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Report to Congress on Abnormal Occurrences

April – June 1993

Date Published: September 1993

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

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Previous Reports in Series

NUREG 75/090 (January–June 1975), published October 1975.

NUREG-0090-1 through 10 (July–September 1975 through October–December 1977), published March 1976 through March 1978.

NUREG-0090, Vols. 1 through 15 (January–March 1978 through October–December 1992), published June 1978 through March 1993.

NUREG-0090, Vol. 16, No. 1 (January–March 1993), published June 1993.

ABSTRACT

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event that 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 through June 30, 1993.

This report discusses four abnormal occurrences at NRC-licensed facilities, three involving medical brachytherapy

misadministrations and one involving a research reactor that operated without a safety system. One pool irradiation facility contamination event, two medical misadministrations (one "sodium iodide" and one brachytherapy), and one industrial radiographer overexposure event that were reported by NRC Agreement States are also discussed. The report also contains information updating one previously reported abnormal occurrence and information on three other events of interest.

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PREFACE

Introduction

The Nuclear Regulatory Commission reports to the Congress each quarter, under provisions of Section 208 of the Energy Reorganization Act of 1974, any abnormal occurrences involving facilities and activities regulated by the NRC. An abnormal occurrence (AO) 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 and accompanying examples 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).

The NRC policy statement was published before licensees were required to report medical misadministrations to the NRC. Few of the examples in the policy statement are applicable to medical misadministrations. Therefore, during 1984, the NRC developed guidelines for selecting such events for abnormal occurrence reporting. These guidelines, which have been used by the NRC since the latter part of 1984, augment the NRC policy statement examples and are summarized in Table A-1 in Appendix A. On January 27, 1992, new medical misadministration definitions became effective. Therefore, revised guidelines for identifying medical misadministrations as abnormal occurrences are currently being developed. The revised guidelines will be published for comment in the Federal Register.

In order to provide wide dissemination of information to the public, a Federal Register notice is issued on these abnormal occurrences. 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 described in this report meet the criteria for abnormal occurrence reporting. This report covers the period from April 1 through June 30, 1993. 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 the 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, the 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 and the uses of byproduct nuclear materials, the NRC follows the philosophy that the health and safety of the public are best ensured through the establishment of multiple levels of protection. These multiple levels can be achieved and maintained through regulations specifying requirements that will ensure the safe use of nuclear materials. The regulations include design and quality assurance criteria appropriate for the various activities licensed by the NRC. An inspection and enforcement program helps ensure 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 ensure that corrective actions are taken to prevent recurrence.

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.

Three primary sources of operational data are Licensee Event Reports (LERs) submitted pursuant to 10 CFR 50.73, immediate notifications made pursuant to 10 CFR 50.72 and medical misadministration reports made pursuant to 10 CFR 35.33.

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 Washington, 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. For the purpose of developing a nationwide database, Agreement States are encouraged to provide information to the NRC on reportable events.

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.

Reopening of Closed Abnormal Occurrences

The NRC reopens previously closed abnormal occurrences if significant new information becomes available. Similarly, previously reported Other Events of Interest items are updated if significant new information becomes available.

REPORT TO CONGRESS ON ABNORMAL OCCURRENCES APRIL-JUNE 1993

Nuclear Power Plants

NRC is reviewing events reported at the nuclear power plants licensed to operate. For this report, NRC has deter-

mined that no events were abnormal occurrences.

Fuel Cycle Facilities (Other than Nuclear Power Plants)

NRC is reviewing events reported by these licensees. For this report, NRC has determined that no events were

abnormal occurrences.

Other NRC Licensees (Industrial Radiographers, Medical Institutions, Industrial Users, etc.)

There are currently over 7,500 NRC nuclear material licenses in effect in the United States, principally for the use of radioisotopes in the medical, industrial, and academic fields. Incidents were reported in this category from licensees such as radiographers, medical institutions, academic institutions, and byproduct material users. NRC is reviewing events reported by these licensees. For this report, NRC has determined that the following events were abnormal occurrences using the criteria and guidelines given in Appendix A. As noted in the Preface to this report, the guidelines for identifying medical misadministrations as abnormal occurrences are currently being revised.

93-5 Medical Brachytherapy Misadministration at Parkview Memorial Hospital in Fort Wayne, Indiana

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see Event Type 3 in Table A-1) of this report notes that a therapeutic exposure to a part of the body not scheduled to receive radiation should be considered an abnormal occurrence.

Date and Place—December 9, 1992; Parkview Memorial Hospital; Fort Wayne, Indiana.

Nature and Probable Consequences—On December 9, 1992, a 62-year-old patient was scheduled to receive a 500 centigray (cGy) (500 rad) radiation dose for vaginal cancer

using a high-dose-rate brachytherapy treatment device. The device uses a 296,000 megabecquerel (MBq) (8 curie [Ci]) iridium-192 (Ir-192) source.

The brachytherapy treatment was the final part of a curative radiation treatment series.

The location of the treatment area was unusual for vaginal treatments and required a different starting position for the Ir-192 source than is normally used for such treatments. Both the dosimetrist and the medical physicist performed the treatment calculations working together (the second series of calculations was not an independent check) and both used the incorrect starting location for the source position. The error was not detected, and the treatment was performed as scheduled. As a result, the intended 500 cGy (500 rad) radiation dose was delivered to an area 5.25 centimeters (2.07 inches) away from the intended treatment area. A small portion of the intended treatment area received a radiation dose ranging from 50 to 300 cGy (50 to 300 rad) according to the licensee.

On January 6, 1993, the error was discovered during a record review by a dosimetrist. The referring physician and the patient were informed of the error. The licensee reported the misadministration to NRC on January 7, 1993. The incident constitutes a misadministration because the radiation dose was administered to the wrong treatment site. On January 18, 1993, the patient received an additional treatment using the high dose rate brachytherapy treatment device. The treatment plan was revised to meet the intended objectives of the earlier treatment, taking into account the lower dose already received by a portion of the treatment area.

The licensee reported that no physical effect was observed as a result of the misadministration. The NRC retained a medical consultant to evaluate the circumstances of the misadministration. The consultant concluded that no noticeable biological effect is expected as a result of the misadministration.

Cause or Causes—Because of the unusual configuration of the treatment area, the standard treatment parameters used for vaginal brachytherapy treatment were not applicable. A medical physicist and a dosimetrist prepared the dose calculations working together and made the same error in assuming the initial position of the treatment source.

The licensee's Quality Management Program requires that an independent check of the dose calculations be performed by a qualified individual before the treatment is initiated. Such an independent check was not performed.

Actions Taken to Prevent Recurrence

License—The licensee has revised its procedures for preparing the treatment plans for the high-dose-rate brachytherapy procedures. It has made improvements in the calculation notebook and other related data used in preparing the treatment plans and the dose calculations.

