UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

CHAIRMAN

August 3, 1990

The Honorable Thomas S. Foley
Speaker of the United States
House of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

I am forwarding the Nuclear Regulatory Commission's (NRC's) report on abnormal occurrences at licensed nuclear facilities for the first calendar quarter of 1990. These quarterly reports are required by Section 208 of the Energy Reorganization Act of 1974 (PL 93-438). In the context of the Act, an abnormal occurrence is an unscheduled incident or event that the Commission determines is significant from the standpoint of public health or safety.

For this reporting period, there were 10 abnormal occurrences. One involved the loss of vital ac power and a subsequent temperature increase in the reactor coolant system at the Vogtle Unit 1 nuclear power plant during shutdown. The event was investigated by an NRC incident investigation team (IIT). The other nine abnormal occurrences involved material licensees and are described in detail under other NRC-issued licenses. Eight of these involved medical therapy misadministrations; the other involved the receipt of an unshielded source at Amersham Corporation in Burlington, Massachusetts. The latter event was also investigated by an NRC IIT. We also have included information that updates a previously reported abnormal occurrence.

We will continue to disseminate information on reportable events through various event reports. These are routinely distributed on a timely basis to the Congress, industry, and the general public.

Sincerely,

Kenneth M. Carr

Enclosure:
Report to Congress on
Abnormal Occurrences
(NUREG-0090, Vol. 13, No. 1)

PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

CHAIRMAN

August 3, 1990

The Honorable J. Danforth Quayle
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

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Report to Congress on Abnormal Occurrences

January – March 1990

Date Published: July 1990

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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 January 1 through March 31, 1990.

For this reporting period, there were 10 abnormal occurrences. One involved the loss of vital ac power with a subsequent reactor coolant system heat-up at the Vogtle Unit 1 nuclear power plant during shutdown. The event was investigate by an NRC Incident Investigation Team (IIT). The other nine abnormal occurrences involved nuclear material licensees and are described in detail under other NRC-issued licenses: eight of these involved medical therapy misadministrations; the other involved the receipt of an unshielded radioactive source at Amersham Corporation in Burlington, Massachusetts. The latter event was also investigated by an NRC IIT. No abnormal occurrences were reported by the Agreement States.

The report also contains information that updates a previously reported abnormal occurrence.

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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 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 described in this report meet the criteria for abnormal occurrence reporting. This report covers the period from January 1 through March 31, 1990.

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 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.

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 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. 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
JANUARY-MARCH 1990

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:

90-1 Loss of Vital AC Power with Subsequent Reactor Coolant System Heat-up at Vogtle Unit 1 During Shutdown

The following information pertaining to this event is also being reported concurrently in the Federal Register. Appendix A (see the second general criterion) of this report notes that a major degradation of essential safety-related equipment can be considered an abnormal occurrence. In addition, there were generic regulatory concerns because of previous incidents that have occurred at plants while in shutdown conditions.

Date and Place - March 20, 1990; Vogtle Unit 1, a Westinghouse-designed pressurized water reactor, operated by Georgia Power Company and located in Burke County, Georgia.

Nature and Probable Consequences - At the time of the event, Unit 1 had been in a refueling outage for about 25 days with its reactor coolant system (RCS) level reduced to "mid-loop" (below the top of the pressure vessel nozzles) to facilitate maintenance. Decay heat in the core was being removed by one train of the residual heat removal (RHR) system. Several pieces of equipment were out of service for maintenance, including one of Unit 1's two emergency diesel generators (EDGs). As described in more detail below, the event involved a loss of all safety ac power to Unit 1 and difficulties in starting the one available EDG with a consequent loss of shutdown cooling. Non-safety power remained available. The significance of the event is that had the licensee been unable to restore power within 1.8 hours, the plant would have been in an inadequately analyzed condition and personnel would not have had adequate procedures and training to deal with the situation. (Had the incident occurred two days after shutdown, the 1.8 hours would have been reduced to less than 15 minutes.) This status of analysis, procedures, and training is believed to be typical of industry preparedness. One alternate source of RCS makeup was available that did not require ac power and would increase the time available for the licensee to restore ac power. This involved gravity feed of borated water from the refueling water storage tank to the RCS.

Plant equipment conditions at the time of the event were as follows:

- The Unit 1 B reserve auxiliary transformer (RAT) was out of service following maintenance.
- The Unit 1 B EDG was disassembled for maintenance.
- The Unit 1 A RAT was supplying offsite power to the crosstied Unit 1 A and B vital buses.
- The RCS temperature was being maintained at 90°F via the train A RHR pump; the train B pump was in standby.

- The vessel head was in place with the studs not fully tensioned.
- The pressurizer manway cover was removed.
- The manways for steam generators 2 and 3 were partially bolted in place and the manways for steam generators 1 and 4 were in place with bolts fully tensioned.
- The inboard charging line check valve and an accumulator isolation valve were open for inspection.
- The containment equipment hatch and the containment personnel hatch were open.

At 9:20 a.m., EST, on March 20, 1990, a truck carrying gasoline, diesel oil, and lubricants in the plant low voltage switchyard backed into a support column for the feeder line supplying power to the Unit 1 A RAT and the Unit 2 B RAT. The insulator for the C phase of the feeder line fractured and initiated a phase-to-ground electrical fault. The fault resulted in a loss of power to the Unit 1 A RAT and the Unit 2 B RAT. The Unit 2 B EDG started and loaded on to the deenergized Unit 2 B vital bus. However, Unit 2, which was operating at 100% power, experienced a turbine trip and reactor trip because of an improperly connected (wrong tap) differential current transformer (DCT). The DCT initiated the trip when the current surge associated with the phase-to-ground fault was sensed. The Unit 2 trip was relatively uncomplicated.

Because both of the Unit 1 vital buses were crosstied and being supplied by the Unit 1 A RAT, the loss of this transformer deenergized both vital buses. Deenergizing these buses resulted in the loss of power to the operating RHR pump. Since the Unit 1 B EDG was disassembled for maintenance, the emergency power supply for the B vital bus was unavailable and the standby B RHR pump could not be started.

The operational Unit 1 A EDG started on bus undervoltage but shut down automatically after 1 minute and 20 seconds, believed to be caused by sensor problems in the EDG control system. At 9:40 a.m., plant operators declared a "Site Area Emergency." (A loss of all onsite and offsite ac power at Vogtle for more than 15 minutes is classified as a "Site Area Emergency." The licensee made its declaration because all vital ac power was lost for greater than 15 minutes.) Approximately 18 minutes after the first start of the A EDG, the operators locally reset the load sequencer which restarted the A EDG on undervoltage. However, after 1 minute and 10 seconds, the diesel again shut down automatically. At 9:56 a.m., plant operators performed an "emergency" manual start of the diesel, which bypassed most of the diesel's protective trips. The diesel started and was loaded to the bus, the A RHR pump was restarted, and core cooling was reestablished to Unit 1. According to control room indication, RCS temperature increased from 90° to 136°F during the 41 minutes required to reenergize the A bus (1.12°F/minute). The "Site Area Emergency" was downgraded to an "Alert" at 10:15 a.m.

