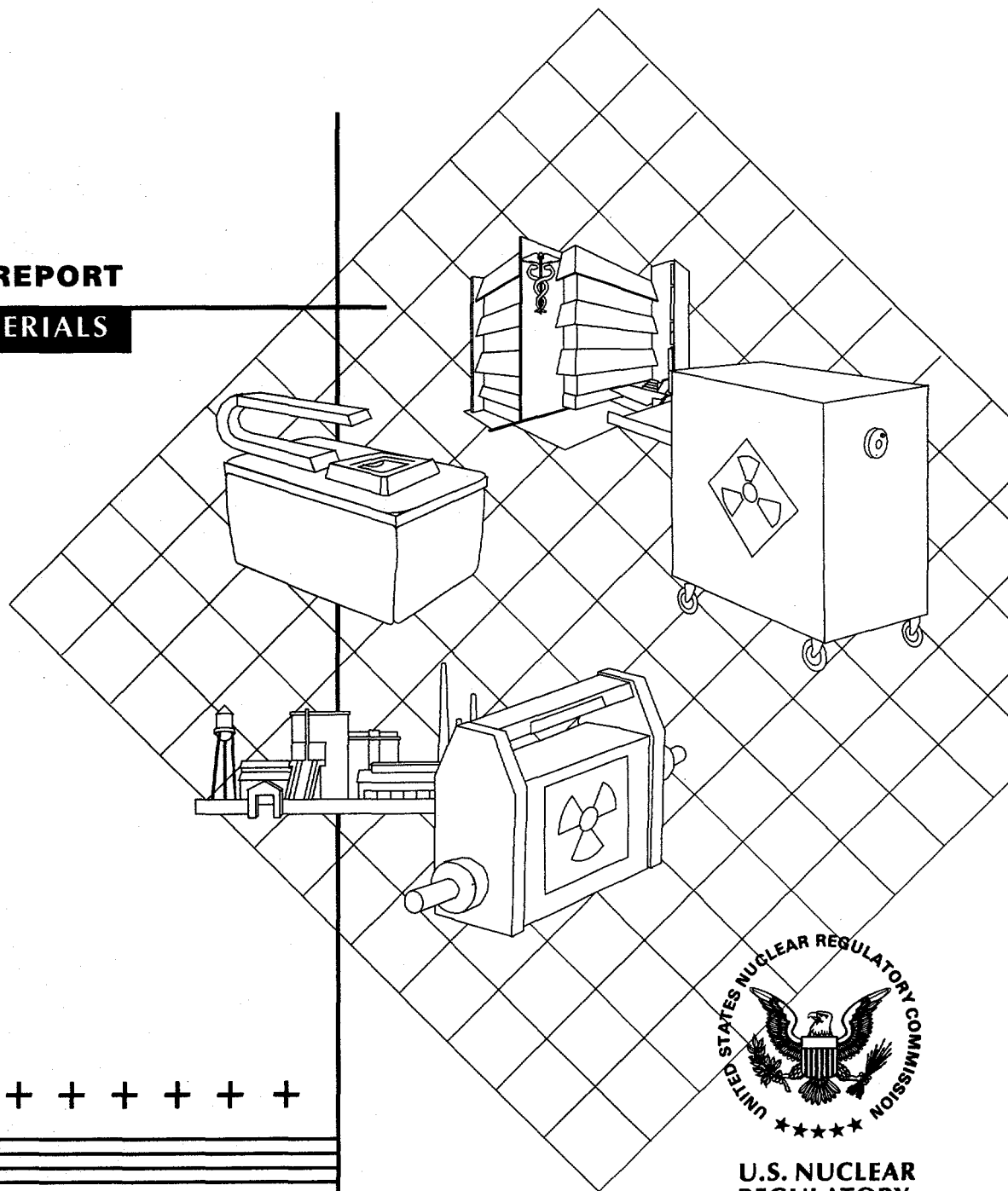


ANALYSIS and EVALUATION of OPERATIONAL DATA

1993 ANNUAL REPORT
NUCLEAR MATERIALS



+ + + + + + + + + +

MAY 1995

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER



U.S. NUCLEAR
REGULATORY
COMMISSION

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Previous Reports in Series

The following semiannual or annual reports have been prepared by the Office for Analysis and Evaluation of Operational Data (AEOD).

- Semiannual Report, January - June 1984, AEOD S/405, September 1984
- Semiannual Report, July - December 1984, AEOD/S502, April 1985
- Annual Report 1985, AEOD/S601, April 1986
- *Report to the U.S. Nuclear Regulatory Commission of Analysis and Evaluation of Operational Data 1986*, NUREG-1272, AEOD/S701, May 1987
- *Report to the U.S. Nuclear Regulatory Commission on Analysis and Evaluation of Operational Data 1987*, Power Reactors, NUREG-1272, AEOD/S804, Vol. 2, No. 1, October 1988
- *Report to the U.S. Nuclear Regulatory Commission on Analysis and Evaluation of Operational Data 1987*, Nonreactors, NUREG-1272, AEOD/S804, Vol. 2, No. 2, October 1988
- *Office for Analysis and Evaluation of Operational Data 1988 Annual Report, Power Reactors*, NUREG-1272, Vol. 3, No. 1, June 1989
- *Office for Analysis and Evaluation of Operational Data 1988 Annual Report, Nonreactors*, NUREG-1272, Vol. 3, No. 2, June 1989
- *Office for Analysis and Evaluation of Operational Data 1989 Annual Report*, NUREG-1272, Vol. 4, No. 1, July 1990
- *Office for Analysis and Evaluation of Operational Data 1989 Annual Report*, NUREG-1272, Vol. 4, No. 2, July 1990
- *Office for Analysis and Evaluation of Operational Data 1990 Annual Report*, NUREG-1272, Vol. 5, No. 1, July 1991
- *Office for Analysis and Evaluation of Operational Data 1990 Annual Report*, NUREG-1272, Vol. 5, No. 2, July 1991
- *Office for Analysis and Evaluation of Operational Data 1991 Annual Report*, NUREG-1272, Vol. 6, No. 1, July 1992
- *Office for Analysis and Evaluation of Operational Data 1991 Annual Report*, NUREG-1272, Vol. 6, No. 2, August 1992
- *Office for Analysis and Evaluation of Operational Data 1992 Annual Report*, NUREG-1272, Vol. 7, No. 1, July 1993
- *Office for Analysis and Evaluation of Operational Data 1992 Annual Report*, NUREG-1272, Vol. 7, No. 2, October 1993
- *Office for Analysis and Evaluation of Operational Data 1993 Annual Report*, NUREG-1272, Vol. 8, No. 1, November 1994

Abstract

This annual report of the U.S. Nuclear Regulatory Commission's Office for Analysis and Evaluation of Operational Data (AEOD) describes activities conducted during 1993. The report is published in two parts. NUREG-1272, Vol. 8, No. 1, covers power reactors and presents an overview of the operating experience of the nuclear power industry from the NRC perspective, including comments about the trends of some key performance measures. The report also includes the principal findings and issues identified in AEOD studies over the past year and summarizes information from such sources as licensee event reports, diagnostic evaluations, and reports to the

NRC's Operations Center. NUREG-1272, Vol. 8, No. 2, covers nuclear materials and presents a review of the events and concerns during 1993 associated with the use of licensed material in nonreactor applications, such as personnel overexposures and medical misadministrations. Note that the subtitle of No. 2 has been changed from "Nonreactors" to "Nuclear Materials." Both reports also contain a discussion of the Incident Investigation Team program and summarize both the Incident Investigation Team and Augmented Inspection Team reports. Each volume contains a list of the AEOD reports issued from 1980 through 1993.

Contents

	<i>Page</i>
Abstract	iii
Abbreviations	vii
Executive Summary	ix
1 Introduction	1
2 Nuclear Materials Operating Experience Feedback	3
2.1 Nuclear Materials Events Data Base	3
2.2 Medical Misadministrations	4
2.3 Radiation Overexposures	7
2.4 Loss of Control of Licensed Material	8
2.5 Leaking Sources	8
2.6 Release of Material	9
2.7 Transportation Events	9
2.8 Equipment Problems	9
2.9 Fuel Cycle Facility Events	10
2.10 Test, Research, and Training Reactors	11
2.11 Annual Radiation Exposure Data	11
3 Abnormal Occurrences	15
3.1 NRC Licensees	15
3.1.1 Medical Institutions	15
3.1.2 Industrial Radiographers	15
3.1.3 Research Reactors	15
3.2 Agreement States	15
3.2.1 Medical Institutions	15
3.2.2 Industrial Radiographers	16
3.2.3 Other Industrial Users	16
4 AEOD Initiatives	17
4.1 Improved Nuclear Materials Events Data Base	17
4.1.1 Background	17
4.1.2 Data Base Development	17
4.1.3 Status of the Nuclear Materials Events Data Base	17
4.1.4 Planned Improvements in the Collection of Operational Experience	18
4.2 Systematic Review of Nuclear Materials Experience	18
4.3 Feedback of Nuclear Materials Experience	18
4.4 Abnormal Occurrences	18
4.4.1 Abnormal Occurrence Reporting	19
4.4.2 Abnormal Occurrence Criteria—Revision of the AO Policy Statement	19
4.5 Non-power Reactors	19

Contents (continued)

	<i>Page</i>
5 Incident Investigation Program	21
5.1 Incident Investigation Teams	21
5.2 Augmented Inspection Teams	21
6 Data From the NRC Operations Center	23

Appendices

- A Nuclear Materials Data by Event Type
- B Summary of 1993 Abnormal Occurrences (Nonreactors)
- C Reports and Videotapes Issued From 1981 Through 1993
- D Status of AEOD Recommendations
- E Status of NRC Staff Actions for Events Investigated by Incident Investigations Teams (Nonreactors)

Tables

2.1 Number of Reportable Events by Event Type for NRC and Agreement State Nuclear Materials Licensees for 1993	4
2.2 Medical Misadministrations Reported by NRC and Agreement State Licensees for 1993	6
2.3 Number of Overexposure Events Reported by NRC and Agreement State Nuclear Materials Licensees for 1993	8
2.4 Fuel Cycle Events Reported for 1993	11
2.5 Annual Exposure Data for NRC Industrial Radiography Licensees, 1988-1993	12
2.6 Annual Exposure Data for NRC Manufacturing and Distribution Licensees, 1988-1993	12
2.7 Annual Exposure Data for NRC Low-Level Waste Disposal Licensees, 1988-1993	13
2.8 Annual Exposure Data for NRC Independent Spent Fuel Storage Licensees, 1988-1993	13
2.9 Annual Exposure Data for NRC Fuel Fabrication and Processing Licensees, 1988-1993	13
6.1 Nuclear Materials Events Reported to the NRC Operations Center in 1993	23
6.2 Alert Events Reported at NRC-Licensed Nuclear Materials Facilities in 1993	23

Abbreviations

ACMUI	Advisory Committee on Medical Uses of Isotopes	mCi	millicuries
AEOD	Analysis and Evaluation of Operational Data (NRC Office for)	NaI	sodium iodide
AO	abnormal occurrence	NMED	Nuclear Materials Events Data Base
ARM	area radiation monitor	NMSS	Nuclear Material Safety and Safeguards (NRC Office of)
ASLB	Atomic Safety and Licensing Board	NRC	U.S. Nuclear Regulatory Commission
Bq	becquerel	NRR	Nuclear Reactor Regulation (NRC Office of)
cGy	centigray	OSC	Oncology Services Corporation
Ci	curie	OSP	Office of State Programs (NRC)
Co	cobalt-60	RCEP	Radiological Contingency and Emergency Plan
DOE	U.S. Department of Energy	REIRS	Radiation Exposure Information Reporting System
DOT	U.S. Department of Transportation	RES	Nuclear Regulatory Research (NRC Office of)
EDO	Executive Director for Operations (NRC)	RI	Region I
FDA	U.S. Food and Drug Administration	RII	Region II
FY	fiscal year	SNM	special nuclear material
I	iodine	SRP	Standard Review Plan
IIP	Incident Investigation Program	TRTR	Test, Research, and Training Reactors
IIT	Incident Investigation Team	TS	Technical Specifications
ISA	integrated safety analysis		
MBq	megabecquerel		

Executive Summary

One of the activities of the Office for Analysis and Evaluation of Operational Data (AEOD) is the review and evaluation of operating experience of programs involving the use of nuclear materials licensed by the United States (U.S.) Nuclear Regulatory Commission (NRC), such as reactor-produced isotopes, natural and enriched uranium, and other special nuclear material (SNM). The AEOD review and evaluation identifies safety-significant events and concerns and their causes. When a safety concern is identified, the AEOD staff recommends NRC actions to resolve the problems underlying the safety concern, and tracks the recommendations until they are resolved.

Twenty-nine States have entered into agreements with the NRC to assume regulatory authority for byproduct materials, source materials, and small amounts of enriched uranium or other SNM. These States, known as Agreement States, regulate the programs of their licensees. The NRC directly regulates licensees in the remaining 21 States, the District of Columbia and all the U.S. territories.

Approximately 7000 licensees are regulated by the NRC and are authorized to possess and use nuclear materials outside of reactors. About 5000 of these licensees are authorized to use byproduct materials for such applications as radiography, gauges, and well-logging. Approximately 2000 licensees are authorized to administer byproduct materials or radiation from byproduct materials to individuals for medical diagnosis and therapy. Approximately 15,000 users are licensed by the 29 Agreement States. Of these, about 10,000 are authorized to use byproduct materials for radiography, and other industrial and commercial uses. The remaining 5000 Agreement State licensees are authorized to use radioactive materials for medical diagnosis or therapy. In response to a 1991 NRC request for annual submittal of information, all 29 Agreement States submitted summary reports on nuclear materials events that occurred in 1993.

In 1993 714 events involving materials licensees were reported to the NRC—416 by NRC licensees

and 298 by Agreement States. Forty-seven of them were medical misadministrations, 13 of which were also reported to Congress as abnormal occurrences. The primary factors contributing to these misadministrations included patient intervention resulting in dislodgement of sources; errors in computer treatment planning; equipment malfunctions; errors in calculating the prescribed dose; and failures to verify the type of administered radiopharmaceutical or the administered dosage, to calibrate the prescribed dosage, to verify patient identification, or to follow physician's orders.

NRC licensees reported 11 events in 1993 that resulted in overexposures to 15 people, and Agreement State licensees reported 22 events that resulted in overexposures to 24 people. Two of these events were reported to Congress as abnormal occurrences. Eighty-two percent (18) of the overexposures involved whole body exposures, and 18 percent involved extremity exposures. The overexposure events reported by NRC licensees were about evenly distributed among medical/academic, research/commercial, and industrial radiography licensees. On the other hand, over 86 percent of the overexposures reported by Agreement States involved industrial radiography.

The primary causes of the medical/academic and research/commercial overexposures were failure to adequately monitor quarterly exposures and failure to wear adequate protective clothing. In most of the events involving industrial radiography for which a cause was provided, the overexposure was attributed to either a personnel error or an equipment problem.

Other nuclear materials events included loss of control of licensed material, leaking sources, release of material, transportation events, equipment problems, fuel facility events, and test, research and training reactor events. For 1993 there were a total of 377 such events reported by NRC licensees and 257 reported by Agreement States. While there were no reported overexposures or significant contaminations as a result of these reported events, several of them

had the potential to affect the public health and safety and two of them met the criteria for abnormal occurrence reporting to Congress.

As part of operational experience feedback, the AEOD staff prepared a videotape entitled "Good Practices in Cobalt-60 Teletherapy," which was distributed in April 1993. The video shows simulated administrations of external cobalt-60 radiation therapy and demonstrates good practices when using teletherapy equipment.

In 1993 AEOD developed a new data base called the Nuclear Material Events Data Base (NMED). The NMED contains about 11,000 detailed records of reported events, including voluntary reports. These records include material events for all categories of material licensees, including non-power reactors. Radiation overexposures for commercial power reactors are also maintained in the NMED. The NMED is expected to be fully operational by the end of 1995.

1 Introduction

The U.S. Nuclear Regulatory Commission (NRC) licenses the use of reactor-produced isotopes, the milling of uranium, and the subsequent processing of both natural and enriched uranium, as well as other special nuclear material (SNM). The NRC directly regulates licensees in 21 States, the District of Columbia, and the U.S. territories. The remaining 29 states, known as Agreement States, have entered into agreements with the NRC under Section 274 of the Atomic Energy Act, as amended, to regulate the use of byproduct materials, source materials, and other SNM.

The NRC's Office for Analysis and Evaluation of Operational Data (AEOD) was created in 1979 to provide, as one of its primary roles, a strong, independent capability to analyze operational data. This role was strengthened and expanded in 1987, in accordance with the Commission's emphasis on operational safety. AEOD implements this role for nuclear materials applications through the analysis and evaluation of operating experience data associated with the use of radiological materials in nonreactor applications. AEOD publishes studies of specific operational events. As appropriate, AEOD recommends actions to reduce the probability that these events will recur with the same frequency or will lead to more serious events. AEOD keeps informed of studies undertaken by other organizations within the NRC, and normally does not duplicate a study unless a particular need or special circumstance exists.

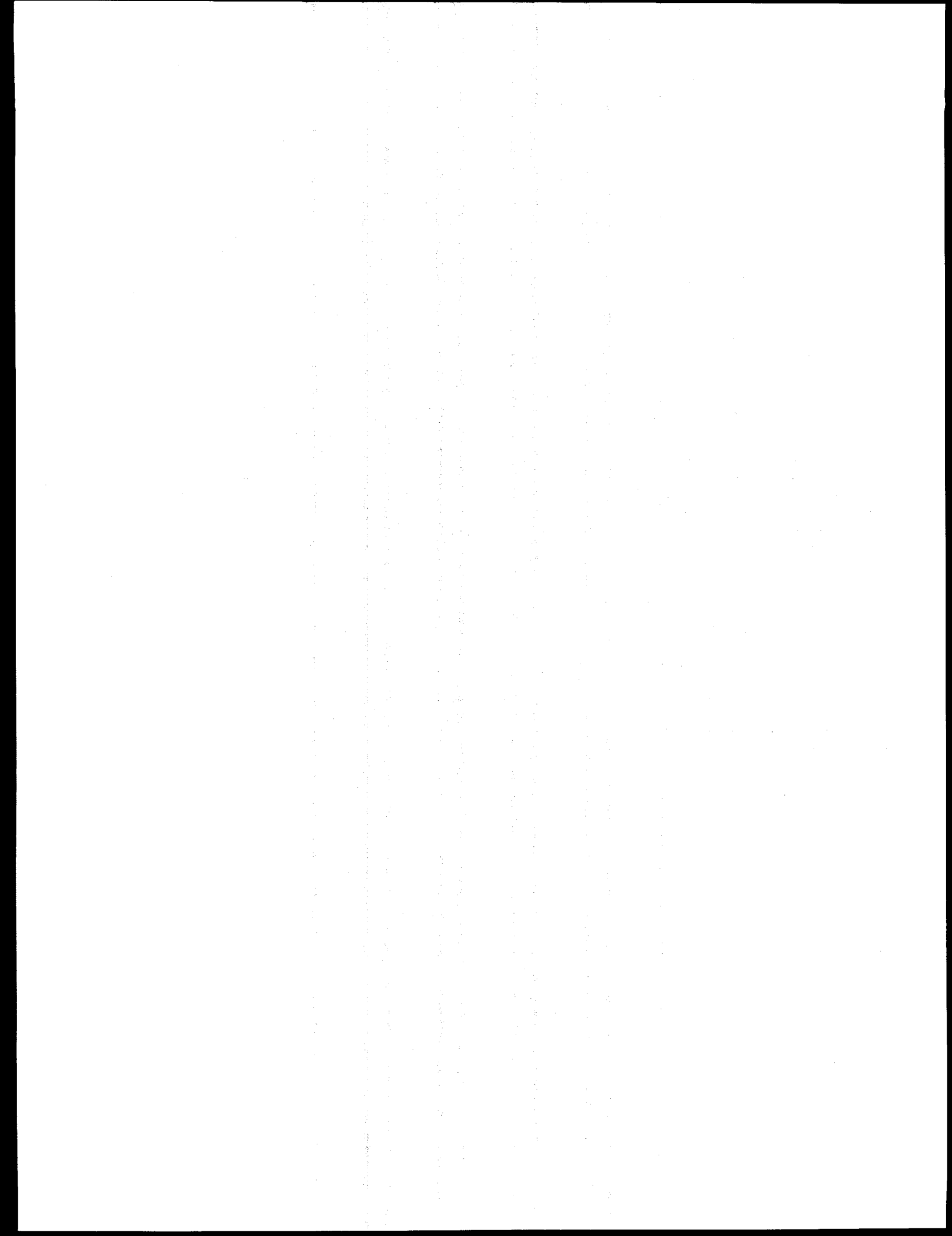
In May 1987 AEOD also became responsible for the NRC's incident response, diagnostic evaluation, technical training, and incident investigation programs. Incidents of potentially major safety significance are investigated by incident investigation teams (IITs) directed by

headquarters offices. (Incidents of lesser significance are investigated by augmented inspection teams directed by one of the NRC regional offices.) AEOD tracks the recommendations and staff actions contained in its own studies and in IIT reports until they are resolved. The appropriate NRC program office or regional office acts on each recommendation or action and is responsible for resolving it.

AEOD also coordinates the overall NRC operational data program and serves as the central point for interaction with domestic and foreign organizations performing similar work.

The 1993 AEOD Annual Report, NUREG-1272, Vol. 8, is published in two parts, entitled "Reactors" and "Nuclear Materials." This report on Nuclear Materials presents an overview of events reported by materials licensees during 1993. The report includes the following appendices:

- Appendix A summarizes the 1993 nuclear materials events by event type.
- Appendix B summarizes the 1993 nuclear materials abnormal occurrences.
- Appendix C lists nuclear materials reports and videotapes issued by AEOD from 1981 through 1993.
- Appendix D presents the Status of Recommendations included in AEOD nuclear materials studies.
- Appendix E presents the status of staff actions resulting from the findings of NRC IITs for nuclear materials events.



2 Nuclear Materials Operating Experience Feedback

The primary concern with the use of radioactive materials is the potential for overexposure which can cause cancer or, in severe cases, death. The potential for radiation-induced genetic mutations is also an important consideration. Extremity or localized skin exposures from radioactively hot particles are a lesser health concern but are still important to the NRC in assessing the effectiveness of byproduct materials control.

One measure of licensees' control of regulated materials is the ability to limit the dose received by monitored employees. Materials licensees are required to monitor all employees who work with, or may be present in the vicinity of, nuclear materials and who have the potential for radiation exposure. Licensees are also required to monitor and control activities that can lead to exposing their employees or the general public to radiation.

Lost or stolen radioactive materials sometimes lead to unintended personnel exposures. Information on leaking sources can provide insights on design deficiencies or problems with handling specific sources, both of which can lead to personnel exposures. Events that involve the release of radioactive materials or result in the introduction of radioactive material into consumer products can also result in unplanned radiation exposure. In accordance with the applicable regulations, the NRC requires licensees to submit reports on events which meet established criteria. In addition, licensees are subject to citation for violation of applicable regulations or failure to meet their license conditions.

The major problem with the use of radioactive materials in medical applications arises from either the licensee's failure to effectively control a licensed material or from other human errors, such as dispensing a radiopharmaceutical that does not comply with a physician's prescription. This can result in a patient receiving an unintended or excessive dose or a dose to the wrong treatment site. Occasionally, a radiopharmaceutical is administered to the wrong patient. Excessive exposures to monitored

employees and uncontrolled exposures to the general public are also a concern in the medical use of radioactive materials. However, such incidents are relatively rare considering that hundreds of thousands of procedures are performed each year.

2.1 Nuclear Materials Events Data Base

AEOD collects, reviews, and codes nuclear materials event information reported by NRC licensees and Agreement States. Approximately 7000 NRC licensees and 15,000 Agreement State licenses submit reports of events, as required by Title 10 of the Code of Federal Regulations (10 CFR), comparable Agreement State regulations, or license conditions. (Licensees also voluntarily submit reports of events that are not required to be reported. Voluntary reports are not considered when evaluating operating experience and are therefore not included in this annual report.) NRC licensees submit reports directly to the NRC regional or headquarters offices. Agreement State licensees submit reports to the States, which in turn voluntarily transmit summary reports to the NRC under an informal information sharing agreement. In addition, the NRC obtains reports of events from other sources, such as NRC inspection reports, and occasionally from non-licensees including members of the public.

Reportable nuclear materials operating events include (1) medical misadministrations of radiation or radiopharmaceuticals to patients, (2) personnel radiation overexposures, (3) loss of control of licensed material, (4) problems with equipment that uses licensed material or is otherwise associated with the use of licensed material, (5) releases of material or contamination, (6) leaking radioactive sources, (7) problems during the transportation of licensed material, (8) problems in fuel cycle facilities, and (9) problems in non-power reactors.

From 1981 through 1992, nuclear materials event data were coded and maintained in two data bases, one containing records of medical misadministration events and the other containing

records of other reported nuclear materials events. In 1993 AEOD developed a new data base called the Nuclear Materials Events Data base (NMED), designed to allow multiple effects of a single event to be appropriately recorded. For example, an event may involve a medical misadministration as well as a radiation overexposure and/or a loss of control of licensed material. In such a case, the event would be included in each applicable category. In 1993 less than 20 percent of the events produced multiple effects. In developing the data base structure, AEOD solicited and received substantial input from the NRC Headquarters Offices of Nuclear Materials Safety and Safeguards (NMSS) and Nuclear Regulatory Research (RES), the regional offices, and the Agreement States.

The NMED contains about 11,000 detailed records of reported events, including voluntary reports, as well as reference information for identifying associated reports, such as inspection reports. (Agreement State data are available only from 1991 on.) The NMED contains records of materials events for all categories of materials licensees, including non-power reactors. Radiation overexposures for commercial power reactors are also maintained in the NMED. The NMED is expected to be fully operational by the end of 1995.

In 1993 714 events involving nuclear materials licensees and nonpower reactors were reported to the NRC—416 by NRC licensees and 298 by Agreement States. Table 2.1 shows the number of reportable events by type for both NRC and Agreement State licensees. Because licensees submit revisions, late reports, or retractions, minor changes may occur in the data published from year to year.

2.2 Medical Misadministrations

The NRC and the Agreement States regulate certain aspects of reactor-produced radioisotopes used in nuclear medicine and therapeutic radiology pursuant to Part 35 of Title 10 of the Code of Federal Regulations (10 CFR Part 35), "Medical Use of Byproduct Material." The misadministration rule, which became effective on

Table 2.1 Number of Reportable Events by Event Type for NRC and Agreement State Nuclear Materials Licensees for 1993

Type of Event	NRC	Agreement States	Total
Misadministration	28	19	47
Overexposure	11	22	33
Loss of Control of Material	116	128	244
Leaking Sources	25	19	44
Release of Material	34	10	44
Transportation	55	33	88
Equipment Problems	93	67	160
Fuel Cycle Operations	46	—	46
Research and Training Reactors	8	—	8
Total	416	298	714

November 10, 1980, required NRC medical licensees to report medical misadministrations to the NRC. This rule was revised in 1987 to require medical licensees in the Agreement States to report misadministrations to the appropriate regulatory agency in their state. Agreement State agencies had 3 years to promulgate State rules compatible with those of the NRC. Therefore, Agreement State licensees were required to report medical misadministrations by 1991. The Agreement States have agreed to voluntarily submit misadministration reports to the NRC.

The Quality Management Program and Misadministrations Rule, which became effective in 1992, requires a quality management program and contains revised definitions of, and reporting requirements for, medical misadministrations. The Agreement States have until January 27, 1995, to adopt these requirements. As part of this rule, the definition of a misadministration was changed to include the following six types of misadministrations.

Type of Procedure	Misadministrations
1. All Diagnostic Radiopharmaceuticals (including < 30 μ Ci sodium iodide I-125 or I-131)	<ul style="list-style-type: none"> • Wrong patient, radiopharmaceutical route, or dosage, and • Dose > 5 rem Effective Dose Equivalent or 50 rem to an organ
2. Sodium Iodide Radiopharmaceuticals (> 30 μ Ci sodium iodide I-125 or I-131)	<ul style="list-style-type: none"> • Wrong patient • Wrong radiopharmaceutical • Administered dosage differs from prescribed dosage by > 20 percent and > 30 μCi
3. Therapeutic Radiopharmaceuticals (other than sodium iodide, I-125 and I-131)	<ul style="list-style-type: none"> • Wrong patient • Wrong radiopharmaceutical • Wrong route of administration • Administered dosage differs by > 20 percent from prescribed dosage
4. Teletherapy	<ul style="list-style-type: none"> • Wrong patient • Wrong mode of treatment • Wrong treatment site • Calculated weekly dose > weekly prescribed dose by 30 percent • Calculated total dose differs by > 20 percent from prescribed dose • If < 3 fractions, calculated total dose differs by > 10 percent from total prescribed dose
5. Brachytherapy	<ul style="list-style-type: none"> • Wrong patient • Wrong radioisotope • Wrong treatment site (excluding migration of permanent implants) • Leaking sources • Failure to remove sources for a temporary implant • Calculated administered dose differs by > 20 percent from prescribed dose
6. Gamma Stereotactic Radiosurgery	<ul style="list-style-type: none"> • Wrong patient • Wrong treatment site • Calculated total administered dose differs by > 10 percent from total prescribed dose

As a result of the 1992 revision of 10 CFR Part 35, a new classification of misadministration was defined to include two types of sodium iodide (NaI) misadministrations: (1) those performed for diagnostic purposes that were previously defined

as diagnostic misadministrations, and (2) those performed for therapeutic purposes that were previously defined as therapeutic radiopharmaceutical misadministrations. These procedures involve either iodine-125 (I-125) or iodine-131

(I-131) as NaI in amounts exceeding 1.11 megabecquerel (MBq) (30 microcuries [μ Ci]).