NRC—NRC Region III conducted a special inspection on January 28 and 29, 1993, to review the circumstances surrounding the misadministration (Ref. 1). An NRC medical consultant was also retained to review the case.

The NRC inspection determined that the licensee failed to follow its Quality Management Program requirement for an independent check of brachytherapy dose calculations. Other violations were identified which did not directly relate to the misadministration. A notice of violation was issued to the licensee.

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

93-6 Inoperable Research Reactor Scrams at University of Virginia in Charlottesville, Virginia

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see Items No. 10 and 11 for all licensees) of this report notes that a major deficiency in operating, management, or procedural controls that impact safety should be considered an abnormal occurrence.

Date and Place—April 28, 1993; the University of Virginia; Charlottesville, Virginia.

Nature and Probable Consequences—Since November of 1992, the University of Virginia's research reactor had been experiencing a series of spurious scrams. The scrams were occurring without any annunciator indication. Because of the design of the scram annunciator system, the licensee staff did not believe that the unannounced scrams were being caused by electrical supply line noise. A member of the licensee's staff who was in charge of the electronic maintenance at the facility concluded that the most likely source of the problem was in the scram logic system. Therefore, when he experienced unannounced scrams on April 28, 1993, while performing the duties of the Senior Reactor Operator (SRO), he independently began trouble-shooting the problem to try to isolate the source of the scrams. There was no specific procedure in place to provide guidance for the trouble-shooting activities.

With the reactor shutdown, the SRO first interchanged some of the electronic equipment in the reactor control console. That action did not remedy the situation so he interchanged some other equipment, i.e., two mixer/driver (MD) modules. The MD modules appeared to be identical in their external appearance and both had the same identification number. After approximately 30 minutes, no further scrams were received so the SRO briefly conferred with the Reactor Administrator about the situation, and the reactor was restarted. Neither the SRO nor the Reactor Administrator realized that the trouble-shooting actions (exchanging the MD modules) were maintenance activities. Therefore, no postmaintenance testing was performed to ensure that the safety systems were operating as required.

The reactor was operated at full power for the next 5.5 hours with a change in SROs every 2 hours. No scram signal was received during that period. During a normal shutdown of the reactor at the end of the day on April 28, another SRO, who was then in charge of reactor operations, decided to complete the shutdown by introducing an electronic period scram. The scram logic, however, failed to produce the expected period scram and the SRO manually scrambled the reactor, which resulted in safe shutdown of the reactor.

Cause or Causes—The principal cause of the incident was the SRO exchanging the MD modules in the reactor control console. This inadvertently defeated five of the scrams required for reactor operation. Other contributing causes were not recognizing the exchanging of the modules as a maintenance activity, lack of adequate procedures defining maintenance and troubleshooting activities, and failure to perform post-maintenance testing of the safety system prior to restarting reactor operations.

Actions Taken to Prevent Recurrence

Licensee—The Reactor Director was notified of the problem when no scram was received the evening of April 28

and an investigation was begun into the cause of the problem. As a result of the investigation, the licensee initiated various corrective actions including: (1) maintaining the reactor in safe shutdown until the problem was investigated, understood, and reviewed with the Reactor Safety Committee (RSC) and with the NRC; (2) notifying the University, the community, and the NRC of the problem; (3) requesting a peer review from the National Organization of Test, Research, and Training Reactors (TRTR); (4) determining the root cause(s) of the event and taking corrective actions; (5) determining if there were any problems with the hardware, schematics, and Standard Operating Procedures (SOPs) which may have contributed to this event and taking actions to correct the problems noted; and (6) determining if any administrative corrective actions were needed.

NRC—A reactive inspection was conducted on May 3, 1993. Staff members from NRC Region II and headquarters participated in this inspection. A follow-up inspection was conducted on June 3 and 4, 1993, again with participation from NRC Region II and headquarters. Apparent violations of regulatory requirements were identified and discussed with licensee management and the SRO involved in the incident during a June 29, 1993, enforcement conference held in the NRC Region II Office. The licensee presented its perspective on the significance of the event, its causes, and the licensee's corrective actions. A notice of violation and proposed imposition of civil penalty was issued by the NRC on July 28, 1993. Violations were proposed for operating the reactor without five safety system channels required by the Technical Specifications and for failing to verify that the safety system channels were operable following maintenance, as required by the Technical Specifications. These were categorized in the aggregate as a Severity Level II problem (Severity Levels I through V range from the most significant to the least significant) and a civil penalty of \$2000 was proposed. The licensee paid the civil penalty on August 26, 1993.

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

93-7 Medical Brachytherapy Misadministration at Mercy Memorial Medical Center in St. Joseph, Michigan

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (See Event Type 3 in Table A-1) of this report notes that a therapeutic exposure to a part of the body not scheduled to receive radiation should be considered an abnormal occurrence.

Date and Place—February 16, 1993; Mercy Memorial Medical Center; St. Joseph, Michigan.

Nature and Probable Consequences—On February 16, 1993, at 5:00 p.m., a patient was undergoing a brachytherapy procedure using cesium-137 (Cs-137) sources. The radiation oncologist involved in this procedure failed to properly rotate the insert of the brachytherapy device containing the sources, and one source containing 862.1 megabecquerel (MBq) (23.3 millicuries [mCi]) Cs-137 fell out of the insert onto the patient's bed. The source landed on an absorbent pad that was placed between the patient and the surface of the bed. The loss of the source was not observed by the oncologist or the medical physicist who was assisting him.

On February 17, at about 8:20 a.m., a nurse observed a small piece of metal between the patient and the absorbent pad. The nurse thought it was a small screw and retrieved it, placing it in a paper cup on the bedside table. The radiation oncologist and the medical physicist were notified, and they identified the object as a Cs-137 source. Using tongs, they placed it in a shielded storage container.

The dislodged source was subsequently placed in the treatment device, and the treatment plan was revised to reflect that the source was implanted for a reduced period of time. The revised treatment plan indicated that this implant time reduction for the one source would result in an underdose of about 6 percent to the intended treatment site.

The licensee calculated that the dislodged source resulted in a radiation dose of about 45.8 centigray (cGy) (45.8 rad) to the perineum, an area different from the intended treatment site. In addition, the licensee stated that there is no evidence of clinical effects on the patient as a result of the radiation exposure from the dislodged source.

This incident is considered a misadministration because a part of the patient's body received unscheduled radiation exposure. The licensee reported that both the patient and the referring physician had been notified of the incident.

The NRC staff calculated the dose to the nurse who discovered and handled the dislodged source. Based on information supplied by the nurse on her handling of the source, NRC calculated that she received a 4.25 cGy (4.25 rad) radiation exposure to the surface of the hand in contact with the source.

Cause or Causes—The cause of the misadministration was the radiation oncologist's failure to properly rotate the Cs-137 source insert while loading the source into the treatment device. In addition, the nurse who discovered the dislodged source had not received any training on the size and appearance of the brachytherapy sources.

