POLICY ISSUE
INFORMATION

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FOR: The Commissioners

FROM: Brian E. Holian, Acting Director
Office of Federal and State Materials
and Environmental Management Programs

SUBJECT: ANNUAL REPORT TO THE COMMISSION ON LICENSEE PERFORMANCE IN THE MATERIALS AND WASTE PROGRAMS FISCAL YEAR 2013

PURPOSE:

This paper provides the twelfth annual report on significant nuclear materials issues and licensee performance trends in the Materials and Waste Programs pursuant to Staff Requirements Memorandum (SRM) SECY-02-0216, "Proposed Process for Providing Information on Significant Nuclear Materials Issues and Adverse Licensee Performance," dated February 25, 2003 (ML030560328). This report covers fiscal year (FY) 2013. This paper does not address any new commitments or resource implications.

SUMMARY:

For FY 2013, the staff evaluated significant nuclear materials issues and performance trends based on aggregated information obtained from operating experience associated with reportable events and generic concerns affecting the industry. With the exception of the review of escalated enforcement actions, this evaluation included both the U.S. Nuclear Regulatory Commission (NRC) and Agreement State licensees. The staff concluded, from the assessment of the overall performance data, that there are no discernible adverse performance trends or generic concerns and that public health and safety were protected.

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BACKGROUND:

On June 28, 2002, the Commission issued SRM M020501 concerning the Agency Action Review Meeting (AARM). In the SRM, the Commission directed the staff to propose a process for providing the Commission with annual updates on significant nuclear materials issues (such as overexposures, medical events or misadministrations, and lost or stolen sources) and on adverse licensee performance.

In response to this SRM, on December 11, 2002, the staff issued SECY-02-0216, providing criteria for determining the nuclear materials licensees to be discussed at the AARM and the process the staff would use to provide the Commission with annual updates on significant nuclear materials issues and adverse licensee performance. On February 25, 2003, the Commission issued an SRM for SECY-02-0216, which approved the staff's proposal to evaluate materials licensees with performance issues for discussion at the AARM, and to provide the Commission with information on the Materials and Waste Programs' performance in an annual report.

On September 16, 2008, the staff issued SECY-08-0135 "Revision of the Criteria for Identifying Nuclear Materials Licensees for Discussion at the Agency Action Review Meeting" (ML082480564), which provided a revision to the criteria provided in Table 1 of SECY-02-0216 for determining nuclear materials licensees that warrant discussion at the AARM. The criteria were revised to provide additional clarity and incorporate the NRC's current policies and procedures. In 2011, the criteria for identifying nuclear material licensees for discussion at the AARM was revised again to include an additional criterion to address licensees who previously were discussed at the AARM but their corrective actions were ineffective in correcting the underlying issues. The information regarding that revision to the criteria for identifying nuclear materials licensees for discussion at the AARM was provided to the Commission in SECY-11-0132, "Revision of the Criteria for Identifying Nuclear Material Licensees for Discussion at the Agency Action Review Meeting," dated September 20, 2011.

DISCUSSION:

The evaluation of significant adverse performance issues and performance trends is based on aggregated information that includes operating experience associated with reportable events and generic concerns affecting the industry. As committed to in SECY-02-0216, the staff has developed a process for providing the Commission with annual updates on significant issues and performance trends that builds on existing processes and systems and has minimal impact on staff resources.

The aggregated information used to evaluate significant adverse performance issues and performance trends was obtained through existing processes and systems and includes the following information: strategic outcomes and performance measures data; annual assessment of events reported to the Nuclear Material Events Database (NMED); Abnormal Occurrence (AO) data; generic and/or special event study results; data derived through escalated enforcement actions; and significant licensee performance issues that were identified based on the criteria described in SECY-11-0132. The following sections represent an evaluation of this information followed by overall conclusions of the licensee performance in the Materials and Waste Programs.

Strategic Outcomes and Performance Measures Data

NRC staff focused on verification and validation of data generated by NRC and the Agreement States to determine the impact on strategic outcomes and performance measures related to nuclear materials event, as reported in NRC's "Fiscal Year 2013 Performance and Accountability Report." The metric for the strategic outcomes is zero occurrences, and there were no occurrences related to nuclear materials that met any of the safety or security strategic outcomes for FY 2013. Also, the safety and security performance measure targets were met in FY 2013.

Assessment of Data Reported to NMED

The NMED contains records of events involving nuclear materials reported to NRC by its licensees, Agreement States, and non-licensees. These reported events are sorted by the event reporting requirements as defined in NRC regulations. The event reports are evaluated to identify any safety significant events and their causes. NMED data is analyzed for the main event types, is aggregated for evaluation of potential trends, and is presented in an annual summary report (NMED Annual Report). For the purposes of the NMED Annual Report data, it should be noted that a single occurrence/event report may be captured in multiple NMED event categories (e.g., a report may describe a loss of licensed material that also resulted in a radiation overexposure). A copy of the FY 2013 NMED Annual Report is available in Enclosure 1. Copies of previous NMED Annual Reports may be found at http://nmed.inl.gov/.

In order to account for the potential random fluctuations in the event data from year to year and to assess an average trend of the data, the data from the last 10 FYs are reviewed. For the 10-year period from FY 2004 through FY 2013, a total of 5,634 events (1,807 NRC and 3,827 Agreement State) associated with materials licensees were reported to NRC, compared to 5,802 events that were reported for the previous 10-year period, from FY 2003 through FY 2012. For the current 10-year period, the review of the data shows that the total number of events per year is relatively stable and very small in comparison with the large number of radioactive materials use activities per year.

Although the total data indicated no statistically significant performance trends, there were some statistically significant trends related to narrow sections of the data (See Enclosure 1, page 4, Table 1, Summary of Trending Analysis). For example, the total number of the NRC events, NRC lost/abandoned/stolen materials events, and NRC medical events indicated statistically significant decreasing trends. The summary table also shows one statistically significant increasing trend in Agreement State medical events. However, based on the analysis of the event, enforcement, and performance metrics data for the current 10-year period, a specific reason was not identified for the statistical trends found in the report. It should be noted that the transfer of licensees from the NRC to Agreement State authority during this 10-year period could result in increasing numbers of Agreement State events and decreasing numbers of NRC events. In addition, the NRC has performed outreach efforts with Agreement States to improve understanding of medical event criteria. The increasing trend of Agreement State medical events may also reflect better reporting.

For FY 2013, 15 of the 415 NMED events were considered to be of higher significance and are described in the FY 2013 NMED Annual Report. The breakdown of these significant events by category was as follows:

- four lost/abandoned/stolen material events involving a total of 12 sources;
- six medical events classified as AOs or potential AOs;
- one radiation overexposure event requiring reporting within 24 hours;
- one contamination event requiring immediate reporting;
- one fuel cycle process event requiring immediate reporting; and
- two "other" events classified as AOs, both involving radiation exposure to the embryo/fetus of a woman undergoing medical treatment.

For the four significant lost/abandoned/stolen material events, it should be noted that none of the nuclear material sources were classified as Category 1 under the International Atomic Energy Agency (IAEA) Code of Conduct on the Safety and Security of Radioactive Sources (2004). Ten Category 2 sources and two Category 3 sources were lost, all of which were subsequently recovered. A summary of the significant events that took place in FY 2013 is provided in the Executive Summary of the enclosed NMED Annual Report (Pages xi – xii), and a detailed description of the significant events and events of interest is provided in the main body of the report for the specific event categories.

Overall analysis of the data reported to NMED did not identify any significant issues that warrant specific action or policy changes.

AO Data

The staff determined that ten events in FY 2013 involving nuclear materials were identified as AOs. All ten events occurred at facilities licensed by Agreement States. Two of the AOs involved radiation exposure to an embryo/fetus. The remaining eight AOs were medical events as defined in 10 CFR Part 35, "Medical Use of Byproduct Material." Given that the number of medical-related AOs is small in comparison with the significantly large number of medical procedures performed annually, the staff does not believe that these events represent a generic concern.

The staff's analysis and evaluation found that human error was a main contributor to the root causes of these AO events. Reported causes for the ten events include inadequate communication, inability of the pregnancy test to provide a positive determination so close to conception, failure to confirm the correct treatment site or parameters, possible malfunction of a treatment applicator or planning system, and probable development of collateral vessels around the tumor between initial treatment planning and treatment delivery.

Four of the eight medical event AOs involved high dose rate remote afterloader (HDR) treatments. In response to recent HDR medical events, the NRC issued Information Notice 2013-16, Importance of Verification of Treatment Parameters for High Dose Rate Remote Afterloader Administrations (ML13058A306).

In addition to the ten AOs that were identified in the FY 2013 AO report, the staff has identified an additional three events (one NRC and two Agreement State) that took place in FY 2008 through FY 2013 that are potential AOs for which additional information is required. The staff is working with the NRC and Agreement State licensees to obtain the necessary information and these events will be included in a future report.

Overall analysis of the AO events did not identify any significant performance trends or generic concerns.

Special Event Study Results

In December 2013, the staff performed a special study to evaluate events involving radiography for a 10-year time period from FY 2004 through FY 2013. The study involved all types of radiography events including equipment issues; radiation overexposures; lost, abandoned, or stolen material; leaking sealed sources; release of licensed material or contamination; and transportation events. A graph and trend analysis of the number of events for each year is provided in Enclosure 2, Figure 1. A description of the statistical methods used in the trend analysis is provided in Enclosure 1, Appendix B.

The numerical analysis of the total number of events shows a statistically significant increase over the 10-year period. However, the staff notes that the 10-year time frame was arbitrarily selected, and analyses of both a shorter, 8-year time period (see Enclosure 2, Figure 2) and a longer, 12-year time period (see Enclosure 2, Figure 3) show a flat trend line, with the FY 2004 and FY 2005 data as slight outliers with smaller numbers of events. Additional review by the staff identified a number of possible explanations for the rising number of events including an increase in radiography volume due to rising oil and gas exploration, an increase in the number of radiography licensees, and an increased licensee awareness of reporting requirements triggered by the 2005 NRC issuance of RIS 2005-15, Reporting Requirements for Damaged Industrial Radiographic Equipment (http://www.nrc.gov/reading-rm/doc-collections/gen-comm/reg-issues/2005/ri200515.pdf). The staff also notes that the number of occurrences of radiography events across the 10-year period is exceedingly low compared to the large number of opportunities for failure--conservative estimates of the failure rate are well below 0.1 percent.

Enclosure 2, Figure 4 shows a graph of the number of radiography events by type for the 10-year time period from FY 2004 through FY 2013. The staff notes that equipment related malfunctions led to a high proportion of the radiography events. A detailed review of the radiography events related to equipment malfunction in FY 2013 identified an unusually high number (14) in which radiography sources could not be retracted because the associated guide tubes or drive cables were damaged after the sources were extended. In 12 of these events, the damage resulted when components of radiography devices were crushed by falling construction equipment or when radiographic devices fell from inadequate placement or supports. In two events, the exterior surfaces of the radiography drive cables were melted by the beam of mirrors at solar power generating stations. It appears that all of these events could have been avoided with better equipment mounting or routing techniques. Six similar events occurred in FY 2012 and 10 occurred in FY 2011. As a result of this study, the staff is planning to issue a generic communication to licensees to raise awareness of the need for proper mounting of radiography equipment at work sites.

In conclusion, this study of radiography events did not reveal significant repetitive or safety issues that warrant specific agency action other than considering issuance of a generic communication such as an Information Notice. The study also did not identify any gap or inadequacy in agency policy. The NRC has in place procedures to monitor the occurrence of radiography events and to promptly respond to emerging events that have the potential to endanger public health and safety.

Data Derived Through Escalated Enforcement Actions

Escalated enforcement actions in the Materials and Waste Programs include civil penalties and Notices of Violation (NOV) for Severity Level I, II, and III violations, as well as Orders and Demands for Information (DFI). The Enforcement Program Annual Report is issued on a calendar year (CY) basis and CY escalated enforcement data was included in recent years in the Annual Report to the Commission on Licensee Performance in the Materials and Waste Programs. For 2013, the Office of Enforcement provided FY data in order to present a consistent reporting interval for all reports of performance in the Materials and Waste Programs. In FY 2013, NRC issued 43 escalated enforcement actions involving NRC materials licensees (including fuel cycle facilities). The escalated enforcement actions issued in FY 2013 include 3 Severity Level II NOVs, 36 Severity Level III NOVs, and 4 Orders. Three of the four Orders were Confirmatory Orders that were issued to confirm commitments associated with Alternative Dispute Resolution (ADR) agreements. The fourth Order was issued to formalize the licensee's commitment to take certain corrective actions. Six of the 43 escalated enforcement actions involved issuance of a civil penalty.

For FY 2013, the number of escalated enforcement actions for the Materials and Waste Programs decreased by 15 from the number of actions issued in FY 2012. The number of escalated enforcement actions issued to materials licensees and fuel cycle facilities in the last four years shows a decreasing trend from 81 actions in FY 2010 to 43 actions in FY 2013. This is mainly due to a decrease in the number of escalated enforcement actions issued to gauge users, radiographers, and fuel cycle facilities over this period. The staff's analysis of the materials enforcement trend has not been conclusive, however, several causal factors have been identified that account for a substantial portion of the decrease. The number of cases involving security-related increased controls violations has decreased over this time period. For gauge users, the Severity Level (SL) of certain violations was changed from SL III to SL IV in 2011, reducing the number of escalated actions issued thereafter. Fuel cycle facilities have implemented improvements in the areas of problem identification and correction and safety culture. In addition, the severity level examples for violations at fuel facilities were changed in the Enforcement Policy to be more risk-informed, reducing the number of escalated enforcement actions issued.

Licensees Identified with Significant Performance Issues

SECY-11-0132 defines the criteria used to identify licensees with significant performance issues and licensees that warrant the highest level of NRC management attention. The criteria target the most critical issues involving very serious events (those triggering NRC's strategic level measures), significant licensee issues, or licensee performance trends. For FY 2013, no nuclear materials licensees were identified that met the criteria in SECY-11-0132 for discussion at the AARM. Two nuclear material licensees discussed in FY 2012 with classified matter protection program issues were issued Severity Level II violations in FY 2013. These licensees

no longer require additional NRC oversight and, as such, do not meet the criteria in SECY-11-0132.

OVERALL PERFORMANCE CONCLUSIONS:

Based on the review of event data and assessment of key events, the staff concludes that the Materials and Waste Programs are functioning effectively to protect public health and safety. Based on staff review and subsequent revisions in 2008 and 2011 to the criteria for identifying nuclear materials licensees that warrant discussion at the AARM, staff has concluded that the current criteria are effective and valid, and appear to be working efficiently. All lost or stolen nuclear materials sources classified as Category 1 through 3 in the IAEA Code of Conduct on the Safety and Security of Radioactive Sources (2004) were recovered. The staff identified no nuclear materials licensees that met the criteria, as described in the enclosure of SECY-11-0132, for identifying nuclear materials licensees for discussion at the AARM.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections.

/RA Marian Zobler for/

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Enclosures:
1. Nuclear Material Events Database Annual Report FY 2013
2. Radiography Event Special Study Breakdown

March 2014

Nuclear Material Events Database

Annual Report

Fiscal Year 2013

Prepared for the U.S. Nuclear Regulatory Commission
by the Idaho National Laboratory (INL/LTD-14-31046)

ENCLOSURE 1

INL/LTD-14-31046

Nuclear Material Events Database

Annual Report

Fiscal Year 2013

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ABSTRACT

This report presents information on trending and analysis of incidents/accidents (events) reported to the Nuclear Regulatory Commission (NRC) that involve radioactive material. The events are reported by NRC licensees, Agreement States, and non-licensees, and are recorded in the NRC's Nuclear Material Events Database. The reported events are classified into categories based on event reporting requirements defined in Title 10 of the Code of Federal Regulations. The categories in this report are (1) Lost/Abandoned/Stolen Material, (2) Medical, (3) Radiation Overexposure, (4) Release of Licensed Material or Contamination, (5) Leaking Sealed Source, (6) Equipment, (7) Transportation, (8) Fuel Cycle Process, and (9) Other.

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ACRONYMS

ALARA	as low as reasonably achievable
ALI	annual limit on intake
AO	abnormal occurrence
CDOH	Colorado Department of Health
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
CRHB	California Health and Human Services Agency, Radiological Health Branch
CT	computed tomography
DDE	deep dose equivalent
DE	dose equivalent
DOT	Department of Transportation
DVA	Department of Veterans Affairs
ECD	electron capture detector
EDE	effective dose equivalent
EQP	Equipment
EXP	Radiation Overexposure
FCP	Fuel Cycle Process
FY	fiscal year
GDOT	Georgia Department of Transportation
GTCC	greater than class C
HDR	high dose rate
HEPA	high-efficiency particulate air
HLW	high-level waste
IAEA	International Atomic Energy Agency
INL	Idaho National Laboratory
IROFS	items relied on for safety
ISA	integrated safety analysis
ISFSI	independent spent fuel storage installation
LAS	Lost/Abandoned/Stolen Material
LKS	Leaking Sealed Source
LS	least squares
MED	Medical
NA	not applicable

NMED	Nuclear Material Events Database
NR	not recovered
NRC	Nuclear Regulatory Commission
NRCB	NRC Bulletin
ODOH	Ohio Department of Health
OTH	Other
PNNL	Pacific Northwest National Laboratory
RLM	Release of Licensed Material or Contamination
RSO	radiation safety officer
SDE	shallow dose equivalent
SNM	special nuclear material
SSE	error sum of squares
SSR	regression sum of squares
SST	total sum of squares
TEDE	total effective dose equivalent
TRS	Transportation
WCA	Waste Consolidation Area
WDOH	Washington Department of Health
WHA	Waste Handling Area

EXECUTIVE SUMMARY

The Nuclear Regulatory Commission's (NRC) Nuclear Material Events Database (NMED) contains records of events involving nuclear material reported to the NRC by NRC licensees, Agreement States, and non-licensees. The reported events are classified based on reporting requirements defined by Title 10 of the Code of Federal Regulations. The event reports are evaluated to identify statistically significant trends and events of higher significance (referred to as significant events in this report).

The significant events that occurred in Fiscal Year 2013 are summarized below. Note that a single event may be listed in more than one event type category.

Lost/Abandoned/Stolen Radioactive Sources/Material Events

Four significant events occurred involving the loss of Category 1-3 sources as defined by the International Atomic Energy Agency's *Code of Conduct on the Safety and Security of Radioactive Sources (2004)*. No Category 1 sources, ten Category 2 sources, and two Category 3 sources were lost, all of which were subsequently recovered.

Two events involved the loss (and subsequent recovery) of all ten Category 2 sources (radiography sources). The sources were lost by a common carrier during shipment from a radiography source manufacturer.

Two events involved the loss (and subsequent recovery) of the Category 3 sources. In the first event, a brachytherapy source was delivered to a medical facility on a Friday during non-business hours. The source remained in an unrestricted shipping/receiving area over the weekend. In the other event, a common carrier delivered a brachytherapy source to the wrong licensee.

Medical Events

Six significant events occurred, all of which were classified as Abnormal Occurrences or potential Abnormal Occurrences. Five of the events involved doses administered to the wrong site: two during high dose rate (HDR) brachytherapy, one during prostate brachytherapy, one during gamma knife treatment, and one during Y-90 microsphere treatment. The sixth event involved the inability to surgically remove a radioactive seed that had been temporarily implanted during a seed localization procedure.

A seventh significant event classified as an Abnormal Occurrence or potential Abnormal Occurrence occurred prior to Fiscal Year 2013, but was recently added to NMED. This was an HDR brachytherapy treatment administered to the wrong site.

Radiation Overexposure Events

One significant event occurred, which was also classified as an International Nuclear Event Scale level 2 event. This event involved the overexposure of a radiographer who entered a permanent radiographic installation without first retracting the source.

Release of Licensed Material or Contamination Events

One significant event occurred. In this event, a waste management facility became contaminated and two employees experienced minor uptakes when a container of H-3 contaminated waste was opened.

Leaking Sealed Source Events
No significant events occurred.

Equipment Failure Events
No significant events occurred.

Transportation Events
No significant events occurred.

Fuel Cycle Process Events
One significant event occurred. In this event, the sole Item Relied On For Safety (IROFS) for a particular process at a nuclear fuel fabrication plant was inoperable. Criticality controls were maintained.

Other Events
Two significant events occurred. Both events involved a dose to an embryo/fetus that resulted from the administration of I-131 to a pregnant patient.

Nuclear Material Events Database Annual Report: Fiscal Year 2013

1. INTRODUCTION

1.1 Overview and Objectives

Nuclear material event reports are evaluated to identify statistically significant trends and significant events. The reported information aids in understanding why the events occurred and in identifying any actions necessary to improve the effectiveness of the nuclear material regulatory program.

A database for tracking nuclear material events was developed by the Nuclear Regulatory Commission (NRC) in 1981. In 1993, using existing material events databases, the NRC developed a new and more comprehensive database for tracking material events. This database, designated the Nuclear Material Events Database (NMED), contains records of events involving nuclear material reported to the NRC by NRC licensees, Agreement States, and non-licensees. The database is maintained by the Idaho National Laboratory (INL) and contains over 22,000 records of material events submitted to the NRC from approximately January 1990 to present.

The events in this report are classified into the following categories based on event reporting requirements defined by Title 10 of the Code of Federal Regulations (CFR):

- Lost/Abandoned/Stolen Material (LAS),
- Medical (MED),
- Radiation Overexposure (EXP),
- Release of Licensed Material or Contamination (RLM),
- Leaking Sealed Source (LKS),
- Equipment (EQP),
- Transportation (TRS),
- Fuel Cycle Process (FCP), and
- Other (OTH).

A description of categories addressed in this report and associated screening criteria are presented in Appendix A.

1.2 NMED Data

A single occurrence report may be captured in more than one NMED event category. For example, a report may describe a loss of licensed material that also resulted in a radiation overexposure. In such a case, both event categories are recorded in the NMED and identified by the same report number (referred to as an item number in the database).

The data presented in this report are limited to reportable events that occurred between October 1, 2003, and September 30, 2013. The data were downloaded from the NMED on January 15, 2014. Because the NMED is a dynamic database that is updated daily, variations in data may be encountered over time. Furthermore, even though many events were reported and entered in the database for operational experience purposes, only those events required to be reported by 10 CFR are addressed in this report.

This report displays annual trend data for each of the event categories for a 10-year period. A trend analysis was performed on each event category to identify the existence or absence of a statistically

significant trend. If a statistically significant trend exists, the display indicates the direction and approximate rate of change with a trend line. For the purposes of this report, a statistically significant trend exists if the analysis indicates that the computed fit and slope of a least squares linear model is valid at a 95% confidence level. A primer on the statistical methods employed in the trend analysis is presented in Appendix B.

Note that the trending methodology is not normalized; the trend only considers the number of reported events and does not directly account for external issues such as changes to regulatory requirements or changes in the number of licensees. For example, an increasing trend in the number of medical events could be caused by an increase in the number of medical procedures being performed. Likewise, an event type showing a decreasing trend for NRC licensees and an increasing trend for Agreement State licensees could be caused by States becoming Agreement States (resulting in fewer NRC licensees and more Agreement State licensees).

Reporting guidance for Agreement States is provided in the *Handbook on Nuclear Material Event Reporting in the Agreement States*. The handbook is an appendix to the NRC Office of Federal and State Materials and Environmental Management Programs procedure SA-300, *Reporting Material Events*. Access to NMED is available to the staff of NRC, Agreement State, and Federal agencies at http://nmed.inl.gov.

For assistance on searches or other questions, contact Robert Sun (nmednrc@nrc.gov, 301-415-3421).

2. ANALYSIS OF NMED DATA

Event reports involving nuclear material submitted to the NRC are reviewed, categorized, and entered into the NMED. Charts are provided to display trends in annual data for the most recent 10-year period (FY04-13).

2.1 All NMED Events

Figure 1 displays the annual number and trend of NMED events that occurred during the 10-year period. The trend analysis determined that the NRC-regulated events represent a statistically significant decreasing trend (indicated by the trend line). However, the Total events and Agreement State-regulated events do not represent statistically significant trends (indicated by the absence of trend lines). Therefore, variations within the Total and Agreement State values represent random fluctuation around the average of the data.

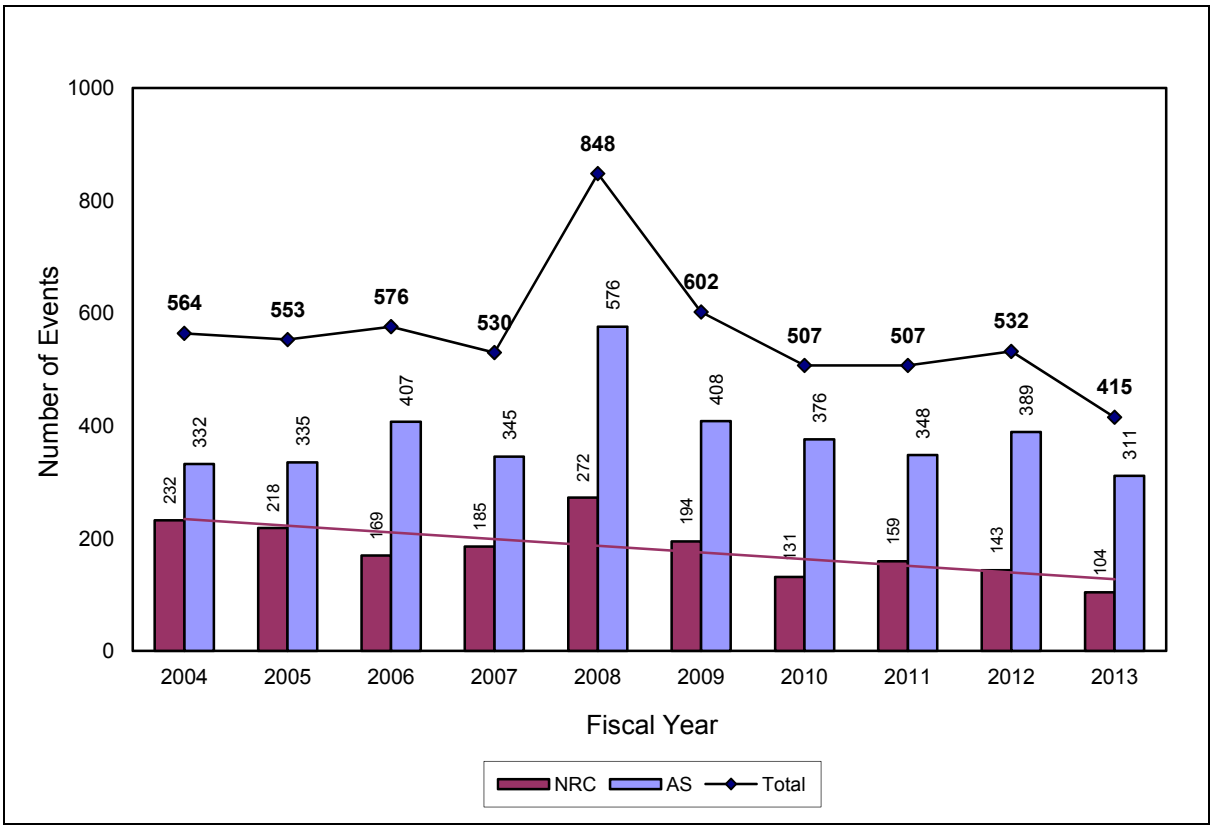

Figure 1. All NMED Events (5,634 total)

The following observations are made regarding the data in Figure 1.

