NUREG--0090-Vol.12-No.2

TI90 003029

Report to Congress on Abnormal Occurrences

April – June 1989

Date Published: October 1989

Office for Analysis and Evaluation of Operational Data
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Previous Reports in Series

NUREG 75/090, January-June 1975, published October 1975
NUREG-0090-1, July-September 1975, published March 1976
NUREG-0090-2, October-December 1975, published March 1976
NUREG-0090-3, January-March 1976, published July 1976
NUREG-0090-4, April-June 1976, published March 1977
NUREG-0090-5, July-September 1976, published March 1977
NUREG-0090-6, October-December 1976, published June 1977
NUREG-0090-7, January-March 1977, published June 1977
NUREG-0090-8, April-June 1977, published September 1977
NUREG-0090-9, July-September 1977, published November 1977
NUREG-0090-10, October-December 1977, published March 1978
NUREG-0090, Vol.1, No.1, January-March 1978, published June 1978
NUREG-0090, Vol.1, No.2, April-June 1978, published September 1978
NUREG-0090, Vol.1, No.3, July-September 1978, published December 1978
NUREG-0090, Vol.1, No.4, October-December 1978, published March 1979
NUREG-0090, Vol.2, No.1, January-March 1979, published July 1979
NUREG-0090, Vol.2, No.2, April-June 1979, published November 1979
NUREG-0090, Vol.2, No.3, July-September 1979, published February 1980
NUREG-0090, Vol.2, No.4, October-December 1979, published April 1980
NUREG-0090, Vol.3, No.1, January-March 1980, published September 1980
NUREG-0090, Vol.3, No.2, April-June 1980, published November 1980
NUREG-0090, Vol.3, No.3, July-September 1980, published February 1981
NUREG-0090, Vol.3, No.4, October-December 1980, published May 1981
NUREG-0090, Vol.4, No.1, January-March 1981, published July 1981
NUREG-0090, Vol.4, No.2, April-June 1981, published October 1981
NUREG-0090, Vol.4, No.3, July-September 1981, published January 1982
NUREG-0090, Vol.4, No.4, October-December 1981, published May 1982
NUREG-0090, Vol.5, No.1, January-March 1982, published August 1982
NUREG-0090, Vol.5, No.2, April-June 1982, published December 1982
NUREG-0090, Vol.5, No.3, July-September 1982, published January 1983
NUREG-0090, Vol.5, No.4, October-December 1982, published May 1983
NUREG-0090, Vol.6, No.1, January-March 1983, published September 1983
NUREG-0090, Vol.6, No.2, April-June 1983, published November 1983
NUREG-0090, Vol.6, No.3, July-September 1983, published April 1984
NUREG-0090, Vol.6, No.4, October-December 1983, published May 1984
NUREG-0090, Vol.7, No.1, January-March 1984, published July 1984
NUREG-0090, Vol.7, No.2, April-June 1984, published October 1984
NUREG-0090, Vol.7, No.3, July-September 1984, published April 1985
NUREG-0090, Vol.7, No.4, October-December 1984, published May 1985
NUREG-0090, Vol.8, No.1, January-March 1985, published August 1985
NUREG-0090, Vol.8, No.2, April-June 1985, published November 1985
NUREG-0090, Vol.8, No.3, July-September 1985, published February 1986
NUREG-0090, Vol.8, No.4, October-December 1985, published May 1986
NUREG-0090, Vol.9, No.1, January-March 1986, published September 1986
NUREG-0090, Vol.9, No.2, April-June 1986, published January 1987
NUREG-0090, Vol.9, No.3, July-September 1986, published April 1987
NUREG-0090, Vol.9, No.4, October-December 1986, published July 1987
NUREG-0090, Vol.10, No.1, January-March 1987, published October 1987
NUREG-0090, Vol.10, No.2, April-June 1987, published November 1987
NUREG-0090, Vol.10, No.3, July-September 1987, published March 1988
NUREG-0090, Vol.10, No.4, October-December 1987, published March 1988
NUREG-0090, Vol.11, No.1, January-March 1988, published July 1988
NUREG-0090, Vol.11, No.2, April-June 1988, published December 1988
NUREG-0090, Vol.11, No.3, July-September 1988, published January 1989
NUREG-0900, Vol.11, No.4, October-December 1988, published April 1989
NUREG-0900, Vol.12, No.1, January-March 1989, published August 1989

ABSTRACT

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event which the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report covers the period from April 1 to June 30, 1989.

For this reporting period, there was one abnormal occurrence at nuclear power plants licensed to operate involving significant deficiencies in management controls at Surry Nuclear Power Station. There was one abnormal occurrence under other NRC-issued licenses; the event involved a medical therapy misadministration. One other abnormal occurrence, involving industrial radiography overexposures, was reported by an Agreement State (Texas).

The report also contains information updating some previously reported abnormal occurrences.

CONTENTS

CONTENTS (Continued)

PREFACE

INTRODUCTION

The Nuclear Regulatory Commission reports to the Congress each quarter under provisions of Section 208 of the Energy Reorganization Act of 1974 on any abnormal occurrences involving facilities and activities regulated by the NRC. An abnormal occurrence is defined in Section 208 as an unscheduled incident or event that the Commission determines is significant from the standpoint of public health or safety.

Events are currently identified as abnormal occurrences for this report by the NRC using the criteria listed in Appendix A. These criteria were promulgated in an NRC policy statement that was published in the Federal Register on February 24, 1977 (Vol. 42, No. 37, pages 10950-10952). In order to provide wide dissemination of information to the public, a Federal Register notice is issued on each abnormal occurrence. Copies of the notice are distributed to the NRC Public Document Room and all Local Public Document Rooms. At a minimum, each notice must contain the date and place of the occurrence and describe its nature and probable consequences.

The NRC has determined that only those events, including those submitted by the Agreement States, described in this report meet the criteria for abnormal occurrence reporting. This report covers the period from April 1 to June 30, 1989.

Information reported on each event includes date and place, nature and probable consequences, cause or causes, and actions taken to prevent recurrence.

THE REGULATORY SYSTEM

The system of licensing and regulation by which NRC carries out its responsibilities is implemented through rules and regulations in Title 10 of the Code of Federal Regulations. This includes public participation as an element. To accomplish its objectives, NRC regularly conducts licensing proceedings, inspection and enforcement activities, evaluation of operating experience, and confirmatory research, while maintaining programs for establishing standards and issuing technical reviews and studies.

In licensing and regulating nuclear power plants, the NRC follows the philosophy that the health and safety of the public are best assured through the establishment of multiple levels of protection. These multiple levels can be achieved and maintained through regulations specifying requirements that will assure the safe use of nuclear materials. The regulations include design and quality assurance criteria appropriate for the various activities licensed by NRC. An inspection and enforcement program helps assure compliance with the regulations.

REPORTABLE OCCURRENCES

Actual operating experience is an essential input to the regulatory process for assuring that licensed activities are conducted safely. Licensees are required to report certain incidents or events to the NRC. This reporting helps to identify deficiencies early and to assure that corrective actions are taken to prevent recurrences.

For nuclear power plants, dedicated groups have been formed both by the NRC and by the nuclear power industry for the detailed review of operating experience to help identify safety concerns early; to improve dissemination of such information; and to feed back the experience into licensing, regulations, and operations. In addition, the NRC and the nuclear power industry have ongoing efforts to improve the operational data systems, which include not only the type and quality of reports required to be submitted, but also the methods used to analyze the data. In order to more effectively collect, collate, store, retrieve, and evaluate operational data, the information is maintained in computer-based data files.

Two primary sources of operational data are Licensee Event Reports (LERs) and immediate notifications made pursuant to 10 CFR § 50.72.

Except for records exempt from public disclosure by statute and/or regulation, information concerning reportable occurrences at facilities licensed or otherwise regulated by the NRC is routinely disseminated by the NRC to the nuclear industry, the public, and other interested groups as these events occur.

Dissemination includes special notifications to licensees and other affected or interested groups, and public announcements. In addition, information on reportable events is routinely sent to the NRC's more than 100 local public document rooms throughout the United States and to the NRC Public Document Room in Washinton, D.C. The Congress is routinely kept informed of reportable events occurring in licensed facilities.

