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

August 15, 1988

NRC INFORMATION NOTICE NO. 88-63: HIGH RADIATION HAZARDS FROM IRRADIATED INCORE DETECTORS AND CABLES

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors, research reactors and test reactors.

Purpose:

This information notice is being provided to alert addressees to the recent high exposure event at Surry Unit 2 resulting from the failure to adequately evaluate the radiation hazards present during work involving irradiated incore neutron detectors. Similar events have occurred at other facilities and are summarized in Attachment 3. 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 March 3, 1988, with Unit 2 at 100-percent power and the containment at subatmospheric pressure, two instrument and control (I&C) technicians and one health physics (HP) technician entered the Surry Unit 2 containment to free a stuck incore detector and drive cable, transfer it to a storage location, and replace the detector and associated drive cable with new equipment (see Figure 1). According to the licensee's event investigation report, the "A" detector cable became mechanically bound in the "B" 10-path transfer device (the incore detector system was being operated in the "Emergency" mode at the time because the "B" incore detector was inoperable). This resulted in the "A" detector and cable being lodged in the core. The binding was a result of the 10-path transfer device becoming misaligned when the 10-path transfer device attempted to rotate to the next core thimble position while the cable

was still inserted in the previous core thimble location. The bound cable could not be electrically retracted from the core.

During efforts to dislodge the detector, about 100 feet of the cable attached to the detector were manually pulled into the Seal Table Room, through the polar crane wall, and taken up on the "A"-drive-unit reel assembly in the outer annulus area. As the incore detector was pulled up to the penetration through





the crane wall (see Figure 2), the HP technician noted rapidly increasing radiation levels near the transfer tube which soon exceeded the maximum onscale reading of his survey meter (1000 R/hr). He then ordered the work stopped and the work platform evacuated. Dose estimates performed by the licensee show that whole body doses for the three workers ranged from approximately 700-1000 mrem. The worker who held and pulled the cable received a dose of 800 mrem to his hand. The beta dose contribution to the workers was small because the stainless steel tube casing through which the activated drive cable was inserted effectively attenuated the beta radiation.

Subsequent licensee and NRC regional review of the event revealed several key factors that contributed to the incident.

1. Failure To Adequately Evaluate the Radiation Hazards Present During Work on an Incore Detector

   Licensee personnel had freed stuck detectors several times in the past. Radiation levels associated with the detector typically ranged between 5 and 35 R/hr; the drive cable had never exhibited significant induced activity. The principal radionuclide of concern in the drive cables used at Surry is manganese-56, which has a half-life of 2.56 hours and which accounts for 99 percent of the dose rate once it has reached equilibrium in the core. (NOTE: the principal radionuclide of concern may vary depending on drive cable composition and core irradiation/decay time.) The reason for the typically low activity levels of the drive cable in the past at Surry is that either the cable had resided in the core for only a short time or that it was allowed to decay to background levels between the time it was removed from the core and the time it was

withdrawn into the Seal Table Room. However, in this event, the drive cable (which had been in the core at 100-percent power for 26 days) had decayed for only 15 minutes before being withdrawn through the Seal Table Room into the outer annulus area and, therefore, was highly radioactive. The licensee failed to evaluate the radiation hazards from the drive cable and several feet of activated cable were manually pulled into the outer annulus area before the HP technician halted work and ordered all personnel out of the area. Survey meter readings of more than 1000 R/hr were measured 12 inches from the cable.

2. Use of Inadequate Procedures With Insufficient Radiological Controls

Because no special procedure was available for freeing the stuck incore detector, the licensee wrote a temporary change to the normal procedure for replacing the detector to cover this operation. This procedure change did not offer any precautions about assessing the detector's location and stay time (irradiation time) in the core or the resultant detector or cable radiation levels. It also did not contain any stop-work limitations based on measured radiation levels or steps to permit withdrawal of the detector through the Seal Table Room and up to the polar crane wall.



Finally, this procedure did not have any requirements for using extremity dosimeters while manually retracting the drive cable. If this procedure had been formally reviewed (as is required by the licensee's Technical Specifications when the purpose of the procedure is changed), the radiological controls described above might have been included.

3. Lack of Communication Among Individuals and Work Groups

Performance of this job under a Standing Radiation Work Permit (RWP) instead of under a Special RWP allowed the job to be carried out without prior review by Health Physics personnel or establishment of special radiological controls. The HP technician covering the job did not receive an adequate pre-job briefing and was not provided with sound-powered headphones to communicate with the control room during the job, as were the other two technicians performing the work. Therefore, he was not aware of the detector's location as it was being withdrawn. In addition, all three individuals performing the work were wearing respirators (because of reduced oxygen in the subatmospheric containment), further hindering communications among the members of the work party.

As a result of this event, the licensee has initiated certain corrective actions which include the following:

(a) Revision of the procedure to replace incore detectors to include steps to free stuck detectors. Performance of this procedure will require the approval of the HP Shift Supervisor, the use of a Special RWP, limitations on manual withdrawal of the detector drive cable, and an evaluation of radiological hazards and detector location.

(b) Revision of appropriate training programs and procedures to incorporate the lessons learned from this event.

(c) Informing appropriate station personnel of the key points and lessons learned from this event.

Discussion:

Irradiated components, such as incore flux detectors and attached drive cables, can create radiation fields in which permissible occupational dose standards can be exceeded in less than a few seconds and acute exposures, sufficient to cause serious radiation injury, are possible with just several minutes of exposure. The event at Surry and a similar incident involving the manual freeing of a stuck incore detector at Indian Point 3 in 1980 were both the result of the licensee's failure to evaluate the radiation hazard from the neutron activation of the incore flux detector drive cable. In both cases, the irradiated drive cable itself, which had not been allowed to decay sufficiently after being removed from the core, was the contributing factor to the high exposures at Surry and the overexposures at Indian Point.



