NUREG-0090
Vol. 14, No. 4

Report to Congress on Abnormal Occurrences

October – December 1991

U.S. Nuclear Regulatory Commission

Office for Analysis and Evaluation of Operational Data

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Post Office Box 37082
Washington, D.C. 20013-7082

A year's subscription consists of 4 issues for this publication.

Single copies of this publication are available from National Technical Information Service, Springfield, VA 22161

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U.S. Nuclear Regulatory Commission
Washington, DC 20555

Previous Reports in Series

NUREG 75/090, January-June 1975,
published October 1975
NUREG-0090-1, July-September 1975,
published March 1976
NUREG-0090-2, October-December 1975,
published March 1976
NUREG-0090-3, January-March 1976,
published July 1976
NUREG-0090-4, April-June 1976,
published March 1977
NUREG-0090-5, July-September 1976,
published March 1977
NUREG-0090-6, October-December 1976,
published June 1977
NUREG-0090-7, January-March 1977,
published June 1977
NUREG-0090-8, April-June 1977,
published September 1977
NUREG-0090-9, July-September 1977,
published November 1977
NUREG-0090-10, October-December 1977,
published March 1978
NUREG-0090, Vol. 1, No. 1, January-March 1978,
published June 1978
NUREG-0090, Vol. 1, No. 2, April-June 1978,
published September 1978
NUREG-0090, Vol. 1, No. 3, July-September 1978,
published December 1978
NUREG-0090, Vol. 1, No. 4, October-December 1978,
published March 1979
NUREG-0090, Vol. 2, No. 1, January-March 1979,
published July 1979
NUREG-0090, Vol. 2, No.2, April-June 1979,
published November 1979
NUREG-0090, Vol. 2, No. 3, July-September 1979,
published February 1980
NUREG-0090, Vol. 2, No. 4, October-December 1979,
published April 1980
NUREG-0090, Vol. 3, No. 1, January-March 1980,
published September 1980
NUREG-0090, Vol. 3, No. 2, April-June 1980,
published November 1980
NUREG-0090, Vol. 3, No. 3, July-September 1980,
published February 1981
NUREG-0090, Vol. 3, No. 4, October-December 1980,
published May 1981
NUREG-0090, Vol. 4, No. 1, January-March 1981,
published July 1981
NUREG-0090, Vol. 4, No. 2, April-June 1981,
published October 1981
NUREG-0090, Vol. 4, No. 3, July-September 1981,
published January 1982
NUREG-0090, Vol. 4, No. 4, October-December 1981,
published May 1982
NUREG-0090, Vol. 5, No. 1, January-March 1982,
published August 1982
NUREG-0090, Vol. 5, No. 2, April-June 1982,
published December 1982
NUREG-0090, Vol. 5, No. 3, July-September 1982,
published January 1983
NUREG-0090, Vol. 5, No. 4, October-December 1982,
published May 1983
NUREG-0090, Vol. 6, No. 1, January-March 1983,
published September 1983
NUREG-0090, Vol. 6, No. 2, April-June 1983,
published November 1983
NUREG-0090, Vol. 6, No. 3, July-September 1983
published April 1984
NUREG-0090, Vol. 6, No. 4, October-December 1983
published May 1984
NUREG-0090, Vol. 7, No. 1, January-March 1984,
published July 1984
NUREG-0090, Vol. 7, No. 2, April-June 1984,
published October 1984
NUREG-0090, Vol. 7, No. 3, July-September 1984,
published April 1985
NUREG-0090, Vol. 7, No. 4, October-December 1984,
published May 1985
NUREG-0090, Vol. 8, No. 1, January-March 1985,
published August 1985
NUREG-0090, Vol. 8, No. 2, April-June 1985,
published November 1985
NUREG-0090, Vol. 8, No. 3, July-September 1985,
published February 1986
NUREG-0090, Vol. 8, No. 4, October-December 1985,
published May 1986
NUREG-0090, Vol. 9, No. 1, January-March 1986,
published September 1986
NUREG-0090, Vol. 9, No. 2, April-June 1986,
published January 1987
NUREG-0090, Vol. 9, No. 3, July-September 1986
published April 1987
NUREG-0090, Vol. 9, No. 4, October-December 1986,
published July 1987
NUREG-0090, Vol. 10, No. 1, January-March 1987,
published October 1987
NUREG-0090, Vol. 10, No. 2, April-June 1987,
published November 1987
NUREG-0090, Vol. 10, No. 3, July-September 1987,
published March 1988
NUREG-0090, Vol. 10, No. 4, October-December 1987,
published March 1988
NUREG-0090, Vol. 11, No. 1, January-March 1988,
published July 1988
NUREG-0090, Vol. 11, No. 2, April-June 1988,
published December 1988
NUREG-0090, Vol. 11, No. 3, July-September 1988,
published January 1989
NUREG-0090, Vol. 11, No. 4, October-December 1988,
published April 1989
NUREG-0090, Vol. 12, No. 1, January-March 1989,
published August 1989
NUREG-0090, Vol. 12, No. 2, April-June 1989,
published October 1989
NUREG-0090, Vol. 12, No. 3, July-September 1989
published January 1990
NUREG-0090, Vol. 12, No. 4, October-December 1989
published March 1990
NUREG-0090, Vol. 13, No. 1, January-March 1990,
published July 1990
NUREG-0090, Vol. 13, No. 2, April-June 1990,
published October 1990
NUREG-0090, Vol. 13, No. 3, July-September 1990,
published January 1991
NUREG-0090, Vol. 13, No. 4, October-December 1990,
published March 1991
NUREG-0090, Vol. 14, No. 1, January-March 1991,
published June 1991
NUREG-0090, Vol. 14, No. 2, April-June 1991,
published September 1991
NUREG-0090, Vol. 14, No. 3, July-September 1991,
published December 1991

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 October 1 through December 31, 1992.

Five abnormal occurrences at NRC-licensed facilities are discussed in this report. None of these occurrences involved a nuclear power plant. Four involved medical therapy misadministrations and one involved a medical diagnostic misadministration. The NRC's Agreement States reported three abnormal occurrences. Two involved exposures of non-radiation workers and one involved a medical therapy misadministration. The report also contains information that updates some previously reported abnormal occurrences.

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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 October 1 through December 31, 1991. 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 OCTOBER-DECEMBER 1991

Nuclear Power Plants

The NRC is reviewing events reported at the nuclear power plants licensed to operate. For this report, the NRC has not determined that any events were abnormal occurrences.

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 over 8000 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.

91-10 Medical Diagnostic Misadministration at I. Gonzalez Martinez Oncologic Hospital in Hato Rey, Puerto Rico

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see the overall 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—June 17, 1991; I. Gonzalez Martinez Oncologic Hospital; Hato Rey, Puerto Rico.

Nature and Probable Consequences—On June 17, 1991, a patient scheduled to receive a diagnostic dose of iodine-131 (I-131), was mistakenly administered a dose of I-131 in the therapeutic range. The misadministration occurred when a nuclear medicine technologist misread the dose calibrator and administered 6.2 millicuries rather than 6.2 microcuries. The technologist realized the error nine minutes after the dose was administered when the printed dose label from the dose calibrator was checked. The physician-in-charge promptly administered potassium iodide solution to the patient to reduce the uptake of the radioactive iodine. The licensee estimated, based on 24-hour uptake measurements, that the uptake of radioactive iodine in the thyroid was approximately five percent resulting in an estimated dose to the thyroid of 1612 rem. The misadministration was promptly reported to the NRC.