Another primary source of operational data is reports of reliability data submitted by licensees under the Nuclear Plant Reliability Data System (NPRDS). The NPRDS is a voluntary, industry-supported system operated by the Institute of Nuclear Power Operations (INPO), a nuclear utility organization. Both engineering and failure data are submitted by nuclear power plant licensees for specified plant components and systems. The Commission considers the NPRDS to be a vital adjunct to the LER system for the collection, review, and feedback of operational experience; therefore, the Commission periodically monitors the NPRDS reporting activities.

AGREEMENT STATES

Section 274 of the Atomic Energy Act, as amended, authorizes the Commission to enter into agreements with States whereby the Commission relinquishes and the States assume regulatory authority over byproduct, source, and special nuclear materials (in quantities not capable of sustaining a chain reaction). Agreement State programs must be comparable to and compatible with the Commission's program for such material.

Presently, information on reportable occurrences in Agreement State licensed activities is publicly available at the State level. Certain information is also provided to the NRC under exchange of information provisions in the agreements.

In early 1977, the Commission determined that abnormal occurrences happening at facilities of Agreement State licensees should be included in the quarterly reports to Congress. The abnormal occurrence criteria included in Appendix A are applied uniformly to events at NRC and Agreement State licensee facilities. Procedures have been developed and implemented, and abnormal occurrences reported by the Agreement States to the NRC are included in these quarterly reports to Congress.

FOREIGN INFORMATION

The NRC participates in an exchange of information with various foreign governments that have nuclear facilities. This foreign information is reviewed and considered in the NRC's assessment of operating experience and in its research and regulatory activities. Reference to foreign information may occasionally be made in these quarterly abnormal occurrence reports to Congress; however, only domestic abnormal occurrences are reported.

REPORT TO CONGRESS ON ABNORMAL OCCURRENCES
APRIL - JUNE 1989

NUCLEAR POWER PLANTS

The NRC is reviewing events reported at the nuclear power plants licensed to operate. For this report, the NRC has determined that the following event was an abnormal occurrence.

89-6 Significant Deficiencies in Management Controls at Surry Nuclear Power Station

The following information pertaining to this event is also being reported concurrently in the Federal Register. Appendix A (see the third general criterion) of this report notes that major deficiencies in design, or management controls for, licensed facilities or material can be considered an abnormal occurrence. In addition, Example 11 of "For All Licensees" of Appendix A notes that serious deficiency in management or procedural controls in major areas can be considered an abnormal occurrence.

Date and Place - This occurrence addresses significant deficiencies in licensee performance over a period of time until May 18, 1989, when the NRC issued Notice of Violations and Proposed Imposition of $500,000 Civil Penalties (Ref. 1); Surry Units 1 and 2, Westinghouse-designed 3-loop pressurized water reactors, operated by Virginia Electric and Power Company (the licensee), and located in Surry County, Virginia.

Nature and Probable Consequences - The significant enforcement action was taken based on the findings of several inspections; these findings, together with several escalated enforcement actions taken since early 1988, demonstrated a major breakdown in the administrative and managerial control system at the Surry Power Station. Serious safety concerns were raised regarding the licensee's ability to self-identify and correct deficiencies without NRC intervention. These deficiencies have generally involved: (1) original design deficiencies that the licensee should have identified on its own; (2) inadequate evaluation of operating events, identified deficiencies and NRC Bulletins and Information Notices; (3) failure to take timely corrective action for known deficiencies; and (4) failure to take adequate corrective actions.

Background

NRC concerns with regard to the licensee's adequacy of safety evaluations and implementation of its corrective action program have been the subject of enforcement actions in the past. Since 1988, in addition to the $500,000 civil penalty discussed in detail below, there have been four escalated enforcement actions with civil penalties issued to the licensee that reflect on its failure to identify problems or take prompt and adequate corrective actions. These enforcement actions are briefly discussed as follows:

- On June 13, 1988, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $50,000 (Ref. 2). In February 1988, NRC identified a violation involving the failure to maintain and verify operability of heat trace circuitry for boric acid flow paths. This problem had existed for an extended period of time without station personnel questioning the reason for continuously lit annunciators.

- In a separate action dated June 13, 1988, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $100,000 (Ref. 3). In March 1988, an event had occurred that had a significant potential for a radiation overexposure during the licensee's attempt to free an incore detector from a thimble tube. The licensee's response to the event was inadequate.

- On August 25, 1988, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $100,000 (Ref. 4). In May 1988, an individual exceeded the whole body quarterly occupational radiation dose limit, due in part to inadequate corrective actions associated with a prior event.

- On November 10, 1988, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $50,000 (Ref. 5). The violation involved insufficient cleanliness controls when working on safety related systems, as foreign material was found in the containment sumps that had gone undetected for an extended period of time. This could have resulted in damage to the low head safety injection and recirculation spray pumps.

Additional Inspections and Issues Identified

Additional inspections conducted from September 1, 1988, through March 4, 1989, identified additional violations. For many of the violations, information was available that, if properly evaluated and acted upon, should have prevented, or led to earlier correction of, those violations. Other violations related to significant design and evaluation issues. These inspections were: an NRC Augmented Inspection Team (AIT) inspection conducted from September 1-3, 1988 (Ref. 6); an NRC Safety System Functional Inspection (SSFI) conducted from September 12-16, September 26-30, and November 14-18, 1988 (Ref. 7); and NRC Resident Inspector inspections conducted from October 2 - November 5, 1988 (Ref. 8), November 6 - December 17, 1988 (Ref. 9), December 18, 1988 - January 28, 1989 (Ref. 10), and January 29 - March 4, 1989 (Ref. 11). The AIT inspection was conducted to review the facts and circumstances associated with the failure of the Unit 1 refueling cavity seal on May 17, 1988. The SSFI focused on the safety-related service water system and the recirculation spray system, including associated electrical systems.

The violations identified in the inspections were grouped into five sections of the May 18, 1989, NRC letter forwarding the Notice of Violations (NOV) and Proposed Imposition of $500,000 Civil Penalties (Ref. 1). The sections are summarized below:

I. Cavity Seal Failure

Violations involved: (a) the inadequate design of the Unit 1 reactor cavity seal that failed on May 17, 1988, resulting in a refueling cavity water leak of about 30,000 gallons; and (b) inadequate licensee actions taken subsequent to the seal failure. The NRC was not informed of this event until August 30, 1988. The NRC AIT found that the licensee's response to NRC Bulletin No. 84-03, "Refueling Cavity Water Seal" (Ref. 12), was deficient in that the evaluation of the unique Surry cavity seal design did not assure that appropriate tolerances and installation instructions were provided.

The inflatable backup seal coincidently failed when a section of instrument air was isolated for unrelated local leak rate testing, at a time when the backup nitrogen bottles were not correctly aligned. The AIT found that the station lacked procedures and drawings for these two systems, and operations personnel had not been adequately trained on operation of these particular systems. The licensee's initial evaluation of the event failed to quantify both the amount and rate of leakage (30,000 gallons in 5 minutes). This inadequate evaluation of the scope and significance of the J-seal failure led to the licensee reloading the core 3 days later with the deficiencies uncorrected, thus placing the plant in an unanalyzed condition during the reloading period.

The violations in this section were assessed a civil penalty of $200,000.

II. Additional Corrective Action Violations

This section involved a number of problems that were not properly evaluated and corrected even though the licensee had information available, either through NRC correspondence or the licensee's internal deficiency reporting system, which should have prompted the licensee to act in a more timely manner.

Violations included: (a) inadequate evaluation and disposition of NRC Information Notice No. 88-23, "Potential for Gas Binding of High-Pressure Safety Injection Pumps During a Loss of Coolant Accident" (Ref. 13), resulting in both Surry Units operating for a period of time with degraded safety systems until mid-September, 1988, when both units were shut down for unrelated reasons; (b) Control Room - Relay Room Ventilation Chiller capacity less than specified in the Final Safety Analysis Report (FSAR); (c) both trains of the Control Room and Emergency Switchgear Room Ventilation System incapable of performing their intended function; (d) use of unqualified replacement parts in some safety-related components; (e) recurring wetting of auxiliary feedwater pump motors during periods of heavy rains due to inadequately sealed roof plugs; and (f) various program deficiencies associated with assuring that quality control inspection and quality assurance audit findings were adequately resolved.

The violations in this section were assessed a civil penalty of $175,000.

