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Nuclear Material Events Database (NMED) Quarterly Report

Fourth Quarter Fiscal Year 2006

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ABSTRACT

This quarterly 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 (NMED). The reported events are classified into categories based on event reporting requirements defined in Title 10 of the Code of Federal Regulations. The event categories are: (1) Medical, (2) Radiation Overexposure, (3) Release of Licensed Material or Contamination, (4) Lost/Abandoned/Stolen Material, (5) Leaking Sealed Source, (6) Equipment, (7) Transportation, (8) Fuel Cycle Facility, and (9) Other. The scope of the NMED quarterly report is limited to a discussion and evaluation of the reportable events in categories (1) through (7) and (9). The Fuel Cycle Facility event category is excluded from this report due to the significant difference in operation of these facilities compared to the operation of other facilities licensed by NRC and Agreement States to use by-product, source, and special nuclear material. Events involving abandoned well-logging sources are also excluded from this report. Event data are presented for a 16-quarter period covering October 1, 2002, through September 30, 2006. Data on events tracked by the NRC as performance measures are presented on page *ix*.

Copies of this report are available on the NMED website at https://nmed.inl.gov.

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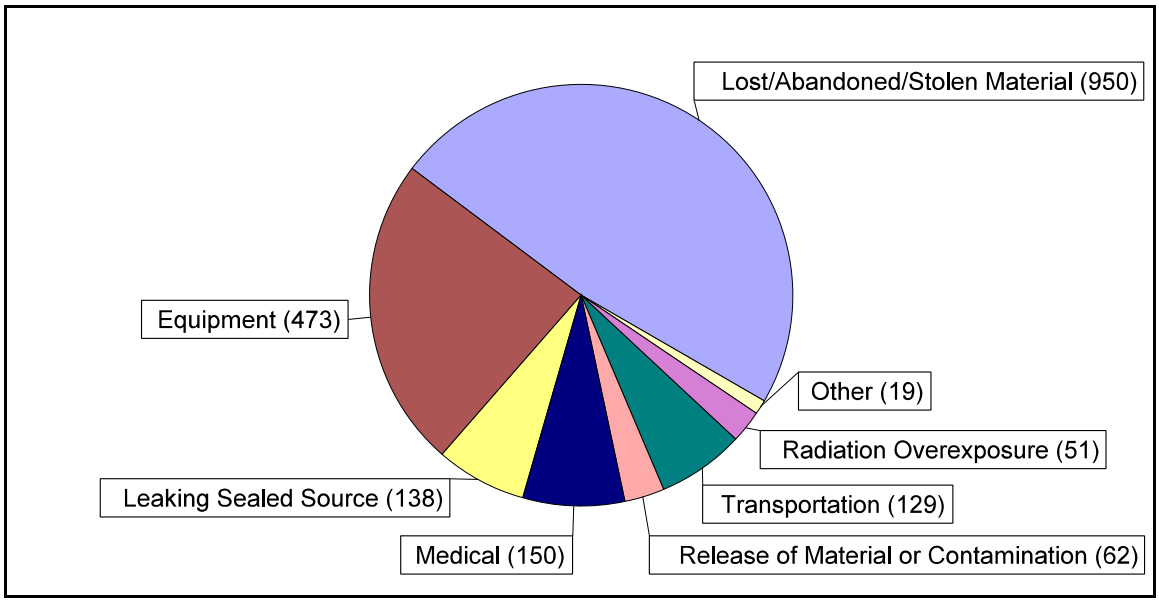
EXECUTIVE SUMMARY

The Nuclear Regulatory Commission's Nuclear Material Events Database 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 event reporting requirements defined by Title 10 of the Code of Federal Regulations. The event reports are evaluated to identify safety-significant events or concerns and their causes. The reported information aids understanding of why the events occurred and in identifying any actions necessary to improve the effectiveness of the nuclear material regulatory program.



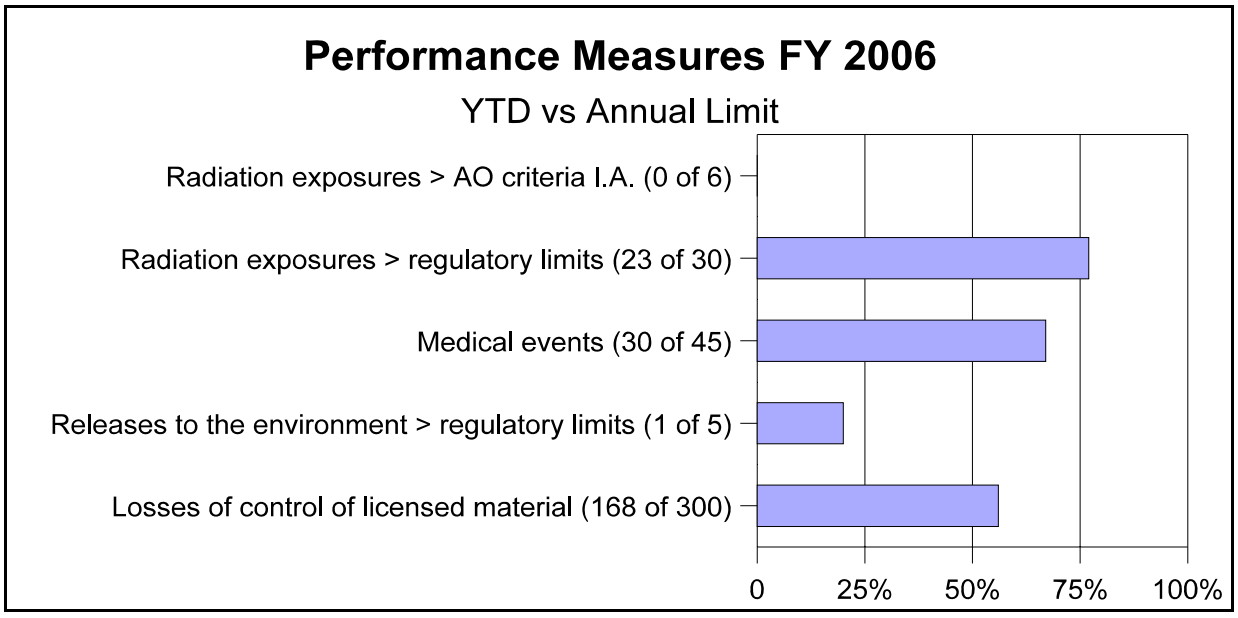
One thousand nine hundred seventy-two events occurred during the 16-quarter period (October 1, 2002, through September 30, 2006). One hundred twelve of these events occurred during the current quarter. Forty-eight percent of the 16-quarter events were classified as lost/abandoned/stolen material events.

During the 16-quarter period, the event reporting rate was about 2.5 events per 100 licensees annually for all events, and about 0.5 events per 100 licensees annually for medical events. This was based on an estimate of 21,991 material licensees (4,387 NRC licensees and 17,604 Agreement State licensees) that averaged 493 events per year. Of the 21,991 material licensees, about 9,028 were medical licensees that averaged about 38 medical events per year. This indicates that, annually, only 2.5% of all licensees report any type of incident/accident involving licensed material. For incidents involving medical events, less than 1% of medical licensees report an event annually.

PERFORMANCE AND STRATEGIC MEASURES

Certain NMED reportable events are tracked by the NRC as performance measures. Those events involve:

1. Radiation exposures from licensed material that exceed the Abnormal Occurrence Criteria I.A. (as published in NUREG 0090, *Report to Congress on Abnormal Occurrences*),
2. Radiation exposures from licensed material that exceed applicable regulatory limits,
3. Medical events,
4. Releases to the environment of licensed material from operating facilities that exceed regulatory limits, and
5. Losses of control of licensed material.



Another measure of interest is the strategic measure of :

Zero unrecovered losses or thefts of risk-significant radioactive sources.

For Fiscal Year 2006, there are currently no events reported that have been determined to meet or potentially meet this measure.

The data for these measures reflects events certified as meeting or potentially meeting the measures, and therefore may be more or less current than the data presented in the body of this report.

Nuclear Material Events Database (NMED) Quarterly Report: Fourth Quarter Fiscal Year 2006

1. INTRODUCTION

1.1 Overview and Objectives

Nuclear material event reports are evaluated to identify statistically significant trends, safety-significant events, event causes, reporting categories, and event types. 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 17,000 records of material events submitted to the NRC from approximately January 1990 through November 2006.

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

1. Medical (MED),
2. Radiation Overexposure (EXP),
3. Release of Licensed Material or Contamination (RLM),
4. Lost/Abandoned/Stolen Material (LAS),
5. Leaking Sealed Source (LKS),
6. Equipment (EQP),
7. Transportation (TRS),
8. Fuel Cycle Facility (FCP), and
9. Other (OTH).

The scope of the NMED quarterly report is limited to a discussion and evaluation of reportable events in categories 1 through 7 and 9. The Fuel Cycle Facility event category is excluded from this report due to the significant difference in operation of these facilities compared to the operation of other facilities licensed by NRC and Agreement States to use by-product, source, and special nuclear material. Events involving abandoned well-logging sources are also excluded from this report. A description of categories addressed in this report and associated screening criteria is presented in Appendix A.

1.2 NMED Data

A single occurrence report may be captured in several NMED event categories. 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). Within this report, the term “event” is used to describe an individual event category; multiple “events” can result from a single occurrence report.

Data presented in this report were downloaded from the NMED on December 1, 2006. Because the NMED is a dynamic database that is updated daily, variations in quarterly data may be encountered over time. Furthermore, even though many events were reported and entered in the database for record keeping purposes, only those events required to be reported by 10 CFR are addressed in this report.

This report displays short-term data for each of the event categories by quarter for a 16-quarter 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 16-quarter display indicates the direction and approximate rate of change with a sloped line. If no statistically significant trend exists, the 16-quarter display indicates the statistical mean (arithmetic average) of the data for the period with a horizontal line. For comparison purposes, long-term annual trend data are also presented to contrast with the short-term results. For the purposes of this report, a statistically significance 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.

In summary, this report focuses on reportable events that occurred between October 1, 2002, and September 30, 2006, that were entered into NMED prior to the data download on December 1, 2006. This report includes a depiction of selected NMED 16-quarter trend data and a breakdown of event causes, reporting categories, and event type data. Performance measures data are presented on page *ix*.

Reporting guidance for Agreement States is presented in the *Handbook on Nuclear Material Event Reporting in the Agreement States*. The handbook is an appendix to the NRC Office of State and Tribal Programs Procedure SA-300, *Reporting Material Events.* Access to NMED is available to the NRC and Agreement State staff at https://nmed.inl.gov.

For assistance on searches or other questions, contact Michele Burgess (mlb5@nrc.gov), (301) 415-5868.

2. ANALYSIS OF NMED DATA

Event reports involving nuclear material submitted to the NRC are reviewed, categorized, and entered into the NMED. Sixteen-quarter (short-term) and annual (long-term) trend charts were developed to show general data trends. For this report, 16-quarter event data through Fiscal Quarter 06-4 were evaluated and compared with annual data starting with Fiscal Year 1997.

Some event reports did not contain sufficient information to determine the event causes. Such events were categorized as "Insufficient Information" with respect to the event causes.

2.1 All NMED Events

Figure 1 displays the annual number and trend of the 5260 NMED events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

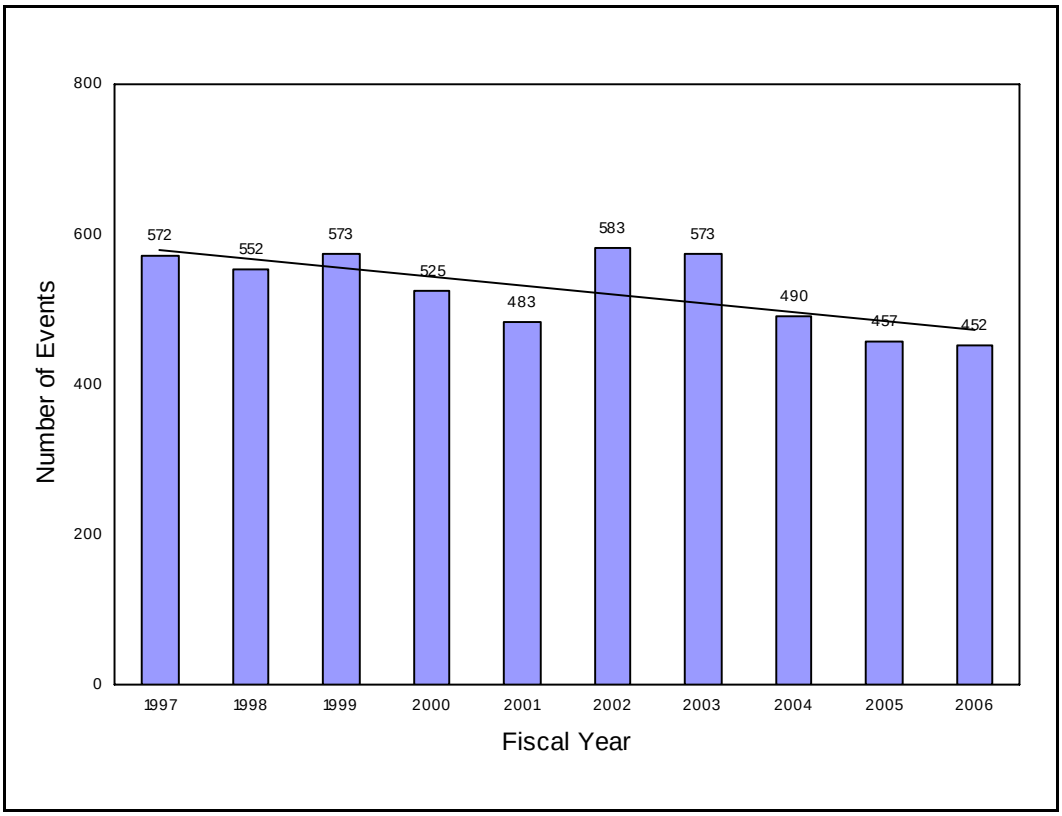


Figure 1. Long-Term Trend of All NMED Events (5260 total)

Figure 2 displays the quarterly number and trend of the 1972 NMED events that occurred during the 16-quarter period. Utilizing a smaller time period for each data point, which results in a smaller data population size, typically has the effect of increasing the proportional (to the average) degree of random fluctuation between the data points. Over the 16-quarter period, the total number of reportable NMED events has shown a noticeable decrease in the later quarters. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

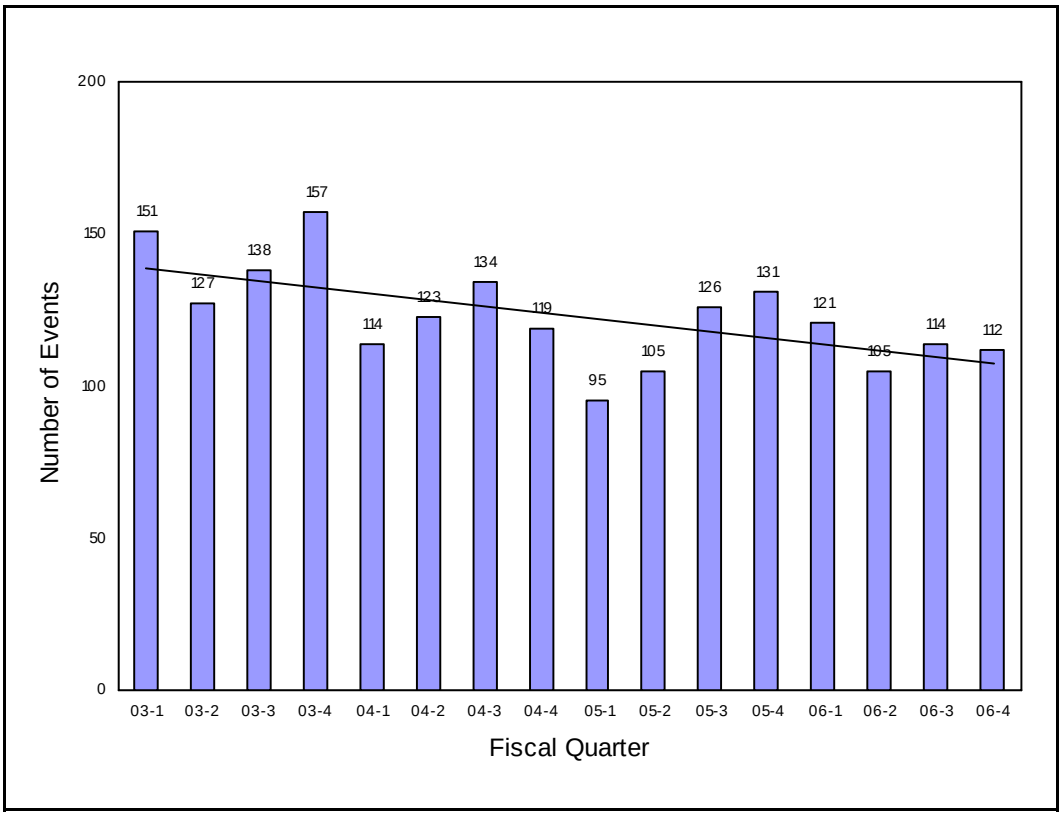


Figure 2. Short-Term Trend of All NMED Events (1972 total)

The following observations are made regarding the short-term decreasing trend.