The critical path item for containment closure, the containment equipment hatch, was closed by approximately 10:40 a.m. This was within the time recommended by the NRC for the existing conditions of the RCS. (There are no regulatory requirements for a closed containment under these conditions.)

Plant personnel returned the Unit 1 B RAT to service after completing formal tagout removal procedures. However, attempts to energize the transformer were delayed for several minutes because of a sticking mechanical interlock in the control circuitry for a motor-operated disconnect switch on the high side of the B RAT. Power was restored to the B vital bus via the B RAT at 11:40 a.m. At 12:38 p.m., core cooling was shifted to the B RHR train to facilitate subsequent electrical alignment changes.

Throughout the event, non-vital power was continuously provided to Unit 1 from offsite sources via backfeed through the main generator transformer. Also, the Unit 2 electrical distribution system remained energized (aside from the momentary loss of power before the reactor trip). However, the Vogtle electrical system was not designed for interconnection of the Unit 1 vital buses to nonvital power or to the Unit 2 electrical buses. Therefore, there were no procedures to provide guidance on interconnecting the Unit 1 vital and nonvital buses or for interconnecting the Unit 1 electrical distribution system with the distribution system at Unit 2. (There are no regulatory requirements that direct the licensee to develop interconnection procedures.)

The licensee restarted Unit 2 and returned it to full power operation. Unit 1 remained shut down to investigate and correct the problems during the event and to complete refueling activities.

On March 20, 1990, NRC Region II sent a team to the site to review the event and the actions taken by the licensee. On March 21, 1990, an Augmented Inspection Team (AIT) was formed consisting of Headquarters and Region II personnel. However, due to the number of past incidents that have occurred at various plants while in shutdown conditions and the potential for regulatory concerns, NRC management decided that the Vogtle event warranted the more formal and detailed review of an Incident Investigation Team (IIT). An IIT consisting of NRC members (Headquarters, Region I and Region V) and industry members (a member from the Institute of Nuclear Power Operations, and two consultants) was formed on March 23, 1990 subsuming the AIT.

The licensee agreed that Unit 1 would not be restarted until approved by NRC management. This approval was granted on April 13, 1990. Criticality was attained on April 16, 1990, and the plant was connected to the electrical grid on April 21, 1990.

The IIT remained at the Vogtle site until April 2, 1990. The Team returned to the NRC Incident Response Center in Bethesda, Maryland to continue evaluation of the event, formulate findings, and to prepare a formal report.

The Team completed its investigation on June 8, 1990. The Team report was issued in June 1990 as NUREG-1410, "Loss of Vital AC Power and the Residual Heat Removal System During Mid-Loop Operations at Vogtle Unit 1 on March 20, 1990" (Ref. 1). The report describes the investigation and the numerous findings and conclusions formulated by the Team. In summary, the Team concluded:

- Adequate precursor information was available to make this incident preventable.
- The Vogtle staff generally handled the incident well.
- Significant potential generic lessons were identified, including:
  - Approaches to shutdown risk management need to be developed.
  - There is incomplete implementation of existing analysis and guidance into procedures and training.
  - There is a need for additional analysis of reactor coolant system behavior following the loss of the residual heat removal system.
  - There is a need for further synthesis of existing operating information.
  - Emergency classification guidance and implementation problems exist.
  - The technical specifications do not take into consideration the risk associated with the various configurations of systems that may exist during shutdown conditions.
  - At least some diesel generator control and annunciator systems are complex and may not be well understood.

Cause or Causes - The direct cause of the loss of offsite Class 1E ac power was (1) driver error by backing the truck into the pole supporting a 230 kV line for the Unit 1 A RAT and the Unit 2 B RAT, and (2) violation of site safety rules that require a flagman for backing vehicles when viewing is impaired. The direct cause of the loss of onsite Class 1E ac power was the failure of the one operational EDG. The licensee concluded that the EDG trips were most likely due to faulty jacket water high temperature sensors.

Actions Taken to Prevent Recurrence

Licensee - The licensee established a management policy on control and operation of vehicles. The defective EDG temperature sensors were replaced and a test program was planned to investigate the reliability of this type of temperature sensor under various conditions. The loss of offsite power (LOSP) diesel start and trip logic was modified for both Unit 1 and Unit 2 so that an automatic "emergency" start will occur upon LOSP; therefore, non-essential diesel engine trips are blocked upon LOSP. The Unit 1 A EDG test frequency was increased until seven consecutive valid tests were completed with no more than one valid failure in the last 20 valid tests.

NRC - On April 16, 1990, the NRC issued Information Notice No. 90-25, "Loss of Vital AC Power with Subsequent Reactor Coolant System Heat-up," that described the Vogtle event (Ref. 2). The Notice advised licensees that the Vogtle event reemphasized the need for careful planning of equipment outages during shutdown.

The NRC will review the IIT findings and will take actions, as appropriate. It is planned to include the resolution or disposition of any action items in

the Office for Analysis and Evaluation of Operational Data (AEOD) Annual Reports (NUREG-1272 series).

This item is considered closed for the purposes of these quarterly abnormal occurrence reports.

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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 events were abnormal occurrences:

90-2 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 - January 17, 1990; Monongahela Valley Hospital; Monongahela, Pennsylvania.

Nature and Probable Consequences - On January 17, 1990, the licensee notified NRC Region I by telephone that earlier that day a cesium-137 brachytherapy source had become dislodged from its applicator while a patient was undergoing treatment for uterine cancer.

During the treatment, a malfunction of a remote afterloading brachytherapy irradiator occurred. The device, a Curietron 2E1000, was manufactured by CIS-U.S., a French-owned company. The malfunction resulted in the disconnection of the tube used to transfer the sources (in this instance, cesium-137) from the shielded storage unit to the patient. The disconnect resulted in one of the cesium-137 sources being located for an undetermined time near the upper part of the patient's leg, rather than in the patient. The licensee initially estimated a range of potential unintended dose to the patient's leg from 23 rem to 23,700 rem, depending on the length of the exposure and the proximity of the

source to the patient's leg. Three physical examinations of the patient have indicated no visible signs of radiation damage to date, which would indicate that the actual exposure was at the lower end of the range. Additional future examinations of the patient will be performed.

The licensee subsequently reported two additional equipment problems with this device on January 18, but neither incident resulted in further unintended radiation exposures.

Cause or Causes - Based upon visual examination of the failed equipment by Region I inspectors dispatched to the site on January 19, 1990, the failure appeared to be faulty material used in the retaining ring of the connector which attached to the applicator, or inadequate equipment design.

Actions Taken to Prevent Recurrence

Licensee - The device was removed from service for evaluation by the manufacturer. The faulty connectors have been replaced by a proven design.

NRC - Region I performed a special inspection (Ref. 3). An NRC medical consultant evaluated the exposure and concluded that the licensee's followup actions were appropriate.

The manufacturer informed Region I that it has distributed only one other similar device in the United States. Region I staff notified the licensee having the similar device of the problem that occurred at Monongahela Valley Hospital. That licensee has also replaced the connectors.

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

* * * * * * * * *

90-3 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 - February 2, 1990; Ball Memorial Hospital; Muncie, Indiana.