III. Design Control

The SSFI identified violations concerning a number of inadequate calculations performed to support certain plant modifications. The most significant example

concerned inaccurate and nonconservative assumptions used for the 1988 recirculation spray heat exchanger replacement that was identified by the NRC and should have been identified by the licensee's review process. If left uncorrected, the plant would have continued to operate with the ultimate heat sink design outside of FSAR assumptions. The other violations demonstrated weaknesses in both the mechanical and electrical engineering disciplines.

The violations in this section were assessed a civil penalty of $25,000.

IV. Technical Specifications Operability Requirements

This violation concerned the operability of the emergency service water pumps. Both the FSAR and technical specification basis specified a 15,000 gpm capacity for each pump. However, pump capacity apparently degraded over the life of the plant to about 12,000 gpm, and plant surveillance test acceptance criteria were changed on several occasions without performing an evaluation for the change in system performance.

This violation was assessed a civil penalty of $100,000.

V. Other SSFI-Identified Violations

These violations involved the adequacy of surveillance tests, incorporation of vendor recommendations into maintenance procedures, material traceability problems, and post maintenance testing.

These violations were classified at a lower severity level than those described in Sections I through IV above, and no civil penalty was assessed.

Cause or Causes - The causes were attributed to significant deficiencies in both site and corporate management controls over Surry Nuclear Power Station activities.

Actions Taken to Prevent Recurrence

Licensee- The licensee had shut down both Surry Unit 1 and Unit 2 in September 1988 (Unit 1 on September 13, due to emergency diesel generator operability concerns; and Unit 2 on September 9, for a refueling outage). The licensee agreed not to restart either unit until the NRC concurred.

During meetings held on February 26, March 30, April 26 and May 22, 1989, senior licensee management presented to the NRC an extensive corrective action plan that included both Design Reconstitution and Configuration Management Programs. For the immediate short term, the licensee performed an operational readiness review (verification of system configuration and document reviews), emergency power testing (similar to original startup testing), and functional testing. In addition, the licensee made a number of recent management changes at the site, and is in the process of enhancing its problem evaluation and corrective action capabilities.

The licensee did not contest the May 18, 1989, NRC NOV and Proposed Imposition of $500,000 civil penalties; the licensee has paid the civil penalty in full.

NRC - Significant NRC efforts were expended in identifying and documenting the numerous deficiencies previously discussed, and in reviewing and monitoring the corrective actions taken by the licensee.

On January 26, 1989, an Enforcement Conference was held at the NRC Region II Office to discuss design control and corrective action problems affecting various plant systems (Ref. 14).

On March 9, 1989, the NRC issued a Confirmation of Action Letter (CAL) to the licensee which itemized the issues yet to be completed by the licensee, and reviewed by the NRC, prior to restart of both units (Ref. 15).

Based on the satisfactory corrective actions taken by the licensee, on June 30, 1989, the CAL was lifted for Unit 1 by discussions between licensee and NRC management. Unit 1 was restarted on July 7, 1989. On September 8, 1989, the CAL was lifted for Unit 2. Unit 2 was restarted on September 16, 1989.

This item is considered closed for the purposes of this report.

* * * * * * * *

FUEL CYCLE FACILITIES

(Other Than Nuclear Power Plants)

The NRC is reviewing events reported by these licensees. For this report, the NRC has not determined that any events were abnormal occurrences.

* * * * * * * *

OTHER NRC LICENSEES

(Industrial Radiographers, Medical Institutions, Industrial Users, etc.)

There are currently about 9,000 NRC nuclear material licenses in effect in the United States, principally for use of radioisotopes in the medical, industrial, and academic fields. Incidents were reported in this category from licensees such as radiographers, medical institutions, and byproduct material users. The NRC is reviewing events reported by these licensees. For this report, the NRC has determined that the following event was an abnormal occurrence:

89-7 Medical Therapy Misadministration

The following information pertaining to this event is also being reported concurrently in the Federal Register. Appendix A (see the general criterion) of this report notes that an event involving a moderate or more severe impact on public health or safety can be considered an abnormal occurrence.

Date and Place - March 13 - 27, 1989; Indiana University School of Medicine; Indianapolis, Indiana. The misadministration was reported to the NRC Region III Office on April 10, 1989.

Nature and Probable Consequences - A 68-year old male patient suffering from metastatic lung disease involving the spine and both hips began receiving cobalt-60 treatments to the lumbosacral spine area on March 11, 1989. Treatment to the spine was to be given at 300 rads per day for 10 days.

On March 13, the senior resident oncologist in the school changed the prescription to include cobalt-60 treatments to the patient's left hip. The new prescription was based on the result of a bone scan. Treatment was to consist of a total dose of 2,700 rads to the hip over a period of nine days.

In the simulation room where the patient's left hip was to be marked for eventual treatment, the patient was placed in the "prone" position (face down) and his hip marked and fluoroscoped. However, the wrong hip was marked. The bone scan, which was the basis for the treatment, had been taken of the patient while he was in the "supine" position (face up). When the patient was placed on the table face down, the patient was now in the opposite position from the bone scan. This mispositioning went unnoticed and the right hip, which was closest to the technologist, was erroneously marked and received the treatment.

Treatment began March 13 and ended March 27, when the resident oncologist discovered the error while reviewing the patient's chart. The patient and the patient's referring physicians were notified of the misadministration; however, the licensee did not notify the NRC until April 10, 1989, contrary to the requirements of 10 CFR § 35.33(a) which states that initial notification must be made within 24 hours after discovery of the misadministration. Treatment on the patient's left hip was subsequently begun on April 10.

An NRC medical consultant was requested to evaluate the medical significance of the event. The consultant concluded that in view of the patient's widespread metastatic disease, the inadvertent 2,700 rads dose to the right hip would not result in a significant, untoward consequence to the patient.

Cause or Causes - It appears that the lack of a written prescription given to the simulator technologist contributed to the mispositioning of the patient on the simulator table and the wrong hip being treated. In addition, the absence of left or right side markers on the simulator radiograph and failure to audit positioning early in the treatment allowed the misadministration to go unnoticed during the treatment period.

In regard to the delay in reporting the event to the NRC, the licensee's communication system apparently broke down in that the facility's radiation protection officer was not told of the misadministration until April 10, 1989.

Actions Take to Prevent Recurrence

Licensee - In response to the Region III Confirmatory Action Letter, and Notice of Violation, described below, on May 17, 1989, the licensee documented its specific corrective actions which have been implemented in regard to teletherapy procedures and reporting requirements.

In regard to teletheraphy procedures, the licensee submitted a copy of its Radiation Oncology Department's quality assurance/quality control (QA/QC) procedure for external beam radiation therapy. The procedure describes precautionary steps to be taken before initiating treatments, a separate review by a physicist, and a weekly review of treatment charts for all patients undergoing treatment.

In regard to reporting requirements, each staff member signed a form that he or she has reviewed 10 CFR § 35.33 requirements; the requirements were added to the departmental manual; and the requirements have been posted in the department. Training will be provided for new personnel.

NRC - An NRC inspection was conducted on April 18, 1989, to review the incident. On May 8, 1989, a Notice of Violation was issued for the licensee's failure to report the misadministration to the NRC within 24 hours of discovery (Ref. 16).

On April 26, 1989, NRC Region III forwarded a Confirmatory Action Letter (Ref. 17) to the licensee documenting the licensee's agreement to (a) provide training to the radiation oncology staff in specific NRC reporting requirements, and (b) incorporate into the teletherapy QA/QC program a comprehensive chart review procedure to be performed at least once a week for all patient charts.

This item is considered closed for the purposes of this report.

* * * * * * * *

AGREEMENT STATE LICENSEES

Procedures have been developed for the Agreement States to screen unscheduled incidents or events using the same criteria as the NRC (see Appendix A) and report the events to the NRC for inclusion in this report. For this report, an Agreement State (Texas) reported the following abnormal occurrence to the NRC:

AS89-1 Industrial Radiography Overexposures

Appendix A (see Example 1 of "For All Licensees") of this report notes that an exposure of the whole body of any individual to 25 rems or more of radiation can be considered an abnormal occurrence.

Date and Place - February 11, 1989; Technical Welding Laboratory, Incorporated (the licensee) of Pasadena, Texas, while performing radiography at Gulf Railcar (GRC), a manufacturing plant in Houston, Texas.