1. The most recent four quarter's data are typically 15-20 records less than their final value when subsequent updates and late reports are received (see Appendix C and Figure C-1). This effect exaggerates the slope of the decreasing trend, but even with the addition of these events, the decreasing trend would remain statistically significant.

2. The NRC's Sensitive Information Screening Process (SISP) reduced the number of public documents available in ADAMS for input into NMED since Fiscal Quarter 05-1, but did not necessarily reduce the number of NMED event records.

3. The revised 10 CFR 35 became effective October 2002. This revision relaxed previous reporting requirements and may have resulted in a decreased number of reportable medical events. A review of Figures 3 and 4 in section 2.2, *Medical* shows a reduction in the number of events in 2005 and 2006. Note that Agreement State agencies had until April 2005 to adopt compatible regulations.

4. The short-term decreasing trend in NMED events cannot be attributed solely to a decreasing trend in a single event category. Rather, it resulted from a compilation of event categories, with two event categories being the primary contributors. During this report's short-term trend period, LKS and EQP events experienced statistically significant, decreasing trends while no event categories experienced statistically significant, increasing trends.

2.2 Medical

Figure 3 displays the annual number and trend of the 371 Medical (MED) events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data do not represent a statistically significant trend in the number of events. Therefore, variations within the annual values represent random fluctuation around the average of the data (indicated by the horizontal line).

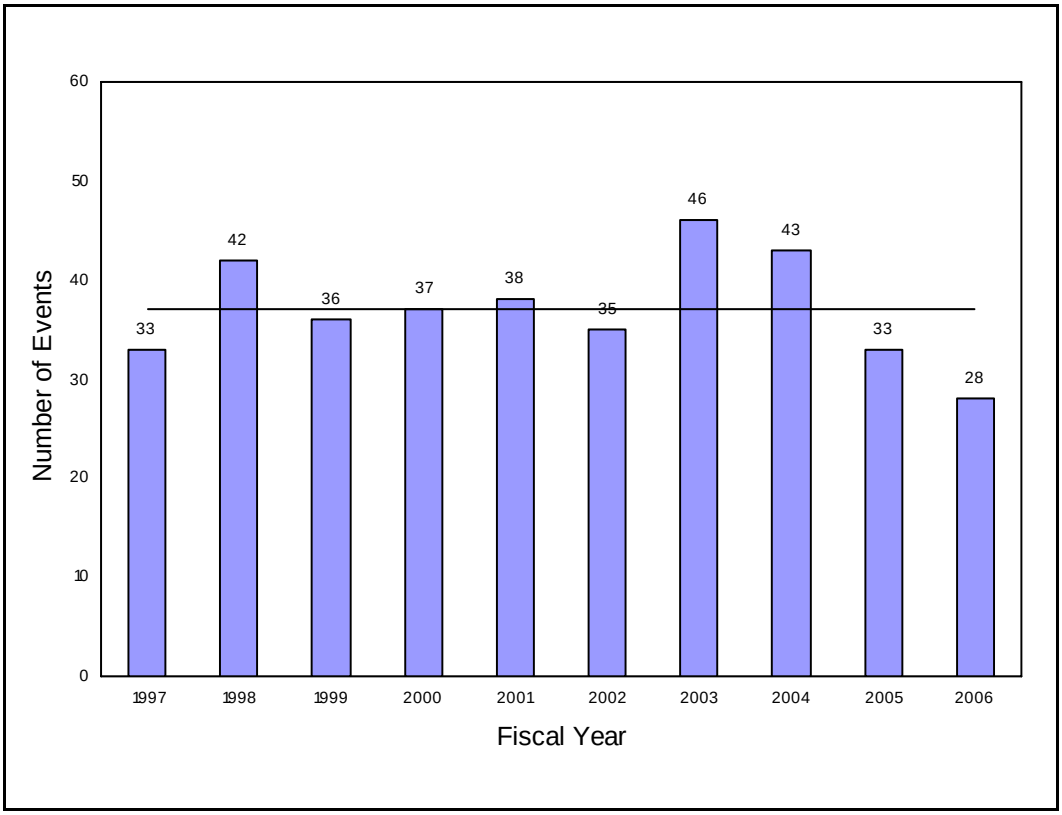


Figure 3. Long-Term Trend of Medical Events (371 total)

Figure 4 displays the quarterly number and trend of 150 MED events that occurred during the 16-quarter period. Utilizing a shorter time period for each data point results in an increased degree of random fluctuation proportional to the average. This increased fluctuation reduces the likelihood of the data representing a trend. The trend analysis determined that the data do not represent a statistically significant trend in the number of events. Therefore, variations within the quarterly values represent random fluctuation around the average of the data (indicated by the horizontal line).

The 150 MED events involved 166 procedures performed on 162 patients. Events 040229 and 050591 involved single patients that received three separate brachytherapy procedures each. Figures 5 through 7 display the distributions of event causes, types of problems (based on reporting requirements), and types of medical procedures involved. It should be noted that although each individual event has only one cause (Figure 5), the event may involve more than one type of problem or procedure (Figures 6 and 7).

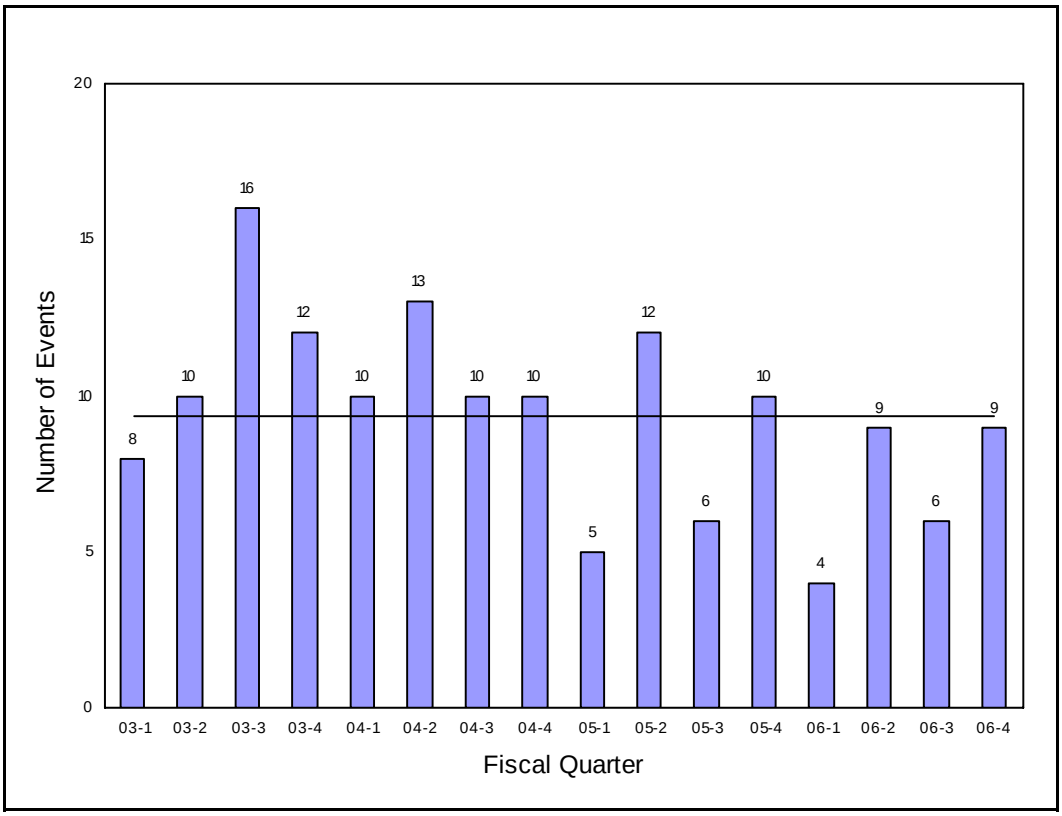


Figure 4. Short-Term Trend of Medical Events (150 total)

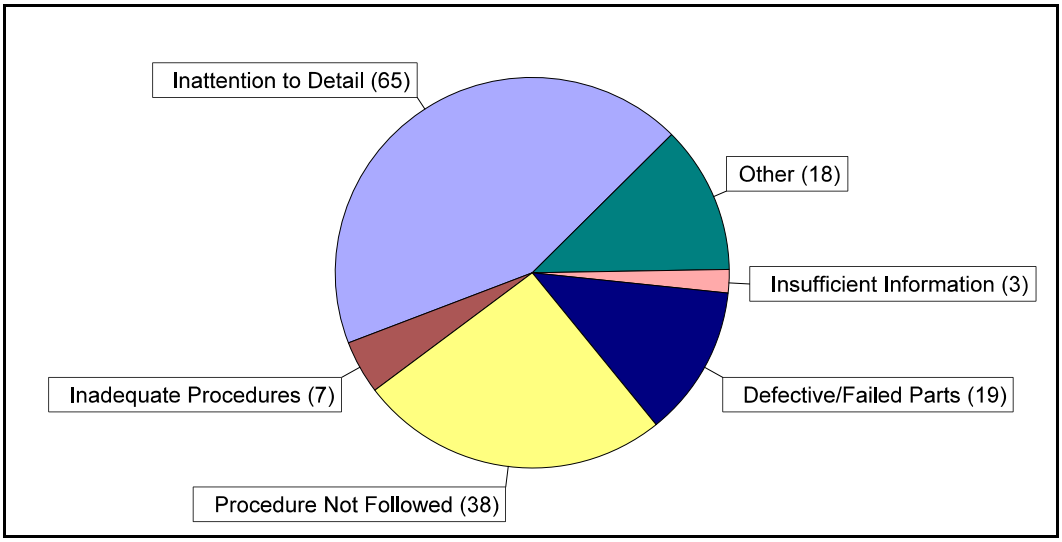


Figure 5. Medical Event Causes (16 quarters)

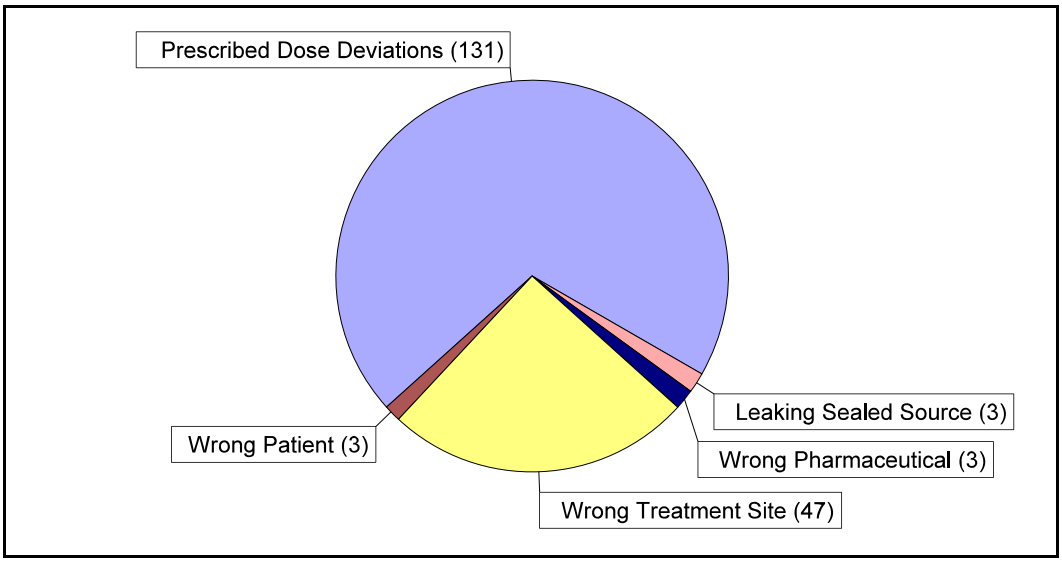


Figure 6. Medical Event Problems (based on reporting requirements - 16 quarters)

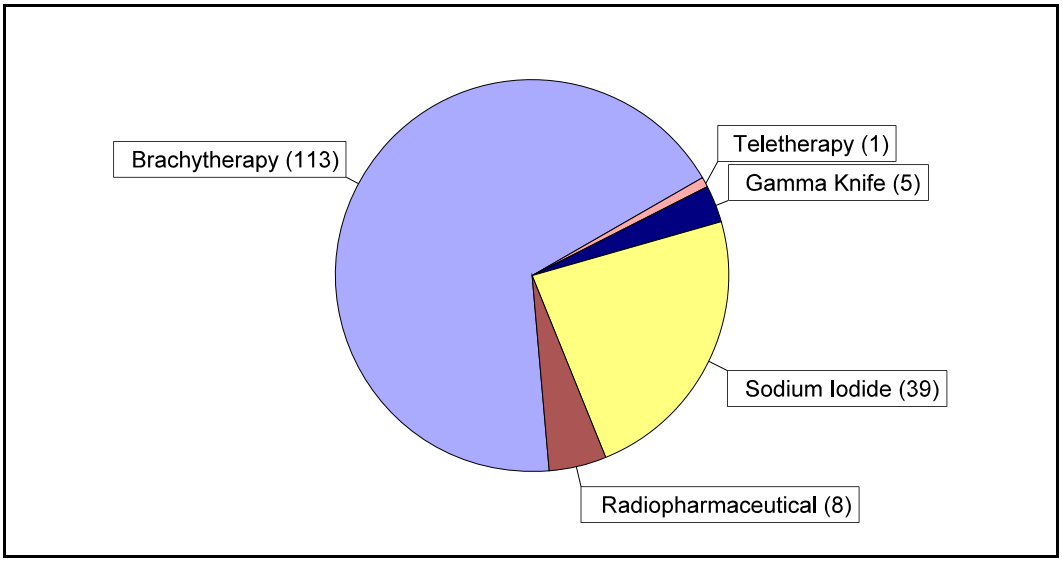


Figure 7. Medical Procedures Performed (16 quarters)

Nine MED events occurred in Fiscal Quarter 06-4, one of which was classified as a potential Abnormal Occurrence (AO). The events are summarized below.

Event 060480 was classified as a potential AO. This event involved a patient that was prescribed 0.19 MBq (5 uCi) of I-131, but administered 74 MBq (2 mCi), 39,900% greater than prescribed. A thyroid uptake diagnostic study was ordered by an endocrinologist at the facility. However, instead of 0.19 MBq (5 uCi), the doctor ordered 74 MBq (2 mCi). The nuclear technologist did not question the request and administered the dose to the patient. When the authorized user came in to do the imaging the next day, he noted the error. The licensee estimated that the patient received a whole body dose of 1.89 cSv (rem) and a dose to the thyroid of 4,140 cSv (rem), based on 59.2% uptake. Using the same assumptions, the intended dose of 0.19 MBq (5 uCi) would have given the patient a thyroid dose of 10.4 cSv (rem). The RSO reported that a physician had determined that the patient was suffering from Graves Disease. As a result, the doctor prescribed an additional 629 to 740 MBq (17 to 20 mCi) of I-131 for treatment in the near future. The Illinois Emergency Management Agency performed an onsite investigation to determine

how the event occurred and to review the licensee's corrective actions. The cause of the incident was determined to be the lack of a written directive and miscommunication between the physician and nuclear medicine technologist. Corrective actions included instituting additional procedures, implementing improved personnel supervision, and providing additional training to personnel.

Event 060461 involved a patient that was administered a dose using a Varian high dose rate brachytherapy afterloader (model VariSource 200) and an Ir-192 source to treat a lung tumor. During the administration, the catheter was about 10 cm short of the planned location for the dose. An unintended dose of less than 100 cGy (rad) was administered to the patient's vocal chord area. The patient was prescribed to receive 500 cGy (rad) to the lung tumor. A licensee physician examined the patient and determined that there was no erythema. The licensee reported that a human error, not a device error, resulted in the medial event.