The term "diagnostic misadministration," as used in NRC regulations, refers to the misadministration of radioisotopes in such nuclear medicine studies as renal, bone, and liver scans. "Therapeutic misadministration" refers to the misadministration of radiation in the treatment of patients using cobalt-60 (Co-60) (the external use of radiation from a single Co-60 source for therapeutic treatment), gamma stereotactic radiosurgery (the external use of radiation from about 200 small Co-60 sources for therapeutic treatment), brachytherapy (the insertion or implantation of sealed sources containing radioactive material for therapeutic treatment), or radiopharmaceutical therapy (the ingestion or injection of radioactive materials for patient therapeutic treatment).

The potential or actual effect of a therapeutic misadministration generally differs from that of a diagnostic misadministration. Therapeutic misadministrations are associated with procedures in which large doses of radiation are administered to patients to achieve a therapeutic effect, while diagnostic misadministrations are associated with clinical or investigative procedures requiring comparatively small doses of radiation. However, some misadministrations involving the use of NaI-125 or NaI-131 for diagnostic purposes may deliver unintended doses in the therapeutic range to the patient's thyroid. Not all therapeutic overdoses result in significant radiation-induced clinical effects to patients. Some misadministrations occur because patients are administered a dose of radiation that is less than that prescribed. In these cases, if the error is found in time, the total prescribed dose can still be achieved.

AEOD routinely reviews reports of therapeutic and NaI misadministrations because of the potential for radiation-induced health effects. Therapeutic and NaI misadministrations, individually and collectively, are more significant than diagnostic misadministrations. AEOD does not review therapeutic misadministrations that involve the use of accelerator-produced

radioisotopes because they are not regulated by the NRC.

Misadministrations that demonstrate a major failure of the radiation safety program or result in adverse health effects to a patient are reported to Congress as abnormal occurrences (AOs). Such administrations that occurred in 1993 are discussed in detail in NUREG-0090, Vol. 16, No. 1 through 4, and are listed in Appendix B to this report. Follow-up of these events may be found in subsequent AO quarterly reports to Congress.

The NRC regulates approximately 2000 licensees in 21 States, the District of Columbia, and the U.S. territories, that use radioisotopes in radiation therapy and nuclear medicine applications. These facilities submitted reports of 28 misadministrations that occurred in 1993. The 29 Agreement States regulate about 5000 medical institutions, which include hospitals, clinics, and physicians in private practice. Agreement States submitted reports of 19 misadministrations that occurred in 1993 (see Table 2.2). These events are listed in Tables A-1.1 and A-2.1, respectively, of Appendix A to this report. Thirteen of these events were reported to Congress as abnormal occurrences.

Table 2.2 Medical Misadministrations Reported by NRC and Agreement State Licensees for 1993

Misadministrations	Agreement		
	NRC	States	Total
Radiopharmaceutical	1	0	1
Sodium Iodide	7	6	13
Brachytherapy	17	9	26
Teletherapy	3	4	7
Total	28	19	47

The primary factors contributing to therapeutic misadministrations (brachytherapy, teletherapy, and radiopharmaceutical) in 1993 included patient intervention resulting in dislodgement of sources, errors in computer treatment planning, equipment malfunctions, and errors in calculating the prescribed dose.

Sodium iodide misadministrations in 1993 most often resulted in overdoses rather than underdoses. The primary causes of the NaI misadministrations were failure to (1) verify the

type of administered radiopharmaceutical, (2) verify the administered dosage, (3) calibrate the prescribed dosage, (4) verify patient identification, and (5) follow physician's orders.

To prevent recurrence, NRC and Agreement State licensees took similar corrective actions, including implementation of procedures established by the licensee's Quality Management Program, to ensure the following:

- patient identification
- verification of the dose calculation
- verification of the treatment planning program
- review of the patient's chart
- staff training verification of the prescribed dose and procedure
- staff communication
- verification of prescribed treatment site

The NRC staff has taken steps to enhance licensee awareness of the potential for misadministrations by (1) conducting workshops and meetings with professional societies as part of the Quality Management rulemaking, (2) issuing NMSS Newsletters and NRC Information Notices and Bulletins, (3) describing NRC requirements in professional society publications, and (4) issuing inspection reports and enforcement actions.

2.3 Radiation Overexposures

The criteria for radiation exposure limits for radiation workers¹ are defined in 10 CFR 20.101, "Radiation dose standards for individuals in restricted areas" (10 CFR 20.1201, "Occupational dose limits for adults"), and 10 CFR 20.103, "Exposure of individuals to concentrations of radioactive material in air in restricted areas" (20.1201, 20.1204, 20.1701, 20.1702, and 20.1703). In addition, 10 CFR 20.105 "Permissible levels of radiation in unrestricted areas" (20.1301 and 20.1302) addresses overexposures to non-radiation workers (members of the public).

Medical misadministrations resulting in doses to patients in excess of planned treatments are not

categorized as overexposures. Only doses to patients not intended to be treated are included in this section.

NRC licensees reported 11 events for 1993 that resulted in overexposures to 15 people, and Agreement States reported 22 events for 1993 that resulted in overexposures to 24 people (see Table 2.3). These events are listed in Tables A-1.2 and A-2.2, respectively, of Appendix A to this report.

Eighty-two percent (32/39) of the overexposures involved whole body exposures, and 18 percent (7/39) involved extremity exposures. The whole body overexposures ranged from 1.25 rems to 27.66 rems with a median value of 2.95 rems. (Four whole body overexposure reports did not provide the dose and were not included in the calculation of the median.) The extremity overexposures ranged from 21.69 rems to 1925 rems with a median value of 146 rems. Two overexposure events were reported to Congress as abnormal occurrences.

The overexposure events reported by NRC licensees were about evenly distributed among medical/academic, research/commercial, and industrial radiography licensees. On the other hand, over 86 percent of the overexposures reported by Agreement States involved industrial radiography.

The primary causes of the medical/academic and research/commercial overexposures were failure to adequately monitor quarterly exposures and failure to wear adequate protective clothing.

In most of the events involving industrial radiography for which a cause was provided, the overexposure was attributed to either a personnel error or an equipment problem. The types of personnel errors involved were failures to (1) make adequate radiation surveys, (2) fully retract and/or secure the source, (3) connect the source, and (4) follow emergency procedures. The types of equipment problems were (1) lock-box malfunctions, (2) source disconnects, and (3) sources stuck in the guide-tube. In essentially all cases involving equipment failures, the overexposures could have been prevented had the radiographer or the assistant performed an adequate radiation survey.

¹A revised 10 CFR Part 20 became effective January 1, 1994. The equivalent section(s) of the new 10 CFR Part 20 is shown in parentheses.

Table 2.3 Number of Overexposure Events Reported by NRC and Agreement State Nuclear Materials Licensees for 1993

Type of Licensee	No. of Reports			No. of Individuals		
	NRC	Agreement States	Total	NRC	Agreement States	Total
Medical/Academic	4	3	7	4	3	7
Research/Commercial	3	0	3	7	0	7
Industrial Radiography	4	19	23	4	21	25
Total	11	22	33	15	24	39

2.4 Loss of Control of Licensed Material

Events included in this category are reportable under 10 CFR 20.402, "Reports of theft or loss of licensed material" (10 CFR 20.2201), except for abandoned well logging sources, which are reported in accordance with 10 CFR Part 39. The primary safety concerns stem from the loss of control of licensed material whether or not the material is recovered later.

Well logging sources may be abandoned (left in place) in accordance with the requirements of 10 CFR 39.77 and guidelines approved by the NRC and Agreement States. They are tracked in the NMED as lost sources so that the associated risk can be more easily quantified.

NRC licensees reported 116 events for 1993 that involved actual loss or loss of control of licensed material, while Agreement States reported 128 such events. These events are listed in Tables A-1.3 and A-2.3, respectively, of Appendix A.

Reported events can be grouped into five general areas: (1) licensed material (mostly medical waste) inadvertently sent to commercial land-fills; (2) licensed material (usually contaminated metal or industrial measuring gauges) inadvertently shipped to metal scrap yards; (3) licensed material (most often in portable moisture density gauges) that was stolen; (4) licensed material (usually cesium-137 and americium-241) in well logging sources that are abandoned downhole; and (5) miscellaneous losses from inventory of calibration sources and medical marker sources. Groups 1 through 4 account for almost two thirds of the reports.

The causes associated with the reported events generally involved inadequate accounting procedures for licensed material or inadequate security procedures, such as leaving material unattended. A review of the event reports shows that radiation monitors installed at commercial landfills and scrap metal yards can reduce the amount of licensed material entering such facilities. For NRC and Agreement State licensees combined, about 22 percent of the event reports involved radioactive material being detected at a landfill or scrap yard by a radiation monitor.

While there were no reported overexposures or significant contaminations as a result of the reported events, several of the events had the potential to affect the public health and safety and one event met the criteria for abnormal occurrence reporting to Congress.

AEOD is sponsoring a study of the loss of control of licensed material. The study will focus on how material is lost, the likely ultimate disposition of the material, and the potential risk to the public. The study is scheduled to be completed by the end of FY 1995.

2.5 Leaking Sources

Sealed sources containing licensed material generally are required to be tested for leakage on a periodic basis. The frequency usually ranges from quarterly to annually, depending on the source construction and the device in which the source is stored. Leak test results that show 18.5 becquerels (Bq) (.0005 μ Ci) or greater of removable beta or gamma emitters, or 185 Bq (.005 μ Ci) of removable alpha emitters, are required to be reported. Detecting leaking sources early is essential to preventing significant facility

contamination, personnel contamination, and personnel exposures.

NRC licensees reported 25 leaking sources for 1993 and Agreement States reported 19. These events are listed in Table A-1.4 and Table A-2.4, respectively, of Appendix A to this report. About 40 percent of the leaking source reports involved nickel-63 foils in gas chromatographs. These sources are covered with a thin film and are prone to show minor leakage with normal use. Another 10 percent of the reports involved leaking iron-55 sources used in portable gas analyses. The remainder of the leaking source reports involved industrial gauges, medical and industrial calibration sources, tritium light sources, well logging sources, and sources used for therapy and diagnosis (strontium-90 eye applicators and bone densitometers). There were no reported facility contaminations or radiation overexposures resulting from leaking sources.

2.6 Release of Material

Release of material events include spills and gaseous or effluent releases where licensed material was released to the environment (air or water) or resulted in personnel and/or facility contamination in excess of regulatory limits. Typically, these events are reported under 10 CFR 20.2202 and 20.2203.

For 1993 NRC licensees reported 34 release of material events and Agreement States reported 10. These events are listed in Table A-1.5 and Table A-2.5, respectively, of Appendix A to this report. Approximately 65 percent of the reported release of material events involved minor contamination of facilities licensed to possess nuclear materials, although one event did result in extensive low level contamination beyond the facility boundaries. One additional event, involving the melting of a multi-curie source at a steel mill, resulted in site contamination that required the facility to shut down to decontaminate the plant's filtration system. Ten of the remaining release of material events involved releases to the general environment, which included four events involving minor contamination found in residential

neighborhoods. The remaining events involved releases or administrative deficiencies, such as the loss of confinement of a sealed source and a failure to perform radiation surveys. For 1993 the reported release of material events did not result in any adverse health effects.

2.7 Transportation Events

NRC licensees reported 55 transportation events for 1993 and Agreement States reported 33. These events are listed in Table A-1.6 and Table 2.6, respectively, of Appendix A to this report. About 57 percent of the transportation events involved administrative deficiencies (e.g., failure to keep records or improperly completed shipping papers) and other shipping deficiencies (e.g., failure to survey or failure to brace and block the package during shipping). Approximately 25 percent were accidents involving vehicles transporting radioactive material that did not result in the loss of shielding or the release of material. Less than 20 percent of the events (16 events) involved contamination, release of material, or radiation levels in excess of regulatory limits. No transportation events reported to the NRC for 1993 had any adverse effects on public health and safety.

2.8 Equipment Problems

Reporting requirements related to equipment problems for material licensees are not contained in a common regulatory requirement, other than the requirement of 10 CFR Part 21, "Reporting of Defects and Noncompliance," to report defects and failures which create a substantial safety hazard. Rather, reporting requirements are specific to the type of licensed program and may be contained in a license condition or clarified in a bulletin.

In addition to the reporting requirements of 10 CFR Part 21, equipment problem reporting requirements are contained in the following regulations:

- 10 CFR 30.50 for notification of events related to the use of byproduct material when equipment is disabled or fails to function as designed

- 10 CFR 31.5(c)(5) for failures of or damage to the shielding or on-off mechanisms of measuring or gauging devices
- 10 CFR 34.30 for radiography equipment problems
- 10 CFR 40.26(c)(2) for notification of failures or unusual conditions in tailings or waste retention systems
- 10 CFR 50.36 (non-power reactors) for notification of exceeding safety limits
- 10 CFR 70.50 for notification of events related to the use of special nuclear material when equipment is disabled or fails to function as designed
- 10 CFR 71.95 for problems with shipping packages

Reports of problems with equipment that use or is integral to the use of licensed material can be helpful in preventing personnel radiation overexposures, personnel and facility contamination, releases of material, and nuclear criticalities. Reported equipment problems in which there are no direct health and safety consequences can provide early warning of more serious events that could have health and safety effects.

NRC licensees reported 93 events for 1993 involving equipment problems and Agreement States reported 67 such events. These events are listed in Table A-1.7 and Table A-2.7, respectively, of Appendix A to this report. Personnel exposure or personnel or facility contamination were reported to have occurred in less than one percent of the events. The reports were about evenly distributed among radiography equipment, medical therapy devices, irradiators, industrial measuring devices and fuel facility equipment. Each of these areas is discussed below, except for fuel facility problems, which is discussed in Section 2.9.

Radiography equipment—Source disconnects, lock box malfunctions and sources stuck in guide tubes account for most of the problems associated with radiography equipment. Past reviews of events of this type have shown the same problems.

Teletherapy, Brachytherapy—Timer failures and sources failing to retract are the primary failure modes of therapy equipment. There was one report of a beam interlock failure that could allow the teletherapy beam to strike the wall or ceiling. Equipment problems reported for high dose brachytherapy rate devices included failure of the source to move to the next position, source blockage, and electronics failures. A problem reported for low dose rate brachytherapy equipment was the ejection of a source without the device being programmed and without the applicator attached to the corresponding umbilical cord. This was caused by excessive moisture in the compressor that caused water to leak into the treatment tube, impeding the pneumatic control of the source.

Irradiators—Irradiator equipment problems reported included interlock problems, irradiator pool excessive conductivity, and sticking of the source rack.

Industrial Measuring Devices—Essentially all problems reported for portable gauges involved damage by construction equipment. Problems with fixed gauges generally involved damage from molten steel and malfunctioning shutter mechanisms.

2.9 Fuel Cycle Facility Events

The NRC regulates all fuel cycle facilities. NRC licensees submitted 46 reports of fuel cycle events for 1993 (see Table 2.4). These events are listed in Table A-1.8 of Appendix A to this report. Fuel cycle events can be grouped into the following four categories: (1) potential criticalities, (2) equipment problems, (3) contamination, and (4) miscellaneous. The majority of the potential criticality events were caused by a lack of management control or equipment failures. Examples of management deficiencies include (1) handling of nuclear material without all physical restraints in place, (2) missing criticality evaluations, and (3) excessive residual nuclear material build-up in undesignated areas. Equipment failures include (1) loss of the uninterruptable power supply, (2) failure of a cooling water jacket, (3) a tear in a rubber boot, (4) a failed gasket, and (5) failed radiation monitors. Other events reported by fuel cycle

facilities include one contamination event, facility fires, and a variety of other administrative deficiencies. Events reported by fuel cycle facilities for 1993 did not have any adverse effects on public health and safety.

Table 2.4 Fuel Cycle Events Reported for 1993

Type of Event	Number
Potential Criticalities	33
Equipment Problems	17
Contamination	1
Miscellaneous	8
Total	59

Note that this table shows the total number of each type of event that occurred at fuel cycle facilities. These numbers differ from the total number of reported events because one event may involve more than one event type.

2.10 Test, Research, and Training Reactors

The NRC regulates all reactor facilities, including power reactors and all test, research, and training reactors (TRTR). NUREG-1272, Vol 8, No. 1, covers power reactors and presents an overview of the operating experience of the nuclear power industry from the NRC perspective. The operating experience of TRTRs is discussed below.

There are 58 TRTR facilities currently licensed by the NRC, 46 with operating licenses, 7 with possession-only licenses, and 5 with dismantling orders. Of the 46 facilities with operating licenses, 37 are owned and operated by universities, 4 by the federal government, and 5 by commercial companies.

Eight TRTR events were reported for 1993. These events are listed in Table A-1.9 of Appendix A to this report. Five TRTR events were reported for 1993 that involved equipment failures resulting in the loss of one or more safety systems required by the licensee's technical specifications (TS). In addition, one licensee reported operating at 115 percent of full power for 11 minutes, resulting in a TS violation. The two remaining events involved releases of radioactive materials. One was caused by a 100 gallon per minute leak from the reactor

pool. Although the release did not exceed the 10 CFR Part 20 effluent release limits, it did exceed the license condition reporting limit for leakage. The second release involved a discharge of 7600 gallons from a collection sump to the reactor facility foundation drain sump as a result of a system misalignment. This discharge exceeded the 10 CFR Part 20 effluent release limit. The TRTR events reported to the NRC did not adversely affect the public health and safety, although one event was reported to Congress as an abnormal occurrence.

2.11 Annual Radiation Exposure Data

People are exposed to naturally occurring radiation and to radiation from man-made applications of radioactive materials, including medical diagnosis and therapy, industrial and commercial activities, production of electricity, and consumer products. According to the National Council on Radiation Protection and Measurements, the total average effective dose-equivalent to a person in the U.S. from all sources is approximately 3.6 mSv (360 mrem) per year. Naturally occurring radon is the largest source of human exposure, about 2.0 mSv (200 mrem) per year. About 1.0 mSv (100 mrem) per year comes from natural background radiation other than radon. The average person in the U.S. receives an effective dose-equivalent of about 0.5 mSv (50 mrem) per year from medical applications. The entire fuel cycle, including reactor operation, contributes less than 0.01 mSv (1 mrem) per year. All other man-made sources of radiation add up to approximately 0.06 mSv (6 mrem) per year effective dose-equivalent.

The NRC is responsible for regulating both reactor and nonreactor applications of nuclear materials. All nuclear materials licensees are required to provide radiation monitoring equipment to each individual who has the potential for receiving a dose in any calendar quarter in excess of 25 percent of the allowable limits specified in Part 20 of Title 10 of the Code of Federal Regulations (10 CFR Part 20), "Standards for Protection Against Radiation." The performance of power reactors is discussed in NUREG-1272, Vol. 8, No. 1. That report also compares the performance of power reactors with the performance of materials licensees.

Personnel exposure data from 1988 through 1993 are given in Tables 2.5 through 2.9 for the following five categories of material licenses: (1) industrial radiography, (2) manufacturing and distribution, (3) low-level waste disposal, (4) independent spent fuel storage, and (5) fuel fabrication and processing. Exposure data for Agreement State licensees are not included in these tables because the Agreement States are not

required to supply this information to the NRC. Because licensees submit revisions, late reports, or retractions, data are updated as appropriate. This may cause minor changes in the data published from year to year. The data are taken from the Radiation Exposure Information Reporting System (REIRS) funded by NRC's Office of Nuclear Regulatory Research.

Table 2.5 Annual Exposure Data for NRC Industrial Radiography Licensees, 1988-1993

Year	No. of Licensees	No. of Monitored Individuals	No. of Workers with Measurable doses	Collective Dose person-cSv (rem)	Average Individual Dose-cSv (rem)	Average Measurable Dose per Worker-cSv (rem)
1988	286	6878	4223	1981	0.29	0.47
1989	276	6745	4352	2067	0.31	0.47
1990	258	6523	4458	2120	0.33	0.48
1991	248	6820	4649	2160	0.31	0.46
1992	156	4582	3005	1540	0.34	0.46
1993	176	4720	3006	1627	0.34	0.54

Table 2.6 Annual Exposure Data for NRC Manufacturing and Distribution Licensees, 1988-1993

Year	No. of Licensees	No. of Monitored Individuals	No. of Workers with Measurable doses	Collective Dose person-cSv (rem)	Average Individual Dose-cSv (rem)	Average Measurable Dose per Worker-cSv (rem)
1987	24	3589	2317	716	0.20	0.31
1988	16	2177	868	343	0.16	0.40
1989	48	4554	2345	770	0.17	0.33
1990	55	4195	2272	693	0.17	0.31
1991	58	4930	1956	721	0.15	0.37
1992	55	3779	1363	461	0.12	0.34
1993	58	4913	2254	680	0.14	0.30

Table 2.7 Annual Exposure Data for NRC Low-Level Waste Disposal Licensees, 1988–1993

Year	No. of Licensees	No. of Monitored Individuals	No. of Workers with Measurable doses	Collective Dose person-cSv (rem)	Average Individual Dose-cSv (rem)	Average Measurable Dose per Worker-cSv (rem)
1987	2	778	173	24	0.03	0.14
1988	2	864	171	27	0.03	0.16
1989	2	925	119	35	0.04	0.29
1990	2	784	115	26	0.03	0.23
1991	2	905	147	39	0.04	0.27
1992	2	467	82	27	0.06	0.33
1993	2	432	76	21	0.05	0.28

Table 2.8 Annual Exposure Data for NRC Independent Spent Fuel Storage Licensees, 1988–1993

Year	No. of Licensees	No. of Monitored Individuals	No. of Workers with Measurable doses	Collective Dose person-cSv (rem)	Average Individual Dose-cSv (rem)	Average Measurable Dose per Worker-cSv (rem)
1987	2	129	64	41	0.32	0.64
1988	2	217	57	25	0.12	0.44
1989	2	190	102	33	0.17	0.33
1990	2	56	22	6	0.11	0.27
1991	2	41	24	4	0.10	0.17
1992	2	279	84	11	0.04	0.13
1993	2	135	52	14	0.10	0.27

Table 2.9 Annual Exposure Data for NRC Fuel Fabrication and Processing Licensees, 1988–1993

Year	No. of Licensees	No. of Monitored Individuals	No. of Workers with Measurable doses	Collective Dose person-cSv (rem)	Average Individual Dose-cSv (rem)	Average Measurable Dose per Worker-cSv (rem)
1987	10	10,370	3,994	514	0.05	0.13
1988	10	11,994	3,869	455	0.04	0.12
1989	8	11,583	2,992	243	0.02	0.08
1990	11	14,505	3,871	422	0.03	0.10
1991	11	11,702	3,929	378	0.03	0.11
1992	7	3,772	1,654	237	0.06	0.14
1993	8	9,649	2,611	339	0.04	0.13

As can be seen from these tables, in 1993 NRC radiography licensees had the highest collective dose and average measurable dose per worker, followed by manufacturers and distributors. Low-level waste disposal licensees and independent spent fuel storage licensees had relatively low collective doses.

From 1987 to 1993 inclusive, there has been a decreasing trend in the number of individuals monitored and the individuals that receive a

measurable dose among all categories of licensees except independent fuel storage licensees and manufacturers and distributors. Over this same period the average measurable dose per worker has been relatively constant for all categories of licensees except low-level waste disposal licensees, where it has doubled, and independent spent fuel storage licensees, where it has dropped by 58 percent. For each category of licensee, the average measurable dose per worker is far below the allowable limits of 10 CFR Part 20.

3 Abnormal Occurrences

AEOD prepares the quarterly "Report to Congress on Abnormal Occurrences," NUREG-0090. This effort requires coordinating staff activities, reviewing and submitting the report to the Commission for approval, and publishing the report and associated Federal Register notices. The quarterly report may include recurring events, generic concerns, or other incidents that the Commission determines to be significant to public health and safety.

In general, the NRC determines whether an event is an abnormal occurrence (AO) by using the criteria promulgated in an NRC policy statement published in the Federal Register on February 24, 1977 (42 FR 10950). That policy statement contained no examples of medical misadministrations. The NRC published misadministration reporting requirements in 1980 (10 CFR Part 35). In 1981 the Commission developed AO guidelines for medical misadministrations that were in effect for about two years. On the basis of the experience with the guidelines, the Commission decided to revise the guidelines again. On July 18, 1989, the staff amended NRC Management Directive 8.1, "Abnormal Occurrence Reporting Procedure," to incorporate the revised guidance. The current guidelines apply different criteria for occupational doses, doses received by a member of the general public, and doses received by a medical patient. (AEOD recently initiated efforts to revise the AO criteria. See Section 4.4.2 for further discussion.)

The four AO reports published in calendar year 1993 contained 15 events reported by NRC licensees and 16 events reported by Agreement States. The events reported by NRC licensees included 13 that occurred at medical institutions, 1 at an industrial radiographer, and 1 at a research reactor. The events reported by the Agreement States included 10 that occurred at medical institutions, 2 at industrial radiographers, and 4 at other industrial users. There were no AOs at fuel cycle facilities. Appendix B of this report includes summaries of the AOs.

3.1 NRC Licensees

3.1.1 Medical Institutions

- Nine brachytherapy misadministrations involving a therapeutic dose to a part of the body not scheduled to receive radiation
- Two sodium iodide misadministrations involving a diagnostic dose of a radiopharmaceutical that was five times the prescribed dose
- One moderate exposure of a 9-month-old nursing infant to iodine-131 that the nursing mother received for a diagnostic scan
- One therapeutic radiopharmaceutical misadministration where the administered dose was half of the prescribed dose

3.1.2 Industrial Radiographers

- One fatal radiation exposure of a radiographer (This 1981 event was previously reported as an Appendix C item. However, in 1993, this event was upgraded to an AO after the NRC became aware of new information.)

3.1.3 Research Reactors

- One event involving research reactor scram functions that were made inoperable because of a major deficiency in operating, management, or procedural controls

3.2 Agreement States

3.2.1 Medical Institutions

- Three brachytherapy misadministration reports involving 10 patients receiving therapeutic doses to a part of the body not scheduled to receive radiation
- One brachytherapy misadministration involving a therapeutic dose greater than 1.5 times the prescribed dose

- Two sodium iodide misadministrations involving a diagnostic dose of a radiopharmaceutical that was five times the prescribed dose
- Three teletherapy misadministrations, one of which was fatal and involved a dose that was twice the prescribed dose, while the other two involved a therapeutic dose to a part of the body not scheduled to receive radiation (The fatal misadministration occurred in 1987, and was investigated by the State of California in 1993. The NRC reevaluated the event and determined that it was an AO.)
- One therapeutic radiopharmaceutical misadministration involving an administered dose that was 50 percent greater than the prescribed dose

3.2.2 Industrial Radiographers

- Two radiation overexposure events involving radiographers

3.2.3 Other Industrial Users

- One event involving contamination of a pool irradiator facility
- One event involving theft of radioactive material during transport and improper disposal
- One event involving a lost source that was found at a scrap metal facility
- One event involving a source lost or stolen from an instrument user

The AOs reported in 1993 at nuclear power plants and research reactors are summarized in Appendix B to NUREG-1272, Vol. 8, No. 1.

4 AEOD Initiatives

AEOD provides a strong, independent capability to analyze the operational experience of programs using nuclear materials licensed by the NRC. This role was expanded in 1987. It was further enhanced in 1993 as a consequence of the increased attention directed toward nuclear materials events by Congress, the NRC's Inspector General, the media, and the public. The AEOD nuclear materials staff was augmented and programs were redesigned to strengthen and expand AEOD's role in ensuring operational safety. AEOD began the following efforts in 1993:

- (1) developing an improved nuclear materials events data base (NMED) that would provide the NRC and Agreement States with consistent coding of material events to identify safety concerns, trends, and performance problems, and would also provide users with information about significant occurrences at other facilities that would help them prevent similar incidents at their own facilities
- (2) performing more in-depth analyses of operational experience to identify trends, performance problems, and good practices
- (3) establishing a more consistent and effective feedback mechanism

4.1 Improved Nuclear Materials Events Data Base

4.1.1 Background

Since 1987 AEOD has published annual compilations of U.S. non-power reactor operational experience (NUREG-1272 series, Part 2). However, to support a comprehensive analysis of nuclear material experience, a nationwide data base of consistently reviewed and coded events was needed.

In the summer of 1993, NRC headquarters offices and the Regions agreed that AEOD would develop and maintain a centralized NMED to serve the needs of the entire agency. This information source would be used for analysis of

nuclear materials experience, which would include a broad range of operating event data. Additionally, it would be directly accessible by the NRC staff and Agreement States.

4.1.2 Data Base Development

In the fall of 1993, the NRC contractor, Idaho Engineering National Laboratory, began reviewing and coding materials events into the NMED. AEOD organized two 1-day workshops in November 1993, with various NRC headquarters and regional staff and Agreement State representatives participating. These workshops provided the forum for all potential users to discuss their individual needs and to come to consensus on suitable fields to satisfy those needs. Based on the input received during the workshops, the INEL staff restructured the data base and continued coding materials events from 1993 and earlier years (event reports from Agreement States are available only from 1991 on and are complete only for 1992 and 1993).

4.1.3 Status of the Nuclear Materials Events Data Base

Once validated for quality and completeness, the NMED be a valuable tool to provide a common information base on nuclear material events for the NRC and the Agreement States. Most importantly, this data base will provide a system for maintaining a traceable and reproducible inventory of consistently coded material events, and will also facilitate systematic and comprehensive assessment of materials experience. For example, this data base will furnish the information base for case studies on single or aggregated events, trends and pattern analyses, and AEOD's Annual Report. It will also support rulemaking and provide the basis for materials performance indicators.