Nature and Probable Consequences - During radiography operations, a source disconnect occurred resulting in overexposures to two radiographers and one trainee. The radiographic device was a Tech Ops Model 660 containing a 115 curie iridium-192 source. The event was investigated by the Texas Department of Health - Bureau of Radiation Control (referred to as the Agency below). The Agency stated that: (a) Radiographer A received an exposure calculated to be between 66 and 179 rem, based on the Agency's reenactment of the incident; and (b) Radiographer B and Trainee B received about 7 rem and 4.3 rem, respectively,

as measured by their personnel monitoring devices. Information regarding the incident is based on the Agency's investigation.

Shortly before midnight on February 11, 1989, three two-man crews (Crews A, B, and C) arrived at GRC and began radiographic operations. Crews A (consisting of Radiographer A and Trainee A) and B (consisting of Radiographer B and Trainee B) worked at one end of the tank assembly building while Crew C (consisting of two radiographers) worked at the opposite end of the building; Crew C was not involved in the incident. Crews A and B worked on the same end of the building as the lead radiographer, Radiographer A, who felt that Radiographer B required some assistance.

After setting up, Crews A and B performed a test shot to test the density of the steel. The radiographers entered the tank that Crew B was radiographing. Neither radiographer performed a survey to ensure the source was in the shielded position. Prior to developing the test film, Trainee B passed equipment to the radiographers in the tank. While in the tank, Radiographer A assisted Radiographer B in the placement of his markers and he ensured that the guide tube was in the proper position for the next radiograph. The radiographers were in the tank for between 15 and 20 minutes, and were approximately 5 feet from the end of the guide tube.

While climbing the ladder to exit the tank, Radiographer B bumped the guide tube. Radiographer A told him he would readjust the guide tube and Radiographer B exited the tank. It took Radiographer A approximately 15 minutes to readjust the guide tube. During this time he was approximately a foot from the end of the guide tube. When he finished adjusting the tube, Radiographer A exited the tank and proceeded to prepare the tank he was radiographing for the next radiograph.

When Radiographer B prepared to crank out the source for the next shot he saw that his survey meter, set next to the crankout, showed that the source was not in its shielded position. He then informed Radiographer A that the source appeared to be out of the camera. Radiographer A, using Radiographer B's survey meter, surveyed the tank; the meter went off-scale. He attempted to return the source to its shielded position without success. Radiographer A instructed all personnel to leave the area and had everyone check their pocket dosimeters. Each dosimeter was discharged beyond its limit.

After being unable to contact the licensee's radiation safety officer, Radiographer A contacted the licensee's Office Manager (OM). Later, the OM and the licensee's Vice President (VP) arrived to perform source recovery. The VP estimated that Radiographer A had received about 13 rem. After some difficulty, the VP was able to remove the source and camera from the tank, reconnect the source, and return the source to its shielded position. During the recovery operations, it was found that the disconnected source was apparently about one foot from the end of the guide tube. Crew B was dismissed for the evening. The OM and VP continued radiographic operations themselves, using Crew A only to deliver and develop films.

The Agency's investigations included a number of issues associated with the event, including:

(1) An allegation that management suggested personnel to lose or damage their personnel monitoring devices. This could not be substantiated.

(2) The VP and OM performed radiography without first having their personnel monitoring devices evaluated.

(3) The personnel monitoring devices for Radiographers A and B and Trainee B were not collected until February 14, 1989, when the Agency instructed the VP to do so.

(4) The Agency was informed that daily records were falsified and that training records were inaccurate. A radiographer was present only a portion of the time he was to be supervising a trainee. The trainee actually performed radiography without the radiographer present. These allegations were found to be accurate.

(5) When Radiographer A's personnel monitoring device was processed, it showed that it received only a minimal exposure. This would be highly unlikely because he should have received considerably more radiation than Radiographer B. Based on reenactments, the Agency calculated that Radiographer A received between about 66 and 179 rem; based on a lack of symptoms, the Agency believes the exposure was closer to about 66 rem.

Cause or Causes - It is the conclusion of the Agency that there was no equipment failure. The disconnect occurred when Radiographer B initially failed to properly connect the source assembly to the drive cable. If the required survey of the radiographic device and guide tube had been performed after the first radiograph, the disconnect would have been discovered and the radiographers, and Trainee B, would not have received overexposures.

Actions Taken to Prevent Recurrence

Licensee - The licensee has held several safety meetings to discuss the importance of performing proper surveys after each radiograph.

Agency - The Agency is determining what level of escalated enforcement will be taken against the licensee. The Agency is also determining what, if any, action will be taken against the VP and OM for returning to work before having their personnel monitoring evaluated. The Agency is also determining what, if any, action to take against the radiographer who said he was providing training when he was not supervising the trainee or was not at the jobsite.

Unless new, significant information becomes available, this item is considered closed for the purposes of this report.

* * * * * * * *

REFERENCES

1. Letter from Stewart D. Ebneter, Administrator, NRC Region II, to W. R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding notice of Violations and Proposed Imposition of $500,000 Civil Penalties, EA 88-296, Docket Nos. 50-280 and 50-281, May 18, 1989.*

2. Letter from J. Nelson Grace, Administrator, NRC Region II, to D.S. Cruden, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding Notice of Violation and Proposed Imposition of Civil Penalty, EA 88-74, Docket Nos. 50-280 and 50-281, June 13, 1988.*

3. Letter from J. Nelson Grace, Administrator, NRC Region II, to D.S. Cruden, Vice President, Nuclear Operations, Virginia and Power Company, forwarding Notice of Violation and Proposed Imposition of Civil Penalty, EA 88-114, Docket Nos. 50-280 and 50-281, June 13, 1988.*

4. Letter from J. Nelson Grace, Administrator, NRC Region II, to D.S. Cruden, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding Notice of Violation and Proposed Imposition of Civil Penalty, EA 88-158, Docket Nos. 50-280 and 50-281, August 25, 1988.*

5. Letter from Malcolm L. Ernst, Acting Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding Notice of Violation and Proposed Imposition of Civil Penalty, EA 88-215, Docket Nos. 50-280 and 50-281, November 10, 1988.*

6. Letter from J. Nelson Grace, Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company forwarding Augmented Inspection Team Reports Nos. 50-280/88-34 and 50-281/88-34, Docket Nos. 50-280 and 50-281, September 30, 1988.*

7. Letter from Malcolm L. Ernst, Acting Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding NRC Inspection Report Nos. 50-280/88-32 and 50-281/88-32, Docket Nos. 50-280 and 50-281, December 15, 1988.*

8. Letter from Malcolm L. Ernst, Acting Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding NRC Inspection Report Nos. 50-280/88-41 and 50-281/88-41, Docket Nos. 50-280 and 50-281, November 30, 1988.*

---

*Available in NRC Public Document Room, 2120 L Street, NW, (Lower Level) Washington, D.C., for public inspection and/or copying.

9. Letter from Malcolm L. Ernst, Acting Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding NRC Inspection Report Nos. 50-280/88-45 and 50-281/88-45, Docket Nos. 50-280 and 50-281, January 17, 1989.*

10. Letter from Luis A. Reyes, Director, Division of Reactor Projects, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding a Notice of Violation and NRC Inspection Report Nos. 50-280/88-51 and 50-281/88-51, Docket Nos. 50-280 and 50-281, February 23, 1989.*

11. Letter from Stewart D. Ebneter, Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, forwarding NRC Inspection Report Nos. 50-280/89-06 and 50-281/89-06, Docket Nos. 50-280 and 50-281, April 3, 1989.*

12. U.S. Nuclear Regulatory Commission, Inspection and Enforcement Bulletin No. 84-03, "Refueling Cavity Water Seal," August 24, 1984.*

13. U.S. Nuclear Regulatory Commission, NRC Information Notice No. 88-23, "Potential for Gas Binding of High Pressure Safety Inspection Pumps During a Loss of Coolant Accident," May 12, 1988.*

14. Letter from Malcolm L. Ernst, Acting Administrator, NRC Region II, to W.R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, Docket Nos. 50-280 and 50-281, February 22, 1989.*

15. Confirmation of Action Letter from Stewart D. Ebneter, Administrator, NRC Region II, to W. R. Cartwright, Vice President, Nuclear Operations, Virginia Electric and Power Company, Docket Nos. 50-280 and 50-281, March 9, 1989.*

16. Letter from Bruce S. Mallett, Chief, Nuclear Materials Safety Branch, NRC Region III, to Robert Welty, Assistant to the Dean, Indiana University School of Medicine, forwarding Inspection Report No. 030-09792/89-2 and Notice of Violation, Docket No. 030-09792, License No. 13-02752-08, May 8, 1989.*

17. Confirmatory Action Letter (CAL) - RIII-89-014 from A. Bert Davis, Administrator, NRC Region III, to Robert Welty, Assistant to the Dean, Indiana University School of Medicine, Docket No. 030-09792, License No. 13-02752-08, April 26, 1989.*

---

*Available in NRC Public Document Room, 2120 L Street, NW, (Lower Level) Washington, D.C., for public inspection and/or copying.