Nature and Probable Consequences - On February 2, 1990, the licensee reported that a therapeutic misadministration was discovered earlier that day in the treatment of a patient for lung cancer. A therapy dose had been administered to an area of the body other than the intended treatment area. The intended procedure called for 1,500 rem to the right lung area over a 25 hour period. A ribbon holding seven seeds (small sealed radiation sources) containing a total of 14.3 millicuries of iridium-192 was inserted into the patient's lung. Between the time the catheter was inserted and the time the iridium-192 seeds were placed in the catheter, a kink developed in the catheter. Because of the kink, the seeds were not inserted into the intended location in the lung, but rather remained in the pharynx area about 25 centimeters (about 10 inches) from the intended treatment area.

The licensee reported that no complications resulted from the misadministration. A medical consultant retained by the NRC concluded that the misadministration would not be of clinical significance because of the localized nature of the radiation dose and the area affected.

The procedure was repeated on the following day, and the intended lung area was successfully exposed.

Cause or Causes - The misadministration was caused when a kink developed in the catheter inserted into the patient's bronchial tubes. The kink prevented the ribbon containing the iridium-192 seeds from being fully inserted, and licensee personnel failed to detect that the ribbon was not properly placed.

Actions Taken to Prevent Recurrence

Licensee - The licensee has revised its treatment procedure for patients with iridium-192 implants. After the ribbon containing the seeds is placed in a patient, its location will be verified using portable X-ray equipment.

NRC - A special inspection was conducted to review the circumstances surrounding this misadministration (Ref. 4). No violations of NRC regulations were identified. The NRC's medical consultant concluded that appropriate procedures had been instituted to minimize the likelihood of a recurrence of a similar misadministration.

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

* * * * * * * * *

90-4 Medical Therapy Misadministrations

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 - February 7, 1990, and March 15, 1990; University of Wisconsin; Madison, Wisconsin.

Nature and Probable Consequences - The licensee notified NRC Region III on February 8 and March 16, 1990, of two therapy misadministrations that occurred on February 7 and March 15, 1990, respectively, due to a common cause (i.e., erroneous information being entered into a computer controlling the treatment location). The second event resulted in the wrong part of a patient's body receiving a therapy dose.

The treatments were performed using an afterloading device that inserts a high-intensity radiation source (nominally 10 curies of iridium-192) into a previously placed tube in the treatment area. The device permits high doses of radiation to a very localized area in a short time period. The placement and movement of the radiation source are controlled by a computer, allowing precise placement and timing.

In the first instance, a 42-year-old patient was undergoing treatment for vaginal cancer. The intended treatment schedule called for a total of four treatments of 1,620 rem each, two each to the left and right sides of the vagina, for a total of 3,240 rem per side. The first dose to the right side was correctly administered, but erroneous information was entered into the control computer for the second dose on February 7, 1990, resulting in a single dose of 2,500 rem to the right side treatment area; therefore, the total dosage to the right side was 4,120 rem - 27 percent higher than prescribed. The error was detected and a revised prescription was administered to the left side.

The second misadministration involved a 66-year-old patient being treated for a bronchial tumor. Incorrect information was entered into the computer for the first of four 400 rem treatments, resulting in the incorrect placement of the iridium-192 source. The treated area was about 9 centimeters (about 3.5 inches) from the intended treatment point. When the error was discovered, the licensee repeated the procedure to provide the intended dose to the intended treatment area. The remainder of the treatments were performed without incident.

In both misadministrations, the licensee does not expect any adverse medical effects.

Cause or Causes - Both misadministrations were caused by the entry of incorrect data into the treatment planning computer. The data from the planning computer was then transferred to a computerized treatment device. Because of the nature of the treatment procedure, dose calculations must be quickly made after the treatment tube has been inserted.

Actions Taken to Prevent Recurrence

Licensee - The licensee prepared an extensive quality control/quality assurance program, including verification of key steps and calculations by a second qualified individual. More extensive training is to be provided to certain personnel involved in the treatment procedures, and the adequacy of training will be verified through examinations. The licensee is also formalizing the treatment procedures and better defining the responsibilities of the various personnel involved in the treatments.

NRC - A special inspection was conducted by NRC Region III on March 26-28, 1990 (Ref. 5). As a result of the inspection findings, the licensee has modified its quality control/quality assurance program and undertaken other corrective actions. The changes have been incorporated into the facility's NRC license.

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

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90-5 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 - February 8, 1990; Cleveland Clinic Foundation; Cleveland, Ohio.

Nature and Probable Consequences - On February 15, 1990, the licensee notified NRC Region III of a potential misadministration, involving cobalt-60 teletherapy, that occurred on February 8, 1990. The patient received a dose 50% greater than the physician's prescribed dose. On February 6, 1990, a physician prescribed nine treatments of cobalt-60 radiation for a 62-year-old patient suffering from cervical spine cancer. The patient was to receive 278 rem of radiation each day for nine consecutive days, beginning February 6. Following the first two treatments on February 6 and 7, the physician decided to stop the treatments to reevaluate the cervical spine area diagnosis. On the evening of February 7, the physician wrote a "stop prescription" on the first page of the patient's treatment chart. On February 8, the technologist did not see the stop treatment order listed on the first page of the chart, but instead turned to the second page where no change was listed. The patient subsequently received an additional 278 rem of radiation to the cervical spine. The technologist, supervising technologist, and chief technologist became aware of the stop treatment order later that day.

The attending physician stated that he did not believe the additional treatment of 278 rem would be clinically harmful to the patient. He based his evaluation on the fact that, among other things, the dose rate was far below a dose rate that would be "deleterious" to spinal cord tissue, and because he still has the option of resuming treatments. The patient's symptoms have improved since the treatments have been halted. The physician plans to withhold further treatments if improvements continue.

Cause or Causes - The licensee did not have a clear mechanism for documenting changes in prescriptions prior to subsequent treatment.

Actions Taken to Prevent Recurrence

Licensee - The licensee's corrective actions included: (1) establishing a clear mechanism for documenting changes in prescriptions prior to subsequent treatment; and (2) conducting annual in-service training regarding misadministration reporting and review.

NRC - An NRC Region III inspector was sent to the hospital March 7-9, 1990, to review circumstances surrounding the misadministration (Ref. 6). An Enforcement Conference was held with the licensee on May 2, 1990, to review the findings of the inspection and possible enforcement actions. The licensee's corrective actions are considered satisfactory.

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

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90-6 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 - February 16, 1990; Washington Hospital Center; Washington, D.C.

Nature and Probable Consequences - On February 16, 1990, the licensee notified Region I by telephone that a therapeutic misadministration involving a teletherapy unit had occurred earlier that day. This was followed by a written report of the incident, dated February 23, 1990, and received by Region I on March 1, 1990.