Event 060469 involved five patients (over a three-month period) that did not receive any of their prescribed doses during high dose rate brachytherapy (Nucleotron Microselectron Clasic) vaginal treatments using an Ir-192 source with an activity of 296 GBq (8 Ci). The delivery tube was 18.5 cm too long, resulting in the source being outside of the patients. The treatments should have delivered 500 cGy (500 rad) per fraction. A typical patient gets 3-5 fractions. Skin doses to the patients were determined to be between 500 and 9600 cGy (rad). The medical physicist discovered the mistakes after observing a treatment. Two different types of applicators are used; one has a longer tube than the other. The tubes were mixed up, which resulted in the incidents. The licensee determined which patients were affected by using the films recorded for each treatment. Corrective actions taken by the licensee included taking the longer transfer tube out of the clinic, providing staff with training on proper service tubes and applicators, implementing applicable procedures, and having photographs on line for proper patient setup.

Event 060475 involved seeds implanted into a patient's prostate that contained 27% more activity than intended. The licensee stated that the seed implant plans are specified in air kerma units on their computer planning system. However, seeds are ordered in units of mCi. When the seeds for this patient were ordered, the activity was not converted to mCi. The patient was prescribed to receive 111 I-125 seeds, each with an activity of 14.58 MBq (0.394 mCi). The patient was implanted with seeds that had an activity of approximately 18.5 MBq (0.5 mCi), each. Corrective actions taken by the licensee included observing compliance to newly established procedures through periodic inspections.

Event 060515 involved a patient that received a dose to the wrong site during the third of three fractional doses using a Nucletron HDR afterloader (model MicroSelectron Classic) and Ir-192 source. The first two fractions were delivered properly. When the third fraction was delivered, the medical physicist inadvertently selected the wrong delivery tube. There were two delivery tubes available depending upon the treatment plan. The longer tube was incorrectly selected for this fraction causing the source to remain outside the patient for the entire fraction. The preliminary estimate of the highest dose in this configuration was approximately 100 to 125 cGy (rad) to the perineum, which was not the intended treatment site, and which would have received less than 50 cGy (rad) with the intended configuration. The patient was returned for an additional treatment. Corrective actions taken by the licensee included using several program cards for repeat patients so that each treatment need not be recalculated during each visit, the physicist and physician will re-verify all treatment information after the physicist prints out the treatment plan programmed on the card (the physician will sign or initial the printout before the treatment is started), and the physicians and physicists will be trained on that procedural change.

Event 060551 involved two patients that received only 10% of their prescribed doses during mammosite treatments of ten fractions using a Varian remote brachytherapy afterloader HDR unit (model VARISOURCE, serial #VS60037) and an Ir-192 source (Alpha-Omega Services, model VS2000, serial #02-01-0699-001-062106-10250-03) containing an activity of 377.4 GBq (10.2 Ci). The two patients were prescribed to receive 340 cGy (rad) per fraction for a total dose of 3,400 cGy (rad), but instead

received 34 cGy (rad) per fraction for a total dose of 340 cGy (rad). It was determined that the treatment planning software, named Eclipse, had a known issue with regard to fractionated doses. A Varian bulletin had been generated in March 2003 and alerted customers to the appropriate method for data entry for fractionated doses. However, the licensee did not acquire their equipment until August 2005 and, although their treatment planning software had been updated to a newer version, the same issue remained. According to the authorized user and medical physicist, there was no training provided on the aspect of use of the software when they had attended the manufacturer's training. Corrective actions taken by the licensee included modifying procedures to require a second method to confirm appropriate treatment time that is independent from the treatment planning software and providing additional training to personnel.

Event 060603 involved a patient that was prescribed 2.74 GBq (74 mCi) of Sm-153 Quadramet for palliative treatment of metastatic bone pain, but received 5.48 GBq (148 mCi), 100% more than prescribed. The licensee ordered the Sm-153 dosage from Bristol Myers Squibb Medical Imaging and Cytogen Corporation (BMS). The dose was ordered per vendor dosage recommendation for a patient weight of 164 pounds. At the time of order, BMS verbally instructed the licensee that two vials would be required to meet the dosage needed. Two vials were received by the licensee. The Oncology nurse drew up and completely emptied both Quadramet vials into a 10 ml syringe. The Radiation Oncologist and Oncology nurse noted only 5 ml in the syringe. That was contradictory to the vials labeled as containing 3 ml each. The Oncology team proceeded with the administration although they were not comfortable with the syringe contents. Following the administration, the physician contacted BMS to discuss the dosage. A member of the BMS staff stated that each vial contained 2.44 GBq (66 mCi) at the time of administration. Calculations based on the activity reported on the vial labels indicated that each vial contained an activity of 2.74 GBq (74 mCi) at the time of administration. Corrective actions included discontinued use of the radioisotope distributor and procedure modification to assure dosage for future administration.

Event 060604 involved a patient that was prescribed 0.93 GBq (25 mCi) of I-131, but administered 0.196 GBq (5.3 mCi), 79% less than prescribed. A technician measured the activity of a vial containing two I-131 therapy capsules in the dose calibrator. The dose was administered by emptying the contents of the vial into the patient's hand. Only one I-131 capsule came out of the vial instead of two. The vial was placed back into the shipping container and returned to the pharmacy. Four days later, the pharmacy notified the licensee that they had returned a capsule with an activity of 0.766 GBq (20.7 mCi). The licensee contacted the patient to make arrangements to administer the rest of the prescribed dose. Licensee corrective actions include instituting changes to their procedures requiring the vial be visually inspected and checked in the dose calibrator following patient administration.

Event 060605 involved a patient that was prescribed 3.7 GBq (100 mCi) of I-131, but administered 1.32 GBq (35.6 mCi), 64% less than prescribed. A technician measured the activity of a vial containing two I-131 therapy capsules in the dose calibrator. The dose was administered by emptying the contents of the vial into the patient's hand. Only one I-131 capsule came out of the vial instead of two. The vial was placed back into the shipping container and returned to the pharmacy. Approximately 3 weeks later, the pharmacy notified the licensee that they had returned a capsule with an activity of 2.6 GBq (70.4 mCi). The licensee contacted the patient to make arrangements to administer the rest of the prescribed dose. Licensee corrective actions include instituting changes to their procedures requiring the vial be visually inspected and checked in the dose calibrator following patient administration.

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". However, it is appropriate to also discuss these events in this section. None of these events occurred in Fiscal Quarter 06-4.

2.3 Radiation Overexposure

Figure 8 displays the annual number and trend of the 171 Radiation Overexposure (EXP) events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data do not represent a statistically significant trend in the number of events. Therefore, variations within the annual values represent random fluctuation around the average of the data (indicated by the horizontal line).

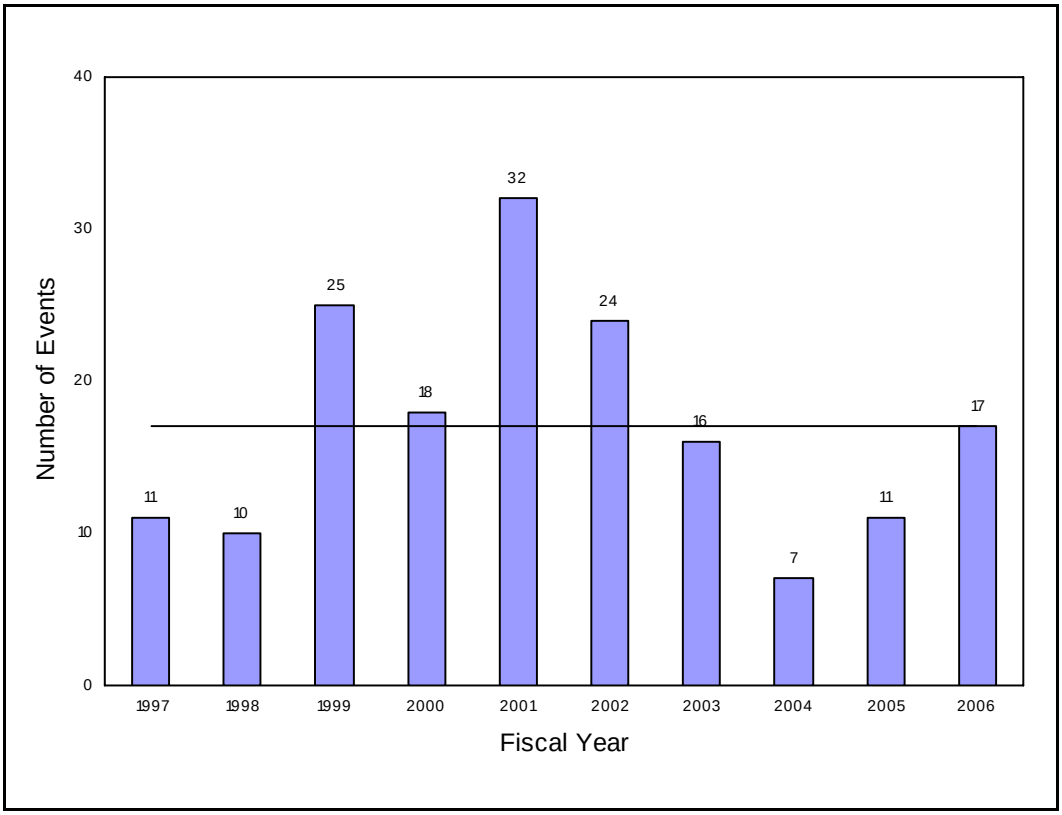


Figure 8. Long-Term Trend of Radiation Overexposure Events (171 total)

Figure 9 displays the quarterly number and trend of the 51 EXP events that occurred during the 16-quarter period. As can be seen, the number of EXP events per quarter can fluctuate substantially. This fluctuation is influenced by the nature of annual exposure limits, which may result in a data spike in the first fiscal quarters. Specifically, individuals typically exceed annual occupational exposure limits in the last quarter of the calendar year (first quarter of the next fiscal year). The presence of this known data influence results in a cyclical fluctuation in the data. Because of this known cyclic, non-random pattern in the data, the quarterly data display of Figure 9 does not lend itself to standard trend analysis techniques. Special methodology would be required to account statistically for the non-random pattern. If standard trending analysis used in the other sections of this report were applied to Figure 9, a statistically significant decreasing trend would not be indicated because of the high degree of random fluctuation in the data.

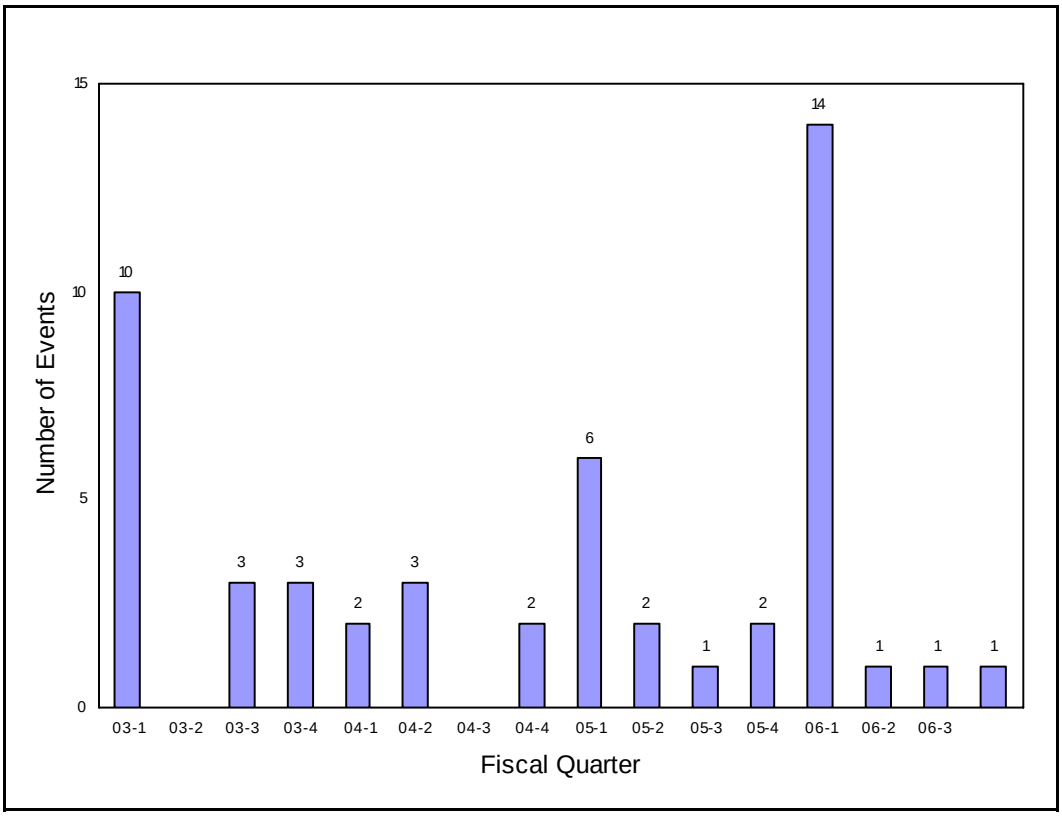


Figure 9. Short-Term Trend of Radiation Overexposure Events (51 total)

The 51 EXP events involved 106 overexposure doses to 102 people. Two events involved extremity and whole body doses to a single individual (030565 and 040517), and one event involved extremity, organ, and whole body doses to a single individual (030726). Figures 10 and 11 display the causes and work activities associated with the 51 EXP events. The pharmaceutical category displayed in Figure 11 refers to overexposure doses to people other than medical patients; events involving patients overexposed during medical procedures are captured as MED events. Figure 12 displays a distribution of the 115 doses by type (occupational or public) and range.

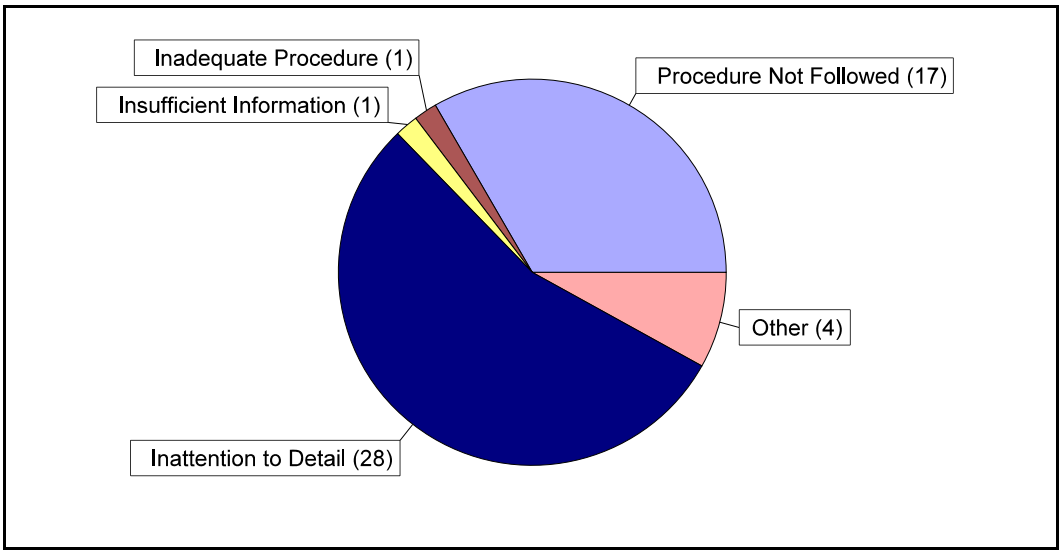


Figure 10. Radiation Overexposure Event Causes (16 quarters)