APPENDIX A

ABNORMAL OCCURRENCE CRITERIA

The following criteria for this report's abnormal occurrence determinations were set forth in an NRC policy statement published in the Federal Register on February 24, 1977 (Vol. 42, No. 37, pages 10950-10952).

An event will be considered an abnormal occurrence if it involves a major reduction in the degree of protection of the public health or safety. Such an event would involve a moderate or more severe impact on the public health or safety and could include but need not be limited to:

1. Moderate exposure to, or release of, radioactive material licensed by or otherwise regulated by the Commission;

2. Major degradation of essential safety-related equipment; or

3. Major deficiencies in design, construction, use of, or management controls for licensed facilities or material.

Examples of the types of events that are evaluated in detail using these criteria are:

For All Licensees

1. Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual to 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation [10 CFR §20.403(a)(1)], or equivalent exposures from internal sources.

2. An exposure to an individual in an unrestricted area such that the whole body dose received exceeds 0.5 rem in one calendar year [10 CFR §20.105(a)].

3. the release of radioactive material to an unrestricted area in concentrations which, if averaged over a period of 24 hours, exceed 500 times the regulatory limit of Appendix B, Table II, 10 CFR Part 20 [CFR §20.403(b)].

4. Radiation or contamination levels in excess of design values on packages, or loss of confinement of radioactive material such as (a) a radiation dose rate of 1,000 mrem per hour three feet from the surface of a package containing the radioactive material, or (b) release of radioactive material from a package in amounts greater than the regulatory limit.

5. Any loss of licensed material in such quantities and under such circumstances that substantial hazard may result to persons in unrestricted areas.

6. A substantiated case of actual or attempted theft or diversion of licensed material or sabotage of a facility.

7. Any substantiated loss of special nuclear material or any substantiated inventory discrepancy that is judged to be significant relative to normally expected performance and that is judged to be caused by theft or diversion or by substantial breakdown of the accountability system.

8. Any substantial breakdown of physical security or material control (i.e., access control, containment, or accountability systems) that significantly weakened the protection against theft, diversion, or sabotage.

9. An accidental criticality [10 CFR §70.52(a)].

10. A major deficiency in design, construction, or operation having safety implications requiring immediate remedial action.

11. Serious deficiency in management or procedural controls in major areas.

12. Series of events (where individual events are not of major importance), recurring incidents, and incidents with implications for similar facilities (generic incidents) which create major safety concern.

For Commercial Nuclear Power Plants

1. Exceeding a safety limit of licensee technical specifications [10 CFR §50.36(c)].

2. Major degradation of fuel integrity, primary coolant pressure boundary, or primary containment boundary.

3. Loss of plant capability to perform essential safety functions such that a potential release of radioactivity in excess of 10 CFR Part 100 guidelines could result from a postulated transient or accident (e.g., loss of emergency core cooling system, loss of control rod system).

4. Discovery of a major condition not specifically considered in the safety analysis report (SAR) or technical specifications that requires immediate remedial action.

5. Personnel error or procedural deficiencies that result in loss of plant capability to perform essential safety functions such that a potential release of radioactivity in excess of 10 CFR Part 100 guidelines could result from a postulated transient or accident (e.g., loss of emergency core cooling system, loss of control rod system).

For Fuel Cycle Licensees

1. A safety limit of license technical specifications is exceeded and a plant shutdown is required [10 CFR §50.36(c)].

2. A major condition not specifically considered in the safety analysis report or technical specifications that requires immediate remedial action.

3. An event that seriously compromised the ability of a confinement system to perform its designated function.

APPENDIX B

UPDATE OF PREVIOUSLY REPORTED ABNORMAL OCCURRENCES

During the April through June 1989 period, NRC licensees, Agreement States, Agreement State licensees, and other involved parties, such as reactor vendors and architect-engineering firms, continued with the implementation of actions necessary to prevent recurrence of previously reported abnormal occurrences. The referenced Congressional abnormal occurrence reports below provide the initial and any subsequent updating information on the abnormal occurrences discussed. The updating provided generally covers events that took place during the report period; some updating, however, is more current as indicated by the associated event dates. Open items will be discussed in subsequent reports in the series.

NUCLEAR POWER PLANTS

79-3 Nuclear Accident at Three Mile Island

This abnormal occurrence was originally reported in NUREG-0090, Vol. 2, No. 1, "Report to Congress on Abnormal Occurrences: January-March 1979," and updated in each subsequent report in this series (NUREG-0090, Vol. 2, No. 2 through Vol. 12, No. 1). It is planned to continue these updates until defueling activities at the site are completed. The update of activities for this report period is as follows:

Reactor Vessel and Ex-Vessel Defueling Operations

During the April through June 1989 period, approximately 45,800 pounds of fuel and debris were removed from the reactor vessel. The total mass loaded into canisters as of the end of the period was approximately 273,100 pounds (about 91 percent out of a total of approximately 300,000 pounds of core debris and other materials). The total mass to be removed includes the mass of the core; structural and absorber materials; mass added by oxidation of core and structural material; and portions of the baffle plates, formers, and other components that will become co-mingled with core debris during cutting operations. The original core area has been defueled; the outer periphery of the Lower Core Support Assembly (LCSA) and the lower head have been partially defueled. The baffle plates have not yet been removed to provide access to the fuel in the area between the core baffle plates and the core barrel.

LCSA disassembly has been completed using a plasma arc cutting torch. The LCSA consists of five layers (plates): the lower grid rib section (LGRS), the flow distributor plate (FDP), the grid forging, the guide tube support plate (GTSP), and the elliptical flow distributor (EFD). The central portions of these five plates have been cut away and removed to provide access to the lower head. During removal of the pieces of the EFD, several of the attached incore instrument guide tubes were observed to have been melted off on their

lower ends. A layer of loose granular debris, fuel pin segments, and small rocklike chunks were removed from the lower head. A large mass of solidified material, approximately 18 inches thick and 5 feet in diameter, was on the bottom of the lower head. The large mass has properties similar to a ceramic and was readily broken up using an impact chisel. The resulting rocklike chunks were removed and placed in defueling canisters. As the incore instrument penetrations were exposed, about a third were observed to be partially melted off. The undamaged penetrations are 12 inches in length and the damaged penetrations had missing portions ranging from 1 to 11 inches.

Decontamination and Dose Reduction Activities

Since early December 1988, the licensee has focused efforts on the completion of defueling and the support of that activity. Decontamination (other than reactor building) and system flushing activities are currently suspended, except limited efforts to maintain access to, and operability of, plant systems.

Fuel Cask Shipments

During the period, one additional shipment containing 21,000 pounds of core debris was made from TMI-2 to the Idaho National Engineering Laboratory (INEL). The total amount shipped is 232,000 pounds of core debris, about 77 percent of the total to be shipped.

Post-Defueling Monitored Storage

As mentioned in previous reports, on April 27, 1988, the NRC issued Draft Supplement 3 to the Programmatic Environmental Impact Statement (PEIS) related to the decontamination and disposal of radioactive waste resulting from the March 29, 1979, accident at TMI-2 (Ref. B-1). This Supplement evaluates the impacts of the licensee's proposal to place the facility in a state of Post-Defueling Monitored Storage (PDMS) until Unit 1 is ready for decommissioning. The staff received final comments on the draft supplement from the Advisory Panel for the Decontamination of Three Mile Island Unit 2 in October 1988. The NRC staff is evaluating the comments and preparing the Final Supplement 3 to the PEIS.