The licensee continues to follow the patient's condition and has advised the NRC that the patient has not experienced any adverse effects because of the misadministration.

Cause or Causes—The cause is attributed to human error by the nuclear medicine technologist. The technologist did not verify the dose by reviewing the printed dose label before administering the dose.

Actions Taken to Prevent Recurrence

Licensee—The licensee's corrective actions included taking disciplinary action against the technologist and requiring that the nuclear medicine supervisor check each dose before the dose is administered to a patient.

NRC—NRC Region II conducted an inspection to review the circumstances associated with the misadministration, and to review the licensee's correc-

tive actions. No violations of NRC requirements were identified during the inspection.

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

91-11 Medical Therapy Misadministration at William Beaumont Army Medical Center in El Paso, Texas

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see the overall 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—August 30, 1991; William Beaumont Army Medical Center; El Paso, Texas.

Nature and Probable Consequences—On August 30, 1991, a patient referred to the Medical Center for therapeutic radioiodine treatment of Graves' disease, mistakenly received a 28.6 millicurie (mCi) oral dosage of iodine-131 (I-131) instead of the prescribed oral dosage of 15.0 mCi I-131. As a result, the patient's thyroid received about 31,900 rads instead of the 16,700 rads intended.

Prior to the administration, the radiopharmacist involved was informed that a radioiodine treatment for Graves' disease had been requested. He assumed that it was a 29 mCi treatment rather than a 15 mCi treatment. [At the Medical Center, a 15.0 mCi dose is routinely used for Graves' disease while a 29.0 mCi dosage is used for thyroid disorders such as multinodular toxic goiters.] He then requested a 29.0 mCi dose from Syncor, the commercial radiopharmacy. The actual dose received from Syncor was 28.6 mCi, and was labeled as such. When the radiopharmacist logged the dosage into the computer, after it had been measured by the dose calibrator, he failed to take note of the intended therapy dose as reflected in the referring physician's prescription. In addition, the counseling nuclear medicine physician did not verify the dosage to be administered with the intended dosage. The 28.6 mCi incorrect dosage was then administered to the patient.

The referring physician was notified on the day of the misadministration. The licensee stated that no adverse effects on the patient were noted. The patient's condition will be appropriately followed in the licensee's Endocrine Clinic.

Cause or Causes—The event was attributed to human error as a result of the radiopharmacist's and consulting nuclear medicine physician's inattentiveness and short experience at this facility. Although the prescribing physician's written request was available at the time the dosage was ordered and administered, both individuals failed to compare the prescribed dosage with the dose calibrator assay result or the radiopharmaceutical package label. Additionally, both the radiopharmacist and consulting nuclear medicine physician had only been working at the facility for a short time and were unfamiliar with the use of radioiodine dosages as low as 15 millicuries for the treatment of Graves' disease. The physician's previous experience and personal preference involved a routine dosage of 25-30 millicuries for a hyperthyroid disorder, and the radiopharmacist had dispensed only a few therapeutic radioiodine dosages, involving higher dosages, prior to this particular case. The licensee also acknowledged that the consulting nuclear medicine physician may not have realized that the patient was receiving treatment for Graves' disease rather than a multinodular toxic goiter at the time the dosage was administered.

Actions Taken to Prevent Recurrence

Licensee—The radiopharmacist and consulting nuclear medicine physician were counseled and reinstructed as to the proper dose verification techniques and safeguards. For future therapies using radiopharmaceuticals, the counseling nuclear medicine physician must visually check the activity of the radiopharmaceutical dosage, as measured by the radiopharmacist or technologist, with the written physician prescription. The licensee also intends to require that the consulting nuclear medicine physician be familiar with the patient's case history prior to administering a therapeutic radiopharmaceutical dosage.

Also, the licensee's Radiation Safety Officer will conduct a training session in which all nuclear medicine personnel will be required to review the videotape entitled, "Good Practices in Preparing and Administering Radiopharmaceuticals," prepared by the NRC's Office for Analysis and Evaluation of Operational Data.

NRC—NRC Region IV conducted an inspection to review the circumstances associated with this misadministration and the licensee's corrective actions as described above (Ref. 1). The inspection revealed no violations of regulatory requirements regarding this misadministration, and the licensee's determination of the cause of the event was considered accurate based upon interviews of the individuals involved. The licensee had implemented

corrective actions as reported, and had continued to closely observe individuals' performance with regard to therapeutic radiopharmaceutical dosages.

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

91-12 Medical Therapy Misadministration at St. Joseph's Hospital and Medical Center in Paterson, New Jersey

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see the overall 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—October 25, 1991; St. Joseph Hospital and Medical Center; Paterson, New Jersey.

Nature and Probable Consequences—On November 13, 1991, NRC Region I was notified by a letter dated October 30, 1991, from the licensee's acting Radiation Safety Officer (RSO), that a therapeutic misadministration involving a strontium-90 (Sr-90) beta applicator, with a nominal activity of 95.5 millicuries, had occurred on October 25, 1991. The therapeutic treatment had been administered to the wrong patient.

The misadministration involved a 52-year-old male who was scheduled for simulation for external beam therapy from a linear accelerator to the head and neck. This occurred when the radiation oncology department secretary placed the patient in the wrong treatment room without the patient's chart. The patient spoke minimal English and the radiation oncologist did not speak the patient's language. The physician questioned the patient more than once as to which area of his body was being treated. The patient pointed toward his head as the area to be treated. Based on this poor exchange of information, and without benefit of review of the patient's chart, the oncology physician then proceeded to administer a Sr-90 dose to the patient's eye. The licensee estimates that about 1,000 rads were delivered in 11 seconds to the surface of the right eye. The licensee estimates that no harmful effects occurred to the patient as a result of this event.

An NRC medical consultant was retained to review the licensee's dosimetry, the possible biological effects of the dose, and the actions to prevent recurrence. The consultant concluded that:

1. The patient should receive a slit-lamp examination of both eyes immediately and annually thereafter for the rest of the patient's life,
2. The possibility of cataracts is low, and
3. The methods to identify patients should be improved.

Based on source and geometry considerations, the consultant agreed with the licensee's estimate of about 1000 rads to the patient's eye. The consultant reviewed the licensee's corrective actions and found them to be appropriate. The consultant provided suggestions to the licensee on how to improve the corrective actions.

Cause or Causes—The cause was attributed to failure to follow the hospital protocol which requires reviewing the patient's chart prior to administering treatment.

Actions Taken to Prevent Recurrence

Licensee—The licensee's planned corrective actions include:

1. Patients will only be directed to the treatment area by an aide who will hand the treatment charts directly to the physician.
2. All patient's charts will include a polaroid photograph of the patient.
3. Access to the Sr-90 beta applicator storage area will be limited to the Physics Department and the Chief Technologist.
4. Physics staff will accompany the physicians during all Sr-90 beta applicator treatments and assist in determining the treatment times.
5. Staff training and reenforcement of appropriate patient processing procedures and NRC notification and reporting requirements will be conducted.