Actions Taken to Prevent Recurrence

Licensee—The licensee conducted refresher training for its nurses to explain brachytherapy procedures and provided them with instructions.

NRC—NRC Region III conducted a special inspection from March 26 through April 7, 1993, to review the circumstances surrounding the misadministration (Ref. 2). An NRC medical consultant was also retained to evaluate the circumstances of the event.

The inspection identified several apparent violations of NRC requirements including: (1) substantial failure to implement a Quality Management Program for brachytherapy procedures; (2) failure of the RSO to adequately investigate the accident to identify a misadministration, and to assess overexposure to the nurse's hands; (3) failure to adequately instruct nurses caring for brachytherapy patients; and (4) failure to make evaluations to assure compliance with NRC exposure limits for occupational workers. On August 2, 1993, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalties in the amount of \$6,250. The licensee paid the civil penalties on August 12, 1993.

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

93-8 Medical Brachytherapy Misadministration at Keesler Medical Center, Keesler Air Force Base, in Biloxi, Mississippi

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see Event Type 3 in Table A-1) of this report notes that a therapeutic exposure to a part of the body not scheduled to receive radiation should be considered an abnormal occurrence.

Date and Place—June 10, 1993; Keesler Medical Center; Keesler Air Force Base; Biloxi, Mississippi.

Nature and Probable Consequences—On June 14, 1993, the United States Air Force Radioisotope Committee Secretariat (RIC) notified NRC Region IV of an incident involving a brachytherapy treatment which occurred at Keesler Medical Center on June 10, 1993. The permittee's Radiation Safety Officer (RSO) was not present at the facility on June 10. The permittee staff involved with the treatment did not initially recognize the incident as a misadministration. The incident and related facts were reported to the RSO when he returned to the medical center on June 14. The RSO subsequently notified RIC of the

incident, who in turn formally notified NRC. RIC's initial report noted that a patient who was to receive a total dose of 1400 centigray (cGy) (1400 rad) to the right lower lung had also received an unintended dose of approximately 2.09 cGy (2.09 rad) to the facial area.

The incident involved a brachytherapy treatment using an iridium-192 highdose-rate remote afterloading device. The written directive prepared by the authorized user prescribed two treatment doses of 700 cGy (700 rad) each to be delivered to the lower lobe of the patient's right lung. The first treatment dose was administered on June 2, 1993, using a single endobronchial catheter, as prescribed in the written directive. The second treatment dose was to be administered on June 10, 1993, using two endobronchial catheters, one positioned in the lower lobe of the right lung and the second positioned in the middle lobe of the lung. The fractional dose prescribed for the lower lobe was delivered as intended. The fractional dose for the middle lobe was not delivered as prescribed in the written directive due to incorrect positioning of the source.

The mispositioning of the source resulted from an error in entering the length of the catheter into the treatment planning computer. The treatment plan established by the authorized user called for use of two catheters, each with a length of 150 centimeters (cm) (59.1 inches [in.]). The length of the first catheter and source position was properly entered at the treatment planning computer console. The permittee's dosimetrist believed that the length and source position for the second catheter were properly entered. However, it was later discovered that due to an erroneous keystroke, a default value of 100 cm (39.4 in.) was entered as the length of the second catheter. This resulted in an error in the source position since the actual distance of source travel is determined by subtracting an "offset" value from the length of the catheter. The error in the source position was recognized by the authorized user as the treatment was underway and the treatment was promptly stopped.

Following consultation with the device manufacturer and review of the treatment planning computer data and the data available from the remote afterloading device control console, permittee representatives determined that the source had been positioned approximately 10 cm (3.9 in.) in front of the patient's face for a period of approximately 46 seconds. The estimated dose to the patient's face was determined to be approximately 2.09 cGy (2.09 rad). In the absence of the licensee's RSO, and based on advice provided by the manufacturer's representative, the permittee's staff determined that the incident did not constitute a therapeutic misadministration. The remainder of the prescribed treatment dose was delivered to the middle lobe of the patient's right lung later that day. Through discussions with the RSO, the RIC, and the NRC staff, the permittee subsequently determined on June 14 that a mis-

administration had occurred and reported the incident to NRC and the patient as required.

NRC inspectors were at the medical center on June 23 and 24, 1993, to review the circumstances associated with the misadministration and its probable cause(s).

Cause or Causes—Based on interviews with permittee representatives and reenactment of the treatment planning and setup, the apparent root cause of the misadministration was determined to be an erroneous keystroke at the treatment planning computer console. The permittee's dosimetrist demonstrated for the NRC inspectors the sequence of steps taken during treatment planning, noting that the correct value of 150 cm (59.1 in.) had been entered for both catheters on June 10. However, the dosimetrist believed that after the length of the second catheter was entered, she depressed the "F2" function key to enter another treatment parameter and accidentally touched the "F1" function key with her hand at the same time. This caused the catheter length value to change to the default value of 100 cm (39.4 in.) with only the sound of a "beep" to warn the operator. Through repetitive testing of different keystroke sequences, the dosimetrist determined that this was the only sequence that would reproduce a reset of the catheter length to the default value once the length was manually entered at the treatment planning console. This sequence of steps was repeated for the inspectors several times during the inspection and in each instance, the catheter length defaulted to 100 cm (39.4 in.).

A contributing factor to the misadministration was the failure of permittee staff to verify the dwell positions for each catheter prior to performing the treatment as required by an "Operating Instruction" established by the permittee. Although this operating instruction was not incorporated in the permittee's Quality Management Program, it did require that individuals administering patient treatments using the high-dose-rate remote afterloading device verify both the source dwell time and source dwell positions prior to administering a treatment. This requirement was established to ensure that treatment parameters entered in the device control unit matched the parameters entered in the treatment planning computer. Both the dosimetrist and medical physicist who adminis-

tered the treatment on June 10 acknowledged that they had only verified the source dwell times noted on the treatment planning and device control computer printouts. Although the dwell position value on both records was incorrect (because the error was propagated in both computer systems), the dosimetrist and physicist stated that they probably would have identified the error if they had verified the dwell positions prior to treatment.

Actions Taken to Prevent Recurrence

Permittee—Following the misadministration, the permittee modified a checklist that had been used by the staff to verify that certain actions were completed prior to treatment. The modifications included requirements to (1) physically measure each catheter prior to use for patient treatments and document the measured length of the catheter on the checklist form, (2) document the planned distance from the end of the catheter to the first dwell position on the checklist form, (3) have the authorized user and medical physicist verify the documented catheter length and dwell positions and sign the checklist for approval, and (4) include a review of the checklist in the permittee's Quality Management Program.