The interim data base program, along with the available NRC and Agreement State data for 1991 through 1994, will be distributed to all potential users in the summer of 1994. This program will also have a data entry module to assist the Agreement States in preparing event data reports. The use of a standard program will ensure

consistent event collection. The test phase for the final data base system will begin in September 1994 (the test group will include selected NRC headquarters and regional offices and Agreement States). The system is scheduled to be operational in the first quarter of CY 1995. It will be accessible NRC-wide through AUTOS and by Agreement States through remote a communication link.

4.1.4 Planned Improvements in the Collection of Operational Experience

Consistent, complete, and timely event reporting from Agreement States is crucial to the successful implementation of the NMED. Timely reporting of events by Agreement States in a format that is compatible with the data base is essential to ensuring a complete and viable materials event information base. There was improved cooperation between the NRC and Agreement States in 1993, which is expected to continue. The NRC will also consider establishing standards for event reporting by the use of a standard report form, where applicable, and will examine licensee reporting requirements to determine if regulatory guidance for reporting is needed. On their part, Agreement States should ensure prompt reporting of events. There is a need for all events to be reported soon after they occur, and also a need for event information to be consistent with the information attributes of the NMED. States may also consider the use of standard computer programs for collecting event data. In the past, workshops and meetings between the NRC and the Agreement States have proven to be very beneficial. They offer a forum to address concerns and issues of mutual interest. Both the NRC and the Agreement States are committed to enhanced cooperation to achieve common goals.

4.2 Systematic Review of Nuclear Materials Experience

In 1993 AEOD implemented a formal process to review nuclear materials operating experience in a timely manner. A computerized Event Tracking System was implemented to log incoming licensee event reports (prompt notifications via telephone as well as written reports), preliminary notifications, and inspection reports. The AEOD

staff use a formal screening process to review event reports to identify AOs for reporting to Congress and other significant events, specific safety issues and concerns, program deficiencies, and performance problems. The results of the staff's event reviews are coded in the tracking system. A two-tier review process provides complete and consistent review. Based on this review, the staff also identified future study topics, some of which are discussed in Section 4.3.

In 1993 AEOD staff participated, along with the Regional Agreement States Officers, in the Annual Program Review of the States of Tennessee and Texas. AEOD's participation focused on the States' event collection and review process. AEOD staff gained a better understanding of the States' efforts and the States came to appreciate the NRC's need for complete and timely collection of event reports, and the NRC process for identifying potential AOs and other significant events.

4.3 Feedback of Nuclear Materials Experience

Between 1981 and 1993 AEOD issued 8 Case Studies, 50 Engineering Evaluations, 4 special studies, and 2 videotapes (see Appendix C). Videotapes have proven to be a particularly effective method for feedback of lessons learned from operating experience. A videotape entitled "Good Practices in Co-60 Teletherapy" was released in 1993. The video shows simulated administrations of external cobalt-60 radiation therapy and demonstrates good practices when using teletherapy equipment. Also in 1993, as a part of its renewed commitment to the systematic and comprehensive assessment of nuclear materials experience, AEOD contracted with national laboratories to initiate a review of the past 5 years of materials experience for case studies on radiography overexposure events, and the loss of licensed material in scrap metal yards.

4.4 Abnormal Occurrences

AEOD continued to fulfill the NRC's statutory obligation to report AOs to Congress by preparing and publishing the quarterly Report to

Congress on Abnormal Occurrences,
NUREG-0090.

4.4.1 Abnormal Occurrence Reporting

In 1993 the NRC reexamined earlier nuclear materials experience. Three events previously reviewed were reclassified as AOs: (1) the 1987 radiation overexposure of a radiographer in Oklahoma which resulted in his death, (2) multiple medical misadministrations in 1988 at the Sacred Heart Hospital in Cumberland, Maryland, and (3) a medical misadministration at Alta Bates Medical Center in Berkeley, California, which resulted in the death of a juvenile patient. The first event was reported as an Appendix C, "Other Events of Interest," item in NUREG-0090, Vol. 4, No. 1. The second event is still an open AO while the NRC continues to work with the State of Maryland to get more information. The third event was reinvestigated by the State of California (assisted by the NRC) and was determined to be a misadministration although it did not qualify as a misadministration according to the regulations existing at the time of the event.

In 1993 there was improved cooperation between the NRC and Agreement States in identifying and reporting AOs at Agreement State-licensed facilities. The States either identified potential AOs during their routine reviews and submitted write-ups to the NRC, or provided the information on potential AOs in response to NRC requests.

4.4.2 Abnormal Occurrence Criteria— Revision of the AO Policy Statement

AEOD initiated efforts to develop a policy statement for AO reporting to use objective criteria to identify events as AOs and Appendix C items, so that only events significant to public health and safety are reported. An interoffice working group was established for this purpose. The final draft policy statement is due to the Commission in September 1994, and the

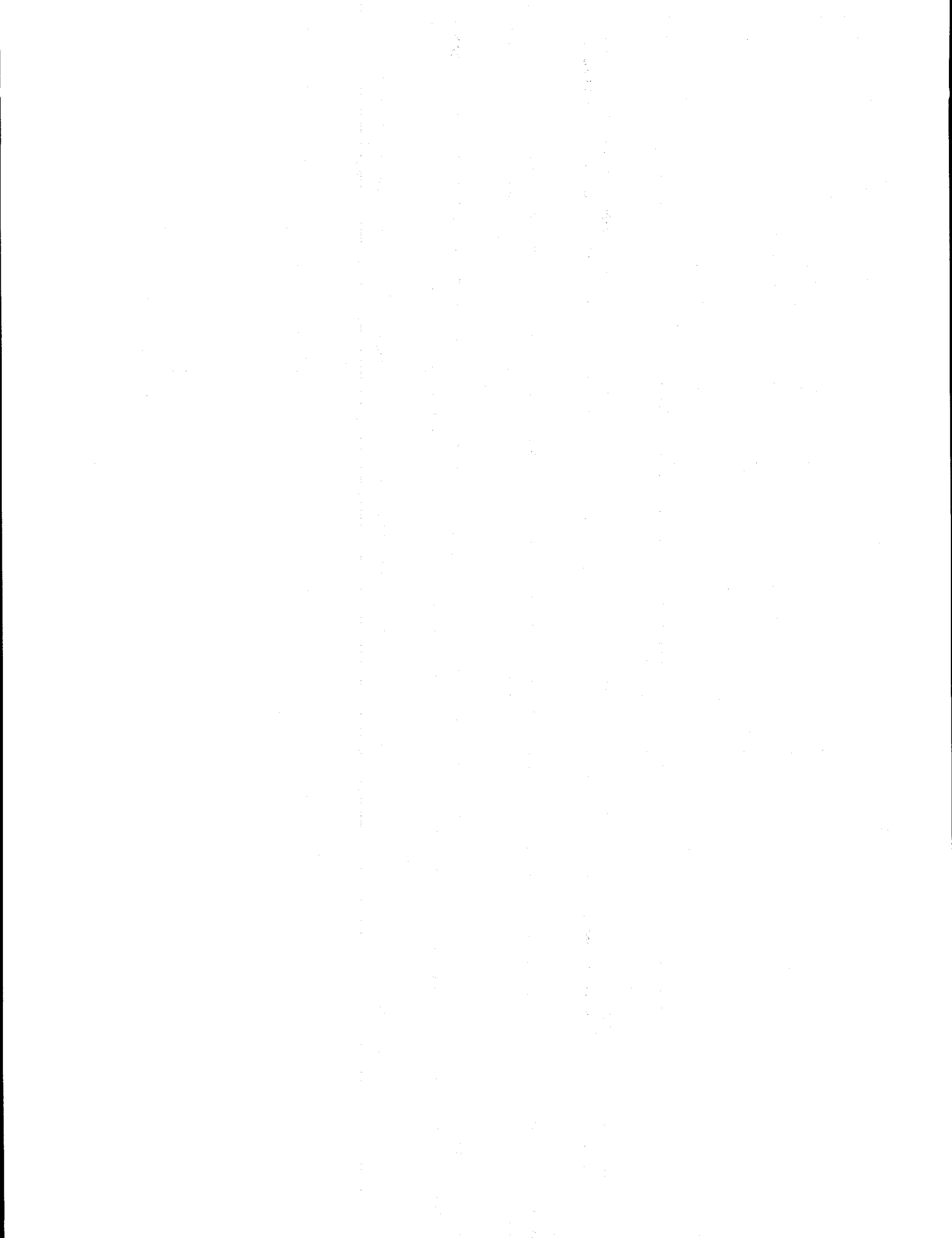
publication of the final policy statement is expected in the spring of 1995. After publishing the final policy statement, the AEOD staff will reevaluate the earlier nuclear materials events to determine if any of the previous events qualify as AOs or as Appendix C items.

AEOD is also streamlining the AO process to assure an efficient internal system and an effective interface with Agreement States. The revised process is aimed at timely identification of potential AOs, transmittal of complete write-ups expeditiously from the appropriate source (NRC Offices/Regions or Agreement States), and prompt preparation and timely publication of the AO report.

4.5 Non-power Reactors

The NRC had not in the past considered research reactors to pose a serious risk because of the low frequency of occurrence and the relatively minor consequences of accidents at these facilities, as well as the initiatives within the academic community to self-regulate. The NRC relied upon the Test, Research and Training Reactor (TRTR) Committee to investigate and report on significant events. However, several events at university reactors in 1992 raised questions about their overall management and safety. Therefore, in 1993 AEOD began a survey of the past five years of TRTR operating experience including operating events, inspection findings, feedback to the TRTR community, NRC feedback of lessons learned, and NRC enforcement actions. The purpose of this survey is to provide an independent assessment of the safety performance of TRTRs, to assess the adequacy of the feedback of operating experience within the TRTR community, to provide insights into safety practices at TRTRs and to identify recommendations for improvement if needed.

The staff is currently reviewing operational data pertaining to TRTRs, augmented by site visits to assess the safety performance of the non-power reactor facilities. This study is expected to be completed in 1995.



5 Incident Investigation Program

The Incident Investigation Program (IIP) ensures that NRC investigations of significant events are timely, thorough, well coordinated, and formally administered. The scope of the IIP includes investigations of significant operational events involving reactor and nonreactor activities licensed by the NRC. Incident Investigations Teams (IITs) are assigned to determine the circumstances and causes of the event and to assess the safety significance so that appropriate followup actions can be taken.

5.1 Incident Investigation Teams

Of the approximately 300 nuclear materials events reported during 1993, none was judged to have a level of safety significance sufficiently high to warrant an IIT investigation. However, one IIT investigation was still ongoing during 1993 for an

event involving a loss of an iridium-192 source, a therapy misadministration, and a patient fatality which occurred at the Indiana Regional Cancer Center in Indiana, Pennsylvania, on November 16, 1992. The final investigation report was issued in February 1993. The results of this IIT investigation were documented in the 1992 AEOD Annual Report. Appendix E documents the status of staff actions that the EDO assigned to various NRC offices associated with IIT report findings.

5.2 Augmented Inspection Teams

During 1993, one augmented inspection team conducted an inspection at the Siemens Power Corporation involving a uranium powder oxide spill on February 7, 1993. This event had no applicability to other facilities and no generic communication was issued.

6 Data From the NRC Operations Center

The NRC Operations Center serves as the focal point for communicating with NRC licensees, as well as State and Federal agencies, about operating events in the commercial nuclear sector. The Operations Center is staffed 24 hours a day by an NRC Headquarters Operations Officer, who is trained to receive, evaluate, and respond to events reported to the Operations Center.

In 1993 the NRC Operations Center received 216 notifications of events related to nuclear materials. These included 44 fuel facility, 3 nonpower reactor, 44 hospital, 18 transportation, 39 radioactive material, and 68 miscellaneous

nuclear materials events. Table 6.1 shows the distribution of these events.

Four of these notifications, all at fuel facilities, were for events classified as emergencies. Three of them were "Notifications of Unusual Event." The only "Alert" was for a fire at the Nuclear Fuel Services facility in Erwin, Tennessee (see Table 6.2). No "Site Area Emergencies" occurred. Actions taken by the NRC operations officer in response to these notifications ranged from making a log entry and the appropriate notifications, to establishing emergency conference calls with the NRC Incident Response staff, the licensee, and senior NRC regional and headquarters staff members.

Table 6.1 Nuclear Materials Events Reported to the NRC Operations Center in 1993

Event Type	Power Reactor	Fuel Facility	Nonpower Reactor	Hospital	Transport	Materials	Miscellaneous	Total
Non-emergency	1413	40	3	44	18	39	68	1625
Notification of Unusual Event	100	3	0	0	0	0	0	103
Alert	7	1	0	0	0	0	0	8
Site Area Emergency	1	0	0	0	0	0	0	1
General Emergency	0	0	0	0	0	0	0	0
Total	1521	44	3	44	18	39	68	1737

Table 6.2 Alert Events Reported at NRC-Licensed Nuclear Materials Facilities in 1993

Facility	Event	Date	Description	Duration*	Response
Nuclear Fuel Services Erwin, TN	26215	10/13/93	Roof fire on "Wet Cell" building	9 minutes	N/A

* Time from commencement to termination of emergency

Appendix A

Nuclear Materials Data by Event Type

A-1 NRC Licensee Events

A-2 Agreement State Licensee Events

Appendix A-1

NRC Licensee Events

Table A-1.1 Medical Misadministrations Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF MISADMINISTRATION
940134	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	06/10/93	BRACHYTHERAPY
940604	CHARLESTON AREA MEDICAL CENTER	47-15473-02MD	CHARLESTON	WV	12/06/93	BRACHYTHERAPY
940876	DEACONESS MEDICAL CENTER	25-01051-01	BILLINGS	MT	09/24/93	BRACHYTHERAPY
941281	DEACONESS MEDICAL CENTER	25-01051-01	BILLINGS	MT	11/30/93	BRACHYTHERAPY
940032	GENESYS REGIONAL MEDICAL CENTER	21-01103-04	FLINT	MI	04/20/93	BRACHYTHERAPY
940072	GOOD SAMARITAN HOSPITAL	34-16725-02	ZANESVILLE	OH	11/10/93	BRACHYTHERAPY
940155	HOSPITAL METROPOLITANO	52-16033-01	SAN JUAN	PR	12/11/93	BRACHYTHERAPY
940036	MARQUETTE GENERAL HOSPITAL	21-05432-04	MARQUETTE	MI	11/19/93	BRACHYTHERAPY
940098	MERCY HOSPITAL	37-01374-03	SCRANTON	PA	04/23/93	BRACHYTHERAPY
940034	MERCY MEMORIAL MEDICAL CENTER, INC.	21-04177-01	SAINT JOSEPH	MI	02/16/93	BRACHYTHERAPY
941659	MIAMI VALLEY HOSPITAL	34-00341-06	DAYTON	OH	01/29/93	BRACHYTHERAPY
940043	MINNESOTA, UNIVERSITY OF	22-00187-46	MINNEAPOLIS	MN	06/08/93	BRACHYTHERAPY
940616	MOUNTAINSIDE HOSPITAL	29-03297-02	MONTCLAIR	NJ	07/01/93	BRACHYTHERAPY
940085	SAINT LOUIS UNIVERSITY	24-00196-07	SAINT LOUIS	MO	11/12/93	BRACHYTHERAPY
940655	V.A., DEPARTMENT OF	42-00084-06	HOUSTON	TX	09/25/93	BRACHYTHERAPY
940958	WASHINGTON UNIV. MEDICAL SCHOOL	24-00167-11	SAINT LOUIS	MO	01/07/93	BRACHYTHERAPY
940003	YALE-NEW HAVEN HOSPITAL	06-00819-03	NEW HAVEN	CT	01/21/93	BRACHYTHERAPY
941012	TRIANGLE RADIATION ONCOLOGY ASSOCIATES	37-20758-01	BEAVER	PA	12/17/93	TELETHERAPY
940001	V.A., DEPARTMENT OF	04-00181-12	LOS ANGELES	CA	05/13/93	TELETHERAPY
940040	X-RAY TREATMENT CENTER, P.C.	21-19572-01	EASTPOINTE	MI	07/13/93	TELETHERAPY
941542	CENTER FOR MOLECULAR MEDICINE AND IMMUNOLOGY	29-28554-01	NEWARK	NJ	03/11/93	RADIOPHARMACEUTICAL

Table A-1.1 Medical Misadministrations Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF MISADMINISTRATION
940106	BRYN MAWR HOSPITAL	37-07722-04	BRYN MAWR	PA	10/07/93	SODIUM IODIDE
940108	CHESTNUT HILL HOSPITAL	37-13919-01	PHILADELPHIA	PA	03/11/93	SODIUM IODIDE
941296	COMMUNITY MEMORIAL HOSPITAL	25-19824-01	SIDNEY	MT	02/02/93	SODIUM IODIDE
941298	COMMUNITY MEMORIAL HOSPITAL	25-19824-01	SIDNEY	MT	01/25/93	SODIUM IODIDE
940090	OSTEOPATHIC HOSPITAL FOUNDERS ASSOCIATION	35-05860-01	TULSA	OK	07/27/93	SODIUM IODIDE
940005	PAPASTAVROS' ASSOCIATES MEDICAL IMAGING	07-16529-01	WILMINGTON	DE	01/14/93	SODIUM IODIDE
940739	PUERTO RICO, UNIVERSITY OF	52-01946-07	SAN JUAN	PR	09/13/93	SODIUM IODIDE

Table A-1.2 Overexposures reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF EXPOSURE	NO. EXPOSED	DOSE (REMS)
940062	COOPER HOSPITAL/ UNIVERSITY MEDICAL CENTER	29-08285-01	CAMDEN	NJ	04/05/93	EXT	1	21.69
940974	WASHINGTON HOSPITAL	08-03604-03	WASHINGTON	DC	10/31/93	WB	1	8.09
940039	HEART INSTITUTE OF MICHIGAN	21-18912-01	KALAMAZOO	MI	03/05/93	WB	1	1.46
941166	ISOTOPE PRODUCTS LABORATORIES	04-16778-01E	BURBANK	CA	02/18/93	WB	1	NR
940030	MICHIGAN, UNIVERSITY OF	21-00215-04	ANN ARBOR	MI	05/12/93	EXT	1	22.87
941599	MILWAUKEE COUNTY MEDICAL COMPLEX	48-04193-01	MILWAUKEE	WI	02/01/93	WB	1	1.33
940074	ADVANCED MEDICAL SYSTEMS, INC.	34-19089-01	GENEVA	OH	11/11/93	WB	5	1.53-3.075
940119	SCIENTIFIC INSPECTION TECHNOLOGIES, INC	41-25027-01	HIXSON	TN	04/16/93	EXT	1	1107
941029	TECHNICAL WELDING LABORATORY, INC.	42-25214-01	PASADENA	TX	06/19/93	WB	1	4.22
941627	TECHNICAL WELDING LABORATORY, INC.	42-25214-01	PASADENA	TX	12/31/93	WB	1	6.48
941567	WESTERN IND. X-RAY INSPECTION CO.	49-27356-01	EVANSTON	WY	07/31/93	WB	1	6

WB indicates WHOLE BODY
EXT indicates EXTREMITY

NR indicates NOT REPORTED

Table A-1.3 Loss of Control of Material Events Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940947	A&K FINISHING, INC.	GENERAL LIC	KENTWOOD	MI	12/16/93	PO-210
941109	AGRICULTURE, DEPARTMENT OF	19-00915-03	HYATTSVILLE	MD	10/26/93	NI-63
942061	AGRICULTURE, DEPARTMENT OF	19-00915-06	GREENBELT	MD	05/01/93	NI-63,
940138	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	04/27/93	SR-90
940266	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	09/22/93	SR-90, SR-90, SR-90, SR-90
941294	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	09/22/93	H-3
940157	ALCO CORP.	52-24843-01	CANOVANAS	PR	12/07/93	CS-137, AM-BE
940082	ALPHA-OMEGA GEOTECH, INC.	15-23181-01	KANSAS CITY	KS	10/05/93	CS-137, AM-BE
940015	ALT & WITZIG ENGINEERING, INC.	13-18685-01	INDIANAPOLIS	IN	09/22/93	CS-137, AM-BE
941007	ALUMINUM CO. OF AMERICA	37-07653-02	ALCOA CENTER	PA	12/28/93	U-NAT
940667	AMERSHAM CORP.	20-12836-01	BURLINGTON	MA	08/18/93	YB-169
941361	ANNISTON ARMY DEPOT	NR	NR	AL	08/10/93	H-3
940006	ARMY, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	10/12/93	H-3
940008	ARMY, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	11/17/93	H-3
940009	ARMY, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	08/15/93	H-3, H-3
940010	ARMY,, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	08/19/93	H-3
940596	ARMY, DEPARTMENT OF THE	42-01368-01	FORT SAM HOUSTON	TX	09/29/93	NI-63
941241	ARROW TERMINAL INDUSTRIES	NON-LICENSEE	INDUSTRY	PA	05/31/93	CO-60
940019	BAKER HUGHES OILFIELD OPERATIONS, INC.	17-27437-01	BROUSSARD	LA	06/11/93	AM-BE
940664	BEST FOOD TECHNICAL CENTER	29-07524-04	SOMERSET	NJ	05/13/93	NI-63
940068	BETHESDA HOSPITAL	34-10921-03	CINCINNATI	OH	12/08/93	CS-137
940990	BLANCHARD VALLEY HOSPITAL	34-06295-02	FINDLAY	OH	04/02/93	ND
940083	BOSTON UNIVERSITY MEDICAL CENTER	20-02215-01	BOSTON	MA	10/01/93	P-32
940989	BURGESS & NIPLE, LTD.	34-20259-01	COLUMBUS	OH	07/23/93	CS-137, AM-BE
940608	CASE WESTERN RESERVE UNIVERSITY	34-00738-04	CLEVELAND	OH	01/22/93	H-3, C-14, P-32
940025	CHARM SCIENCES INC.	20-18145-01E	MALDEN	MA	12/29/93	H-3, C-14
940187	CHILDRESS SERVICE CORP.	GENERAL LIC	BEAVER	WV	07/22/93	CS-137

Table A-1.3 Loss of Control of Material Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940088	CINCINNATI, UNIVERSITY OF	34-06903-05	CINCINNATI	OH	10/05/93	SR-90
940079	COMMUNITY NUCLEAR RADIOLOGY FACILITY	34-25962-01	MAYFIELD HEIGHTS	OH	04/23/93	CS-137
940933	CTS	GENERAL LIC	STOUTSVILLE	OH	02/10/93	NR
940724	DANA-FARBER CANCER INSTITUTE	20-19761-01	BOSTON	MA	11/05/93	S-35
940727	DELAWARE STATE COLLEGE	07-11871-05	DOVER	DE	08/19/93	H-3
941402	EDWARDS PIPELINE TESTING, INC.	35-23193-01	TULSA	OK	01/04/93	IR-192
940186	EVART PRODUCTS CO.	GENERAL LIC	EVART	MI	01/12/93	PO-210
941447	FIBER-LITE CORP.	GENERAL LIC	HEBRON	OH	08/20/93	KR-85, KR-85
941953	FOX CHASE CANCER CENTER	37-02766-01	PHILADELPHIA	PA	09/07/93	P-32
940969	GARDEN CITY OSTEOPATHIC HOSPITAL	21-04072-01	GARDEN CITY	MI	04/14/93	TC-99M
940160	GENERAL ATOMICS	SNM-696	SAN DIEGO	CA	05/21/93	U-HE
940972	GENERAL DYNAMICS HEIGHTS	21-21068-01	STERLING	MI	11/22/93	H-3
940065	GOODYEAR TIRE & RUBBER CO.	34-00508-16	AKRON	OH	09/10/93	PO-210
940131	HALLIBURTON CO.	42-01068-07	HOUSTON	TX	02/26/93	CS-137, AM-BE
940726	HARTFORD HOSPITAL	06-00253-04	HARTFORD	CT	09/12/93	TC-99M
940016	INDIANA DEPARTMENT OF TRANSPORTATION	13-26344-01	CRAWFORDVILLE	IN	01/18/93	CS-137, AM-BE
940685	INLAND STEEL CO. 8-213	13-03086-03	EAST CHICAGO	IN	04/02/93	PM-147
940725	KCE STRUCTURAL ENGINEERS, PC	08-30006-01	WASHINGTON	DC	11/25/93	CS-137, AM-BE
940999	KUAKINI MEDICAL CENTER	53-17797-01	HONOLULU	HI	11/04/93	I-125, I-131
940162	LOUISIANA STATE UNIVERSITY	SNM-1966	BATON ROUGE	LA	10/21/93	PU-BE
940956	LUKENS STEEL CO.	NON-LICENSEE	COATESVILLE	PA	12/12/93	U-238
940051	MALLINCKRODT MEDICAL, INC.	24-04206-13MD	SAINT LOUIS	MO	07/09/93	MO-99
940096	MCKEESPORT HOSPITAL	37-00896-03	MCKEESPORT	PA	09/27/93	I-125
940145	MEDICAL COLLEGE OF HAMPTON ROADS	45-15877-01	NORFOLK	VA	01/26/93	P-32
940905	MELICK-TULLY & ASSOCIATES, INC.	29-20773-01	SOUTH BOUND BROOK	NJ	08/07/93	CS-137, AM-BE
941033	MICHIGAN HEALTH CENTER	21-03835-01	DETROIT	MI	01/05/93	ND
940695	MOBILE CARDIOVASCULAR TESTING	48-24566-01	MILWAUKEE	WI	05/26/93	TC-99M

Table A-1.3 Loss of Control of Material Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940994	MOUNT SINAI MEDICAL CENTER	34-00746-02	CLEVELAND	OH	04/20/93	I-125
941028	NAVY, DEPARTMENT OF THE	45-23645-01NA	WASHINGTON	DC	04/19/93	AM-241, AM-241
941045	NEN RESEARCH PRODUCTS	NON-LICENSEE	BOSTON	MA	07/30/93	NR
940962	NEWARK BETH ISRAEL MEDICAL CENTER	29-00102-07	NEWARK	NJ	11/08/93	I-131
941023	NEWARK BETH ISRAEL MEDICAL CENTER	SNM-1370	NEWARK	NJ	03/03/93	PU-238
940184	O'SULLIVAN CORP.	GENERAL LIC	WINCHESTER	VA	01/28/93	PO-210
941887	OGDEN-MARTIN SYSTEMS	NON-LICENSEE	BOSTON	MA	12/20/93	NR
940027	OPTICAL CORP. OF AMERICA	20-23742-01	MARLBORO	MA	11/29/93	H-3
941645	PANTEX PLANT	DOE	AMARILLO	TX	12/01/93	PU-OTH
940064	PAULUS, SOKOLOWSKI & SARTOR	29-19269-01	WARREN	NJ	07/15/93	CS-137, AM-BE
940671	PENNSYLVANIA, COMMONWEALTH OF	37-06677-01	HARRISBURG	PA	12/18/93	CS-137, AM-BE
940189	PORT WASHINGTON PLANT OF WISCONSIN	GENERAL LIC	MILWAUKEE	WI	08/31/93	H-3
940612	PRINCETON COMMUNITY HOSPITAL	47-16307-01	PRINCETON	WV	09/13/93	NR
941249	PROFESSIONAL SERVICES INDUSTRIES, INC.	12-16941-01 AM-BE	LOMBARD	IL	05/25/93	CS-137,
941600	PUERTO RICO, UNIVERSITY OF	52-01946-07	SAN JUAN	PR	09/10/93	P-32, S-35, CR-51, I-131
941991	PUERTO RICO, UNIVERSITY OF	52-01946-07	SAN JUAN	PR	02/02/93	I-131
940057	R.W. JOHNSON PHARMACEUTICAL RESEARCH INSTITUTE	29-02608-03	RARITAN	NJ	01/22/93	FE-59
940681	ROCKY MOUNTAIN PHOENIX SURVEYS INC.	GENERAL	BRIGHTON	CO	11/14/93	CS-137
940968	RUTGERS STATE UNIVERSITY	29-05218-28	PISCATAWAY	NJ	04/27/93	NI-63
941032	SAINT ANNE'S HOSPITAL CORP.	20-05696-02	FALL RIVER	MA	10/03/93	I-131
940103	SAINT ELIZABETH HOSPITAL MEDICAL CENTER	13-08615-04	LAFAYETTE	IN	11/10/93	AU-198
940114	ST. ELIZABETH MEDICAL CENTER	34-02176-01	DAYTON	OH	12/03/93	I-125
940966	SAINT JOSEPH RADIOLOGY ASSOCIATES, INC.	24-05592-01	SAINT JOSEPH	MO	04/26/93	CO-60, U-DEP
940048	SAINT JOSEPH'S HOSPITAL	22-01448-01	SAINT PAUL	MN	01/18/93	NR
940954	SAM KATZ CO.	NON-LICENSEE	CLEVELAND	OH	06/02/93	TA-182
940121	SCHLUMBERGER TECHNOLOGY	42-00090-03	HOUSTON	TX	07/18/93	AM-BE