NRC—An NRC Region I inspector was dispatched to conduct a special inspection on November 15, 1991, of the circumstances surrounding this misadministration (Ref. 2).

On December 26, 1991, the NRC transmitted to the licensee a Notice of Violation and Proposed Imposition of Civil Penalties in the amount of $6,250 (Ref. 3). Two violations were identified: (1) the failure to review the patient's prescription which resulted in the misadministration ($3,750); and (2) the failure to report the misadministration to the NRC within 24 hours of its discovery ($2,500). Both violations were

classified as Severity Level III on a scale in which Severity Levels I through V range from the most significant to least significant, respectively. The licensee admitted the violations and paid the civil penalties in full.

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

91-13 Medical Therapy Misadministration at University of Pittsburgh Presbyterian-University Hospital in Pittsburgh, Pennsylvania

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see the overall 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—November 22, 1991; University of Pittsburgh Presbyterian-University Hospital; Pittsburgh, Pennsylvania.

Nature and Probable Consequences—On November 22, 1991, NRC Region I was notified by the licensee's Radiation Safety Officer (RSO) that a therapeutic misadministration involving a cobalt-60 teletherapy unit had occurred at their Presbyterian-University Hospital facility on November 21, 1991. The therapeutic treatment had been administered to the wrong part of a patient's body.

The technologist had looked at the patient's chart but set up the wrong treatment field. The patient received 287 rads to the thoracic vertebrae (upper back) instead of the prescribed 300 rads to the cervical vertebrae (lower neck). Because the patient had previously undergone thoracic vertebrae treatment, the technologist erroneously assumed that the thoracic treatment was continuing and administered the treatment without adequately reviewing the patient's chart which indicated the correct treatment area (cervical).

The licensee has determined that the treatment will not have any adverse effects on the patient. The patient is suffering from metastatic cancer of the breast and was receiving palliative radiation treatments to the spine.

Cause or Causes—The cause was attributed to failure to follow the written prescription in the patient's chart.

Actions Taken to Prevent Recurrence

Licensee—Corrective actions included stressing to the radiation technologists the need to carefully read patients' charts and to recognize notations of changes in the fields to be treated. When a field is completed on a patient, the administered dose is to be written down in the patient's chart using a different color ink.

NRC—NRC Region I will examine the licensee's preventive and corrective actions at the next scheduled inspection.

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

91-14 Medical Therapy Misadministration at University of Wisconsin Hospital in Madison, Wisconsin

The following information pertaining to this event is also being reported concurrently in the *Federal Register*. Appendix A (see the overall 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—November 27, 1991; University of Wisconsin; Madison, Wisconsin.

Nature and Probable Consequences—A patient was undergoing a series of five treatments for a cancer of the nasal septum using a high dose rate iridium-192 afterloading unit. In this type of treatment, a brachytherapy catheter was positioned in the patient's nasal passage. The computerized device then moved the source through the catheter into the treatment area. The source had a nominal strength of 4 curies.

The initial four treatments were completed without incident. However, prior to the fifth treatment on November 27, 1991, the operating physicist picked up the wrong patient chart located next to the device's control panel and entered the treatment program information into the computerized device. While the treatment was underway, a student technologist inquired about the length of time to complete the treatment. The prescribing physician and the operating physicist indicated different lengths of time. The physician, realizing there was an error, directed that the treatment be stopped immediately. Subsequently, it was discovered that the physicist had used the wrong patient chart and, therefore, entered incorrect treatment program information into the computer. The correct treatment information was then entered into the computer and the treatment series completed.

The erroneous treatment information positioned the iridium-192 source so that the patient's lips received an unintended exposure for about one minute. The dose calculation by the licensee indicated the patient received approximately 73 rads to the lips. According to the licensee, the radiation exposure received to the lips, for a correctly administered treatment to the nasal septum, would be about 25 rads. The licensee does not expect any consequences resulting from the additional exposure to the patient's lips from this misadministration.

Cause or Causes—The physicist failed to verify the identity of the patient and assumed incorrectly that the chart at the control panel was for the patient undergoing treatment.

Actions Taken to Prevent Recurrence

Licensee—The licensee has directed that the operating physicist check the identity of each patient before treatment, using patient photos or other means of verification. Patient charts for treatment series will be placed in a specified location. No exceptions will be made to the training required of a user. In the future, training will include a general section on high dose rate afterloading devices.

NRC—A special inspection was conducted on December 17, 1991, to review the circumstances surrounding the misadministration and to review the licensee's corrective actions (Ref. 4). No violations of NRC requirements were identified. The corrective actions appeared sufficient to prevent a recurrence of the misadministration. While the licensee has a viable quality assurance program in place, the changes adopted will strengthen the previous procedures.

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. For this period, the Agreement States reported the following events as abnormal occurrences.

AS91-5 Exposure of a Non-Radiation Worker

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 can be considered an abnormal occurrence.

This writeup is based on information provided to the NRC in December 1991 by the Agreement State of California for inclusion in this report.

Date and Place—September 1, 1989; exposures to sources occurred at San Gabriel Valley Medical Center in San Gabriel, California, and during delivery to Methodist Hospital of Southern California in Arcadia, California.

Nature and Probable Consequences—On August 1, 1989, an intracavitary procedure was performed at San Gabriel Valley Medical Center. Two cesium-137 sources, 42.2 mCi each, were loaded into colpostat devices and inserted into the patient for treatment. After the procedure was completed, the physician removed the devices and placed them in a lead container. The container was then transported to the room where the cesium storage safe was located; however, the sources were not removed from the inserts and placed in the safe as they should have been. On September 1, an employee of the Medical Center removed the inserts, still containing the sources, from the lead transport container, and thinking they were empty, placed them in an envelope to be transported to Methodist Hospital where they were intended to be used. The envelope was placed in the Radiology Department where it was picked up by an employee of a private medical group a few days later. This individual placed the envelope in his private car and drove to Methodist Hospital which took approximately 25 minutes.

When the inserts were received by Methodist Hospital, the envelope was opened immediately and the sources were discovered inside. They were placed in a lead transport container and removed to the storage safe by staff of the hospital.

San Gabriel Valley Medical Center hired a medical physicist to evaluate and determine the extent of exposures that individuals had received as the result of this incident. Extensive time and motion studies were conducted, as well as the processing of personnel monitoring devices, to determine doses received. The individual who had transported the sources from one hospital to the other was a non-radiation worker and therefore did not wear a personnel monitoring device. It was estimated that he received about 106 rem

to his right hand and 0.168 rem whole-body exposure. All others who came in contact with the sources wore personnel monitoring devices. It was estimated that their exposures were within the occupational dose limits specified by the State's Radiation Control Regulations.

The Medical Center was cited for causing the delivery man to receive 106 rem to his right hand as a result of this event. He was notified in writing by the hospital of the nature and extent of his exposure and was provided a medical review. A medical examination of his hands on the day after the exposure and three weeks later did not reveal any evidence of skin changes or other symptoms. Also, his blood count showed no significant abnormalities.