Proposal to Dispose of Accident-Generated Water

The public hearing on evaporation of accident-generated water (AGW) at Three Mile Island Unit 2 by the Atomic Safety and Licensing Board Panel (ASLBP) concluded on November 15, 1988. Contentions litigated were the analysis of the "no action alternative," characterization of the AGW, evaluations of potential release of microorganisms, and the health effects of tritium. The ASLBP ruled in favor of the licensee on February 3, 1989. The joint intervenors requested a stay and appealed the decision to the Atomic Safety and Licensing Appeal Panel (ASLAP). The request for a stay was denied on April 4, 1989. The Commission made the ASLBP decision immediately effective on April 13, 1989. The appeal process continues with oral arguments scheduled for July 26, 1989.

TMI-2 Advisory Panel Meetings

The Advisory Panel for the Decontamination of Three Mile Island Unit 2 (Panel) met on Thursday, April 13, 1989. The NRC staff briefed the Panel on the ongoing revision of the PEIS on PDMS. The licensee briefed the Panel on its offsite radiation monitoring program, cleanup funding, and schedule.

Future reports will be made as appropriate.

* * * * * * *

87-1 NRC Order Suspends Power Operations of Peach Bottom Facility Due to Inattentiveness of the Control Room Staff

This abnormal occurrence was originally reported in NUREG-0090, Vol. 10, No. 1, "Report to Congress on Abnormal Occurrences: January-March 1987," and updated in subsequent reports in this series (NUREG-0090, Vol. 10, No. 2; Vol. 10, No. 3; and Vol. 11, No. 3). It is further updated, and closed out, as follows:

As discussed in the previous report, on October 19, 1988, the NRC staff issued a Safety Evaluation Report (Ref. B-2), which concluded that the licensee's (Philadelphia Electric Company) proposed "Plan for Restart of Peach Bottom Atomic Power Station (PBAPS)" was acceptable to meet the requirements of the March 31, 1987 NRC shutdown order (Ref. B-3) for a detailed and comprehensive plan and schedule to ensure that the facility will be operated safely and comply with all requirements. Subsequently, the licensee continued with its plans to prepare for plant restart and the NRC staff continued to monitor the effectiveness of the licensee's implementation of the restart plan and associated activities.

On February 2, 1989, the licensee reported that subject to resolution of certain identified issues, PBAPS was ready for startup and safe operation. Unit 2 would be restarted first, with Unit 3 to follow later in 1989. In order to assess the status and results of the licensee's corrective actions, the NRC performed an independent review of the effectiveness of the licensee's management control, programs, and personnel during an Integrated Assessment Team Inspection conducted February 3-17, 1989 (Ref. B-4). In addition, extensive evaluations of the control room operators and shift managers were conducted by the NRC on the plant specific simulator.

The Team consisted of a senior NRC Region I manager, a Team leader and members of the NRC Region I and Headquarters staff. The Team also included an observer representing the Commonwealth of Pennsylvania and one representing the State of Maryland. These observers had access and input to all aspects of the inspection as provided by the established protocol. The areas reviewed during the inspection included site management/operations, licensed operator resource development, station culture, corporate oversight, radiological controls, maintenance/surveillance, engineering/technical support, and security. The Team reported directly to the Regional Administrator of NRC Region I.

Overall, the Team concluded with high confidence that the licensee's management controls, programs, and personnel were generally ready and performing at a level to support safe startup and operation of Peach Bottom Unit 2. The Team also concluded that the corrective actions implemented as stated in the Plan for Restart of PBAPS were generally effective. Further, although the Team identified certain items that required licensee actions or evaluation, there were no fundamental flaws found in the licensee's management structure, performance, programs or implementation that would inhibit its ability to assure reactor and public safety.

The licensee's plan and accomplishments were reviewed by the Advisory Committee on Reactor Safeguards (ACRS) and discussed in an ACRS letter dated March 14, 1989. The ACRS stated that the Committee found no reason to disagree with the staff's position that, subject to certain conditions, the licensee could operate the plant without undue risk to the health and safety of the public. The staff considered public comments as well as Maryland and Pennsylvania comments on February 28 and March 1, 1989. Their comments were factored into the staff's review regarding restart. No new issues were identified.

On April 17, 1989, in a meeting open to public attendance, the Commission was briefed by the licensee and the NRC staff on the licensee's readiness to restart PBAPS, upon completion of all appropriate prerequisites, and to proceed with power ascension in Unit 2 under NRC staff oversight. The Commission agreed, and requested the NRC staff to: a) closely monitor that the licensee meets its commitments for improved performance; and (b) continue discussions with the officials of the Commonwealth of Pennsylvania and the State of Maryland to resolve any outstanding concerns.

Subsequently, on April 26, 1989, the March 31, 1987 NRC shutdown order was modified to allow Unit 2 operation, not to exceed 35% of full power, in order to demonstrate the effectiveness of the licensee's corrective actions in an operating environment, in accordance with their approved restart power testing plan (Ref. B-5). Based on continued satisfactory licensee performance, the NRC shutdown order was further modified on June 28, 1989, and July 21, 1989, to permit operation up to 70% and 100% power, respectively (Refs. B-6 and B-7). Final release from the requirements of the shutdown order is being considered pending further demonstration by the licensee, and review by the NRC staff, of the effectiveness of the licensee's corrective actions in an operating environment.

Unless new, significant information becomes available, this item is considered closed for the purposes of this report.

* * * * * * * *

OTHER NRC LICENSEES

89-5 Medical Diagnostic Misadministration

This abnormal occurrence, which occurred at New England Medical Center Hospitals, Boston, Massachusetts, was originally reported in NUREG-0090, Vol. 12, No. 1, "Report to Congress on Abnormal Occurrences: January-March 1989." It is updated, and closed out, as follows:

As discussed in the previous report, on March 14, 1989, a patient was administered five millicuries of iodine-131, rather than the intended dose of one millicurie of iodine-123. This resulted in a therapeutic dose to the patient's thyroid of 4,000 to 5,000 rads, with a possible range between 1,200 and 9,000 rads.

A special safety inspection was conducted by NRC Region I on June 5, 1989, to review the circumstances associated with the event (Ref. B-8). An apparent violation was identified in regard to a license condition that requires that licensed material be used by, or under the supervision of, individuals designated by the licensee's Radiation Safety Committee.

On July 10, 1989, an enforcement conference was conducted to discuss the violation, its cause, and the licensee's corrective actions. The licensee's corrective actions included: a change in the radiopharmaceutical requisition forms to include the patient's name, type of study and isotope; approval of all iodine-131 use by the Chief Nuclear Medicine Technologist before administration of doses to patients; and additional training to all radiology residents, endocrinologists, and technologists during regularly scheduled Quality Assurance Meetings.

This incident was also reviewed by an NRC medical consultant. One of the consultant's recommended courses of action was to follow the patient yearly with thyroid function and imaging studies and palpation to reduce the risk of thyroid cancer and hypothyroidism. The hospital committed to follow this course of action; however, prior to the July 10, 1989, enforcement conference, the patient died due to a longstanding cardiac condition.

On July 25, 1989, the NRC issued a Notice of Violation to the licensee (Ref. B-9) regarding the previously mentioned apparent violation identified during the inspection on June 5, 1989. No civil penalty was proposed because of the licensee's (a) prompt identification of the misadministration, (b) prompt and extensive corrective actions, and (c) good enforcement history.

This item is considered closed for the purposes of this report.

* * * * * * * * *

APPENDIX C

OTHER EVENTS OF INTEREST

The following items are described because they may possibly be perceived by the public to be of public health or safety significance. The items did not involve major reductions in the level of protection provided for public health or safety; therefore, they are not reportable as abnormal occurrences.

1. Hydrogen Storage on the Roof of the Control Room at Trojan

During the Trojan 1989 refueling outage, an NRC special chemistry team inspection was performed on April 17-21, 1989. The inspectors identified potential safety problems concerning the location of the hydrogen storage facility. Trojan is a Westinghouse-designed pressurized water reactor, operated by Portland General Electric Company (the licensee), and located in Columbia County, Oregon. [Hydrogen is used in pressurized water reactor (PWR) plants for (1) providing a cover gas in the volume control tank, and (2) cooling the main turbine generator. At boiling water reactor (BWR) plants, hydrogen is also used for cooling the main turbine generator and for injection into the feed system for plants which have implemented hydrogen water chemistry.] As noted in the Team Inspection Report No. 50-344/89-07 (Ref. C-1), the licensee's hydrogen storage facility, as well as a nitrogen storage facility, were located on the roof of the building housing the control room. The control room is located on the top floor of this building. The roof consists of 30-inch-thick reinforced concrete. The potential safety problems were as follows:

(a) Leakage of hydrogen gas from the storage facility in proximity to the air intakes to the control room ventilation and emergency pressurization system may introduce a flammable or explosive gas mixture into the control room. Because the hydrogen storage facility, containing four 8,000-scf hydrogen tanks at up to 2450 psig, is Seismic Category II, a seismic event may result in a hydrogen leak. Furthermore, the pressure relief valves in the hydrogen facility exhaust downward to within 6 inches of the control room roof in the vicinity of the control room ventilation system air intakes. It was also noted that six 8,000-scf nitrogen tanks were located in the vicinity of the control room air intakes. Nitrogen leakage and dispersion into the air intakes may lead to incapacitation of the control room operators.

