

December 22, 2000

MEMORANDUM TO: Thomas L. King, Director  
Division of Risk Analysis and Applications  
Office of Nuclear Regulatory Research

FROM: David B. Matthews, Director */RA/*  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

SUBJECT: PROPOSED ABNORMAL OCCURRENCE AND EVENTS OF INTEREST  
FOR FISCAL YEAR 2000

In your October 23, 2000, memorandum you requested that the Division of Regulatory Improvement Programs (DRIP) provide you with write-ups for events which may be reportable as abnormal occurrences (AOs) and other "Events of Interest" (EOI) items for the third and fourth quarters of FY 2000. This input would be combined with the input for the first and second quarters of FY 2000 to form the final report to Congress. No AOs were identified during the third and fourth quarters of FY2000. However there were two separate events at the University of Missouri-Columbia Research Reactor which we have determined to be EOIs, and their write-ups are attached. They are being included in this report as EOIs because they received substantial public and media attention and required increased NRC attention.

Previously, in your April 17, 2000, memorandum, you requested that DRIP provide you with write-ups for events that may be reportable as AOs or EOIs for the first and second quarter of FY 2000. In my response to you dated May 24, 2000, I forwarded two write-ups which we considered EOIs, one at the University of Texas research reactor and the other at Indian Point Unit 2. Additional inspections have been conducted at Indian Point Unit 2 since my last response. In a letter to Consolidation Edison Company on November 20, 2000, the NRC provided the final results of the Significance Determination Process for the inspection at Indian Point Unit 2. This letter identified deficiencies in the overall direction and execution of the 1997 steam generator in-service examinations at Indian Point Unit 2. Specifically, the licensee did not identify and correct a significant condition adverse to quality, namely the presence of primary water stress corrosion cracking (PWSCC) flaws in steam generator tubes, despite opportunities to do so. As a result, tubes with PWSCC were left in service following the 1997 steam generator inspection until one of these tubes failed on February 15, 2000, when the reactor was at 100% power. Based on this additional information regarding the degraded

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condition of the primary coolant pressure boundary which ultimately led to the steam generator tube failure, I have determined that the Indian Point Unit 2 steam generator tube failure event is a potential AO under Criteria II.A.2, serious degradation of primary coolant pressure boundary, rather than an EOI. A revised writeup is attached.

In the SRM on SECY-96-193, "Implementation of Section 208 Energy Reorganization Act of 1974; Final Policy Statement," the Commission directed that "The staff should file incident information on potential AOs in the public document rooms (PDRs) as soon as possible. In following this direction the staff should place already existing documents on these incidents in the PDRs and identify the incident as a potential AO." To comply with this requirement, a copy of this memorandum is being placed in the PDR. In accordance with MD 8.1 the following statement is included in this memorandum:

The Nuclear Regulatory Commission (NRC) staff has identified the attached event as a potential abnormal occurrence (AO), and it may be included in the AO Report that the NRC prepares annually to inform Congress of events reported by NRC and Agreement State licensees which the Commission has determined are significant to public health and safety.

Attachment: As stated

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## **NON-POWER REACTORS**

### Unplanned High Radiation Field at the University of Missouri-Columbia Research Reactor

This event resulted in a large amount of public interest and caused NRC to increase its oversight of the licensee's activities.

The University of Missouri-Columbia (the licensee) operates a 10-megawatt non-power reactor. On April 6, 2000, the licensee removed a portion of the biological shield, adjacent to an in-pool fuel storage area, to perform inspections of the reactor pool liner. On April 12, 2000, an unscheduled shut down occurred that resulted in reactor refueling. During this refueling process, a fuel element was placed, by mistake, in the storage area near where the shielding had previously been removed. This resulted in unplanned high radiation levels in the basement floor level of the reactor containment, which triggered a radiation alarm. The licensee moved the fuel element to a different location in the storage area which did not alleviate the situation, and then moved the fuel back to the reactor which ended the event. The elevated radiation field, with a calculated maximum dose rate at the opening in the shielding of 400 R/hr, existed for about three minutes.

Subsequent review by the NRC determined that no over exposures to radiation occurred and that the event did not affect members of the public. However, the NRC concluded that the licensee did not properly evaluate the removal of the shielding to determine if NRC review and approval was required prior to removing the shielding. The failure of the licensee to perform this evaluation was a violation of NRC regulations. NRC's review of this event also raised concerns in reactor operations, radiation protection, fuel handling, procedures, and emergency preparedness.

The NRC issued a Notice of Violation on October 5, 2000. The licensee has instituted numerous corrective actions which the NRC will review during future inspections.

This event is closed for the purpose of this report.

### Removal of Control Rod With Improper Core Configuration at the University of Missouri-Columbia Research Reactor

This event resulted in a large amount of public interest and caused NRC to increase its oversight of the licensee's activities.

The University of Missouri-Columbia (the licensee) operates a 10-megawatt non-power reactor. On June 12, 2000, as part of normal maintenance activities, the licensee removed one of four control rods from the reactor without meeting the requirement to first unload two of eight fuel elements from the reactor core. When the licensee recognized this error they removed two fuel elements which ended the event.