Cause or Causes—The apparent cause of this exposure was the failure of hospital employees to follow proper procedures for storage of brachytherapy sources following their use. The individual who transported the sources from the patient's room to the cesium storage location at the Medical Center did not remove them from the colpostat source holders and place them in the storage safe. By leaving the sources in the holders, other personnel were easily exposed because the sources were invisible and could only be detected by careful examination or use of a survey meter.

Actions Taken to Prevent Recurrence

Licensee—The Medical Center purchased a bench top Geiger-Mueller detector equipped with an audible alarm and installed it at their cesium storage location. The detector will alarm if sources are not secured inside the storage safe. Also, a refresher training was held for all staff covering the proper handling of brachytherapy sources held under the license. This training included removal and replacement of sources from the storage safe as well as quarterly inventories. Methods for surveying devices that contained cesium sources prior to taking them out of service was emphasized.

Agency—The inspection agency cited the Medical Center for six items of noncompliance. The licensee responded to the Notice of Violation on November 14, 1989, and the investigation was closed on November 30, 1989. A follow-up inspection was conducted in October 1990, and no similar type personnel exposures were found; therefore, the corrective actions appeared to be effective in preventing further similar incidents.

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

AS91-6 Exposures of Non-Radiation Workers

Appendix A (see Example 5 of "For All Licensees") notes that any loss of licensed material in such quantities and under such circumstances that substantial hazard may result to persons in unrestricted areas can be considered an abnormal occurrence. In addition, Example 2 of "For All Licensees" in Appendix A notes that an exposure to an individual in an unrestricted area such that the whole body dose received exceeds 0.5 rem in one calendar year can be considered an abnormal occurrence.

This writeup is based on information provided to the NRC in December 1991 by the Agreement State of California for inclusion in this report.

Date and Place—November 1990; exposures to employees at Federal Express Los Angeles Airport Hub Sort Facility at Los Angeles, California, from sources shipped from Anaheim Memorial Hospital in Anaheim, California.

Nature and Probable Consequences—On November 2, 1990, Anaheim Memorial Hospital, Anaheim, California, shipped 7 cesium-137 sources that had been used for a brachytherapy implant back to the supplier, Therapeutic Nuclides, Inc., Valencia, California. The sources consisted of two 50 mCi, three 25 mCi, and two 12 mCi sizes.

The Type 7A package used for shipment consisted of a plastic source retainer, fitted into a lead pig that was then placed inside a metal can. This metal can was placed inside a 5-gallon metal container and was surrounded on all sides by a high-density polyurethane foam. The inside container was secured with a lid and a snap ring. The outside container was secured with a lid and level lock ring.

The package was picked up by Federal Express on November 2, 1990, and was taken first to the Fullerton, California, sort facility and then to the Los Angeles Airport (LAX) Hub Sort Facility. At LAX, the package came open while descending 8 feet on a 45-degree angle conveyor belt. At the bottom of the descent, all contents of the package became separated and scattered on the conveyor belt and around the work area.

A Federal Express employee noticed that the package had a radioactive label and immediately repacked the 5-gallon container; however, he did not realize that the sources had fallen out. The employee reported the incident to his supervisor who called in a hazardous materials specialist to examine the container. The specialist used a survey meter and determined that there was no radiation level at the surface

of the drum. Rather than question why he did not register any reading, he assumed that all items inside the package had been properly secured and he allowed it to continue on to its destination.

The package arrived at Therapeutic Nuclides on Monday, November 5, 1990, but it was not opened until the following day. When the package was opened and discovered empty, the Radiation Safety Officer for Therapeutic Nuclides immediately notified the Los Angeles County Radiation Control office (Agency) and an investigation was begun. An Agency inspector contacted Federal Express in an attempt to backtrack the route the package took from the time it was picked up at the hospital. She was able to focus her search on the Hub facility at LAX and discovered the sources there as soon as she entered the facility.

All seven sources were located in various places throughout the facility by the inspector. Federal Express personnel who came in contact or worked near where the sources were found were interviewed. Those individuals who came in close contact with the sources were sent for medical evaluation and followup. Dose estimates were established for all workers and all were notified of their estimated doses. Individual dose estimates for the 24 employees involved ranged from 10 mrem to 1810 mrem whole body. Also, three individuals who said they touched the sources had estimated extremity doses that ranged from 90 to 260 rem.

The U.S. Department of Transportation (DOT) investigated whether the package of sources was properly secured prior to pick-up by Federal Express. There is strong evidence that the package was not properly sealed; therefore, when it fell down the conveyor belt it easily spilled open. The hospital staff supplied sworn statements to Radiation Control Program staff that they had followed all procedures when they packaged the sources; however, DOT has run extensive tests on the container and has concluded that if it had been sealed properly, it would not have spilled its contents.

Actions Taken to Prevent Recurrence

Hospital—After long delays, the hospital complied with the dose notification requirements.

State Agency—A Notice of Violation was issued to the hospital for failure to report the incident and also for the exposures to personnel in excess of permissible levels. The case was closed on November 13, 1991.

Other—Therapeutic Nuclides has redesigned their container to prevent this type of spill in the future.

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

AS91-7 Medical Therapy Misadministration at Northridge Hospital Medical Center in Northridge, California

Appendix A (see the overall criterion) of this report notes that an event involving a moderate or more severe impact on public health and safety can be considered an abnormal occurrence.

This writeup is based on information provided to the NRC in December 1991 by the Agreement State of California for inclusion in this report.

Date and Place—May 3, 1991; Northridge Hospital Medical Center in Northridge, California.

Nature and Probable Consequences—On May 3, 1991, 15 mCi of iodine-131 intended for patient "A" was administered in error to patient "B" who had the same first and last names as patient "A." The administration was made by the hospital's Certified Nuclear Medicine Technologist without the responsible physician present, which is a violation of the California Radiation Control Regulations. Patient "B" had reported to the hospital's Outpatient Department for a preoperational chest x-ray instead of reporting to her doctor's private office as she was instructed. Patient "A" was scheduled to receive a hyperthyroidism treatment that same morning.

When her name was called, patient "B" answered and signed the consent form. She asked questions of her technologist about thyroid disorders and was given answers. The dose of 15 mCi was administered.

Later that same day, patient "A" presented herself for the treatment. It was then that the hospital discovered that they had administered the dose to the wrong patient. Patient "B's" doctor was contacted and consulted with the Chief Nuclear Medicine physician. They decided to give patient "B" 15 drops of a potassium iodine solution three times daily for three days plus forced fluids to reduce the uptake of the radioactive iodine. She underwent the previously scheduled surgical procedure three days after the dose was administered without any regard for the possible exposure of surgical room staff from the patient.

This incident was reported to the wrong unit of California's Department of Health Services by the

hospital five days after it occurred. Not realizing the significance of the error, Radiologic Health was not contacted until May 31, 1991, 28 days after it occurred. An investigation was begun by the Radiologic Health Unit of the Los Angeles County Health Department, the inspection agency for this licensee. The inspector discovered that the hospital had originally estimated the patient's thyroid dose to be much lower than it actually was. The agency retained a consultant who performed a complete workup of the patient. The patient's dose was established at 3000 rem to the thyroid and she was informed of this in writing by the hospital. She was placed into a treatment followup program.