(b) A detonation of a hydrogen storage tank (energy equivalent to 217 pounds of TNT) may structurally damage and affect performance of safety-related equipment on the control room roof such as the ventilation system intake and exhaust structure, the emergency pressurization system, and equipment in the control room itself.

(c) An explosion of the hydrogen delivery truck that provides hydrogen to the facility through a fill line located at ground level on the wall of the auxiliary building may structurally damage safety-related component

cooling water pumps and radwaste storage tanks located inside the auxiliary building and in the vicinity of the hydrogen fill line.

The findings raised issues regarding whether the design met the intent of 10 CFR Part 50, Appendix R ("Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979"), and 10 CFR Part 50, Appendix A, General Design Criteria Nos. 3 (regarding fire protection) and 19 (regarding control room protection by multiple fission product barriers). In addition, there was reasonable doubt that the design met the Electric Power Research Institute's (EPRI) guidelines regarding recommended separation distances for hydrogen storage to prevent damage to nuclear power plant structures from hydrogen explosion. These guidelines, prepared by EPRI and the Boiling Water Reactor Owner's Group, are part of a licensing topical report which was reviewed and accepted by the NRC. The NRC's approval letter, dated July 13, 1987, stated that the topical report may be useful in providing industry guidance for the design, operation, maintenance, surveillance, and testing of hydrogen systems for (1) providing a cover gas in a pressurized water reactor volume control tank and (2) cooling the main turbine generator.

The licensee was unable to find documentation to support the design basis for these systems. The Inspection Team considered the matter to be unresolved and stated it would be addressed in a later inspection.

On April 27, 1989, the NRC issued Information Notice (IN) No. 89-44 (Ref. C-2) to all holders of operating licenses or construction permits for nuclear power plants. The IN was issued to describe the situation at Trojan, and to alert recipients to potential generic problems pertaining to the storage of hydrogen in the vicinity of safety-related structures and air pathways into safety-related structures.

Subsequent to issuance of IN No. 89-44, the NRC surveyed all U.S. nuclear power plants regarding separation distance between the hydrogen storage facility and safety-related structures and air intakes and the volume of gaseous or liquid hydrogen stored onsite. The guidelines in the previously mentioned EPRI topical report were used in assessing safe separation distances. Results from the survey indicated a potential generic problem. About 29 percent of plants met the EPRI guidelines and about 38 percent did not (11 percent did not meet explosion separation distance and 27 percent did not meet the air intake separation distance). The remaining 33 percent included plants that may have hydrogen storage piping sizes that upon breaking could result in the dispersion of flammable or explosive mixtures into safety-related air intakes. The survey also identified propane tanks located in proximity to safety-related structures and air intakes.

On July 12-14, 1989, the NRC conducted a special inspection (Ref. C-3) at Trojan in regard to the unresolved item identified during the April 17-21, 1989, special chemistry team inspection. The inspection concentrated on the actions taken by the licensee in regard to the hydrogen gas supply system since NRC issuance of IN No. 87-20 on April 20, 1987 (Ref. C-4), until the April 17-21, 1989, inspection. The IN had alerted licensees to three reactor events involving hydrogen during the first quarter of 1987, and suggested reports that would be useful in evaluating hydrogen gas supply systems.

The inspection identified one apparent violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions." The NRC letter forwarding the inspection report noted that following receipt of IN No. 87-20, the licensee had promptly made an initial review; however, the review was narrow and flawed in that a serious reevaluation was not made using the industry standards referenced in the IN.

In addition, although the licensee had identified some corrective actions on May 3, 1987, the actions had not yet been implemented at the time of the April 1989 NRC Chemistry Team Inspection.

Following the NRC Chemistry Team Inspection, the licensee took prompt and extensive corrective actions. Immediate compensatory measures were taken to assure that the plant was in a safe condition. The hydrogen storage tanks were closed and an oxygen monitor was installed in the control room to prevent incapacitation of the control room operators in the event of a nitrogen leak.

For a permanent solution, the licensee subsequently relocated the plant's hydrogen storage facility to a remote area, which is 900 feet away from any plant safety-related components or structures. The hydrogen fill station was also moved to the same remote location. In addition, the licensee has submitted to the NRC an evaluation of the existing nitrogen system (on the roof of the control room).

In addition to the specific actions taken in regard to the Trojan plant, the NRC is reviewing the potential generic implications identified during the previously mentioned survey made of all nuclear plants. These implications remain under review.

* * * * * * * *

2. Erosion/Corrosion - Induced Pipe Wall Thinning

Pursuant to 10 CFR §50.54 (f), on May 2, 1989, the NRC issued Generic Letter (GL) 89-08 (Ref. C-5) to all holders of operating licenses or construction permits, requiring information to assess safe operation of reactors when erosion/corrosion significantly degrades piping and components of high-energy carbon steel piping systems. The principal concern is whether the affected plants continue to meet their licensing basis when erosion/corrosion degrades the pressure boundary to below the applicable code design value.

Systems such as main feedwater system, as well as other power conversion systems, are made of carbon steel and are important to safe operation. Failures in these systems of active components such as valves or pumps or of passive components such as piping can result in undesirable challenges to plant safety systems required for safe shutdown and accident mitigation or to operating staff and the plant because of potential system interactions of high-energy steam and water with other systems, such as electrical distribution, fire protection, and security. Concerns regarding this issue were prompted by incidents at Surry Unit 2 (a Westinghouse - designed pressurized water reactor, operated by Virginia Electric and Power Company, and located in Surry County, Virginia) and the Trojan Nuclear Plant (a Westinghouse-designed pressurized water reactor, operated by Portland General Electric Company, and located in Columbia County, Oregon).

On December 9, 1986, a catastrophic pipe rupture occurred at Surry Unit 2. A 2-by-4-foot section of the wall of the suction 18 inch line to the A main feedwater pump was blown out. Because of the circumstances associated with this event, including the death of four plant workers, the event was reported as abnormal occurrence No. 86-22 in NUREG-0090, Vol. 9, No. 4. Later, during a September 1988 outage, the licensee discovered that pipe wall thinning was occurring more rapidly than expected. On the suction side of one of the main feedwater pumps, an elbow installed during a 1987 refueling outage lost 20 percent of its 0.500-inch wall in 1.2 years. In addition, wall thinning was continuing in safety-related main feedwater piping and in other nonsafety-related condensate piping.

During a June 1987 outage at the Trojan Nuclear Plant, at least two areas of the straight sections of the main feedwater piping system were discovered to have experienced wall thinning to an extent that the pipe wall thickness would have reached the minimum thickness required by the design code during the next refueling cycle. In addition, numerous piping components of the nonsafety-related portions of the feedwater lines were also found to have experienced extensive wall thinning. This event was reported in Appendix C ("Other Events of Interest") in NUREG-0090, Vol. 10, No. 3. In light of the above experiences, the NRC has previously issued seven Information Notices [No. 86-106 (Ref. C-6), and its Supplements 1 (Ref. C-7), 2 (Ref. C-8), and 3 (Ref. C-9); No. 87-36 (Ref. C-10); and No. 88-17 (Ref. C-11)], and Bulletin No. 87-01 (Ref. C-12). In addition, just prior to issuance of GL 89-08, Arkansas Nuclear One, Unit 2 (a Combustion Engineering-designed pressurized water reactor, operated by Arkansas Power and Light Company, and located in Pope County, Arkansas), experienced a rupture of an extraction steam line on the high pressure turbine on April 18, 1989. This event, also caused by erosion/corrosion, was described in Information Notice No. 89-53 dated June 13, 1989 (Ref. C-13).