NRC—An inspection was conducted on June 23 and 24, 1993, to review the misadministration and its probable cause(s) (Ref. 3). Based on the results of the inspection, two apparent violations were identified relative to the permittee's Quality Management Program. These included (1) a failure to implement and maintain a Quality Management Program that met the objective of ensuring that radiation from byproduct material was administered in accordance with a written directive, and (2) failure to indicate the radioisotope to be used for brachytherapy treatments in 22 written directives. In addition, several weaknesses were identified in the permittee's written Quality Management Program. The inspection findings indicated that the failure to verify the source dwell positions prior to performing a patient treatment was an isolated event and that the permittee staff had complied with the applicable operating instruction during previous patient treatments. A Notice of Violation was issued on July 20, 1993. A Civil Penalty was not proposed.

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 these quarterly reports to Congress. During this period, the Agreement States reported four events as abnormal occurrences.

AS 93-1 Contamination of Pool Irradiator Facility Owned by Radiation Sterilizers, Inc., in Decatur, Georgia

Appendix A (see Example 5 of "For All Licensees") of this report notes that any loss of licensed material in such quantities and under such circumstances that substantial hazard may result to persons in unrestricted areas should be considered an abnormal occurrence.

This event occurred in June 1988 in Georgia, an Agreement State by a joint Georgia and NRC incident Evaluation Task Force. The investigated incident was documented in NUREG-1392, "Leakage of an Irradiator Source - the June 1988 Georgia RSI Incident," published in February 1990. At that time, neither the State nor NRC identified the event as an AO. The state reevaluated the incident against the reporting criteria in 1993 and concluded that the event should be classified as an AO.

Date and Place—June 6, 1988; Radiation Sterilizers, Inc., Decatur, Georgia.

Nature and Probable Consequences—On June 6, 1988, the Radiation Sterilizers, Inc. (RSI) facility in Decatur, Georgia, ceased sterilizer operations utilizing its pool irradiator because of the detection of dissolved radioactive cesium-137 (Cs-137) in a 25,000 gallon pool of water in which 252 stainless steel encapsulated radioactive sources were stored. The Cs-137 sources, which were leased from the Department of Energy (DOE), had a total activity of approximately 444,000 terabecquerel [TBq] (12 megacuries) [MCi]. The sources were Waste Encapsulation Storage Facility (WESF) capsules manufactured by DOE, under the By-product Utilization Program (BUP). This DOE program was initiated with a mission to develop the means for application of radioactive fission products for the benefit of society. Under BUP, the sources were designed for waste storage, not as gamma radiation sources. In 1985, however, NRC agreed that use of WESF sources could be authorized in a limited number of commercial demonstration facilities, including irradiators such as RSI's that operate in the "wet load, wet storage, dry irradiation" mode.

Operators of the RSI pool irradiator notified the State of Georgia Radiation Control Program that the safety system had prevented them from raising sources from the storage pool. Subsequently, radiation levels of 600 microsievert (Sv) (60 millirem) per hour at the surface of the pool water were found, which indicated that one or more of the 252 Cs-137 source capsules used in the irradiator were leaking. Discrete samples of pool water were collected and analyzed and the analytical results showed

elevated levels of Cs-137 dissolved in the pool water, confirming the presence of one or more leaking sources. This was the first recorded instance of a leaking WESF capsule. A joint Federal/State task force, consisting of the Georgia Department of Natural Resources (DNR), the Georgia Department of Human Resources (DHR), and NRC, was established to assist with the RSI incident.

After review and recommendation by the joint task force and upon discussion with RSI, on June 11, 1988, the State of Georgia formally requested that DOE manage the effort to identify the leaking capsule, develop a plan for the safe removal of the leaking capsule, manage the removal of the damaged capsule, and oversee the cleanup and recovery activities at RSI. DOE responded immediately to the State's request and dispatched resources from the Westinghouse Hanford Corporation. The joint Federal/State task force was also expanded to include representatives from the Food and Drug Administration (FDA) and the U.S. Environmental Protection Agency (EPA).

This incident generally was confined to the RSI facility, with no evidence of major discharges to the environment. There was no evidence of overexposure, although areas of minor contamination were found in a warehouse, the office carpet, one automobile seat, one individual's pants and spots on a carpet at a residence, all of which were decontaminated. Some medical products sterilized at the RSI facility before the incident was discovered were contaminated; however, the only contaminated products released from the RSI facility were in a shipment that was recalled before it reached its destination.

Five suspected leaking (damaged) sources were initially removed from the storage pool. One was confirmed to be leaking. Subsequently, the remaining 247 source capsules were examined for leakage. None were found to be leaking. On November 19, 1990, the last of the capsules was shipped off site and final decontamination of the facility began. On September 11, 1992, the DOE contractor completed decontamination of the facility and began the survey. DOE estimated cost of the cleanup to be 45 million dollars. On November 11, 1992, the DOE contractor completed the free release survey and the DNR contractor completed the confirmatory survey. By December 16, 1992, DNR received the free release survey. On January 5, 1993, after review and evaluation of the reports, DNR returned control of the facility to the owner, Sterigenics International (formerly RSI), and terminated its radioactive materials license.

Cause or Causes—The facility contamination resulted from one stainless steel cesium-137 source capsule, out of a total of 252 capsules, leaking in the source storage pool.

DOE has not identified the exact cause of failure of the Cs-137 source capsule.

Actions Taken to Prevent Recurrence

Licensee—The licensee requested that DOE (the source manufacturer and the source lessor) manage the effort to identify the leaking capsule, develop a plan for its safe removal, manage its removal, and oversee the cleanup and recovery activities at RSI.

NRC—Following the incident, NRC reevaluated the WESF sources and determined in early 1991 that WESF sources were not appropriate for long-term use in commercial irradiator facilities and ensured that the remaining commercial users were so notified and advised to cooperate with DOE in scheduling removal of WESF sources from their facilities. As of the date of this report, WESF capsules remain in place in two licensed irradiators, one in Virginia and one in Colorado (licensed by the State of Colorado). According to DOE staff, if certain technical matters are resolved, DOE plans to begin removing the remaining WESF sources from these facilities by the end of 1993.

State Agency—The State of Georgia secured the services of an independent consultant to verify the results of decontamination efforts by the DOE contractor. Once it was verified that the facility met Federal and State regulatory standards for decontamination, the State terminated RSI's material license and returned control of the facility to its owner. Georgia will no longer license highly soluble cesium for this application.

Future reports will be made as appropriate.

AS 93-2 Medical "Sodium Iodide" Misadministration at Grenada Lake Medical Center in Grenada, Mississippi

Appendix A (see Event Type 4 in Table A1) of this report notes that administering a diagnostic dose of a radiopharmaceutical that is greater than five times the prescribed dose should be considered an abnormal occurrence.

This report is based on information provided to the State of Mississippi on April 3, 1992.

Date and Place—April 1, 1992; Grenada Lake Medical Center; Grenada, Mississippi.