- In FY13, 378 occurrences accounted for 415 events; a single occurrence can be classified in different event categories.
- The FY08 and FY09 data include 272 and 65 events respectively that resulted from Wal-Mart's one-time review of their tritium exit sign inventory. Excluding these events would result in a statistically significant decreasing trend in the total remaining events.
- The most recent year's data are typically many records less than their final value when subsequent updates and late reports are received (see Appendix D, Figure D-1).

- The transition of states from NRC to Agreement State jurisdiction could result in increasing trends in Agreement State data and decreasing trends in NRC data.

Table 1 displays a summary of the trending analysis for all NMED event types included in this report. A more detailed discussion of the trending analysis results can be found in the section of this report devoted to each event type.

Table 1. Summary of Trending Analysis

Event Type	Total	NRC	Agreement State
All NMED Events	-	↘	-
Lost/Abandoned/Stolen Material (LAS)	-	↘	-
Medical (MED)	-	↘	↗
Radiation Overexposure (EXP)	-	-	-
Release of Licensed Material or Contamination (RLM)	-	-	-
Leaking Sealed Source (LKS)	↘	↘	-
Equipment (EQP)	-	-	-
Transportation (TRS)	-	-	-
Other (OTH)	NA	NA	NA
	Total	**Unique**	**Other**
Fuel Cycle Process (FCP)	-	-	-

Notes:

- ↗ indicates a statistically significant increasing trend.
- ↘ indicates a statistically significant decreasing trend.
- - indicates no statically significant trend.
- NA indicates that the data does not support trending analysis.
- The FCP event type differs from other types in that all FCP events are NRC-regulated. Subcategories include Unique and Other (see Section 2.9).

2.2 Lost/Abandoned/Stolen Material

2.2.1 Ten-Year Data

Figure 2 displays the annual number and trend of LAS events that occurred during the 10-year period. The trend analysis determined that the NRC-regulated events represent a statistically significant decreasing trend (indicated by the trend line). However, the Total events and Agreement State-regulated events do not represent statistically significant trends (indicated by the absence of trend lines). Therefore, variations within the Total and Agreement State values represent random fluctuation around the average of the data.

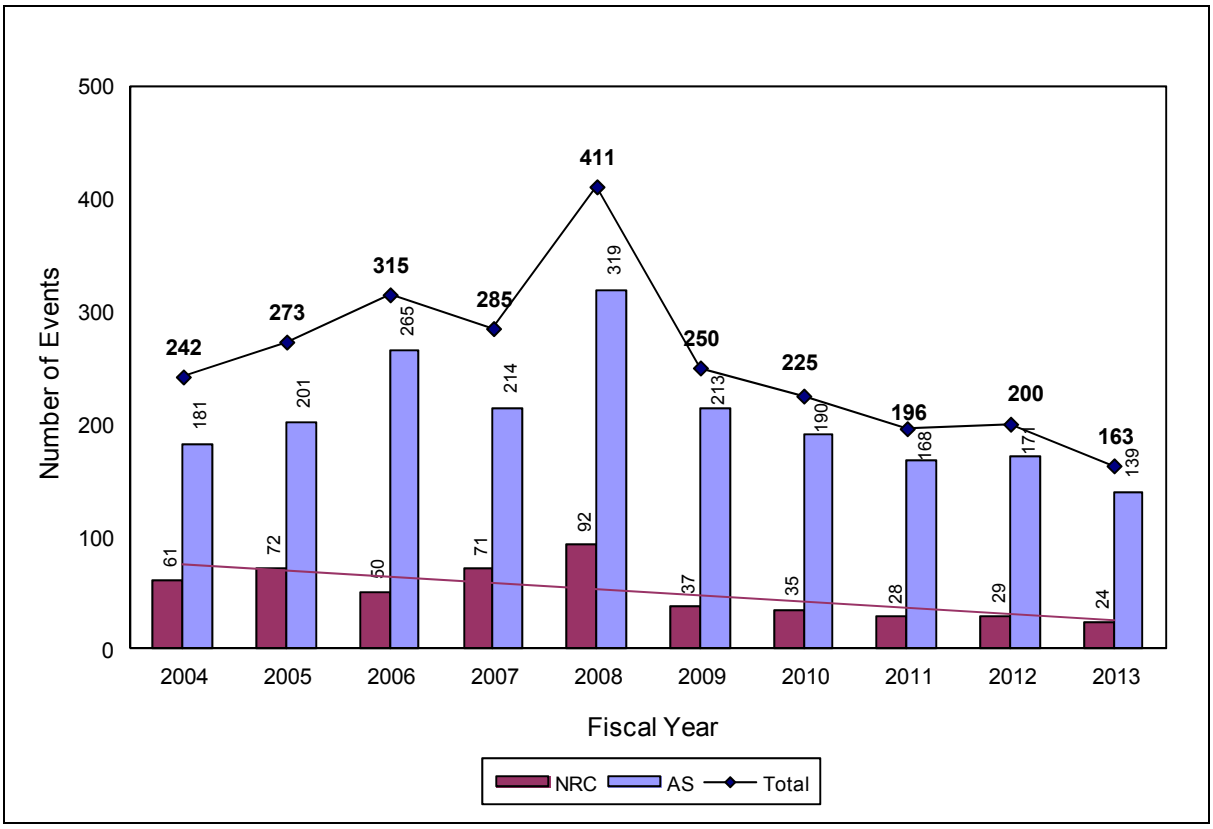

Figure 2. Lost/Abandoned/Stolen Material Events (2,560 total)

The FY08 and 09 data include 142 and 45 LAS events respectively that resulted from Wal-Mart's one-time review of their tritium exit sign inventory. Excluding these events would result in a statistically significant decreasing trend in the total remaining events.

Appendix C contains a list of radionuclides derived from the International Atomic Energy Agency's (IAEA) *Code of Conduct on the Safety and Security of Radioactive Sources (2004)*. These radionuclides are grouped by the amount of radioactivity into five categories that correspond to the relative hazard, with Category 1 being the most hazardous.

For this report, IAEA Category 1 through 3 source events (excluding irretrievable well-logging source events) are considered significant. Regardless of IAEA category, events involving irretrievable well-logging sources are not considered significant. Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

Table 2 displays the number of sources lost (approximately 4,247, excluding irretrievable well-logging sources) during the 10-year period and the number that have not been recovered (approximately 2,221),

grouped by IAEA category where possible. These included zero Category 1 sources, 47 Category 2 sources, and 33 Category 3 sources. All of these sources were recovered, with the exception of two Category 2 and four Category 3 sources.

Table 2. Number of Sources Lost/Abandoned/Stolen (LAS) and Sources Not Recovered (NR) - Excluding Irretrievable Well Logging Sources

Category		Fiscal Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
1	LAS[4]	0	0	0	0	0	0	0	0	0	0	**0**
	NR[5]	0	0	0	0	0	0	0	0	0	0	**0**
2	LAS	5	8	4	2	11	2	0	2	3	10	**47**
	NR	0	1	0	0	0	0	0	1	0	0	**2**
3	LAS	1	6	4	1	3	1	4	4	7	2	**33**
	NR	0	2	0	0	0	0	1	0	1	0	**4**
4	LAS	76	110	95	57	71	50	75	42	43	21	**640**
	NR	29	36	48	18	35	25	28	21	14	10	**264**
5	LAS	106	151	109	70	129	76	88	78	77	54	**938**
	NR	34	58	43	19	57	20	30	10	25	8	**304**
< 5	LAS	4	7	0	2	0	2	1	1	0	1	**18**
	NR	4	4	0	0	0	2	1	0	0	0	**11**
Activity Not Known[1]	LAS	9	3	7	3	9	5	13	12	21	4	**86**
	NR	3	0	1	0	0	0	1	0	10	0	**15**
Nuclide Not Known[2]	LAS	0	3	0	2	0	0	0	5	1	1	**12**
	NR	0	0	0	0	0	0	0	5	0	0	**5**
Other[3]	LAS	253	233	307	276	432	264	183	206	184	135	**2473**
	NR	172	146	181	146	354	161	127	137	122	70	**1616**
Total	**LAS**	**454**	**521**	**526**	**413**	**655**	**400**	**364**	**350**	**336**	**228**	**4247**
	NR	**242**	**247**	**273**	**183**	**446**	**208**	**188**	**174**	**172**	**88**	**2221**

Notes:

1. The "Activity Not Known" category includes sources containing radionuclides listed in Appendix C for which the activity was not reported. Therefore, the sources were not included in Categories 1 through 5.
2. The "Nuclide Not Known" category includes those sources for which the radionuclide was not reported. Thus, the sources were not included in Categories 1 through 5 or Other.
3. The "Other" category includes sources containing radionuclides not included in Appendix C.

4. Events involving a larger number of sources are sometimes entered as a single source with an aggregate activity (for example, the loss of a container of brachytherapy seeds may be entered as a single source with a total combined activity). The Category 1 through 3 source counts were corrected for the "aggregate" source events.
5. Events involving the loss/theft of multiple sources may involve the recovery of only some of the sources and are entered as being partially recovered (rather than marking each source individually). The Category 1 through 3 "not recovered" source counts were corrected for the "partially recovered" source events.

Tables 3 and 4 provide more detail regarding the 10-year and current year "not-recovered" data highlighted in Table 2 in yellow and green, respectively. Table 3 displays radionuclide data pertaining to the IAEA Category 1 through 3 sources lost during the 10-year period that have not yet been recovered. The Decayed Activity values are conservative estimates in that the values are typically decayed from the loss date instead of the manufacturer's assay date. As a result, the actual decayed activities (based on the manufacturer's assay date) are likely less than the estimates. Table 4 is similar to Table 3, but limited to the current year.

Table 3. Summary of IAEA Category 1-3 Sources Not Recovered (FY04-13)

Radionuclide	Half-life[1]	Number of Sources Not Recovered[2,3]	Total Activity (Ci)	Total Decayed Activity (Ci)[4]	Total Decayed Activity IAEA Category
Ir-192	73.83 days	5	100.70	0.01	5
Pu-238	87.7 years	1	2.50	2.46	3
Total		**6**	**103.20**	**2.47**	**3**

Notes:

1. Half-life values from the Chart of the Nuclides, 16th Edition.
2. Events involving a larger number of sources are sometimes entered as a single source with an aggregate activity (for example, the loss of a container of brachytherapy seeds may be entered as a single source with a total combined activity). The source counts were corrected for the "aggregate" source events.
3. Events involving the loss/theft of multiple sources may involve the recovery of only some of the sources and are entered as being partially recovered (rather than marking each source individually). The source counts were corrected for the "partially recovered" source events.
4. The source activities were decayed from the event date to 1/15/2014 (data download date).

Table 4. Summary of IAEA Category 1-3 Sources Not Recovered (FY13)

Radionuclide	Half-life[1]	Number of Sources Not Recovered[2,3]	Total Activity (Ci)	Total Decayed Activity (Ci)[4]	Total Decayed Activity IAEA Category
None		0			
Total		**0**			

Notes:

1. Half-life values from the Chart of the Nuclides, 16th Edition.
2. Events involving a larger number of sources are sometimes entered as a single source with an aggregate activity (for example, the loss of a container of brachytherapy seeds may be entered as a

single source with a total combined activity). The source counts were corrected for the "aggregate" source events.

3. Events involving the loss/theft of multiple sources may involve the recovery of only some of the sources and are entered as being partially recovered (rather than marking each source individually). The source counts were corrected for the "partially recovered" source events.
4. The source activities were decayed from the event date to 1/15/2014 (data download date).

2.2.2 FY13 Data

One hundred sixty-three LAS events occurred in FY13, 17 of which involved irretrievable well logging sources. Excluding the irretrievable well logging sources, approximately 228 sources were lost/abandoned/stolen, 88 of which have not been recovered. Of the 228 lost sources, none were Category 1, 10 were Category 2, and two were Category 3 sources. All of the Category 1-3 sources were recovered.

Four of the FY13 LAS events were considered significant (involved Category 1-3 sources). Note that regardless of IAEA category, events involving irretrievable well logging sources are not considered significant.

Significant Events - Category 1 Source Events
None

Significant Events - Category 2 Source Events
Item Number 130218 - QSA Global reported the loss and recovery of a shipment containing eight Ir-192 radiography sources. Each source contained an activity of 3.7 TBq (100 Ci). QSA expected the shipment to arrive at their facility in Baton Rouge, Louisiana, on the morning of 5/6/2013. When the shipment did not arrive, QSA contacted the common carrier to locate the shipment. The last known location of the shipment was in Memphis, Tennessee. Later in the evening of 5/6/2013, the common carrier contacted QSA and stated that the shipment had been located in Memphis.

Item Number 130230 - QSA Global reported the loss and recovery of two Ir-192 radiography sources. One source contained 1.14 TBq (30.9 Ci) and the other source contained 3.73 TBq (100.9 Ci). The sources had been loaded into a source changer on 5/6/2013 and shipped to Norfolk Naval Shipyard. The source changer was expected to be delivered on 5/8/2013. Norfolk Naval Shipyard notified QSA when the source changer did not arrive as scheduled. The transportation company was then notified. The transportation company searched their facilities in Newark, New Jersey, and Boston, Massachusetts. The sources were found in the Newark facility and were expected to arrive at Norfolk Naval Shipyard on 5/10/2013.

Significant Events - Category 3 Source Events
Item Number 120706 - Geisinger Health Systems reported that a 385.91 GBq (10.43 Ci) Ir-192 high dose rate brachytherapy source was delivered to their facility by Federal Express on Friday 10/13/2012, during non-business hours. The source shipment remained in an unrestricted shipping/receiving area until Monday 10/15/2012, when the senior health physics technician arrived at work. The cause of the incident was determined to be the failure of shipping/receiving personnel to follow standard protocol for receipt of radioactive packages during non-business hours. The source was secured, surveyed, and wiped for leakage. Radiation levels were normal and there was no indication of leakage. To prevent recurrence, Geisinger will notify shipping/receiving personnel of all radioactive material orders and their expected delivery dates. They will also work with the source vendor so packages will not be shipped on weekends. The Radiation Safety Officer (RSO) will discuss the importance of securing radioactive material with shipping/receiving personnel.

Item Number 130165 - Alpha & Omega Services reported that a 360.75 GBq (9.75 Ci) Ir-192 brachytherapy source was delivered to the wrong licensee on 4/2/2013. A common carrier picked up the

source from Alpha & Omega Services and delivered it to Cardinal Health instead of Radiation Oncology Center of Nevada. The delivery to Cardinal Health occurred in the morning and they notified Radiation Oncology Center of Nevada. The common carrier retrieved the source that afternoon and delivered it to Radiation Oncology Center of Nevada. The source shielding and shipping container were intact during the entire incident; neither were damaged or opened. The cause of the delivery to the wrong facility was determined to be human error by the driver. Involved personnel received additional training.

Events of Interest

Item Number 120628 - Diversified Scientific Services received a 30-gallon waste container from Savannah River Nuclear Solutions that contained H-3 contaminated waste oil and absorbents. The waste container was opened and sampled on 10/9/2012. That sample was analyzed and results were received on 10/18/2012. Results revealed an activity of 318.2 TBq (8,600 Ci) of H-3. However, the Savannah manifest stated that the waste only contained 0.55 TBq (14.9 Ci) of H-3. Following container sampling, Diversified identified an elevated level of H-3 contamination in their process room. The contamination was controlled and that the room was under negative ventilation. Maximum survey results revealed 762,058 dpm/100 cm^2 in an area of the process room. Radiation surveys of other areas of the facility were conducted on 10/10/2012. The highest levels of contamination were in the process room. The process room was decontaminated and resurveyed on 10/30/2012. Those results revealed between 3,167 and 48,968 dpm/100 cm^2. Two employees that had sampled the container submitted urine bioassays. The results revealed 96.57 and 41.07 Bq/ml (2.61 and 1.11 nCi/ml), with intake retention factors of 3.76E-2 and 3.51E-2, respectfully. The employees were assigned CEDE whole body exposures of 0.10 and 0.04 mSv (9.98 and 3.76 mrem). Contents of the waste container were overpacked and placed in a safe state. Savannah is holding shipments to Diversified until causes have been determined and corrective actions implemented. The State of Tennessee investigated the incident. The magnitude of the release was estimated at between 4.35 TBq (117.61 Ci) and 11.26 TBq (304.21 Ci). Further sampling and analysis of the container estimated the H-3 activity to be 101.75 TBq (2,750 Ci). The Diversified work plan for safe handling of the container was not designed to accommodate such a degree of inaccuracy. The maximum exposure to any member of the public was estimated to be 4.7 μSv (0.47 mrem). The event was caused by poor characterization by the generator and no follow-up confirmatory sampling was performed by Savannah prior to shipping. Savannah is working with Diversified to have the waste repackaged and shipped back to the Savannah River Site for storage to allow for decay of H-3. Corrective actions included improving radioactive material labeling and handling and procedure modifications. This event was classified as an LAS and RLM event.

Item Number 130121 - The New Jersey Department of Environmental Protection was contacted on 2/28/2013 and informed that an international shipping container was being held at Port Elizabeth due to elevated levels of Cs-137. The owner of the shipment was International Forest Products Corporation. The shipment contained bails of paper that came from Connecticut. It was originally sent to China and rejected. International Forest Products was informed of the rejection, but was not given a reason for the rejection. Several agencies were notified and responded to the site. The bails were unloaded at the U.S. Customs East Coast Warehouse at Port Elizabeth. Radiation surveys identified a six-inch long plastic cigar holder wrapped in cardboard and duct tape. Using a Victoreen model 450P ion chamber, radiation readings were 2.5 mR/hour on contact. The cigar holder was partially shielded in lead pigs that were not quite big enough to contain it. The highest radiation reading around the pigs was 20 μR/hour. The item and pigs were placed into a 5-gallon bucket and filled with vermiculite. The bucket was then placed into a 55-gallon drum, which was also filled with vermiculite. Radiation readings on the outside of the drum were 15 μR/hour. Using an IdentiFinder, the radionuclide was confirmed to be Cs-137. On 3/18/2013, two Cs-137 source rods were identified inside the cigar holder. The sources appeared to be pieces that had been sawed off a rod. The total length with the pieces together would have been 10.5 inches. The two separate pieces had magenta and yellow radioactive material tape wrapped around them. One source was marked as containing 5.55 MBq (150 μCi). There were no other markings on the two sources and the

manufacturer was not determined. A waste broker packaged and removed the sources for proper disposal on 3/25/2013.

Item Number 130175 - SA Recycling reported receiving a Sr-90 eye applicator and a temperature gauge that contained Ra-226 on 3/27/2013. Initial radiation surveys of the eye applicator conducted by Los Angeles County Radiation Management on 3/27/2013 using a Victoreen 451B ion chamber revealed 25 R/hour on contact. The eye applicator was placed into a 5-gallon plastic bucket filled with sand. Radiation readings on the outside of the bucket revealed 2.1 mR/hour. On 4/4/2013, additional radiation measurements were performed by the California Health and Human Service Agency, Radiological Health Branch (CRHB) using a Bicron RSO-50E. A reading of 1 R/hour was obtained at one foot from the Sr-90 source tip, with 250 mR/hour at two feet, and 140 mR/hour at three feet (background was less than 0.1 mR/hour). Pictures of the eye applicator were sent to the University of Wisconsin, who confirmed the device as an eye applicator. The applicator originally contained an activity of 1.85 GBq (50 mCi) and was manufactured between 1969 and 1973. The applicator contains a current activity of between 629 and 703 MBq (17 and 19 mCi). CRHB delivered the two items to SA Recycling in Anaheim, California, on 4/4/2013. SA Recycling placed the items into their locked storage unit. CRHB searched for the owner of the eye applicator without success. The US Army was contacted for disposal of the temperature gauge.

Item Number 130240 - Mesa County Landfill reported that a load of trash set off their radiation monitor alarms on 4/24/2013. The roll-off containing the trash came from a residential spring clean-up event sponsored by the city of Grand Junction. A Colorado Department of Health (CDOH) inspector responded to the site on the same day. The roll-off was moved to a secure location following initial radiation surveys. On 5/7/2013, CDOH examined the contents of the roll-off and identified a one-foot long section of plastic pipe and a small source (3 mm by 2 cm) bound with tape. It appeared that the source had been taped to the side of the pipe at one time and the word “source” was written on the pipe. Using an Identifinder multi-channel analyzer, the radionuclide was identified as Ra-226. Dose rates were greater than 2 mSv/hour (200 mrem/hour) on contact with the source and 0.1 mSv/hour (10 mrem/hour) at one foot. The source was placed into a secure location. The CDOH issued a press release that requested anyone with additional information to contact them. Several days later, a member of the public contacted CDOH with a lead. Inspectors were able to trace the source back to a private residence in Grand Junction. On 5/24/2013, inspectors visited the residence and found additional radioactive material in the garage. The material included 11 more Ra-226 sources and nine small jars containing an unknown radioactive powder, which appeared to be uranium mill tailings. The total volume of tailings was estimated to be no more than 0.3 cubic feet. The radioactive material was removed and taken to a secure storage location for measurement and analysis. The elderly female resident stated that her late husband manufactured Geiger counters during the uranium boom years. Based on the radiation readings obtained by the inspectors, it is possible, and even likely, that family members received exposures in excess of member of the public limits. However, without additional information and cooperation by the family, which isn't likely, quantitative exposure estimates are not possible. CDOH is continuing their investigation.

Item Number 130339 - ThruBit reported the loss and recovery of a 65.86 GBq (1.78 Ci) Cs-137 well logging source. On 7/28/2013, a well-logging crew finished operations at a well site in Colorado and removed the logging tool from the well around noon. Seventeen hours later, the logging crew discovered that the source was missing from the tool. They returned to the well site and recovered the source from the ground. The source had fallen out of the logging tool while the tool was being returned to the logging truck. ThruBit investigated the incident and determined that the highest exposed member of the public had an estimated whole body exposure of 509 μSv (50.9 mrem), with a probable exposure of 378 μSv (37.8 mrem). The highest exposed occupational worker had an estimated whole body exposure of 2.69 cSv (rem), with a probable exposure of 1.08 cSv (rem). The well logging supervisor and well logging assistant both handled the source directly. ThruBit performed an extremity dose estimate for the two and identified that the supervisor received approximately 45.6 cSv (rem), while the assistant received

approximately 0.73 cSv (rem). Medical evaluations and blood analysis for both individuals revealed no abnormalities.

2.2.3 Events Recently Added to NMED That Occurred Prior to FY13

Twenty-six LAS events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. None of these events were considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events - Category 1 Source Events
None

Significant Events - Category 2 Source Events
None

Significant Events - Category 3 Source Events
None

Events of Interest
Item Number 120610 - During a routine inspection performed at Loma Linda University Medical Center on 10/8/2012, State of California inspectors discovered a potential medical event that occurred on 5/23/2012. A patient was prescribed to receive 3,000 cGy (rad) to each ovary for carcinoma treatment of the endometrium near both ovaries. Two Cs-137 sources, each containing 1.71 GBq (46.25 mCi), and an ovoid applicator were used during the procedure. While removing the implant following completion of the 26.5 hour procedure, it was discovered that the Cs-137 source was missing from the left side insert. Radiation surveys identified the source on a monitor stand, which was approximately two feet from the patient's head, partially blocked by a portable lead shield that had been placed in its location the day before. The original patient treatment plan was revised and the patient was subsequently treated on the left side (completed on 5/29/2012). It was determined that only one of two Cs-137 brachytherapy sources was properly inserted into the applicator at the start of patient treatment. One source had dropped out of the applicator and onto the patient's bed. The loose source was discovered approximately 12 hours later by two nursing staff members, when the patient's top layer of bedding was being removed. A nurse, not realizing it was a radioactive source, placed it onto the monitor stand by hand. The medical center estimated that the nurse (radiation worker) received an extremity dose of 130 mSv (13 rem). The cause was attributed to human error, procedures not followed, and inadequate training. Corrective actions included modifications to several procedures and additional training to involved personnel. In addition, nursing staff received updated training on dosimetry badge requirements and radioactive source identification/handling. This event was classified as an LAS and MED event.

Item Number 130426 - Chiquita Canyon Landfill reported that a transfer truck triggered their radiation monitor alarms on 8/28/2012. A handheld survey meter measured 7.84 μSv/hr (784 μrem/hr) in a background of 0.08 μSv/hr (8 μrem/hr). A portable multichannel analyzer was unable to identify the radionuclide. After a review of the spectrum concluded that the radionuclide was non-medical, it was decided to dump the load and isolate the radioactive material. A California Health and Human Services Agency inspector found a clear bag that measured 88 mR/hr on contact and 1.2 mR/hr at one meter. The inspector also found training records belonging to Isotope Products Laboratories. Spectral analysis identified the radionuclide as Gd-153. On 8/29/2013, the inspector visited Isotope Products Laboratories, who confirmed that the material originated from their Burbank facility and consisted of a 296 MBq (8 mCi) source. Trace amounts of Co-57 was also identified. The Gd-153 source was secured in a lead pig, while the remaining material was placed in Isotope Products Laboratories' radioactive trash.

2.3 Medical

2.3.1 Ten-Year Data

Figure 3 displays the annual number and trend of MED events that occurred during the 10-year period. The trend analysis determined that the Agreement State-regulated events represent a statistically significant increasing trend and the NRC-regulated events represent a statistically significant decreasing trend (indicated by the trend lines). However, the Total events do not represent statistically significant trends (indicated by the absence of a trend line). Therefore, variations within the Total values represent random fluctuation around the average of the data.