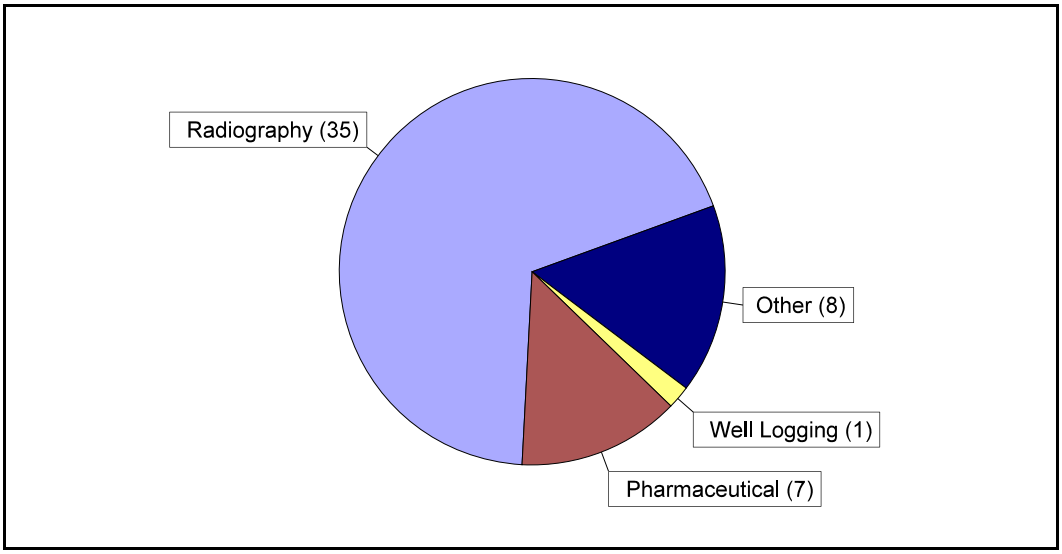


Figure 11. Radiation Overexposure Event Work Activities (16 quarters)

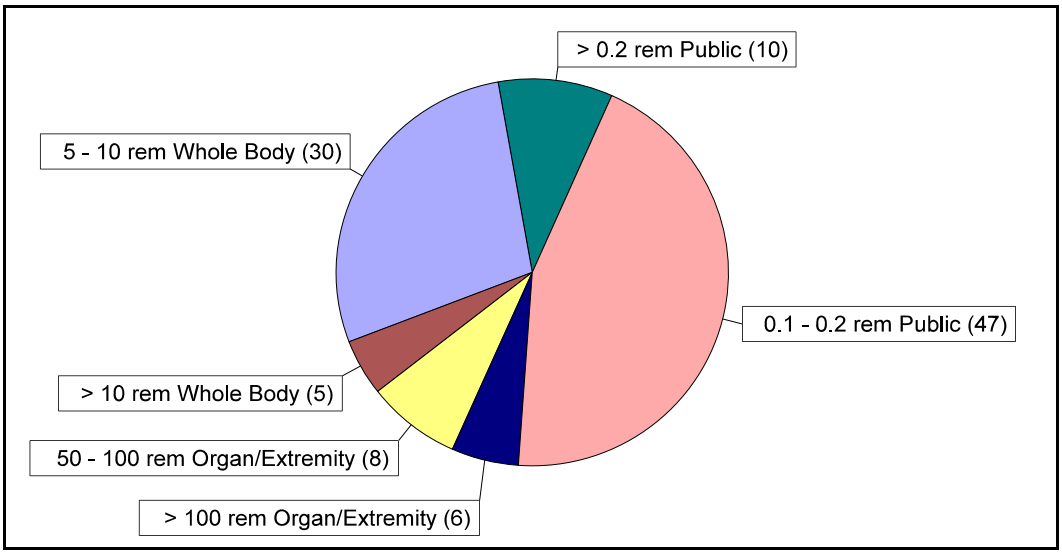


Figure 12. Radiation Overexposure Dose Types (Occupational or Public) and Ranges (16 quarters)

Figure 12 shows that 57 overexposure doses were received by members of the public during the 16-quarter period. A single event accounted for 42 of these doses (030565).

Event 030565 resulted in overexposure doses to 42 members of the public. This event involved a loss of control of a 37 GBq (1 Ci) Cs-137 source that came out of a damaged level gauge. Employee A picked up the broken gauge pieces, which included the Cs-137 source, and placed them on employee B's desk. The source remained on the desk for approximately 2 weeks. During this time, employee B occupied the desk for approximately 50 to 60 hours and received a whole body dose of approximately 40 cSv (rem). Employee A received an extremity dose of approximately 1,800 cSv (rem) to the hand. Re-enactments were performed to estimate the exposures to 100 individuals employed at the plant. The two highest exposures were estimated to be 74 and 18 cSv (rem). Altogether, 42 non-radiation workers exceeded the 0.1 cSv (rem) exposure limit for members of the public. This event was also classified as an LAS and EQP event. The NRC classified this event as an AO.

One EXP event (060629) occurred in Fiscal Quarter 06-4. This event involved an overexposure to a radiographer using a SPEC exposure device (model 150, serial #C-0224) and Ir-192 source (model G-60, serial #NG1708) with an activity of 2.85 TBq (77 Ci). The radiographer returned the source to the exposure device following an exposure. He noted that the survey meter, sitting approximately 20 feet in front of the exposure device, was returning to zero. He disconnected the guide tube from the exposure device and relocated it to a new location. Upon returning to pick up the exposure device, he noticed that the source was hanging out of the device. He cranked the source back into the device. The radiographer was near the exposed source for approximately 15 minutes. The radiographer's supervisor instructed him to cease work and return his film badge, alarming dosimeter, and dosimeter to the office. The film badge was over-nighted to the licensee's badge processor. The badge read 16.543 cSv (rem) DDE, increasing the radiographer's annual exposure to 19.538 cSv (rem) DDE. A Texas Department of Health Services inspector visited the licensee. It was determined that the radiographer failed to follow procedures (did not ensure the source was locked in the exposure device and failed to perform a 360-degree survey around the device. The licensee held a safety meeting for all radiographers to discuss proper performance of radiological surveys when conducting operations.

2.4 Release of Licensed Material or Contamination

Figure 13 displays the annual number and trend of the 197 Release of Licensed Material or Contamination (RLM) events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

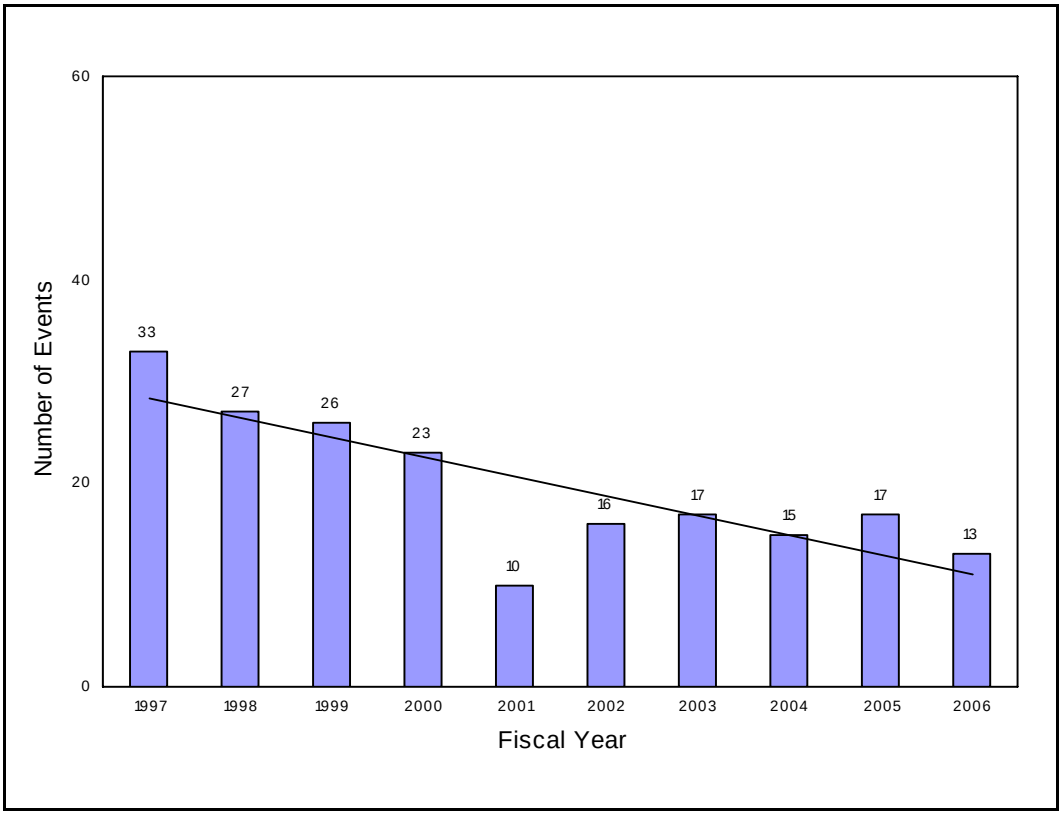


Figure 13. Long-Term Trend of Release of Licensed Material or Contamination Events (197 total)

A review of the types of contamination involved over the 10-year period indicates that a decrease in surface contamination events accounted for the majority of the overall decrease in RLM events. The other types of contamination involved in RLM events (air, water, and personnel) did not contribute notably to the decrease shown in Figure 13. This is understandable as 79% of RLM events between Fiscal Years 1997 and 2006 involved surface contamination. The other three contamination types (water, air, and personnel) were collectively involved in only 39% of the RLM events during the same period (an RLM event can involve more than one release type).

Figure 14 displays the quarterly number and trend of the 62 RLM events that occurred during the 16-quarter period. The trend analysis determined that the data do not represent a statistically significant trend in the number of events. Therefore, any changes in RLM numbers over the 16-quarter period represent random fluctuation around the average of the data (shown by the horizontal line).

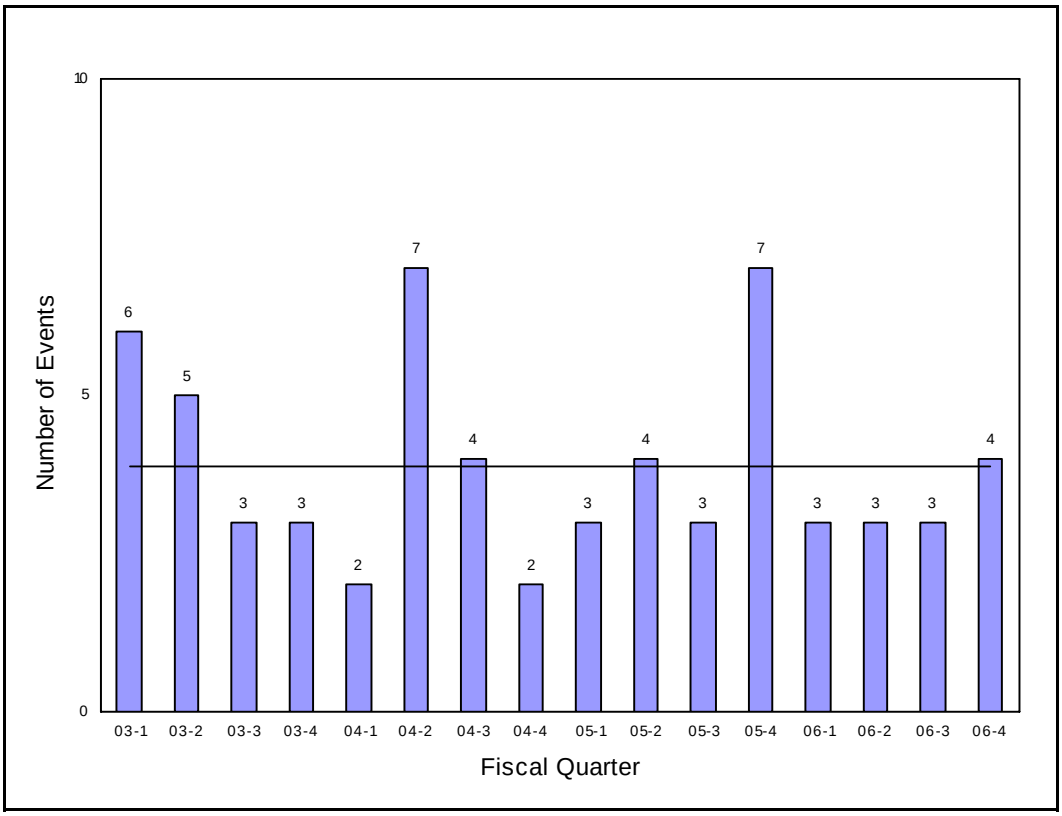


Figure 14. Short-Term Trend of Release of Licensed Material or Contamination Events (62 total)

Figures 15 and 16 display the distributions of event causes and release/contamination media for the 62 RLM events. It should be noted that although each individual event has only one cause (Figure 15), the event may involve more than one type of release/contamination media (Figure 16).

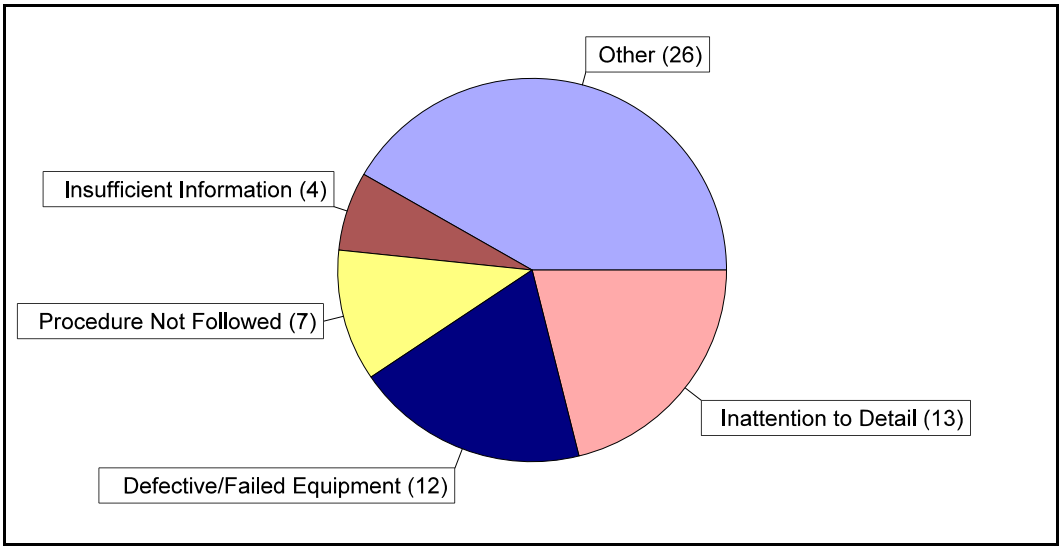


Figure 15. Release of Licensed Material or Contamination Event Causes (16 quarters)

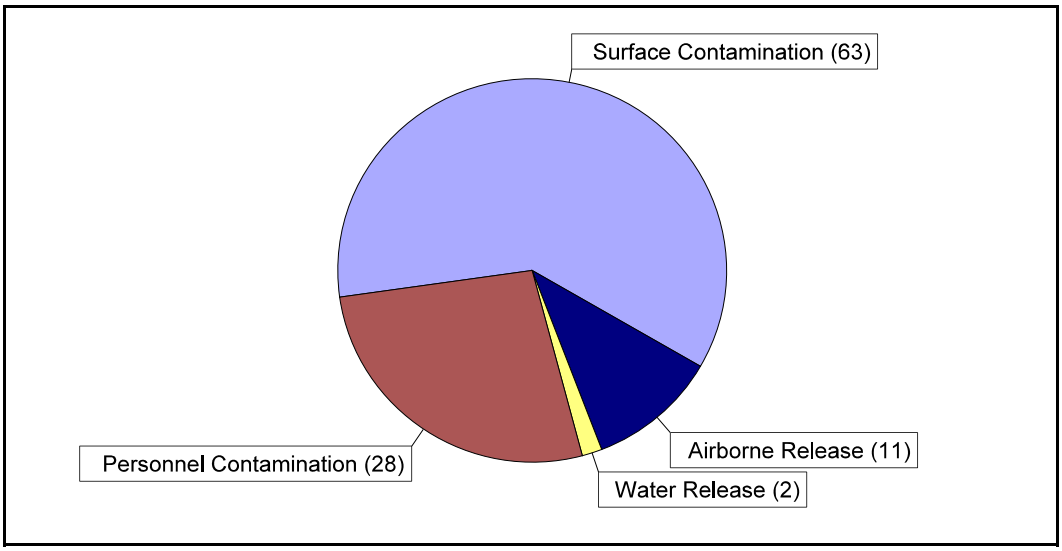


Figure 16. Release and Contamination Media (16 quarters)

Four RLM events occurred in Fiscal Quarter 06-4, none of which were classified as potential AOs. These events are summarized below.