Table A-1.3 Loss of Control of Material Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940122	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	08/18/93	AM-BE, AM-BE
940123	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	05/19/93	CS-137, AM-BE
940125	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	03/20/93	AM-BE
940126	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	01/29/93	AM-BE
940127	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	11/01/93	AM-BE, AM-BE
940128	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	01/31/93	AM-BE
940129	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	12/02/93	CS-137, AM-BE, AM-BE
940130	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	11/15/93	AM-BE, AM-BE
940588	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	07/29/93	CS-137, AM-BE
940714	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	02/03/93	CS-137, AM-BE
940789	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	12/29/93	AM-241
940861	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	06/29/93	AM-BE,
940995	SCHLUMBERGER TECHNOLOGY CORP.	42-00090-03	HOUSTON	TX	08/06/93	CS-137, AM-BE
940022	SCHNABEL ENGINEERING ASSOCIATES, INC.	45-19703-01	RICHMOND	VA	04/16/93	NR
940165	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	02/08/93	UF4
940837	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	12/12/93	NR
940142	SPERRY-SUN DRILLING SERVICES, INC.	42-26844-01	HOUSTON	TX	06/18/93	CS-137, AM-BE
940143	SPERRY-SUN DRILLING SERVICES, INC.	42-26844-01	HOUSTON	TX	08/11/93	CS-137, AM-B,
940144	SPERRY-SUN DRILLING SERVICES, INC.	42-26844-01	HOUSTON	TX	11/07/93	CS-137, AM-BE
940894	SPERRY-SUN DRILLING SERVICES, INC.	42-26844-01	HOUSTON	TX	01/24/93	CS-137, AM-BE
940101	SYNCOR INTERNATIONAL CORP.	06-19661-01MD	GLASTONBURY	CT	07/26/93	I-131

Table A-1.3 Loss of Control of Material Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940919	SYNCOR INTERNATIONAL CORP.	21-17189-01MD	SOUTHFIELD	MI	03/24/93	ND
940906	TELEDYNE ISOTOPES, INC.	29-00055-14	WESTWOOD	NJ	07/08/93	CO-60, H-3
940991	TOLEDO HOSPITAL	34-01710-05	TOLEDO	OH	01/06/93	ND
940992	TOLEDO HOSPITAL	34-01710-05	TOLEDO	OH	06/30/93	IR-192
940091	TULSA GAMMA RAY, INC.	35-17178-01	TULSA	OK	04/07/93	IR-192
940023	UNIFORMED SERVICES UNIV. OF HEALTH SCIENCES	19-23344-01	BETHESDA	MD	03/26/93	GD-153, IN-114M, SN-113, SR-85, NB-95, SC-46
940137	AIR FORCE, DEPARTMENT OF THE	GENERAL LIC	SAN ANTONIO	TX	09/22/93	H-3
940029	UPJOHN CO.	21-00182-03	KALAMAZOO	MI	04/29/93	P-32
941333	V.A. HOSPITAL	36-01395-01	PORTLAND	OR	06/11/93	NR
940060	V.A. MEDICAL CENTER	29-04481-01	EAST ORANGE	NJ	05/24/93	P-32, S-35
940613	V.A. MEDICAL CENTER	09-12467-02	GAINESVILLE	FL	04/30/93	H3, S-35, C-14
940944	VISHAY	NON-LICENSEE	MALVERN	PA	05/18/93	PM-147
940967	WASHINGTON UNIVERSITY MEDICAL CENTER	24-00063-04	SAINT LOUIS	MO	09/13/93	MG-TH
940038	WAYNE COUNTY OFFICE OF PUBLIC SERVICE	21-13687-01 AM-BE	DETROIT	MI	07/07/93	CS-137,
941030	WESTERN ATLAS INTERNATIONAL, INC.	42-02964-01	HOUSTON	TX	12/05/93	CS-137, CS-137, AM-BE

NR indicates NOT REPORTED
ND indicates NOT DETERMINED

Table A-1.4 Leaking Sources Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
942002	ABB PROCESS AUTOMATION, INC.	34-00255-03	COLUMBUS	OH	06/30/93	PM-147
940021	AGRICULTURE, DEPARTMENT OF	19-00915-06	GREENBELT	MD	04/28/93	NI-63
940742	AGRICULTURE, DEPARTMENT OF	19-00915-06	GREENBELT	MD	09/09/93	NI-63
940007	ARMY, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	09/29/93	H-3
940708	ARMY, DEPARTMENT OF THE	29-00047-02	PICATINNY ARSEN	NJ	06/14/93	CS-137
940031	DOW CHEMICAL CO.	21-00265-06	MIDLAND	MI	04/20/93	NI-63
940081	ENVIRONMENTAL PROTECTION AGENCY	05-14892-01	DENVER	CO	11/10/93	NI-63
940615	GERMANIUM POWER DEVICES	GENERAL LIC	ANDOVER	MA	08/18/93	CD-109
940089	HALLIBURTON CO.	35-00502-03	DUNCAN	OK	11/16/93	CS-137
940092	HAYES EVALUATION LOGGING & PERFORATING, INC.	35-19614-01	ARDMORE	OK	05/27/93	CS-137
940153	HES	48-26453-01	MADISON	WI	11/07/93	NI-63
941026	I. GONZALEZ MARTINEZ ONCOLOGIC HOSPITAL	52-13471-01 CS-137	HATO REY	PR	07/06/93	CS-137,
941011	KEMRON ENVIRONMENTAL SERVICES, INC.	34-26054-01	MARIETTA	OH	02/12/93	NI-63
940961	MERCK & CO., INC.	29-00117-06	RAHWAY	NJ	06/29/93	NI-63
940035	MICHIGAN, STATE OF	21-05199-03	LANSING	MI	09/10/93	NI-63
940042	MINNESOTA MINING & MANUFACTURING CO.	22-00057-03	SAINT PAUL	MN	11/30/93	AM-241
940112	OHMART CORP.	34-00639-01	CINCINNATI	OH	09/10/93	CS-137, CS-137
940052	RALSTON PURINA CO.	24-08334-02	SAINT LOUIS	MO	02/01/93	NI-63
940070	SAINT-GOBAIN/NORTON	34-13845-01	NEWBURY	OH	04/22/93	CS-137
940213	V.A., DEPARTMENT OF	04-00181-04	LOS ANGELES	CA	09/27/93	NI-63
940609	VARIAN CHROMATOGRAPH SYSTEMS	NR	WALNUT CREEK	CA	12/10/93	NI-63
940788	VIRGINIA, UNIVERSITY OF	45-00034-26	CHARLOTTESVILLE	VA	06/16/93	CF-252
940154	WISCONSIN ELECTRIC POWER CO.	48-16729-01	MILWAUKEE	WI	01/30/93	NI-63
940152	WISCONSIN, UNIVERSITY OF, AT MADISON	48-09843-18	MADISON	WI	02/09/93	NI-63
941302	ZENECA PHARMACEUTICALS GROUP	07-03990-01	WILMINGTON	DE	12/21/93	NI-63

NR indicates NOT REPORTED

Table A-1.5 Release of Material Events Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF RELEASE	RADIO-NUCLIDE
940135	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	09/15/93	SURFACE	I-131
1940605	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	02/05/93	SURFACE	CS-137
941985	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	05/18/93	SURFACE	NR
942011	ARMY, DEPARTMENT OF THE	12-00722-06	ROCK ISLAND	IL	01/22/93	SURFACE	H-3
940873	BABCOCK & WILCOX FUEL CO.	SNM-1168	LYNCHBURG	VA	11/23/93	SURFACE	H-3
940985	BAKER HUGHES OILFIELD OPERATIONS, INC.	17-27437-01	BROUSSARD	LA	09/28/93	SURFACE	CS-137
940026	BIOGEN, INC.	20-19808-01	CAMBRIDGE	MA	04/16/93	SURFACE	P-32
941683	CHEMETRON CORP.	SUB-1357	PROVIDENCE	RI	09/17/93	SURFACE	U-DEP
941684	CHEMETRON CORP.	SUB-1357	PROVIDENCE	RI	06/23/93	SURFACE	U-DEP
940852	COMBUSTION ENGINEERING, INC.	SNM-33	HEMATITE	MO	07/02/93	AIR	UO2
940853	COMBUSTION ENGINEERING, INC.	SNM-33	HEMATITE	MO	08/25/93	AIR	UF6
941571	CURATORS OF THE UNIVERSITY OF MISSOURI	24-00513-32	COLUMBIA	MO	12/18/93	SURFACE	P-32
941004	DOE-PINELLAS PLANT	DOE	LARGO	FL	04/20/93	AIR	KR-85
940099	GEISINGER MEDICAL CENTER	37-01421-01	DANVILLE	PA	01/28/93	SURFACE	TC-99M
940024	HARVARD UNIVERSITY	20-00297-53	CAMBRIDGE	MA	01/13/93	SURFACE	P-32
941989	HENRY FORD HOSPITAL	21-04109-16	DETROIT	MI	02/01/93	SURFACE	TC-99M
940602	JOSLYN ELECTRONIC SYSTEMS CORP.	04-13468-01E	GOLETA	CA	06/06/93	AIR	H-3
940044	MAYO FOUNDATION	22-00519-03	ROCHESTER	MN	03/21/93	SURFACE	P-32
940086	MIAMI VALLEY HOSPITAL	34-00341-06	DAYTON	OH	09/10/93	SURFACE	SR-89
940028	MICHIGAN STATE UNIVERSITY	21-00021-29	EAST LANSING	MI	03/09/93	SURFACE	C-14
940748	MICHIGAN, UNIVERSITY OF	R-28	ANN ARBOR	MI	07/30/93	SURFACE	H-3
940215	MORTON INTERNATIONAL	NO LICENSE	OGDEN	UT	10/19/93	SURFACE	TH-NAT
941027	NAVY, DEPARTMENT OF THE	45-23645-01NA	WASHINGTON	DC	10/07/93	SURFACE	P-32
940059	NEW JERSEY UNIVERSITY OF MEDICINE & DENTISTRY	29-02957-13	NEWARK	NJ	12/24/93	SURFACE	P-32
940678	NORTH CAROLINA STATE UNIVERSITY	R-120	RALEIGH	NC	11/23/93	SURFACE	NR
941837	NUCLEAR PHARMACY OF IDAHO, INC.	11-27398-01MD	BOISE	ID	12/31/93	AIR	I-131
940689	PENNSYLVANIA, UNIVERSITY OF	37-00118-07	PHILADELPHIA	PA	07/14/93	WATER	TC-99M

Table A-1.5 Release of Material Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF RELEASE	RADIO-NUCLIDE
940164	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	05/18/93	SURFACE	U-DEP
940849	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	03/17/93	AIR	UF4
941716	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	10/01/93	SURFACE	ND
941010	TRINITECH INTERNATIONAL, INC.	34-26496-01	TWINSBURG	OH	08/05/93	SURFACE	H-3
940691	V.A., DEPARTMENT OF	42-00084-06	HOUSTON	TX	09/17/93	AIR	XE-133
940874	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	11/10/93	SURFACE	H-3
940740	XAVIER UNIVERSITY	34-08941-01	CINCINNATI	OH	12/29/93	SURFACE	CS-137

NR indicates NOT REPORTED
 ND indicates NOT DETERMINED

Table A-1.6 Transportation Events Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF TRANSPORTATION EVENT
940139	AIR FORCE, DEPARTMENT OF THE	42-23539-01AF	BROOKS AFB	TX	02/08/93	EXCESS RADIATION LEVELS
940710	ALARON CORP.	37-20826-02	WAMPUM	PA	07/20/93	EXCESS RADIATION LEVELS
941260	ARKANSAS NUCLEAR ONE	NR	RUSSELLVILLE	AR	02/18/93	VEHICLE ACCIDENT
940656	ARMY, DEPARTMENT OF THE	42-05255-07	EL PASO	TX	01/29/93	IMPROPER SHIPPING PAPERS
941445	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	06/04/93	IMPROPER SHIPPING PAPERS
942008	CHMP, INC.	21-18701-01	GRAND BLANC	MI	07/01/93	IMPROPER SHIPPING PAPERS
942017	CONSULTING ENGINEERS CORP.	45-25053-01	VIENNA	VA	09/02/93	IMPROPER SHIPPING PAPERS
942005	CTI, INC.	50-19202-01	ANCHORAGE	AK	07/14/93	IMPROPER SHIPPING PAPERS
940698	DRAPER ADEN ASSOCIATES	45-25246-01	GLEN ALLEN	VA	08/18/93	IMPROPER SHIPPING PAPERS
940981	DU PONT MERCK PHARMACEUTICAL CO.	20-00320-16MD	NORTH BILLERICA	MA	02/21/93	VEHICLE ACCIDENT
942018	FAIRFAX, CITY OF	45-10273-02	FAIRFAX	VA	08/30/93	IMPROPER SHIPPING PAPERS
942025	FLUOR DANIEL, INC.	39-01261-04	GREENVILLE	SC	05/03/93	IMPROPER SHIPPING PAPERS
942003	FORT WAYNE, CITY OF	13-16526-02	FORT WAYNE	IN	04/21/93	IMPROPER SHIPPING PAPERS
940866	GENERAL ELECTRIC CO.	SNM-1097	WILMINGTON	NC	12/01/93	VEHICLE ACCIDENT
941922	GEORGIA INSTITUTE OF TECHNOLOGY	R-97	ATLANTA	GA	08/02/93	IMPROPER SHIPPING PAPERS
940706	GREAT FALLS, CITY OF	25-15247-01	GREAT FALLS	MT	08/09/93	IMPROPER SHIPPING PAPERS
942006	HEALTH & HUMAN SERVICES, DEPARTMENT OF	50-23219-01	ANCHORAGE	AK	07/19/93	FAILURE TO MAINTAIN RECORDS
942007	HERRON TESTING LABORATORIES, INC.	34-00681-03	CLEVELAND	OH	01/01/93	IMPROPER SHIPPING CONTAINER, IMPROPER SHIPPING PAPERS, FAILURE TO BRACE AND BLOCK PACKAGE
942022	HORNOR BROTHERS ENGINEERS	47-24962-01	CLARKSBURG	WV	05/26/93	IMPROPER SHIPPING PAPERS
941606	INDEPENDENT TESTING LABORATORIES	GEN. LICENSE	HOUSTON	TX	12/14/93	IMPROPER SHIPPING PAPERS
941987	INDIANA, DEPARTMENT OF TRANSPORTATION	13-26343-01	VINCENNES	IN	09/21/93	IMPROPER SHIPPING PAPERS
942021	INDUSTRIAL NDT CO., INC. CHARLESTON	39-24888-01	NORTH	SC	06/16/93	FAILURE TO BRACE AND BLOCK PACKAGE

Table A-1.6 Transportation Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF TRANSPORTATION EVENT
942000	LIVINGSTON COUNTY ROAD COMMISSION	21-20064-01	HOWELL	MI	06/29/93	FAILURE TO BRACE AND BLOCK PACKAGE
940610	MALLINCKRODT MEDICAL, INC.	24-04206-13MD	SAINT LOUIS	MO	05/07/93	CONTAMINATED PACKAGE
940611	MALLINCKRODT MEDICAL, INC.	24-04206-13MD	SAINT LOUIS	MO	05/11/93	EXCESS RADIATION LEVELS
940097	MALLINCKRODT, INC.	37-23326-01MD	FOLCROFT	PA	05/07/93	CONTAMINATED PACKAGE
942001	MALLINCKRODT, INC.	24-04206-01	MARYLAND HEIGHTS	MO	02/19/93	FAILURE TO CHECK FOR SURFACE CONTAMINATION
941998	MAYO FOUNDATION	22-00519-03	ROCHESTER	MN	01/07/93	FAILURE TO MAINTAIN RECORDS
940665	MEDI+ PHYSICS, INC.	29-28341-02MD	LIVINGSTON	NJ	09/03/93	EXCESS RADIATION LEVELS
940907	MICHIGAN STATE UNIVERSITY	21-00021-29	EAST LANSING	MI	02/28/93	IMPROPER SHIPPING PAPERS FAILURE TO BRACE AND BLOCK PACKAGE
941997	MINNESOTA MINING & MANUFACTURING CO.	22-00057-07	SAINT PAUL	MN	01/27/93	IMPROPER SHIPPING CONTAINER
940824	MISSOURI, UNIVERSITY AT COLUMBIA	R-103	COLUMBIA	MO	01/01/93	IMPROPER SHIPPING PAPERS
940677	NAVY, DEPARTMENT OF	45-23645-01NA	WASHINGTON	DC	08/03/93	IMPROPER SHIPPING PAPERS
940690	NORTH AMERICAN INSPECTION, INC.	37-23370-01	WHITEHALL	PA	09/01/93	IMPROPER SHIPPING PAPERS
941999	NORTH COUNTRY HOSPITAL	22-24742-01	BEMIDJI	MN	08/19/93	FAILURE TO CHECK FOR SURFACE CONTAMINATION
942033	OPTICAL CORP. OF AMERICA	20-23742-01	MARLBORO	MA	11/19/93	IMPROPER SHIPPING PAPERS
940715	PUBLIC SERVICE CO. OF COLORADO	NR	PLATTEVILLE	CO	03/04/93	VEHICLE ACCIDENT
942010	QUALITY INSPECTION & TESTING	50-29038-01	FAIRBANKS	AK	08/04/93	IMPROPER SHIPPING CONTAINER
941835	RADIATION MANAGEMENT CONSULTANTS	37-13129-01	PHILADELPHIA	PA	03/31/93	IMPROPER SHIPPING PAPERS
940683	RADIOPHARMACY, INC.	13-26246-01MD	EVANSVILLE	IN	02/24/93	IMPROPER SHIPPING PAPERS
941608	SAINT LUKE'S MEDICAL CENTER	34-00398-08	CLEVELAND	OH	04/07/93	IMPROPER SHIPPING CONTAINER, IMPROPER SHIPPING PAPERS
941005	SAINT MARGARET MEMORIAL HOSPITAL	37-14014-01	PITTSBURGH	PA	05/03/93	CONTAMINATED PACKAGE

Table A-1.6 Transportation Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF TRANSPORTATION EVENT
940676	SCHNABEL ENGINEERING ASSOCIATES, INC.	45-19703-01	RICHMOND	VA	08/25/93	IMPROPER SHIPPING PAPERS
940879	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	01/20/93	VEHICLE ACCIDENT
940660	SOIL ENGINEERS & SCIENTISTS, INC.	21-26066-01	TRENTON	MI	08/18/93	IMPROPER SHIPPING PAPERS
940699	SUPERIOR PAVING CORP.	45-24949-01	CENTREVILLE	VA	07/21/93	IMPROPER SHIPPING PAPERS
941460	TROJAN NUCLEAR PLANT	NR	PRESCOTT	OR	12/23/93	EXCESS RADIATION LEVELS
940659	UNITED STATES TESTING CO., INC.	41-25235-01	MEMPHIS	TN	09/09/93	IMPROPER SHIPPING PAPERS
940497	V.A., DEPARTMENT OF	04-00181-04	LOS ANGELES	CA	12/20/93	IMPROPER SHIPPING PAPERS
940704	V.A., DEPARTMENT OF TRANSPORTATION	30-01747-02	ALBUQUERQUE	NM	02/02/93	IMPROPER
940132	WESTERN ATLAS INTERNATIONAL, INC.	42-02964-01	HOUSTON	TX	06/02/93	EXCESS RADIATION LEVELS
941992	WILLIAM BEAUMONT HOSPITAL	21-01333-01	ROYAL OAK	MI	05/21/93	IMPROPER SHIPPING CONTAINER
940694	WILSON ENGINEERING	50-23263-01	JUNEAU	AK	09/09/93	IMPROPER SHIPPING PAPERS
942020	WILSON ENGINEERING	50-23263-01	JUNEAU	AK	08/12/93	IMPROPER SHIPPING PAPERS
942009	WOLVERINE ENGINEERS AND SURVEYORS, INC.	21-25970-01	MASON	MI	01/19/93	IMPROPER SHIPPING PAPERS, FAILURE TO BRACE AND BLOCK PACKAGE

NR indicates NOT REPORTED

Table A-1.7 Equipment Problems Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940591	ABBOTT HEALTH PRODUCTS, INC.	52-249944-01	VEGA ALTA	PR	10/19/93	IRRADIATOR
940963	ABBOTT-NORTHWESTERN HOSPITAL	22-04588-01	MINNEAPOLIS	MN	01/06/93	BRACHYTHERAPY NON-MAN AFT-HDR
940020	AGRICULTURE, DEPARTMENT OF	19-00915-03	HYATTSVILLE	MD	07/14/93	GAUGE, MOISTURE DENSITY
940595	AIR FORCE, DEPARTMENT OF	42-23539-01AF	BROOKS AFB	TX	09/03/93	MODERATOR COLLIMETER SHIELD
940713	AIR FORCE, DEPARTMENT OF	42-23539-01AF	BROOKS AFB	TX	10/19/93	IRRADIATOR INTERLOCK
940218	AMERSHAM CORP.	NO LICENSE	BURLINGTON	MA	11/22/93	55 GALLON DRUM
940668	AMERSHAM CORP.	20-12836-01	BURLINGTON	MA	07/29/93	COBALT SOURCE ASSEMBLY
940669	AMERSHAM CORP.	20-12836-01	BURLINGTON	MA	07/16/93	SOURCE ASSEMBLY
940982	ARMY, DEPARTMENT OF THE	19-17250-05	ADELPHI	MD	10/26/93	IRRADIATOR POOL
940146	ATEC ASSOCIATES OF VIRGINIA, INC.	45-16546-04	ALEXANDRIA	VA	04/09/93	GAUGE, MOISTURE DENSITY
940794	ATEC ASSOCIATES, INC.	34-18893-01	CINCINNATI	OH	07/29/93	GAUGE, MOISTURE DENSITY
940827	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	07/02/93	EVACUATION ALARM
940845	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	10/21/93	EVACUATION ALARM
940094	BARNETT INDUSTRIAL X-RAY	35-26953-01	STILLWATER	OK	06/10/93	RADIOGRAPHY CAMERA
940095	BARNETT INDUSTRIAL X-RAY	35-26953-01	STILLWATER	OK	08/18/93	RADIOGRAPHY CAMERA
940156	BETTERROADS ASPHALT CORP.	52-19845-01	RIO PIEDRAS	PR	02/04/93	GAUGE, MOISTURE DENSITY
940973	BRIDGEPORT BRASS CORP.	13-26078-01	INDIANAPOLIS	IN	06/15/93	GAUGE
940014	CALUMET TESTING SERVICES, INC.	13-16347-01	HIGHLAND	IN	06/14/93	RADIOGRAPHY CAMERA
940217	COBIN, RHODA H., M.D. PARK	29-18376-01	MIDLAND	NJ	03/05/93	DOSE CALIBRATOR
940069	COLUMBUS, CITY OF	34-13103-02	COLUMBUS	OH	04/06/93	GAUGE, MOISTURE DENSITY
940869	COMBUSTION ENGINEERING, INC.	SNM-1067	WINDSOR	CT	08/04/93	CRITICALITY ALARM
940150	CONSOLIDATED PAPERS, INC.	48-01117-01	WISCONSIN RAPIDS	WI	01/06/93	GAUGE
940151	CONSOLIDATED PAPERS, INC.	48-01117-01	WISCONSIN RAPIDS	WI	09/17/93	GAUGE

Table A-1.7 Equipment Problems Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940116	CONSTRUCTION ENGINEERING CONSULTANTS, INC.	37-18456-02	PITTSBURGH	PA	06/15/93	GAUGE, MOISTURE DENSITY
940666	CTL ENGINEERING, INC.	34-18533-01	COLUMBUS	OH	07/22/93	GAUGE, MOISTURE DENSITY
941281	DEACONESS MEDICAL CENTER	25-01051-01	BILLINGS	MT	11/30/93	THERAPLAN-L COMPUTER
940228	DEFENSE NUCLEAR AGENCY	19-08330-03	BETHESDA	MD	06/22/93	IRRADIATOR
940229	DEFENSE NUCLEAR AGENCY	19-08330-03	BETHESDA	MD	06/16/93	IRRADIATOR
940686	DEFENSE NUCLEAR AGENCY	19-08330-03	BETHESDA	MD	10/19/93	IRRADIATOR INTERLOCK
940147	ENGINEERING CONSULTING SERVICES, LTD.	45-24974-01	CHANTILLY	VA	04/28/93	GAUGE, MOISTURE DENSITY
940705	EVERGREEN RADIOLOGY ASSOCIATES	29-02023-06	WAYNE	NJ	05/14/93	BRACHYTHERAPY NON-MAN AFT-HDR
940622	FARWELL & HENDRICKS, INC.	NO LICENSE	CINCINNATI	OH	11/29/93	OVERLOAD RELAYS
941449	FOX CHASE CANCER CENTER	37-02766-01	PHILADELPHIA	PA	08/18/93	HDR PLANNING SYSTEM
940183	GEISINGER MEDICAL CENTER	37-01421-04	DANVILLE	PA	03/31/93	TELETHERAPY UNIT
940868	GENERAL ELECTRIC CO.	SNM-1097	WILMINGTON	NC	05/13/93	RECEIVING PAIL SENSOR
940111	GLENN O. HAWBAKER, INC.	37-19636-01	STATE COLLEGE	PA	08/16/93	GAUGE, MOISTURE DENSITY
940071	GLITSCH FIELD SERVICES/NDE, INC.	34-14071-01	NORTH CANTON	OH	04/08/93	RADIOGRAPHY CAMERA
941424	H&G INSPECTION CO., INC.	42-26838-01	HOUSTON	TX	02/09/93	RADIOGRAPHY GUIDE TUBE
940625	HEALTH & HUMAN SERVICES, DEPARTMENT OF	19-00296-12	BETHESDA	MD	10/07/93	IRRADIATOR
940687	HEALTH & HUMAN SERVICES, DEPARTMENT OF	19-00296-12	BETHESDA	MD	09/24/93	IRRADIATOR
940743	HEALTH & HUMAN SERVICES, DEPARTMENT OF	19-00296-17	BETHESDA	MD	12/03/93	IRRADIATOR
940819	HEALTH & HUMAN SERVICES, DEPARTMENT OF	19-00296-17	BETHESDA	MD	12/15/93	IRRADIATOR
940680	HENRICO DOCTORS HOSPITAL	45-16231-02	RICHMOND	VA	04/30/	IRRADIATOR INTERLOCK
940984	HEALTH & HUMAN SERVICES, DEPARTMENT OF	19-00296-10	BETHESDA	MD	08/04/93	SELECTION REMOTE AFTERLOAD-LDR

Table A-1.7 Equipment Problems Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940589	HONOLULU RESOURCE RECOVERY VENTURE	53-23291-01	EWA BEACH	HI	12/27/93	ASH TOWER SURGE BINS
940692	HULL & ASSOCIATES, INC.	34-24957-01	TOLEDO	OH	06/17/93	GAUGE, MOISTURE DENSITY
940623	INTERIOR, DEPARTMENT OF	02-21080-01	TUBA CITY	AZ	09/28/93	GAUGE, MOISTURE DENSITY
940158	LAS PIEDRAS CONSTRUCTION CORP.	52-25125-01	LAS PIEDRAS	PR	07/13/93	GAUGE, MOISTURE DENSITY
940077	MARIETTA COAL CO.	34-23333-01	SAINT CLAIRSVILLE	OH	02/25/93	SOURCE HOLDER
940124	MOUNT SINAI MEDICAL CENTER	34-00746-02	CLEVELAND	OH	03/01/93	SOURCE SAFE
941852	NORTH AMERICAN INSPECTION, INC.	37-23370-01	WHITEHALL	PA	05/06/93	PROJECTOR
941854	NORTH AMERICAN INSPECTION, INC.	37-23370-01	WHITEHALL	PA	11/03/93	RADIOGRAPHY CAMERA
941972	NORTH AMERICAN INSPECTION, INC.	37-23370-01	WHITEHALL	PA	07/29/93	RADIOGRAPHY CAMERA
940075	NORTH STAR STEEL OHIO	34-20328-01	YOUNGSTOWN	OH	05/28/93	GAUGE, FIXED
940971	NTH CONSULTANTS, LTD.	21-14894-01	FARMINGTON HILLS	MI	09/24/93	GAUGE, MOISTURE DENSITY
940914	NUCLEAR FUEL SERVICES, INC.	SNM-124	ERWIN	TN	11/16/93	SUPTIG TYPE B PROTOVERPACKS
940182	NUCLETRON CORP.	19-28772-01	COLUMBIA	MD	03/02/93	BRACHYTHERAPY NON-MAN AFT-HDR
940803	NUCLETRON CORP.	19-28772-01	COLUMBIA	MD	04/01/93	BRACHYTHERAPY NON-MAN AFT-HDR
940988	NUMERICAL APPLICATIONS, INC.	NR	RICHLAND	WA	11/06/93	COMPUTER PROGRAM
940087	OHIO DEPARTMENT OF TRANSPORTATION	34-05239-01	COLUMBUS	OH	08/03/93	GAUGE, MOISTURE DENSITY
940494	OHIO STATE UNIVERSITY	R-75	COLUMBUS	OH	03/05/93	REACTOR
941054	OMNITRON INTERNATIONAL, INC.	NO LICENSE	HOUSTON	TX	03/09/93	BRACHYTHERAPY NON-MAN AFT-HDR
940709	OMNITRON INTERNATIONAL, INC.	NO LICENSE	HOUSTON	TX	03/03/93	BRACHYTHERAPY NON-MAN AFT-HDR
940603	PARKVIEW HOSPITAL	37-12141-01	PHILADELPHIA	PA	01/20/93	NR
940711	PERMAGRAIN PRODUCTS, INC.	37-17860-02	MEDIA	PA	06/01/93	IRRADIATOR POOL