Nature and Probable Consequences—On April 1, 1992, a patient scheduled to receive 3.7 megabecquerel (MBq) (100 microcuries [Ci]) of iodine-131 (I-131) for a thyroid uptake study was administered 218.3 MBq (5.9 millicuries [mCi]) of I-131. The 218.3 MBq (5.9 mCi) dosage of I-131 was to be administered to another patient. The technolo-

gist immediately discovered the error and notified the physician (authorized user). Vomiting was induced within 5 minutes of administering the I-131 capsule. The patient was also administered a thyroid blocking agent, 1.2 milliliters (ml) (0.04 fluid ounces [fl. oz.]) of potassium iodide. The patient was also instructed to take additional thyroid blocking agent, 0.3 ml (0.01 fl. oz.) of potassium iodide, once a day for 14 days. A thyroid uptake and scan were performed 24 hours after the incident. The thyroid uptake was 0.3 percent. The referring physician and the patient were informed of the misadministration.

Cause or Causes—The misadministration occurred because the nuclear medicine technologist failed to identify the patient prior to the administration of the radiopharmaceutical.

Actions Taken to Prevent Recurrence

Licensee—The Radiation Safety Officer has implemented new procedures for verification of patient identification and has committed to improve the supervision of personnel. The licensee also stated that patients who are prescribed radiation therapeutic procedures will no longer be included in the same schedule with patients who are prescribed diagnostic procedures.

State Agency—The state agency staff has reviewed the circumstances of the misadministration and will evaluate the licensee's corrective actions during the next inspection to be conducted in the near future.

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

AS 93-3 Medical Brachytherapy Misadministration at Maine Medical Center in Portland, Maine

Appendix A (see Event Type 3 in Table A-1) of this report notes that a therapeutic exposure to a part of the body not scheduled to receive radiation should be considered an abnormal occurrence.

Date and Place—November 11, 1992; Maine Medical Center; Portland, Maine.

Nature and Probable Consequences—A patient was prescribed a brachytherapy treatment using 13 seeds of iridium-192 in a nylon ribbon. The catheter used for the treatment developed a kink and stopped 26 centimeters (cm) (10.24 inches [in.]) from the prescribed treatment area. This resulted in a dose to the patient's hypopharynx area of 3500 centigrays (cGy) (3500 rad), which was the prescribed dose to the lung. The intended treatment area of

the lung was estimated to have received less than 10 cGy (10 rad).

Prior to implantation of the radioactive seeds, nonradioactive sources were implanted for visualization and dosimetry/treatment planning. The licensee performed x-rays which showed that the dummy seeds had reached their desired location. The active seeds were to be inserted immediately after withdrawal of the dummy seeds. However, because of scheduling difficulties with the patient's room, and not wanting a patient with radioactive seeds to remain in the therapy department for an undetermined period of time, the dummy seeds were withdrawn but the catheter remained in the patient. The radioactive seeds were implanted sometime later. In retrospect the licensee estimated that the kink in the catheter developed during the interval of removing the dummy seeds and inserting the active seeds.

After the treatment was completed and while removing the catheter and the nylon ribbon together, the doctor and the Radiation Safety Officer both noticed the kink. The licensee stated that no long-term effects are expected. The patient was notified of the misadministration.

Actions Taken to Prevent Recurrence

Licensee—The licensee implemented the following actions: (1) measuring the nonradioactive seed strand when properly inserted (verified by x-ray) and marking the distance on the active strand; (2) the dummy strand or similar wire will be left in the catheter until immediately prior to insertion of the radioactive strand; and (3) a film will be taken of the area to be treated after the active seeds are inserted to ensure that they are in the correct location.

State Agency—The state agency is reviewing this event to determine necessary actions.

Future reports will be made as appropriate.

AS 93-4 Industrial Radiographer Overexposure Event at Murphy Oil Refinery in Meraux, Louisiana

Appendix A (See example 1 of "For All Licensees") of this report notes that any loss of licensed material in such quantities and under such circumstances that substantial

hazard may result to persons in unrestricted areas should be considered an abnormal occurrence.

Date and Place—May 7, 1993; Murphy Oil refinery; Meraux, Louisiana.

Nature and Probable Consequences—While working at a temporary job site at the Murphy Oil refinery, a 21 year-old industrial radiographer employed by Inspection Specialists, Inc., using 3700 gigabecquerel (GBq) (100 curies) of iridium-192 in a SPEC 2-T exposure device, received a 276.6 millisievert (mSv) (27.66 rem) wholebody exposure as indicated by a thermoluminescent dosimeter badge. Reenactment of the events appears to indicate that the radiographer received the wholebody dose, and that there was probably no extremity dose that would cause acute (short-term) injury. A preliminary physical examination with blood tests indicated no indication of excessive exposure.

The radiographer's assistant is estimated to have received a dose of 9.6 mSv (0.96 rems).

Cause or Causes—Radiography operations were being conducted on a large, open-top steel tank. The radiographers and camera had to be moved from place to place along the side of the tank in personnel baskets. The radiographer failed to lock the exposure device, so that when the radiographer's assistant moved toward the device with the control handle, the source moved slightly out of the shielded position. The radiographer apparently failed to read the survey meter while the source was exposed. The radiographer and assistant realized after several additional exposures that their dosimeters were off scale.

Actions Taken to Prevent Recurrence

Licensee—The licensee provided retraining to the entire staff with special counseling for the Operations Manager, who apparently did not follow written operating procedures.

State Agency—The Louisiana Radiation Protection Division (RPD) recommended to the licensee that routine physical examinations and blood work be performed. Enforcement actions included citations for violations associated with wholebody and extremity overexposures and a lack of adequate training. A civil penalty is being considered for lack of management control.

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

REFERENCES

1. Letter from Charles E. Norelius, Director, Division of Radiation Safety and Safeguards, NRC Region III, to David Ridderheim, President, Parkview Memorial Hospital, dated March 3, 1993, forwarding Inspection Report No. 030-1593/93-001, License No. 13-01284-02, Docket No. 030-01593.*
2. Letter from Charles E. Norelius, Director, Division of Radiation Safety and Safeguards, NRC Region III, to Robert P. Harrison, Chief Operating Officer, Mercy Memorial Medical Center, forwarding Inspection Report No. 030-0249/93001, Docket No. 030-02049, May 10, 1993.*
3. Letter from L. J. Callan, Director, Division of Radiation Safety and Safeguards, NRC Region IV, to Major David Adams, USAF Radioisotope Committee, July 20, 1993, forwarding Inspection Report No. 030-28641/93-06, License No. 42-23539-01AF, Docket No. 030-28641.*

*A copy is available for inspection or copying for a fee in the NRC Public Document Room, 2120 L Street NW (Lower Level), Washington, DC 20555.

APPENDIX A

ABNORMAL OCCURRENCE CRITERIA

The following criteria for this report's abnormal occurrence (AO) 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 AO 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 rem or more of radiation; exposure of the skin of the whole body of any individual to 150 rem or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rem 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)(2)].
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) that create major safety concern.