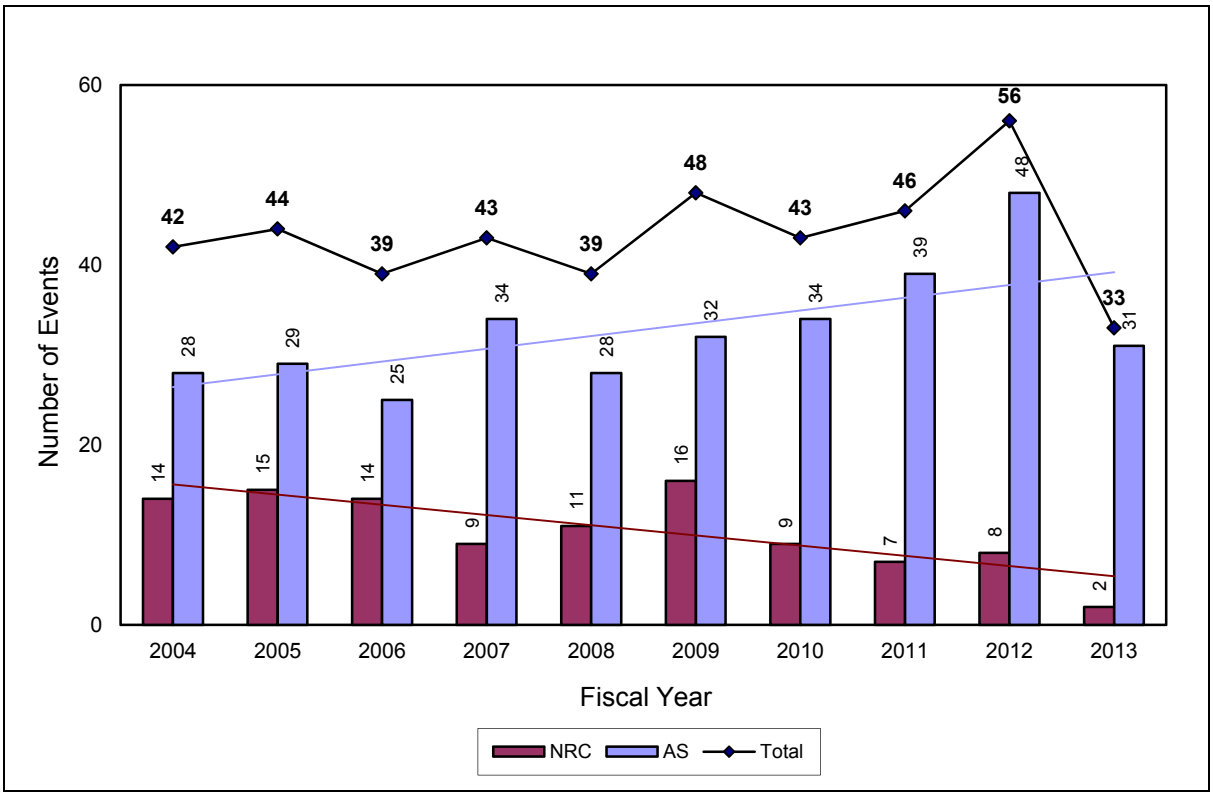

Figure 3. Medical Events (433 total)

Table 5 lists the number of MED events that were classified as Abnormal Occurrences (AOs) in NUREG-0090, *Report to Congress on Abnormal Occurrences*. Table 5 also includes events involving doses to an embryo/fetus or a nursing child (reportable per 10 CFR 35.3047). By definition, these events are not medical events (reportable per 10 CFR 35.3045) and are captured in NMED as an "Other" event. However, they are included here for reference.

Table 5. Medical and Embryo/Fetus or Nursing Child AO Events

	Fiscal Year										
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total[1]**
Medical	12	10	7	11	12	15	12	14	13	6	**112**
Embryo[2]	1	1	3	2	2	2	2	1	1	2	**17**
Total	**13**	**11**	**10**	**13**	**14**	**17**	**14**	**15**	**14**	**8**	**129**

Notes:

1. Events are marked as potential AOs until they complete the NRC's formal AO determination process and are reported in NUREG-0090. Potential AOs are included in this table.
2. Includes doses to an embryo/fetus or a nursing child reportable per 10 CFR 35.3047.

For this report, events classified as AOs (or potential AOs) are considered significant. Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

2.3.2 FY13 Data

Thirty-three MED events occurred in FY13, six of which were considered significant.

Significant Events - AOs or Potential AOs

Item Number 130001 - University of Toledo reported that a patient only received a D90 dose of approximately 36.5% of prescribed dose during a prostate seed implant procedure performed on 11/27/2012. The incident was identified during post-implant computed tomography (CT) scan performed on 12/10/2012. The prostate was prescribed to receive 88 I-125 brachytherapy seeds containing a total activity of 1.24 GBq (33.44 mCi). The prescribed D90 dose to the prostate was 16,000 cGy (rad), but only received about 6,400 cGy (rad). Six seeds were inadvertently implanted in the patient's perineum. Dose to that unintended area was approximately 1,000 cGy (rad). The physician was informed of the discrepancy on 12/12/2012 and the patient was informed on 12/13/2012. The patient will be re-implanted to correct for the D90 discrepancy. The Ohio Department of Health (ODOH) performed a reactive inspection on 12/19/2012. The University determined that the root cause included inadequate ultrasound image visualization of the live time seed implant, involvement of a urology resident during the procedure, and a potential tensioning adjustment issue on the Mick applicator. ODOH concluded that the cause was human error. The University revised their procedures to include additional checks to prevent recurrence.

Item Number 130150 - Rosa of North Dallas reported that a patient received less than 50% of their prescribed dose during high dose rate (HDR) brachytherapy. The incident involved an HDR unit with a 253.302 GBq (6.846 Ci) Ir-192 source. The physicist selected the wrong length source guide tubes for three of four fractions. The physicist planned the patient's treatment with the treatment lengths of 119.9 cm in the HDR tandem and ring treatment planning procedure and forms, but used the 132 cm tubes for delivery. The error was not discovered until after the third fraction. The patient's cervix received a mean dose of 1,390 cGy (rad) instead of the prescribed 5,139 cGy (rad) during the four fractions, which was 73% less than intended. Fraction one resulted in a mean dose of 42.5 cGy (rad) versus the prescribed dose of 1,192.4 cGy (rad). Fraction two resulted in a mean dose of 34.6 cGy (rad) versus the prescribed dose of 1,416.3 cGy (rad). Fraction three resulted in a mean dose of 45.2 cGy (rad) versus the prescribed dose of 1,262.2 cGy (rad). The patient's urethra received a mean dose of 1,607 cGy (rad) for the four fractions. The maximum dose to 1 cc of the urethra for the four fractions was 1,849 cGy (rad). The patient's anterior vagina received a mean dose of 1,549 cGy (rad) for the four fractions. The maximum dose to 1 cc of the anterior vagina was 3,049 cGy (rad) for the four fractions. The patient and physician were notified of the error. Rosa of North Dallas suspended all HDR treatments pending review of their process and procedures. The Texas Department of State Health Services investigated the incident. Corrective actions included procedure, equipment, and training modifications.

Item Number 130176 - The New York State Department of Health reported that during a radioactive seed localization procedure, the implanted I-125 seed migrated deeper into patient tissue and could not be removed during the tumor removal surgery. The patient was being treated for axillary node dissection with an 8.33 MBq (225.14 μCi) I-125 seed placed at the tumor site under ultrasound guidance on 3/25/2013. The surgeon successfully removed the tumor and lymph node; however, the location of the migrated seed prevented safe extraction due to scarring from previous node removal, mastectomy, and reconstructive surgery. The patient, referring physician, medical oncologist, and radiologist were

notified. A localized dose at 0.5 cm from the seed of 2,290 cGy (rad) was calculated and negligible dose at 6 cm. Corrective actions included no longer using radioactive seed localization for axillary node lesions. Policy updates and staff notifications will be evaluated during the next routine inspection.

Item Number 130248 - Tufts Medical Center reported that a patient received a gamma knife treatment to the wrong side of the brain on 5/17/2013. The incident involved a gamma knife unit with 201 Co-60 sources, each with an activity of 410.7 GBq (11.1 Ci). The patient was undergoing a second gamma knife treatment to the left side of the brain, but received 7,500 cGy (rad) to the right side. The oncologist mistakenly entered the numerical coordinates for treatment on the right side of the brain, which was discordant with the diagnosis. The oncologist printed the written directive and signed it, as did the authorized medical physicist and neurosurgeon. All three incorrectly verified that the treatment was to be performed on the right side. Following treatment, the oncologist was dictating the end-of-treatment notes and realized the error. The medical team determined that the likely effect would be possible transient numbness to the right side of the patient's face. The patient and prescribing physician were informed. Corrective actions taken by Tufts Medical Center included implementing additional time-out procedures to further reduce the probability of such an error and developing an updated gamma knife safety checklist, which will be implemented as soon as practical.

Item Number 130405 - Abbott Northwestern Hospital reported that a patient prescribed to receive 400 cGy (rad) to a tumor volume during the second of six fractions, received 0 cGy (rad) to the tumor volume on 9/4/2013. The incident involved an HDR remote afterloader with a 237.06 GBq (6.407 Ci) Ir-192 source. Due to an error in the catheter lengths entered into the treatment planning system, the HDR fraction dose was unintentionally delivered to a region located 5.4 cm superior to the tumor volume in the patient's small bowel near the bladder wall. The maximum dose delivered to the unintended area was 1600 cGy (rad). That unintended area was a significant volume approximately 6 mm in diameter by 2.8 cm in length. The remaining fractions of the treatment were increased to compensate for the lack of tumor dose from the second fraction. The hospital and the Minnesota Department of Health investigated the incident. Corrective actions included procedure modifications that added catheter length verification to the daily HDR pre/post treatment checklist and universal timeout protocol, and a formal HDR treatment console safe site timeout process script posted by the treatment console area.

Item Number 130438 - Cleveland Clinic Foundation reported that a patient received dose to the wrong organ during microsphere treatment conducted on 5/9/2013. The patient complained of abdominal pain during treatment. The post-treatment scan was inconclusive regarding shunting to the stomach. The patient continued to complain of stomach pain and returned to Cleveland Clinic on 9/5/2013 for an endoscopy, which revealed ulcers in the potentially affected areas. The cause of the incident was determined to be a small shunt of microspheres that was not identified at the time of the procedure. Cleveland Clinic determined that the gastric duodenum, an unintended treatment area, received 14.8 MBq (400 μCi) for a dose of 6,200 cGy (rad). The Ohio Department of Health conducted an onsite investigation on 10/8/2013.

Events of Interest

Item Number 130146 - Vanderbilt University reported a medical event associated with a patient treatment on 1/29/2013 involving 37 GBq (1 Ci) of I-131 metaiodobenzylguanidine. The treatment was for neuroblastoma, refractory, and metastatic. A day after the administration, the patient's Foley catheter leaked and some urine contaminated the patient and bedding. Upon discovery, the patient's skin was immediately cleaned, the catheter removed, and the patient's clothing and sheets changed. The patient's catheter was replaced with a larger one and medication was given to stop bladder spasms. No other problems were noted and the patient was released from the hospital on 2/2/2013, at which time there was no evidence of skin irritation. On 3/18/2013, a physician examining the patient in preparation for a second treatment noted skin irritation on the patient's inner thighs and buttocks consistent with radiation injury. The estimated dose to the patient's skin was approximately 1,000 cGy (rad). The patient and doctor were both notified of the incident. The Tennessee Division of Radiological Health visited

Vanderbilt University on 4/10/2013 to investigate. Corrective actions included procedure modifications and providing additional training to personnel.

Item Number 130168 - MidMichigan Medical Center reported that a patient received less dose than prescribed during the first of three brachytherapy fractions on 4/8/2013. The patient also received excess dose to a non-treatment site. The medical procedure was performed at the Saginaw Radiation Oncology Center in Saginaw, Michigan, under MidMichigan's license. The patient was treated with an HDR with a 310.8 GBq (8.4 Ci) Ir-192 source. The prescribed dose during cervical/vaginal cancer treatment was 400 cGy (rad); however, the catheter used was 4 cm longer than it should have been. That error placed the source 4 cm inferior to the intended treatment site. The intended site received approximately 233.7 cGy (rad). The incorrect site received 525.9 cGy (rad) rather than the 233.7 cGy (rad) it should have received. The error was discovered on 4/9/2013 shortly after starting the second treatment fraction. Both the prescribing physician and patient were informed of the error. This event occurred when the catheter from a tandem was mistakenly used on the cylinder. To prevent recurrence, catheters will be marked to indicate the intended use. Also, a new time-out checklist will be used for each fraction to verify catheter length. The subsequent fractions were modified to compensate for this error and the intended treatment site received 1,200 cGy (rad).

Item Number 130388 - Tulane University Hospital reported that a patient received two HDR therapy fractions to the wrong location on 8/6 and 8/22/2013. The incident involved an HDR unit with a 312.65 GBq (8.45 Ci) Ir-192 source. The error was discovered on 8/27/2013 while preparing for the third and final fraction. It was determined that the HDR source intended for the cervical area had "dog legged" into the bowel area. The cervical tissue had not received the intended dose. The cervical tissue was prescribed 2400 cGy (rad) in three fractions, each of 800 cGy (rad). The distal colon and upper rectum received 630 cGy (rad) during the first fraction. The sacrum received 700 cGy (rad) during the second fraction. The third fraction was not administered. The cause of the incident was determined to be human error (equipment positioning problem) and not an equipment malfunction. The patient's physician was notified of the incident. The patient, though heavily sedated, and the patient's mother were also notified. Tulane intends to administer the entire corrected therapy dose prescribed. Corrective actions included procedure changes in which treatment catheter placement/position will be reviewed and approved by two attending physicians before treatment begins.

Embryo/Fetus or Nursing Child Dose Events - AOs or Potential AOs

Doses to an embryo/fetus or nursing child are reportable per 10 CFR 35.3047. By definition, these events are not medical events (reportable per 10 CFR 35.3045) and are captured in NMED as "Other" events. However, it is appropriate to also discuss these events in this section. Two of these events occurred in FY13, both of which were classified as potential AOs.

Item Number 130192 - Baptist Medical Center Princeton reported that a pregnant patient received 1.85 GBq (50 mCi) of I-131 (sodium iodide) on 3/26/2013. The patient had a thyroidectomy performed on 3/1/2013, due to thyroid cancer. The patient had general laboratory work, including a pregnancy test, performed on 3/6/2013. That pregnancy test revealed negative results. The patient had another pregnancy test performed on 3/26/2013, prior to I-131 administration. However, the administering technician was not informed of that second pregnancy test and its positive results. Subsequently, it was determined that the patient was four to five weeks pregnant on 3/26/2013. Dose calculations performed by a consultant estimated that the embryo/fetus received approximately 12.6 cSv (rem). The cause was determined to be lack of procedures and inattention to detail. Corrective actions included generating a new procedure, providing personnel with improved supervision, and reprimanding involved personnel.

Item Number 130209 - Radiological Associates of Sacramento reported that a pregnant female patient was administered 6.55 GBq (176.9 mCi) of I-131 on 2/20/2013. A serum pregnancy test conducted on 2/18/2013 revealed negative results. However, on 4/22/2013, Radiological Associates received a phone call from the patient's endocrinologist informing them that the patient was pregnant. An ultrasound

evaluation performed on 3/18/2013 determined that the embryo/fetus would have been approximately two weeks old at the time of I-131 administration. The dose to the embryo/fetus was determined to be 47 cGy (rad).

2.3.3 Events Recently Added to NMED That Occurred Prior to FY13

Six MED events and no embryo/fetal dose events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. One of the MED events was considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events - AOs or Potential AOs

Item Number 130271 - University of Minnesota reported a medical event that occurred on 8/20 through 8/22/2012 and involved a high dose rate brachytherapy unit with a 233.1 GBq (6.3 Ci) Ir-192 source. The event was discovered on 5/26/2013 during a transfer of electronic treatment planning records to a new system. The patient was prescribed five HDR fractions at 500 cGy (rad) per fraction to the target area in the uterus. The first fraction was administered after confirmation of treatment planning, followed by two treatments per day over the next two days. However, the tips and ends of the treatment catheters had been inverted in the planning system by an auto-locate tool whose function was to automatically detect catheters. As a consequence, the actual treatment delivery was not given as planned. The source moved to where it thought the tip of the catheter was located, which turned out to be twice the catheter length. That resulted in some source dwell positions that were below the target or outside the patient completely. The patient was prescribed 2,500 cGy (rad), but only received 1,950 cGy (rad). The patient was informed of the incident on 5/27/2013. The patient showed significant treatment response with no evidence of residual cervical tumor on 5/27/2013. However, the patient also experienced possible rectal wall thickening, urethral stricture, and ulceration of the anterior rectal wall. The patient has been monitored closely. Urethral stricture required dilation on 5/10/2013. A colonoscopy performed on 6/3/2013 revealed ulceration at the anterior rectal wall by the dentate line. The tissue was friable. The University estimated the dose to the patient's skin of the inner thigh that was bordering the applicator to be 300 cGy (rad) per fraction, for a total of 1500 cGy (rad). The urethra received an estimated 185.5 cGy (rad). The Minnesota Department of Health investigated the incident. Corrective actions taken by University of Minnesota include no longer using the auto-locate tool, augmenting dosimetry planner and checker training, conducting an external audit of previous interstitial cases, and changing the written directive and treatment day checklist.

Events of Interest

None

Embryo/Fetus or Nursing Child Dose Events - AOs or Potential AOs

None

2.4 Radiation Overexposure

2.4.1 Ten-Year Data

Figure 4 displays the annual number and trend of EXP events that occurred during the 10-year period. The trend analysis determined that the data does not represent statistically significant trends in the number of events (indicated by the absence of trend lines). Therefore, variations within the annual values represent random fluctuation around the average of the data.

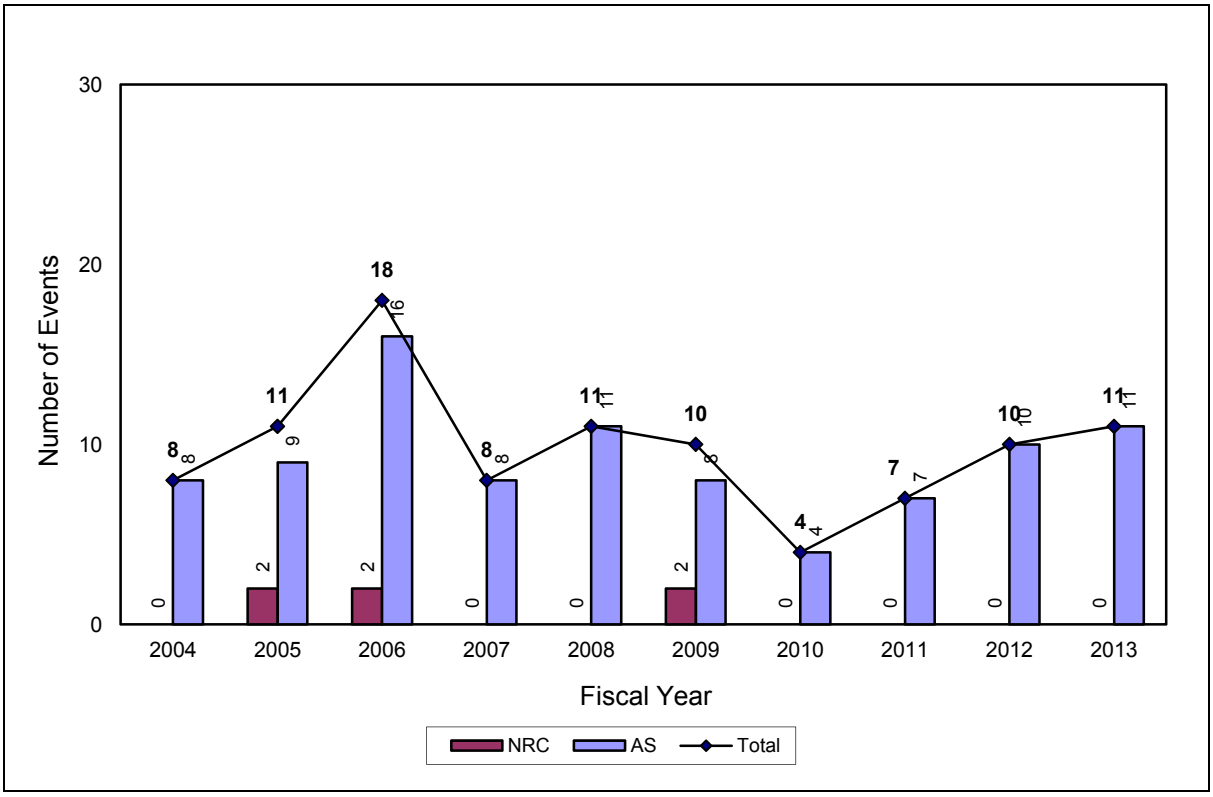

Figure 4. Radiation Overexposure Events (98 total)

The significance of individual EXP events may be determined by the CFR reporting requirement applicable to the event. For example, an event that is required to be immediately reported is typically more significant than an event with a 30-day reporting requirement. For this report, events requiring immediate or 24-hour reporting are considered significant. Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

Table 6 displays the number of events based on the different reporting requirement time categories. Note that each event is counted only once. If an event involved exposures that were reportable in more than one category, the event is counted in only the most restrictive category.

Table 6. EXP Events Classified by CFR Reporting Requirement

	Fiscal Year										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Immediate	1	0	1	1	0	0	0	1	1	0	**5**
24-Hour	1	1	3	1	3	1	1	0	4	1	**16**
30-Day	6	10	14	6	8	9	3	6	5	10	**77**
Total	**8**	**11**	**18**	**8**	**11**	**10**	**4**	**7**	**10**	**11**	**98**

2.4.2 FY13 Data

Eleven EXP events occurred in FY13, one of which was considered significant.

Significant Events - Immediate Reports
None

Significant Events - Within 24-Hour Reports
Item Number 130140 - Tulsa Gamma Ray reported that a radiographer received a deep dose equivalent of 6.734 cSv (rem) on 3/19/2013, which brought his year-to-date exposure to 7.578 cSv (rem). Radiography was being performed at the American Foundry Group in Muskogee, Oklahoma. The radiographer walked into a permanent radiographic installation while a 1.85 TBq (50 Ci) Co-60 source was exposed. The assistant radiographer was in the darkroom developing film; the radiographer was working alone. There were two other Tulsa Gamma Ray employees at the facility, but they were also developing film in the darkroom. The Oklahoma Department of Environmental Quality investigated the event on 4/5/2013. The radiographer stated that he cranked out the source, got sidetracked, and then entered the permanent radiographic installation without retracting the source. He stated that he had not seen the warning lights due to the brim of his safety helmet and did not hear the audio alarm. Investigation revealed that the warning lights and audio alarm functioned properly. Corrective actions included an engineering change to the system. As of 6/4/2013, this incident was classified as an International Nuclear Event Scale level 2 event.

Events of Interest
Item Number 130384 - The Children's Hospital at Montefiore reported that a pediatric patient's mother received an exposure of 5.925 cSv (rem). The patient received 555 MBq (15 mCi) of I-131 for therapy on 3/22/2013 and was hospitalized from 3/22 through 3/29/2013. The patient's mother stayed in the hospital's residential facilities. During the patient's hospitalization, visitors (including family members) were provided with radiation badges to monitor exposure. The badges were processed by Landauer on 5/5/2013 and identified that the patient's mother received 5.925 cSv (rem) effective dose equivalent during the period of hospitalization. The badge was re-read on 5/6/2013, which confirmed the initial reading. The hospital was notified on 5/10/2013. A radiation survey of the patient's room found little contamination. The hospital and the New York Office of Radiological Health conducted an extensive investigation, but could not definitively identify the cause of the incident. Corrective actions included creating an instruction form for inpatients/visitors regarding radiation precautions of I-131 treated patients. The patient's mother was counseled and received a thyroid uptake test on 6/6/2013. No thyroid uptake was detected. A thyroid stimulating hormone test also revealed normal results.

2.4.3 Events Recently Added to NMED That Occurred Prior to FY13

One EXP event was recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. This event was not considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and

subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events - Immediate or 24-Hour Reporting
None

Events of Interest
None

2.5 Release of Licensed Material or Contamination

2.5.1 Ten-Year Data

Figure 5 displays the annual number and trend of RLM events that occurred during the 10-year period. The trend analysis determined that the data does not represent statistically significant trends in the number of events (indicated by the absence of trend lines). Therefore, variations within the annual values represent random fluctuation around the average of the data.

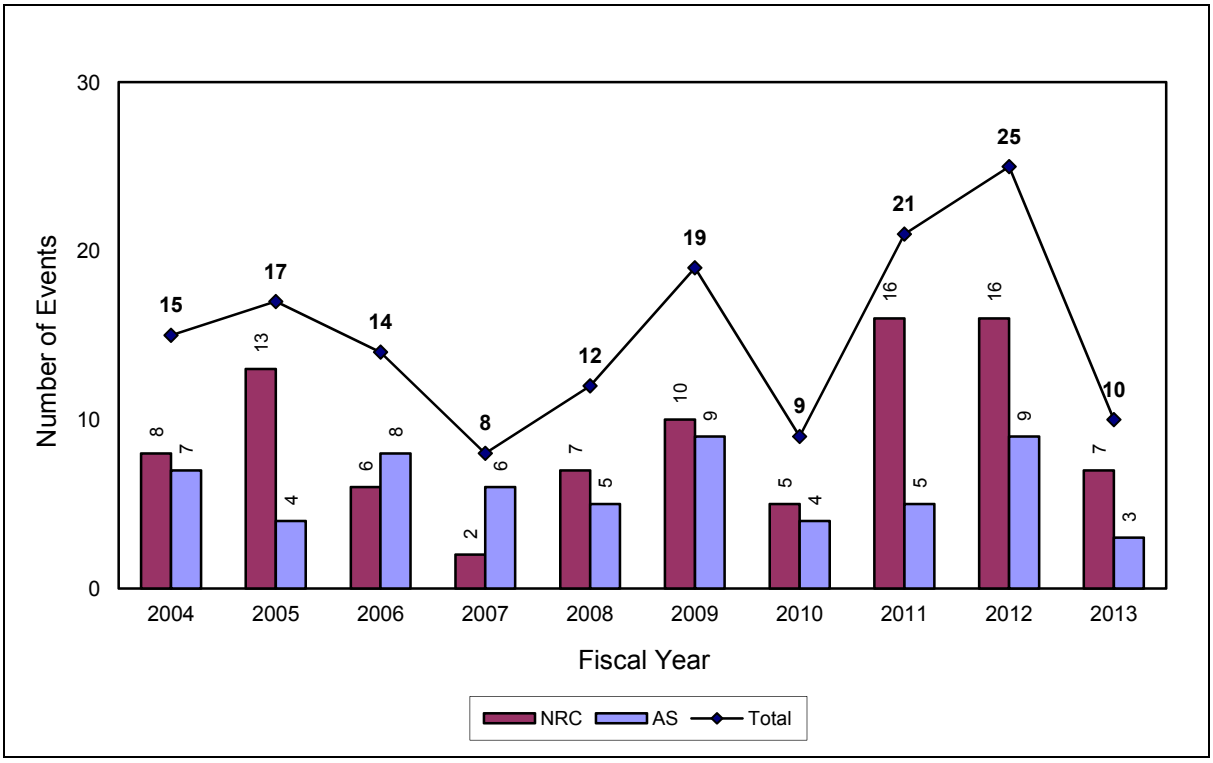

Figure 5. Release of Licensed Material or Contamination Events (150 total)

The significance of individual RLM events may be determined by the CFR reporting requirement applicable to the event. For example, an event that is required to be immediately reported is typically more significant than an event with a 30-day reporting requirement. For this report, events requiring immediate reporting are considered significant. Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

Table 7 displays the number of events based on the different reporting requirement time categories. Note that each event is counted only once. If an event involved exposures that were reportable in more than one category, the event is counted in only the most restrictive category.