An evaluation of exposures to the surgical room staff was also made by the consultant. Their exposures were determined to be minimal and they were also notified by the hospital.

Cause or Causes—The administration was made by the hospital's Certified Nuclear Medicine Technologist without the responsible physician present.

Actions Taken to Prevent Recurrence

Licensee--An enforcement conference was held at the Los Angeles County Health Department between members of the hospital administrative staff and representatives of the County and State Radiation Control Program staff. The hospital presented an extensive corrective action plan and explained new controls that would be put in place.

Agency—Representatives of the Radiologic Health Branch accepted the plan and the case was referred to the city attorney's office for determination if charges should be filed.

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

REFERENCES

1. Letter from L.J. Callan, Director, Division of Radiation Safety and Safeguards, NRC Region IV, to LTC Albert Moreno, Department of the Army, William Beaumont Army Medical Center, forwarding Inspection Report No. 030-03260/91-02 and Notice of Violation, License No. 42-05255-07, Docket No. 030-03260, January 30, 1992.*

2. Letter from Malcolm R. Knapp, Director, Division of Radiation Safety and Safeguards, NRC Region I, to Sister Jane Frances Brady, President, St. Joseph's Hospital and Medical Center, forwarding Inspection Report No. 030-02526/91-003, License No. 29-10191-02, Docket No. 030-02526, December 9, 1991.*

3. Letter from Thomas T. Martin, Regional Administrator, NRC Region I, to Sister Jane Frances Brady, President, St. Joseph's Hospital and Medical Center, forwarding Notice of Violation and Proposed Imposition of Civil Penalties (Notice)—$6250, License No. 29-10191-02, Docket No. 030-02526, December 26, 1991.*

4. Letter from William H. Schultz, Chief, Nuclear Materials Inspection Section 1, NRC Region III, to Abdul Ben Zakri, Radiation Safety Officer, University of Wisconsin—Madison, forwarding Inspection Report No. 030-03465/91-002, License No. 48-09843-18, Docket No. 030-03465, February 6, 1992.*

*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 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 October through December 1991 period, NRC licensees, Agreement States, Agreement State licensees, and other involved parties, such as reactor vendors and architect-engineering firms, continued with the implementation of actions necessary to prevent recurrence of previously reported abnormal occurrences. The referenced Congressional abnormal occurrence reports below provide the initial and any subsequent updating information on the abnormal occurrences discussed. (The updating provided generally covers events that took place during the report period; some updating, however, may be more current as indicated by the associated event dates.) Open items will be discussed in subsequent reports in the series.

Fuel Cycle Facilities

91-6 Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility in Wilmington, North Carolina

This abnormal occurrence was originally reported in NUREG-0090, Vol. 14, No. 2, "Report to Congress on Abnormal Occurrences: April-June 1991," and updated in Vol. 14, No. 3. The event, involving degraded nuclear criticality safety controls, was investigated by an NRC Incident Investigation Team (IIT). As mentioned in the previous reports, the NRC IIT formal report was published in August 1991 as NUREG-1450 ("Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility, May 29, 1991"). Also, as previously mentioned, the licensee's solvent extraction system remained shutdown until October 16, 1991, when the NRC authorized the licensee to restart operation of the system. The abnormal occurrence is updated as follows:

Significant NRC inspector presence was maintained at the site during the mid-October to mid-November 1991 time period. The inspectors reviewed operations in progress as the licensee restarted the solvent extraction process, and reviewed actions being taken by the licensee to improve its performance in the area of nuclear criticality safety. The licensee's solvent extraction process has been operated in a safe manner since operation was resumed in mid-October. In an emergency exercise on December 18, 1991, the licensee demonstrated effective corrective actions for problems in the licensee's emergency response program. These problems were identified by the IIT and NRC followup inspections.

The NRC held an enforcement conference with the licensee on February 7, 1992 to discuss causes and corrective actions for apparent violations identified as a result of the IIT and NRC followup inspections. Licensee attendees included the new plant manager for the facility, who officially assumed this position on February 9, 1992.

The licensee continues to evaluate its nuclear criticality safety program; as areas for improvement are identified, they are being added to the licensee's Performance Improvement Program (PIP). Status reports on the PIP have been submitted monthly by the licensee to the NRC. The NRC will be meeting with the licensee on a quarterly basis to review the licensee's progress in completing the elements specified in the licensee's PIP. The first such meeting is scheduled for March 4, 1992.

As mentioned in the previous reports, the NRC staff developed a Staff Action Plan in response to the IIT report findings. Some of the short term Staff Action Plan items were completed during the latter part of 1991. In addition, responses to NRC Bulletin 91-01 ("Reporting Loss of Criticality Safety Controls"), which requires all fuel cycle and uranium fuel research and development licensees to evaluate and modify as necessary their criticality safety criteria and procedures, are due by the end of January 1992 (Ref. B-1). These responses will be reviewed by the NRC's Office of Nuclear Material Safety and Safeguards (NMSS); then the licensees' implementation of any needed improvements will be reviewed during NRC inspections.

Also as previously mentioned, NMSS established a Materials Regulatory Review Task Force. The purpose of the Task Force was to conduct a broad-based review of the Commission's current licensing and oversight programs for fuel cycle and large material plants. The Task Force was requested to define the components and subcomponents of an ideal regulatory evaluation system for these types of licensed

plants and compare them to the components and subcomponents of the existing regulatory evaluation system. The Task Force prepared a report which discusses the findings from this comparison and proposes recommendations on the basis of the findings. This report (Draft NUREG-1324) was issued for public comment during February 1992 (Ref. B-2).

Further updating of this item will be made as appropriate.

Other NRC Licensees

85-17 Exposure of Radiographic Personnel Due to Management and Procedural Control Deficiencies

This abnormal occurrence was originally reported in NUREG-0090, Vol. 8, No. 3, "Report to Congress on Abnormal Occurrences: July-September 1985." The event involved Western Stress, Inc., with offices in Evanston, Wyoming and Houston, Texas. The abnormal occurrence is updated, and closed out, as follows:

An investigation by the NRC Office of Investigations (OI) was initiated to determine whether employees of Western Stress, Inc., had intentionally withheld information from the NRC concerning radiation overexposures to Western Stress employees and the general public. The result of this investigation demonstrated that the Western Stress District Operations Manager for the Evanston office, the Radiation Safety Officer (RSO) for the Evanston office, two radiographers, and a radiography assistant conspired to make false verbal and written statements. The results of this investigation further demonstrated that the RSO, the two radiographers, and the radiography assistant knowingly and intentionally made false verbal and written statements to the NRC.

These investigation findings were referred to the U.S. Department of Justice (DOJ) for potential prosecution on July 9, 1986. In an indictment on September 16, 1987, a Grand Jury for the U.S. District Court, for the District of Wyoming, charged the five employees of Western Stress, Inc. with "making of false, fictitious, and fraudulent statements" (18 USC 1001), "aiding and abetting" (18 USC 2), and "conspiring" (18 USC 371). All five individuals were convicted for the violations stated in the OI investigation. The final DOJ judgment was made March 16, 1989.