For Commercial Nuclear Power Plants

1. Exceeding a safety limit of license 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.

Medical Misadministrations

As discussed in the Preface to this report, the NRC policy statement on AOs was published before licensees were required to report medical misadministrations to the NRC. Therefore, during 1984, the NRC developed guidelines for selecting such events for AO report-

ing. These guidelines, which are summarized in Table A-1, augment the NRC policy statement.

As noted in the Preface, revised guidelines are currently being developed because new medical misadministration definitions became effective on January 27, 1992.

Table A-1 NRC Guidelines for Selecting Medical Misadministration Events for Abnormal Occurrence (AO) Reporting

Event Type	AO Reporting Threshold	
	Diagnostic Exposure	Therapeutic Exposure
(1) Administering a radiopharmaceutical or radiation from a sealed source other than the one intended.	<p>If the improper administration results in any part of the body receiving unscheduled radiation, an AO report should be proposed if:</p> <ul style="list-style-type: none"> (a) the actual dose to the wrong body part is greater than five times the upper limit of the normal range of exposures prescribed for diagnostic procedures involving that body part, or (b) there are clinical indications of any adverse health effects to the wrong body part. <p>If the parts of the body receiving radiation improperly would have received radiation anyway, had the proper administration been used, an AO report should be proposed if:</p> <ul style="list-style-type: none"> (a) the actual dose is greater than five times that intended to the above described body parts, or, (b) the above described body parts show signs of adverse health effects greater than expected had the proper administration been used. 	<p>If the improper administration results in any part of the body receiving unscheduled radiation, an AO report should be proposed for any such event.</p> <p>If the parts of the body receiving radiation improperly would have received radiation anyway, had the proper administration been used, an AO report should be proposed if:</p> <ul style="list-style-type: none"> (a) the actual dose is greater than 1.5 times that intended to the above described body parts, or, (b) the actual dose is less than 0.5 times that intended to the above described body parts, or, (c) the above described body parts show signs of adverse health effects greater than expected had the proper administration been used, or (d) the event (regardless of any health effects) affects two or more patients at the same facility.
(2) Administering a radiopharmaceutical or radiation to the wrong patient.	<p>An AO report should be proposed if:</p> <ul style="list-style-type: none"> (a) the actual dose to the wrong patient exceeds five times the prescribed dose for the intended patient, or (b) the event results in any adverse health effects. 	<p>An AO report should be proposed for any such event.</p>
(3) Administering a radiopharmaceutical or radiation by a	<p>Same guidelines as for Event Type 1.</p>	<p>Same guidelines as for Event Type 1.</p>

Table A-1 (Continued)

Event Type	AO Reporting Threshold	
	Diagnostic Exposure	Therapeutic Exposure
route of administration other than that intended by the prescribing physician.		
(4) Administering a diagnostic dose of a radiopharmaceutical differing from the prescribed dose by more than 50 percent.	<p>An AO report should be proposed if:</p> <p>(a) the actual dose is greater than five times the prescribed dose, or,</p> <p>(b) the event results in adverse health effects worse than expected for the normal range of exposures prescribed for the diagnostic procedure.</p>	Not applicable.
(5) Administering a therapeutic dose of a radiopharmaceutical differing from the prescribed dose by more than 10 percent; or administering a therapeutic radiation dose from a sealed source such that errors in the source calibration, time of exposure, and treatment geometry result in a calculated total treatment dose differing from the final prescribed total treatment dose by more than 10 percent.	Not applicable.	<p>An AO report should be proposed if:</p> <p>(a) the actual dose is greater than 1.5 times the prescribed dose, or,</p> <p>(b) the actual dose is less than 0.5 times the prescribed dose, or</p> <p>(c) the event results in adverse health effects worse than would be expected for the normal range of exposures prescribed for the therapeutic procedure, or,</p> <p>(d) the event (regardless of any health effects) affects two or more patients at the same facility.</p>
(6) Recurring or series of events (regardless of the number of patients or facilities involved).	For either diagnostic or therapeutic exposures, an AO report should be proposed for recurring events or a series of events (in which each individual misadministration is not of major importance) that create a significant public health or safety concern.	
(7) Generic events.	For either diagnostic or therapeutic exposures, an AO report should be proposed for misadministrations with generic implications that create a significant public health or safety concern.	

APPENDIX B

UPDATE OF PREVIOUSLY REPORTED ABNORMAL OCCURRENCES

During the April through June 1993 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 Abnormal Occurrence Reports below provide the initial

and any subsequent updated information on the abnormal occurrences discussed. (The update provided generally covers events that took place during the report period; some updating, however, may be more current as indicated by the associated event dates.) Open items will be discussed in subsequent reports in the series.

Other NRC Licensees

92-18 Loss of Iridium-192 Source and Medical Therapy Misadministration at Indiana Regional Cancer Center in Indiana, Pennsylvania

This abnormal occurrence was originally reported in NUREG-0090, Vol. 15, No. 4, "Report to Congress on Abnormal Occurrences: October-December 1992." The abnormal occurrence is updated as follows:

On December 1, 1992, the licensee, Oncology Services Corporation (OSC), notified NRC Region I of the loss of an approximately 159.1 gigabecquerel (GBq) (4.3 curie [Ci]) sealed iridium-192 source from their high-dose-rate (HDR) remote afterloader unit at their Indiana Regional Cancer Center (IRCC), Indiana, Pennsylvania. The source was left within a patient on November 16, 1992, and as a result, the patient received an estimated dose at 1 centimeter (cm) (0.39 inches) of 16,000 gray (Gy) (1,600,000 rad) instead of the intended dose of 18 Gy (1800 rad). In addition, several members of the general public were also exposed and their radiation exposures ranged between 0.40 millisievert (mSv) to 0.22 sievert (Sv) (40 millirem [mrem] to 22 rem).

The NRC Region I conducted an inspection of the IRCC on December 1 and 2, 1992. On December 3, 1992, NRC upgraded its response to an Incident Investigation Team (IIT). An order suspending the OSC license was issued on January 20, 1993. On February 8, 1993, the IIT presented its findings to NRC.

NRC Region I conducted inspections of the licensee's facilities in Exton and Lehigh, Pennsylvania, on December 8, 1992. The inspectors identified several potential violations. In the Order suspending license, the issues discussed in the IIT report and the inspection report for the

licensee's facilities in Exton and Lehigh, Pennsylvania, were outlined.

There were four main causes of the event as discussed in the IIT report: 1) OSC had weaknesses in its radiation safety program that contributed to the seriousness of the event and radiation exposure consequences; 2) a number of weaknesses were found in the design and testing of Omnitron 2000; 3) the safety culture at IRCC contributed significantly to the event; and 4) the overall regulatory oversight of HDR afterloaders was weak.

The manufacturer's (Omnitron) actions to prevent recurrence are still undergoing FDA review.