Table A-1.7 Equipment Problems Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940109	PRECISION COMPONENTS CORP.	37-16280-01	YORK	PA	09/07/93	RADIOGRAPHY CAMERA
940063	PROCESS TECHNOLOGY OF	29-13613-02	ROCKAWAY NORTH JERSEY	NJ	03/08/93	CIRCULATION PUMP
940702	PROCTER & GAMBLE CO.	34-01572-13	CINCINNATI	OH	04/02/93	GAUGE, FIXED
940100	ROBERT PACKER HOSPITAL	37-01893-01	SAYRE	PA	04/22/93	BRACHYTHERAPY NON-MAN AFT-HDR
940594	ROCKINGHAM MEMORIAL HOSPITAL	45-05594-02	HARRISBURG	VA	12/13/93	TELETHERAPY UNIT
940860	RTS TECHNOLOGY, INC. ANDOVER	20-27966-01	NORTH	MA	05/11/93	SOURCE ASSEMBLY
940697	RUSSELL COUNTY MEDICAL CENTER, INC.	45-19940-01	LEBANON	VA	04/15/93	DOSE CALIBRATOR
940102	SAINT FRANCIS HOSPITAL	13-02128-02	BEECH GROVE	IN	07/02/93	TELETHERAPY UNIT
940210	SAINT LOUIS COUNTY	24-26279-01	CLAYTON	MO	06/14/93	GAUGE, MOISTURE DENSITY
940033	SAINT MARY'S MEDICAL CENTER	21-03646-04	SAGINAW	MI	05/19/93	TELETHERAPY UNIT
940675	SCHNABEL ENGINEERING ASSOCIATES, INC.	45-19703-01	RICHMOND	VA	07/11/93	GAUGE, MOISTURE DENSITY
940847	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	02/25/93	OFF SITE SIRENS
940848	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	04/03/93	OFF SITE SIRENS
940888	SHADYSIDE HOSPITAL	SNM-1531	PITTSBURGH	PA	08/30/93	NUCLEAR PACEMAKER
940212	SHANNON & WILSON, INC.	24-18839-01	SAINT LOUIS	MO	09/12/93	GAUGE, MOISTURE DENSITY
940662	SOIL ENGINEERS & SCIENTISTS, INC.	21-26066-01	TRENTON	MI	07/16/93	GAUGE, MOISTURE DENSITY
940115	SUMMIT TESTING & INSPECTION CO.	34-23416-01	AKRON	OH	07/08/93	GAUGE, MOISTURE DENSITY
940118	TEI ANALYTICAL SERVICES, INC.	37-28004-01	WASHINGTON	PA	01/26/93	RADIOGRAPHY CAMERA
940045	TWIN CITY TESTING CORP.	22-01376-02	SAINT PAUL	MN	02/02/93	RADIOGRAPHY CAMERA
940046	TWIN CITY TESTING CORP.	22-01376-02	SAINT PAUL	MN	06/04/93	RADIOGRAPHY CAMERA
940875	TWIN CITY TESTING CORP.	22-01376-02	SAINT PAUL	MN	06/29/93	RADIOGRAPHY CAMERA
940078	VALLEY ASPHALT CORP.	34-24771-01	CINCINNATI	OH	03/17/93	GAUGE, MOISTURE DENSITY

Table A-1.7 Equipment Problems Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940161	WASHINGTON HOSPITAL CENTER	SNM-1446	WASHINGTON	DC	04/19/93	NUCLEAR PACEMAKER
940049	WASHINGTON UNIVERSITY MEDICAL SCHOOL	24-00167-11	SAINT LOUIS	MO	05/05/93	SEALED SOURCE
940958	WASHINGTON UNIVERSITY MEDICAL SCHOOL	24-00167-11	SAINT LOUIS	MO	02/26/93	BRACHYTHERAPY REMOTE AFT-LDR
940037	WAYNE COUNTY OFFICE OF PUBLIC SERVICE	21-13687-01	ROMULUS	MI	08/16/93	GAUGE, MOISTURE DENSITY
940056	WHEATON GLASS CO.	29-00968-02	MILLVILLE	NJ	08/23/93	GAUGE, FIXED
941036	WISCONSIN ELECTRIC POWER CO.	GENERAL LIC	MILWAUKEE	WI	08/31/93	EXIT SIGN

NR indicates NOT REPORTED

Table A-1.8 Fuel Cycle Events Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF FUEL CYCLE EVENT
940631	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	04/19/93	POTENTIAL CRITICALITY
940828	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	06/02/93	POTENTIAL CRITICALITY
940829	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	04/20/93	POTENTIAL CRITICALITY
940830	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	04/16/93	POTENTIAL CRITICALITY
940831	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	02/26/93	POTENTIAL CRITICALITY
940846	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	09/16/93	POTENTIAL CRITICALITY
940893	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	03/11/93	POTENTIAL CRITICALITY
941601	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	11/11/93	POTENTIAL CRITICALITY
941602	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	04/09/93	POTENTIAL CRITICALITY
941677	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	02/16/93	POTENTIAL CRITICALITY
941680	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	02/19/93	POTENTIAL CRITICALITY
941686	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	07/17/93	POTENTIAL CRITICALITY
940864	GENERAL ELECTRIC CO.	SNM-1097	WILMINGTON	NC	12/21/93	POTENTIAL CRITICALITY
940843	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	04/07/93	POTENTIAL CRITICALITY
940841	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	05/20/93	POTENTIAL CRITICALITY
940842	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	05/10/93	POTENTIAL CRITICALITY
940880	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	01/27/93	POTENTIAL CRITICALITY
941570	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	02/08/93	POTENTIAL CRITICALITY
940882	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	04/27/93	POTENTIAL CRITICALITY
940883	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	06/09/93	POTENTIAL CRITICALITY
940884	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	12/28/93	POTENTIAL CRITICALITY
941020	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	04/08/93	POTENTIAL CRITICALITY
940850	BABCOCK & WILCOX CO. EQUIPMENT PROBLEM	SNM-42	LYNCHBURG	VA	07/17/93	POTENTIAL CRITICALITY,
940835	COMBUSTION ENGINEERING, INC.	SNM-33	HEMATITE	MO	03/31/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940871	GENERAL ATOMICS	SNM-696	SAN DIEGO	CA	01/11/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940865	GENERAL ELECTRIC CO.	SNM-1097	WILMINGTON	NC	12/09/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM

Table A-1.8 Fuel Cycle Events Reported by NRC Licensees, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF FUEL CYCLE EVENT
940895	NUCLEAR FUEL SERVICES EQUIPMENT PROBLEM	SNM-124	ERWIN	TN	01/28/93	POTENTIAL CRITICALITY,
940881	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	02/07/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940887	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	06/16/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940862	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	05/21/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940896	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	08/13/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940897	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	07/20/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
941703	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	02/16/93	POTENTIAL CRITICALITY, EQUIPMENT PROBLEM
940851	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	07/04/93	EQUIPMENT PROBLEM
941701	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	06/04/93	EQUIPMENT PROBLEM
940844	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	02/04/93	EQUIPMENT PROBLEM
941679	SEQUOYAH FUELS CORP.	SUB-1010	GORE	OK	02/25/93	EQUIPMENT PROBLEM
940886	SIEMENS NUCLEAR POWER CORP.	SNM-1227	RICHLAND	WA	10/13/93	EQUIPMENT PROBLEM, CONTAMINATION
940870	COMBUSTION ENGINEERING, INC.	SNM-1067	WINDSOR	CT	01/06/93	EQUIPMENT PROBLEM, OTHER
940839	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	10/13/93	OTHER
940840	NUCLEAR FUEL SERVICES	SNM-124	ERWIN	TN	09/02/93	OTHER
940892	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	01/21/93	OTHER
940832	BABCOCK & WILCOX CO.	SNM-42	LYNCHBURG	VA	01/27/93	OTHER
940939	CHEMETRON CORP.	SUB-1357	PROVIDENCE	RI	12/08/93	OTHER
941688	GENERAL ATOMICS	SNM-696	SAN DIEGO	CA	08/16/93	OTHER
940863	WESTINGHOUSE ELECTRIC CORP.	SNM-1107	PITTSBURGH	PA	01/13/93	OTHER

Table A-1.9 Research and Training Reactor Events Reported by NRC Licensees, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF REACTOR EVENT
940825	ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE	R-84	BETHESDA	MD	11/05/93	EQUIPMENT PROBLEM
940770	MASSACHUSETTS INSTITUTE OF TECHNOLOGY	R-37	CAMBRIDGE	MA	12/07/93	EQUIPMENT PROBLEM
940820	MICHIGAN, UNIVERSITY OF	R-28	ANN ARBOR	MI	03/24/93	LICENSE CONDITION VIOLATION
940748	MICHIGAN, UNIVERSITY OF	R-28	ANN ARBOR	MI	07/30/93	AQUEOUS RELEASE OF RADIOACTIVE MATERIAL
940826	MISSOURI, UNIVERSITY OF, AT ROLLA	R-79	ROLLA	MO	10/26/93	EQUIPMENT PROBLEM
940494	OHIO STATE UNIVERSITY	R-75	COLUMBUS	OH	03/05/93	EQUIPMENT PROBLEM
940771	VIRGINIA, UNIVERSITY OF	R-66	CHARLOTTESVILLE	VA	04/28/93	EQUIPMENT PROBLEM
940747	VIRGINIA, UNIVERSITY OF	R-66	CHARLOTTESVILLE	VA	11/05/93	WATER LOSS FROM REACTOR POOL

Appendix A-2

Agreement State Licensee Events

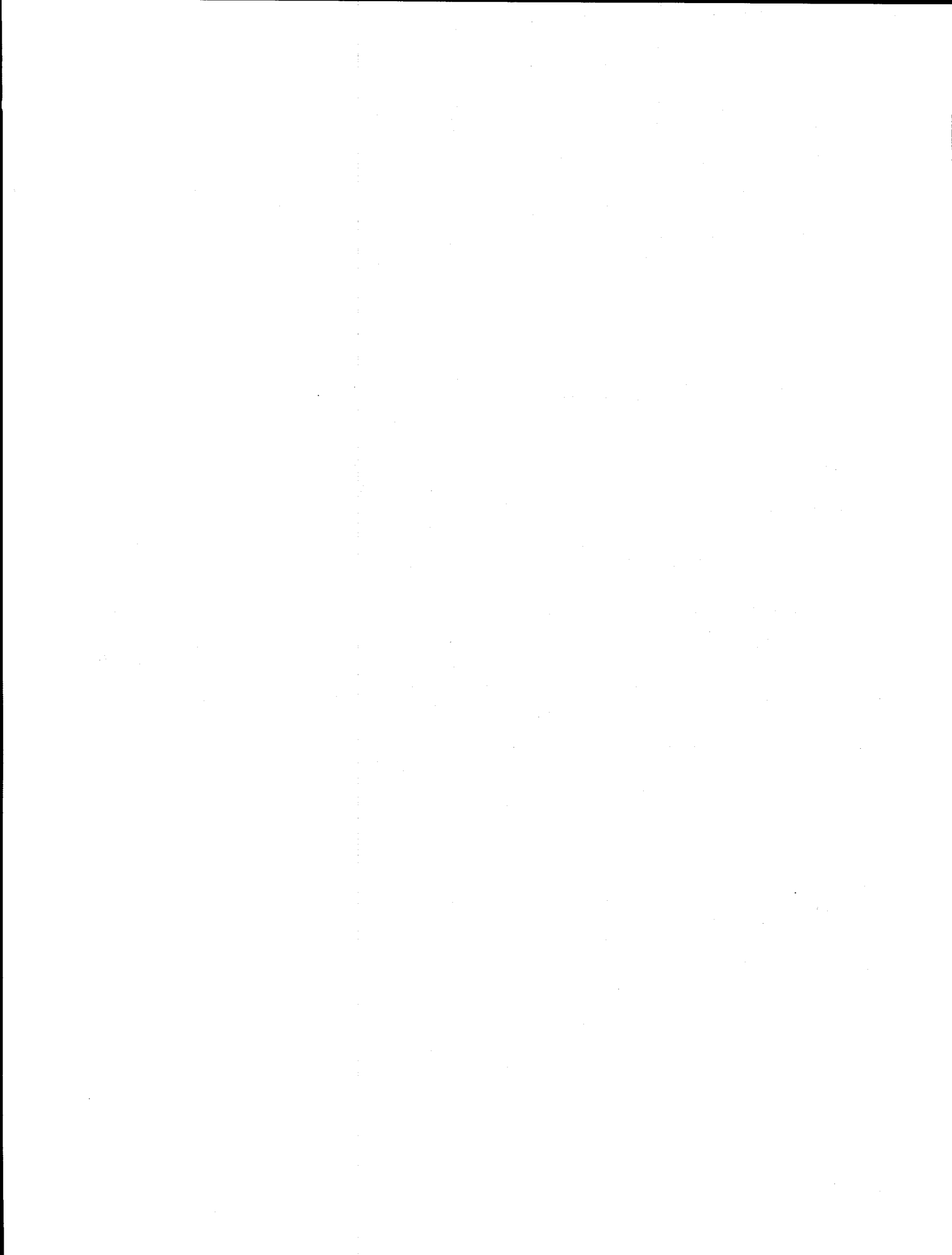


Table A-2.1 Medical Misadministrations Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF MISADMINISTRATION
940270	BAPTIST MEMORIAL HOSPITAL	R-79032-F97	MEMPHIS	TN	11/26/93	BRACHYTHERAPY
941126	CALIFORNIA, UNIVERSITY OF, AT DAVIS	1334-57	DAVIS	CA	12/14/93	BRACHYTHERAPY
940734	CLEAR LAKE REGIONAL MEDICAL CENTER	NR	WEBSTER	TX	07/06/93	BRACHYTHERAPY
940207	JOHNSON CITY MEDICAL CENTER	R-90005-K97	JOHNSON CITY	TN	04/21/93	BRACHYTHERAPY
941975	LONG HOSPITAL, UNIVERSITY OF CALIFORNIA	1725-90	SAN FRANCISCO	CA	12/07/93	BRACHYTHERAPY
940738	MEMORIAL MEDICAL CENTER	NR	LUFKIN	TX	10/05/93	BRACHYTHERAPY
940457	MICHAEL REESE HOSPITAL & MEDICAL CENTER	86-01097-01	CHICAGO	IL	10/10/93	BRACHYTHERAPY
941001	MOUNT SINAI MEDICAL CENTER	FL-64-12	MIAMI	FL	11/24/93	BRACHYTHERAPY
940295	REGIONAL MEDICAL CENTER OF MEMPHIS	R-79160-L97	MEMPHIS	TN	06/16/93	BRACHYTHERAPY
940524	AS TELETHERAPY LICENSEE	NR	ALBANY	NY	05/10/93	TELETHERAPY
940477	PRESBYTERIAN HOSPITAL	60-019-A	CHARLOTTE	NC	10/01/93	TELETHERAPY
941245	SAINT FRANCIS MEDICAL CENTER	LA-0193-L01	MONROE	LA	01/19/93	TELETHERAPY
940802	ROCKY MOUNTAIN GAMMA KNIFE CENTER	NR	DENVER	CO	07/08/93	TELETHERAPY-GAMMA KNIFE
941127	CALIFORNIA, UNIV. OF, AT SAN FRANCISCO	1725-90	SAN FRANCISCO	CA	07/19/93	SODIUM IODIDE
941125	CENTINELA HOSPITAL	0940-70	NR	CA	05/18/93	SODIUM IODIDE
940205	HIGHSMITH RAINEY HOSPITAL	26-129-2	FAYETTEVILLE	NC	05/27/93	SODIUM IODIDE
940284	KAISER-FRANKLIN MEDICAL CENTER	NR	DENVER	CO	08/17/93	SODIUM IODIDE
940473	NORTH CAROLINA BAPTIST HOSPITAL	34-158-1	WINSTON-SALEM	NC	06/17/93	SODIUM IODIDE
941128	SIERRA VISTA HOSPITAL	3822-70	NR	CA	06/29/93	SODIUM IODIDE

NR indicates NOT REPORTED

Table A-2.2 Overexposures Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF EXPOSURE	NO. EXPOSED	DOSE (REM)
940380	MOUNT SINAI MEDICAL CENTER	0064-1	MIAMI BEACH	FL	09/14/93	WB	1	5.6
940539	WESTCHESTER COUNTY MEDICAL CENTER	586-2	VALHALLA	NY	07/31/93	WB	1	2.79
940682	X-CEL GROUP, INC.	NR	CORPUS CHRISTI	TX	05/22/93	EXT	1	1925
940200	MQS INSPECTION, INC.	86-01136-01	ELK GROVE	IL	07/15/93	EXT	1	146
940629	TECHNICAL WELDING LABORATORY, INC.	NR	PASADENA	TX	04/12/93	EXT	1	65
940813	UNIVERSAL TESTING, INC.	UT-06003-23	CLEARFIELD	UT	07/28/93	EXT	1	306.4
940790	ANAID, INC.	NR	DICKINSON	TX	09/01/93	WB	1	3.71
940804	APPLIED STANDARDS INSPECTION, INC.	NR	BEAUMONT	TX	11/05/93	WB	1	6.159
940805	APPLIED STANDARDS INSPECTION, INC.	NR	BEAUMONT	TX	11/05/93	WB	1	3.371
940584	B.F. SHAW	074	LAURENS	SC	02/02/93	WB	1	1.6
941422	BASIN INDUSTRIAL X-RAY	NR	CORPUS CHRISTI	TX	01/25/93	WB	1	4.7
941611	BERRY FABRICATORS	NR	CORPUS CHRISTI	TX	02/01/93	WB	1	1.44
941612	BERRY FABRICATORS	NR	CORPUS CHRISTI	TX	05/01/93	WB	1	1.68
940766	D-ARROW INSPECTION, INC.	NR	HOUSTON	TX	09/01/93	WB	1	3.1
941902	EL PASO INSPECTION	NR	EL PASO	TX	08/01/93	WB	1	1.9
940626	GUARDIAN NDT SERVICES	NR	CORPUS CHRISTI	TX	03/15/93	WB	2	1.25, 1.25
940735	GUARDIAN NDT SERVICES	NR	CORPUS CHRISTI	TX	06/01/93	WB	1	4.223
940383	GULF COAST QUALITY ASSOCIATES, INC.	1495-1	JAY	FL	09/21/93	WB	2	1.32, 2.81
940204	INSPECTION SPECIALISTS, INC.	LA-4266-L01	MERAUX	LA	05/07/93	WB	1	27.66
941620	PHOENIX NON-DESTRUCTIVE TESTING CO., INC.	NR	CHANNELVIEW	TX	10/31/93	WB	1	3.265
940581	PROFESSIONAL SERVICES INDUSTRIES	NR	LONGVIEW	TX	05/10/93	WB	1	1.66
941621	RADIOGRAPHIC SPECIALISTS, INC.	NR	HOUSTON	TX	10/01/93	WB	1	4.495

WB indicates WHOLE BODY

NR indicates NOT REPORTED

EXT indicates EXTREMITY

Table A-2.3 Loss of Control of Material Events Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940312	ACRE IRON AND METAL	NON-LICENSEE	PINELLAS PARK	FL	03/12/93	U-DEP
940777	ALUMAX MILL PRODUCTS	NR	TEXARKANA	TX	09/14/93	FE-55
941400	AMERICAN EAGLE WELL LOGGING, INC.	NR	WITCHITA FALLS	TX	01/07/93	CS-137
940453	AMERSHAM CORP.	12-12836-01	NR	IL	08/27/93	P-32
940800	APPLIED STANDARDS INSPECTION, INC.	NR	BEAUMONT	TX	09/29/93	IR-192
940178	AS SCRAP METAL DEALER	NON-LICENSEE	MAGNOLIA	AR	03/24/93	CS-137
940648	AT LABORATORIES, INC.	NR	ARLINGTON	TX	06/01/93	CS-137, AM-BE
940381	ATLANTIC COAST ELECTRONICS	023-GL	POMPANO BEACH	FL	09/14/93	SR-90
941609	BAYLOR COLLEGE OF MEDICINE	NR	HOUSTON	TX	10/12/93	CS-137
941209	BFI	NR	NR	CA	06/12/93	NR
940226	BFI LANDFILL	NON-LICENSEE	BILOXI	MS	08/14/93	NR
940566	BFI WASTE SYSTEMS	NR	GALVESTON	TX	04/01/93	CS-137
940586	BOGGS/VAUGHN	090-0892-1	MONROE	NC	09/10/93	CS-137, AM-BE
941313	BRADFORD SQUARE NURSING HOME	NON-LICENSEE	FRANKFORT	KY	11/26/93	I-131
940812	BRIGHAM YOUNG UNIVERSITY	UT-25000-81	PROVO	UT	01/04/93	NI-63
941141	BROTMAN MEDICAL DTR	NR	NR	CA	01/22/93	PU-238
941201	CALIFORNIA TRANSPORTATION DISTRICT 15	NR	NR	CA	05/24/93	CS-137, AM-BE
941208	CALIFORNIA, UNIVERSITY OF, AT DAVIS	NR	DAVIS	CA	06/11/93	C-14
940401	CENTRAL FLORIDA TESTING LABORATORIES, INC.	1062-1	LARGO	FL	12/09/93	CS-137, AM-BE
940674	CHAPARRAL STEEL	NR	MIDLOTHIAN	TX	05/11/93	CS-137
940755	CHAPARRAL STEEL	NR	MIDLOTHIAN	TX	09/18/93	CS-137
940201	CHICAGO, UNIVERSITY OF	12-00509-03	CHICAGO	IL	05/04/93	CS-137
940562	CLARKSTOWN RECYCLING, INC.	NON-LICENSEE	WEST NYACK	NY	06/29/93	I-131
941563	CONVERSE CONSULTANTS SOUTHWEST	00-11-0094-01	LAS VEGAS	NV	04/26/93	CS-137, AM-BE
941913	CORSICANA WASTE WATER TREATMENT DEPT., CITY OF	NR	CORSICANA	TX	12/27/93	CS-137
940632	CUMMINGS WIRELINE SERVICES, INC.	NR	SOMERSET	TX	03/20/93	AM-BE

Table A-2.3 Loss of Control of Material Events Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940620	DAVID JOSEPH SCRAP CO.	NON-LICENSEE	TAMPA	FL	03/12/93	NR
941248	DAVID JOSEPH SCRAP CO.	NR	NEWPORT	KY	05/19/93	ND
941251	DAVID JOSEPH SCRAP CO.	NR	NEWPORT	KY	03/24/93	NR
941273	DAVID JOSEPH SCRAP CO.	NON-LICENSEE	NEWPORT	KY	07/14/93	NR
941261	ELK CORP.	GEN. LICENSEE		AR	03/24/93	CS-137
940952	ELK ROOFING COMPANY	NR	STEVENS	AR	03/24/93	CS-137
940461	ENGINEERS INTERNATIONAL, INC.	86-01385-01	CHICAGO	IL	11/05/93	CS-137, AM-BE
940406	ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.	2119-1	GAINESVILLE	FL	11/17/93	TH-229, TH-230, PU-239, AM-241, CM-244
940196	FLO-LOG, INC.	4204-70	SOUTH GATE	CA	02/17/93	CS-137
940352	FLORIDA ATLANTIC UNIVERSITY	734-1(3L(3))	BOCA RATON	FL	04/29/93	S-35
940346	FLORIDA KIDNEY CENTER	1976-1(5D)	TAMRAC	FL	04/22/93	I-125
940407	FLORIDA, UNIVERSITY OF	0356-1	GAINESVILLE	FL	11/10/93	AM-BE
941423	FUGRO-MCCCELLAND, INC.	NR	AUSTIN	TX	02/17/93	CS-137, AM-BE
940235	GALLET ASSOCIATE	AL-991	GAINESVILLE	GA	11/22/93	CS-137, AM-BE
941914	GEORGIA-PACIFIC CORPORATION	ND	PALATKA	FL	03/19/93	CS-137
941120	GLYNN IRON AND STEEL CO.	NR	BRUNSWICK	GA	04/19/93	RA-226
941119	GOLDBERG BROTHERS, INC.	NR	AUGUSTA	GA	01/11/93	KR-85
940322	GOOD SAMARITAN HOSPITAL	493-1(5B)	WEST PALM BEACH	FL	02/18/93	NA
941264	GREATLAKES CHEMICAL CORP.	ARK-515	NR	AR	10/14/93	CS-137
940192	GROUND ENGINEERING & TESTING SERVICE, INC.	NR	NR	AL	08/24/93	CS-137, AM-241
941243	HALLIBURTON CO.	LA-2353-L01	VENICE	LA	03/24/93	CO-60, CO-60, CO-60, CO-60
941197	HALLIBURTON ENERGY SERVICES	WL086	HOUSTON	TX	10/03/93	CS-137
941198	HALLIBURTON ENERGY SERVICES	WL086	HOUSTON	TX	09/20/93	CS-137
941505	HENDRICK MEDICAL CENTER	L02433	ABILENE	TX	01/15/93	I-131

Table A-2.3 Loss of Control of Material Events Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940349	HENDRY COUNTY GENERAL HOSPITAL	NR	CLEWISTON	FL	05/02/93	PD-103
940324	HIALEAH HOSPITAL	340-3(5B)	HIALEAH	FL	01/20/93	I-131
941623	HOECHST CELANESE CORP.	L00409	CORPUS CHRISTI	TX	12/23/93	NI-63
940555	HUDSON METAL	NON-LICENSEE	ALBANY	NY	06/11/93	AM-241
940447	ILLINOIS, UNIVERSITY OF, AT CHICAGO	12-00088-06	CHICAGO	IL	08/23/93	S-35
940199	JACKSONVILLE, CITY OF, WASTE WATER DIVISION	1031-1	JACKSONVILLE	FL	10/22/93	CS-137, CS-137, CS-137
941270	JEWISH HOSPITAL	202-15	LOUISVILLE	KY	08/22/93	I-131
941016	JOHNS HOPKINS MEDICAL INSTITUTIONS	NR	BALTIMORE	MD	01/21/93	I-125
941385	KASELAAN AND D'ANGELO ASSOCIATES	NR	NEW YORK	NY	12/22/93	NR
941373	KCI TECHNOLOGY	MD-05-037-01	ELLCOTT CITY	MD	02/08/93	CS-137, AM-BE
941268	KENTUCKY, UNIVERSITY OF	NR	LEXINGTON	KY	05/25/93	CS-137
941142	LAYTON AND ASSOCIATES	NR	NR	CA	01/27/93	NR
941357	LEVIN'S SCRAP	NR	NR	NY	01/28/93	CO-60
940437	MEDI+ PHYSICS, INC.	86-01109-01	NR	IL	06/11/93	I-125
941389	MEDI-RAY, INC.	NR	TUCKAHOE	NY	06/21/93	GE-68
941397	MEDI-RAY, INC.	NR	TUCKAHOE	NY	04/01/93	NR
941288	MEDICAL	NR	NR	OR	12/17/93	PU-238
941610	MEDICAL PHYSICS CONSULTANTS	NR	DALLAS	TX	10/04/93	CO-57, BA-133, CS-137
940456	MEMORIAL MEDICAL CENTER	86-01343-01	NR	IL	10/01/93	I-131
941246	METAL CENTER	NON-LICENSEE	LOUISVILLE	KY	06/29/93	U-DEP
940645	METHODIST HOSPITAL	NR	LUBBOCK	TX	06/24/93	I-131
940757	MUSEUM OF NATURAL HISTORY	NR	NR	NY	03/02/93	NR
940107	NEWPORT STEEL	20-1450-56	WILDER	KY	08/03/93	NR
941269	NON-LICENSEE	NON-LICENSEE	JEFFERSONVILLE	KY	08/26/93	XE-133
941344	NON-LICENSEE	NR	NR	OR	03/03/93	NR
941326	NUCLEAR MEDICINE	NR	NR	OR	10/06/93	PU-238

Table A-2.3 Loss of Control of Material Events Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940325	NUTTING ENGINEERS	934-1(3L(1))	BOYNTON BEACH	FL	01/17/93	CS-137, AM-BE
941207	ORANGE COAST ANALYTICAL LABS	NR	NR	CA	06/10/93	NR
940368	PARKWAY HOSPITAL	ND	NR	FL	08/16/93	I-131
940269	PRIVATE INDIVIDUAL	NON-LICENSEE	KINGSPORT	TN	12/09/93	CS-137
941002	PRIVATE INDIVIDUAL	NON-LICENSEE	LARGO	FL	09/14/93	CO-60
941236	PRIVATE INDIVIDUAL	NON-LICENSEE	TUCSON	AZ	11/12/93	CO-60
941338	PRIVATE INDIVIDUAL	NR	NR	OR	04/24/93	U-235
941564	PRIVATE INDIVIDUAL	NON-LICENSEE	MOUNDHOUSE	NV	05/31/93	CS-137
940759	PROCTOR AND GAMBLE	NR	NR	NY	02/22/93	THORIUM
940409	PROFESSIONAL SERVICES INDUSTRIES, INC.	0022-8	LOMBARD	IL	11/03/93	CS-137, AM-BE
940779	QRS SYSTEMS INC.	NR	SAN ANTONIO	TX	09/29/93	AM-BE
940510	RADIAN CORP.	NR	AUSTIN	TX	03/17/93	PO-210
940558	RECSO	NON-LICENSEE	PEEKSKILL	NY	06/21/93	GE-68, GA-68
940783	ROCKWELL INTERNATIONAL	NR	RICHARDSON	TX	10/05/93	H-3
941212	ROGER PRATER ASSOCIATES	NR	NR	CA	06/25/93	NR
940438	RUSH-PRESBYTERIAN-SAINT LUKES	12-00929-13	CHICAGO	IL	06/17/93	NI-63
941228	SACRED HEART MEDICAL CENTER	WN-M031-1	SPOKANE	WA	03/29/93	MO-99, TC-99M
940424	SAINT JOSEPH HOSPITAL	86-01268-01	ELGIN	IL	03/11/93	I-125
940241	SAINT THOMAS HOSPITAL	R-19001-B98	NASHVILLE	TN	03/08/93	I-125
941386	SCHNEIDER FREIGHT USA, INC.	NR	JAMAICA	NY	11/23/93	CS-137, CS-137
941327	SCRAP METAL YARD	NR	NR	OR	09/20/93	NR
940649	SETON NORTHWEST	NON-LICENSEE	AUSTIN	TX	07/22/93	I-131
941317	SHEELABRATOR CONDORD CO.	NON-LICENSEE	PENACOOK	NH	04/09/93	I-131
941218	SIEMENS	WN-I030-1	REDMOND	WA	08/30/93	CO-57, CO-57, AM-241
940193	SOILS LABORATORY	7-386	MESA	AZ	05/26/93	RA-226
940756	SONIC SURVEYS, INC.	NR	MONT BELVIEU	TX	08/31/93	CO-60