By request of the licensee, the NRC terminated License No. 49-23490-01 on April 30, 1986.

In 1986, Western Stress was purchased by MITEC International. A new license was issued which specifically prohibited any of the five individuals from acting as radiographers or radiography assistants without written permission from the NRC.

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

86-28 Immediately Effective Order Modifying License and Order to Show Cause Issued to an Industrial Radiography Company

This abnormal occurrence was originally reported in NUREG-0090, Vol. 9, No. 4, "Report to Congress on Abnormal Occurrences: October-December 1986." The Order involved an employee of Met-Chem Testing Laboratories of Utah, Inc., of Salt Lake City, who had also been employed by the predecessor company Met-Chem Engineering Laboratories, Inc. (The predecessor company's assets were purchased by Met-Chem Testing Laboratories of Utah, Inc. on September 10, 1984, and a new license was issued on July 31, 1986.) The abnormal occurrence is updated, and closed out, as follows:

An investigation by the NRC Office of Investigations (OI) was initiated to determine whether the employee, while employed by the predecessor company, deliberately forged a letter to cover up a radiation exposure of a radiographer. The results of this investigation demonstrated that the employee knowingly and willfully wrote a fictitious letter to suppress and/or conceal information about the overexposure.

This area was referred to the U.S. Department of Justice for potential prosecution. The U.S. District Court for the District of Utah sentenced the individual for violation of 10 USC 1018, "making a false statement," on May 25, 1989.

By request of the licensee, on May 28, 1987, the NRC retired License No. 43-19662-01, which had expired on March 31, 1987.

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

87-8 Significant Breakdown of Management Controls for Radiographic Operations

This abnormal occurrence was originally reported in NUREG-0090, Vol. 10, No. 1, "Report to Congress

on Abnormal Occurrences: January–March 1987." The event involved A-1 Inspection, Inc., of Evanston, Wyoming. The abnormal occurrence is updated, and closed out, as follows:

As previously mentioned, the NRC issued an Order on April 10, 1987, suspending this byproduct material license and requiring the licensee to show cause why the license should not be revoked (Ref. B-3). The licensee responded in a letter dated April 27, 1987. The NRC deferred consideration of this matter pending the completion of an investigation of related matters conducted by the NRC's Office of Investigations.

In view of the fact that this license expired on May 31, 1989, and in view of the actions already taken in this case, the NRC concluded that no purpose would be served by considering additional enforcement action. Therefore, NRC terminated A-1 Inspection, Inc.'s license effective July 10, 1989, and NRC's enforcement actions in this case were considered closed.

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

90-11 Deficiencies in Brachytherapy Program

This abnormal occurrence was originally reported in NUREG-0090, Vol. 13, No. 2, "Report to Congress on Abnormal Occurrences: April–June 1990." As previously mentioned, Orders suspending the brachytherapy procedures were issued to the St. Mary Medical Center facilities in Gary and Hobart, Indiana, and to Porter Memorial Hospital in Valparaiso, Indiana. The Order to the St. Mary Medical Center facilities was issued on April 27, 1990 (Ref. B-4) and the Order to Porter Memorial Hospital was issued on May 2, 1990 (Ref. B-5). The abnormal occurrence is updated, and closed out, as follows:

1. St. Mary Medical Center facilities—In a letter dated October 15, 1991, the licensee indicated it plans to seek reinstatement of its radiation therapy program. It has not, however, submitted a formal request for the necessary license amendments.

2. Porter Memorial Hospital—On January 10, 1992, the NRC rescinded the Order suspending radiation therapy activities. The licensee has complied with the terms of the NRC Order. An audit report from an independent consultant, previously submitted December 27, 1990, identified no misadministrations identified during the audit of brachytherapy procedures. In the latter part of 1991, the licensee submitted a therapy quality management program to be incorporated into its license. Inspection findings have also been favorable.

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

91-8 Radiation Exposures of Members of the Public from a Lost Radioactive Source

This abnormal occurrence was originally reported in NUREG-0090, Vol. 14, No. 3, "Report to Congress on Abnormal Occurrences: July–September 1991." The abnormal occurrence is updated as follows:

As previously mentioned, on September 5, 1991, the licensee (Western Atlas International) reported the loss of a 2-curie cesium-137 sealed well logging source from a vehicle en route from the licensee's Yukon, Oklahoma, facility to its Houston, Texas, facility. As a result, two members of the general public received unnecessary radiation exposures.

On December 20, 1991, the NRC issued a Notice of Violation and Proposed Imposition of Civil Penalty in the amount of $10,000 for violating NRC requirements in the loss of the radioactive source (Ref. B-6). The proposed civil penalty was based on two violations: (1) failure to block and brace the radioactive source container adequately during transportation; and (2) failure to ensure that the container's closure device was properly installed, secured, and free of defects. The NRC also cited the licensee for five other violations which were not assessed a civil penalty.

The letter informing the licensee of the action indicated NRC's concern that a responsible licensee manager had disregarded findings of an August 1991 safety audit which had directed that the containers not be used until identified defects had been fixed. The letter noted that the violations resulted in an incident which had posed a significant threat to the health and safety of the general public.

This item remains open pending the licensee's response to the December 20, 1991, letter and pending further review of the company's licensed activities.

APPENDIX C
OTHER EVENTS OF INTEREST

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

Nuclear Power Plants

1. Evaluation of Plant Internal Flooding Vulnerability for Surry Nuclear Power Station

On August 30, 1991, Virginia Electric and Power Company (the licensee) submitted its Individual Plant Examination (IPE) report for Surry Units 1 and 2 (Ref. C-1). The report identified an unexpectedly high core damage frequency (CDF) estimate of 1.1E-03 per reactor year (i.e., about 1 in 1,000 reactor years) for internal flooding events. Surry Units 1 and 2 are Westinghouse-designed pressurized-water reactors located in Surry County, Virginia.

Background

On August 8, 1985, the Commission issued a policy statement on severe accidents applicable to future designs and existing plants. Although the policy statement concluded that existing plants posed no undue risk to public health and safety, the Commission recognized the need for a systematic examination of each nuclear power plant for plant-specific vulnerabilities.

On November 23, 1988, the NRC issued Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities," which stated that licensees of existing plants should perform a systematic examination, IPE, to identify any plant-specific vulnerabilities to severe accidents and report the results to the Commission. The specific purpose of the IPE is to have each licensee of a nuclear power plant do the following:

1. Develop an appreciation of severe accident behavior;

2. Understand the most likely severe accident sequences that could occur at its plant;

3. Gain a more quantitative understanding of the overall probabilities of core damage and fission product releases; and, if necessary,

4. Reduce the overall probabilities of core damage and fission product releases by modifying, where appropriate, hardware and procedures that would help to prevent or mitigate severe accidents.

Discussion

The specific internal flooding vulnerability identified by the licensee for the Surry facility is a rupture in an 8-foot water intake pipe in the Unit 1 or Unit 2 turbine building which could flood and damage the common emergency switchgear room. This might potentially lead to disabling of important safety equipment, core damage, and possible release of radiation.

