criticality event occurred at Millstone Unit 1 when an operator withdrew the wrong control rod during a shutdown margin test on a partially loaded core. The operator was supposed to withdraw two diagonally adjacent control rods, in positions 46-23 and 42-19, as part of a shutdown margin test during a core-loading procedure. The operator had positioned rod 46-23 at notch 10, but then erroneously selected the rod at position 46-19, which was directly adjacent to the first rod, and withdrew it to notch 10 also. He then continued to withdraw rod 46-23 in steps. When rod 46-23 was

withdrawn from notch 14 to notch 16, the reactor went critical and scrammed a few seconds later. A few minutes later, the operator made the same error, withdrawing both rods 46-23 and 46-19 to notch 10 and then attempted to withdraw rod 46-23 further. This time the operator saw that the startup-range monitor was increasing and inserted the rods before another scram occurred.

Once again, the presence of an operational scram system prevented any serious consequences from this event. Personnel exposures were normal. The four fuel bundles surrounding rod 46-23 were removed, partially disassembled, and examined. No damage was found.

Discussion:

These events highlight the importance of maintaining an operable fast-acting scram capability whenever any coupled control rods are withdrawn from a reactor core. Licensees are encouraged to review their procedures and training programs to ensure there is no ambiguity on this point.

These events also highlight the importance, during control rod manipulations, of following procedures and staying alert to the relevant instrumentation, even when the reactor is not expected to become critical. In each of the three cases described, procedures were violated. At Oskarshamn, withdrawing control rods with the fast-acting scram inoperable was a violation of the plant procedures. At Vermont Yankee, the "Lifted Lead Log" procedure that was required to be used for jumper installation was not adhered to. The jumper installation was not recorded in the general plant log and consequently operating personnel were not adequately informed of the jumpered interlock status. In addition, the jumpers were not removed immediately after core verification. At Millstone, the operator who was performing the shutdown margin test reselected the incorrect control rod and tried to withdraw it a second time without determining the cause of the initial reactor scram.

In each of the three cases, the operators failed to observe indications on the instruments that could have prevented or mitigated the event. At Oskarshamn, when the core unexpectedly went critical, the flux rise was indicated on the instrument panels. However, the operators were not immediately aware that the reactor was critical. At Vermont Yankee, the operator failed to observe that rod 30-23 was mistakenly left in the withdrawn position, though it was later proved that the rod's digital position display was functioning properly. At Millstone, the operator observed that the startup-range monitor was increasing during the second erroneous rod withdrawal and managed to prevent a second reactor trip. If the operator had observed that the startup-range monitor was increasing the first time, both the initial criticality and the subsequent repetition of the error might have been prevented.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the technical contacts listed below or the Regional Administrator of the appropriate regional office.

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

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(301) 492-1188

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(301) 492-1152

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
88-20	Unauthorized Individuals Manipulating Controls and Performing Control Room Activities	5/5/88	All holders of OLs or CPs for nuclear power, test and research reactors, and all licensed operators.
88-19	Questionable Certification of Class 1E Components	4/26/88	All holders of OLs or CPs for nuclear power reactors.
88-18	Malfunction of Lockbox on Radiography Device	4/25/88	All NRC licensees authorized to manufacture, distribute, and/or operate radiographic exposure devices.
88-17	Summary of Responses to NRC Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants"	4/22/88	All holders of OLs or CPs for nuclear power reactors.
88-16	Identifying Waste Generators in Shipments of Low-Level Waste to Land Disposal Facilities	4/22/88	Radioactive waste collection and service company licensees handling prepackaged waste, and licensees operating low-level waste disposal facilities.
88-15	Availability of U.S. Food and Drug Administration (FDA)-Approved Potassium Iodide for Use in Emergencies Involving Radioactive Iodine	4/18/88	Medical, Academic, and Commercial licensees who possess radioactive iodine.
88-14	Potential Problems with Electrical Relays	4/18/88	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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~~D/DOEA:NRR~~	*C/OGCB:DOEA:NRR	*PPMB:ARM	*D/DEST:NRR	*SAD/DEST:NRR
~~CERossi~~	CHBerlinger	TechEd	LCShao	AThadani
~~04/3~~/88	04/15/88	04/08/88	04/26/88	04/25/88
*OGCB:DOEA:NRR	*OTSB:DOEA:NRR	*SC/OTSB:DOEA:NRR	*C/OTSB:DOEA:NRR	*C/SRXB:DEST:NRR
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04/07/88	04/14/88	04/25/88	04/25/88	04/25/88

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