Table 7. RLM Events Classified by CFR Reporting Requirement

	Fiscal Year										
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Immediate	2	0	0	0	2	1	2	0	2	1	**10**
24-Hour	13	17	12	8	8	13	4	20	21	8	**124**
30-Day	0	0	2	0	2	5	3	1	2	1	**16**
Total	**15**	**17**	**14**	**8**	**12**	**19**	**9**	**21**	**25**	**10**	**150**

2.5.2 FY13 Data

Ten RLM events occurred in FY13, one of which was considered significant.

Significant Events - Immediate Reporting

Item Number 120628 - Diversified Scientific Services received a 30-gallon waste container from Savannah River Nuclear Solutions that contained H-3 contaminated waste oil and absorbents. The waste container was opened and sampled on 10/9/2012. That sample was analyzed and results were received on 10/18/2012. Results revealed an activity of 318.2 TBq (8,600 Ci) of H-3. However, the Savannah manifest stated that the waste only contained 0.55 TBq (14.9 Ci) of H-3. Following container sampling, Diversified identified an elevated level of H-3 contamination in their process room. The contamination was controlled and that the room was under negative ventilation. Maximum survey results revealed 762,058 dpm/100 cm^2 in an area of the process room. Radiation surveys of other areas of the facility were conducted on 10/10/2012. The highest levels of contamination were in the process room. The liquid scintillation counter was unable to reveal results because they exceeded 1,000,000. The process room was decontaminated and resurveyed on 10/30/2012. Those results revealed between 3,167 and 48,968 dpm/100 cm^2. Two employees that had sampled the container submitted urine bioassays. The results revealed 96.57 and 41.07 Bq/ml (2.61 and 1.11 nCi/ml), with intake retention factors of 3.76E-2 and 3.51E-2, respectfully. The employees were assigned CEDE whole body exposures of 0.10 and 0.04 mSv (9.98 and 3.76 mrem). Contents of the waste container were overpacked and placed in a safe state. Savannah is holding shipments to Diversified until causes have been determined and corrective actions implemented. The State of Tennessee investigated the incident. The magnitude of the release was estimated at between 4.35 TBq (117.61 Ci) and 11.26 TBq (304.21 Ci). Further sampling and analysis of the container estimated the H-3 activity to be 101.75 TBq (2,750 Ci). The Diversified work plan for safe handling of the container was not designed to accommodate such a degree of inaccuracy. The maximum exposure to any member of the public was estimated to be 4.7 μSv (0.47 mrem). The event was caused by poor characterization by the generator and no follow-up confirmatory sampling was performed by Savannah prior to shipping. Savannah is working with Diversified to have the waste repackaged and shipped back to the Savannah River Site for storage to allow for decay of H-3. Corrective actions included improving radioactive material labeling and handling and procedure modifications. This event was classified as an LAS and RLM event.

Events of Interest

Item Number 130246 - Thermo Process Instruments reported a contamination incident involving Cs-137 that occurred on 5/15/2013. Thermo received a drum containing 18 nuclear gauges from System Service Corporation in North Carolina. Thermo was to dismantle the gauges and properly dispose of the sources. System Service stated that they had leak tested the gauges and results were below regulatory limits. Thermo performed a contamination survey of the drum prior to removing gauges. The first gauge Thermo removed from the drum contained a 12.95 GBq (350 mCi) Cs-137 source. When Thermo opened the gauge shutter, they found a piece of lead inside the gauge cavity between the shutter and the source. As Thermo removed the piece of lead, they noted background radiation levels increase. The individual

stopped work and notified his supervisor. Contamination surveys revealed radioactivity on the worker's hands, shirt sleeves, and personal dosimetry. Radioactive contamination was also identified on the table top and on the floor of the immediate work area. The worker was decontaminated within 15 minutes and he did not exceed any exposure limits. Thermo attempted to decontaminate the table top and floor in the work area, but some areas remained contaminated. Lead plates with fixed contamination labels were affixed over the areas of contamination. Access to the area was restricted. Thermo notified System Service. Thermo intends to paint the floor with an epoxy coating to prevent contamination from seeping into porous concrete or cracks in the floor. Thermo eventually removed the sources from all 18 gauges. Thermo updated their procedures to require leak tests be performed on all devices received at their facility. Thermo also instructed personnel to be more cautious when handling gauges that appear to have been altered. This event was classified as an EQP, LKS, and RLM event.

Item Number 130301 - Whittaker Corporation reported an unplanned fire and explosion at a remediation project site. Whittaker received a call from the Pymatuning Township Fire Department's emergency response team on 6/27/2013 of an explosion inside the operating area of the site. The site is a decommissioning/cleanup site where rare earth metals had been recovered and the resultant low-level radioactive waste is being removed for license termination. It is believed that an exothermic chemical reaction resulted in a contained fire, with material being ejected from the waste pile and outside the remediation area boundary. The responding fire department did not enter the area and there were conflicting reports on the use of water or other fire-fighting agents. Due to the very low radioactivity concentrations of uranium/thorium series within the waste pile materials, release of licensed material offsite was unlikely. All work at the site was suspended pending an investigation into the event. Radioactivity surveys and air samples were collected on 6/28/2013 to confirm no offsite release. The material ejected from the waste pile during the explosion was surveyed, with no significant activity identified. A sample of the material was sent to an offsite laboratory to determine chemical and radiological content. Whittaker established a 24-hour fire watch until a cause could be identified. Sample results were unable to determine the reactive material. Whittaker developed and implemented a plan to sort the remaining waste pile prior to packaging for disposal. Approximately 6,000 tons of waste has already been checked and shipped according to the new plan without identifying any reactive material. Corrective actions included procedure modifications.

2.5.3 Events Recently Added to NMED That Occurred Prior to FY13

One RLM event was recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. This event was not considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events - Immediate Reporting
None

Events of Interest
None

2.6 Leaking Sealed Sources

2.6.1 Ten-Year Data

Figure 6 displays the annual number and trend of LKS events that occurred during the 10-year period. An event reporting anomaly associated with a single electron capture detector (ECD) manufacturer occurred from Fiscal Year 2000 through early 2005, which notably increased the number of LKS events. The anomalous events were not significant and involved leaking ECD sources (Ni-63 foil sources) that had been returned to the manufacturer for refurbishment. The manufacturer discontinued refurbishing ECDs and now disposes of the returned sources without leak testing. To show this affect, Figure 6 displays the anomalous events as yellow shaded bars.

The trend analysis determined that the Total events represent a statistically significant decreasing trend (indicated by the trend line). The NRC-regulated events also represent a statistically significant decreasing trend, even when the anomalous data is excluded. The Agreement State-regulated events do not represent a statistically significant trend (indicated by the absence of a trend line). Therefore, variations within the Agreement State-regulated values represent random fluctuation around the average of the data.

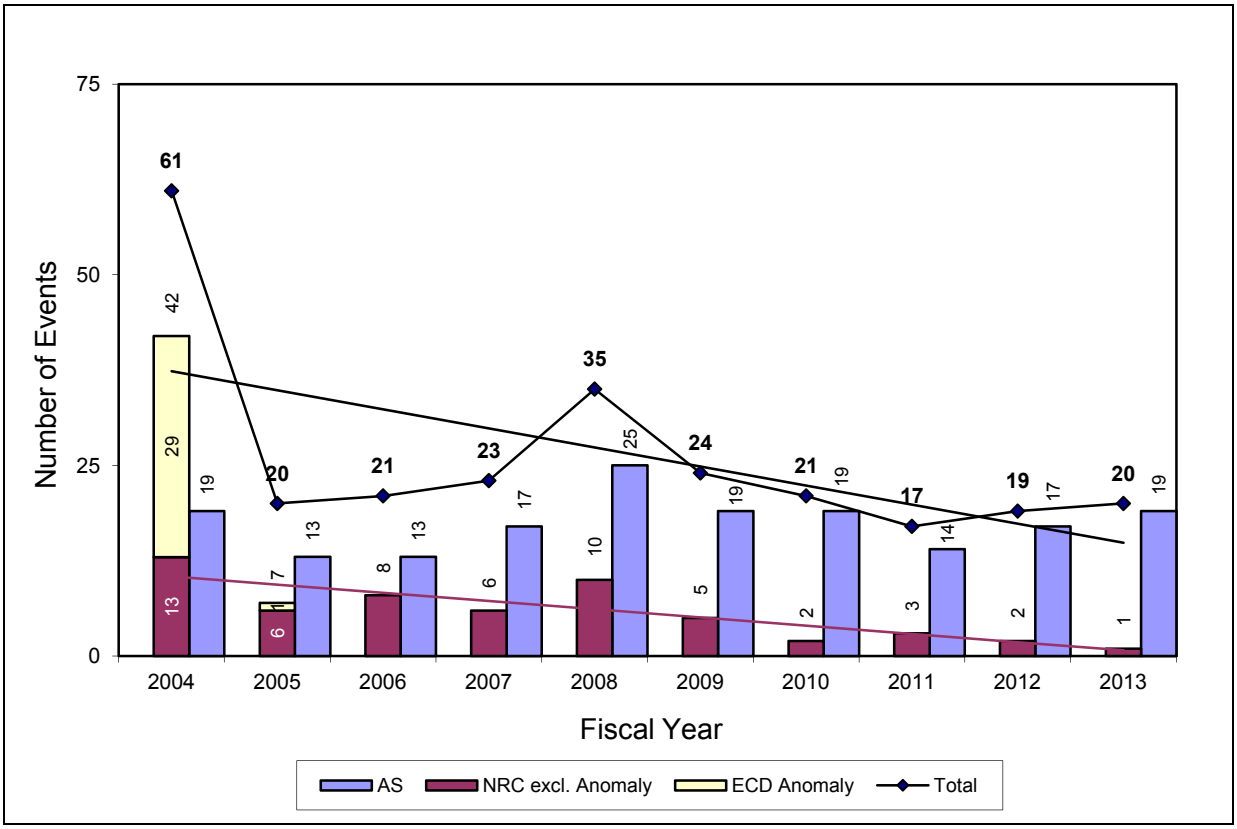

Figure 6. Leaking Sealed Source Events (261 total)

It is not possible to discern the significance of LKS events strictly from the CFR reporting requirements (as in Sections 2.4, 2.5, and 2.9). There are essentially no immediate or 24-hour reporting requirements for leaking sources. The exception is 39.77(a), which is an immediate report to the NRC Regional office of a ruptured well logging source. Therefore, event significance will be determined on an event-by-event basis based on the severity of the event (e.g., significant exposure to workers, members of the public, and/or the environment). Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

2.6.2 FY13 Data

Twenty LKS events occurred in FY13, none of which were considered significant.

Significant Events
None

Events of Interest
Item Number 130107 - Thermo Fisher Scientific reported that a wipe test on an SVAC-G module containing a Ni-63 source revealed 251.6 Bq (0.0068 μCi) of removable activity. The module was contained within a gas chromatograph. Prior to receiving results of a second wipe test, the device was accidentally transferred from the Thermo Fisher Milford facility to their Franklin facility. That action resulted in contamination of the Franklin facility assembly area. Radiation surveys of the assembly area revealed removable contamination at 7,015 dpm or 118.4 Bq (3.2 nCi). The area was restricted for decontamination activities. The module was double bagged and stored in a secure container pending proper disposal. A State of Massachusetts inspector performed a special investigation on 3/29/2013 at the Franklin facility. Corrective actions included purchasing appropriate Ni-63 counting equipment to analyze leak test samples and contamination swipes, revising their radiation safety manual, and providing additional training to personnel. The NRC Registry of Radioactive Sealed Sources and Devices indicates that this source contains a maximum activity of 185 MBq (5 mCi).

Item Number 130246 - Thermo Process Instruments reported a contamination incident involving Cs-137 that occurred on 5/15/2013. Thermo received a drum containing 18 nuclear gauges from System Service Corporation in North Carolina. Thermo was to dismantle the gauges and properly dispose of the sources. System Service stated that they had leak tested the gauges and results were below regulatory limits. Thermo performed a contamination survey of the drum prior to removing gauges. The first gauge Thermo removed from the drum contained a 12.95 GBq (350 mCi) Cs-137 source. When Thermo opened the gauge shutter, they found a piece of lead inside the gauge cavity between the shutter and the source. As Thermo removed the piece of lead, they noted background radiation levels increase. The individual stopped work and notified his supervisor. Contamination surveys revealed radioactivity on the worker's hands, shirt sleeves, and personal dosimetry. Radioactive contamination was also identified on the table top and on the floor of the immediate work area. The worker was decontaminated within 15 minutes and he did not exceed any exposure limits. Thermo attempted to decontaminate the table top and floor in the work area, but some areas remained contaminated. Lead plates with fixed contamination labels were affixed over the areas of contamination. Access to the area was restricted. Thermo notified System Service. Thermo intends to paint the floor with an epoxy coating to prevent contamination from seeping into porous concrete or cracks in the floor. Thermo eventually removed the sources from all 18 gauges. Thermo updated their procedures to require leak tests be performed on all devices received at their facility. Thermo also instructed personnel to be more cautious when handling gauges that appear to have been altered. This event was classified as an EQP, LKS, and RLM event.

2.6.3 Events Recently Added to NMED That Occurred Prior to FY13

Four LKS events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. None of these events were considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events
None

Events of Interest
None

2.7 Equipment

2.7.1 Ten-Year Data

Figure 7 displays the annual number and trend of EQP events that occurred during the 10-year period. The trend analysis determined that the data does not represent statistically significant trends in the number of events (indicated by the absence of trend lines). Therefore, variations within those annual values represent random fluctuation around the average of the data.

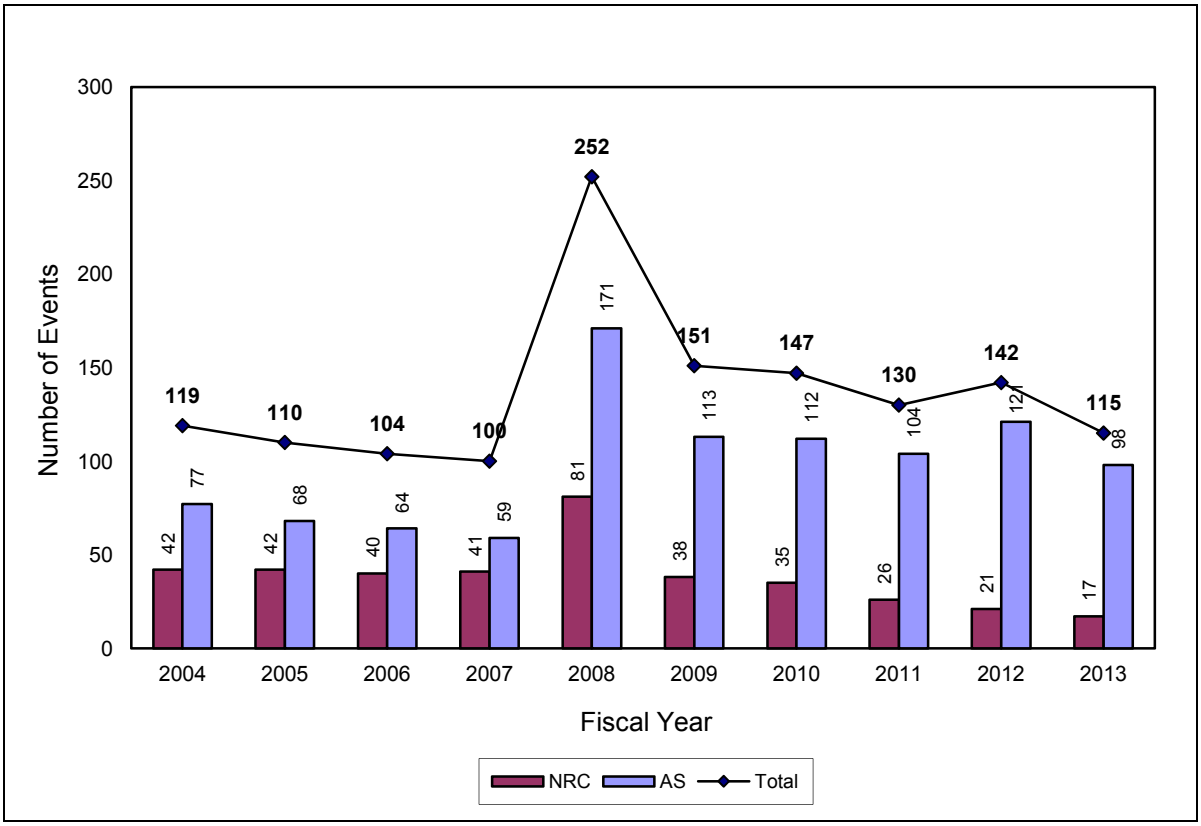

Figure 7. Equipment Events (1,370 total)

The FY08 and 09 data include 130 and 20 EQP events, respectively, which resulted from Wal-Mart's one-time review of their tritium exit sign inventory. Excluding these events would not result in a statistically significant trend in the total remaining events.

It is not possible to discern the significance of EQP events strictly from the CFR reporting requirements (as in Sections 2.4, 2.5, and 2.9) because essentially all of the CFRs associated with EQP events require reporting within 24-hours. Therefore, event significance will be determined on an event-by-event basis based on the severity of the event (e.g., significant exposure to workers, members of the public, and/or the environment). Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

2.7.2 FY13 Data

One hundred fifteen EQP events occurred in FY13, none of which were considered significant.

Significant Events
None

Events of Interest

Item Number 130051 - Methodist Hospital reported that an Ir-192 brachytherapy source became stuck in an HDR remote afterloader transfer tube during the first fraction of a patient's treatment on 1/14/2013. The source contained approximately 370 GBq (10 Ci) and became stuck before reaching the patient. The patient was prescribed to receive 600 cGy (rad) during the first fraction. The patient received 10.62 cGy (rad) to the thigh and an estimated whole body dose of 4.24 mSv (424 mrem). The patient was prescribed to receive five fractions for a total dose of 3,000 cGy (rad). The physicists and physician followed the policy and procedure for removal of the source and tubing. The source was placed into a shielded container. Nucletron (HDR manufacturer) was notified of the incident and responded to the site. Nucletron was unable to dislodge the source from the transfer tube. The source and transfer tube were sent back to Nucletron and replacements have been ordered. The Tennessee Division of Radiological Health investigated the incident. This event was classified as an EQP and MED event.

Item Number 130063 - Indian Point Unit 3 (IP3) nuclear power plant reported experiencing an interlock failure involving an instrument calibrator and gamma irradiator that occurred on 1/24/2013 during pre-use interlock testing. The 4.81 GBq (130 mCi) Cs-137 calibrator source could be raised while the shield door was open. The device also contains a 4.81 TBq (130 Ci) Cs-137 source, but this source does not come into use during the interlock test. The source was returned to the shielded position and the device was locked and removed from service. This event was caused by the failure of a switch in the interlock. The calibrator was repaired and returned to operation.

Item Number 130068 - Desert NDT reported that a 1,406 GBq (38 Ci) Ir-192 source disconnected from a radiography exposure device on 1/22/2013. The radiographers had performed nine exposures and were moving the device to another location when they discovered that the source was still in the guide tube. The radiographers had not performed a post exposure radiation survey prior to moving the exposure device. A source recovery team was dispatched to the site and the source was returned to the device and locked into its shielded position. The direct reading dosimeter for the radiographer that relocated the guide tube was off scale. His personnel dosimeter was sent for immediate processing. Results revealed 7.91 mSv (791 mrem) DDE. The radiographer was also assigned extremity exposures of 2.8 cSv (rad) to the right hand and 0.6 cSv (rad) to the left hand. The radiographers stated that their alarming dosimeter had not alarmed. The cause of the source disconnect was that the drive cable separated from the pigtail. The second radiographer had not challenged the drive cable after he connected it to the source pigtail. The spring was found in the locked open position after the source disconnect occurred. The exposure device and cables were returned to the manufacturer for inspection. The manufacturer found two small crimps on the connector. They stated that those crimps could cause a source disconnect from the drive cable. Both radiographers received an additional eight hours of training.

Item Number 130073 - Halliburton Energy Services reported that a slurry densimeter that contained a 321.9 MBq (8.7 mCi) Cs-137 source was subjected to intense heat from a fire at a natural gas well. The fire erupted early on the morning of 1/22/2013. The gauge was mounted to a truck in-line after a chicksan on a down-hole pump. The truck was parked approximately 40 feet from the blowout preventer (wellhead). The fire continued to occasionally flare, but a Halliburton representative was able to gain brief access to the gauge. Halliburton stated that the sealed source was not leaking and that the gauge containment housing was still intact. Fire control operations continued and efforts to drag the truck away from the drill rig occurred on 1/25/2013. The densimeter was returned to Halliburton for repair or disposal. The manufacturer determined that the heat from the fire caused as much as half of the lead shielding to melt. Radiation levels were 15 mR/hour. They further stated that the source was primarily shielded by the tungsten collimator and that the collimator was not affected by the heat.

Item Number 130084 - Bruker AXS Handheld, Incorporated, received an excepted package from a Massachusetts distributor with high radiation levels on 1/9/2013. The package held an x-ray fluorescence device that contained a 458.8 MBq (12.4 mCi) Co-57 source. Radiation survey results revealed 0.06 mSv/hour (6 mrem/hour) on contact with the package and 0.3 mSv/hour (30 mrem/hour) at a distance of

10 cm from the device. The device had been shipped with the shutter in the open position. The cause was determined to be improperly packaged material. Corrective actions included generating a new quality management plan. This event was classified as an EQP and TRS event.

Item Number 130112 - Sterigenics reported the inability to lower a pool irradiator source rack into its completely secured position on 2/20/2013. The irradiator contained 62,900 TBq (1,700,000 Ci) of Co-60. It was determined that a tote on the conveyor had become lodged against the source rack #2 protective barricade upright, causing it to halt before the rack was completely secured. The maintenance manager and a technician were able to manually reverse the system approximately two inches, which removed the pressure and allowed the rack to fully retract into the pool. No additional radiation exposure was received by the manager or technician. All alarms and interlocks functioned as designed. Sterigenics conducted an in-depth evaluation. To prevent recurrence, guard rails were installed on rack #2.

Item Number 130122 - Sterigenics US reported that one of two source racks containing 62,900 TBq (1,700,000 Ci) of Co-60 failed to fully lower into its storage pool on 2/28/2013. The rack had descended 11 of the intended 24 feet when it became stuck. The operator determined that the drive motor had failed and disengaged the motor from the drive mechanism, which allowed the source rack to lower into the fully shielded position on its own. Sterigenics stated that all alarms and interlocks functioned as designed. The drive motor was replaced and successfully tested on 3/1/2013. Evaluation of the failed motor determined that the bearing failure was most likely caused by a low oil situation. The irradiator has two oil ports; one on the motor and one on the gearbox. The port on the motor had not been used. All maintenance personnel were trained to use the motor oil port and corporate engineering is evaluating options to upgrade the design.

Item Number 130145 - RSO Services reported that the internal lead shielding of two fixed nuclear gauges (owned by IIG, Minwool) melted. Each gauge contained a 3.7 GBq (100 mCi) Cs-137 source. IIG melts rock in a cupola to make insulation. The cupola had the two gauges mounted on it, one at the top and one at the bottom. The cupola was superheated to about 3,500 degrees Fahrenheit, above the operating limits for the gauges. RSO Services performed radiation surveys and identified a maximum reading of 2.5 mR/hour at one foot from the back of the gauge mounted at the top of the cupola. The shutters on both gauges were closed and locked. RSO Services removed the gauges and returned them to Ohmart.

Item Number 130179 - Pacific Gas and Electric reported that the loading procedure for the Diablo Canyon Power Plant independent spent fuel storage installation (ISFSI) multi-purpose canisters placed the canisters in an unanalyzed condition. The procedure contained steps to install caps on canister vents while the canisters contained an air/water mixture. This placed the canisters in an isolated condition without any relief path, a condition previously not analyzed in the Final Safety Analysis Report. This process was used for 23 canisters beginning in 2009. The amount of time each canisters was isolated was approximately 40 to 60 minutes. Diablo Canyon expects that no appreciable canister pressure increase occurred; a conservative evaluation shows a potential pressure increase of less than 2 psig. With a design pressure of 100 psig, there is no reason to believe that the integrity of any of the 23 canisters was challenged. Corrective actions included revising the procedure before the next loading campaign in August 2013, reviewing all existing vendor technical information to ensure proper entry into the Operating Experience Assessment Program, and developing and distributing a meeting notice to communicate the details of this occurrence. This event was classified as an EQP and FCP event.

Item Number 130182 - Cornerstone Chemical Company reported that the shutter on a fixed nuclear gauge was stuck half closed on 3/13/2013. The gauge contained a 1.15 GBq (31 mCi) Cs-137 source, with an original activity of 1.85 GBq (50 mCi). The gauge had been removed from its mounted location to service a pipe during a turnaround activity. After the gauge was removed, the shutter was discovered to be stuck half closed and could not be completely closed. An employee who carried the gauge was calculated to have received a whole body exposure of 13 μSv (1.3 mrem). BBP Sales serviced the shutter, reinstalled the gauge, performed a leak test, and conducted an installation survey. Cornerstone

Chemical was reminded that all activities involving nuclear gauges are to be conducted by licensed contractors.

Item Number 130246 - Thermo Process Instruments reported a contamination incident involving Cs-137 that occurred on 5/15/2013. Thermo received a drum containing 18 nuclear gauges from System Service Corporation in North Carolina. Thermo was to dismantle the gauges and properly dispose of the sources. System Service stated that they had leak tested the gauges and results were below regulatory limits. Thermo performed a contamination survey of the drum prior to removing gauges. The first gauge Thermo removed from the drum contained a 12.95 GBq (350 mCi) Cs-137 source. When Thermo opened the gauge shutter, they found a piece of lead inside the gauge cavity between the shutter and the source. As Thermo removed the piece of lead, they noted background radiation levels increase. The individual stopped work and notified his supervisor. Contamination surveys revealed radioactivity on the worker's hands, shirt sleeves, and personal dosimetry. Radioactive contamination was also identified on the table top and on the floor of the immediate work area. The worker was decontaminated within 15 minutes and he did not exceed any exposure limits. Thermo attempted to decontaminate the table top and floor in the work area, but some areas remained contaminated. Lead plates with fixed contamination labels were affixed over the areas of contamination. Access to the area was restricted. Thermo notified System Service. Thermo intends to paint the floor with an epoxy coating to prevent contamination from seeping into porous concrete or cracks in the floor. Thermo eventually removed the sources from all 18 gauges. Thermo updated their procedures to require leak tests be performed on all devices received at their facility. Thermo also instructed personnel to be more cautious when handling gauges that appear to have been altered. This event was classified as an EQP, LKS, and RLM event.