Event 060436 involved Am-241 contamination in Room 215 of Magill Hall. The contamination involved several spots, approximately 7.6 to 15.2 cm in circumference ranging up to a maximum of approximately 5,000 cpm alpha fixed and no removable contamination. There was some removable contamination after wetting the areas. The room was posted as a contaminated area with access controls in place. A cabinet was taken from Room 215 by two movers and loaded onto a truck. A radiation survey identified radioactive contamination on the truck lift gate and bed. The contamination was not uniform; there were approximately 10 to 15 spots total - on the floor, cabinet, and truck, all at less than or equal to 100 cm2. Estimated maximum activity of any single spot was 0.15 Bq/100 cm2 (4 pCi/100 cm2). Total involved activity was conservatively estimated at 1.48 to 2.22 kBq (40 to 60 nCi). Radioactively contaminated spots were decontaminated below release limit criteria. This event was caused by failure to conduct a reasonable and necessary survey of the cabinet prior to its removal from Magill Hall to an unrestricted area. Corrective actions included providing refresher training regarding radiological survey requirements. The areas were decontaminated by the licensee.

Event 060457 involved a mortar range indicator (model M224) containing four H-3 lamps, each with an activity of 29.6 GBq (800 mCi), that was damaged at Fort Bragg, North Carolina. While performing routine maintenance on the device, two contractors used an improper method to remove the range indicator from the handle assembly. This resulted in breaking one of the H-3 sources (model 11834818). When the workers realized that the range indicator was broken, they immediately placed the device in a bag and contacted the RSO. As a result of the breakage, the room was closed for five days, surveyed, and decontaminated. Initial wipe tests showed removable H-3 contamination ranging from 200 to 65,000 dpm. A leak test of the broken range indicator showed maximum removable contamination of 3.52 kBq (0.95 uCi). The device was double bagged and placed into storage for disposal as radioactive waste. The two contractors received small uptakes of H-3 that resulted in a whole body dose of 6 uSv (0.6 mrem) and 3 uSv (0.3 mrem). This event was caused by the failure of the contractors to follow current procedures due to a lack of training. Corrective actions included procedure modification and training for all contractors involved in the maintenance of devices containing H-3. This event was also classified as an EQP event.

Event 060550 involved a potentially radioactively contaminated individual was transported to an offsite medical facility for treatment. While performing work on the refuel floor of a commercial nuclear power plant, an operator received a hand injury. The first aid team responded and the injured hand was bandaged. Radiation Protection personnel verified that the individual was free of radioactive contamination with the exception of the injured hand. The accompanying personnel collected materials that came in contact with the injured hand that had not been surveyed prior to transport. At the hospital, the bandage that had been applied by the first aid team was removed and no contamination was found on the bandage. The cotton glove liner, which had been left on the injured hand when the first aid team removed the rubber glove, was surveyed and found to have low level contamination on it (100 to 250 cpm above background). The cotton glove was removed and the injured hand was surveyed and found to be free of contamination.

Event 060702 involved quarterly ground water samples from monitoring well 74 at a shutdown metal production facility that showed concentrations of uranium in excess of limits. This well is down-gradient from pond 3. During September 2005, the licensee became aware of an increase in the radioactivity concentrations in the well. Routine sampling of the well was conducted on 3/15/2006, and the U-238 and U-234 concentrations exceeded the limits at 202 and 175.4 Bq/L (5,460 and 4,740 pCi/L), respectively. The next quarterly sample taken on 6/28/2006 exceeded the limits for U-238 and U-235 at 334.5 and 298.3 Bq/L (9,040 and 8,630 pCi/L), respectively. Additional samples taken in July and August 2006 also exceeded the limits for U-238 and U-234. The 10 CFR 20 Appendix B Table 2 limits for U-238, U-235, and U-234 is 111 Bq/L (3,000 pCi/L). The cause of the increase seems to be related to the reclamation of pond 3, which commenced in June 2005. Enhanced groundwater monitoring has been established to track and trend the monitoring wells around pond 3. The licensee expects the concentrations to return to normal after reclamation of pond 3 is complete.

2.5 Lost/Abandoned/Stolen Material

Figure 17 displays the annual number and trend of the 2363 Lost/Abandoned/Stolen Material (LAS) events that occurred from Fiscal Year 1997 through 2006, excluding abandoned well-logging sources. The trend analysis determined that the data do not represent a statistically significant trend in the number of events. Therefore, variations within the annual values represent random fluctuation around the average of the data (indicated by the horizontal line).

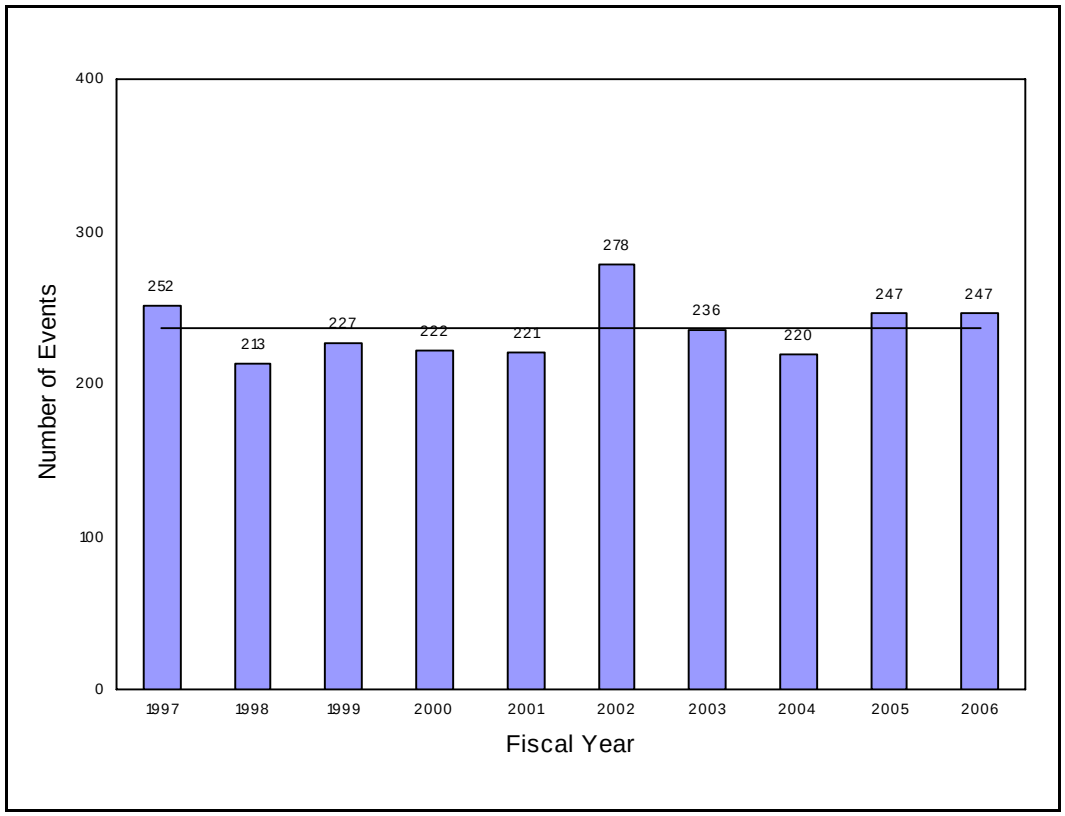


Figure 17. Long-Term Trend of Lost/Abandoned/Stolen Material Events (2363 total)

Figure 18 displays the quarterly number and trend of the 950 LAS events that occurred during the 16-quarter period. The trend analysis determined that the data do not represent a statistically significant trend. Therefore, variations within the 16-quarter values represent random fluctuation around the average of the data (indicated by the horizontal line).

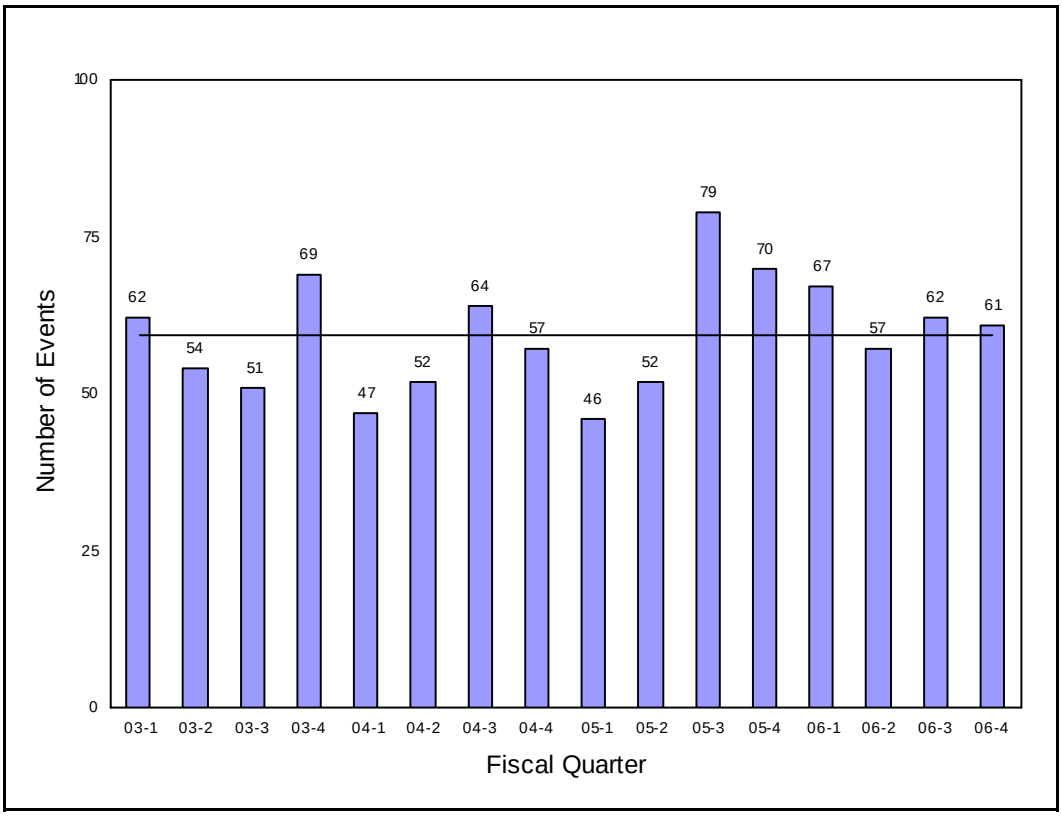


Figure 18. Short-Term Trend of Lost/Abandoned/Stolen Material Events (950 total)

Figures 19 through 21 display the distributions of event causes, type of material lost (based on reporting requirements), and nature of the losses. Figure 21's "Found" category represents material found for which the owner is unknown (e.g., material discovered at a landfill). "Partially Found" or "Partially Recovered" is used for events involving multiple lost/stolen sources, where some (but not all) sources were found/recovered.

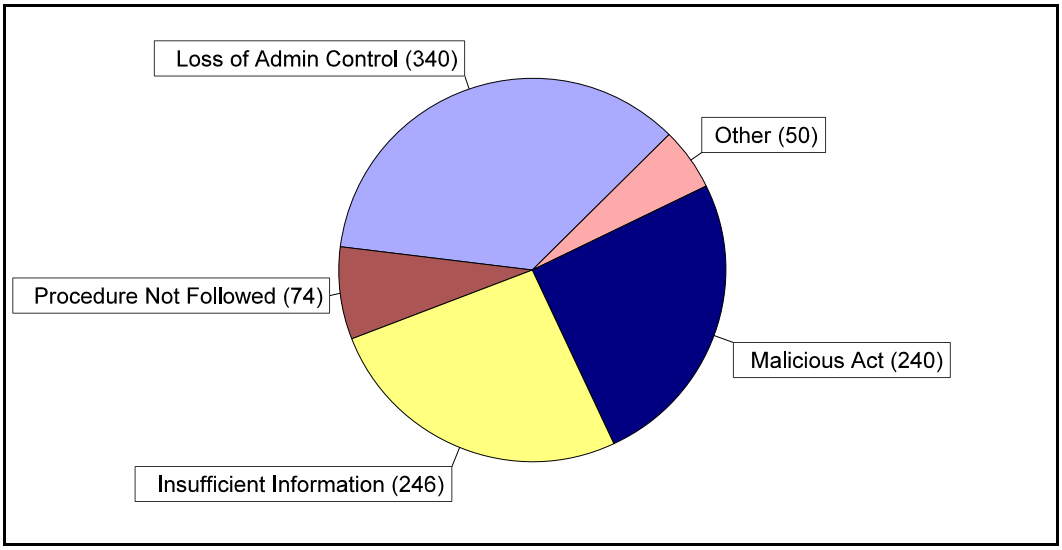


Figure 19. Lost/Abandoned/Stolen Material Event Causes (16 quarters)

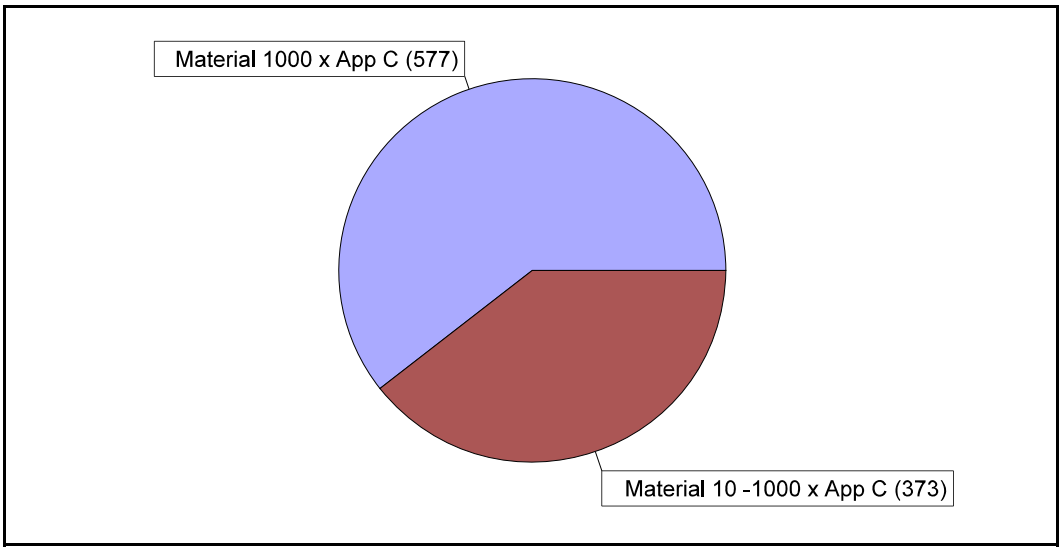


Figure 20. Lost/Abandoned/Stolen Material Event Material Types (based on reporting requirements - 16 quarters)

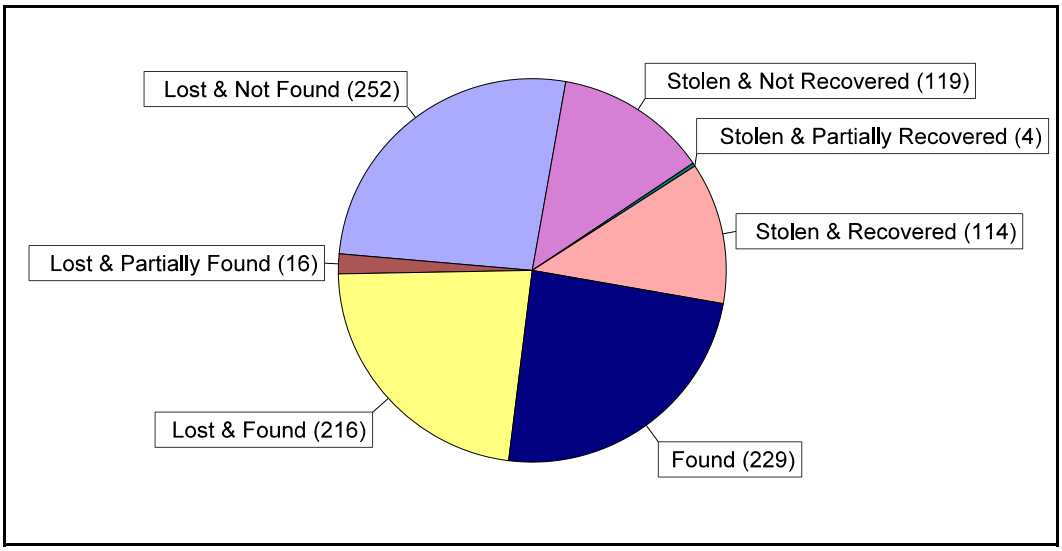


Figure 21. Nature of Loss Associated with Lost/Abandoned/Stolen Material Events (16 quarters)

Sixty-one LAS events occurred in Fiscal Quarter 06-4, none of which were classified as a potential AOs. The event causes, types of material lost, and nature of the losses reflected distributions similar to those shown in the pie-charts above for the 16-quarter period. Loss of administrative control and malicious act were the primary identifiable causes of the Fiscal Quarter 06-4 events. Approximately 60% of the events involved lost material greater than or equal to 1000 times the 10 CFR 20 Appendix C limits.