The misadministration occurred when the wrong patient was administered 45 rem to the lung. The radiation therapy technologist called patient A's name, however, the wrong patient (patient B) responded. The technologist did not confirm the patient's identity with patient B's wrist band or the name on his hospital chart. The technologist questioned patient B when she could not find the lung treatment positioning marks. Patient B responded that the marks had been washed off. This same technologist also commented to patient B that he looked different from the Oncology Department treatment chart picture. (At the time, the technologist was actually looking at patient A's treatment chart.) Patient B responded that his appearance had changed since he lost his hair. The technologist positioned the patient and, together with a second technologist, who had returned from lunch, proceeded with the treatment. While patient B was undergoing treatment to the lung, the second technologist noticed that the name on patient B's hospital chart did not match the name on the department treatment chart and terminated the treatment. The patient was then identified as patient B who was at the hospital for radiation therapy to the brain.

The licensee has advised the NRC that no adverse effects are anticipated as a result of the misadministration.

Cause or Cause - The cause was attributed to human error on the part of the radiation therapy technologist. The technologist did not verify the patient's identity with the available wrist band and patient's hospital chart.

Actions Taken to Prevent Recurrence

Licensee - The licensee's corrective actions included counseling of the technologist, re-instruction of all the therapy technologists on the proper method for patient identification, and discussion of the incident at a department staff meeting for additional emphasis on patient identification techniques.

NRC - Region I reviewed the circumstances surrounding this incident. The licensee's corrective actions are considered satisfactory.

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

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90-7 Receipt of an Unshielded Radioactive Source at Amersham Corporation in Burlington, Massachusetts

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. In addition, Example 2 (i.e., exposure to an individual in an unrestricted area such that the whole body dose received exceeds 0.5 rem in one calendar year) of Appendix A is applicable to this event.

Date and Place - Event discovered on March 8, 1990; Amersham Corporation; Burlington, Massachusetts.

Nature and Probable Consequences - On March 8, 1990, Amersham Corporation informed NRC Region I that a shipment of 14 Model 500-SU source changers (reportedly empty) received from its customer, NDI Corporation, Seoul, Korea, contained an unshielded radioactive source. The wooden crate containing the source changers was not labelled as containing radioactive material. Shipping documentation indicated that the source changers were empty. However, routine surveys of the crate on its receipt at Amersham's Burlington, Massachusetts facility revealed a radiation level of about 100 millirem per hour near the back of the truck that delivered the package to Amersham and about 10 rem per hour near the package. Subsequent surveys revealed levels of about 150 rem/hr, a significant radiation level, at contact with the source changer (approximately 4" to 6" from source). The licensee subsequently retrieved the radiography source from an interior, unshielded part of the source changer.

Inquiries made by NRC and Amersham indicated that the package left Pusan, Korea by ship on January 29, 1990. The ship arrived in Los Angeles, California on February 11, 1990; the crate remained on the ship until February 13, when it was off-loaded and picked up by a local trucker and taken to a repackaging facility. The crate was subsequently transported to a Nova Transportation Services Company Container Freight Station in Compton, California on February 14, where it stayed until February 16, 1990, when it was transported by Covenant Transport, Inc. to the Patriot Trucking Co. warehouse in Boston, Massachusetts. The truck transporting the package made three stops enroute to Boston, two in Pennsylvania and one in Maryland, arriving at the Patriot warehouse on February 22, 1990. The crate remained there until delivery to Amersham on March 8, 1990. The shipment from Los Angeles to Boston was made in-bond, such that the crate cleared U.S. Customs in Boston. No radioactive contamination was found in the source changer. The other source changers were found not to contain any radioactive material. The licensee stated that the source had been cut from its pigtail connector.

Based on the nature and potential consequences of the event, and the generic questions generated by the event, an NRC Incident Investigation Team (IIT) was organized on March 9, 1990. The IIT was charged to: (a) quickly resolve questions of radiation exposure; (b) determine what happened; (c) identify the probable causes as to why it happened; and (d) make appropriate findings and conclusions which would form the basis for any necessary follow-up actions.

One part of the Team began work on March 10, 1990 at the Amersham facility in Burlington. The other part of the Team began work on March 12, 1990, in Los Angeles, where the wooden crate containing the source changers had arrived.

The Team completed its investigation of the event in April 1990. The Team report was issued in May 1990 as NUREG-1405," Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, in Burlington, Massachusetts" (Ref. 7). The principal findings and conclusions of the Team are as follows:

1. The cause of the incident was that a stored source was inadvertently left in a source changer when the device was returned from the end-user to Amersham's Korean distributor for shipment. Neither the end-user, Korea Industrial Testing Company, Ltd. (KIT), nor the distributor (shipper) NDI Corporation (NDI), used effective methods to ensure that there was no source in the changer. The inability of the two parties to detect the source was exacerbated by the fact that the connecting cable, or pigtail, had been removed, that is, cropped from the source. Events leading to the inclusion of the iridium-192 source in the shipment are also being investigated by the Ministry of Science and Technology, and the Korean Institute of Nuclear Safety, the responsible regulatory authorities in Korea.

2. The Team was able to identify the radiographic source as a 56-curie, iridium-192 source manufactured on April 13, 1989, by Industrial Nuclear Company, San Leandro, California. Using the manufacturer's decay curve for the iridium-192 source, the Team determined the source's activity at the times when potential exposures to individuals might have occurred. Independent measurements made of the source's activity at the Amersham Corporation facility were consistent with the values derived from the manufacturer's decay curve for the source.

3. While potential radiation exposure to the general public was possible, the number of individuals that could have been exposed was limited because the shipment was maintained "in-bond" from its arrival in Los Angeles on February 11, 1990, to the time it cleared U.S. Customs Service in Boston on March 7, 1990. The transport vehicle carrying the shipment from Los Angeles to Boston was driven across country with infrequent stops of mostly short duration.

4. Although the maximum estimated potential whole-body radiation exposures range from 27 to 35 rem for the two long-distance drivers, and 0.5 to 5.6 rem for other individuals that may have been in close proximity to the source for extended periods of time, these estimates are not supported by cytogenetic studies done on the five individuals that had the highest potential for exposure. The cytogenetic data suggest that the source may have remained shielded so that no actual exposures occurred until the shipment was transferred from storage in Boston to Amersham's facility in Burlington, Massachusetts.

5. The safe handling and transportation of radioactive materials imported to the United States are highly dependent on the actions of foreign shippers

and their agents to properly prepare packages for shipment, properly identify the contents, and accurately describe the contents in shipping documents. There are no DOT or NRC requirements for carriers or shipping agents to monitor or survey shipments during transit.

6. Carriers, freight forwarders, or shipping agents do not independently verify the accuracy of shipping documents for import shipments at the U.S. place of entry. Misclassified or mislabeled shipments are usually discovered by the receiving organization. There are no clear-cut requirements for a receiver to report to DOT or NRC instances where packages are not properly prepared for shipment or where the contents are not accurately identified. Current DOT regulations require carriers to report incidents where there is death, serious injury, or substantial property damage, breakage, spillage, or suspected radioactive contamination. NRC regulations require that licensees report any instance in which there is significant reduction in the effectiveness of any NRC-authorized packaging during use (10 CFR 71.95), if there is a high radiation level or contamination on packages when received (10 CFR 20.205), and for incidents in which there is the potential for significant exposure (10 CFR 20.403). The Team could not determine whether NRC regulations would have required Amersham to report previous instances where cropped sources had been inadvertently shipped from the Republic of Korea. Although the shipment was mislabeled and misidentified in these instances, the sources arrived within the shielded source tubes of the source changers. The Team could find no evidence that the instances were reported to either the NRC or DOT. The incident being investigated, where the source was received in an unshielded position, was reported pursuant to NRC requirement, 10 CFR 20.403.