The licensee hired a consultant to assess its radiation safety program immediately after the event occurred. The consultant provided the licensee with audit findings and suggested program upgrades. The licensee addressed the audit findings, created new operating and emergency procedures, trained personnel on procedures and the NRC requirements, and requested a Management Meeting with NRC to discuss the implemented program upgrades. The licensee met with the NRC on January 27, 1993. NRC issued a meeting report on February 19, 1993, discussing all commitments the licensee made during the meeting. The licensee requested on February 9, 1993, permanent relaxation of the order suspending license to treat patients at the Greater Harrisburg Cancer Center and the Greater Pittsburgh Cancer Center. The licensee submitted its action plan to NRC in a letter dated February 15, 1993. The NRC reviewed the action plan and issued a deficiency letter to the licensee on March 5, 1993. The licensee again requested a management meeting to discuss the issues described in the NRC's March 5, 1993, deficiency letter. The licensee met with NRC on March 23, 1993. On March 29, 1993, NRC issued a report discussing all commitments the licensee made during the meeting. On April 8, 1993, the licensee submitted its upgraded action plan and invited NRC to inspect its Harrisburg and Pittsburgh facilities to verify that all licensee procedures and NRC requirements were being followed as required. On

April 22, 1993, NRC acknowledged receipt of the licensee's April 8, 1993 letter and agreed to inspect the Harrisburg and the Pittsburgh facilities.

The licensee submitted its program upgrades in letters dated February 15, 1993, March 26, 1993, and April 8, 1993, that had been implemented to address all items outlined in the Order suspending license. NRC Region I conducted an inspection at the licensee's facility in Harrisburg, Pennsylvania on April 26, 27, and on May 3, 1993, and an inspection at the licensee's facility in Pittsburgh, Pennsylvania, on April 28 and 29, 1993. The inspectors concluded that the licensee had addressed all procedure requirements, order suspending license issues, Bulletin requirements, and other regulatory requirements. The inspectors also concluded that all personnel were trained on all licensee and NRC requirements as they pertain to their job.

The licensee requested that its NRC license be amended to include its current program as described in its February 15, 1993, March 26, 1993, April 8, 1993, May 7, 1993, and

May 11, 1993, letters. NRC issued a license amendment on May 26, 1993, and an inspection report on May 28, 1993. On June 3, 1993, the NRC Region I Regional Administrator approved a full Order relaxation request to treat patients, limited to OSC's facilities in Harrisburg and Pittsburgh.

Since learning of the loss of the HDR afterloader source and the death of the patient, the NRC conducted the incident investigation, issued the team's report, and completed the following actions: issued a Bulletin to Users of Omnitron 2000 HDR afterloaders (Bulletin 92-03), a Bulletin to Users of any HDR machine (Bulletin 93-01), an Information Notice to all NRC licensees (Information Notice 92-84) to assure the other users of HDRs were aware of the event. In addition, NRC issued Confirmatory Action Letters to both OSC and Omnitron documenting safety precautions, and an Order on January 20, 1993, suspending the OSC license.

Future reports will be made as appropriate.

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 a major re-

duction in the level of protection provided for public health or safety; therefore, they are not reportable as an abnormal occurrence.

Nuclear Power Plants

1. High Pressure Coolant Injection Steam Release at Quad Cities Nuclear Power Station

Quad Cities Nuclear Power Station consists of two General Electric designed boiling water reactors (BWRs) located near Cordova, Illinois, and operated by Commonwealth Edison Company.

On June 9, 1993, licensee personnel were performing a routine quarterly surveillance test of the Unit 1 high pressure coolant injection (HPCI) system at Quad Cities Nuclear Power Station. The HPCI system is one of the plant's emergency reactor cooling systems. The HPCI pump is driven by a turbine which uses steam produced in the reactor. During the test, both rupture discs on the steam exhaust pipe from the HPCI turbine ruptured, releasing steam into the room containing the equipment. Five people in the room were injured. The steam was radioactive and the workers also received minor skin contamination.

Valves on the steam supply line to the HPCI turbine automatically closed fully after about 50 seconds, terminating the steam release into the room. A reactor operator manually tripped the turbine when he observed that the steam line valves were closing.

Both Quad Cities units were in operation at the time of the accident, and reactor operations were not affected.

The injured workers were taken by ambulance to local medical facilities. They were decontaminated and treated for burns. Four of the workers were released after treatment. The fifth worker had first and second degree burns over 20 percent of her body and was hospitalized.

The pressure surge in the HPCI room, associated with the bursting of the rupture disc, blew a set of fire doors in the room off their hinges and blew open two additional sets of doors, damaging their latching

mechanisms. There was no measurable release of radioactivity from the plant.

The rupture discs which burst are 40.64 centimeters (16 inches) in diameter and are designed to prevent overpressurization of the steam exhaust piping leading from the HPCI turbine. The installation at Quad Cities has two rupture discs in sequence about 6 centimeters (2.5 inches) apart. Both discs must rupture before steam is released from the piping.

A special NRC inspection team was dispatched to the Quad Cities site. The four members of the team conducted an inspection from June 9 through 24, 1993.

The NRC team was not able to conclusively determine the cause of the bursting of the rupture discs. A likely explanation is that water in the steam line caused a brief, localized pressure increase, and ruptured the discs. It is also possible, however, that the age or service degradation of the disc material could have caused the discs to rupture at a lower pressure than their design pressure of 1,034 kilopascals (150 pounds per square inch).

The utility has replaced all rupture discs in the HPCI system and in the reactor core isolation cooling system. Steam drain level switches which control the draining of water from the turbine and the steam lines were also repaired. The inspection team concluded that these repairs and replacements were sufficient corrective actions to prevent a recurrence of the accident, regardless of the actual rupture mechanism.

2. Electrical Power Transient at Oconee Nuclear Station

Oconee Nuclear Station consists of three Babcock and Wilcox designed pressurized water reactors (PWRs) located near Seneca, South Carolina, and operated by Duke Power Company.

On October 19, 1992, Oconee Units 1, 2 and 3 were operating at 100 percent power. Two units at Keowee

Hydrostation are the redundant emergency power sources in the event of a loss of offsite power, and are routinely used for a few hours several times a week to generate electrical power to the transmission grid. On the day of the event, Keowee Unit 1 was generating power to the transmission grid for power peaking and Keowee Unit 2 was in standby, aligned to its emergency power path. Maintenance was in progress to replace an Oconee switchyard control power battery. To support the replacement, the battery was disconnected and its battery charger was placed in service, supplying the dc bus. With the battery disconnected, the charger output voltage was expected to vary and voltage instabilities were not suppressed. A battery charger failure resulted in a voltage surge that caused spurious relay actuations, which initiated the event and isolated offsite power to Oconee Unit 2. A lockout of the Oconee Unit 2 main generator transformer caused a Unit 2 turbine generator trip with a subsequent reactor trip. The reactor was sufficiently cooled via natural circulation of reactor coolant and feedwater addition from the turbinedriven emergency feedwater pump. The other two Oconee units were not directly affected and continued to operate; however, they would not have had automatic offsite power available in the event of a turbine generator trip.