Table A-2.3 Loss of Control of Material Events Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
941244	SOUTHERN SCRAP METAL	NON-LICENSEE	BATON ROUGE	LA	05/21/93	CO-60
940955	SOUTHERN ZINC CO.	NON-LICENSEE	EAST POINT	GA	04/22/93	U-DEP
941121	SOUTHERN ZINC CO.	NR	EAST POINT	GA	04/21/93	RA-226, U-DEP
941366	SOUTHERN ZINC CO.	NR	EAST POINT	GA	04/21/93	U-DEP
941204	SRI INTERNATIONAL	NR		CA	05/26/93	SR-90
940197	STONE AND WEBSTER ENGINEERING CORP.	FL-1693-1	PLANTATION	FL	12/15/93	CS-137, CS-137, AM-BE, AM-BE
940285	STONE CONTAINER	NON-LICENSEE	LOUISVILLE	KY	06/25/93	KR-85
941407	STRUCTURAL METALS, INC.	NR	SEQUIN	TX	01/15/93	CS-137
940624	SUN STATE RECYCLING	NON-LICENSEE	GAINESVILLE	FL	06/25/93	CS-137
942114	SYNCOR INTERNATIONAL CORP.	MS-493-01	JACKSON	MS	12/13/93	TC-99M
941622	TEXAS HEALTH CENTER, UNIVERSITY OF	NR	TYLER	TX	12/22/93	I-125
940653	TEXAS, UNIVERSITY OF, AT DALLAS	NR	DALLAS	TX	07/15/93	NI-53
940763	TEXAS, UNIVERSITY OF, M.D. ANDERSON CANCER CTR	NR	HOUSTON	TX	08/18/93	H-3, C-14, P-32, S-35, I-125
940750	TEXAS, UNIVERSITY OF, MEDICAL BRANCH	NR	GALVESTON	TX	09/15/93	P-32, I-125
940838	TMG ENTERPRISES METAL CENTER	NON-LICENSEE	LOUISVILLE	KY	06/29/93	U-DEP
940202	TMG ENTERPRISES METAL CENTER	NON-LICENSEE	LOUISVILLE	KY	06/29/93	U-DEP
941303	TRACERCO	NR	HOUSTON	TX	03/14/93	CO-60
940810	TRINITY ENGINEERING & TESTING	NR	ABILENE	TX	11/11/93	CS-137, AM-BE
940365	TROXLER ELECTRONICS LABORATORIES, INC.	NR	RESEARCH TRI. PARK	NC	08/05/93	AM-BE
940723	UNAFORM, INC.	LA-5652-L01	SHREVEPORT	LA	07/12/93	AM-241
940177	UNITED METAL RECYCLERS	NON-LICENSEE	KERNERVILLE	NC	03/15/93	ND
940585	W.R. GRACE AND CO.	232	SIMPSONVILLE	SC	08/13/93	AM-241
940347	WALT DISNEY WORLD CO. VISTA	12731-1(3L(1))	LAKE BUENA	FL	04/23/93	H-3, H-3
940397	WEST PALM BEACH SOLID WASTE AUTHORITY	NON-LICENSEE	WEST PALM BEACH	FL	12/14/93	I-131
940399	WEST PALM BEACH SOLID WASTE AUTHORITY	NON-LICENSEE	WEST PALM BEACH	FL	12/10/93	I-131
940538	WESTCHESTER COUNTY MEDICAL CENTER	586-2	VALHALLA	NY	10/29/93	I-125

NR indicates NOT REPORTED

ND indicates NOT DETERMINED

Table A-2.4 Leaking Sources Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	RADIO-NUCLIDE
940194	ALZA CORP.	1994-43	PALO ALTO	CA	02/06/93	NI-63
940417	AMERSHAM CORP. HEIGHTS	12-12836-01	ARLINGTON	IL	01/21/93	AM-241
940418	AMERSHAM CORP. HEIGHTS	12-12836-01	ARLINGTON	IL	01/28/93	I-125
940480	ASOMA INSTRUMENTS, INC.	NR	AUSTIN	TX	12/19/93	FE-55
940481	ASOMA INSTRUMENTS, INC.	NR	AUSTIN	TX	01/07/93	FE-55
940482	ASOMA INSTRUMENTS, INC.	NR	AUSTIN	TX	01/29/93	FE-55
941165	BECKMAN	NR	NR	CA	02/18/93	CS-137
941203	CALIFORNIA, UNIVERSITY OF AT SANTA BARBARA	NR	SANTA BARBARA	CA	05/25/93	NR
940458	CHICAGO, UNIVERSITY OF	99-90974-11	CHICAGO	IL	10/27/93	CS-137
940745	LFE	NR	NR	NY	02/19/93	CS-137
941167	NORTHROP	NR	NR	CA	02/19/93	PM-147
941101	REGIONAL WEST MEDICAL CENTER	21-01-02	SCOTTSBLUFF	NE	04/15/93	SR-90
940529	ROCHESTER, UNIVERSITY OF	436	ROCHESTER	NY	06/08/93	NI-63
940485	SOUTHWEST RESEARCH INSTITUTE	NR	SAN ANTONIO	TX	03/10/93	NI-63
940574	TEXAS NUCLEAR TECHNOLOGIES, INC.	NR	ROUND ROCK	TX	04/08/93	FE-55
940774	TN TECHNOLOGIES, INC.	NR	ROUND ROCK	TX	09/14/93	FE-55
940769	TUBOSCOPE VETCO	NR	HOUSTON	TX	05/19/93	CS-137
941427	TUBOSCOPE VETO INTERNATIONAL	NR	HOUSTON	TX	01/25/93	CS-137, CS-137
940814	UTAH STATE UNIVERSITY	UT-03001-59	LOGAN	UT	10/22/93	NI-63

NR indicates NOT REPORTED

Table A-2.5 Release of Material Events Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF RELEASE	RADIO-NUCLIDE
941262	ARKANSAS, UNIVERSITY OF MEDICAL SERVICES	ARK-001	LITTLE ROCK	AR	03/29/93	SURFACE	I-131
940206	AUBURN STEEL	NR	SYRACUSE	NY	05/17/93	SURFACE	H-3
940801	AUSTIN DIAGNOSTIC CLINIC	NR	AUSTIN	TX	10/15/93	SURFACE	H-3
940646	AUSTIN HEART ASSOCIATES	NR	AUSTIN	TX	06/14/93	SURFACE	TC-99M
941421	DIAGNOSTIC SYSTEMS LABORATORIES, INC.	NR	WEBSTER	TX	02/17/93	SURFACE	ND
940262	FEDERAL EXPRESS	NON-LICENSEE	MEMPHIS	TN	08/31/93	SURFACE	SR-89
940423	MEDI + PHYSICS, INC.	86-01109-01	NR	IL	03/08/93	AIRBORNE	I-125
941625	SAINT PAUL MEDICAL CENTER	NR	DALLAS	TX	12/01/93	SURFACE	TC-99M
941330	SMOKE DETECTOR MANUFACTURER	NR	NR	OR	08/06/93	SURFACE	ND
941123	THERAGENICS CORP.	881-3MD	BUFORD	GA	07/01/93	SURFACE	ZN-65, RH-102M, PD-103

NR indicates NOT REPORTED
ND indicates NOT DETERMINED

Table A-2.6 Transportation Events Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF TRANSPORTATION EVENT
941015	AMERSHAM CORP. HEIGHTS	NR	ARLINGTON	IL	01/30/93	CONTAMINATED PACKAGE
941102	AS NON-LICENSEE TRANSIT	NR	OMAHA	NE	11/19/93	RELEASE DURING
941113	AS NON-LICENSEE PACKAGE	NR	ORLANDO	FL	05/09/93	CONTAMINATED
941331	AS NUCLEAR MEDICINE LICENSE	NR	NR	OR	08/03/93	FAILURE TO BRACE AND BLOCK PACKAGE
940393	BLACK SHEEP EXPRESS	NON-LICENSEE	GROVE CITY	FL	12/27/93	DAMAGED SHIPPING CONTAINER
941381	CONSTRUCTION TECHNOLOGY	NR	SCOTIO	NY	10/20/93	IMPROPER PLACARDING
941163	COUNTY HAZARDOUS MATERIALS	NR	NR	CA	02/11/93	VEHICLE ACCIDENT
940315	FLORIDA DEPARTMENT OF TRANSPORTATION	109-1(6)	NR	FL	03/08/93	VEHICLE ACCIDENT
940356	FLORIDA DEPARTMENT OF TRANSPORTATION	109-1(3L-1)	BARTOW	FL	06/10/93	VEHICLE ACCIDENT
940387	FLORIDA DEPARTMENT OF TRANSPORTATION, SMO	0109-1	GAINESVILLE	FL	10/04/93	VEHICLE ACCIDENT
940391	FLORIDA DEPARTMENT OF TRANSPORTATION, SMO	0109-1	GAINESVILLE	FL	10/28/93	VEHICLE ACCIDENT
940395	FLORIDA DEPARTMENT OF TRANSPORTATION, SMO	0109-1	GAINESVILLE	FL	12/21/93	VEHICLE ACCIDENT
940396	FLORIDA DEPARTMENT OF TRANSPORTATION, SMO	0109-1	GAINESVILLE	FL	12/20/93	VEHICLE ACCIDENT
940403	FLORIDA DEPARTMENT OF TRANSPORTATION, SMO	0109-1	GAINESVILLE	FL	11/22/93	VEHICLE ACCIDENT
940436	KAY RAY/SENSALL	IL-01010-03	MT. PROSPECT	IL	06/08/93	CONTAMINATED PACKAGE
940305	MEDI + PHYSICS, INC.	2133-2(3B)	MELBOURNE	FL	03/26/93	DAMAGED SHIPPING CONTAINER
940441	MEDI + PHYSICS, INC.	86-01052-01	CHICAGO	IL	07/10/93	VEHICLE ACCIDENT
941158	MEDICAL MESSENGERS INC	NR	NR	CA	02/01/93	VEHICLE ACCIDENT
941199	NEW MEXICO STATE COMMISSION	W1150	SANTA FE	NM	09/01/93	VEHICLE ACCIDENT
940440	NORDION INTERNATIONAL INC.	NON-LICENSEE	CHICAGO	IL	07/01/93	FAILURE TO BRACE AND BLOCK PACKAGE
941258	NUCLEAR PHARMACY, INC.	AL-927	MOBILE	AL	10/01/93	VEHICLE ACCIDENT
941383	NUCLETRON	NR	NR	NY	05/14/93	FAILURE TO BRACE AND BLOCK PACKAGE

Table A-2.6 Transportation Events Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	TYPE OF TRANSPORTATION EVENT
940355	PROFESSIONAL SERVICES INDUSTRIES, INC.	22-4(3L(1))	LOMBARD	IL	06/09/93	FAILURE TO BRACE AND BLOCK PACKAGE
940513	QUALITY INSPECTION SERVICES CO.	NR	BATAVIA	NY	04/12/93	VEHICLE ACCIDENT
940459	SAINT JOSEPH HOSPITAL LEVEL	86-01475-01	CHICAGO	IL	10/28/93	EXCESS RADIATION
940274	SCIENTIFIC ECOLOGY GROUP	R-37008-E94	OAK RIDGE	TN	09/07/93	CONTAMINATED VEHICLE
941305	SPECTRATEK PROTECHNICS INTER., INC.	TA172	ALBUQUERQUE	NM	02/04/93	VEHICLE ACCIDENT
940222	SYNCOR INTERNATIONAL CORP.	MS-493-01	JACKSON	MS	01/29/93	VEHICLE ACCIDENT
940460	SYNCOR INTERNATIONAL CORP.	86-01721-01	CHICAGO	IL	11/02/93	VEHICLE ACCIDENT
941017	SYNCOR INTERNATIONAL CORP.	NR	AUGUSTA	GA	09/03/93	VEHICLE ACCIDENT
940793	TECHNICAL WELDING LABORATORY, INC.	NR	PASADENA	TX	09/21/93	VEHICLE ACCIDENT
940791	TEXAS FOUNDRIES	NR	LUFKIN	TX	08/30/93	CONTAMINATED PACKAGE
940321	WEST PARK COMMUNITY HOSPITAL	NR	HAMMOND	LA	02/25/93	IMPROPER PLACARDING

NR indicates NOT REPORTED

Table A-2.7 Equipment Problems Reported by Agreement States, 1993

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940795	APPLIED STANDARDS INSPECTION, INC.	NR	BEAUMONT	TX	09/20/93	RADIOGRAPHY CAMERA
941336	AS IRRADIATOR LICENSE	NR	NR	OR	05/05/93	IRRADIATOR
941267	ATEC ASSOCIATES	20-1221-52	LOUISVILLE	KY	10/22/93	GAUGE, MOISTURE DENSITY
940234	ATLANTIC STEEL	GA-461-1	CARTERSVILLE	GA	09/03/93	GAUGE, LEVEL
941232	BASS AND MAVES TESTING	I0277-1	EVERETT	WA	06/16/93	GAUGE, MOISTURE DENSITY
940579	BAXTER HEALTHCARE CORP.	NR	EL PASO	TX	04/29/93	SOURCE RACK
940578	BIX TESTING LABORATORIES	NR	BAYTOWN	TX	03/13/93	RADIOGRAPHY CAMERA
940637	BIX TESTING LABORATORIES	NR	BAYTOWN	TX	NR	RADIOGRAPHY DRIVE CABLE
940900	BOEING COMPUTER SERVICES	NO LICENSE	NR	WA	03/03/93	STRUCTURAL ANALYSIS PROGRAM
940652	BROWNWOOD, CITY OF	NR	BROWNWOOD	TX	07/29/93	GAUGE, MOISTURE DENSITY
940448	CHICAGO, UNIVERSITY OF	12-00509-03	CHICAGO	IL	08/25/93	BRACHYTHERAPY NON-MAN AFT-HDR
940450	CHICAGO, UNIVERSITY OF	12-00509-03	CHICAGO	IL	08/27/93	IRRADIATOR
941559	CONVERSE CONSULTANTS SOUTHWEST	00-11-0094-01	LAS VEGAS	NV	07/14/93	GAUGE, MOISTURE DENSITY
940806	COONEY X-RAY	NR	ODESSA	TX	10/20/93	RADIOGRAPHY CAMERA
941825	COOPER INDUSTRIES	7095-L01	VILLE PLATTE	LA	12/10/93	RADIOGRAPHY CAMERA
940785	EAGLE X-RAY	NR	MONT BELVIEU	TX	10/04/93	RADIOGRAPHY CAMERA
941239	EXXON REFINERY	NR	NR	LA	08/02/93	GAUGE, MOISTURE DENSITY
941263	FLORENCE AND HUTCHISON	20-1129-52	PADUCAH	KY	08/23/93	GAUGE, MOISTURE DENSITY
940291	G.A. TECHNICAL SERVICES	R-19168	NASHVILLE	TN	04/22/93	GAUGE, MOISTURE DENSITY
941363	GAUGE LICENSE	NR	NR	AL	06/12/93	GAUGE, LEVEL
941364	GAUGE LICENSE	NR	NR	AL	06/02/93	GAUGE, MOISTURE DENSITY
941098	GEOTECHNICAL SERVICES, INC.	01-38-01	OMAHA	NE	05/05/93	GAUGE, MOISTURE DENSITY

Table A-2.7 Equipment Problems Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940753	GOOLSBY TESTING LABORATORIES	NR	HUMBLE	TX	06/09/93	RADIOGRAPHY CAMERA
940390	HARRIS SEMICONDUCTOR	0662-3 CORP.	MELBOURNE	FL	09/23/93	LEAK DETECTION EQUIPMENT
940640	HOECHST CELANESE	NR	BISHOP	TX	06/16/93	GAUGE, LEVEL
940792	HOECHST CELANESE	NR	BISHOP	TX	09/17/93	GAUGE, LEVEL
940244	INDUSTRIAL LABORATORIES, INC.	R-33017	CHATTANOOGA	TN	03/09/93	RADIOGRAPHY CAMERA
941238	INDUSTRIAL RADIOGRAPHY MAINTENANCE AND SUPPLY	LA-4342-L01	AMELIA	LA	02/05/93	RADIOGRAPHY CAMERA
940682	ITT BARTON	NR	CITY OF INDUSTRY	CA	03/29/93	PLASTIC LENS
941311	JOHN D. JAQUESS AND ASSOCIATES	DM112	ROSWELL	NM	06/09/93	GAUGE, MOISTURE DENSITY
940506	LAW ENGINEERING	NR	HOUSTON	TX	02/19/93	GAUGE, MOISTURE DENSITY
940815	MET-CHEM TESTING LABORATORIES OF UTAH, INC.	UT-18001-46	SALT LAKE CITY	UT	06/26/93	RADIOGRAPHY CAMERA
940752	MIDLAND INSPECTION & ENGINEERING	NR	MIDLAND	TX	08/04/93	RADIOGRAPHY CAMERA
940679	MMP QUALITY INSPECTIONS, INC.	4832-70	NR	CA	06/04/93	RADIOGRAPHY CAMERA
940809	NAN YA PLASTICS CORP., USA	NR	WHARTON	TX	10/26/93	GAUGE, MOISTURE DENSITY
941558	NEVADA DEPARTMENT OF TRANSPORTATION	00-14-0012-01	CARSON CITY	NV	07/01/93	GAUGE, MOISTURE DENSITY
940787	NEW YORK CITY SANITATION	NR	NEW YORK CITY	NY	03/29/93	GAUGE DEPARTMENT
940449	NICHOLS ALUMINUM	86-01801-01	LINCOLNSHIRE	IL	08/25/93	GAUGE
940816	NUCOR STEEL CORP.	UT-02001-03	PLYMOUTH	UT	05/14/93	GAUGE, FIXED
940817	NUCOR STEEL CORP.	UT-02001-03	PLYMOUTH	UT	04/12/93	GAUGE, FIXED
940516	OUR LADY OF LOURDES HOSPITAL	25	BINGHAMTON	NY	04/06/93	BRACHYTHERAPY REMOTE AFT-HDR
941378	P. FLANIGAN & SONS, INC.	MD-07-136-01	BALTIMORE	MD	07/29/93	GAUGE, MOISTURE DENSITY
940630	PERRY EQUIPMENT CORP.	NR	MINERAL WELLS	TX	04/21/93	RADIOGRAPHY CAMERA
940505	PETROLEUM INDUSTRY INSPECTORS	NR	HOUSTON	TX	03/09/93	RADIOGRAPHY SOURCE TUBE

Table A-2.7 Equipment Problems Reported by Agreement States, 1993 (continued)

ITEM NO.	LICENSEE	LICENSEE NO.	CITY	STATE	EVENT DATE	EQUIPMENT
940634	PETROLEUM INDUSTRY INSPECTORS	NR	HOUSTON	TX	05/10/93	RADIOGRAPHY CAMERA
940773	PROFESSIONAL SERVICES INDUSTRIES, INC.	NR	HOUSTON	TX	09/08/93	GAUGE, MOISTURE DENSITY
941380	RADAMERICA	MD-05-051-01	BALTIMORE	MD	12/20/93	TELETHERAPY UNIT
941135	RADCLIFFE, PHILIP	NR	NR	CA	01/13/93	RADIOGRAPHY CAMERA
941377	RATRIE, ROBBINS & SCHWEIZER	MD-05-116-01	WALDORF	MD	07/06/93	GAUGE
941384	RTS TECHNOLOGY, INC. ANDOVER	NR	NORTH	NY	05/20/93	RADIOGRAPHY CAMERA
940290	SCIENTIFIC INSPECTION TECHNOLOGIES, INC.	R-33092-B96	HIKSON	TN	04/16/93	RADIOGRAPHY CAMERA
941426	SCIENTIFIC TUBULAR INSPECTIONS	NR	CORPUS CHRISTI	TX	01/01/93	GAUGE, PIPE INSPECTION UNIT
941130	SOUTHERLAND GEOTECHNICAL	NR	NR	CA	01/05/93	GAUGE
940567	SOUTHERN TECHNICAL SERVICES	NR	LAKE JACKSON	TX	04/13/93	RADIOGRAPHY CAMERA
940575	SOUTHWESTERN LABORATORIES INC.	NR	HOUSTON	TX	03/01/93	RADIOGRAPHY DRIVE CABLE
941374	STATE HIGHWAY ADMINISTRATION	MD-05-049-01	BALTIMORE	MD	03/03/93	GAUGE, MOISTURE DENSITY
940416	STERIGENICS	86-01220-01	SCHAUMBURG	IL	01/08/93	IRRADIATOR
940776	TECHNICAL WELDING LABORATORY, INC.	NR	PASADENA	TX	12/13/93	RADIOGRAPHY SOURCE ASSEMBLY
941217	TERRA ASSOCIATES INC.	WN-0246-1	SEATTLE	WA	10/19/93	GAUGE, MOISTURE DENSITY
940462	TESTING SERVICE CORP.	86-01178-01	CAROL STREAM	IL	11/08/93	GAUGE, MOISTURE DENSITY
940796	TEXAS A&M UNIVERSITY	NR	COLLEGE STATION	TX	09/11/93	TELETHERAPY UNIT
941256	WEAVEXX	MS-745-01	STARKSVILLE	MS	01/08/93	GAUGE
940533	WESTCHESTER COUNTY MEDICAL CENTER	586-2	VALHALLA	NY	12/07/93	TELETHERAPY UNIT TIMER
940542	WESTCHESTER HOSPITAL, NORTHERN	585	MOUNT KISCO	NY	11/02/93	TELETHERAPY UNIT
940195	WESTEX COMPANY	5324-56	OXNARD	CA	12/19/93	RADIOGRAPHY CAMERA
941259	WILLIAMS, WILLIAMS, AND CLARK	MS-633-01	YAZOO CITY	MS	09/23/93	GAUGE, MOISTURE DENSITY
940628	X-CEL GROUP, INC.	NR	CORPUS CHRISTI	TX	05/22/93	RADIOGRAPHY DRIVE CABLE CONNECTOR

NR indicates NOT REPORTED

Appendix B

Summary of 1993 Abnormal Occurrences (Nonreactors)

Summary of 1993 Abnormal Occurrences (Nonreactors)

93-2 Medical Sodium Iodide Misadministration at Ingham Medical Center in Lansing, Michigan

On May 11, 1992, a patient was administered a diagnostic dose of a radiopharmaceutical that was greater than five times the prescribed dose. This patient received 366.3 megabecquerel (MBq) (9.9 millicurie [mCi]) of iodine-131 in preparation for a whole body scan instead of the intended technetium-99m thyroid scan. This misadministration was caused by a miscommunication of the verbal request between the referring physician's office and the licensee; no written directive was provided.

The referring physician and the patient have been notified. An NRC medical consultant determined the most probable effect to the patient would be permanent hypothyroidism, and noted that this condition appears to have already occurred. The licensee has also observed indications of decreased thyroid function.

93-3 Medical Brachytherapy Misadministration at Yale-New Haven Hospital in New Haven, Connecticut

On January 21, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. A patient was prescribed three treatments of 700 centigray (cGy) (700 rad) to the vagina. During the first treatment, the physician mistakenly inserted the brachytherapy applicator into the patient's rectum and incorrectly administered the 700 cGy (700 rad) directly to the rectum instead.

The licensee discovered the error after the treatment was completed and immediately notified the patient. The requesting physician, the attending physician, and an NRC medical consultant are presently evaluating the probable consequences of this misadministration.

93-4 Medical Therapy Misadministration at Papastavros' Associates Medical Imaging in Wilmington, Delaware

On January 14, 1993, a patient was administered a therapeutic dose that was 0.5 times the prescribed dose. A patient was prescribed 1.11 gigabecquerel (GBq) (30 millicurie [mCi]) of iodine-131 for hyperthyroidism and only received one capsule of a two capsules dosage, 0.56 GBq (15 mCi) of iodine-131. The technologists failed to read the vial label and was unaware that two capsules were provided to meet the prescribed dose.

The patient and the patient's physician were notified of the error and the patient was scheduled for follow-up therapy. No adverse effects are expected as a result of the misadministration.

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

On December 9, 1992, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. The patient was scheduled to receive a 500 centigray (cGy) (500 rad) radiation dose for vaginal cancer using a high-dose-rate brachytherapy treatment device. The dosimetrist and the medical physicist worked together during dose calculation and both used the same source start position which was incorrect. The wrong start position resulted in the intended 500 cGy (500 rad) radiation dose being delivered to an area 5.25 centimeters (2.07 inches) away from the intended treatment site. No second independent check of the calculations were performed.

The referring physician and the patient were informed of the error. The licensee reported that no physical effect was observed as a result of the misadministration. An NRC medical consultant concluded that no noticeable biological effect was expected as a result of this misadministration.

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

On April 28, 1993, the University of Virginia reported an incident involving a major deficiency in operating, management, or procedural controls of its research reactor that impacted reactor safety. The reactor had been experiencing repeated, unannounced scrams for approximately 6 months. In an attempt to trouble-shoot one of these scrams, a senior reactor operator began interchanging some of the electronic equipment in the reactor control console. After approximately 30 minutes, no further scrams were received because the operator had unknowingly defeated five scram functions. These actions were performed without procedure or post-maintenance testing to ensure safety systems operations.

The reactor was subsequently restarted and operated at full power for 5.5 hours with the defeated scram functions. During normal plant shutdown at the end of the day, an electronic period scram was introduced to complete the shutdown but failed. The reactor had to be manually scrammed to complete the shutdown.

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

On February 16 and 17, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. During a brachytherapy implant, one 862.1 megabecquerel (MBq) (23.3 millicuries [mCi]) cesium-137 seed fell out of the insert onto the patient's bed. About 15 hours later, a nurse found the source beneath the patient and removed it. The licensee calculated that the dislodged source resulted in an exposure of about 45.8 centigray (cGy) (45.8 rad) to the perineum, an area different from the intended treatment site.

The referring physician and patient were notified of the misadministration. The licensee stated that there was no observable clinical effect as a result

of the radiation exposure from the dislodged source.

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

On June 10, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. The United States Air Force Radioisotope Committee Secretariat reported an incident of a patient receiving an unintended dose of approximately 2.09 cGy (2.09 rad) to the facial area. An iridium-192 high-dose-rate remote afterloader source was mispositioned during the second of two treatments. Due to an erroneous keystroke, a default catheter length of 100 cm (39.4 in.) was entered into the treatment plan instead of the intended 150 centimeters (cm) (59.1 inches [in.]). The incorrect catheter length resulted in the source being positioned about 10 cm (3.9 in.) in front of the patient's face for approximately 46 seconds.

The patient was notified of the misadministration. No adverse effects are expected from the misadministration.

93-9 Medical Sodium Iodide Misadministration at Osteopathic Hospital Founders Association DBA (doing business as) Tulsa Regional Medical Center in Tulsa, Oklahoma

On July 27, 1993, a patient was administered a diagnostic dose of a radiopharmaceutical that was greater than five times the prescribed dose. A technologist mistakenly administered 0.21 gigabecquerel (GBq) (5.7 millicuries [mCi]) of iodine-131 (I-131) to a patient that was prescribed technetium-99m (Tc-99m). The technologist, who was preparing to administer doses to two patients, called the patient whom she believed was to receive the I-131, and verified his identity by reviewing a second form of identification. However, the patient name on the written directive was not checked, resulting in the wrong patient receiving the I-131 dose. The error was quickly discovered and the second patient was not administered the remaining Tc-99m dose.

The patient was notified of the misadministration. An NRC medical consultant estimated the dose to the patient's thyroid to be in the range of 400–700 cGy (400–700 rad) and believes the medical consequences of this misadministration will be negligible.

93-10 1981 Fatal Radiation Exposure of a Radiographer in Northeast Oklahoma

In January 1981 an individual received a fatal dose of radiation. This event was previously reported to Congress in NUREG-0090, Vol. 4, No. 1, as an "Other Event of Interest." It was not previously reported as an abnormal occurrence because the NRC was unable to conclusively determine that the exposure in question resulted from material subject to NRC regulation.

On January 5, 1981, an NRC-licensee in Henryetta, Oklahoma, reported that a radiographic exposure device containing a 1221 gigabecquerel (33 curie) iridium-192 source was stolen from a locked camper on or about December 30, 1980. The licensee subsequently reported that the source was anonymously returned intact to a licensee representative's residence. On January 22, 1981, the State of Oklahoma notified the NRC that an unemployed radiographer had been hospitalized with serious radiation injuries to his chest and left forearm.

The NRC performed an in-depth investigation which included interviewing the exposed individual. He stated that he could not recall how or when he received the exposure but stated that he had last worked with a radioactive source in October 1980. Medical authorities estimated his exposure occurred between December 15, 1980, and January 5, 1981. Cytogenetic studies of the patient's blood indicated that he received an equivalent whole body dose of 365 centigray (cGy) (365 rad) from iridium-192 or 405 cGy (405 rad) from cobalt-60. On July 27, 1981, the NRC was notified that the individual had died of his injuries.

93-11 Medical Brachytherapy Misadministration at Washington University Medical School in St. Louis, Missouri

On January 7, 1993, and again on February 26, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. A malfunction in a Nucletron Micro-Selectron low-dose-rate remote afterloader unit resulted in an unprogrammed ejection of a radioactive source without a guide tube and applicator attached to the channel. The first ejected unguided source resulted in an estimated 0.1 centigray (cGy) (0.1 rad) of additional dose to the patient's skin surface. The second ejected source resulted in an estimated 3.5 cGy (3.5 rad) of additional dose to the patient's skin surface. In both cases, the patient treatment was completed on another unit. The failure was eventually determined to be a faulty operational amplifier.