7. As an importer, Amersham was required to provide the shipper and the forwarding agent, at the place of entry into the United States, complete information on how to comply with DOT regulations. The instructions provided to the shipper by Amersham for classifying and preparing the source changers for shipment were incomplete. While instructions were included for preparing the shipment of the source changers as an "excepted" package, no specific directions were provided for the case where the empty source changers did not meet the requirements for an "excepted" package. In spite of the inadvertent inclusion of an iridium-192 source, the shipment of empty source changers was improperly prepared for transport. Because the surface radiation level of the shipment exceeded 0.5 mrem/hr, it was required to be shipped within the United States as a Type A package. Lack of instructions for preparing a Type A package may have contributed to the misclassification of the package as an excepted package. However, proper classification of the shipment as Type A would probably not have prevented the incident.

8. Amersham's instructions for returning an empty Model 500-SU source changer were made available to NDI and KIT and were adequate for determining whether a source changer contained an authorized (i.e., uncropped) source, since a visual examination would detect the presence of a pigtail. However, in view of previous incidents involving the receipt by Amersham of cropped sources from the Republic of Korea, the instructions were deficient in that they did not anticipate that sources without pigtails might be stored in the source changer and not removed before shipment. Specific instructions requiring

both a radiation survey and a probe of the source tubes, if implemented by the end-user, would have prevented this incident.

9. Amersham did not provide "shipper" instructions to the freight forwarder at the place of entry into the United States (Los Angeles), as required, but rather to its Customs broker in Boston. In this case, Amersham provided an erroneous instruction to transport the package as an "excepted" package.

10. The Team found no violation of NRC regulations with respect to the receipt of the source changer shipment at Amersham. NRC's regulations do not apply to the shipment of these source changers across the United States, other than 10 CFR Part 110.27, which specifies requirements for importing byproduct material. Shipment of the source changers within the United States was subject to DOT transportation regulations.

11. DOT regulations permit the use of an NRC-certified Type B package*, such as the Model 500-SU source changer, for shipment of a Type A** quantity, for example, either as empty (with the DU shielding) or with source totaling less than 20 curies. However, DOT regulations are ambiguous as to whether an NRC-certified Type B package must be used in strict accordance with the NRC certificate for shipment of Type A quantities or whether the package need only comply with the general requirements for Type A packages in the DOT regulations. Thus, the Team could not determine whether the source involved in this incident could have been shipped in the Model 500-SU source changer as a Type A quantity, because the source (with or without the pigtail) is not authorized in the NRC certificate.

12. The 14 source changers involved in the incident did not conform to the drawings referenced in NRC Certificate of Compliance 9006, Revision No. 9, in that all of these source changers were constructed without a source cable locking assembly. In addition, 6 of the 14 source changers were not constructed according to the dimensions specified in the drawings referenced in the Certificate of Compliance. However, the Team determined that these discrepancies did not contribute to the cause of this incident.

Cause or Causes - The cause of the incident is described above in Item 1 of the Team's findings and conclusions.

Actions Taken to Prevent Recurrence

Based on the findings and conclusions of the IIT, the NRC Executive Director for Operations has assigned staff responsibilities for generic and facility-specific actions to be taken. It is planned to include the resolution or disposition of each IIT finding and conclusion in the Office for Analysis and Evaluation of Operation Data (AEOD) Annual Reports (NUREG-1272 series).

This item is considered closed for the purposes of these quarterly abnormal occurrence reports.

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* A Type B package is required to transport iridium-192 in encapsulated sources exceeding 20 curies.

** A Type A quantity for iridium-192 in encapsulated sources is less than 20 curies.

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90-8 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 16, 1990; Riverside Regional Medical Center; Newport News, Virginia.

Nature and Probable Consequences - On March 16, 1990, the licensee notified NRC Region II that a therapy misadministration had occurred earlier that day when the wrong patient was administered 296 rads (from a teletherapy unit) to the midline of the brain. The radiation therapy technologist had gone to the waiting room and called for the patient by surname only. However, the technologist did not properly identify the patient prior to treatment by comparing the patient to the photograph which is affixed to the medical chart. The patients in question had the same last name and first initial, were of the same race and gender, were of approximately the same age, had approximately the same treatment region, same treatment technologist, and approximately the same appointment time. The patient for whom the treatment was intended was late for his appointment and was not present when called for in the waiting area. The wrong patient, who was in for followup examination only, responded to the call.

The licensee has advised the NRC that no adverse effects are anticipated as a result of the misadministration.

Cause or Causes - The cause is attributed to human error by the licensee's radiation therapy staff. The technologists did not confirm the identity of the patient by comparing the patient to the photograph affixed to the medical chart.

Actions Taken to Prevent Recurrence

Licensee - The licensee's corrective actions included strengthening of their patient identification policies to add a photograph to the therapy setup sheet for the patient, and use of skin marks to identify the treatment area, where appropriate. The entire radiation therapy staff was trained in the revised procedures for patient identification.

NRC - Region II conducted a special inspection on March 19, 1990, to review the circumstances associated with the misadministration, and to review the licensee's immediate corrective actions (Ref. 8). Region II conducted an Enforcement Conference with the licensee on April 12, 1990, to discuss the event, and agreed with the corrective actions to prevent recurrence. One violation of NRC requirements was identified (Ref. 9).

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

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90-9 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 16, 1990; John F. Kennedy Memorial Hospital; Edison, New Jersey.

Nature and Probable Consequences - On March 16, 1990, the licensee notified NRC Region I that earlier that day a patient, receiving an endobronchial iridium-192 treatment, received an unintended therapy dose to the face. The misadministration was estimated to have occurred from as early as 10:30 p.m. March 15, to midnight when it was first observed, and continued to approximately 4:45 a.m. on March 16 when the iridium was removed to a lead shielded container.

The misadministration occurred when a ribbon containing 25 seeds with 3.5 millicuries each of iridium-192, inserted into a previously placed endotracheal catheter, became displaced. The catheter, inserted in the patient's bronchi, remained in place. However, the ribbon containing the iridium seeds became completely dislodged from the catheter outside the lung and ultimately came to rest beside the patient's face. The duty nurse noticed the dislodged source about midnight, but took no action at the time. The ribbon remained unsecured until 2:00 a.m. when the duty nurse taped the unsecured end, which contained the iridium seeds, to the left side of the patient's face where it remained for approximately 3 hours. To tape the ribbon to the patient's face, the nurse handled the active part of the ribbon with unshielded fingers.

At about 4:15 a.m., the Charge Nurse attended the patient and noticed the dislodged source. The Charge Nurse called the Radiation Safety Officer who directed removal of the ribbon from the patient, using a remote handling tool, and placed the source in a shielded container.