Item Number 130264 - The Methodist Hospital reported a source retraction failure during an intravascular brachytherapy treatment performed on 6/3/2013. The intravascular brachytherapy system contained a 1.67 GBq (45.1 mCi) Sr-90 source. While retracting the source at the end of the treatment, the source became stuck in another area of the blood vessel approximately 5 cm from the treatment site for one minute. The unintended absorbed dose to that area of the vessel was approximately 40 cGy (rad) at 10 mm on the wall of the arch. The manufacturer conducted visual and physical examinations of all equipment. They also conducted functional testing in the laboratory. All equipment functioned normally. The Methodist Hospital stated that since they had begun using the system in December 2012, it had failed to fully retract three out of four times. The hospital staff received additional training, but will not use the system unless the manufacturer's RSO is present during operation. The cause appears to be intermittent equipment failure. No personnel errors were noted.

Item Number 130352 - Aerojet Ordnance Tennessee reported the failure of a primary ventilation system. On 8/5/2013, an employee at the casting camera de-flash station observed smoke outside of the operation booth while operations were being conducted to grind burrs off of radiography camera castings. Investigation revealed that the ventilation system was working, but the belt connecting the pump and fan had broken. Operations were suspended and personnel evacuated. The belt was replaced on the pump and the ventilation system was operational within 30 minutes of the failure. The incident resulted in elevated airborne uranium concentrations. Workers and contractors were exposed to airborne depleted uranium in concentrations ranging from 9E-12 to 2.21E-10 μCi/ml. The highest concentration was measured at the camera de-flash station, where the grinding was taking place. The worker performing the grinding was wearing respiratory protection as required. He was the only worker in the immediate area. Other workers were in the mold assembly and carousel work areas. Initial urinalysis sample results for the individual performing the grinding (the most exposed worker) revealed 143 ppb uranium for a sample submitted one hour after the incident. The second sample submitted 18 hours after the incident revealed 17.3 ppb. A third submittal at six days revealed 1.24 ppb. Two other workers received lung counts on 8/26/2013 and both revealed less than minimum detectable activity. Corrective actions included repairs to the involved equipment, including engineering changes and equipment procedure modifications. The manufacturer was notified of the event.

Item Number 130355 - Geotechnical Environmental Testing Solutions reported fire damage to a moisture/density gauge. A Geotechnical employee took the gauge to his residence in the bed of his work truck. The employee mishandled charcoal embers from a grill on 8/8/2013, which caused a fire in the bed of the truck. When Virginia Beach fire trucks arrived, the employee stated that the truck contained a portable nuclear gauge. The fire was extinguished and radiation surveys were performed of the gauge by the Hazardous Material team, which revealed 1 mR/hour. The Geotechnical RSO responded to the site and also performed radiation surveys. Results indicated that the sources were in their shielded positions. The transportation case and plastic casing of the gauge were melted. The RSO packaged the damaged gauge in another transportation case and returned it to the Virginia Beach office. Geotechnical contacted the manufacturer and performed a leak test of the sources. The gauge was returned to the manufacturer. The gauge contained a 0.33 GBq (9 mCi) Cs-137 source. The NRC Registry of Radioactive Sealed Sources and Devices indicates that this gauge also contains an Am-Be source with a maximum activity of 1.63 GBq (44 mCi).

Item Number 130362 - SA Recycling reported finding an abandoned density gauge that contained a Cs-137 source with a current activity of 2.22 GBq (60 mCi). The source contained an activity of 3.7 GBq (100 mCi) on 3/1991. It was stated that someone from the California Health and Human Services Agency, Radiological Health Branch (CRHB), transported the gauge to SA Recycling in Anaheim, California, on 2/1/2010 and logged it into their database. However, a full investigation was not conducted. On 7/3/2013, another CRHB inspector was onsite and asked to survey the Cs-137 source. Pictures were taken and sent to a density device manufacturer for identification. The gauge was identified and it was determined to have been sold to Owl Rock Products on 7/1/1991. Radiation surveys were conducted using a Bicron ion chamber. Contact radiation levels on the back of the shielded source revealed 36 mR/hour on contact and approximately 50 mR/hour one foot from the source's face (background was 0.01 mR/hour). CRHB believes the shutter may be partially open due to damage. The gauge was placed inside a large metal box and inside a locked hazardous material container. Owl Rock Products was contacted and will be responsible for proper disposal. It is not known how the gauge became scrapped in 2010. A waste broker will package the gauge for inspection and eventual disposal by Thermo Fisher Scientific. This event was classified as an EQP and LAS event.

Item Number 130387 - Nabors Completion & Production Services Company reported that a nuclear density gauge was involved in a fire at a well site near Williston, North Dakota, on 8/24/2013. The gauge was being used during fracking activities and contained a Cs-137 source. Local fire department personnel arrived onsite and established control of the scene. The fire was extinguished later that night. Nabors personnel were able to approach the gauge on the morning of 8/25/2013. Using a Ludlum model 3, radiation readings were higher than expected and it was believed that the lead shielding had melted inside the steel casing and shifted to the lower area of the casing. The steel casing remained intact. The Nabors' radiation compliance coordinator arrived onsite on 8/26/2013. The highest radiation levels noted around the gauge were 2.6 R/hour on contact and 20 mR/hour at one meter. Wipe test results revealed no contamination. The manufacturer was contacted concerning disposal, but was not willing to accept receipt of the gauge. The manufacturer suggested Nabors contact a waste broker for final disposition. A waste broker removed the gauge, packaged it in a lead lined 55-gallon steel drum for transport, and shipped the gauge for final disposal on 8/29/2013. The North Dakota Department of Health completed an investigation of the incident. The NRC Registry of Radioactive Sealed Sources and Devices indicates that this source contains a maximum activity of 9.25 GBq (250 mCi).

Item Number 130392 - Acuren Inspection Incorporated reported a potential radiation overexposure to a radiographer that occurred on 9/1/2013. Radiography was being performed on welds at a refinery in Wyoming. While moving the exposure device to another location, the radiographer's dosimeter alarmed. Acuren suspected that the source was not fully retracted into the safe position. The source was subsequently retracted back into the fully shielded position. The radiation overexposure portion of this

event was retracted on 9/4/2013. Acuren sent the radiographer's dosimetry badge for processing, which revealed an exposure of 3.28 mSv (328 mrem) for the entire month of August 2013.

2.7.3 Events Recently Added to NMED That Occurred Prior to FY13

Ten EQP events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. None of these events were considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events
None

Events of Interest
Item Number 090432 - The Georgia Department of Transportation (GDOT) reported that a moisture/density gauge was damaged in Perry, Georgia, along Highway 341, mile marker 3, on 5/13/2009. The gauge contained a 1.48 GBq (40 mCi) Am-Be source and a 0.3 GBq (8 mCi) Cs-137 source. The gauge operator had improperly secured the gauge in the back of his truck before leaving a worksite. After about eight miles, the gauge fell from the truck onto the pavement. A member of the public was able to flag down the operator, who returned to the location of the gauge. The gauge was broken into several pieces and the operator moved those pieces to the highway shoulder using a shovel. The Cs-137 source was found intact in the end of the source rod. The rod had been broken into two pieces. A radiation survey of the smaller piece revealed approximately 300 mR/hour and it was placed into a lead pig. The Am-Be source was found intact and undamaged in the base of the gauge. All pieces of the gauge were retrieved and placed into an approved transport container and returned to the GDOT facility. Leak tests of both sources revealed negative results. The pieces of the gauge were returned to Troxler for proper disposal. GDOT reprimanded the operator and required that he attend additional safety training.

Item Number 120547 - The Arizona Department of Transportation reported the theft of a moisture/density gauge that contained a 1.63 GBq (44 mCi) Am-Be source and a 0.37 GBq (10 mCi) Cs-137 source. The theft occurred sometime during the night of 9/12/2012. A contractor had taken the gauge home for the night and left it in the back of a truck, instead of securing it within his home. The gauge had been in a Type 7A package, locked in a 16-gage steel box, which was bolted to the bed of a truck. The steel box lid had been pried open and the gauge removed. The El Mirage Police Department was notified and investigated the incident. On 2/1/2013, the Arizona Radiation Regulatory Agency investigated a scrap metal shipment that was being returned to Glendale, Arizona, from Taiwan through California. A Cs-137 source was found on 1/31/2013. Identifying numbers on the source rod confirmed that the source was part of the stolen gauge. The Am-Be source was not located. No other parts of a moisture/density gauge were located in the shipment. The Arizona Radiation Regulatory Agency stored the Cs-137 source in a secure location pending disposal.

2.8 Transportation

2.8.1 Ten-Year Data

Figure 8 displays the annual number and trend of TRS events that occurred during the 10-year period. The trend analysis determined that the data does not represent statistically significant trends in the number of events (indicated by the absence of trend lines). Therefore, variations within those annual values represent random fluctuation around the average of the data.

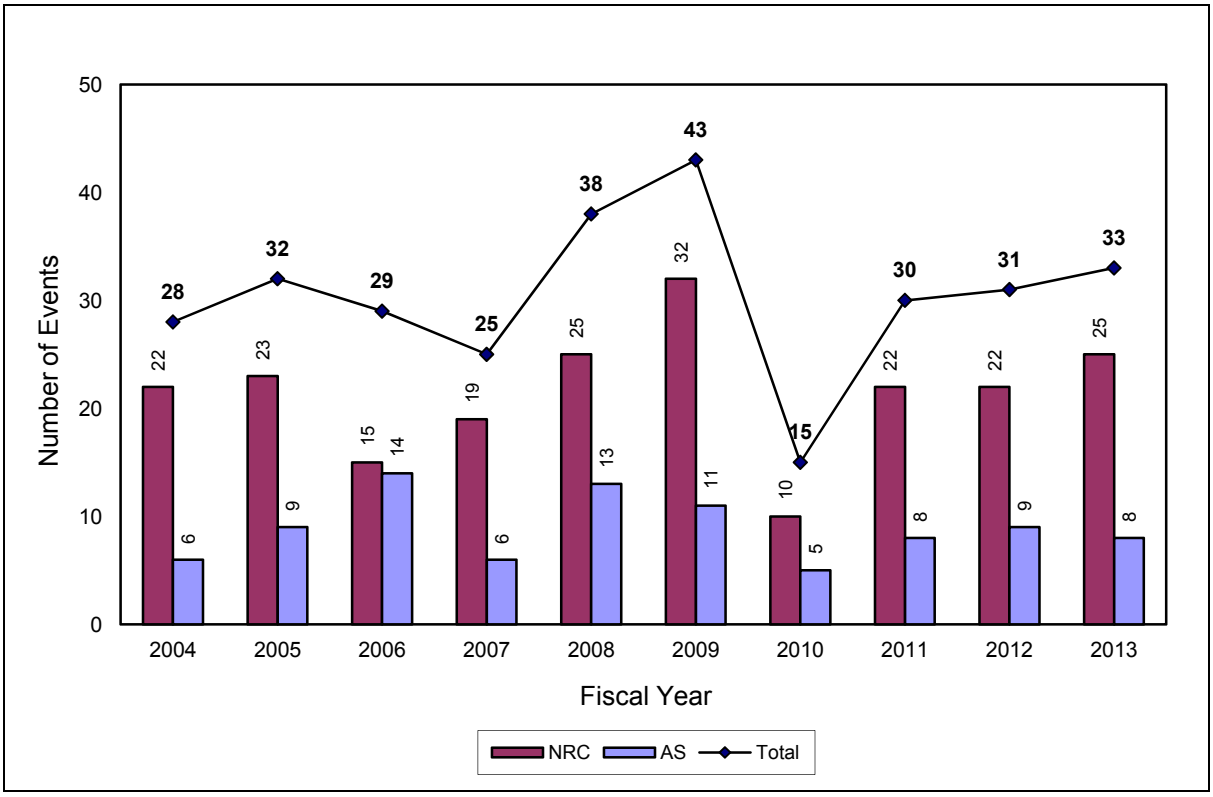

Figure 8. Transportation Events (304 total)

It is not possible to discern the significance of TRS events strictly from the CFR reporting requirements (as in Sections 2.4, 2.5, and 2.9). Therefore, event significance will be determined on an event-by-event basis based on the severity of the event (e.g., significant exposure to workers, members of the public, and/or the environment). Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

2.8.2 FY13 Data

Thirty-three TRS events occurred in FY13, none of which were considered significant.

Significant Events
None

Events of Interest
Item Number 130017 - Pacific Northwest National Laboratory (PNNL) sent a shipment of radioactive waste from the Hanford reservation to Perma-Fix Northwest that exceeded radiation level limits. During the unloading evolution, Perma-Fix noted that the dose rates on the bottom of two drums exceeded the manifest values and one drum exceeded 200 mR/hour on contact. The Washington Department of Health (WDOH) was notified and an inspector responded to the site on 12/6/2012. Using a Ludlum M-9, the dose rate was identified as 350 mR/hour. Using an Eberline RO2, the dose rate was 220 mR/hour. The

dose rates at the driver's area and on the outside of the shipment vehicle were within limits. The drums contained Sr-90 with a total activity of 240 GBq (6.49 Ci) in both drums. WDOH suspended all radioactive waste shipments to Perma-Fix by PNNL. A point of origin inspection was performed from 4/29 through 5/1/2013. PNNL was determined to be in compliance with pertinent Federal and State of Washington regulations and conditions of the site operator's license. PNNL's privilege to ship waste to Perma-Fix was reinstated on 5/2/2013.

Item Number 130018 - U.S. Ecology reported receiving a shipment of waste from G.E. Healthcare on 12/11/2012 that exceeded external radiation level limits. The shipment manifest listed the radionuclides as Zn-65 and Co-60, with a total activity of 3,020 GBq (81.62 Ci). The shipment contained accelerator targets from G.E. Healthcare facilities in Illinois and New Jersey. Drums had been loaded into boxes, which were loaded into drums, and then cemented in place. The outer drums were DOT Type 7A. U.S. Ecology performed radiation surveys of the shipping vehicle. Using an Eberline RO2 ion chamber, dose rates on the bottom of the floor of the vehicle were 250 mR/hour. It was determined that the shipment had not been braced to withstand conditions of normal transportation and shifted during transit. A more detailed inspection of the packages was conducted on 12/12 and 12/13/2012. Using an Eberline RO2 ion chamber, dose rates on the bottom of two drums revealed contact results of 1.5 R/hour. It was also noted that one drum's lid had not been correctly installed. There was no evidence of leakage, nor had the lid come off. In addition, one drum could not be correlated to the shipment manifest. The waste generator was contacted and corrected that discrepancy. Dose rates in the driver's area and on the outside of the shipping vehicle were within limits. The cause of the incident was determined to be a lack of adequate procedures. Contributing factors included this being a non-routine shipment (activity of waste and size of containers), procedural errors in performing exposure rate surveys, and failure of the transporter to notify them of a vehicle breakdown that possibly caused a shift of the packages. Corrective actions included procedure modifications and providing additional training to personnel. A point-of-origin inspection was performed by the Washington Department of Health on 6/12/2013 and G.E. Healthcare was determined to be in compliance with pertinent federal and state regulations and conditions of the site operator's license. G.E. Healthcare's privilege to ship waste to U.S. Ecology was reinstated on 6/13/2013.

Item Number 130084 - Bruker AXS Handheld, Incorporated, received an excepted package from a Massachusetts distributor with high radiation levels on 1/9/2013. The package held an x-ray fluorescence device that contained a 458.8 MBq (12.4 mCi) Co-57 source. Radiation survey results revealed 0.06 mSv/hour (6 mrem/hour) on contact with the package and 0.3 mSv/hour (30 mrem/hour) at a distance of 10 cm from the device. The device had been shipped with the shutter in the open position. The cause was determined to be improperly packaged material. Corrective actions included generating a new quality management plan.

Item Number 130096 - Nuclear Fuel Services reported the discovery of an instance in which conditions of approval in Certificate of Compliance (CoC) #9315 for the ES-3100 shipping container were not followed during a shipment from the B&W Y-12 facility in Oak Ridge, Tennessee, to the Nuclear Fuel Services facility in Erwin, Tennessee. A total of 35 ES-3100 containers were involved in the shipment on 12/10/2012. After receipt at Nuclear Fuel Services on 12/11/2012, personnel discovered that all eight of the drum lid nuts on one ES-3100 container (serial #2007-66-325), containing 93% enriched uranium, were not torqued to the specified 30 ft-lb. The drum lid nuts were found to be only finger-tight. No tampering issues were identified and the container's contents were verified. Investigations by Y-12 personnel indicated that this event was caused by the failure to follow procedures. Oak Ridge placed a production hold on loaded shipments of ES-3100 packages until torqueing on drum lids was verified. To prevent recurrence, additional administrative controls were established to ensure compliance with torque requirements, and personnel received additional training.

Item Number 130342 - Department of Veterans Affairs (DVA; VA Southern Nevada Healthcare System) reported receipt of a package with external radiation levels of 160 mR/hour on contact and 32 mR/hour at one meter. The package contained two lead pigs; one pig contained 12.95 GBq (350 mCi) of F-18 and

the other contained 0.44 GBq (12 mCi) of F-18. The package was received on 7/31/2013 and surveys were performed using a pressurized ionization chamber. The highest readings were identified on the top of the package. Contamination surveys of the outside of the package were within limits. DVA contacted Cardinal Health and it was determined that the wrong shipping box was used and that the package should have been shipped later in the day. DVA isolated the package in their medical center hot laboratory and additional lead shielding was placed on top of the package. The root cause was determined to be human error by an insufficiently trained novice technician. Corrective actions included providing refresher training to all employees involved in packaging and preparation of shipping papers, retention of training records and certification, and counseling the pharmacy manager and RSO to use appropriate resources for training.

2.8.3 Events Recently Added to NMED That Occurred Prior to FY13

Eleven TRS events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. None of these events were considered significant. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events
None

Events of Interest
None

2.9 Fuel Cycle Process

2.9.1 Ten-Year Data

Figure 9 displays the annual number and trend of FCP events that occurred during the 10-year period. This figure differs from those in previous sections of this report because FCP events are only associated with NRC-regulated facilities (not Agreement State-regulated). Additionally, unlike the other event types, NMED incorporates a dual use of the FCP event type; one use (Unique FCP) is for events unique to the fuel cycle process (such as a degradation of criticality controls), while the other use (Other FCP) is for any event occurring at a fuel cycle process facility (such as a lost calibration source).

The trend analysis determined that the data does not represent statistically significant trends in the number of events (indicated by the absence of trend lines). Therefore, variations within those annual values represent random fluctuation around the average of the data.

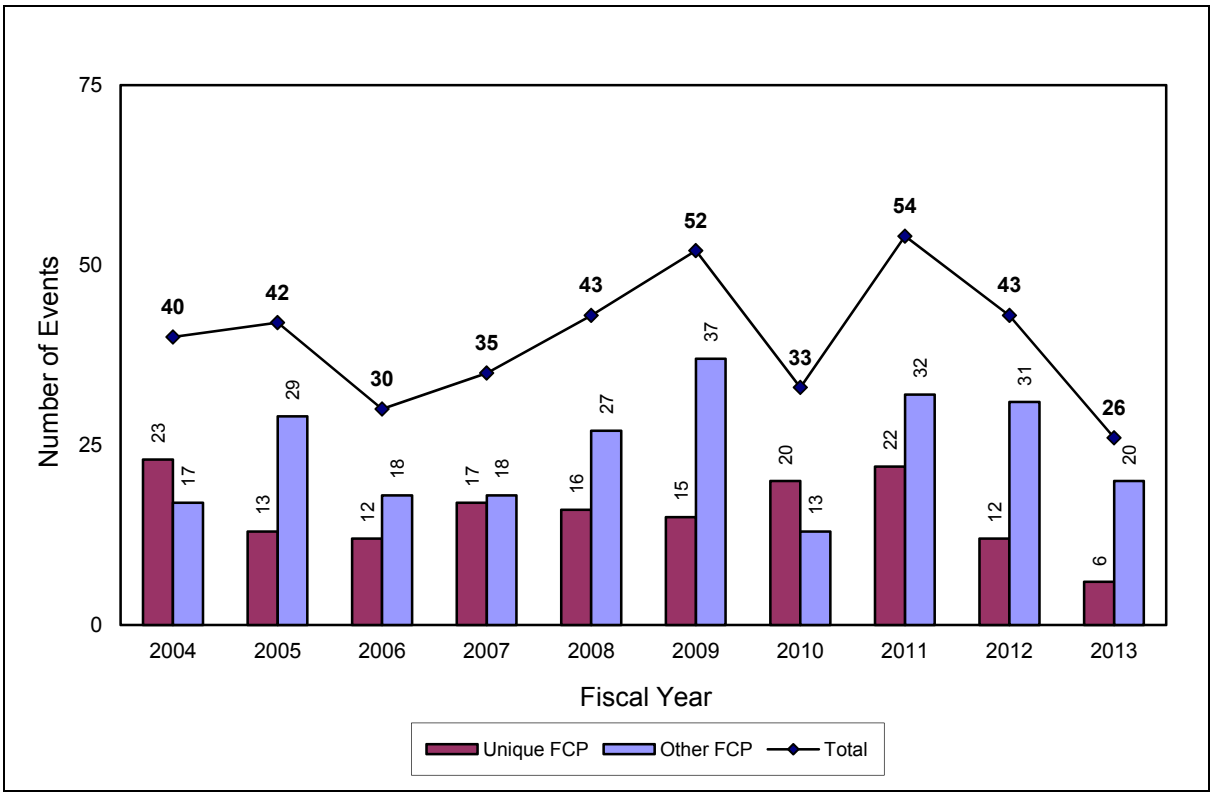

Figure 9. Fuel Cycle Process Events (398 total)

The remainder of this section will limit discussion to only those Unique FCP events (156 events).

The significance of individual FCP events may be determined by the CFR reporting requirement applicable to the event. For example, an event that is required to be immediately reported is typically more significant than an event with a 24-hour reporting requirement. For this report, those events requiring immediate reporting are considered significant. Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

Table 8 displays the number of events based on the different reporting requirement time categories. Note that each event is counted only once. If more than one reporting requirement applied to an event, the event is counted in only the most restrictive category.

Table 8. Unique FCP Events Classified by CFR Reporting Requirement

	Fiscal Year										
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Immediate	5	3	3	5	3	3	1	1	2	1	**27**
24-Hour	18	10	9	12	13	12	19	21	10	5	**129**
Total	**23**	**13**	**12**	**17**	**16**	**15**	**20**	**22**	**12**	**6**	**156**

2.9.2 FY13 Data

Six Unique FCP events occurred in FY13, one of which was considered significant.

Significant Events - Immediate Reports

Item Number 130118 - Global Nuclear Fuel - Americas reported that a pressure mat did not function as designed on 3/5/2013. The incident was discovered during a post maintenance test of a sole Item Relied On For Safety (IROFS) in the swarf press area. The pressure mat is designed to ensure operator presence. The clutch that should have disengaged when the pressure switch was not active failed to do so. The press was immediately shut down. Similar presses have also been shut down. Criticality controls for the operation were maintained (moderation and mass). The sole IROFS is designed to mitigate the consequences of a potential fire accident scenario. At no time was an unsafe condition present. An investigation determined that the actual failure was a degraded clutch assembly controlled by the pressure switch, not the switch itself. The failure was the result of a clutch pad bolt backing out and contacting the drive plate, rotating the press even though the clutch pad was not intentionally engaged. This issue was resolved. Global Nuclear added mass control to the accident sequence, so that the pressure mat is no longer the sole IROFS for the accident sequence.

Events of Interest

Item Number 120589 - Westinghouse Electric Company reported identifying unanalyzed accident scenarios for certain consequences of concern. Westinghouse reviewed a recent NRC event report submitted by AREVA NP (see NMED Item 120585) for applicability to their facility. This evaluation determined that the Integrated Safety Analysis (ISA) currently identifies Items Relied On For Safety (IROFS) for scenarios based on Emergency Response Planning Guides for chemical consequences. However, the Process Hazards Analysis conducted for the ISA did not specifically identify high or intermediate events that may require additional IROFS for dermal or ocular exposures from the plant's chemical processes. There is no actual safety significance and the potential safety significance is low due to an extensive number of IROFS to prevent chemical spills, existing requirements for worker protection from these hazards, and robust procedures, training, and personal protective equipment in place. However, the failure to specifically identify the dermal/ocular exposure as potentially high or intermediate consequence events led to these sequences not being included in the ISA Summary, and therefore, IROFS were not designated for the accident sequences. Until the Process Hazards Analysis and Job Safety Analysis are reviewed for identification of specific IROFS, applicable elements of the Chemical Safety Program will be treated as IROFS.

Item Number 130356 - B&W Nuclear Operating Group reported that poisoned ≤ 2.5 liter container storage racks were determined to be in an unanalyzed condition on 8/9/2013. These racks had twenty individual storage locations and were fitted with horizontal poison plates that covered a majority of the posterior side of the storage rack. A nuclear criticality safety engineer determined that the storage racks were improperly analyzed in October 2000. That analysis was based on an evaluation of a poisoned transport cart completed in 1997. However, a review indicated the conclusions of that earlier analysis were not properly applied to the analysis of the storage racks. No controls for mass or moderation were lost in this event and there was no immediate risk to criticality safety. Corrective actions included

removing the containers from the top row of each storage rack, additional training for criticality safety staff, and procedure modification.

Item Number 130366 - Westinghouse Hematite reported the failure to identify two items that required criticality control. Westinghouse had begun excavating legacy burial pits containing enriched uranium in April 2012. Material was screened prior to transfer to the Waste Consolidation Area (WCA). These two items were identified while moving soil from the WCA to the Waste Handling Area (WHA). The first item was identified on 8/20/2013 and consisted of a crushed metal container, approximately 16 inches in diameter and 4 inches thick, reading approximately 430,000 cpm. Further analysis determined that the container possessed approximately 22 grams of U-235, which requires criticality safety controls. The container was placed into a collared drum and properly stored. The second item was identified on 8/22/2013 and consisted of another crushed metal container with the same dimensions as the first container, reading approximately 100,000 cpm. Further analysis determined that this container possessed approximately 23.4 grams of removable U-235 and 2.3 grams of non-removable U-235, for a total of 25.7 grams of U-235, which also requires criticality control. This item was also placed in a collared drum and properly stored. After 8/22/2013, Westinghouse ceased soil/debris transfer between the WCA and the WHA pending retraining of workers and the development of additional engineered measures. Material in the WCA and part of the WHA was re-surveyed. This event was caused by inadequate excavation and survey procedures, especially in the case of shielded U-235. Corrective actions included procedure modification and personnel training.