The referring physician and the patient were notified. No adverse health effects are expected from either misadministration.

93-12 Medical Brachytherapy Misadministration at Mercy Hospital in Scranton, Pennsylvania

On April 23, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. The patient was scheduled to receive brachytherapy treatment to the apex of her vagina in three fractions of 500 centigray (cGy) (500 rad) each. After the first treatment, the physician revised the written directive. While entering the changes, the therapist erroneously entered the wrong catheter length into the treatment computer which resulted in 500 cGy (500 rad) being delivered to the wrong treatment site and a 20 percent underdose to the intended treatment site.

The referring physician and the patient have been notified. The attending physician stated that no adverse clinical effects are expected as a result of the underdose to the target site. The oncologist stated that the patient is not expected to experience any adverse effects from the 500 cGy (500 rad) overexposure to the wrong treatment site. The NRC medical consultant also stated that

it is unlikely the patient would suffer any adverse effects from this misadministration.

**93-13 Medical Brachytherapy
Misadministration at Mountainside
Hospital in Montclair, New Jersey**

On July 1, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. The patient was prescribed three brachytherapy treatments of 700 centigray (cGy) (700 rad) to the right mainstem bronchus using a Nucletron Micro-Selectron high-dose-rate remote afterloader. During the last treatment, a shorter than required catheter was used, preventing the source from reaching the target site. A negligible dose was delivered to the tumor site. The misadministration also resulted in a surface dose to the lens of 1.97 cGy (1.97 rad), a dose to the chin of 4.56 cGy (4.56 rad), and a dose to the thyroid of 3.07 cGy (3.07 rad).

The referring physician and patient were notified. An NRC medical consultant concluded that the patient would not suffer any adverse effects from this misadministration.

**93-14 Exposure to a Nursing Infant at
Queen's Hospital in Honolulu, Hawaii**

On December 2, 1991, a moderate exposure to, or release of, radioactive material licensed by the NRC resulted in an exposure of a 9-month old infant. A nursing mother was administered 0.56 megabecquerel (15 microcurie) of iodine-131 for a diagnostic scan. Although the patient noted on a hospital form that she was breastfeeding, the technologist failed to notice this notation until the patient returned the following day for a scan.

The patient was informed of the oversight and was instructed to stop breastfeeding. An NRC medical consultant estimated the dose to the infant's thyroid to be between 160 to 650 mSv (16 to 65 rem) and concluded that the infant was not likely to experience any adverse effects as a result of this misadministration.

**93-15 Medical Brachytherapy
Misadministration at Good Samaritan
Medical Center in Zanesville, Ohio**

On November 10, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. A lung cancer patient was prescribed a 6000 cGy (6000 rad) dose to be delivered by an iridium-192 therapeutic implant. A catheter was surgically implanted and a ribbon of iridium-192 seeds was inserted into the catheter. A radiograph was completed but was not reviewed for two hours. When the seeds could not be seen in the radiograph, additional radiographs were taken which showed the seeds to be in the patient's throat. The ribbon was moved to the proper location about 1 hour later. The misadministration resulted in a dose of approximately 282 centigray (282 rad) to the larynx.

The patient was notified of the misadministration. An NRC medical consultant concluded that the dose to the larynx and surrounding area was not clinically significant.

**93-16 Medical Brachytherapy
Misadministration at Marquette
General Hospital in Marquette,
Michigan**

From November 17 to 19, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive exposure. A patient undergoing cesium-137 brachytherapy treatment to the uterus was administered 2700 centigray (2700 rad) to the vaginal area because a shorter than required catheter was used. The intended treatment area received only 50 percent of the intended dose.

The patient was informed of the treatment error. An NRC medical consultant concluded that the radiation dose to the vagina would not be expected to cause any acute or long-term effects because vaginal tissue is extraordinarily tolerant of radiation. Subsequently the patient received an additional dose to the uterus to complete the prescribed treatment.

Agreement State Licensees

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

In June 1988 an event involving the loss of licensed material in such quantities, and under such circumstances that substantial hazard may result to persons in unrestricted areas, was reported to the State of Georgia. An event review was preformed by a joint Georgia and NRC incident evaluation task force and documented in NUREG-1392, "Leakage of an Irradiator Source - the June 1988 Georgia RSI Incident." At the time, this event was not identified as an abnormal occurrence (AO). In 1993 this event was reevaluated against current reporting criteria and classified as an AO.

On June 6, 1988, the Radiation Sterilizers, Inc. (RSI) facility in Decatur, Georgia, ceased operations because radiation levels on the surface of the pool were 600 microsievert (Sv) (60 millirem) per hour. Analysis of the pool water indicated that one or more of the 252 cesium-137 source capsules (444,000 terabecquerel [12 megacuries]) used in the irradiator were leaking. The U.S. Department of Energy (DOE) was asked to manage the safe removal of the leaking capsule and oversee the cleanup and recovery activities at RSI. Five capsules were suspected of leaking but only one capsule was confirmed to be leaking. The cause of the capsule leaking was not determined. On September 11, 1992, the DOE contractor completed decontamination of the facility. DOE estimated the cost of the cleanup to be \$45 million.

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

On April 1, 1992, a patient was administered a diagnostic dose of a radiopharmaceutical that was greater than five times the prescribed dose. The patient was scheduled to receive 3.7 megabecquerel (MBq) (100 microcurie [μ Ci]) of iodine-131 (I-131) for a thyroid uptake study but was

administered a 218.3 MBq (5.9 millicuries [mCi]) I-131 dose intended for another patient. The technologist immediately discovered the error. Vomiting was induced within 5 minutes of administration and then the patient was given a thyroid blocking agent. A thyroid uptake and scan were performed 24 hours after the incident and showed the thyroid uptake to be about 0.3 percent of the dose administered.

The referring physician and patient were notified of the misadministration. No adverse effects were expected as a result of this misadministration.

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

On November 11, 1992, a patient was administered a therapeutic dose to a part of the body not scheduled to receive radiation. The patient was prescribed a brachytherapy treatment using 13 seeds of iridium-192 in a nylon ribbon. A kink in the catheter stopped the ribbon 26 centimeters (cm) (10.24 inches) from the prescribed treatment area. This resulted in a dose to the patient's hypopharynx area of 3500 centigray (cGy) (3500 rad), which was the prescribed dose to the lung. The intended treatment area of the lung was estimated to have received less than 10 cGy (10 rad). The licensee stated that no long-term effects are expected. The patient was notified of the misadministration.

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

On May 7, 1993, a moderate exposure to, or release of, radioactive material licensed by the NRC resulted in a 21-year old industrial radiographer receiving a 27.66 centisievert (27.66 rem) whole body exposure as indicated by a thermoluminescent dosimeter badge. The radiographer failed to lock the exposure device, so that when the radiographer's assistant moved toward the device with the control handle, the source moved out of the shielded position. A preliminary physical examination of the

radiographer's blood showed no indication of any adverse effects from the overexposure.

**AS 93-5 Medical Teletherapy
Misadministration at Alta Bates
Medical Center in Berkeley,
California.**

In response to an inquiry in April 1992, the State of California investigated a fatal radiation exposure that occurred in 1987. At the request of the State, the NRC assisted in the investigation. This event was not required to be reported under the State law in affect at that time.

A 9-year old autistic boy, diagnosed to have cancer of the nasopharynx, was prescribed radiation therapy using a cobalt-60 source of 186,850 gigabecquerel (5050 Curie). An error in the treatment plan resulted in the patient receiving double the total prescribed dose during the initial treatment phase.

The patient's physicians and mother were promptly notified. The patient died on August 21, 1988, of complications resulting from this misadministration.

**AS 93-6 Overexposure of a Radiographer
at X-Cel Group in Corpus Christi,
Texas**

On May 22, 1993, a radiographer received an exposure of the right hand of more than 375 rem. A camera locking mechanism came apart from the camera allowing the source assembly (pigtail) and the 3626 gigabecquerel (98 curie) iridium-192 source to be pulled from the camera. Thinking that the source had disconnected, the radiographer picked up the source with the thumb and index finger of his right hand, resulting in an estimated overexposure of 19.25 sievert (1925 rem). No symptoms of radiation injury were noted on the radiographer's hand.

**AS 93-7 Medical Radiopharmaceutical
Misadministration by
"Unspecified Licensee" in Albany,
New York**

On October 5, 1992, a patient was administered a therapeutic dose that was greater than 1.5 times the prescribed dose. The patient was inadvertently administered 303.4 megabecquerel (MBq) (8.2 millicurie [mCi]) of phosphorus-32 (P-32), instead of the prescribed 185 MBq (5 mCi) of P-32.

The attending physician and patient were notified of the misadministration. No long-term adverse effects are expected as a result of this misadministration.

**AS 93-8 Medical Sodium Iodide
Misadministration at Inland
Imaging in Spokane, Washington.**

On December 14, 1992, a patient was administered a diagnostic dose that was greater than 5 times the prescribed dose. A patient that was prescribed a diagnostic thyroid procedure using 0.26 to 0.37 megabecquerel (MBq) (0.007 to 0.010 millicurie [mCi]) of iodine-131 (I-131) erroneously received 196.1 MBq (5.3 mCi) of I-131. The licensee estimated that the patient's thyroid received a dose of approximately 7950 centigray (7950 rad) and did not show any signs of adverse side effects 3 days after the misadministration. The referring physician and patient were notified.

**AS 93-9 Medical Teletherapy
Misadministration by
"Unspecified Licensee" in New
York, New York**

On July 11, 1992, a patient was administered a therapeutic dose to a part of the body not scheduled to receive radiation. The patient was prescribed multiple cobalt-60 teletherapy treatments of 200 centigray (200 rad) to the right axilla. However, the first five treatments were given to the left axilla in error.

The NRC has not yet been informed that the referring physician and patient have been notified.

The potential adverse effects as a result of this misadministration have not yet been determined.

AS 93-10 Theft of Radioactive Material During Transport and Improper Disposal

In February 1993, the NRC was notified of a substantiated case of actual theft or diversion of licensed material that had been going on for several years. This event involved the diversion of spent nuclear medicine generators from the transportation stream by an employee of a courier service. They were stolen in order to reclaim the lead shielding as scrap metal. The generator internals were burned in an open barrel in a residential area and the ashes were often discarded in rural wooded areas. Several attempts to interview the individual suspected, and later confirmed, of diverting the licensed material were unsuccessful and on February 22, State officials were informed that the individual had died the day before from natural causes.

Although the risk to the general public from this prolonged diversion of licensed material was not significant, the radiation exposure to the deceased individual could have been significant due to his repeated direct contact with the generators. However, no estimate of his exposure could be made without more information.

AS 93-11 Found Source at Scrap Metal Facility in Magnolia, Arkansas

On March 24, 1993, a licensee reported a source of licensed material found in such quantities and under such circumstances that a substantial hazard may have resulted to persons in unrestricted areas. TN Technologies notified the State that a Texas Nuclear Model 5176 source holder, containing a 148 gigabecquerel (4 curies) cesium-137 source, had been located at Tillman Scrap Yard in Magnolia, Arkansas. The holder shutter was found to be padlocked in the open position. The padlock was cut away and the shutter was secured in the closed position. The source was removed from the affected area. A contamination survey of the entire work area was carried out. No contamination was found. The area was released for unrestricted use.

AS 93-12 Medical Teletherapy Misadministration at Rocky Mountain Gamma Knife Center in Denver, Colorado

On July 8, 1993, a patient was administered a therapeutic dose to a part of the body not scheduled to receive radiation. A patient was admitted for treatment of a longstanding arteriovenous malformation (AVM) in the left posterior dura of the brain. During treatment of this malformation, the patient's brainstem received a dose of no more than 2.5 gray (Gy) (250 rad) due to an error in the gamma plan program input. The program error was caused by the posterior/anterior angiogram being reversed during setup. The tolerance dose for the brainstem was stated to be 10 Gy (1000 rad).

The patient was notified of the misadministration. It was the opinion of the neurosurgeon that the dose delivered was well below the dose-volume threshold for inducing any neurological damage.

AS 93-13 Lost or Stolen Radiation Source at BPB Instruments, Inc., in Midland, Texas

On September 2, 1993, a licensee reported a lost source of licensed material in such quantities and under such circumstances that a substantial hazard may exist to persons in unrestricted areas. The licensee notified the State of Texas that during a physical inventory a 555 gigabecquerel (15 curie) americium/beryllium source made by Amersham (Serial Number 7004NE) was not located and may have been lost or stolen. The licensee believes that a disgruntled employee may have taken the source to cause problems for the company. Surveys were performed in areas around Midland. BPB placed an ad in the Midland newspaper offering a \$10,000 reward for information leading to the recovery of the source. The State agency issued a press release describing the source, warning that it should not be handled, and requesting that the licensee or the State agency be contacted if the source is found. All attempts to locate the source have been unsuccessful.

**AS 93-14 Medical Brachytherapy
Misadministration at Michael
Reese Medical Center in Chicago,
Illinois**

On October 6 through 10, 1993, a patient was administered a therapeutic dose greater than 1.5 times the prescribed dose. The patient was prescribed a total dose of 6000 centigray (cGy) (6000 rad) by a combination of 4000 cGy (4000 rad) from an external beam (linear accelerator) and 2000 cGy (2000 rad) from vaginal implant therapy. The external beam therapy was completed as prescribed. The required time of the implant therapy was then incorrectly calculated to deliver 6000 cGy (6000 rad) instead of the remaining 2000 cGy (2000 rad). The attending physician reviewed the dose calculations on the fourth day of the implant and immediately terminated the treatment. The patient received 4000 to 4500 cGy (4000 to 4500 rad) from the brachytherapy treatment. The patient has been notified of the misadministration.

**AS 93-15 Medical Brachytherapy
Misadministration at Mt. Sinai
Medical Center in Miami Beach,
Florida**

From September 28 to November 24, 1993, eight patients were administered therapeutic doses to a part of their body not scheduled to receive radiation during 22 gynecological treatments. The cause of the misadministrations was the use of a 1.5 meter (4.9 foot) obstetrical/gynecological

transfer tube/applicator combination length instead of a 1.0 meter (3.3 foot) length as intended. Seven of the eight patients received an average dose per treatment of 3.6 centigray (cGy) (3.6 rad) at approximately 51 centimeters (cm) (20 inches) from the intended site and outside of the patients' bodies, with the source approximately 30 to 34 cm (12 to 13 inches) from the patients' knees. Two of these patients sustained third-degree skin injury and five had no physical effects. One patient received an estimated dose of 4000 to 6000 cGy (4000 to 6000 rad) and developed skin erythema in the area of the knee.

**AS 93-16 Medical Brachytherapy
Misadministration at Richland
Memorial Hospital in Columbia,
South Carolina**

On September 24, 1992, a patient was administered a therapeutic dose to a part of the body not scheduled to receive radiation. A radiation oncology nurse found a 1.1 gigabecquerel (GBq) (30 millicurie [mCi]) cesium-137 source under a patient undergoing treatment. The source was misplaced for approximately 2 hours and resulted in a dose of less than 10,000 centigray (10,000 rad).

The patient and her family were notified. The unscheduled exposure resulted in an ulceration beneath her right thigh which responded favorably to treatment. A second treatment to makeup for the dose deficiency to the target site was not attempted because the patient was unable to cooperate.

Appendix C

**Reports and Videotapes
Issued From 1981 Through 1993
(Nonreactors)**

Reports and Videotapes Issued From 1981 Through 1993 (Nonreactors)

Nonreactor Reports Issued in 1993

Video Tapes			
Date	Title	No.	Author
04/93	Good Practices in Cobalt-60 Teletherapy	-	H. Karagiannis

Nonreactor Reports Issued in 1992

Engineering Evaluations			
Date	Title	No.	Author
08/92	Report on 1991 Nonreactor Events	NUREG-1272 Vol. 6, No.2, App.A	K. Black
08/92	Report on 1991 NRC Licensee Misadministrations	NUREG-1272 Vol. 6, No. 2, App.B	H. Karagiannis
08/92	Report on 1991 Agreement State Licensee Nonreactor Events and Misadministrations	NUREG-1272 Vol. 6, No. 2, App.C	H. Karagiannis

Nonreactor Reports Issued in 1991

Engineering Evaluations			
Date	Title	No.	Author
01/91	Brachytherapy Incidents Involving a Handloading, Endobronchial Technique	N91-01	H. Karagiannis
07/91	Report on 1990 Nonreactor Events	NUREG-1272 Vol.5, No. 2, App.A	K. Black
07/91	Report on 1990 Misadministrations Reports	NUREG-1272 Vol. 5, No. 2, App.B	H. Karagiannis

Video Tapes			
Date	Title	No.	Author
02/91	Good Practices in Preparing and Administering Radiopharmaceuticals		H. Karagiannis

Nonreactor Reports Issued in 1990

Engineering Evaluations			
Date	Title	No.	Author
06/90	Report on 1989 Nonreactor Events	NUREG-1272 Vol. 4, No. 2, App.A	K. Black
06/90	Medical Misadministration Report -	NUREG-1272 Vol. 4, No. 2, App.B	H.Karagiannis

Nonreactor Reports Issued in 1989

Engineering Evaluations			
Date	Title	No.	Author
06/89	Use of Radioactive Iodine for Infrequent Medical Studies and Those Performed Under an FDA Investigational Exemption of a New Drug (IND)	N901	H. Karagiannis
06/89	Report on 1988 Nonreactor Events	NUREG-1272 Vol. 3, No. 2, App.B	K. Black
06/89	Medical Misadministration Report - Medical Misadministrations Reported to NRC From January 1988 Through December 1988	NUREG-1272 Vol. 3, No. 2, App.B	H.Karagiannis
05/89	Review of Therapy Misadministrations That Involved Multiple Patients and the Use of Computer Programs	T908	K. Black

Nonreactor Reports Issued in 1988

Date	Title	No.	Author
09/88	Review of Events at Large Pool-Type Irradiators (NUREG-1345, March 1989)	S807	E. Trager
10/88	Report on 1987 Nonreactor Events	N801	K. Black
10/88	Medical Misadministration Report - to NRC for the Period January Through 1987 Through December 1987	N802	S. Pettijohn

Nonreactor Reports Issued in 1987

Special Study Report			
Date	Title	No.	Author
10/87	Radiography Overexposure Events Involving Industrial Field Radiography	S703	S. Pettijohn

Engineering Evaluations			
Date	Title	No.	Author
01/87	Diagnostic Misadministrations Involving the Administration of Millicurie Amounts of Iodine-131	N701	S. Pettijohn
03/87	Diagnostic Misadministrations Reported to NRC for the Period January 1986 Through December 1986	N702	S. Pettijohn
03/87	Report on 1986 Nonreactor Events	N703	K. Black

Technical Review Reports			
Date	Title	No.	Author
11/87	Review of Data on Teletherapy Misadministrations Reported to the State of New York That Were the Title of PNO-1-87-74A	T711	S. Pettijohn
12/87	Distribution of Information Notices and Other "Mass Mailing" Information to Licensees That Have Users at Locations Remote From the Headquarters Locations	T714	S. Pettijohn

Nonreactor Reports Issued in 1986

Case Study			
Date	Title	No.	Author
08/86	Rupture of an Iodine-125 Brachytherapy Source at the University of Cincinnati Medical Center	C601	S. Pettijohn

Engineering Evaluations			
Date	Title	No.	Author
06/86	Report of 1985 Nonreactor Reported and Five-Year Assessment for 1981 - 1985 Reports	N601	K. Black
06/86	Medical Misadministrations Reported for 1985 and Five-Year Assessment of 1981-1985	N602	S. Pettijohn

Nonreactor Reports Issued in 1985

Case Studies			
Date	Title	No.	Author
12/85	Therapy Misadministrations Reported to NRC Pursuant to 10 CFR 35.42	C505	S. Pettijohn
05/85	Summary of the Nonreactor Event Report Data Base for the Period January Through June 1984	N501	K. Black
Engineering Evaluations			
Date	Title	No.	Author
06/85	Summary of the Nonreactor Event Data Base for the Period July Through December 1984	N502	K. Black
07/85	Report on Medical Misadministrations for January Through December 1984	N503	S. Pettijohn

Nonreactor Reports Issued in 1984

Case Studies			
Date	Title	No.	Author
09/84	Breaching of the Encapsulation of Sealed Well-Logging Sources	C405	S. Pettijohn
05/84	Report on Medical Misadministrations for January Through June 1983	N204D	S. Pettijohn
06/84	Nonreactor Event Report Database for the Period July Through December 1983	N401	K. Black
06/84	Events Involving Undetected Unavailability of the Turbine-Driven Auxiliary Feedwater Train	N402	E. Trager
07/84	Report on Medical Misadministrations for July Through December 1983	N403	S. Pettijohn

Nonreactor Reports Issued in 1983

Engineering Evaluations and Technical Reviews			
Date	Title	No.	Author
01/83	Nonreactor Event Report Database for the Period January Through June 1982	N209A	E. Trager
03/83	I-125/I-131 Effluent Releases by Material Licensees	N301	S. Pettijohn
06/83	Mound Laboratory Fabricated PuBe Sources	N302	K. Black
06/83	Americium Contamination Resulting From Rupture of Well-Logging Sources	N303	K. Black
06/83	Nonreactor Event Report Database From July Through December 1982	N209B	K. Black
07/83	Americium-241 Sources	N304	
07/83	Report on Medical Misadministrations for January 1981 Through December 1982	N204C	S. Pettijohn
12/83	Potentially Leaking Americium-241 Sources Manufactured by Amersham Corporation	N306	S. Pettijohn
]12/83	Nonreactor Event Report Database for the Period January Through June 1983	N307	K. Black
03/83	Internal Exposure to Am-241	NT301	K. Black
04/83	Kay-Ray, Inc. Reports of Suspected Leaking Sealed Sources Manufactured by General Radioisotope Products	NT302	S. Pettijohn
08/83	Possession of Unauthorized Sealed Sources/Exposure Device Combinations by MidCon Inspection Services, Inc.	NT303	S. Pettijohn

Nonreactor Reports Issued in 1982

Engineering Evaluations			
Date	Title	No.	Author
02/82	Report on Medical Misadministrations for the Period November 10, 1980 - September 30, 1981	N201	S. Pettijohn
01/82	Buildup of Uranium-Bearing Sludge in Waste Tanks	N202	K. Black
02/82	Lost Plutonium-238 Source	N203	K. Black
03/82	Report on Medical Misadministrations for CY 1981	N204	S. Pettijohn
04/82	Preliminary AEOD Review of Iodine-125 Sealed Source Leakage Incidents	N205	E. Trager
05/82	Eberline Instrument Corporation Part 21 Report	N206	K. Black
05/82	AEOD Review of Iodine-125 Sealed Source Leakage Incidents	N207	E. Trager
08/82	Potentially Leaking Plutonium-Beryllium Neutron Sources	N208	S. Pettijohn
08/82	A Summary of the Nonreactor Event Report Data Base for 1981	N209	K. Black
11/82	Leaking Hoses on Self-Contained Breathing Apparatus (SCBA) Manufactured by MSA	N210	K. Black

Nonreactor Reports Issued in 1981

Engineering Evaluations			
Date	Title	No.	Author
03/81	Interim Report on Brown Boveri Betatron Calibration Check Source	N101	E. Trager
03/81	Irradiator Incident at an Agreement State Facility (Becton-Dickinson, Broken Bow, Nebraska)	N102	K. Black
04/81	Interim Report on the October 1980 Fire at the Licensee's Sweetwater Uranium Mill	N103	E. Trager
04/81	Interim Report on the January 2, 1981, Fire at the Atlas Uranium Mill	N104	E. Trager
05/81	Interim Report on Tailings Impoundment Liner Failure at the Sweetwater Uranium Mill	N105	E. Trager

Nonreactor Reports Issued in 1981 (continued)

Engineering Evaluations			
Date	Title	No.	Author
08/81	Review of Reports of Leaking Radioactive Sources	N106	E. Trager
12/81	Engineering Evaluation of Fire Protection at Nonreactor Facilities	N107	E. Trager
12/81	Notes on AEOD Review of Emissions From Tritium Manufacturing and Distribution Licensees	N108	E. Trager

Appendix D

Status of AEOD Recommendations

Status of AEOD Recommendations

The Office for Analysis and Evaluation of Operational Data (AEOD) tracking system ensures that all formal AEOD recommendations are tracked until resolution. At this time, no

issues involving AEOD recommendations are unresolved that warrant the attention of the Executive Director for Operations.

Appendix E

Status of NRC Staff Actions for Events Investigated by Incident Investigation Teams (Nonreactors)

Status of NRC Staff Actions for Events Investigated by Incident Investigation Teams (Nuclear Materials)

In accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program [IIP]," dated August 12, 1992, the Executive Director for Operations shall, upon receipt of an Incident Investigation Team (IIT) report, identify and assign NRC office responsibility for generic and plant-specific actions resulting from the investigation that are safety significant and warrant additional attention or action. Office Directors designated by the EDO as having responsibility for the resolution of issues or concerns are responsible for providing written status reports on the disposition of assigned actions. AEOD is responsible for monitoring the status of assigned staff actions, evaluating the

adequacy of the actions taken by the responsible office(s), and documenting the resolution of all staff actions.

This Appendix provides the written disposition or status, along with appropriate references, for each of the NRC staff action items that the EDO assigned to the various NRC offices associated with the IIT reports on the 1990 event at Amersham Corporation, the 1991 event at General Electric Nuclear Fuels Component Manufacturing Facility, and the 1992 event at the Indiana Regional Cancer Center. This Appendix also provides the status of the staff actions that were not documented as resolved in the 1992 *AEOD Annual Report*.

Action Source: IIT Report on "Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, Burlington, Massachusetts," NUREG-1405, dated May 1990 (Reference 1).

Item 6: Adequacy of Reporting Requirements

Action: Evaluate whether NRC and U.S. Department of Transportation (DOT) regulations should be amended to include the requirement to report the receipt of shipments of radioactive materials that were improperly prepared, labeled, identified, or classified, or had improper contents. (Responsible Office: NMSS)

Disposition: Ongoing

On August 13, 1990, the NRC requested that DOT provide comments on the need for a requirement for consignees to report improperly labeled or prepared packages upon receipt. The staff evaluated NRC and DOT reporting requirements (Reference 2) and concluded that requiring licensees to report all mislabeled or misidentified packages would require both licensees and the NRC staff to expend significant resources for problems that are of little or no safety concern. However, the staff also concluded that the NRC should be informed and should respond to any situation similar to the Amersham incident. The NRC staff determined that because the new 10 CFR Part 20 requirements will only apply to labeled or damaged packages, the previous situation in which Amersham received a cropped source in a package thought to be empty may not be covered. The NMSS staff recommended to RES that Section 20.906 of 10 CFR Part 20 be amended to require licensees to notify the NRC if the licensee determines that it has received an unlabeled package containing radioactive materials that should have been labeled in accordance with DOT requirements (Reference 3).

Item 9: Adequacy of Shipper Instructions

Action: (a) Meet with DOT and determine (1) the purpose and expectations of actions by forwarding agents at the place of United States entry for shipments of radioactive materials, (2) whether such agents are informed of the pertinent DOT requirements, and (3) whether such requirements are realistic and important to the handling of radioactive material shipments and should be enforced. (Responsible Office: NMSS)

Disposition: Resolved (Pending AEOD independent review)

On August 13, 1990, the NRC requested that DOT provide comments on this issue. DOT completed its initial investigation on July 30, 1991. NRC licensees, in NRC Information Notice 90-56 (Reference 4), were informed of the need to comply with DOT import and export requirements. If appropriate, the NRC will notify licensees of the DOT investigation findings in a supplemental Information Notice.

The responsible office considers this item resolved.

Action: (b) Pending the results of Action Item 9(a), initiate action to ensure that Amersham has taken appropriate corrective measures to ensure the completeness and accuracy of information provided to forwarding agents. (Responsible Office: RI)

Disposition: Resolved (Pending AEOD independent review)

DOT issued a proposed Notice of Violation to Amersham on July 31, 1991. Amersham has since requested a formal hearing before an administrative law judge. However, based on a review of the DOT investigation, NMSS and RI concluded that Amersham has taken the appropriate corrective measures. The responsible office considers this item resolved.

- References:**
1. NUREG-1405, "Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, Burlington, Massachusetts," dated May 1990.
 2. Memorandum for J. Glenn to J. Hickey, "Evaluation of NRC and DOT Reporting Requirements: NMSS Followup to Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation" (NUREG-1405), dated October 31, 1990.
 3. Memorandum from R. Bernero to E. Beckjord, "Request for Rulemaking - Amendment to 10 CFR 20.906, Procedures for Receiving and Opening Packages," dated February 5, 1991.
 4. NRC Information Notice 90-56, "Inadvertent Shipment of a Radioactive Source in a Container Thought to be Empty," dated September 4, 1990.

Action Source: IIT Report on General Electric Nuclear Fuels and Component Manufacturing Facility (GE-Wilmington) Potential Criticality Event of May 29, 1991 (References 1, 2, 3).