The Surry event is just one in a series of overexposures or near overexposures in which a lack of management oversight led to inadequate radiological assessment and a resultant lack of proper control over work activities involving irradiated components. Several NRC and Institute of Nuclear Power Operations (INPO) generic communications have been issued over the last several years informing licensees of the dangers involved with entry into high radiation areas (see Attachment 4). On June 13, 1988, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $100,000 for the Surry event to emphasize the importance of using proper radiological procedures in high radiation areas.

No specific action or written response is required by this information notice.

If you have any questions about this matter, please contact one of 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

Technical Contacts: Charles S. Hinson, NRR
(301) 492-3148

Craig Bassett, RII
(404) 242-5570

Attachments:
1. Figure 1, Typical Westinghouse Incore Neutron Monitoring System
2. Figure 2, Relative Positions of Individuals During Incident
3. Related Event Summaries
4. Past Related Correspondence
5. List of Recently Issued NRC Information Notices

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## Related Event Summaries

Overexposure of Workers Retrieving Stuck Incore Neutron Detector
(Indian Point 3, PWR)

Inspection
Report No.: 50-286/80-09

Event Date: 6/24/80

Event Cause: Lack of Maintenance Procedure

Abstract: When a problem developed with retrieval of a neutron flux detector, two instrument and control (I&C) personnel and a health physics (HP) technician entered the containment to inspect and repair the moveable detector system. When it was

discovered that the drive cable was severed, the workers decided to retract the cable by hand (without benefit of approved procedural guidance). After withdrawing, cutting, and bagging approximately 90 percent of the cable, the remaining 8-10 feet of cable were extracted. The detector was cut off and put in a shielded container; the remaining cable was bagged and set between one of the I&C workers and the HP technician. When the HP technician noticed that the dose rate above the bagged end cable section was nearly 200 R/hr, he evacuated the area. This incident resulted in quarterly exposures to the two I&C workers of 4.2 and 4.1 rem whole body, 7.1 and 8.2 rem skin, and 43.7 and 17.1 rem extremity, respectively. One of the corrective actions taken by the licensee to prevent a recurrence of this event was the preparation of a procedure for removing and replacing incore detectors.

Traversing Incore Probe (TIP) Room Entry (Vermont Yankee, BWR)

Inspection
Report No.: 50-271/85-21

INPO SER 50-85

Event Date: 8/8/85

Event Cause: Inexperienced HP Technician

Abstract: After a TIP probe had remained in the core at 90 percent power for more than 2 hours (because of a TIP drive power loss from a shorted TIP ball valve solenoid), the probe was manually cranked into its storage area inside the TIP room. Since a radiation work permit (RWP) was required in order to enter the room to

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repair the ball valve solenoid, a backshift HP technician prepared to survey the area to gather information to fill out the RWP. After notifying the shift supervisor, the HP technician and an auxiliary operator entered the room. Using a hand-held ionization chamber, the HP technician measured dose rates near the door of 200 R/hr. The HP technician then proceeded further into the room and measured dose rates of

1000 R/hr near the core probes using a teletector. After the HP technician noticed that his 0-500 mR dosimeter was offscale, the two individuals left the room. The HP technician received 1.3 rem; the auxiliary operator received 270 mrem. The radiation hazards of an activated TIP and cable were inadequately evaluat-ed because the HP technician had little experience on what precautionary actions to take upon encountering the high exposure rates that existed in the TIP room. Among the corrective actions taken by the licensee to prevent recurrence of this event were issuance of procedures for TIP room entrance (including an RWP requirement for all entries), HP training on the lessons learned from this incident, and installation of a TIP room remote area radiation monitor.

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Past Related Correspondence:

INPO Significant Event Report (SER) 6-88, "Uncontrolled Radiation Exposure," March 9, 1988.

IE Information Notice No. 86-44, "Failure To Follow Procedures When Working in High Radiation Areas," June 10, 1986.

INPO Significant Event Report (SER) 50-85, "Uncontrolled Personnel Radiation Exposure," November 4, 1985 (discusses two events).

INPO Significant Operating Experience Report (SOER) 85-3, "Excessive Personnel Radiation Exposures," April 30, 1985.

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LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

| Information Notice No. | Subject | Date of Issuance | Issued to |
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| 88-62 | Recent Findings Concerning Implementation of Quality Assurance Programs by Suppliers of Transport Packages | 8/12/88 | All holders of NRC quality assurance program approval for radioactive material packages. |
| 88-61 | Control Room Habitability - Recent Reviews of Operating Experience | 8/11/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-60 | Inadequate Design and Installation of Watertight Penetration Seals | 8/11/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-04, Supplement 1 | Inadequate Qualification and Documentation of Fire Barrier Penetration Seals | 8/9/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-59 | Main Steam Isolation Valve Guide Rail Failure at Waterford Unit 3 | 8/9/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-58 | Potential Problems with ASEA Brown Boveri ITE-51L Time-Overcurrent Relays | 8/8/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-57 | Potential Loss of Safe Shutdown Equipment Due to Premature Silicon Controlled Rectifier Failure | 8/8/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-56 | Potential Problems with Silicone Foam Fire Barrier Penetration Seals | 8/4/88 | All holders of OLs or CPs for nuclear power reactors. |
| 88-55 | Potential Problems Caused by Single Failure of an Engineered Safety Feature Swing Bus | 8/3/88 | All holders of OLs or CPs for nuclear power reactors. |

OL = Operating License
CP = Construction Permit