The licensee believes the vulnerability has been overestimated because of various conservatisms assumed in the analyses. Nevertheless, the licensee has implemented plant modifications and interim measures to reduce the likelihood of flood event initiation, which the licensee estimates to reduce risk by about a factor of 10. Such steps include sump pump improvements, replacement of selected motor-operated valves and expansion joints, and inspection of valve bolting. Additional enhancements that were implemented, but not taken credit for in the flooding analysis, include installation of flow limiters, improvements of a device to prevent the backflow of water, round-the-clock flood watches, quicker flood response, and installation of diesel-driven sump pumps not dependent on electric power. The licensee is currently evaluating other possible modifications and measures to further reduce the potential for internal flooding scenarios.

The issue remains under NRC review and the licensee's efforts will continue to be closely monitored and evaluated.

2. Catastrophic Failure of Salem Unit 2 Turbine-Generator

On November 9, 1991, Public Service Electric and Gas Company (the licensee) experienced a catastrophic failure of its Salem Unit 2 turbine-generator. Because of the failure, the plant is expected to be out of service for an extended period of time. Salem Unit 2 is a Westinghouse-designed

pressurized water reactor, located in Salem County, New Jersey. It is equipped with a Westinghouse turbine assembly, a Westinghouse Electro-Hydraulic Control (EHC) system, and a General Electric generator and exciter. The event was reviewed by an NRC Augmented Inspection Team (AIT). The following details are generally based on the AIT report which was issued on January 7, 1992 (Ref. C-2).

At about 11:00 a.m., with Unit 2 operating at 100 percent reactor power, plant operators initiated a routine test procedure to verify the operability of the steam turbine automatic mechanical trip mechanisms. The test procedure involved the manipulation of mechanical trip devices in the turbine auto stop oil (AST) system, the primary turbine protection mechanism. By design, the test procedure required the complete isolation of the AST system from any turbine control or trip function (including the mechanically-actuated turbine overspeed trip device) in order to prevent an actual turbine trip during testing of the mechanical devices.

A redundant backup system for turbine overspeed protection and emergency trip functions was assumed to be operational. The backup system consists of three electrically actuated solenoid valves designed to provide redundant automatic control and trip of the turbine in an overspeed condition (by reliance on the two redundant overspeed protection solenoid valves, OPC-20-1 and OPC-20-2) and to cause a turbine trip on a reactor trip (by reliance on the backup emergency trip solenoid valve ET-20).

During the performance of the test, a momentary oil pressure perturbation (a pronounced decrease lasting about 1.5 seconds) occurred in the AST system. Though of short duration, the oil pressure decrease was sufficient to open the AST interface valve. This valve functioned to relieve the emergency trip fluid (ETF) pressure from the pilot valves affecting operation of turbine steam admission valves, i.e., stop valves, governor valves, reheat stop valves, and intercept valves. Consequently, those valves closed and isolated steam flow to the high and low pressure turbines.

The oil pressure perturbation also resulted in the activation of three low AST pressure signals to the reactor protection system (RPS). In accordance with the design of the RPS logic, two out of three low AST pressure signals are considered as indicative of a turbine trip. Consequently, the reactor trip breakers (RTBs) opened to cause an immediate reactor plant trip. Because of the test in progress, the primary turbine trip system (auto stop oil) was isolated and incapable of providing turbine trip assurance. Therefore, reliance was placed on the backup emergency turbine trip system involving solenoid valve ET-20.

By design, opening of the RTBs caused ET-20 to be electrically energized. The reactor trip also initiated a 30-second delay for opening the output breakers from the main generator. Though energized, the ET-20 solenoid valve failed to open to assure relief of ETF pressure to maintain the turbine steam admission valves closed.

When the AST oil pressure returned to normal, after the momentary perturbation, the AST interface valve closed (by design). Because the ET-20 solenoid valve, though energized, did not function, ETF pressure was returned to the pilot valves which initiated reopening of the turbine steam admission valves. Steam may have also been admitted to the turbine through the bypass valve associated with each stop valve. Apparently, steam was admitted to the turbine at about the same time that the output breakers from the main generator opened. The disconnection of the main generator from the grid effectively removed all load resistance from the turbine-generator system. Consequently, as high energy steam was readmitted to the turbine, the turbine began to overspeed.

At the normal overspeed control setpoint (103% of the normal rated turbine speed of 1800 rpm), the OPC-20-1 and OPC-20-2 solenoid valves were electrically energized. However, the valves failed to open to relieve the ETF pressure that was maintaining the governor and intercept valves open. Therefore, the turbine-generator unit continued to overspeed.

The turbine speed reached approximately 2900 rpm and several blades in the No. 22 low pressure turbine section separated from the rotor disc, penetrated the 1.25 inch thick steel turbine casing, and became projectiles from the turbine. Because the Salem turbine generators are outside on the turbine building roof, the projectiles landed on the roof and the ground around the turbine building. No nuclear safety systems were affected by the turbine projectiles.

The resulting eccentric motion of the rotor shaft caused severe vibration at the main generator. Consequently, the generator's hydrogen seals failed and seal oil lines ruptured. Hydrogen gas (used for generator cooling) and seal oil (used to pressurize the generator hydrogen seals) were released and ignited. A fire erupted in the immediate area of the generator.

When the operators performing the turbine test recognized the situation (about 70 seconds after the reactor trip), they restored the AST system to normal. An operator also manually tripped the turbine to assure that the AST system functioned to open the

interface valve and relieve the EHF pressure that was maintaining the steam admission valves open. These actions isolated the turbine from further steam admission. The event duration was about 74 seconds.

In accordance with its emergency plan, the licensee declared an Unusual Event. The event was later briefly upgraded to an Alert until the licensee determined that turbine projectiles had not affected any safety-related system. All reactor plant systems operated normally and the reactor was brought to a safe shutdown condition. No radiological releases occurred and no safety injection was required. The fire was extinguished within 20 minutes by a combination of automatically actuated fire suppression systems and rapid response from the on-site fire brigade.

Licensee management representatives immediately responded to the site to provide oversight, direction, and control of recovery efforts. Actions were initiated to comprehensively investigate the event and determine causal factors. No significant personnel injuries occurred. NRC Resident Inspectors reported to the site to begin evaluation of the event and the licensee's response. The Unusual Event was terminated in about three hours.

The proximate cause of the event was the failure of all the backup emergency and overspeed protection trip devices to function as a result of mechanical binding of the three solenoid valves. The mechanical binding was a result of foreign debris and sludge in the two OPC solenoid valves; and foreign debris, rust, and corrosion in the ET-20 solenoid valve.

Several contributing causes and precursor events were identified. The principal findings included the determination that there was no preventive maintenance performed on the three solenoid valves since installation, and the periodic operational testing of the same valves was insufficient to effectively verify the hydraulic performance of each device. Further, by design, the majority of the automatic turbine trip features were bypassed when the mechanical trip testing procedure was performed. In this configuration, the turbine trip capability is principally dependent on the proper functioning of a single backup emergency turbine trip solenoid valve, ET-20.