Subsequent review by the NRC determined that the reactor met the minimum requirements for shut down at all times during the event and the event had no impact on the health and safety of the licensee staff or the public. However, the NRC determined that the licensee did not follow procedures that required the two fuel elements to be removed from the core. Also, with eight fuel elements in the reactor core and the control rod removed, the reactor was in a

configuration that was in violation of the licensee's Technical Specifications. The NRC also had concerns in the areas of organizational function, shift turnover and communication, operator cognizance of facility conditions, and procedural implementation.

The NRC issued a Notice of Violation on October 5, 2000. The licensee has instituted numerous corrective actions which the NRC will review during future inspections.

This event is closed for the purpose of this report.

## NUCLEAR POWER PLANTS

Using the criteria and guidelines in Appendix A to this report, one of the events that occurred at a U.S. nuclear power plant during this reporting period was determined to be an Abnormal Occurrence (AO):

Steam Generator Tube Failure at Indian Point Unit 2 in Buchanan, New York.

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see Criteria II. A. 2. "For Commercial Nuclear Power Plant Licensees") to this report states, in part, that an event will be considered an AO if it involves a serious degradation of the primary coolant pressure boundary.

Date and Place -- February 15, 2000; Indian Point Unit 2, a commercial nuclear power plant operated by Consolidated Edison Company, located about 24 miles north of New York City.

Nature and Probable Consequences -- On February 15, 2000, at 7:17 p.m., the Indian Point Unit 2 nuclear plant experienced a steam generator tube failure which required the declaration of an Alert at 7:29 p.m., and a manual reactor trip at 7:30 p.m. The steam generator is a heat exchanger which allows heat to pass from the reactor (primary system) to the turbine generator (secondary system). It also provides the boundary between the radioactive primary system and the non-radioactive secondary system. At Indian Point Unit 2 there are four steam generators and each steam generator has approximately 3300 tubes. On February 15, the failure of one of these tubes allowed reactor water to leak into the secondary system. By 8:31 p.m. the operators had taken steps to isolate the steam generator which contained the leaking tube. After the steam generator was isolated, the operators began to cool down the plant. At 9:02 p.m. they were forced to suspend the cooldown process when they realized they had inadvertently established an excessive cooldown rate. This excessive cooldown rate caused a rapid reduction in reactor coolant system (pressurizer) level. To restore the level the licensee pumped borated water into the reactor coolant system using the safety injection system. After the level was restored the operators resumed the cooldown and reached cold shutdown at 4:57 p.m. on February 16, 2000. The licensee exited the Alert at 6:50 p.m. that day.

The steam generator tube failure resulted in an initial primary-to-secondary leak of reactor coolant of approximately 146 gallons per minute, and required an "Alert" declaration (the second level of emergency action in the NRC required emergency response plan). This event involved some procedural and equipment issues that challenged operators, complicated the event response, and delayed achieving the cold shutdown condition. It caused significant public and media interest, and required increased NRC attention. The event resulted in a minor radiological release to the environment that was well within regulatory limits. No radioactivity was measured off-site above normal background levels, and the event did not impact the public health and safety.

Following the event an NRC inspection determined that Con Edison did not perform an adequate examination of the steam generator tubes during their 1997 outage. As a result, degraded tubes were allowed to remain in service during plant operation and ultimately led to a steam generator tube failure.

Cause or Causes – The event was caused by primary water stress corrosion cracking (PWSCC) flaws in steam generator tubes. There were deficiencies in the overall direction and execution of the 1997 steam generator in-service examinations at Indian Point Unit 2. Specifically, the licensee did not identify and correct the presence of PWSCC flaws in steam generator tubes, despite opportunities to do so. As a result, tubes with PWSCC were left in service following the 1997 steam generator inspection until one of these tubes failed on February 15, 2000, when the reactor was at 100% power. Other plants have experienced steam generator tube failures in the past. These plants include Point Beach Unit 1 in 1975, R.E. Ginna in 1982, North Anna Unit 1 in 1987 and 1989, McGuire Unit 1 in 1989, and Palo Verde Unit 2 in 1993. Some of these tube failures were caused by stress corrosion cracking induced by various mechanisms.

#### Actions Taken to Prevent Recurrence

Licensee – The licensee performed the necessary actions to protect the health and safety of the public. Prior to the event, the licensee was in the process of implementing a station improvement program. This event demonstrated the need for continuous management attention to planned improvements to ensure they are timely and effective. Subsequently the licensee made the decision to replace all four steam generators prior to returning to power. The industry completed a lessons-learned report based on the Indian Point Unit 2 steam generator tube failure event and provided it to the NRC on October 26, 2000.

NRC – The NRC reviewed the causes, safety implications, and licensee actions following the event. Information Notice 2000-09, “Steam Generator Tube Failure at Indian Point Unit 2,” was issued on June 28, 2000, to alert other licensees to this event. A Notice of Violation was issued to Indian Point 2 on November 20, 2000. A lessons-learned report on the steam generator tube failure at Indian Point Unit 2 was completed on October 23, 2000. In this report, the NRC evaluated the staff’s technical and regulatory processes related to assuring steam generator tube integrity and identified and recommended areas for improvement applicable to the NRC and/or the industry. The NRC plans to study the recommendations and implement them, as appropriate.

This event is closed for the purpose of this report.