The 61 LAS events that occurred in Fiscal Quarter 06-4 (date of "loss" was in Fiscal Quarter 06-4) involved 84 sources, 58 of which were recovered. Table 1 lists the different radionuclides associated with those sources. Note that the Sources Recovered and Activity Recovered columns contain the subset of sources from the Lost column that were subsequently recovered, regardless of recovery date. These columns do not contain data on sources that were lost during previous quarters and found during Fiscal Quarter 06-4.

Table 1. Radionuclide Data of Sources Lost During Fiscal Quarter 06-4

Radionuclide	Sources Lost, Stolen, or Abandoned (note 1)	Activity Lost, Stolen, or Abandoned (Ci)	Sources Recovered (note 2)	Activity Recovered (Ci)
Am-241	2	0.000008	0	0
Am-Be	17	0.704	9	0.384
C-14	1	0.0018	0	0
Co-60	1	0.000011	1	0.000011
Cs-137	23	0.6147748	13	0.3442348
Ge-68	3	0.02322	3	0.02322
I-125	1	0.000418	0	0
I-131 (note 3)	28	0.0999834	27	0.0999684
Ir-192	3	185	3	185
P-32	1	0.00025	1	0.00025
Po-210	1	0.0019	0	0
U-Depleted	1	0.001356	1	0.001356
TOTAL excluding H-3	**82**	**186.4477212**	**58**	**185.8530402**
H-3	2	100.6	0	0
TOTAL including H-3	**84**	**287.0477212**	**58**	**185.8530402**

Notes:
1. Sources where the date of "loss" occurred in Fiscal Quarter 06-4.
2. Sources from the Lost column that were subsequently recovered, regardless of recovery date.
3. The 28 sources lost and 27 sources recovered include 4 sources whose activity was not reported and thus can not be included in the total activity values.

Three Fiscal Quarter 06-4 events involved orphan sources and are summarized below.

Event 060555 involved a truck carrying waste material from Adams Steel that set off the radiation monitor alarms at the Simi Valley Landfill. The landfill monitor reading was approximately 600 kcpm (background was 4 kcpm). Los Angeles County personnel responded to the landfill and identified the isotope as Cs-137, with radiation levels of 13 mR/hour on the side of the truck, 1.2 mR/hour at three feet from the side of the truck, and background in the cab of the truck. After a DOT Exemption form was generated by Los Angeles County Radiation Management personnel, the truck returned to Adams Steel and parked in a remote location. The California Radiation Control Program (RCP) responded to Adams Steel and recovered a Cs-137 source with an activity of approximately 0.26 GBq (7 mCi). The source was taken by RCP to hold until Adams Steel can arrange for disposal of the source.

Event 060565 involved a rail shipment of scrap steel that set off Cascade Steel's radiation monitor alarms. During investigation, a Texas Nuclear gauge (model 5193, serial #B1207) containing a Cs-137 source (serial #MA5033) with an activity of 9.25 GBq (250 mCi) was recovered. The gauge was manufactured in October 1978 and had an original activity of 18.5 GBq (500 mCi). Oregon Department of Health staff recovered the unshuttered gauge. Radiation levels one foot from the gauge were 5.2 mSv/hour (520 mrem/hour). Thermo MeasureTech (formerly Texas Nuclear) was contacted and confirmed that the gauge belonged to FMC Idaho (formerly ASTARIS-Idaho). The NRC license was issued to ASTARIS, but was transferred to the FMC Idaho in 2002 and terminated in 2003. The licensee's phosphorus facility is currently being dismantled. The shipment of scrap metal that set off the radiation monitor alarms came from Pacific Hide and Fur Recycling Company, who is processing the materials removed from the facility. Six more train car loads of scrap metal are expected. Oregon Department of Health personnel plan to survey each load upon arrival. Records available from Thermo MeasureTech indicate that as many as six devices distributed to the licensee's facility were not returned to them for disposal. The NRC Region IV continued efforts to reconcile the licensee's gauge disposition. An NRC Region IV inspector, accompanied by an Idaho health inspector, performed site visits at the FMC Idaho and Pacific Hide and Fur facilities. It was stated that Thermo MeasureTech collected and disposed of radioactive sources at the licensee's location in 2002. Radiation doses to involved scrapyard personnel were estimated to be less than 0.2 mSv (20 mrem). Thermo MeasureTech examined the gauge and determined that the shutter had been sheared off. They are working with the State of Oregon to safely dispose of the gauge. The NRC cannot locate the disposition of the other six gauges. No corrective actions were taken.

In event 060563, the Florida Department of Health (DOH) received a report that Strata Healthcare (dba Strata Diagnostic Imaging) was out of business and had used radioactive sources in PET scanning. An inspector investigated the licensee's office and found four abandoned sources. They included a Cs-137 source with an activity of 8.7 MBq (234.8 uCi), and three Ge-68 sources with activities of 399.6, 399.6, and 59.9 MBq (10.8, 10.8, and 1.62 mCi). The licensee could not be found. The DOH impounded the sources, assigned Tag #P-016, and will hold them for disposal.

2.6 Leaking Sealed Source

Figure 22 displays the annual number and trend of the 325 Leaking Sealed Source (LKS) events that occurred from Fiscal Year 1997 through 2006. As noted in previous reports, an Agilent Technologies reporting anomaly occurred from Fiscal Year 2000 through early 2005, which notably increased the number of LKS events. This anomaly was solely responsible for the increasing trend in the total number of LKS events through Fiscal Year 2004. To show this affect, Figure 22 displays the Agilent events as yellow shaded bars and all other LKS events (excluding Agilent events) as blue shaded bars. A trend analysis performed on the total LKS data, and on the data excluding Agilent events, determined that neither data set represents a statistically significant trend. Therefore, variations within the annual values represent random fluctuation around the average of the data (indicated by the two horizontal lines).

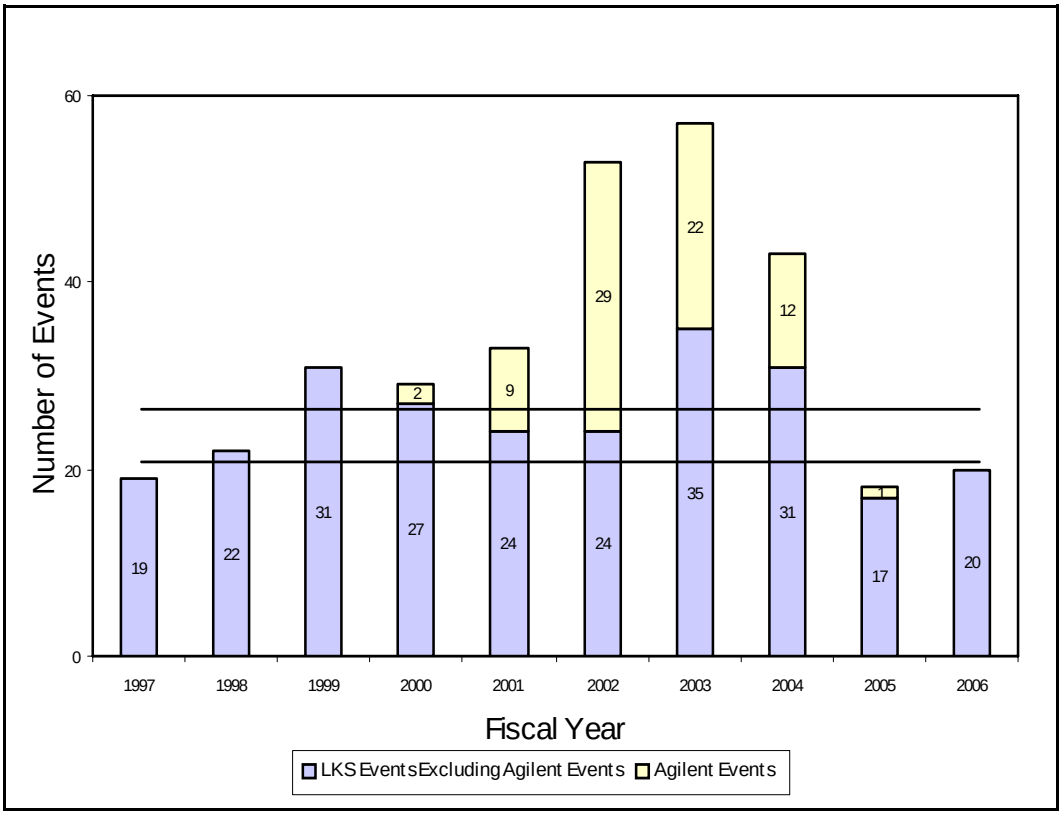


Figure 22. Long-Term Trend of Leaking Sealed Source Events (325 total)

Figure 23 displays the quarterly number and trend of the 138 LKS events that occurred during the 16-quarter period. Similar to Figure 22, the Agilent events are displayed as yellow shaded bars and all other LKS events (excluding Agilent events) as blue shaded bars. A trend analysis was performed on the total LKS data and on the data excluding Agilent events. The analysis determined that both data sets represent statistically significant decreasing trends (indicated by the two sloped lines).

Figures 24 through 26 display the distributions of event causes, device types (based on reporting requirements), and types of sealed sources for the reportable LKS events in the 16-quarter period. It should be noted that although each individual event has only one cause (Figure 24), the event may involve devices associated with more than one reporting requirement or sealed source (Figures 25 and 26).

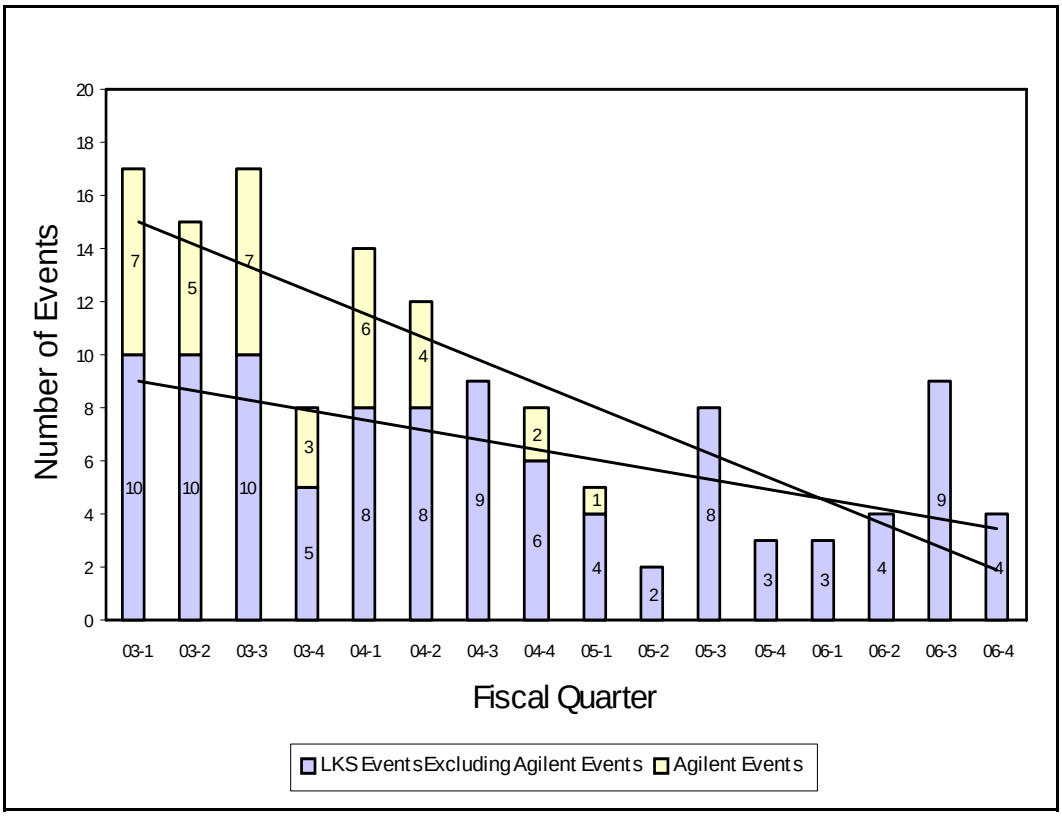


Figure 23. Short-Term Trend of Leaking Sealed Source Events (138 total)

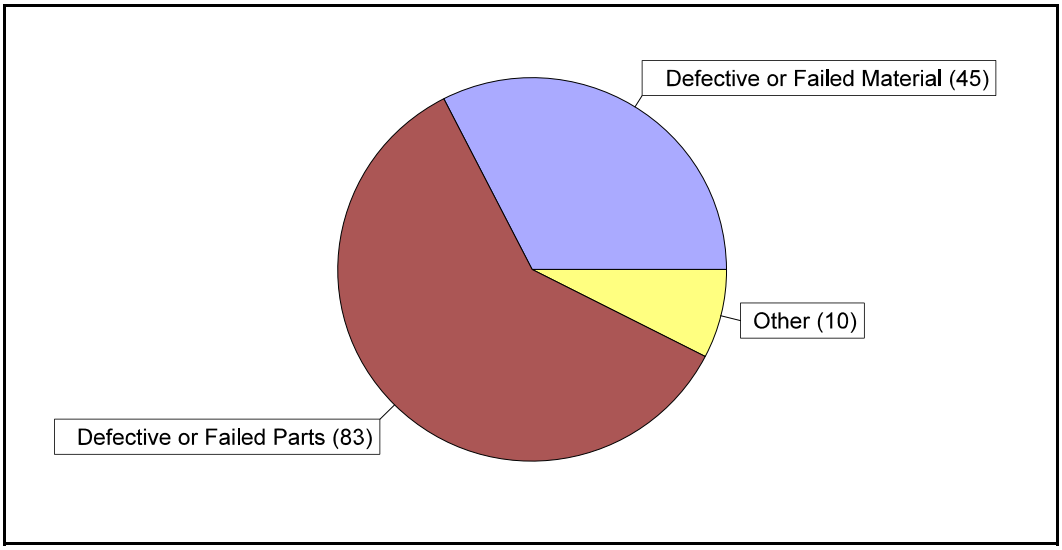


Figure 24. Leaking Sealed Source Event Causes (16 quarters)

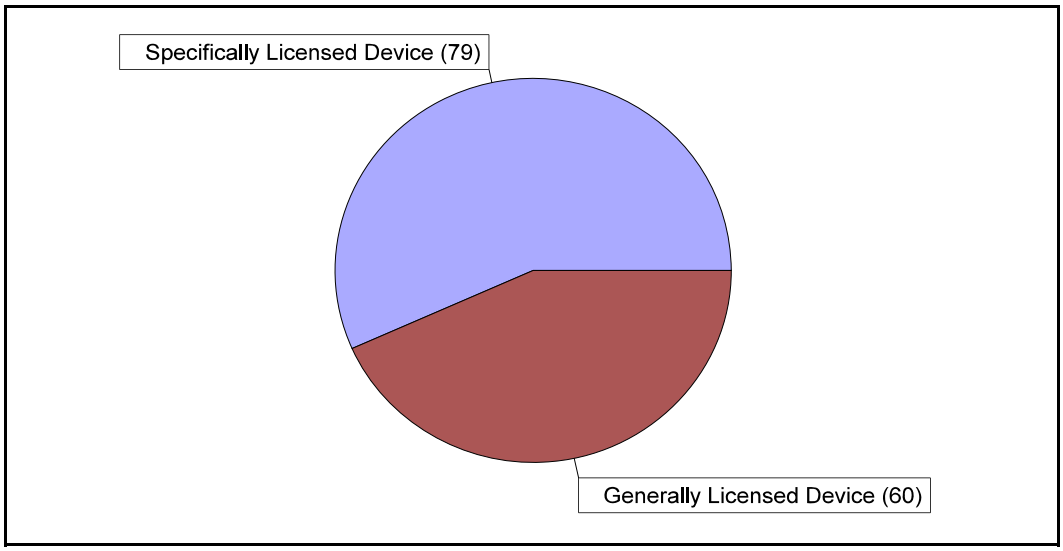


Figure 25. Leaking Sealed Source Device Types (based on reporting requirement - 16 quarters)

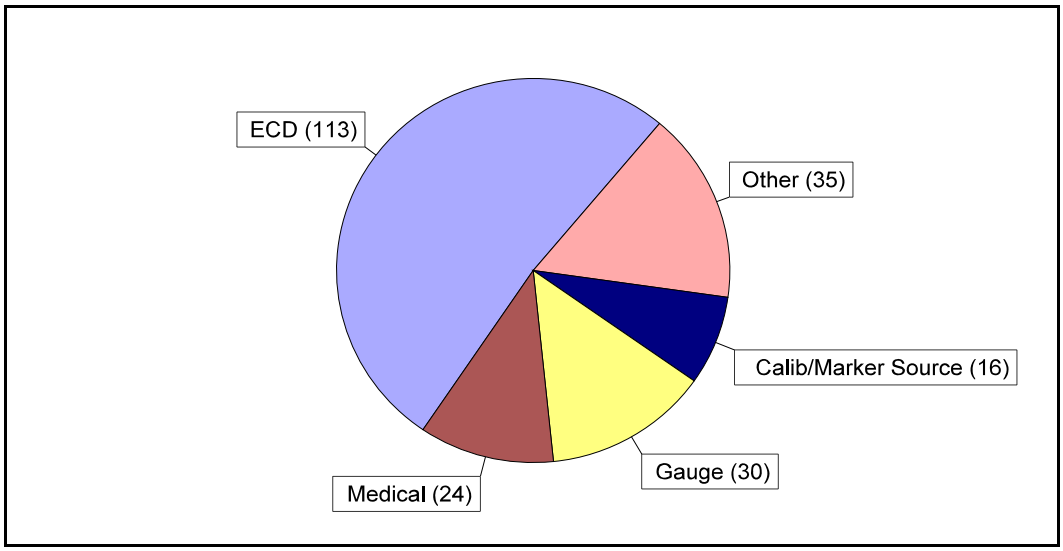


Figure 26. Leaking Sealed Source Types (16 quarters)

Four LKS events occurred in Fiscal Quarter 06-4, none of which were classified as potential AOs. The events are summarized below.