Erosion/corrosion, or flow-assisted corrosion, is a form of material degradation that can affect metallic materials that are normally resistant to corrosion because they are protected by an oxide film that forms on the surface. However, turbulent and fast-flowing water or wet steam wears away the protective film and leads to continued dissolution of the underlying metal. Erosion/corrosion differs from erosion that is caused by mechanical processes such as abrasion (caused by particles in water), impingement (caused by water droplets in steam), and cavitation (caused by collapsing gas bubbles). Substantial research has been performed to establish the main factors that control erosion/corrosion. These factors include: (1) alloy composition of the piping; (2) oxygen concentration, pH and temperature of the fluid; (3) piping configuration; and (4) flow rate.

NRC staff review indicates that the pipe wall thinning problem is widespread for single-phase and two-phase high-energy carbon steel systems. Prior to the December 9, 1986, pipe rupture event at Surry Unit 2, Electric Power Research Institute (EPRI) research programs had helped the industry by identifying two-phase erosion/corrosion as a flow-accelerated corrosion process that leads to wall thinning (metal loss) of carbon steel components exposed to flowing wet steam. An inspection guideline was issued to help utilities in developing their erosion/corrosion monitoring program for the two-phase lines. After the

Surry Unit 2 event, industry took the initiative to address the single-phase erosion/corrosion issue. In March 1987, the Nuclear Utility Management and Resource Council (NUMARC) established a working group on erosion/corrosion. To assist utilities in identifying areas of carbon steel piping that might be undergoing erosion/corrosion damage under single-phase conditions, NUMARC and EPRI developed a recommended inspection plan to monitor pipe wall-thinning problems.

In April 1989, the NRC staff issued NUREG-1344 (Ref. C-14) which provides a brief review of the erosion/corrosion phenomena and its major occurrences in nuclear power plants. In addition, efforts to address this issue are described. Finally, findings are discussed of audits performed at 10 operating plants (7 pressurized and 3 boiling water reactors) in late 1988 to assess implementation of erosion/corrosion monitoring programs by the licensees and to ensure that adequate guidance was provided for corrective actions and other activities regarding repair and replacement of degraded piping and components. In general, the licensees had developed and put in place an erosion/corrosion monitoring program that meets the intent of the NUMARC guidelines. However, the staff found that none of these licensees had implemented formalized procedures or administrative controls to ensure continued long-term implementation of its erosion/corrosion monitoring program for piping and components within the licensing basis. NUREG-1344 formed the basis of GL 89-08 to provide assurance that all licensees have a systematic long term program in place. The NUREG was forwarded to all licensees as an attachment to GL 89-08.

* * * * * * * *

REFERENCES (FOR APPENDICES)

B-1 U.S. Nuclear Regulatory Commission, "Programmatic Environmental Impact Statement (PEIS) Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident at Three Mile Island Nuclear Station, Unit 2, Draft Supplement 3 Dealing with Post-Defueling Monitored Storage and Subsequent Cleanup," NUREG-0683, Draft Supplement No. 3, April 1988.*

B-2 Letter from W.T. Russell, Administrator, NRC Region I, to C.A. McNeill, Executive Vice President-Nuclear, Philadelphia Electric Company, forwarding "Peach Bottom Atomic Power Station Safety Evaluation Report," Docket Nos. 50-277 and 50-278, October 19, 1988.*

B-3 Letter from Victor Stello, Jr., NRC Executive Director for Operations, to J.C. Everett, III, Chairman of the Board and Chief Executive Officer, Philadelphia Electric Company, forwarding an "Order Suspending Power Operation and Order to Show Cause (Effective Immediately)," Docket Nos. 50-277 and 50-278, March 31, 1987.*

B-4 Letter from William F. Kane, Director, Division of Reactor Projects, NRC Region I, to C.A. McNeill, Executive Vice President - Nuclear, Philadelphia Electric Company, forwarding Integrated Assessment Team Inspection Report Nos. 50-277/89-81 and 50-278/89-81, Docket Nos. 50-277 and 50-278, March 6, 1989.*

B-5 Letter from W.T. Russell, Administrator, NRC Region I, to C.A. McNeill, Executive Vice President - Nuclear, Philadelphia Electric Company, Docket Nos. 50-277 and 50-278, April 26, 1989.*

B-6 Letter from W.T. Russell, Administrator, NRC Region I, to C.A. McNeill, Executive Vice President - Nuclear, Philadelphia Electric Company, Docket Nos. 50-277 and 50-278, June 28, 1989.*

B-7 Letter from W.T. Russell, Administrator, NRC Region I, to C.A. McNeill, Executive Vice President - Nuclear, Philadelphia Electric Company, Docket Nos. 50-277 and 50-278, July 21, 1989.*

B-8 Letter from Malcolm R. Knapp, Director, Division of Radiation Safety and Safeguards, NRC Region I, to E. Cohen, Administrator, New England Medical Center Hospitals, Boston, Massachusetts, forwarding Inspection Report No. 030-01868/89-002, Docket No. 030-01868, June 28, 1989.*

B-9 Letter from William T. Russell, Administrator, NRC Region I, to E. Cohen, Associate Director, New England Medical Center Hospitals, Boston, Massachusetts, forwarding a Notice of Violation, Docket No. 030-01868, July 25, 1989.*

---

*Available in NRC Public Document Room, 2120 L Street, NW, (Lower Level), Washington, D.C., for public inspection and/or copying.

C-1 Letter from Ross A. Scarano, Director, Division of Radiation Safety and Safeguards, NRC Region V, to David W. Cockfield, Vice President, Nuclear, Portland General Electric Company, forwarding Inspection Report No. 50-344/89-07, Docket No. 50-344, May 23, 1989.*

C-2 U.S. Nuclear Regulatory Commission, Information Notice No. 89-44, "Hydrogen Storage on the Roof of the Control Room," April 27, 1989.*

C-3 Letter from Ross A. Scarano, Director, Division of Radiation Safety and Safeguards, NRC Region V, to David W. Cockfield, Vice President, Nuclear, Portland General Electric Company, forwarding a Notice of Violation and Inspection Report No. 50-344/89-18, Docket No. 50-344, August 3, 1989.*

C-4 U.S. Nuclear Regulatory Commission, Information Notice No. 87-20, "Hydrogen Leak in Auxiliary Building," April 20, 1987.*

C-5 Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," from James G. Partlow, Associate Director for Projects, NRC Office of Nuclear Reactor Regulation, to all holders of operating licenses or construction permits for nuclear power plants, May 2, 1989.*

C-6 U.S. Nuclear Regulatory Commission, Information Notice No. 86-106, Feedwater Line Break, December 16, 1986.*

C-7 U.S. Nuclear Regulatory Commission, Information Notice No. 86-106, Supplement 1, "Feedwater Line Break," February 13, 1987.*

C-8 U.S. Nuclear Regulatory Commission, Information Notice No. 86-106, Supplement 2, "Feedwater Line Break," March 18, 1987.*

C-9 U.S. Nuclear Regulatory Commission, Information Notice No. 86-106, Supplement 3, "Feedwater Line Break," November 10, 1988.*

C-10 U.S. Nuclear Regulatory Commission, Information Notice No. 87-36, "Significant Unexpected Erosion of Feedwater Lines," August 4, 1987.*

C-11 U.S. Nuclear Regulatory Commission, Information Notice No. 88-17, "Summary of Responses to NRC Bulletin 87-01, 'Thinning of Pipe Walls in Nuclear Power Plants,'" April 22, 1988.*

C-12 U.S. Nuclear Regulatory Commission, Bulletin No. 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," July 9, 1987.*

C-13 U.S. Nuclear Regulatory Commission, Information Notice No. 89-53, "Rupture of Extraction Steam Line on High Pressure Turbine," June 13, 1989.*

---

*Available in NRC Public Document Room, 2120 L Street, NW, (Lower Level), Washington, D.C., for public inspection and/or copying.

C-14 U.S. Nuclear Regulatory Commission, NUREG-1344, "Erosion/Corrosion-Induced Pipe Wall Thinning in U.S. Nuclear Power Plants," published April 1989.**

** Available for purchase from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082. Also available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. A copy is also available for public inspection and/or copying at the NRC Public Document Room, 2120 L Street, NW, (Lower Level), Washington, DC.