2.9.3 Events Recently Added to NMED That Occurred Prior to FY13

No Unique FCP events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. Note that this data may differ from the associated Appendix D graph, which displays the number of events (all FCP events, not just Unique FCP events) added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events
None

Events of Interest
None

2.10 Other

2.10.1 Ten-Year Data

Figure 10 displays the annual number of OTH events that occurred during the 10-year period. Because OTH events do not fit a defined criterion that ensures consistency within the data, trending analysis is not performed on this data.

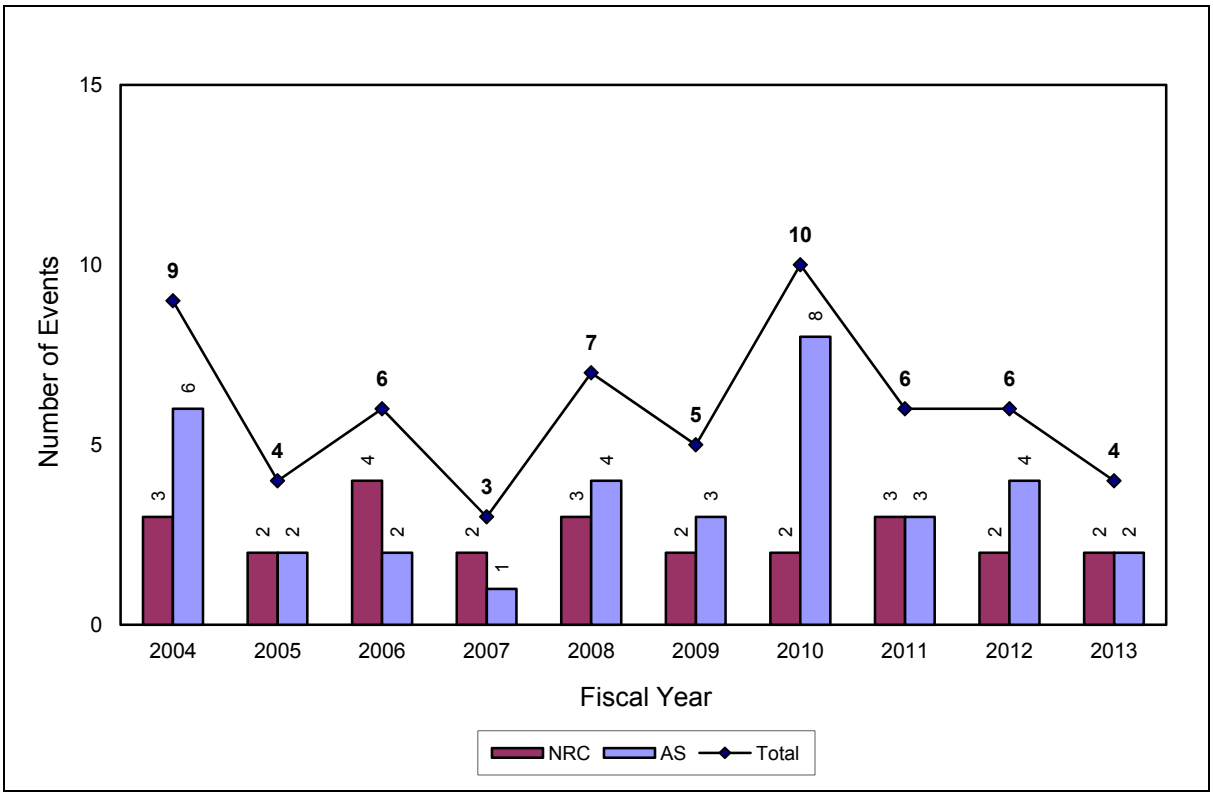

Figure 10. Other Events (60 total)

It is not possible to discern the significance of OTH events strictly from the CFR reporting requirements (as in Sections 2.4, 2.5, and 2.9). Therefore, event significance will be determined on an event-by-event basis based on the severity of the event (e.g., significant exposure to workers, members of the public, and/or the environment). Events possessing one or more unusual aspects, but that do not meet the significant event threshold, are considered events of interest.

2.10.2 FY13 Data

Four OTH events occurred in FY13, two of which were considered significant.

Significant Events

Item Number 130192 - Baptist Medical Center Princeton reported that a pregnant patient received 1.85 GBq (50 mCi) of I-131 (sodium iodide) on 3/26/2013. The patient had a thyroidectomy performed on 3/1/2013, due to thyroid cancer. The patient had general laboratory work, including a pregnancy test, performed on 3/6/2013. That pregnancy test revealed negative results. The patient had another pregnancy test performed on 3/26/2013, prior to I-131 administration. However, the administering technician was not informed of that second pregnancy test and its positive results. Subsequently, it was determined that the patient was four to five weeks pregnant on 3/26/2013. Dose calculations performed by a consultant estimated that the embryo/fetus received approximately 12.6 cSv (rem). The cause was determined to be lack of procedures and inattention to detail. Corrective actions included generating a new procedure, providing personnel with improved supervision, and reprimanding involved personnel.

Item Number 130209 - Radiological Associates of Sacramento reported that a pregnant patient was administered 6.55 GBq (176.9 mCi) of I-131 on 2/20/2013. A serum pregnancy test conducted on 2/18/2013 revealed negative results. However, on 4/22/2013, Radiological Associates received a phone call from the patient's endocrinologist informing them that the patient was pregnant. An ultrasound evaluation performed on 3/18/2013 determined that the embryo/fetus would have been approximately two weeks old at the time of I-131 administration. The dose to the embryo/fetus was determined to be 47 cGy (rad).

Events of Interest
None

2.10.3 Events Recently Added to NMED That Occurred Prior to FY13

No OTH events were recently added to NMED that occurred prior to the current fiscal year and had not been included in any previous annual report. Note that this data may differ from the associated Appendix D graph, which displays the number of events added and subtracted from specific years within the most recent 10-year period, including events moved between years due to changes in the recorded event date.

Significant Events
None

Events of Interest
None

Appendix A

Event Type Descriptions and Criteria

Appendix A
Event Type Descriptions and Criteria

The NMED events covered by this report are divided into the following categories based on the event reporting requirements defined in 10 CFR. Note that the tables in this appendix do not contain the full text of the applicable CFRs.

Lost/Abandoned/Stolen Material (LAS)

The LAS event category includes those events where licensed radioactive material is lost or found, abandoned or discovered, and stolen or recovered. The radioactive material involved can be sealed or unsealed material, specifically or generally licensed, exempt or non-exempt quantities, involve a licensee or a non-licensee, and can be found anywhere.

NMED LAS reportable events are those that meet the reporting requirements of 10 CFR Part 20.2201. Events that do not meet the 20.2201 reporting requirement thresholds are captured as not-reportable LAS events. Additionally, LAS events involving non-Atomic Energy Act material are entered into NMED as not-reportable events.

All reportable LAS events will be coded as one of the following reporting requirements. For events involving more than one source, the decision of 10 × or 1,000 × the 10 CFR Part 20 Appendix C quantity is based on the aggregate quantity of licensed material.

Table A-1. Primary LAS Reporting Requirements

Primary LAS Reporting Requirements	Reporting Requirement Summary
20.2201(a)(1)(i)	Aggregate activity ≥ 1,000 × 10 CFR Part 20 Appendix C quantity
20.2201(a)(1)(ii)	Aggregate activity > 10 and < 1,000 × 10 CFR Part 20 Appendix C quantity
39.77(d)	Irretrievable well logging source

The following additional (secondary) CFRs will be added as applicable.

Table A-2. Secondary LAS Reporting Requirements

Secondary LAS Reporting Requirements	Reporting Requirement Summary
30.55(c)	Theft/diversion of 10 Ci (or 100 Ci per year) of H-3 (not generally licensed).
39.77(b)	Loss/theft of well logging sources.
40.64(c)(1)	Theft/diversion of 15 lbs (or 150 lbs per year) of source material (uranium or thorium).
73.71(a)(1)	Lost shipment of any SNM.
73.App G(I)(a)(1)	Actual or attempted theft or unlawful diversion of SNM.
74.11(a)	Loss, theft or unlawful diversion (actual or attempted) of SNM or the unauthorized production of enriched uranium.
76.120(a)(2)	Loss, other than normal operating loss, of special nuclear material.
76.120(a)(3)	Actual or attempted theft or unlawful diversion of special nuclear material.
150.16(b)(1)	Actual or attempted theft or unlawful diversion of SNM.
150.17(c)(1)	Attempted theft or unlawful diversion of more than 6.8 kg (15 lb) of Uranium or Thorium at any one time or more than 68 kg (150 lb) in any one calendar year.
150.19	Theft/diversion of 10 Ci (or 100 Ci per year) of H-3 (not generally licensed). Note: This requirement is just like 30.55(c), but applies to Agreement States and offshore waters.

Medical (MED)

MED events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-3. MED Reporting Requirements

MED Reporting Requirements	Reporting Requirement Summary
35.3045(a)(1)(i)	Total dose delivered that differs from the prescribed dose by 20% or more; and differs from the prescribed dose by more than 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE.
35.3045(a)(1)(ii)	Total dosage delivered differs from prescribed by 20% or more or falls outside the prescribed range; and results in a dose that differs from prescribed by more than 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE.
35.3045(a)(1)(iii)	Fractionated dose delivered that differs from the prescribed dose for a single fraction by 50% or more; and differs from the prescribed dose by more than 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE.
35.3045(a)(2)(i)	Administration of a wrong radioactive drug containing byproduct material that results in a dose that exceeds 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE.
35.3045(a)(2)(ii)	Administration of a radioactive drug containing byproduct material by the wrong route of administration that results in a dose that exceeds 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE to the skin.
35.3045(a)(2)(iii)	Administration of a dose or dosage to the wrong individual or human research subject that results in a dose that exceeds 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE to the skin.
35.3045(a)(2)(iv)	Administration of a dose or dosage delivered by the wrong mode of treatment that results in a dose that exceeds 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE to the skin.
35.3045(a)(2)(v)	Leaking sealed source that results in a dose that exceeds 0.05 Sv (5 rem) EDE, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) SDE to the skin.
35.3045(a)(3)	Dose to the skin, organ, or tissue, other than the treatment site, that exceeds the prescribed dose by 0.5 Sv (50 rem) and 50% or more (excluding permanently implanted seeds that migrated from the treatment site).
35.3045(b)	Event resulting from patient intervention in which the administration of byproduct material or radiation from byproduct material results in unintended permanent functional damage to an organ or a physiological system, as determined by a physician.

Events are not considered MED events if they involve:

- Only a linear accelerator,
- Doses administered in accordance with a written directive (even if the directive is in error), or
- Patient intervention.

Events are considered MED events if, for example, a linear accelerator is used for therapy by mistake instead of a teletherapy unit or a teletherapy unit instead of a linear accelerator.

For purposes of determining whether to categorize an event as MED or EXP, MED events occur to patients only (i.e., those being administered a medical procedure). For example, if a patient receives too much dose during a procedure, the event would be categorized as MED rather than EXP. However, radiation exposure received from a cause other than the patient's medical procedure may be categorized as EXP.

Radiation Overexposure (EXP)

EXP events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-4. EXP Reporting Requirements

EXP Reporting Requirements	Reporting Requirement Summary
20.2202(a)(1)(i)	An individual received a total effective dose equivalent of 25 rem (0.25 Sv) or more.
20.2202(a)(1)(ii)	An individual received a lens dose equivalent of 75 rem (0.75 Sv) or more.
20.2202(a)(1)(iii)	An individual received a shallow-dose equivalent to the skin or extremities of 250 rad (2.5 Gy) or more.
20.2202(b)(1)(i)	Loss of control of material causing or threatening to cause an individual to receive a total effective dose equivalent exceeding 5 rem (0.05 Sv) in a period of 24 hours.
20.2202(b)(1)(ii)	Loss of control of material causing or threatening to cause an individual to receive an eye dose equivalent exceeding 15 rem (0.15 Sv) in a period of 24 hours.
20.2202(b)(1)(iii)	Loss of control of material causing or threatening to cause an individual to receive a shallow-dose equivalent to the skin or extremities exceeding 50 rem (0.5 Sv) in a period of 24 hours.
20.2203(a)(2)(i)	Doses in excess of the occupational dose limits for adults in 20.1201.
20.2203(a)(2)(ii)	Doses in excess of the occupational dose limits for a minor in 20.1207.
20.2203(a)(2)(iii)	Doses in excess of the limits for an embryo/fetus of a declared pregnant woman in 20.1208.
20.2203(a)(2)(iv)	Doses in excess of the limits for an individual member of the public in 20.1301.
20.2203(a)(2)(v)	Doses in excess of any applicable limit in the license.
20.2203(a)(2)(vi)	Doses in excess of the ALARA constraints for air emissions established under 20.1101(d).

The EXP event category includes all regulatory overexposures of radiation workers or exposures of members of the public to radiation. The overexposure can be external or internal and can be whole body, extremity, skin, lens of the eye, or internal dose. When the overexposure involves multiple individuals or an individual with multiple overexposure types (such as whole body and extremity), the different types of overexposures are entered separately. Note that dosimeters record exposure if improperly stored near a radiation source and, depending on the type of dosimeter, may react as though they are in a radiation field when exposed to heat or humidity. It is NRC policy to classify only those events that positively involve a personnel overexposure, and not just a dosimeter exposure, as reportable EXP events. For example, either the licensee does not contest the personnel overexposure, or in cases where the licensee does contest the overexposure, the State or NRC determines the event to be personnel overexposure.

EXP limits do not apply to patients receiving medical procedures.

Release of Licensed Material or Contamination (RLM)

RLM events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-5. RLM Reporting Requirements

RLM Reporting Requirements	Reporting Requirement Summary
20.2202(a)(2)	Release of radioactive material, inside or outside of a restricted area, so that had an individual been present for 24 hours, the individual could have received an intake 5 times the ALI.
20.2202(b)(2)	Release of material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of 1 ALI.
20.2203(a)(3)(i)	Radiation or concentrations of radioactive material in a restricted area in excess of any applicable limit in the license.
20.2203(a)(3)(ii)	Radiation or concentrations of radioactive material in an unrestricted area in excess of 10 times any applicable limit set forth in Part 20 or in the license.
20.2203(a)(4)	Levels of radiation or releases of radioactive material in excess of the standards in 40 CFR Part 190, or of license conditions related to those standards.
30.50(a) 40.60(a) 70.50(a) 76.120(b)	Event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of material that could exceed regulatory limits.
30.50(b)(1) 40.60(b)(1) 70.50(b)(1) 76.120(c)(1)	Unplanned contamination event that requires access to be restricted for > 24 hours, involves > 5 times the lowest ALI, and has access restricted for a reason other than to allow isotopes with a half-life of < 24 hours to decay.
30.50(b)(3) 40.60(b)(3) 70.50(b)(3) 76.120(c)(3)	Event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body.
50.72(b)(3)(xii) 72.75(c)(3)	Event requiring the transport of a radioactively contaminated person to an offsite medical facility for treatment.

The RLM event category includes two types of events. The first type is a radioactive release to air or water exceeding the 10 CFR Part 20 Appendix B annual limit on intake (ALI). The second type of RLM event involves contamination events such as a radioactive spill outside of work areas, removable contamination found on equipment, or material tracked around a laboratory such that additional radiological control measures had to be implemented. This category does not include spills inside of laboratory hoods, radiopharmaceutical dose preparation areas, or hot cells where radioactive work routinely requires cleanup or changing of absorbent paper after the performance of a task. Should there be multiple release types (e.g., surface, air, water, or person) or areas of contamination associated with the release, this information is entered individually.

Leaking Sealed Source (LKS)

LKS events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-6. LKS Reporting Requirements

LKS Reporting Requirements	Type of Source
31.5(c)(5)	Generally licensed
34.27(d)	Radiography
35.67(e)	Medical
39.35(d)(1)	Well logging (leaking)
39.77(a)	Well logging (ruptured)
30.50(b)(2)	All other sources

The NRC requires that most sealed sources be periodically leak tested to verify that the material is still sealed and that the source is still considered safe to use without contamination controls, including protective clothing or gloves. Sources are generally exempt from leak testing under the following conditions [see 10 CFR Part 31.5(c)(2), 34.27(c), 35.67(f), and 39.35(e)]:

- Sources containing only gaseous radioactive material (like H-3, Kr-85, etc.),
- Sources containing licensed material with a half-life of 30 days or less,
- Sources containing <= 100 μCi of other beta and/or gamma emitting material,
- Sources containing <= 10 μCi of alpha emitting material,
- Sources held in storage in the original shipping container prior to initial installation,
- Seeds of Ir-192 encased in nylon ribbon, or
- Sources in storage and not in use (must be leak tested prior to use or transfer).

A source is considered leaking if a leak test can detect greater than 0.005 μCi of removable radioactive material. The leaking source is then removed from service, disposed of or returned to the manufacturer for repair, and a report is sent to the NRC or Agreement State with the details of the leaking source.

For regulatory reporting purposes, a leaking source is generally considered a failed device under 10 CFR Part 30. Therefore, in most cases an LKS event is also coded as an EQP event. An exception is the Ni-63 foil source, which is coded as only an LKS event.

Equipment (EQP)

EQP events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-7. EQP Reporting Requirements

EQP Reporting Requirements	Reporting Requirement Summary
21.21(d)(1)(i)	A failure to comply or a defect affecting the construction or operation of a facility or an activity that is subject to licensing requirements.
21.21(d)(1)(ii)	A failure to comply or a defect affecting a basic component that is supplied for a facility or an activity that is subject to licensing requirements.
30.50(a) 40.60(a) 70.50(a) 76.120(b)	Event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of material that could exceed regulatory limits.
30.50(b)(2) 40.60(b)(2) 70.50(b)(2) 72.75(d)(1) 76.120(c)(2)	Equipment is disabled or fails to function as designed.
30.50(b)(4) 40.60(b)(4) 70.50(b)(4) 76.120(c)(4)	Unplanned fire or explosion that damages any licensed material or any device, container, or equipment containing licensed material.
31.5(c)(5)	Actual or indicated failure to shielding, the on-off mechanism or indicator, or upon the detection 0.005 μCi or more of removable radioactive material.
34.101(a)(1)	Unintentional disconnection of the radiographic source assembly from the control cable.
34.101(a)(2)	Inability to retract and secure the radiographic source assembly to its fully shielded position.
34.101(a)(3)	Failure of any radiographic component (critical to the safe operation of the device) to properly perform its intended function.
36.83(a)(1)	An irradiator source stuck in an unshielded position.
36.83(a)(2)	Fire or explosion in an irradiator radiation room.
36.83(a)(3)	Damage to the irradiator source racks.
36.83(a)(4)	Failure of the irradiator cable or drive mechanism used to move the source racks.
36.83(a)(5)	Inoperability of the irradiator access control system.
36.83(a)(6)	Detection of irradiator source by the product exit monitor.
36.83(a)(7)	Detection of irradiator radioactive contamination attributable to licensed radioactive material.
36.83(a)(8)	Structural damage to the irradiator pool liner or walls.
36.83(a)(9)	Abnormal water loss or leakage from the irradiator source storage pool.
36.83(a)(10)	Irradiator pool water conductivity exceeding 100 microsiemens per centimeter.
39.77(a)	Ruptured well logging sealed source.
72.75(c)(1)	Defect in any spent fuel, HLW, or reactor-related GTCC waste storage structure, system, or component that is important to safety.
72.75(c)(2)	Significant reduction in the effectiveness of any spent fuel, HLW, or reactor-related GTCC waste storage confinement system during use.
72.242(d)	Design or fabrication deficiency for any spent fuel storage cask delivered to a licensee which affects the ability of components important to safety to perform their safety function.

The EQP event category includes all types of radiological equipment problems, including generally licensed device problems covered in 10 CFR Part 31; radiography equipment problems covered in 10 CFR Part 34; irradiator problems covered in 10 CFR Part 36; well logging problems covered in 10 CFR Part 39, and other types of equipment covered in 10 CFR Part 30, 40, 70, and 76. EQP events are defined as the failure of, or a defect in, any piece of equipment that either contains licensed radioactive materials as an integral part, or whose function is to interact with such materials.

Transportation (TRS)

TRS events are determined and coded per the 10 CFR reporting requirements listed below.

Table A-8. TRS Reporting Requirements

TRS Reporting Requirements	Reporting Requirement Summary
20.1906(d)(1)	Transported package exceeds removable surface contamination limits.
20.1906(d)(1)	Transported package exceeds external radiation limits.
71.5	Transportation of licensed material.
71.95(a)(1)	Significant reduction in the effectiveness of any NRC-approved Type B or Type AF packaging during use.
71.95(a)(2)	Defects with safety significance in any NRC-approved Type B or fissile material packaging, after first use.
71.95(a)(3)	Conditions of approval in the Certificate of Compliance were not observed in making a shipment.
71.95(b)	Conditions in the Certificate of Compliance were not followed during a shipment.

Fuel Cycle Process

The FCP event type is used two ways. One usage is identical to the other event types in that it is used to code events involving FCP reporting requirements. However, it is also used to denote any type of event occurring at (or involving) a fuel cycle process facility. Therefore, reporting requirements other than those listed below can be used with the FCP event type. In this case, the event will be coded with multiple event types.

For those events involving only the FCP event type, the events are determined and coded per the 10 CFR reporting requirements, NRC Bulletin, and Safety Equipment Actuation requirement listed below.

Table A-9. FCP Reporting Requirements

FCP Reporting Requirements	Reporting Requirement Summary
70.52(a)	Inadvertent nuclear criticality.
70.App A(a)(1)	Inadvertent nuclear criticality.
70.App A(a)(2)	Acute intake by an individual of 30 mg or greater of uranium in a soluble form.
70.App A(a)(3)	Acute chemical exposure to an individual from licensed material or hazardous chemicals produced from licensed material that exceeds the quantitative standards established to satisfy the requirements in 70.61(b)(4).
70.App A(a)(4)(i)	Event or condition such that no IROFSs remain available and reliable to perform the safety function in accordance with 70.61(b) and 70.61(c).
70.App A(a)(4)(ii)	Event or condition such that no IROFSs remain available and reliable to prevent a nuclear criticality accident (i.e., loss of all controls in a particular sequence).
70.App A(a)(5)	Loss of controls such that only one IROFS has been available and reliable (for longer than the past eight hours) to prevent a nuclear criticality accident.
70.App A(b)(1)	Event or condition that results in the facility being in a state not analyzed, improperly analyzed, or different from that analyzed, and results in failure to meet the performance requirements of 70.61.
70.App A(b)(2)	Loss or degradation of IROFSs that results in failure to meet the performance requirement of 70.61.
70.App A(b)(3)	Acute chemical exposure to an individual from licensed material or hazardous chemicals produced from licensed materials that exceeds the quantitative standards that satisfy the requirements of 70.61(c)(4).
70.App A(b)(4)	Natural phenomenon or external event, including fires internal and external to the facility, that affected or may have affected the safety function, availability, or reliability of one or more IROFSs.
70.App A(b)(5)(i)	Occurrence of an event or process deviation that was considered in the ISA and was dismissed due to its likelihood.
70.App A(b)(5)(ii)	Occurrence of an event or process deviation that was considered in the ISA, categorized as unlikely, and whose associated unmitigated consequences would have exceeded those in 70.61(b) had the IROFSs not performed their safety function(s).
72.74(a)	Accidental criticality or any loss of special nuclear material.
76.120(a)(1)	Criticality event.
76.120(a)(4)	Emergency condition that has been declared an alert or site area emergency.

NRCB 91-01 Immediate reports: NRCB 91-01 – A 24 hour reports: NRCB 91-01 – B	The loss of criticality safety controls where (1) moderation is used as the primary criticality control, or (2) more than a safe mass of fissionable material is involved (regardless of the type of controls used to satisfy the double contingency principle), and that meet one or more of the following immediate reporting criteria: 1. Any event that results in the violation of the double contingency principle, as defined in ANSI 8.1, and where the double contingency principle cannot be re-established within 4 hours after the initial observation of the event. 2. The occurrence of any unanticipated or unanalyzed event for which the safety significance of the event or corrective actions to re- establish the double contingency principle are not readily identifiable. 3. Any case where it is determined that a criticality safety analysis was deficient and where the necessary controlled parameters were not established or maintained. 4. Any event involving a controlled parameter previously identified by the NRC or the licensee as requiring immediate reporting to the NRC and where the double contingency principle cannot be re- established within 4 hours after the initial observation of the event. All other criticality safety events that do not meet the aforementioned criteria, but still result in a violation of the double contingency principle, such as events where the double contingency principle is violated but control is immediately re-established, should be reported to the NRC within 24 hours in accordance with the commitments in the responses to the bulletin.
S.E.A	Safety equipment actuation.

Other (OTH)

The OTH event category includes the following types of events:

1. Doses to an embryo/fetus or nursing child reportable per 10 CFR Part 35.3047. Note that these events are not MED events (reportable per 10 CFR Part 35.3045).
2. Exposure rates in an unrestricted area in excess of 2 mR/hr, but no individual received a dose in excess of limits (if a dose in excess of limits is received, the event is an EXP event).
3. Reportable events that do not specifically fit into one of the previous event types.
4. Events not reportable to the NRC but included in the NMED program for informational purposes.

For items 1 and 2 above, OTH events are determined and coded per the 10 CFR reporting requirements listed below. Due to the nature of items 3 and 4 above, other reporting requirements may also be used.

Table A-10. OTH Reporting Requirements

OTH Reporting Requirements	Reporting Requirement Summary
35.3047(a)	Dose to an embryo/fetus greater than 50 mSv (5 rem) DE from administration of byproduct material or radiation from byproduct material to a pregnant individual unless specifically approved, in advance, by the authorized user.
35.3047(b)(1)	Dose to a nursing child greater than 50 mSv (5 rem) TEDE resulting from an administration of byproduct material to a breast-feeding individual.
35.3047(b)(2)	Dose to a nursing child resulting in unintended permanent functional damage to an organ or physiological system, as determined by a physician, resulting from an administration of byproduct material to a breast-feeding individual.
20.2203(a)(2)(iv)	Exposure rates in an unrestricted area in excess of 2 mR/hr, but no dose received in excess of limits.

Appendix B

Statistical Trending Methodology

Appendix B
Statistical Trending Methodology

General

The following is a general discussion of statistical trending techniques.