Event 060488 involved a leaking 1.06 GBq (28.6 mCi) Cs-137 brachytherapy source (Medi Physics model CDC.T1, serial #CY 389). A routine leak test revealed the presence of 111 Bq (0.003 uCi) of removable activity at the Cs-137 photopeak. The full spectrum counts noted an activity of 222 Bq (0.006 uCi). The licensee removed the source from service pending return to the manufacturer or disposal. This event was also classified as an EQP event.

Event 060624 involved a leaking 16.65 GBq (450 mCi) Cs-137 source that was part of a Texas Nuclear/Nuclear Chicago density gauge (model 5176, serial #1965). The source was manufactured by 3M Company in the mid 1960's. The density gauge was received by a facility in Michigan for repairs. No radioactive contamination was discovered on the outside of the gauge, but once the gauge was opened contamination greater than 185 Bq (0.005 uCi) was discovered on the inside. The last assay date for the

source was November 1965. Operations were temporarily suspended to determine the extent of the radioactive contamination. The licensee was notified and instructed to wipe the area where the gauge was stored prior to transfer. The source was removed from the source holder, further encapsulated, placed in an appropriate storage container, secluded in a fenced area, and is awaiting disposal. Tools and the work area were decontaminated as necessary. Subsequent wipe analysis by the licensee of the gauge storage area revealed no contamination. This event was also classified as an EQP event.

Event 060628 involved a leaking 1.57 GBq (42.4 mCi) Sr-90 eye applicator (Atlantic Research Corporation, model B1, serial #178). Prior to sending the wipe sample to the evaluation company, the physicist noted radioactive contamination on the wipe sample. The physicist checked the wipe sample with an S.E. International Inspector instrument and received a reading of 6,800 cpm. The efficiency of the instrument was 38% and indicated a removable activity of 298 Bq (0.008 uCi). A repeat test revealed removable activity of 132 Bq (0.0036 uCi). The eye applicator was removed from service, secured with tape in a container, and posted with warning signs. The physics department maintains the keys to the secured area. The wipe samples were bagged, labeled, and placed in the source closet. Records were reviewed, which revealed that the post-procedure radiation surveys of the patient and room were at background. This event was also classified as an EQP event.

Event 060708 involved an electron capture detector (ECD; Agilent model G2397A) that failed a routine leak test. The ECD contained a 555 MBq (15 mCi) Ni-63 source. The initial wipe test result was 703 Bq (0.019 uCi). This event was likely caused by chemicals in use in the ECD. The gas chromatograph containing the ECD was removed from service and decontaminated.

2.7 Equipment

Figure 27 displays the annual number and trend of the 1355 Equipment (EQP) events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

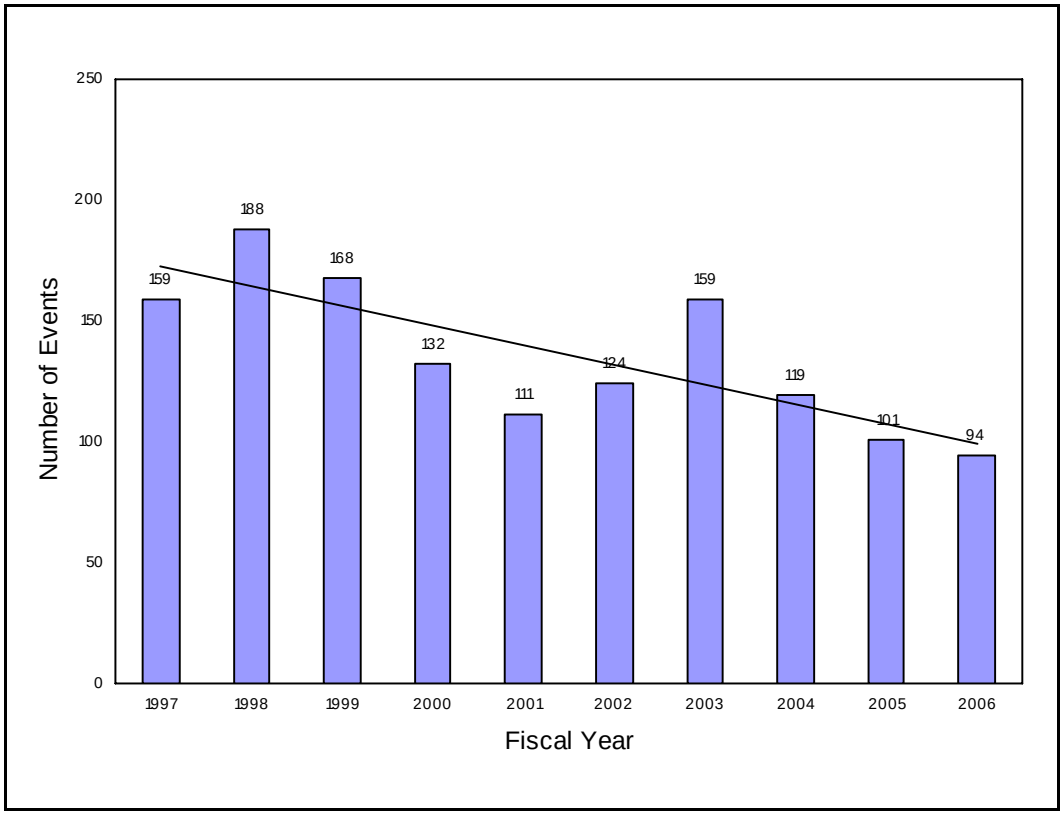


Figure 27. Long-Term Trend of Equipment Events (1355 total)

Figure 28 displays the quarterly number and trend of the 473 EQP events that occurred during the 16-quarter period. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

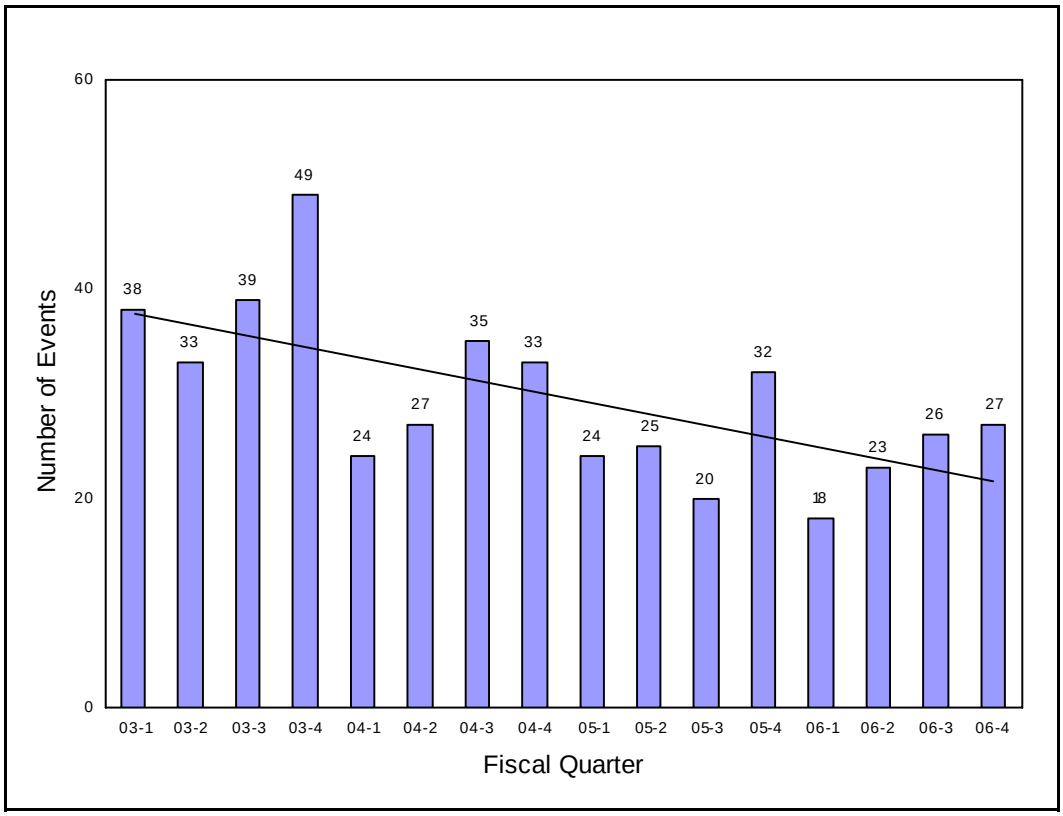


Figure 28. Short-Term Trend of Equipment Events (473 total)

In response to questions from NMED users, and to ensure accurate event coding, a change has been made in the EQP event coding methodology. Previously, EQP events were marked as reportable, even if they did not meet all CFR reporting thresholds. For example, a damaged gauge event would have been marked reportable if it met one, but not necessarily all three thresholds of 30.50(b)(2)(i), (ii), and (iii). This coding practice primarily stemmed from NMED's original and underlying purpose as a means to capture operational experience for trending and historical research, not necessarily to limit inclusion to reportable events.

Starting 10/01/06, NMED will only mark EQP events reportable if they meet all applicable reporting thresholds [(i), (ii), and (iii)]. If the report to NMED is not sufficient to clearly determine that all thresholds were met, the event reportability will be coded as Uncertain (U), and the event will be included in the normal request for additional information (RAI) process. If followup information specifies that the event does not meet all thresholds, the reportability will be changed to Not Reportable.

The overall effect of this change should be a decreased number of EQP events. Note that this coding change will only be applied to NMED events entered or updated beginning 10/01/06. If an NMED user wishes this coding to be applied to an older event, they should send an event update to the NMED staff.

Figures 29 through 31 display the distributions of event causes, EQP problem types based on reporting requirements, and types of equipment for the reportable EQP events in the 16-quarter period. It should be noted that although each individual event has only one cause (Figure 29), the event may involve more than one type of problem or equipment (Figures 30 and 31).

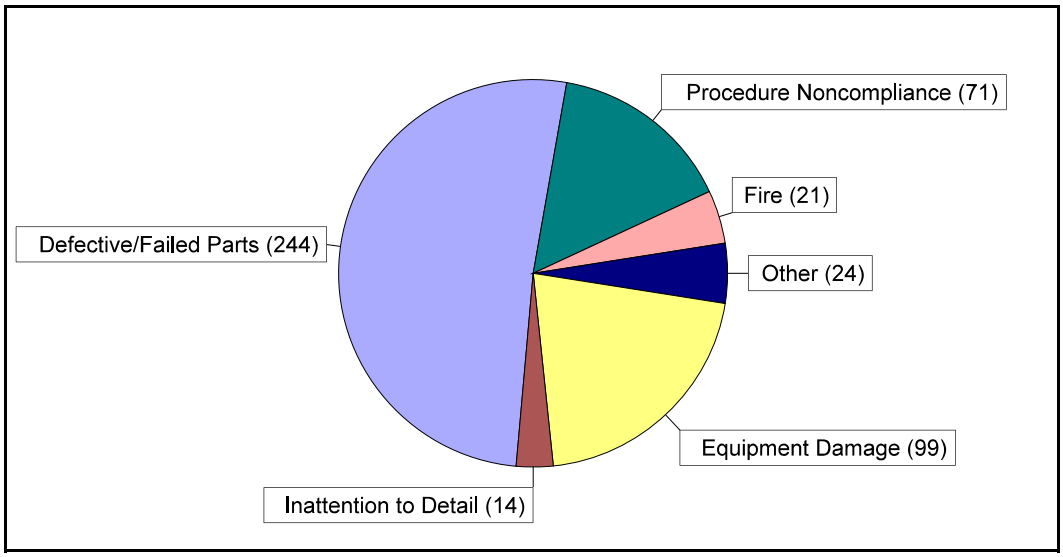


Figure 29. Equipment Event Causes (16 quarters)

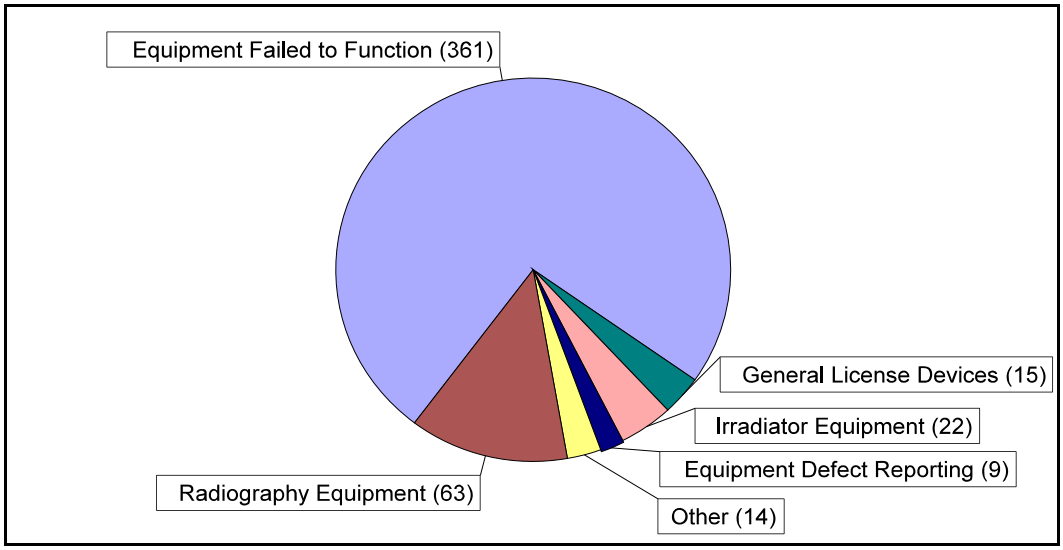


Figure 30. Equipment Event Types (based on reporting requirement - 16 quarters)

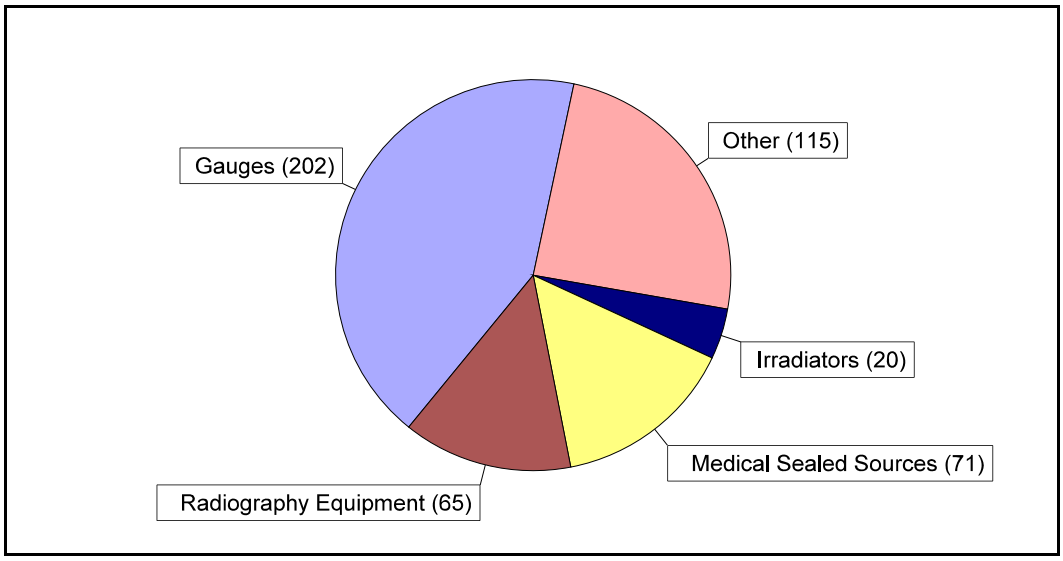


Figure 31. Types of Equipment Involved (16 quarters)

Twenty-seven EQP events occurred in Fiscal Quarter 06-4, none of which were classified as potential AOs. The event causes, event types, and types of equipment reflected distributions similar to those shown in the pie-charts above for the 16-quarter period. Gauges were involved in approximately half of the events.