The licensee made preliminary dose estimates of 1,032 rem to the left side of the patient's face, 282 rem to the eyes, and 357 rem to the scalp since the patient at one point folded the ribbon in her hair. The duty nurse who handled the ribbon received an estimated 17.6 rem to the fingers.

At 7:30 a.m. on March 16, the radiation oncologist rethreaded the iridium ribbon through the catheter and the patient's endobronchial treatment was continued, ending at 9:30 p.m. the same day. The patient was discharged from the hospital on March 20, 1990. The licensee advised the NRC that no adverse effects were anticipated as a result of the misadministration.

However, at 1:00 a.m. on March 22, 1990, the patient was readmitted to the hospital through the Emergency Room complaining of burning eyeballs and sensitivity to light. The patient's eyes were medicated and bandaged. Later that day, the patient was seen by an ophthalmologist who diagnosed the condition as keratoconjunctivitis; the doctor said that this condition could be viral-related but did not rule out the possibility of radiation-induced conjunctivitis. The patient was discharged from the hospital the following day.

An NRC medical consultant reviewed the event and concluded that the patient should not have any long term adverse effects except for the remote possibility of change in the lens of the eye.

Cause or Causes - The cause of the event was due to the source becoming completely dislodged outside the catheter, and the inappropriate response of the duty nurse to the dislodged source. The nurse's response resulted in a significant, unnecessary radiation dose to the patient, as well as an unnecessary dose to the nurse's fingers.

The nurse had received training in the equipment and procedures in March 1988, two years prior to assignment to this, the nurse's first case, in March 1990. Refresher training given in December 1989 did not include visuals or handling of simulated brachytherapy seeds. Therefore, the nurse did not recognize the configuration of the ribbon containing the radioactive seeds. The licensee's procedure for brachytherapy implants requires that shift nurses be briefed on radiation safety precautions related to the specific case. The procedure requires that initially, this briefing be given by the Radiation Safety Officer to the nurses on duty at the time of the implant. They then pass this information on to the succeeding shifts, etc. In this event, the briefing was not done for the shifts subsequent to the initial shift.

Actions Taken to Prevent Recurrence

Licensee - The licensee's corrective actions included: (1) review of the content of the training course; (2) provision during training of visuals of each type of brachytherapy configuration and handling; (3) a Post Test with a minimal score of 80% - this includes retraining and retesting, if necessary, to obtain 80%; (4) a picture or sketch on each patient's chart and/or each patient's door of the configuration of the brachytherapy implant; (5) exploration of means to make sources more secure in the implant site; (6) deferring the nurse from working with brachytherapy patients until retraining takes place; and, (7) formulation of a subcommittee of the Radiation Safety Committee to investigate this incident and render a full report to the Radiation Safety Committee.

NRC - NRC Region I performed an inspection to review the circumstances associated with the event. The licensee's corrective actions were considered to be satisfactory. However, two violations of NRC requirements were identified, i.e., (1) the duty nurse had not been adequately briefed concerning radiation safety precautions associated with care of the patient, and (2) the Radiation Safety Officer had not established a procedure for performing a radiation survey or evaluation prior to and upon entry into the room of a brachytherapy implant patient. On May 21, 1990, the NRC issued to the licensee a notice of violation and proposed civil penalty in the amount of $1,250 (Ref. 10). The licensee paid the civil penalty.

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

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90-10 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 19, 1990; St. Mary's Medical Center; Saginaw, Michigan.

Nature and Probable Consequences - On March 19, 1990, the licensee reported to NRC Region III that earlier that day a 46-year-old patient received a therapeutic radiation dose of 250 rem to the thoracic portion of the spine rather than to the intended treatment area (i.e., the lumbar portion, which is a lower portion of the spine).

The patient had previously received a total radiation dose of about 4,500 rem to the thoracic portion of the spine during treatments in April 1986 and December 1987. In March 1990, a prescription for further treatment, this time to the lumbar portion of the spine, was prepared. The treatment plan was prepared and an X-ray of the treatment area was taken. The treatment plan called for a series of 31 treatments, of 250 rem each, administered with a cobalt-60 teletherapy unit. On March 19, 1990, the patient received the first treatment of the series, but the radiation technologist mistakenly administered the 250 rem dose to the thoracic spine rather than the intended lumbar portion of the spine. The technologist then reviewed the patient's chart and immediately realized the error.

The unintended treatment of the thoracic area brought the total radiation dose to that area to approximately 4,800 rem. The licensee stated that there is a low probability of radiation damage to the spinal cord from a total radiation dose of this magnitude. The patient will be monitored for possible future conditions, but no medical treatment is required for the additional radiation dose.

Cause or Causes - The cause was due to human error in failing to follow procedures. The radiation technologist, in preparing the first treatment procedure, asked the patient to identify the treatment area. The patient indicated an area of the thoracic spine which contained a tattoo from the earlier treatments.

The technologist failed to follow normal treatment procedures that require technologists to review the patient's chart, examine the X-ray film showing the treatment area, and obtain verification of the treatment setup by a second technologist, prior to initiating treatment. The patient's chart and X-ray film clearly showed the correct treatment area.

Actions Taken to Prevent Recurrence

Licensee - The licensee provided training to the technologist involved, and other staff technologists, on the correct treatment procedures and quality assurance measures, including verification of treatment setups by a second qualified individual. The licensee also submitted its quality assurance procedures to be incorporated into its NRC license in accordance with the NRC Confirmatory Action Letter (CAL) described below.

NRC - The NRC retained a medical consultant to evaluate the circumstances of the misadministration and possible consequences. The consultant agreed with the licensee's evaluation. A special inspection was conducted by NRC Region III in April 1990 to review the incident (Ref. 11). The licensee's corrective actions were considered satisfactory. On April 4, 1990, a CAL was issued by NRC Region III (Ref. 12) to document the licensee's agreement to assure that two individuals review dose calculations and patient setups for all cobalt-60 teletherapy procedures. The licensee submitted its quality assurance procedures to the NRC and they have been incorporated into the facility's NRC license.

This item is considered closed for the purposes of this report

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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 period, the Agreement States reported no abnormal occurrences to the NRC.

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REFERENCES

1. U.S. Nuclear Regulatory Commission, NUREG-1410, "Loss of Vital AC Power and the Residual Heat Removal System During Mid-Loop Operations at Vogtle Unit 1 on March 20, 1990," published June 1990.**

2. U.S. Nuclear Regulatory Commission, NRC Information Notice No. 90-25, "Loss of Vital AC Power with Subsequent Reactor Coolant System Heat-up," April 16, 1990.*

3. Letter from Mohamed M. Shanbaky, Chief, Nuclear Materials Safety Section A, NRC Region I, to M. R. Strang, Chief Operating Officer, Monogahela Valley Hospital, forwarding Inspection Report No. 030-07584/90-01, Docket No. 030-07584, License No. 37-06575-03, March 14, 1990.*

4. Letter from George M. McCann, Acting Chief, Nuclear Materials Safety Section 1, NRC Region III, to Mitchell Carson, Vice President of Operations, Ball Memorial Hospital, forwarding inspection summary, Docket No. 030-01586, March 30, 1990.*