A common approach to the statistical analysis of trend is based on regression methods. In particular, it is often the case that a relationship exists between the values assumed by a pair of variables. For example, if x is time (in years), and y is the rate of events per year, then we could use regression methods to study whether there is a relationship between time and event rate.

Regardless of the application, it is standard practice to refer to x as the independent variable and y as the dependent variable. Another common term for the dependent variable is "response variable," and the terms covariant and explanatory variable are sometimes used for the independent variable. Also, it is typical with regression modeling that the independent variable can be measured with little or no error, but the dependent variable involves a random error. Consequently, even if there is a deterministic functional relationship between the two variables, when data pairs (x_1, y_1), (x_2, y_2),..., (x_n, y_n) are plotted, the points will not coincide exactly with the function, but instead will tend to be scattered. Such a plot is called a scatter diagram, and shows the variation in the data. The plots in this report are bar charts containing the same information.

Fitting a Straight Line to Data

Consider a linear function

$$f(x) = \alpha + \beta x \tag{B-1}$$

where α and β are unknown parameters. A common model is that y is the sum of a linear function of the form (1) and a random error term, e. Standard results on estimation and inference about the parameters of the model assume that e is a normally distributed random variable with mean 0 and constant (but unknown) variance, σ^2. These assumptions mean that:

- Each yi is an observed value of a random quantity that is normally distributed [with mean f(xi)], and
- All the observations yi are of variables with a common variance, σ2.

The y_i are also assumed to be observations of random quantities that are independent of each other.

Under these conditions, the usual approach to estimating the unknown parameters α and β is the method of least squares (LS). In this method, α and β are selected so that the sum of the squares of the vertical distances between the data points and the fitted line is as small as possible. The LS method leads to the estimates

$$\hat{\beta} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})y_i}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \text{ and} \tag{B-2}$$

$$\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}\,, \tag{B-3}$$

where $\bar{x}$ and $\bar{y}$ are arithmetic averages. The estimated LS regression line is then

$$\hat{y} = \hat{\alpha} - \hat{\beta}x\,, \tag{B-4}$$

and an estimate of σ is

$$s = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-2}} \,. \tag{B-5}$$

Testing for Trend

A trend exists whenever the true slope, β, is not zero. We start the analysis with the idea that β is zero, and then ask whether the data tell us otherwise. Two quantities computed from the data are used in this assessment. The first, the *error sum of squares* (SSE), appears in the numerator of s. It is defined as

$$SSE = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \,. \tag{B-6}$$

This quantity is the number that is minimized in order to find the estimates of α and β. The differences being squared in SSE represent random variations that remain after the linear fitting process. The second quantity is the *regression sum of squares* (SSR), defined by the following equation

$$SSR = \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2 \,. \tag{B-7}$$

Note that SSR looks at deviations between the fitted line and the default notion that the data are constant and have no slope.

One can show by algebra that

$$SSE + SSR = SST \,, \tag{B-8}$$

where the *total sum of the squares* (SST), is defined as

$$SST = \sum_{i=1}^{n}(y_i - \bar{y})^2 \,. \tag{B-9}$$

SST measures the overall variation in the data. It is the numerator that would be used to estimate the variance in a sample from a normally-distributed random variable, where all the data in the sample have the same distribution (and thus no trend). This variance measures "random variation" in such a sample.

In the framework of the linear function (1), the regression's effectiveness is measured by the *SSR* term defined above. When it is small, the fitted curve will not differ very much from the horizontal line $y = \bar{y}$. *SSE* will be approximately equal to *SST*, and, from the data, both *SSE* and *SST* will be estimates of mere random variation. In this case, the data does not provide evidence that β is different from zero.

On the other hand, if the y values tend to vary linearly with respect to the independent variable, x, then some of the variation in the y values can be attributed to this dependence on x. Since *SSR* assesses the difference between the least squares predictions of the y values and the arithmetic mean, $\bar{y}$, it is a measure of the variation which is "explained" by the linear relationship. When the slope of the fitted line is large, more of these differences will tend to be large, resulting in a large value of *SSR*.

In the equation, $SST = SSE + SSR$, the total variation is partitioned into two parts, the variation due to random error and the variation due to the linear relationship. The fraction of the total variation that is due to the linear relationship is called the coefficient of determination, or r^2, and is defined by:

$$r^2 = \frac{SSR}{SST} \,. \tag{B-10}$$

r^2 is a fraction that varies from 0 to 1. It will be near 0 if most of the variation is due to randomness, and it will be near 1 if most of the variation is due to the linear relationship.

The closeness to 1 needed for the data to show that the slope is not zero depends on the number of data points. If the dependent data are independent, normally-distributed at each x, with constant variance, and no trend, then the quantity, F, defined by

$$F = \frac{(n-2)\,r^2}{1-r^2} \tag{B-11}$$

can be shown to have an F distribution with degrees of freedom 1 and $n - 2$, where n is the number of data points. When the data satisfy the assumptions except that there is a significant trend, r^2 will be closer to 1 and the computed F statistic will be much larger. Specifically, if the computed F exceeds the upper fifth percentile of the F distribution with 1 and $n - 2$ degrees of freedom, we infer that the data contain evidence that β is not zero, at the 5% level of significance. In this case, we reject the null hypothesis that $\beta = 0$ and conclude that a statistically significant trend exists, with 95% confidence.

As an example, for an assumed set of data fit to the linear model, assume the $r^2 = 0.9369$ and that n is 13. Then the calculated F is 163.3. The upper 95th percentile of the $F(1,11)$ distribution is 4.84. Since 163.3 far exceeds the upper 95th F percentile, the linear model is statistically significant. In this example, the data show that it would be very unlikely for a trend not to exist. The linear model explains too much of the variation in the data for a trend not to exist.

Applying the Model to the NMED Data

The method described above was applied for each category of NMED event data, for the overall NMED data, and for additional subgroups of data when trends were found in the overall data. When the calculated F exceeded the 95th percentile, the trend line was shown on the graph and identified as being statistically significant.

In future reports, methods slightly different than that explained above could be employed because the NMED data in many cases does not follow the assumptions listed above. In particular, three considerations apply.

- The data are counts, and thus are discrete rather than being normally distributed. This problem is most pronounced when the counts are relatively low or sparse. Also, normally-distributed data in general can be negative, but the counts are always greater than or equal to zero.
- Variations in counts tend to increase as the counts increase. If the events occur at random, with a constant occurrence rate in a particular year or quarter, then the variance of the count for that year or quarter is equal to the mean or average for that year or quarter. Thus, the assumption of a constant variance for the data in each year may not apply.
- Finally, more than one count can be associated with a single reported incident in a single event category. This situation would occur, for example, if several pieces of equipment fail in an event or if several types of overexposure occur. In these cases, the data are not independent.

One way to address the first two concerns is to identify the number of licensees in various NMED categories and study the event occurrence rates rather than the counts. The rates are more likely to come from a continuum, and might have a more constant variance.

Taking logarithms of the counts and then applying the LS method avoids the problem of possible negative trend lines. The resulting models can be converted back to the scale of the counts after the regression line is identified. In the scale of the counts, the resulting trend, if any, has a slight curvature.

Weighted regression is a method similar to the LS method described above, but it compensates explicitly for the effect of the different variances from year to year.

Another approach that deals with the first two concerns is to apply regression methods that have been designed specifically for counts. Poisson regression, for example, is based on the idea that the data in each time period are counts observed from a Poisson distribution, with an occurrence rate that is described by the model. Given occurrence rates in each time period, and independent counts, the probability of seeing the observed data is easily computed by multiplying the occurrence probabilities for the individual time periods. The slope and intercept parameter estimates are selected so that the model maximizes the resulting "likelihood function."

The third issue may have little effect on the results of a trend analysis, as long as there are many counts with relatively few occurring in clumps, no trends in the occurrence of clumps, and no large clumps of counts coming from a single occurrence report. The best way to address the dependence issue is to identify and remove the duplicate counts prior to the trend analysis.

Appendix C

IAEA Radionuclide Categorization

Appendix C
IAEA Radionuclide Categorization

Table C-1 lists the radionuclides that this report uses to determine the significance for events involving the loss, abandonment, or theft of radioactive sources. This list is derived from the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources (2004)* and from IAEA Safety Guide RS-G-1.9, *Categorization of Radioactive Sources*. Based on the amount of radioactivity involved, the radionuclides are grouped into five categories, with Category 1 being the most hazardous. These categories may be summarized as follows (derived from IAEA Safety Guide RS-G-1.9, *Categorization of Radioactive Sources*):

Category 1: **Extremely dangerous.** These sources could cause permanent injury within a few minutes if handled. Doses could be fatal to someone in close proximity to an unshielded source for periods ranging from a few minutes to an hour.

Category 2: **Very dangerous.** These sources could cause permanent injury within minutes to hours if handled. Doses could be fatal to someone in close proximity to an unshielded source for periods ranging from hours to days.

Category 3: **Dangerous.** These sources could cause permanent injury within hours if handled. Doses could possibly (but unlikely) be fatal to someone in close proximity to an unshielded source for periods ranging from days to weeks.

Category 4: **Unlikely to be dangerous.** These sources would not cause permanent injury, although delayed health effects are possible. Doses could possibly (but unlikely) cause temporary injury to someone in close proximity to an unshielded source for a period of many weeks.

Category 5: **Most unlikely to be dangerous.** These sources would not cause permanent injury.

Table C-1. IAEA Code of Conduct Category 1 through 5 Radionuclide Activity Thresholds

Radionuclide	Category 1		Category 2		Category 3		Category 4		Category 5	
	TBq	Ci [1]	TBq	Ci [1]	TBq	Ci [1]	TBq	Ci [1]	TBq	Ci [1]
Am-241	60	1,622	0.6	16.2	0.06	1.62	0.0006	0.0162	1.0e-08	2.7e-07
Am-241/Be	60	1,622	0.6	16.2	0.06	1.62	0.0006	0.0162	1.0e-08	2.7e-07
Cf-252	20	541	0.2	5.4	0.02	0.54	0.0002	0.0054	1.0e-08	2.7e-07
Cm-244	50	1,352	0.5	13.5	0.05	1.35	0.0005	0.0135	1.0e-08	2.7e-07
Co-60	30	811	0.3	8.1	0.03	0.81	0.0003	0.0081	1.0e-07	2.7e-06
Cs-137	100	2,703	1.0	27.0	0.10	2.70	0.001	0.0270	1.0e-08	2.7e-07
Gd-153	1,000	27,030	10.0	270.3	1.00	27.03	0.01	0.2703	1.0e-05	2.7e-04
Ir-192	80	2,162	0.8	21.6	0.08	2.16	0.0008	0.0216	1.0e-08	2.7e-07
Pm-147	40,000	1,081,200	400.0	10,812.0	40.00	1,081.20	0.4	10.8120	1.0e-05	2.7e-04
Pu-238	60	1,622	0.6	16.2	0.06	1.62	0.0006	0.0162	1.0e-08	2.7e-07
Pu-239/Be	60	1,622	0.6	16.2	0.06	1.62	0.0006	0.0162	1.0e-08	2.7e-07
Ra-226	40	1,081	0.4	10.8	0.04	1.08	0.0004	0.0108	1.0e-08	2.7e-07
Se-75	200	5,406	2.0	54.1	0.20	5.41	0.002	0.0541	1.0e-06	2.7e-05
Sr-90 (Y-90)	1,000	27,030	10.0	270.3	1.00	27.03	0.01	0.2703	1.0e-08	2.7e-07
Tm-170	20,000	540,600	200.0	5,406.0	20.00	540.60	0.2	5.4060	1.0e-06	2.7e-05
Yb-169	300	8,109	3.0	81.1	0.30	8.11	0.003	0.0811	1.0e-05	2.7e-04

Notes

1. The primary values are given in TeraBequerel (TBq). Curie (Ci) values are provided for practical usefulness only and are rounded after conversion.

Appendix D

Revision of Data

Appendix D
Revision of Data

The NMED is a dynamic database with new reports and revisions to previous reports being added on a continuing basis. This activity can result in additions or subtractions to data that was published in previous issues of this report. Numerical changes in NMED numbers can result from several different types of technical changes to coded data. The most common types of changes to database records are:

- Record additions due to late reporting
- Record additions or subtractions due to changes in event type
- Changes between fiscal years due to event date changes on individual events
- Record additions or subtractions due to changes in event reportability
- Record additions or subtractions due to reclassifying a single combined event as multiple individual events (or vice versa)
- Record deletions due to duplicated records or NRC direction

Figures D-1 through D-10 below display the changes in the data published in the previous quarterly report. A positive value indicates that records were added and a negative value indicates that records were removed.