Item 1: Adequacy of Criticality Safety Reviews

Action: (a) Evaluate existing regulatory requirements, guidance, and review standards for criticality safety analyses of fuel facility licensees to modify processes, procedures, and facilities and to develop new regulatory guidance, requirements, and review standards (Responsible Office: NMSS/RES)

Disposition: Ongoing

In February 1992, the NMSS Materials Regulatory Review Task Force issued its report, NUREG-1324, "Proposed Method for Regulating Major Materials Licensees," evaluating these and other weaknesses in the fuel facilities regulatory requirements, guidance, and review standards. After collecting and reviewing public comments on NUREG-1324, staff of the NMSS Division of Fuel Cycle Safety and Safeguards developed an action plan (SECY-93-128) that presented an integrated approach to revamping the regulations and guidance for fuel facility licensing, and developed a standard review plan (SRP) for license reviews. As stated in SECY-93-128, NMSS is taking a fresh look at the fuel cycle regulatory, licensing, and inspection programs, emphasizing activities that will offer the greatest and/or near-term safety benefit without placing undue burden on the licensees. Among the principal products of the effort will be a major revision of 10 CFR Part 70 and its supporting regulatory guidance, and issuance of a review standard in the form of an SRP. The review will require performance of an integrated safety analysis (ISA) for the initial application and, as appropriate, reanalysis to support amendment of the application or a 10 CFR 50.59-type process. Criticality safety is one aspect to be analyzed by the ISA. These activities supersede the recommendation to consider separate action on criticality safety provided in the February 1993 task force report. The expected completion date is August 31, 1994.

Action: (b) Evaluate the use of safety operating specifications for radiation and nuclear safety instruments and controls. (Responsible Office: NMSS)

Disposition: Ongoing

The staff has evaluated and rejected establishment of criteria for fuel facility structures, systems, and components important to safety. The staff has evaluated a requirement for licensees to include in their applications technical specifications for nuclear safety instrumentation and controls. Instead, the staff intends to address radiation and nuclear safety instruments and controls in the same manner as other safety-related structures, systems, and components. Specifically, the staff is involved in the planned revision to 10 CFR Part 70 and accompanying standard format and content guidance for fuel cycle facility license applications. It is expected that the planned revision to 10 CFR Part 70 will require licensees to perform ISAs. These ISAs will allow determination of defects or failures to comply which could create substantial safety hazards. Once the ISAs are in place, licenses will have NRC-approved analyses to ensure that changes to facility operations do not introduce new risks that have not been evaluated by the NRC staff.

The licensing project manager and the inspection staff will ensure that a licensee does not significantly change its ISA process without NRC approval, and that the tool is used on an ongoing basis to evaluate any changes to the operations. The rule will make clear that licensees can make changes to the facility, including plant operations and equipment, without prior Commission approval, only under certain limited conditions that involve no additional risk. This rulemaking and associated guidance will address management control and oversight of safety-related equipment and procedures, including assurance of reliability and availability, human factors aspects, and training regarding safety significance and deviations from the licensee's safety basis standard. This staff action has been included in the action plan in SECY-93-128. The expected completion date is August 31, 1994.

Action: (c) Evaluate the need to change the licensing practice of incorporating a license condition by reference in fuel facility licenses. Ensure that the resultant licensing practice is mutually understood by all involved in the process. (Responsible Office: NMSS)

Disposition: Ongoing

The staff has been working with the fuel facility licensees during the amendment and renewal processes to include greater specificity in the commitments on their applications. The revamping of the regulations and guidance for fuel facility licensing, discussed in 1(a) above, will specifically address the information to be included in Part I of the application. The expected completion date is August 31, 1994.

Action: (d) Evaluate the existing NRC programs and develop new guidance for the inspection of changes to criticality safety controls at fuel fabrication facilities. (Responsible Office: NMSS)

Disposition: Ongoing

The staff will evaluate the existing NRC programs for the inspection of changes to criticality safety controls at fuel fabrication facilities. This evaluation will include a review of Regulatory Guide 3.52, "Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Processing and Fuel Fabrication," and Inspection Manual Chapter 2600, "Fuel Cycle Facility Operational Safety Inspection Program" including Inspection Procedures 88015, "Criticality Safety," and 88025, "Operations Review." These documents will be revised as appropriate after the evaluation is completed. In addition, the evaluations will include the reviews and evaluations associated with NUREG-1324, mentioned in Item 1(a) above. The NRC expects that inspector training will be provided under Action 1(e) below.

Expected completion date is September 30, 1994.

Action: (e) Evaluate the adequacy of NRC training and qualification programs to effectively support criticality safety inspections at fuel facilities, and develop enhancements to the training program. (Responsible Office: NMSS/AEOD)

Disposition: Resolved (Pending AEOD independent review)

A criticality safety training program for NRC inspectors has been developed under contract and made part of the curriculum of the NRC's Technical Training Center. The program was given for the first time in June 1993. The responsible office considers this item resolved.

Action: (f) Evaluate General Electric's (GE) response to the IIT report with respect to the site-specific corrective actions. Include in this evaluation the adequacy of (1) the current license, (2) the Facility Change Request process and its implementation, and (3) the criticality safety margins. (Responsible Office: NMSS/RII)

Disposition: Resolved (Pending AEOD independent review)

The staff evaluated GE's response to the IIT report with respect to the site-specific corrective actions. This evaluation included the adequacy of the current license, the facility change request process and its implementation, and criticality safety margins. The NRC conducted inspections to verify that adequate corrective actions have been taken. The responsible office considers this item resolved.

Item 2: Adequacy of Facility Operational Safety

Action: (a) Upgrade existing inspection guidance related to management controls and oversight, including audits, personnel training, and procedure adequacy and compliance for major materials licensees. (Responsible Office: NMSS/RES)

Disposition: Ongoing

The staff will evaluate the existing inspection guidance related to management controls and oversight, including audits, personnel training, and procedural adequacy and compliance for major materials licensees. This evaluation will include guidance presently found in Inspection Manual Chapters 2600 and 2800. In addition, the reviews associated with NUREG-1324, mentioned in Item 1(a) above, will be included in this evaluation. If the evaluation determines that new guidance is appropriate, the NRC will issue new guidance. The expected completion date is September 30, 1994.

Action: (b) Determine the need for regulatory requirements, guidance, and standard review plans regarding management controls and oversight, including audits, personnel training, and procedural adequacy and compliance for major materials licensees. Conduct reviews or inspections at selected licensees to collect additional information on management controls and practices. If necessary, on the basis of these assessments, develop new guidance, requirements, and standards as appropriate. (Responsible Office: NMSS/RES/NRR)

Disposition: Ongoing

NUREG-1324 placed considerable emphasis on improving licensees' management controls because past accidents can be traced directly to breakdowns in these controls. The staff has allocated FY94 funds for a contract to develop a guidance document, for licensees and applicants, in the form of a NUREG report on modern organizational control theory and practice, and the role of management control in ensuring the safety of operations. It is intended that the contractor report will present management control systems in detail, because the breakdown of these systems has allowed development of conditions adverse to safety. In addition, the planned revision to 10 CFR Part 70, discussed in 1(a) above, will include requirements for management controls and oversight. These requirements are being addressed in detail in the SRP for review of applications for fuel cycle facility licenses both in general and in chapters on specific topics, such as, nuclear criticality safety. The Standard Format and Content Guidance, derived directly from the SRP, will convey the details to the licenses. An NMSS task

force produced the rough draft of the SRP, which is being further developed in parallel with the revision of 10 CFR Part 70. The expected completion date is August 31, 1994.

Action: (c) Examine the overall inspection process for monitoring and collecting fuel facility safety performance information. Include in the evaluation the merits of (1) a resident inspector program; (2) more frequent inspections, including use of team inspections; (3) establishment of a systematic performance appraisal and feedback program analogous to the Systematic Assessment of Licensee Performance (SALP) for 10 CFR Part 50 licensees. (Responsible Office: NMSS/NRR)

Disposition: Ongoing

The staff will examine the overall inspection process for monitoring and collecting fuel facility safety performance information. This examination includes the merits of (1) a resident inspector program; (2) more frequent inspections, including the use of team inspections; and (3) establishment of a systematic performance appraisal and feedback program analogous to the SALP program for 10 CFR Part 50 licensees. In addition, the reviews associated with NUREG-1324, mentioned in Item 1a above, will be included in this examination. The expected completion date is September 30, 1994.

Action: (d) Evaluate the adequacy of the NRC training and qualification programs to effectively support fuel cycle facility inspections and to develop enhancements to the training program. (Responsible Office: NMSS/AEOD)

Disposition: Resolved (Pending AEOD independent review)

A training course, title "Fuel Cycle Technology (H-107)" was presented in FY 1992. This 5-day course provided an overview of the nuclear fuel cycle. Course topics included uranium mining and milling; uranium conversion, including dry and wet processes; uranium enrichment, including gaseous diffusion, gas centrifuge, and atomic vapor laser isotope separation; and uranium fuel fabrication and scrap recovery. The course was developed by the Technical Training Center through a contract for technical assistance through NMSS. The course has been revised to incorporate feedback from the pilot course.

Additionally, a Fuel Cycle and Materials Training Advisory Group has been formed. This advisory group will continue to evaluate the adequacy of NRC training programs to effectively support criticality safety and fuel cycle facility inspections. The responsible office considers this item resolved.

Item 3: Adequacy of Emergency Preparedness

Action: (b) Reevaluate the adequacy of the GE fuels facility Radiological Contingency and Emergency Plan (RCEP) and implementing procedures for emergency planning and event classification and notifications. Ensure that the RCEP and implementing procedures are revised as necessary. (Responsible Office: NMSS/RII)

Disposition: Resolved (Pending AEOD independent review)

By letter dated January 17, 1992, GE submitted an amended application, dated December 28, 1991, to update its RCEP. From January to September 1992, GE submitted several draft applications, and several meetings and telephone conference calls were held

between GE, Region II, and the NMSS staff. On October 2, 1992, GE resubmitted the amendment application to incorporate all changes agreed to by GE, Region II, and NMSS staff. This amendment application replaced the submittal of January 17, 1992, in its entirety. It was later supplemented by a submittal dated October 26, 1992. On October 29, 1992, the NRC issued License Amendment No. 27 authorizing GE to implement the RCEP changes.

A routine inspection in October 1992 included evaluation of the annual emergency response exercise and detailed review of the RCEP implementing procedures. No exercise weaknesses or program deficiencies were identified. The responsible office considers this item resolved.

Item 4: Adequacy of Operating Experience Reviews

Action: (a) Reevaluate regulatory requirements and guidance for event reporting for fuel facilities as related to potential criticalities and failed contingencies (barriers). Develop additional guidance and requirements as appropriate. (Responsible Office: NMSS/RES/AEOD)

Disposition: Resolved (Pending AEOD independent review)

The staff is continuing to reevaluate the regulatory requirements and guidance for event reporting for fuel facilities as related to potential criticalities and failed contingencies (barriers). On October 18, 1991, the staff issued NRC Bulletin 91-01, "Reporting Loss of Criticality Safety Controls." The bulletin requested that licensees evaluate their criticality safety criteria and procedures, modify them as appropriate to assure that events involving degradation of controls will promptly be evaluated and reported to licensee management and the NRC as appropriate, and provide a description of their criteria and procedures to the NRC. Supplement 1 to NRC Bulletin 91-01, published on July 27, 1993, clarified which events need to be reported within 4 hours, and which could be reported within 24 hours. The responsible office considers this item resolved.

Action: (b) Reevaluate NRC operating experience review and feedback program for fuel facilities. Revise the program as appropriate. (Responsible Office: NMSS)

Disposition: Ongoing

The staff will reevaluate the NRC operating experience review and feedback program for fuel facilities. After completing the evaluation, the staff will revise the program as appropriate. The expected completion date is September 30, 1994.

Action: (c) Develop NRC inspection guidance for licensee event reporting and reviews for fuel facilities. Issue new guidance as appropriate. (Responsible Office: NMSS/AEOD)

Disposition: Ongoing

The staff will evaluate the need to develop NRC inspection guidance for licensee event reporting and reviews for fuel facilities and will issue new guidance. This evaluation will primarily include the guidance presently in Inspection Manual Chapter 2600, "Fuel Cycle Facility Operational Safety Inspection Program." The expected completion date is September 30, 1994.

Action: (d) Extend the independent NRC operating experience program to nuclear fuel fabrication facilities. Examine the existing operating experience review program for other licensee

groups not in the scope of AEOD activities. Revise the program as appropriate.
(Responsible Office: AEOD)

Disposition: Ongoing

AEOD currently reviews reports from fuel fabrication facilities as well as inspection reports to obtain information on operating events. The NRC is revising the reporting threshold. New reporting requirements (10 CFR Part 70 revision and the bulletin on criticality reports) will provide additional information to identify precursors.

The NRC (contractor) will visit fuel fabrication plants and audit licensee internal event reviews for adequacy. The audit will also include an evaluation of the adequacy of reporting requirements to provide NRC with the information necessary to assess important safety significant events.

AEOD reviews event reports and inspection reports for all licensee groups licensed by the NRC. Efforts are currently underway to obtain reports of events from Agreement States on a timely basis so that they can be added to the operating experience base. This program was begun in late 1991.

AEOD will review Agreement State data, in conjunction with non-Agreement State data, to determine whether the AEOD review program needs revision to include classes of licensees that exist only in Agreement States.

The full implementation of this item requires completion of Action 4a and implementation of reporting of incidents pursuant to 10 CFR Part 70 and agreements with the Office of State Programs. The expected completion date is September 30, 1994.

References:

1. NUREG-1450, "Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility, May 29, 1991," August 1991.
2. Memorandum from J. Taylor to NRC staff, "Staff Actions Resulting from the Investigation of the Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility, May 29, 1991 (NUREG-1450)," August 13, 1991.
3. Memorandum from E. Jordan to J. Taylor, "Staff Actions in Response to the Investigation of the Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility Findings" (NUREG-1450), September 6, 1991.
4. Memorandum from R. Bernero to J. Taylor, "Staff Action Plan Responding to the Investigation of the May 29, 1991, Incident at the General Electric (GE) Nuclear Fuel and Component Manufacturing Facility" (NUREG-1450) September 9, 1991.
5. Letter to S.D. Ebnetter to W. Ogden, "NRC Incident Investigation Team Report Followup" (NUREG-1450), August 13, 1991.
6. NRC Inspection Report No. 70-1113/91-0, August 12, 1991.

7. Letter from J. Stohr to W. Ogden, "Management Meeting Summary," October 2, 1991.
8. Letter from B. Wolfe (GE) to J. Taylor (NC), August 26, 1991.
9. Letter from W. Ogden to J. Taylor, August 27, 1991.
10. NRC Inspection Report No. 70-1113/91-04, December 23, 1991.
11. NRC Inspection Report No. 70-1113/91-09, January 15, 1992.
12. NRC Inspection Report No. 70-1113/91-06, January 22, 1992.
13. Regulatory Guide 3.67, "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities," January 1992.
14. Letter from G. Bidinger to T.P. Winslow, January 7, 1992.
15. NRC Bulletin No. 91-01, "Reporting Loss of Criticality Safety Controls," October 18, 1991.
16. NUREG-1324, "Proposed Method for Regulating Major Materials Licensees," dated February 1992.
17. Memorandum from R. Bernero to J. Taylor, "Staff Actions Resulting from the Investigation of the May 29, 1991, Incident at General Electric (GE) Wilmington," dated September 29, 1993.
18. Memorandum from R. Bernero to J. Taylor, "Completion of Item 1.F to General Electric Staff Action Plan, Response to Investigation of the May 29, 1991, Incident at the General Electric Nuclear Fuel and Component Manufacturing Facility" (NUREG-1450), dated August 2, 1993.
19. Memorandum from E. Jordan to R. Bernero, "Completion of Items 1.E and 2.D to General Electric Staff Action Plan, Response to Investigation of the May 29, 1991, Incident at the General Electric Nuclear Fuel and Component Manufacturing Facility," dated September 13, 1993.
20. Memorandum from R. Bernero to J. Taylor, "Completion of Item 3.B to General Electric (GE) Staff Action Plan, Response to Investigation of the May 29, 1991, Incident at the GE Nuclear Fuel and Component Manufacturing Facility" (NUREG-1450), dated December 2, 1992.

Action Source: IIT Report on "Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center, Indiana, Pennsylvania, on November 16, 1992 (NUREG-1480)," dated March 12, 1993. (Reference 1)

Item 1: Adequacy of Oncology Services Radiation Protection Program

Action 1a: Review by Oncology Services Corporation (OSC) corrective actions in response to the finding of ineffectiveness of the radiation safety program. (Responsible Office: RI)

Disposition: Ongoing

In a letter dated September 13, 1993, OSC requested a relaxation of the NRC order to obtain high-dose-rate sealed sources for two facilities. In addition, in a letter dated September 20, 1993, OSC requested authorization to perform patient treatments. Finally, in letters dated September 17, and October 4, 1993, OSC requested individual licenses for all six facilities. Region I sent a deficiency letter dated November 1, 1993, stating that OSC's request would not be considered until the order affecting all six facilities was relaxed. The staff is currently reviewing the licensee's response in a letter dated December 7, 1993. A meeting with the Atomic Safety and Licensing Board (ASLB) was held on January 27, 1994, to identify the issues for future litigation, and to determine whether to combine the license suspension actions for OSC and Dr. Bauer, the authorized user at Indiana Regional Cancer Center, during the November 1992 misadministration. The ASLB will issue an order establishing a schedule for actions leading to a hearing. The expected completion date was February 11, 1994.

Action 1b: Evaluate whether NRC regulations and guidance need to be modified to explicitly define the functions and responsibilities of the radiation safety officer and the authorized user. (Responsible Office: NMSS)

Disposition: Ongoing

A task force of NMSS, regional, and Agreement State representatives for development of a NUREG report for radiation safety officers met during September and December 1993 and is scheduled to again meet from January 31 through February 2, 1994. Additionally, the staff will evaluate the need to further define and provide guidance on the responsibilities of the authorized user. This issue will be addressed during a major revision of 10 CFR Part 35, scheduled for completion in December 1997. The project was also discussed with the Advisory Committee on Medical Uses of Isotopes (ACMUI) at the November 1993 meeting. At that time, the ACMUI requested a copy of the draft NUREG report for review and discussion at its May 1994 meeting. In addition, the draft report will undergo a peer review during the March to April 1994 time frame. As a result of the ACMUI request and the staff's decision on peer review, the due date for publication of the NUREG has been extended from June 30, 1994, to September 30, 1994. The expected completion date is December 30, 1997.

Action 1c: Evaluate the performance and design of PrimAlert-10 Area Radiation Monitors (ARMs) and take appropriate followup action. (Responsible Office: NMSS/Regions)

Disposition: Ongoing

The staff wrote to Victoreen, the manufacturer, and requested an evaluation of the potential for non-ionizing radiation fields or electromagnetic fields (associated with linear accelerators) to cause spurious alarms by the PrimAlert-10 ARM, as well as similar models used by medical licenses (such as the PrimAlert-50 ARM).

Victoreen responded to the staff's letter in October 1993. The staff intends to forward a second letter to Victoreen by February 15, 1994, to seek additional information regarding guidance for licensee event reporting and reviews for fuel facilities, and will issue new guidance as appropriate. The staff's evaluation will primarily include the guidance presently in Inspection Manual Chapter 2600, "Fuel Cycle Facility Operational Safety Inspection Program." In addition, NMSS will develop a Temporary Instruction for the Regions to review the operation and reliability of PrimAlert ARMs as part of the routine inspection program. The staff will evaluate the information compiled by the Regions as well as the manufacturer's response and, if appropriate, will issue an Information Notice to licensees. The expected completion date is September 30, 1994.

Action: (1) Extend the independent NRC operating experience program to nuclear fuel fabrication facilities. Examine the existing operating experience review program for other licensee groups not in the scope of AEOD activities. Revise the program as appropriate. (Responsible Office: AEOD)

Disposition: Ongoing

AEOD currently reviews reports from fuel fabrication facilities, as well as inspection reports, to obtain information on operating events. The NRC is revising the reporting threshold. New reporting requirements defined in the forthcoming 10 CFR Part 70 revision and the bulletin on criticality reports will provide additional information to identify precursors.

The NRC (contractor) will visit fuel fabrication plants and audit licensee internal event reviews for adequacy. The audit will also include an evaluation the adequacy of instrument response at the high-energy spectrum. In addition, the staff will review the response to the second letter, as well as information developed by the Regions and, if appropriate, issue an Information Notice to licensees. The expected ate is April 29, 1994.

Item 2: **Adequacy of NRC Protocols for Informing the Public and Authorities of Radiation Exposures Resulting from Licensed Activities.**

Action 2a: Evaluate the NRC's process for assessing exposures and consequences, and notifying individuals and authorities following an elevated exposure. (Responsible Office: NMSS/NRR/Office of the General Counsel)

Disposition: Ongoing

The staff has developed guidance to address this recommendation for material licensees based on the experience of the Amersham source incident. This guidance was previously approved by the EDO; however, it is being revised to incorporate the lessons learned from the IIT, and will be issued as Inspection Manual Chapter 1302. The staff is in the process of resolving comments and expects to issue the manual chapter by February 28, 1994.

Action 2b: Evaluate the need to further define licensee responsibility for assessing radiation exposure and notifying members of the public and authorities. (Responsible Office: NMSS/NRR)

Disposition: Ongoing

The staff received guidance from OGC regarding the applicability of 10 CFR Parts 19 and 20 to licensees for assessing radiation exposure and notifying members of the public and authorities. This guidance was forwarded to RES for incorporation into a final rule package on 10 CFR Parts 19 and 20. The final rule package was submitted to the EDO on December 17, 1993, for his signature and for Commission review. The final rule makes minor clarifications to 10 CFR Parts 19 and 20 to make such reports required by Part 20. The expected completion date was March 31, 1994.

Item 3: Adequacy of Regulatory Oversight of Sealed Sources and Devices and Medical Licenses

Action 3a: Evaluate the need to update licensing and inspection guidance and requirement for high-dose-rate afterloaders. (Responsible Office: NMSS/RES)

Disposition: Ongoing

The staff has undertaken several efforts with regard to evaluating the need to update licensing and specific guidance and regulations for high-dose-rate afterloaders. The staff revised Policy and Guidance Directive 86-4 to incorporate the requirements of the two bulletins. A Temporary Instruction was issued in September 1993 to provide guidance on routine inspection of high-dose-rate afterloaders. In addition, research efforts are continuing into quality assurance plans for remote afterloaders and human factors related to brachytherapy. RES will document the results of these various efforts into a user need memorandum to revise 10 CFR Part 35. The expected completion date for this memorandum is March 31, 1995.

The staff continues to monitor and evaluate contractors' findings regarding quality assurance and quality control and human factors research studies on remote afterloader procedures. NMSS and RES will document these findings in a final report to be issued on June 30, 1994. The expected completion date to revise 10 CFR part 35 is December 31, 1997.

Action 3b: Evaluate the relative merits of a performance-based approach versus schooling or certification to verify the radiation safety knowledge of high-dose-rate afterloader users. (Responsible Office: NMSS/NRR)

Disposition: Ongoing

The staff will conduct an evaluation as requested, and continue to discuss this issue with the ACMUI. The staff will incorporate this issue into the user need memorandum described in 3a above, as appropriate.

This issue was discussed with the ACMUI in May 1993, and will be discussed at future meetings. The ACMUI advised the staff that there are no simple methods or prescriptive requirements to determine if a physician has achieved the necessary competency to independently supervise the use of byproduct material for diagnosis or therapy. The ACMUI noted that the staff does not have statistical data to demonstrate that the current system is not working. However, the ACMUI did recommend a paradigm shift in the methods used by the NRC to assess the adequacy of training and experience in order to remove the NRC from disputes between competing specialties within the medical

community. The paradigm shift would involve preceptoring by a qualified physician, attestation of the competency of the candidate by the preceptor, and independent testing on behalf of the NRC. The staff's plan to evaluate all current training and experience criteria will include a determination regarding the relative merits and resource costs of different training approaches to ensure adequate radiation safety knowledge of all users. These findings will be incorporated into the user need memorandum.

Action 3c: Evaluate the licensing interface among the NRC, the U.S. Food and Drug Administration (FDA), and the Agreement States for sealed sources and devices, including licensee requirements for design reviews and quality assurance and quality control. Develop a Memorandum of Understanding with the FDA to further clarify respective roles. (Responsible Office: NMSS/OSP/OGC)

Disposition: Ongoing

The staff reviewed the FDA's description of its regulatory review of devices such as the Omnitron 2000, and met with FDA staff to clarify the NRC/FDA interface agreement which was signed on August 26, 1993. NMSS procedures for implementation of the Memorandum of Understanding were drafted and circulated for comment on October 15, 1993. The procedures will be issued as an Inspection Manual Chapter by March 31, 1994.

The staff will also review the interface between the NRC and the Agreement States with respect to approval of sealed sources and devices, and will make appropriate recommendations for improving the definition of that interface.

Action 3d: Revise the inspection guidelines to trigger consideration for licensees whose programs have significantly expanded or changed. (Responsible Office: NMSS)

Disposition: Ongoing

A task force composed of headquarters and regional staff has been formulated and was scheduled to meet during February 1994 to make significant changes to the inspection guidance in Manual Chapter 2800, "Materials Inspection Program." Areas to be addressed include guidance on inspection of satellite facilities; field offices and temporary job sites; adjustment of inspection frequency based on performance; and emphasis on programs that have significantly expanded or changed. To provide guidance to license reviewers in advance of issuance of Inspection Manual Chapter 2800, the staff will issue a Policy and Guidance Directive by June 30, 1994. This directive will provide criteria for licensee reviewers to use in determining if licensee's programs have significantly expanded or changed. The expected completion date is January 29, 1995.

Action 3e: For near-term, and where indicated, conduct inspections of licensees whose programs have significantly expanded or changed since the last routine inspection. (Responsible Office: NMSS/Regions)

Disposition: Ongoing

The staff issued a memorandum to the Regions requesting that they poll the licensing staff to identify licensees whose programs (i.e., number of sites, scope of licensed activities, and/or possession limits) have significantly expanded or changed within the last two years.

The Regions proposed a schedule for the conduct of inspections by March 31, 1994. The expected completion date is May 9, 1994.

Item 4: **Lack of guidance for nonradioactive waste collectors and brokers for handling highly radioactive material.**

Action: Evaluate the need for assisting the nonradioactive waste processing industry in establishing guidance for detecting, and obtaining expert assistance for handling, radioactive materials. (Responsible Office: NMSS/OSP)

Disposition: Ongoing

The staff has initiated efforts to prepare guidance. Specifically, the staff met with representatives from the Agreement States and the waste processing industry on June 29, 1993, to develop the guidance which will incorporate lessons learned from the IIT.

During October 1993, the staff received diverse comments from the industry and Agreement States concerning its draft guidance. Addressing these comments resulted in a slip of the due date from January 31, 1994, to March 31, 1994. Two forms of guidance will be issued: (1) emergency response information to be distributed to facility workers, and (2) more detailed technical guidance for managers of waste processor facilities. The guidance will incorporate lessons learned from the IIT. The expected completion date is March 31, 1994.

Item 5: **Cause of Source Wire Failure**

Action: Evaluate Southwest Research's final report on the source wire failure and document the findings. (Responsible Office: NMSS/OSP)

Disposition: Resolved (Pending AEOD independent review)

The staff received the final report from Southwest Research which confirmed the staff's hypothesis regarding the cause of the source-wire breakage. The contractor's final report was transmitted to the Commission via a memorandum dated October 27, 1993. The responsible office considers this item resolved.

References:

1. NUREG-1480, "Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center, Indiana, Pennsylvania, on November 16, 1992," February 1993.
2. Memorandum from J. Taylor to Office Directors and Regional Administrators, "Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center, Indiana, Pennsylvania, on November 16, 1992," dated March 12, 1993.
3. Memorandum from R. Bernero to J. Taylor, "Status Report on Staff Action Plan Responding to the Investigation of the Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center, Indiana, Pennsylvania, on November 16, 1992" (NUREG-1480), dated February 6, 1994.

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 Num- bers, if any.) NUREG-1272, Vol. 8, No. 2				
2. TITLE AND SUBTITLE Office for Analysis and Evaluation of Operational Data 1993 Annual Report - Nuclear Materials		3. DATE REPORT PUBLISHED <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; text-align: center;">MONTH</td> <td style="width: 50%; text-align: center;">YEAR</td> </tr> <tr> <td style="text-align: center;">May</td> <td style="text-align: center;">1995</td> </tr> </table>	MONTH	YEAR	May	1995
		MONTH	YEAR			
		May	1995			
4. FIN OR GRANT NUMBER 						
5. AUTHOR(S) 		6. TYPE OF REPORT Annual summary of regulatory activities for nuclear materials				
		7. PERIOD COVERED (Inclusive Dates) CY 1993				
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 20555-0001						
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 in item 8						
10. SUPPLEMENTARY NOTES 						
11. ABSTRACT (200 words or less) <p>The annual report of the U.S. Nuclear Regulatory Commission's Office for Analysis and Evaluation of Operational Data (AEOD) is devoted to the activities performed during 1993. The report is published in two separate parts. NUREG-1272, Vol. 8, No. 1, covers power reactors and presents an overview of the operating experience of the nuclear power industry from the NRC perspective, including comments about the trends of some key performance measures. The report also includes the principal findings and issues identified in AEOD studies over the past year and summarizes information from such sources as licensee event reports, diagnostic evaluations, and reports to the NRC's Operations Center. NUREG-1272, Vol. 8, No. 2, covers nuclear materials and presents a review of the events and concerns during 1993 associated with the use of licensed material in nonreactor applications, such as personnel overexposures and medical misadministrations. Note that the subtitle of No. 2 has been changed from "Nonreactors" to "Nuclear Materials." Both reports also contain a discussion of the Incident Investigation Team program and summarize both the Incident Investigation Team and Augmented Inspection Team reports. Each volume contains a list of the AEOD reports issued for 1981-1993.</p>						
12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.) nuclear materials operating experience abnormal occurrences IIT staff action status AEOD recommendations AEOD report listing		13. AVAILABILITY STATEMENT Unlimited				
		14. SECURITY CLASSIFICATION (This Page) Unclassified				
		(This Report) Unclassified				
		15. NUMBER OF PAGES 				
		16. PRICE 				