5. Letter from Charles E. Norelius, Director, Division of Radiation Safety and Safeguards, NRC Region III, to Susan Engelhardt, Radiation Safety Officer, University of Wisconsin - Madison, forwarding Inspection Report No. 90-001, Docket No. 030-034645, License No. 48-09843-18, May 21, 1990.*

6. Letter from Bruce S. Mallett, Chief, Nuclear Materials Safety Branch, NRC Region III, to Floyd Loop, Chief Executive Officer, Cleveland Clinic Foundation, forwarding Inspection Report No. 90-001, Docket Nos. 030-02649, 030-00394, 030-14577, 030-03044, April 27, 1990.*

7. U.S. Nuclear Regulatory Commission, NUREG-1405, "Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, Burlington, Massachusetts," published May 1990.**

8. Letter from J. Philip Stohr, Director, Division of Radiation Safety and Safeguards, NRC Region II, to Gerald R. Brink, President, Riverside Regional Medical Center, forwarding Inspection Report No. 45-09001-03/90-01, Docket No. 030-10073, License No. 45-09001-03, April 5, 1990.*

9. Letter from Stewart D. Ebneter, Regional Administrator, NRC Region II, to Gerald R. Brink, President, Riverside Regional Medical Center, forwarding a Notice of Violation, Docket No. 030-10073, License No. 45-09001-03, April 30, 1990.*

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

**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.

10. Letter from Thomas T. Martin, Regional Administrator, NRC Region I, to Stephen Yenchek, Vice President, Medical Affairs, John F. Kennedy Medical Center, forwarding a Notice of Violation and Proposed Imposition of Civil Penalty, Docket No. 030-02555, License No. 29-12611-01, May 21, 1990.*

11. Letter from Bruce S. Mallett, Chief, Nuclear Materials Safety Branch, NRC Region III, to Fred Fraizer, Vice President, St. Mary's Hospital, forwarding Inspection Report No. 90-001, Docket No. 030-17056, License No. 21-03646-04, May 21, 1990.*

12. Confirmatory Action Letter from A. Bert Davis, Regional Administrator, NRC Region III, to Fred Fraizer, Vice President, St. Mary's Hospital, Docket No. 030-17056, License No. 21-03646-04, April 4, 1990.*

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*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 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 1000 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.

APPENDIX B

UPDATE OF PREVIOUSLY REPORTED ABNORMAL OCCURRENCES

During the January through March 1990 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 each abnormal occurrence 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. 4). Previous reports have stated that these updates would be continued until defueling activities at the site were completed. As discussed below, defueling activities have now been completed and all core debris removed has been shipped off site. Therefore, no further updates are anticipated for this item in these quarterly abnormal occurrence reports.

Defueling Completion

On January 25, 1990, General Public Utilities Nuclear (GPUN), the licensee, completed flushing, brushing, and vacuuming the loose fines in the reactor vessel. Following video verification of these activities, GPUN declared an end to defueling on January 30, 1990. However, subsequent detailed review of the video tapes revealed that some redistributed fuel fines remained in accessible areas and that the video was not adequate to demonstrate that certain flow holes in the lower core support assembly were empty of fuel debris. In March of 1990, GPUN defueling crews re-flushed and re-vacuumed the areas where the redistributed material was observed and obtained video verification that the 18 flow holes were empty. All of the canisters used to contain defueled core debris were subsequently removed from the reactor vessel, dewatered, and weighed.

During the January to March 1990 time period, approximately 7,200 pounds of fuel and debris were removed from the reactor vessel. The total mass removed during defueling operations was approximately 304,000 pounds. This slightly exceeded the NRC staff's original estimate of 300,000 pounds. The total mass removed included 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 became commingled with core debris during defueling operations. There remains a small amount of core debris in the reactor coolant system in inaccessible areas that will not be removed.

Decontamination and Dose Reduction Activities

Since early December 1988 the licensee focused its efforts on the completion of defueling and the support of that activity. Decontamination (other than the reactor building) and system flushing activities were suspended, except limited efforts to support defueling and to maintain access to and operability of plant systems. In late March 1990, the licensee began placing shielding in the reactor building, primarily over the reactor vessel. This will allow area access after the reactor vessel is drained.

Fuel Cask Shipments

The final shipment, consisting of about 13,500 pounds of core debris, was made to Idaho National Engineering Laboratory on April 15, 1990. Therefore, all core debris removed (a total of about 304,000 pounds) has been shipped from the TMI site.

Reactor Vessel Metallurgical Research Program

During the month of February 1990, an international research effort obtained metallurgical samples from the TMI-2 reactor vessel. The program was sponsored by the NRC's Office of Nuclear Regulatory Research and the Organization for Economic Cooperation and Development. A total of 15 prism shaped samples were obtained from the reactor vessel lower head. Additionally, 14 incore instrument penetrations were cut off 1 to 2 inches above the lower head and obtained as samples. Two incore instrument guide tubes were also cut free from the flow distributor head as samples. The samples will be used to study interactions between core melt and reactor vessel components.

Proposal to Dispose of Accident-Generated Water

The licensee continued testing of the evaporator which will be used to dispose of the accident generated water (AGW). As of the end of March 1990, no AGW has been processed through the evaporator. The initial testing results have indicated that the evaporator is capable of achieving the desired decontamination factor of 1000. However, the evaporator system has not been successful in conducting sustained operations. Frequent maintenance problems have forced shutdown of the facility. The licensee and the vendor are working to significantly improve the reliability of the evaporator.

TMI-2 Advisory Panel Meetings

A meeting of the Advisory Panel for the Decontamination of Three Mile Island Unit 2 (Panel) was held on March 14, 1990. Topics discussed included GPUN's Defueling Completion Report, the international research effort taking samples from the TMI-2 reactor vessel, NRC staff actions, and the future of the Panel. The Panel members decided that it was not yet the time to disestablish the Panel. They felt that they had a continuing role in monitoring the accident generated water evaporation, post defueling monitored storage, and decommissioning funding.

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

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APPENDIX C

OTHER EVENTS OF INTEREST

The following item is described because it may possibly be perceived by the public to be of public health or safety significance. The item did not involve a major reduction in the level of protection provided for public health or safety; therefore, it is not reportable as an abnormal occurrence.

1. Radioactive Releases to Indian Kill Reservoir and Subsequent Shutdown of a Radioisotopes Production Facility in New York State

On February 9, 1990, Cintichem Incorporated, of Tuxedo, New York, reported identification of iodine-131 (I-131) and sodium-24 (Na-24) in an onsite retention pond that collects runoff from the storm drain system. The NRC and New York State dispatched teams to the site. (NRC licenses operation of the 5 Mw reactor and use of special nuclear material; the State of New York licenses the possession and use of byproduct materials in hot cells and related facilities adjacent to the reactor.) Until February 20, the NRC and New York State believed that no releases of radioactively contaminated water to the nearby Indian Kill Reservoir had occurred. However, on February 20, the licensee indicated that, prior to completing the analysis of water samples from the retention pond early on February 9, the onsite retention pond was drained to the reservoir several times due to runoff from heavy rainfall. The retention pond was later determined to have had I-131 slightly in excess of the NRC limits for releases to unrestricted areas. The State of New York subsequently measured I-131 in the reservoir, but at levels less than the EPA's standards for drinking water. While there was no effect on public health or safety, the event was of particular interest because: (1) the reservoir serves as a drinking water source for about 150 families in the Tuxedo, NY area; and (2) the plant is the nation's largest manufacturer of radioisotopes for medical purposes. The details of the event are as follows:

The licensee irradiates uranium oxide targets in its pool-type reactor. The target material is transferred through a water-filled canal to a storage pool (called the gamma pit) below the hot cells. After being placed in the hot cells, a variety of radioisotopes produced in the irradiation process are separated, refined, and shipped for use with various radiopharmaceuticals to diagnose and treat a number of medical conditions.