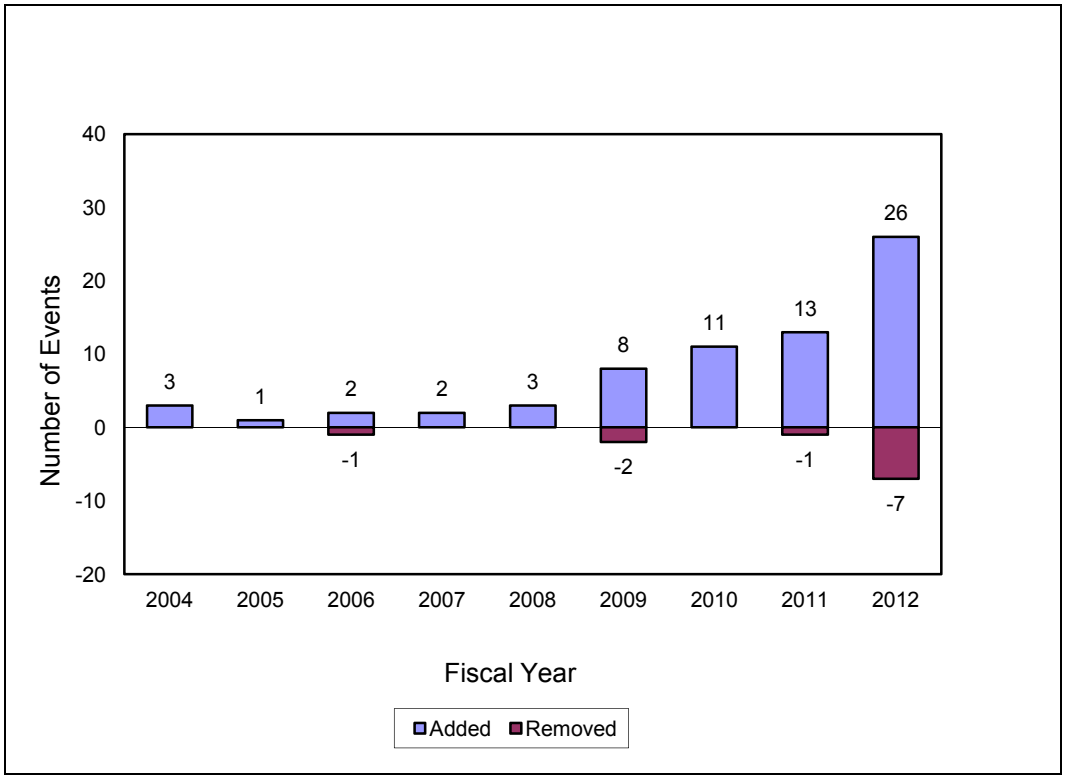

Figure D-1. Changes to All NMED Event Data

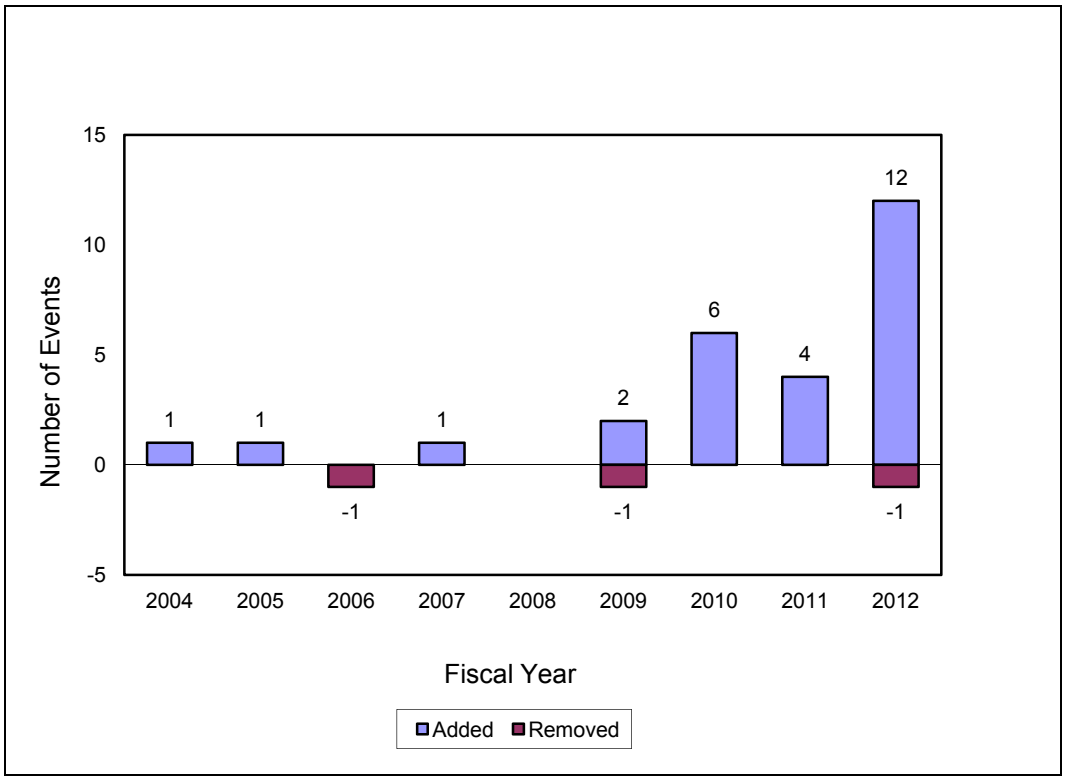

Figure D-2. Changes to LAS Data

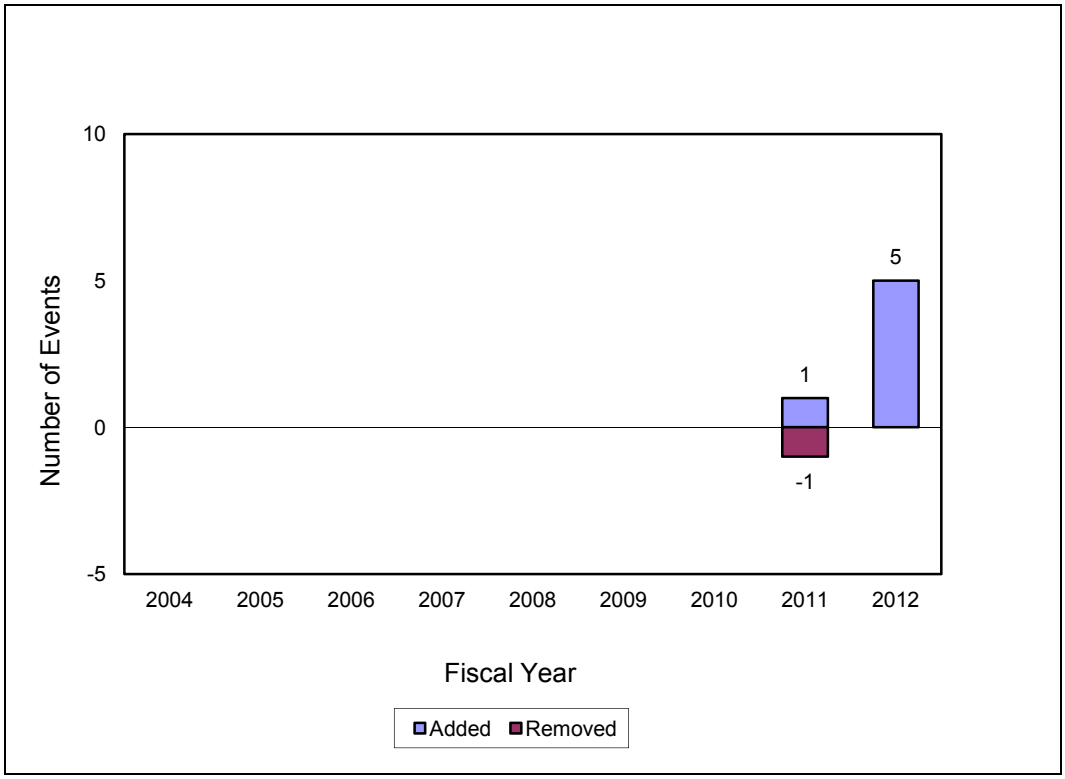

Figure D-3. Changes to MED Data

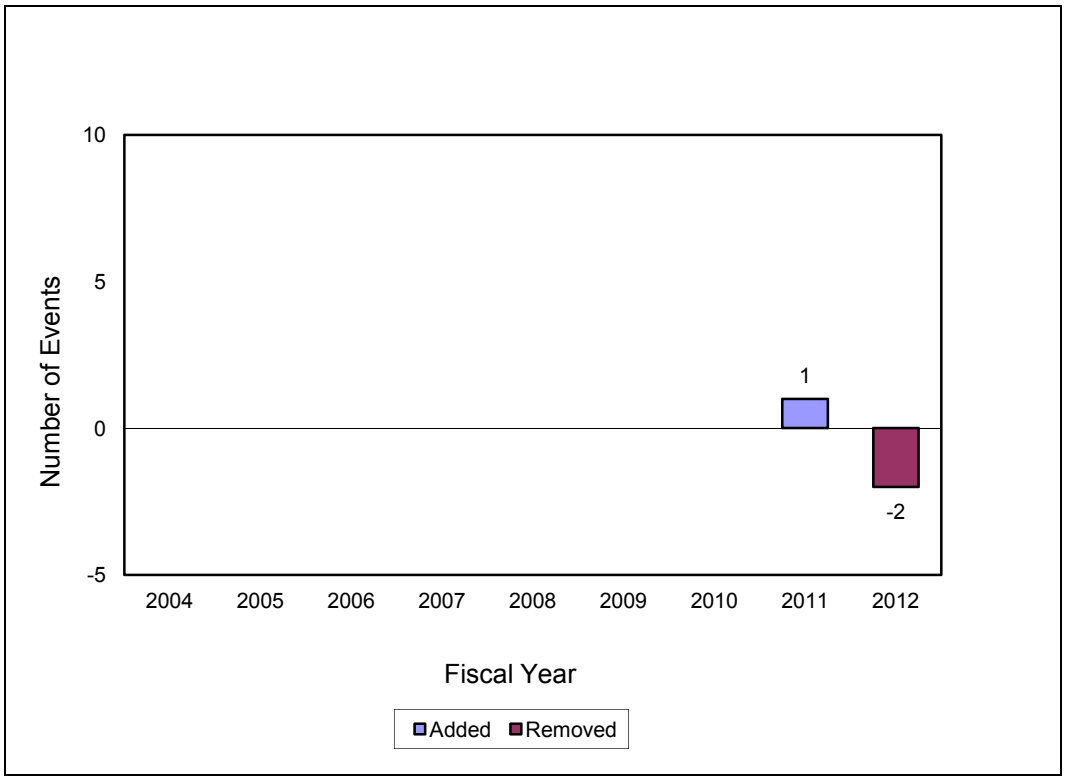

Figure D-4. Changes to EXP Data

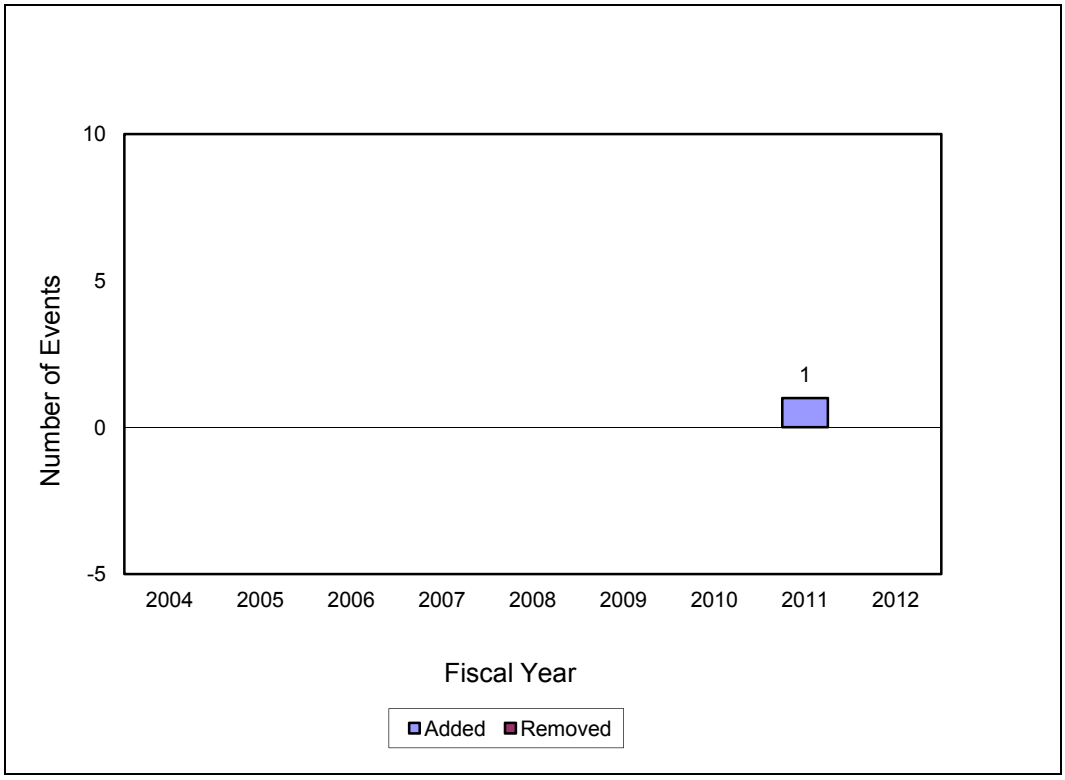

Figure D-5. Changes to RLM Data

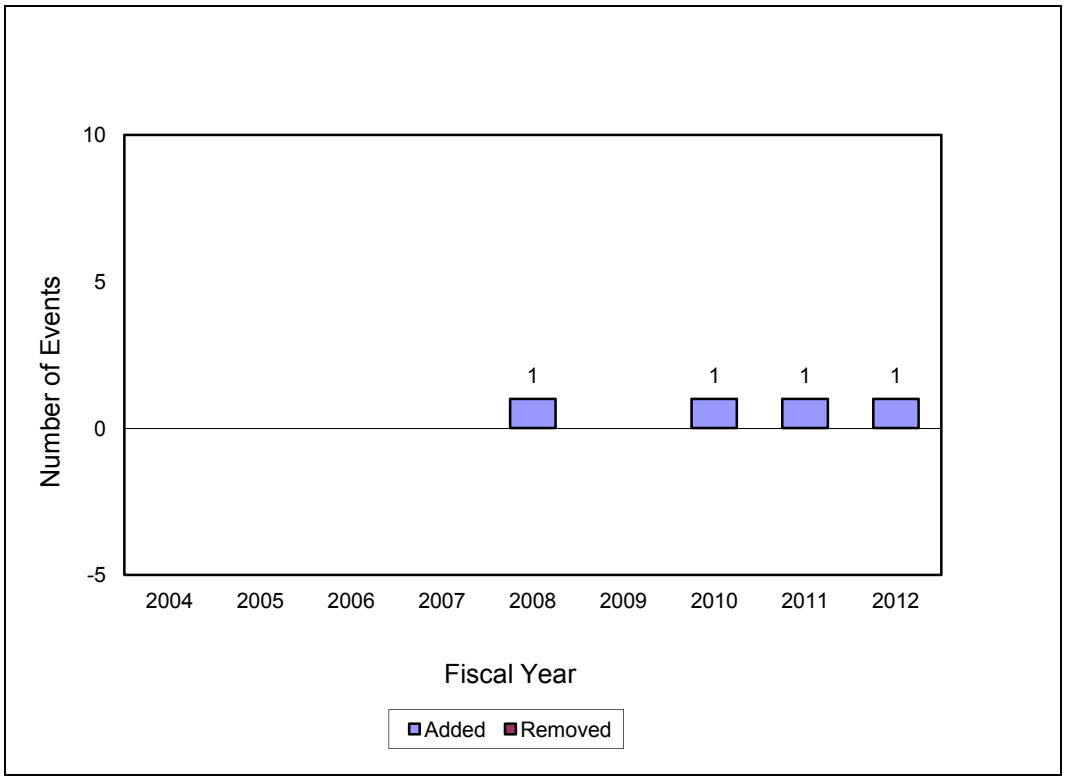

Figure D-6. Changes to LKS Data

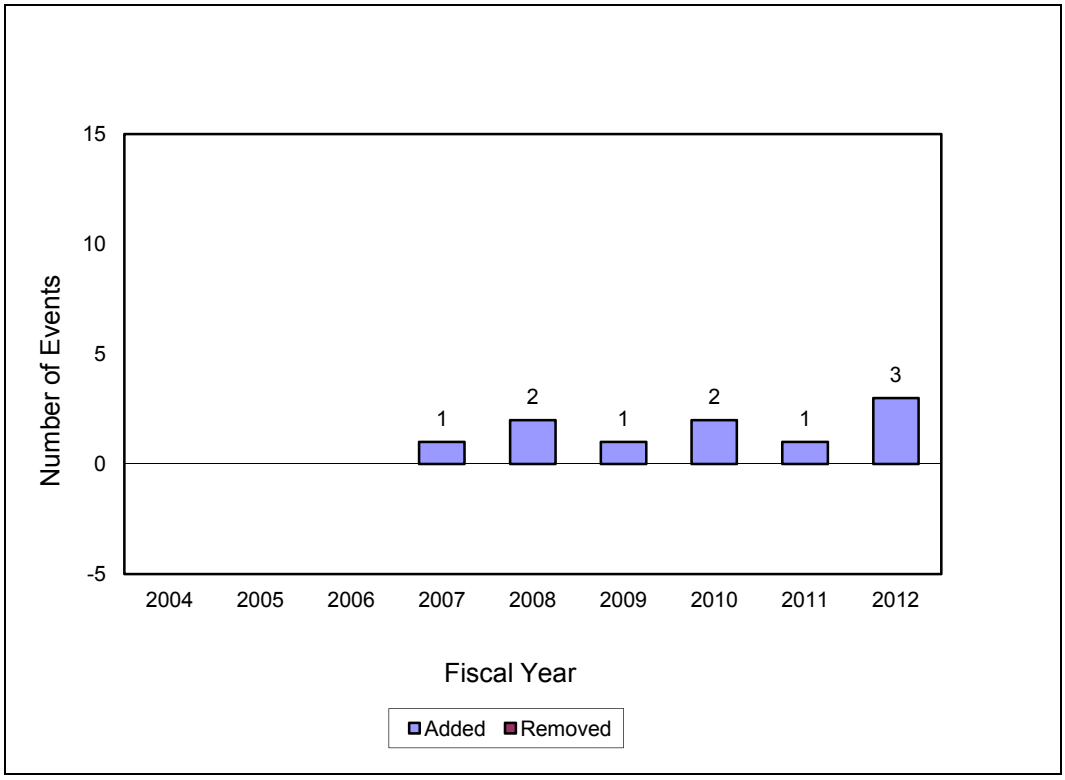

Figure D-7. Changes to EQP Data

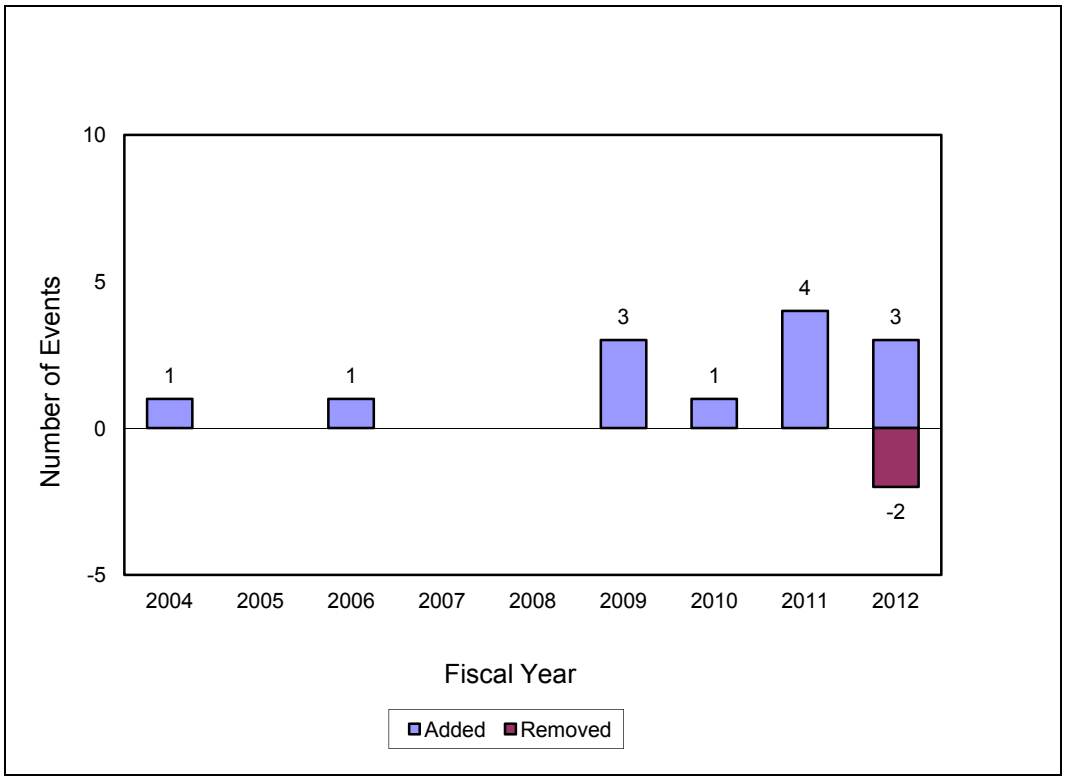

Figure D-8. Changes to TRS Data

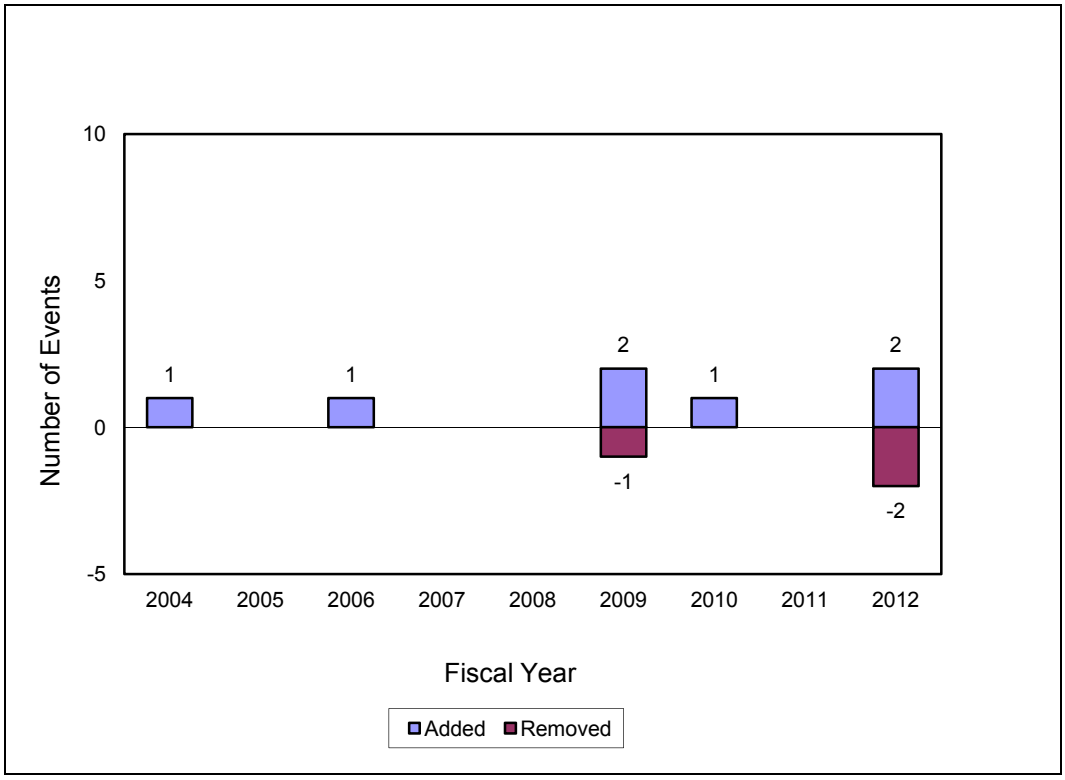

Figure D-9. Changes to FCP Data

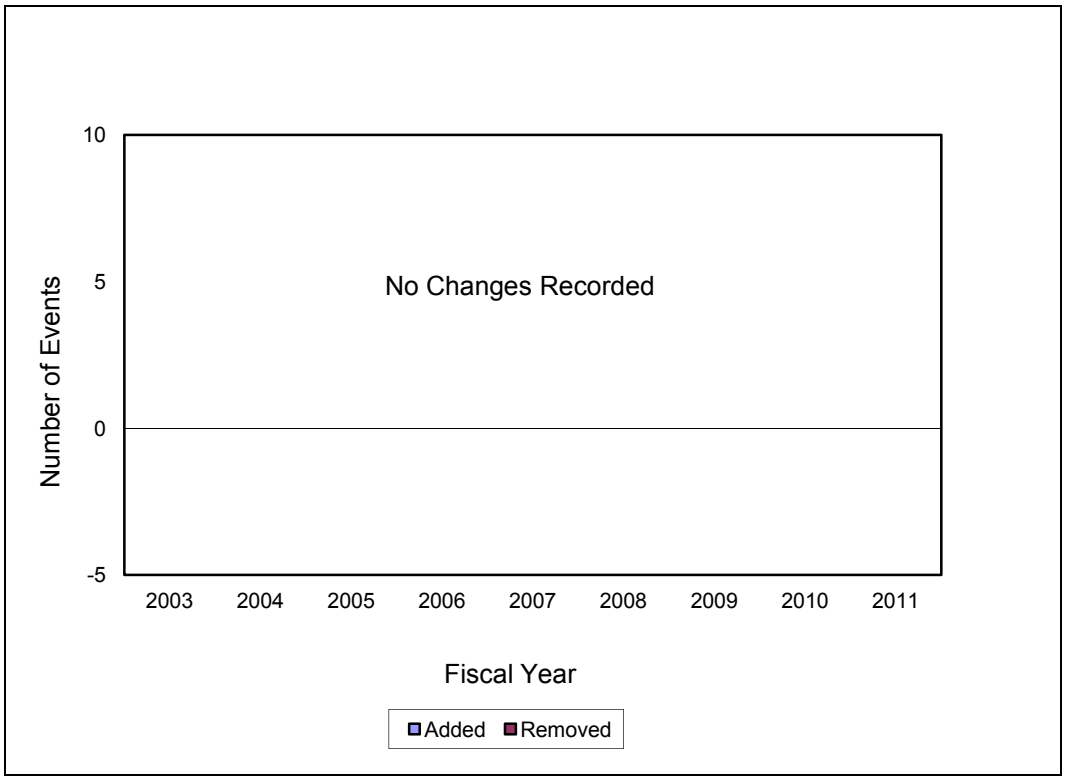

Figure D-10. Changes to OTH Data

Enclosure 2

Radiography Event Special Study Breakdown

Figure 1 displays the annual number of occurrences of radiography events during the 10-year period FY 2004 to FY 2013. A trend analysis determined that the total number of occurrences for both NRC and Agreement State licensees represents a statistically significant, increasing trend (indicated by the trend line). Note that four States became Agreement States during the 10-year period. This causes the difference between the NRC-regulated and Agreement State-regulated events to widen. Because of this influence, trending was only performed on the total number of occurrences.

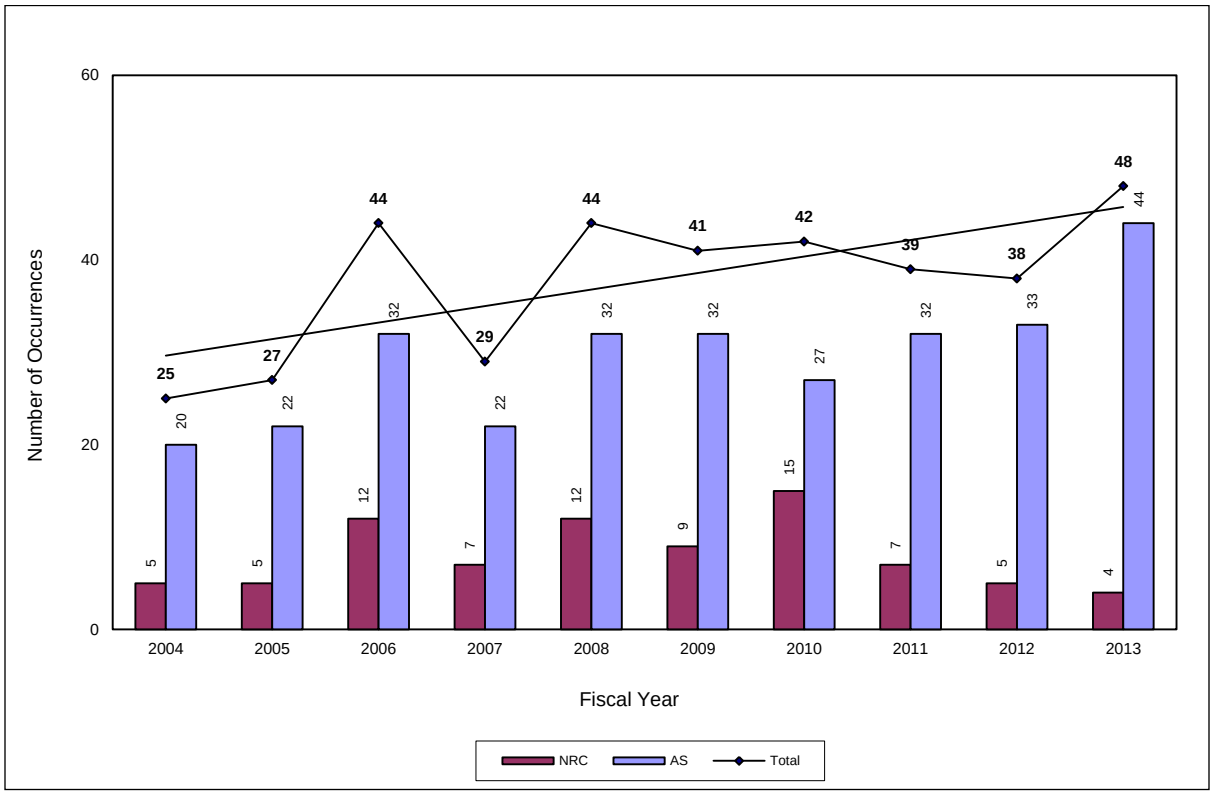

Figure 1. Radiography event occurrences for the 10-year period FY 2004 through FY 2013 (377 total, 296 Agreement State-regulated, 81 NRC-regulated)

Figure 2 displays the same data as Figure 1, but excluding FY 2004 and FY 2005. The total number of occurrences does not represent a statistically significant, increasing trend for the remaining 8-year period. Note that the FY 2013 total data is just a few occurrences higher than the preceding years.

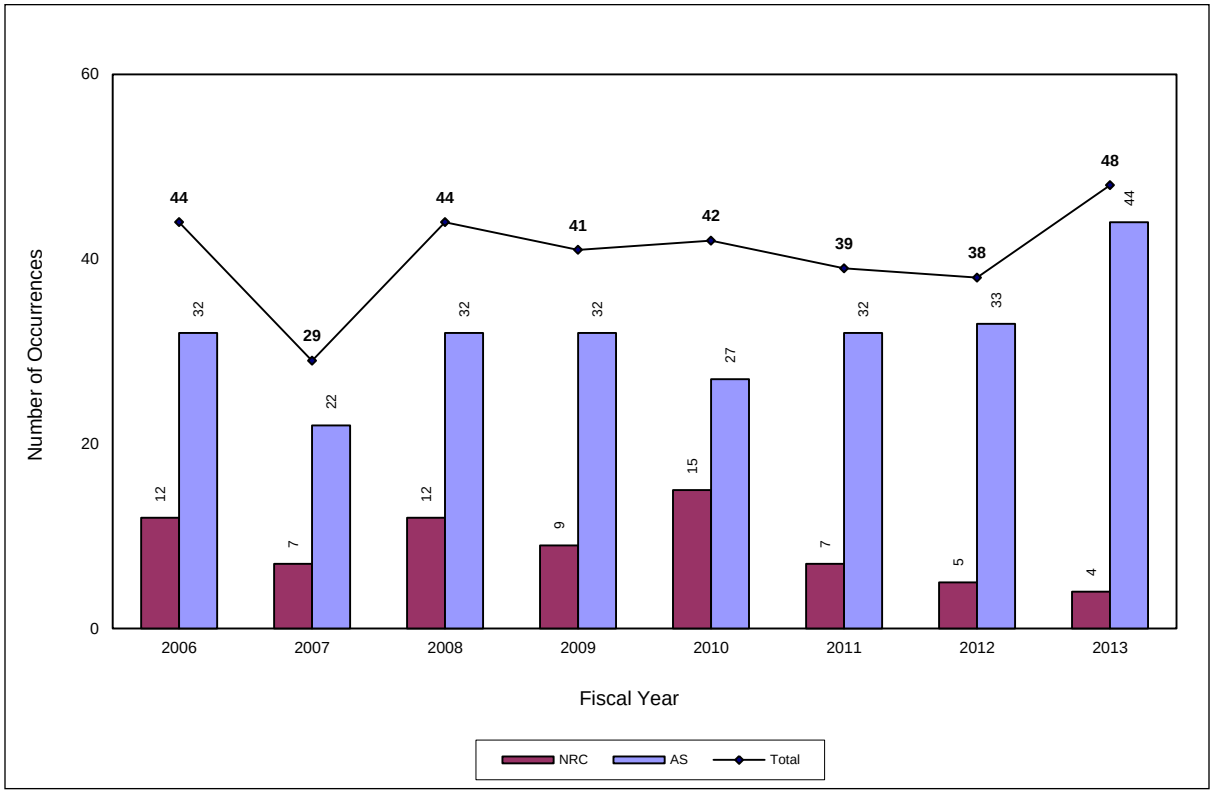

Figure 2. Radiography event occurrences for the 8-year period FY 2006 through FY 2013 (325 total, 254 Agreement State-regulated, 71 NRC-regulated)

Figure 3 displays the same data as Figure 1, adding FY 2002 and 2003. Similar to the 8-year data displayed in Figure 2, the total number of occurrences does not represent a statistically significant, increasing trend for the 12-year period.

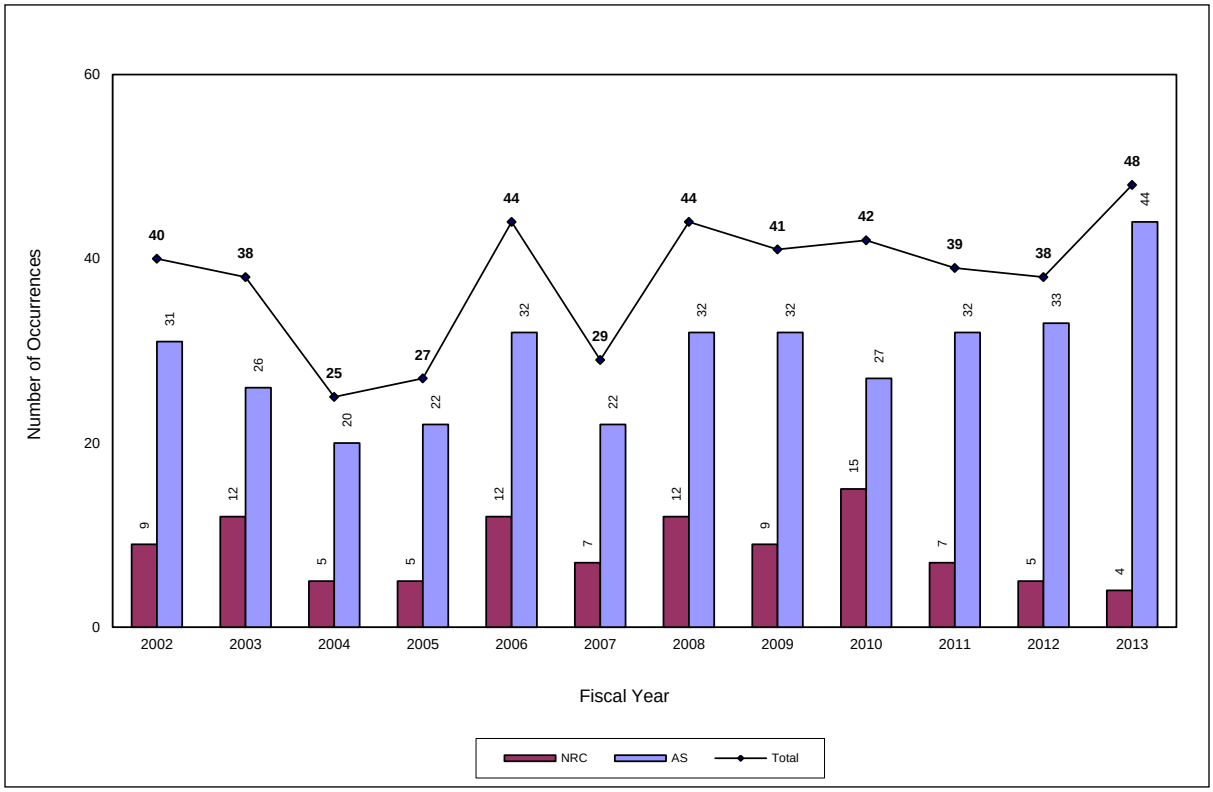

Figure 3. Radiography event occurrences for the 12-Year period FY 2002 through FY 2013 (455 total, 353 Agreement State-regulated, 102 NRC-regulated)

Figure 4 displays the number of events by type for the 10-year period FY 2004 through FY 2013. The black line represents the total number of events; the green line represents events involving equipment-related malfunctions; the red line represents radiation overexposure events; the blue line represents lost, stolen, or abandoned materials events; and the purple line represents all other types of events. The number of equipment-related events increased over the 10-year period, while the numbers of other types of events remained relatively constant.

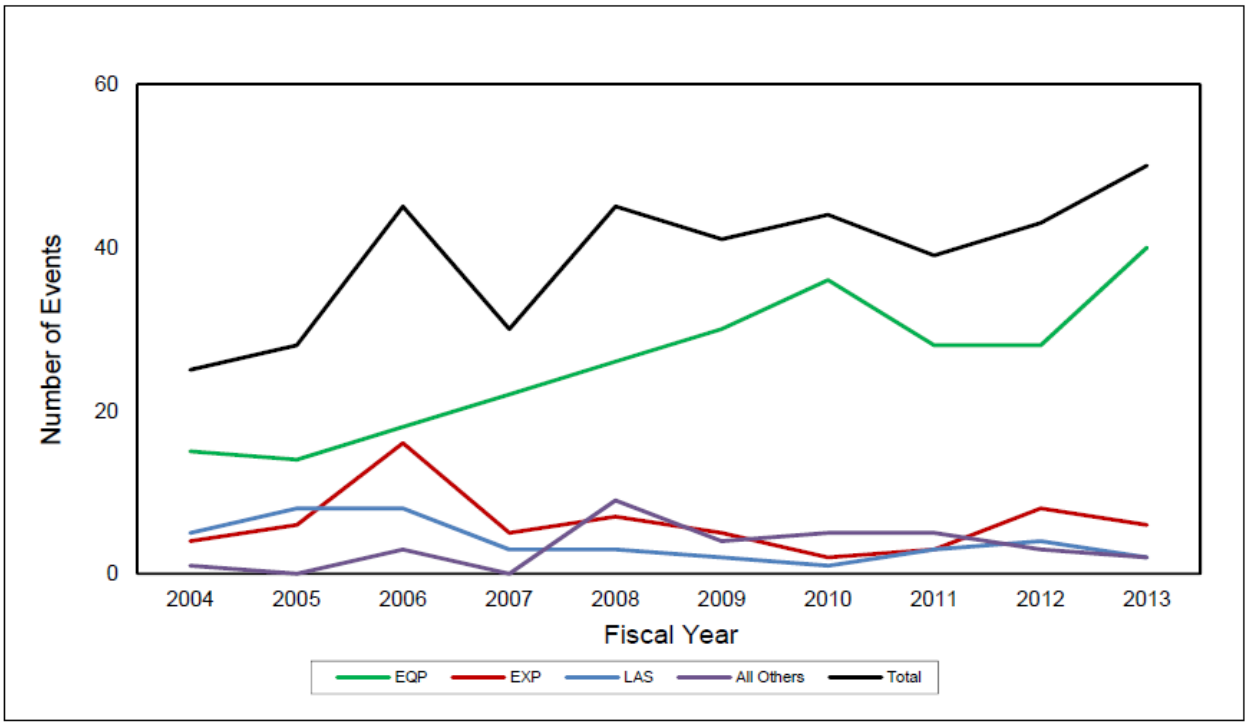

Figure 4. Radiography events by type of event for the 10-year period FY 2004 through FY 2013