Potentially, this event was preventable. In a Licensee Event Report, the licensee committed to replace the ET-20, OPC-20-1, and OPC-20-2 solenoid valves in Unit 2 after discovering on September 10, 1990, that similar components in Unit 1 were defective. An opportunity was available in May 1991 to effect replacement. However, the work was deferred to the planned January 1992 refueling outage because of a management decision that may have been caused by a deficiency in commitment tracking. Additionally, on October 20, 1991, operators and their supervisors permitted turbine startup without resolving a turbine system test discrepancy which indicated that the turbine overspeed protection system was not functioning properly.

The licensee's actions subsequent to the event were effective and correct. However, the circumstances leading up to the event remain under review by the NRC and enforcement action is pending.

3. Transportation Accident Involving Unirradiated Fuel

At about 4:00 a.m., on December 16, 1991, a flatbed trailer truck loaded with 12 shipping containers (each containing two new, unirradiated, low-enriched fuel assemblies) was traveling north on Interstate 91 in Springfield, Massachusetts, when it was struck head-on by an automobile traveling south in the wrong lane. The truck driver and his assistant were transported to a local hospital with minor injuries. The automobile driver was apparently uninjured. The truck was enroute from the General Electric (GE) fuel fabricating facility in Wilmington, North Carolina, to the Vermont Yankee nuclear power plant at Vernon, Vermont.

Each steel, 11.5" X 18" X 179" shipping container was positioned inside an all-wooden outer container. Following the collision, a fire ensued which ignited the outer containers. Four containers remained on the trailer while the other eight fell to the ground during the accident or the ensuing fire. The local fire department responded; however, because of concerns about the safety of fighting a fire involving radioactive material, they chose to let the containers burn. The fire caused varying amounts of damage to the inner containers and their contents. Representatives of the NRC, the Commonwealth of Massachusetts, and Vermont Yankee were dispatched to the accident site. They detected no release of radioactive material.

At about 4:00 p.m., on December 16, 1991, the metal inner packages were taken to Westover Air Force Base. When GE representatives arrived, they supervised repackaging of the containers into new wooden outer packages. The repackaged fuel was then transported by trailer truck back to the GE-Wilmington facility. The shipment arrived safely at the GE-Wilmington facility on December 19, 1991.

During the week of January 13, 1992, the licensee removed the burned containers from their outer packages and moved them into a radiologically controlled area where the fuel assemblies were disassembled and a preliminary inspection conducted. The licensee

will perform further evaluations before removing the individual fuel pellets from their rods for examination. Lawrence Livermore National Laboratory, which is conducting an investigation of the event for the NRC, observed the opening of the packages. No contamination was detected during the disassembly.

This incident resulted in widespread media and public interest. However, the damaged fuel assemblies posed no threat to public health or safety, and no release of radioactive material from the containers was detected.

REFERENCES FOR APPENDICES

B-1 U.S. Nuclear Regulatory Commission, NRC Bulletin 91-01, "Reporting Loss of Criticality Safety Controls," October 18, 1991.*

B-2 U.S. Nuclear Regulatory Commission, Draft NUREG-1324, "Proposed Method for Regulating Major Materials Licensees," issued for public comment during February 1992.**

B-3 Letter from James M. Taylor, Director, NRC Office of Inspection and Enforcement, to G.W. Wyrick, President, A-1 Inspection, Inc., forwarding Order Temporarily Suspending License (Effective Immediately) and Order to Show Cause, License No. 49-21496-01, Docket No. 30-20866, April 10, 1987.*

B-4 Letter from James Lieberman, NRC Director of Enforcement, to Scott Hardtman, Vice President, Operations, St. Mary Medical Center—Hobart, Indiana, and St. Mary Medical Center—Gary, Indiana, transmitting, "Order Suspending Brachytherapy Activities and Modifying Licenses," License Nos. 13-03459-02 and 13-03459-03, Docket Nos. 030-01615 and 030-31379, April 27, 1990.*

B-5 Letter from Hugh L. Thompson, Jr., NRC Deputy Executive Director for Nuclear Materials Safety, Safeguards, and Operations Support, to Wiley N. Carr, Administrator and Chief Executive Officer, Porter Memorial Hospital, forwarding "Confirmatory Order Suspending Brachytherapy Activities and Modifying License," License No. 13-17073-01, Docket No. 030-12150, May 2, 1990.*

B-6 Letter from Robert D. Martin, Regional Administrator, NRC Region IV, to Bill Rose, Radiation Protection Officer, Western Atlas International, forwarding Notice of Violation and Proposed Imposition of Civil Penalty—$10,000, License No. 42-02964-01, Docket No. 030-06402, December 20, 1991.*

C-1 Letter from W.L. Stewart, Senior Vice President—Nuclear, Virginia Electric and Power Company, to Document Control Desk, USNRC, "Virginia Electric and Power Company Surry Power Station Units 1 and 2 Response to Generic Letter 88-20 and Supplement 1 Individual Plant Examination (IPE) for Severe Accident Vulnerabilities," Docket Nos. 50-280 and 50-281, August 30, 1991.*

C-2 Letter from Charles W. Hehl, Director, Division of Reactor Projects, NRC Region I, to Steven E. Miltenberger, Vice President and Chief Nuclear Officer, Public Service Electric and Gas Company, forwarding NRC Region I Augmented Inspection Team Report 50-311/91-81, Docket No. 50-311, January 7, 1992.*

*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.

**A free single copy is available, to the extent of supply, upon written request to the Office of Administration, Distribution and Mail Services Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555. A copy is also available for inspection or copying for a fee at the NRC Public Document Room, 2120 L Street, NW., Lower Level, Washington, DC 20555.

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)
NUREG-0090
Vol. 14, No. 4

2. TITLE AND SUBTITLE
Report to Congress on Abnormal Occurrences:
October - December 1991

3. DATE REPORT PUBLISHED
MONTH: March
YEAR: 1992

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

6. TYPE OF REPORT
Quarterly

7. PERIOD COVERED (Inclusive Dates)
October - December 1991

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

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

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)

Same as 8., above

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

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 and safety and requires a quarterly report of such events to be made to Congress. This report covers the period October through December 1991. Five abnormal occurrences at NRC-licensed facilities are discussed in this report. None of these occurrences involved a nuclear power plant. Four involved medical therapy misadministrations and one involved a medical diagnostic misadministration. The NRC's Agreement States reported three abnormal occurrences. Two involved exposures of non-radiation workers and one involved a medical therapy misadministration. The report also contains information that updates some previously reported abnormal occurrences.

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

Medical Therapy Misadministrations
Medical Diagnostic Misadministration
Exposures of Non-Radiation Workers
Surry Units 1 and 2 Internal Flooding Vulnerability
Catastrophe Failure of Salem Unit 2 Turbine-Generator
Transportation Accident Involving Unirradiated Fuel

13. AVAILABILITY STATEMENT
Unlimited

14. SECURITY CLASSIFICATION
(This Page)
Unclassified
(This Report)
Unclassified

15. NUMBER OF PAGES

16. PRICE

THIS DOCUMENT WAS PRINTED USING RECYCLED PAPER

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

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

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P-223
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NUREG-0090, Vol. 14, No. 4

REPORT TO CONGRESS ON ABNORMAL OCCURRENCES

MARCH 1992