On December 12, 1989, NRC Region I received notification that the licensee, through its routine sampling program, had identified a possible discharge of slightly contaminated water in a storm drain in the onsite parking lot. However, samples from a number of surface and groundwater locations on site revealed no additional measurable contamination and no obvious source of the contamination in the storm drain water. In particular, an onsite retention pond which received water from the storm drain system (and which itself drained to the Indian Kill Reservoir) showed no detectable contamination. The NRC monitored the licensee's actions to identify the source of the radioactivity, and on January 5, 1990, following the latest in a series of cyclic changes in the amount of radioactivity in the storm drain, NRC Region I instructed the licensee to release no water

from the retention pond to the reservoir prior to sampling and analyzing the samples to ensure that no measurable release to the reservoir occurred. Until February 9, 1990, no measurable activity was observed in the retention pond. On February 9, 1990, Cintichem reported to Region I the identification of several radioisotopes in the retention pond. All but one were at concentrations that could be released to unrestricted areas. However, I-131 was present at nearly twice the maximum permissible concentration (MPC) permitted for such releases. Following the discovery of radioactivity in the retention pond on February 9, 1990, all discharges to the reservoir were halted. The licensee began pumping the contents of the retention pond to onsite holding tanks and additional tanks that were brought on site. The licensee processed this water to remove the radioactivity and transferred it to another tank for sampling and analysis prior to discharge downstream of the reservoir.

Between February 9 and 16, 1990, a team of specialists monitored the licensee's corrective actions, confirmed that the reactor had been shut down, confirmed the licensee's measurements of radionuclides in water, and assured that, after the team's arrival on site, all liquid releases met regulatory limits. The team also monitored the licensee's actions to identify the source of the contamination leaks. A concrete wall in a portion of the gamma pit was identified as a source of the leak to the retention pond. A leak was also identified in a part of the reactor coolant system called the hold-up tank.

On February 13, 1990, an NRC Order was issued to Cintichem requiring submission of a plan of short and long term actions to correct current and prevent future leaks (Ref. C-1).

Subsequently, on February 20, 1990, the licensee informed the NRC that several discharges, contaminated with I-131 at about twice the appropriate MPC and with several other radioisotopes at concentrations less than MPC, were made from the retention pond to the reservoir on February 9, 1990. Subsequent to this notification, the NRC issued Confirmatory Action Letter (CAL) No. 1-90-005 on February 23, 1990 (Ref. C-2), which confirmed the licensee's commitment to (1) stop all intentional releases of water from the onsite retention pond to the reservoir; (2) eliminate leakage/seepage from the retention pond to the reservoir through the discharge pipe; (3) divert all discharges from the retention pond to a discharge point in the creek downstream of the reservoir, but only after sampling and analyses to assure the radioactivity is below applicable maximum permissible concentrations; and (4) immediately notify the NRC Region I Office if radioactivity is measured in the retention pond above background levels or if any unmeasured releases occur. Subsequent to receipt of this CAL, the licensee notified the Region I Office on the evening of February 23, 1990, that elevated levels of radioactivity (although less than the appropriate MPCs) were found in the retention pond and that, due to heavy rainfall during the day, the retention pond had to be discharged to the stream prior to completion of analyses, in order to protect the integrity of the retention pond. These releases were made in accordance with the CAL.

On March 5, 1990, in response to the NRC Order, the licensee submitted a plan for locating and repairing all leaks, and verifying the effectiveness of the repairs. Implementation of the plan would include various tests of the integrity

of the reactor pool system, repair of all identified leaks, retest of all systems for water leakage, and development and installation of a monitoring system or program for the early detection of leaks in the reactor pool system. In addition, the licensee initiated a hydrologic investigation to evaluate characteristics of the groundwater bearing formations beneath the site and the extent of groundwater contamination resulting from the reactor pool system leaks.

The reactor would remain shut down while all leaks were being identified and repaired. The licensee expected to have all tests to identify leaks completed by March 31, 1990. Depending upon the extent of water leakage identified, the structural repairs could take several months.

However, on April 4, 1990, Cintichem announced in a press release a voluntary decision to close and decommission the company's research reactor used for the production of medical radioisotopes. The company stated that the decision was based on the analysis of the long-term economic viability and the costs of re-start. The company also stated that due to long-term agreements in place for radiosotopes, the closure would not impact the radiopharmaceutical production of Medi-Physics, the parent company of Cintichem. In an announcement to Cintichem employees, the plant manager indicated that both the reactor and hot laboratory operations were to be permanently shut down. About 25 positions would be affected. Cintichem will prepare a detailed decommissioning plan for submission to the NRC for its approval.

During the course of the events described above, NRC representatives, along with representatives of the New York State agencies responsible for regulating activities at Cintichem involving radioactive materials, met with local officials and members of the public on several occasions to inform them of the situation at Cintichem. Both regulatory bodies agreed that the releases to the reservoir, though undesirable, did not represent a hazard to public health or safety.

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REFERENCES (FOR APPENDICES)

C-1 Letter forwarding an Order Modifying License (Effective Immediately) from Hugh L. Thompson, Jr., NRC Deputy Executive Director for Nuclear Safety, Safeguards, and Operations Support, to James J. McGovern, Plant Manager, Cintichem, Incorporated, Docket Nos. 50-54 and 70-687, License Nos. R-81, SNM-639, February 13, 1990.*

C-2 Confirmatory Action Letter (CAL) No. 1-90-005 from Malcolm R. Knapp, Director, Division of Radiation Safety and Safeguards, NRC Region I, to James J. McGovern, Plant Manager, Cintichem, Incorporated, Docket Nos. 50-54 and 70-687, License Nos. R-81, SNM-639, February 23, 1990.*

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

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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 and safety and requires a Quarterly report of such events to be made to Congress. This report covers the period January 1 through March 31, 1990. For this reporting period, there were 10 abnormal occurrences. One involved the loss of vital ac power with a subsequent reactor coolant system heat-up at the Vogtle Unit 1 power plant during shutdown. The event was investigated by an NRC Incident Investigation Team (IIT). The other nine abnormal occurrences involved nuclear material licensees and are described in detail under other NRC-issued licenses: eight of these involved medical therapy misadministrations; the other involved the receipt of an unshielded radioactive source at Amersham Corporation in Burlington, Massachusetts. The latter event was also investigated by an NRC IIT. No abnormal occurrences were reported by the Agreement States. The report also contains information that updates a previously reported abnormal occurrence.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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