Keowee Unit 1 responded to the loss of offsite power by separating its generator from the grid and attempting to align to the overhead emergency power path; however, a circuit breaker lockout prevented this function. Keowee Unit 2 started and, within 31 seconds, successfully energized the Oconee Unit 2 emergency busses through the underground emergency power path. The Keowee Hydrostation operator failed to identify that an emergency start signal for the hydro units was present. The operator observed no load on Keowee Unit 1 and since the unit had previously been operating connected to the grid, he opened its output breaker based upon a perceived grid problem without realizing that Keowee Unit 1 was supplying auxiliary power to Keowee Units 1 and 2. The auxiliary power transfer scheme was such that both units then attempted to transfer to their respective alternate power sources; however, two more circuit breaker failures resulted in a loss of the ac power supplies to both Keowee units' auxiliaries. Corrective actions by operators and a technician to reset the spurious lockout signals allowed Keowee Unit 1 to align to its emergency path 52 minutes later and offsite power to be restored 57 minutes after the initiation of the event.

In reviewing this event, several problems were identified. The switchyard battery charger lineup was not sufficiently reviewed regarding the potential for voltage surges if the battery was disconnected. Al-

though not discussed in the licensee's vendor manual, discussions with the vendor verified that voltage swings were expected. The voltage surge in excess of 200VDC was propagated through the switchyard 125VDC control power system. This single failure actuated several breaker failure circuits in the switchyard Power Circuit Breakers and caused isolation. The licensee had not implemented a vendor recommended modification, which would have reduced the susceptibility of the relays to voltage surges. The NRC issued Information Notice 91-81 that alerted licensees to the potential for this type of problem. The Keowee Hydrostation operator response was not adequate in that actions taken could have interfered with the safety function of Keowee Unit 1. Additionally, the operator did not restore auxiliary power to the Keowee units in a timely manner. These were a result of a lack of adequate training and procedural guidance attributed to the organizational structure. Although it was relied upon as the source of onsite emergency power, the Keowee Hydrostation was not under the direct supervision of Oconee Nuclear operations but rather part of the Duke Power Hydrostation Department. This organizational structure allowed for lack of effective management oversight regarding Keowee operations. Procedures to recover from a switchyard isolation were not adequate. Use of the inadequate recovery plan led to a Keowee Unit 2 trip during the recovery and the loss of automatic offsite power availability to Oconee Units 1 and 3 in the event of a turbine generator trip. The bus transfer scheme of Keowee auxiliary power unnecessarily challenged circuit breakers and resulted in a loss of auxiliary power for 51 minutes on Keowee Unit 1 and 37 minutes on Keowee Unit 2. The recovery was made only after an "on-call" Keowee technician arrived at the site, diagnosed the problem, and restored power. The length of time that a unit can operate is limited by the ability to maintain hydraulic control oil pressure to the governor. This controls the wicket gates of the turbine. Without AC power, preloaded air pressure is used to pressurize the oil. The licensee has stated in documentation that one hour is the expected maximum time.

The event was caused by failure of the switchyard battery charger to properly regulate dc voltage to its bus when placed in a configuration without its battery connected. Voltage surges from the battery charger actuated breaker failure circuits on several switchyard power circuit breakers resulting in an isolation of the switchyard from offsite power and isolation of Keowee Unit 1 from the overhead path.

The licensee has taken numerous steps to prevent recurrence and to improve reliability. The battery replacement procedure was revised to ensure that a battery charger is not loaded without its associated

battery. The breaker failure relays were modified per vendor instructions to increase reliability during high voltage conditions. Indication lights were installed at the Keowee control panel to provide direct indication of an emergency start. Procedures were issued to provide guidance for operators following an emergency start. The ability of a Keowee unit to separate from the transmission grid and energize the emergency path was tested. The organizational

structure was revised placing Keowee under the supervision of Oconee. The auxiliary power transfer scheme was modified to increase reliability. In addition, planned corrective actions include circuit breaker modifications, the development of a preventive maintenance program for relays, replacement of certain relays, the development of job and task analysis for Keowee operators.

Other NRC Licensees

3. Radiographer Radiation Exposure Exceeding Regulatory Limits

On April 16, 1993, a radiography event occurred which resulted in a radiographer employed by Scientific Inspection Technology, Inc. (SITI), Hixson, Tennessee, receiving a radiation dose in excess of NRC limits. [While SITI is located in an Agreement State (TN), SITI holds an NRC license (41-25027-01) and was working under this license in the State of New Jersey when the overexposure occurred.] The event occurred as preparations were being made to begin a radiography procedure at a work site in Salem County, New Jersey. While having difficulties in locking a radiography exposure device containing 3,626 gigabecquerel (GBq) (98 curies [Ci]) of iridium-192, a radiographer received 2.75 sievert (Sv) (275 rem) to his right hand and a 12 mSv (1.2 rem) whole body dose. The radiographer did not respond properly to indications provided by his radiation survey meter or his alarming-rate-meter. The dose estimates are based on a reenactment of the event using the same equipment. NRC agreed with these dose estimates.

The radiographer was examined by a physician trained at the Radiological Emergency Assistance Center and Training Site (REAC/TS) in Oak Ridge, Tennessee. The physician continued to follow the radiographer for several weeks after the event and no observable effects of the exposure had been evident.

The radiographer received the radiation overexposure as a result of his failure to correctly respond to warnings provided by his alarming-ratemeter and the radiation survey meter off-scale reading. Instead of leaving the immediate area of the exposure device, he attempted to correct the problem. He also failed to follow SITI's emergency procedures by attempting to correct the problem with the exposure

device before contacting the licensee's Radiation Safety Officer.

SITI took the following corrective actions: verbally informed every radiographer of the event; followed up the verbal discussion with a written notice of the event; increased emphasis on the use of emergency procedures during audits of the radiographer's performance; conducted classroom training on emergency procedures and use of alarming-ratemeters; reiterated management's expectations relative to emergency procedures; reviewed and assessed past incidents to stress the need for safety; and increased emphasis on safety requirements involved in examination of equipment prior to placing it in service.

The radiographer involved in the event was removed from licensed activities until the end of the calendar quarter in which the event occurred to prevent further exposure.

The licensee sent the exposure device along with the source guide tube and drive cable mechanism to the equipment manufacturer for examination and testing. The manufacturer found minor damage involving a bent connector, but was unable to identify any failure mechanism that could have prevented the source from returning to the shielded position and repositioning the selector ring to the locked position.

An NRC inspection was conducted at the licensee's facilities on April 19, 1993, to review the circumstances surrounding the event. An NRC medical consultant was retained to assess the medical aspects of the event. The medical consultant concluded that the licensee's dose estimates were reasonable. An enforcement conference was held with the licensee and escalated enforcement action resulted in Notice of Violation, Severity Level II (Severity Levels I through V range from the most significant to the least significant) and a \$4000 Civil Penalty.

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