2.8 Transportation

Figure 32 displays the annual number and trend of the 407 Transportation (TRS) events that occurred from Fiscal Year 1997 through 2006. The trend analysis determined that the data represent a statistically significant decreasing trend in the number of events (indicated by the sloped line).

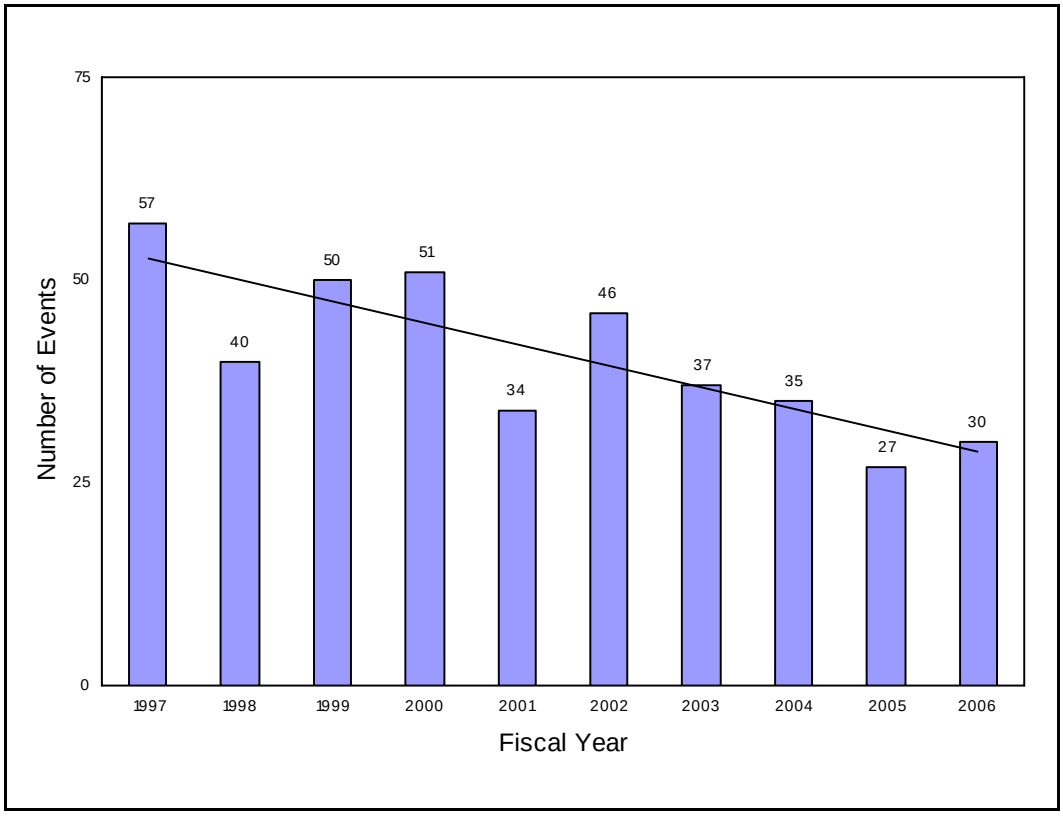


Figure 32. Long-Term Trend of Transportation Events (407 total)

Figure 33 displays the number and trend of the 129 TRS events that occurred during the 16-quarter period. The trend analysis determined that the data do not represent a statistically significant trend. Therefore, variations within the 16-quarter values represent random fluctuation around the average of the data (indicated by the horizontal line).

Figures 34 through 36 display the distributions of event causes, TRS problem types based on reporting requirements, and types of material involved in the reportable TRS events in the 16-quarter period. It should be noted that although each individual event has only one cause (Figure 34), the event may involve more than one type of problem or material (Figures 35 and 36).

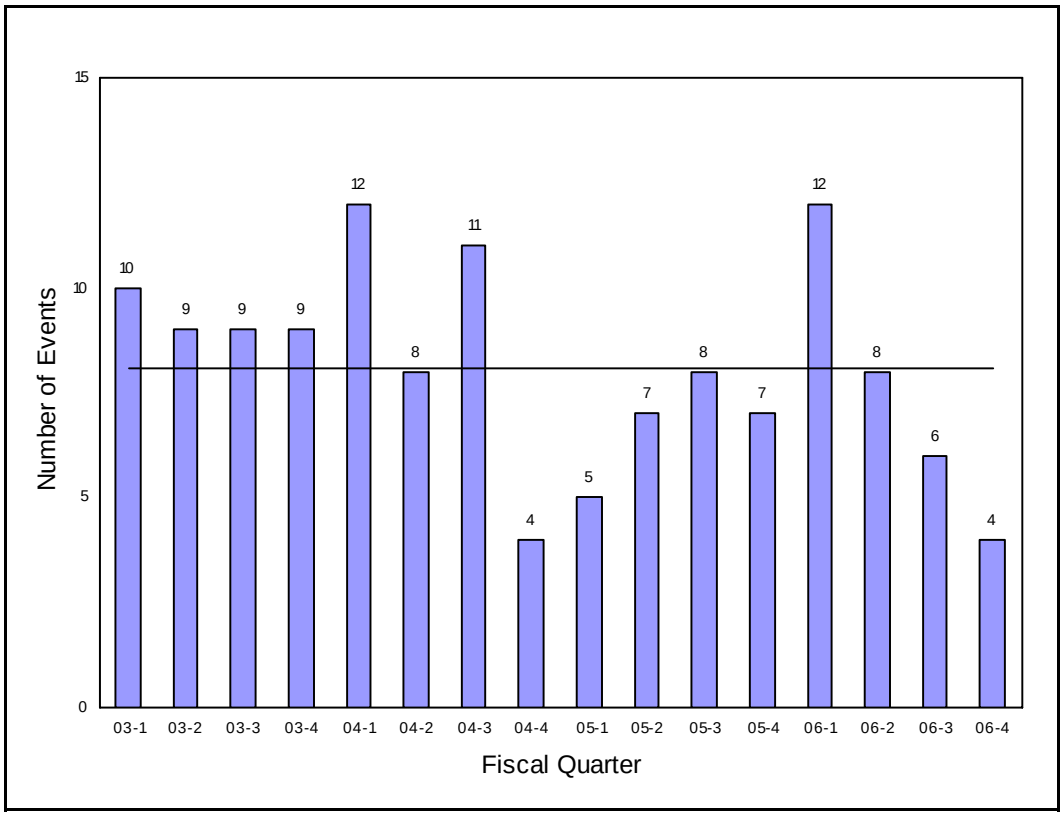


Figure 33. Short-Term Trend of Transportation Events (129 Total)

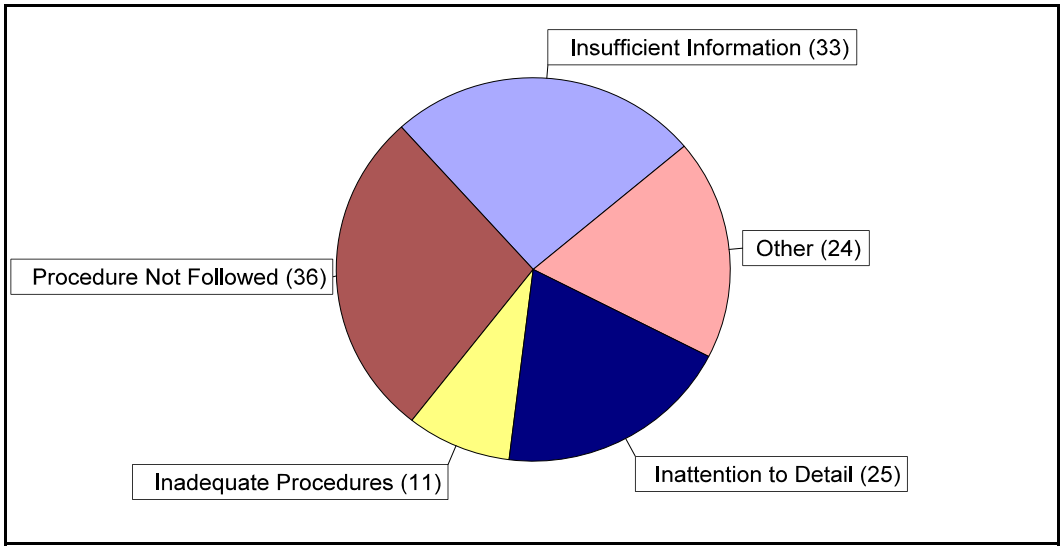


Figure 34. Transportation Event Causes (16 quarters)

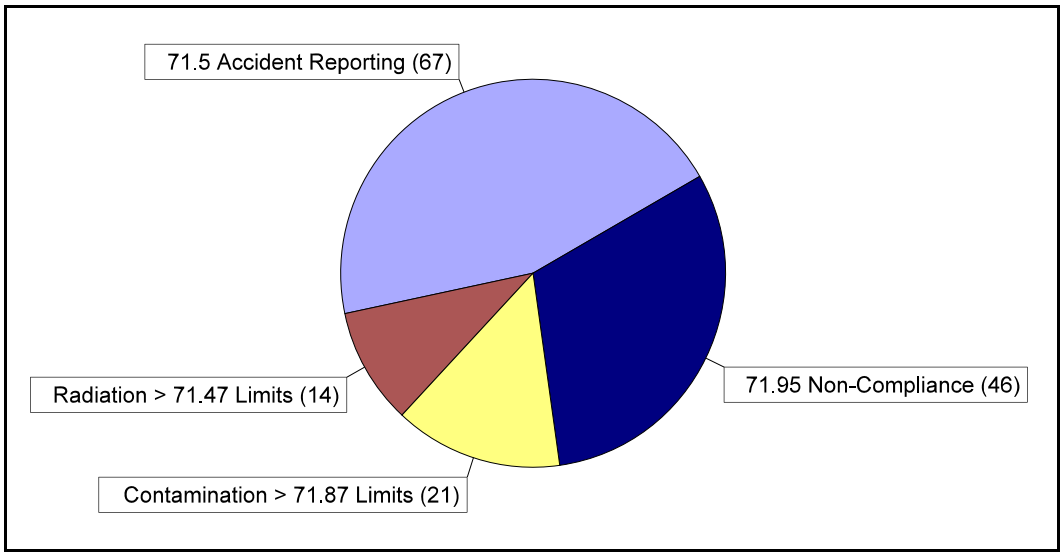


Figure 35. Transportation Problem Types (based on reporting requirements -16 quarters)

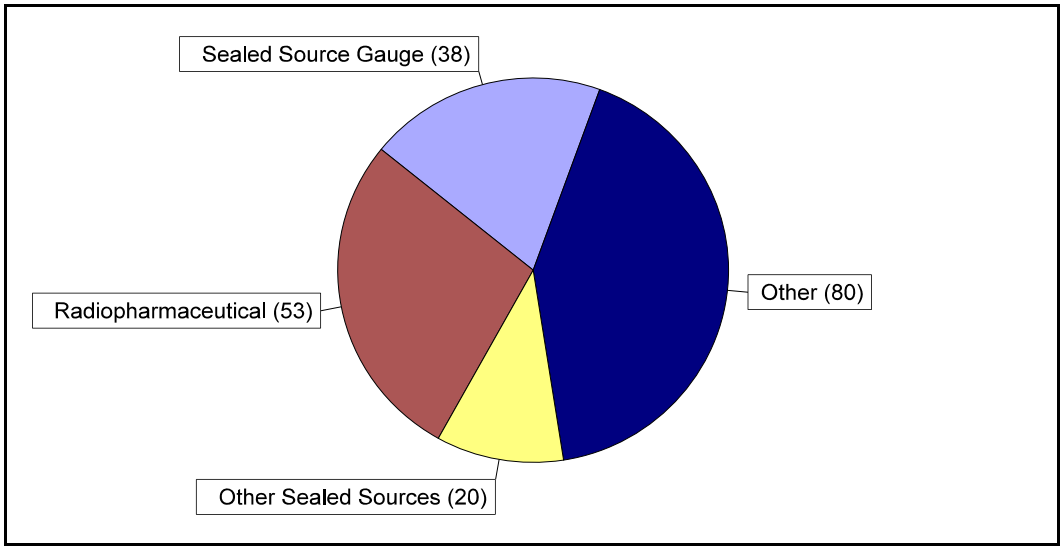


Figure 36. Material Involved in Transportation Events (16 quarters)

Four TRS events occurred in Fiscal Quarter 06-4, none of which were classified as potential AOs. The events are summarized below.

In event 060456, Global Nuclear Fuels received a control rod drive mechanism from the Laguna Verde Nuclear Power Plant with external package radiation levels exceeding transportation limits. Surface radiation levels from the bottom of the transport container were 2.45 mSv/hour (245 mrem/hour). There was no external radioactive contamination on the container and all other aspects of the shipment were within regulatory limits. The shipment was transported by Tri-State Motor Transport as an exclusive use shipment. Although the Global Nuclear Fuels is an NRC licensee, the activity being performed for Laguna Verde is being conducted under their North Carolina State license. The cause was determined to be failure to follow procedures and corrective actions taken by the licensee included providing additional training to personnel.

In event 060554, a radioactive material shipment from the Vermont Yankee nuclear power plant was found to exceed the Department of Transportation (DOT) regulatory limit of 2 mSv/hr (200 mrem/hr) when it arrived at the Susquehanna nuclear power plant. Surveys prior to shipment indicated a maximum surface dose rate of 0.6 mSv/hr (60 mrem/hr). However, the receipt survey identified radiation levels of 8.2 mSv/hr (820 mrem/hr) on the bottom external surface. The package contained contaminated equipment. Susquehanna personnel opened the package to determine the source of the high radiation levels. Upon close examination, several small highly radioactive pieces of debris were identified with radiation levels ranging from 4 to 14 mSv/hr (400 to 1,400 mrem/hr). The apparent cause of this event was ineffective decontamination of the package contents, and an insufficient radiological survey prior to shipment. Corrective actions included modification of decontamination and survey procedures.

In event 060595, a Cardinal Health Nuclear Pharmacy vehicle transporting radiopharmaceuticals was involved in an accident. Material transported included 44.92 GBq (1,214 mCi) of Tc-99m and 1.48 GBq (40 mCi) of Xe-133. The incident took place in Picayune, Mississippi, on Highway 43. The road was wet due to rain and the driver lost control of the vehicle and collided with two other vehicles. Several of the shipping containers were ejected from the vehicle. The licensee notified the appropriate authorities in Mississippi. Local sheriff and fire departments responded to the accident scene. Cardinal Health and Mississippi Department of Radiological Health personnel also responded. No radioactive material leaked from the containers and no personnel were contaminated.

In event 060664, Westinghouse Electric reported that the conditions in Certificate of Compliance (CoC) #9239 for the MCC-3, MCC-4, and MCC-5 shipping containers were not followed during a shipment to a Part 50 licensee. Westinghouse shipped two fresh fuel assemblies. During the receipt inspection, it was discovered that eight of the nine restraining clamps were closed and secured on the fuel rods rather than on the structural grids. The Part 50 licensee did not accept the shipment and it was returned to Westinghouse. This event was caused by incorrect markings on the container, inexperienced personnel, inadequate procedures, and procedure non-compliance. Corrective actions included retraining personnel, improved supervision, procedure modification, and disciplinary actions.

2.9 Other

Figure 37 displays the annual number of the 71 Other (OTH) events that occurred from Fiscal Year 1997 through 2006. Figure 38 displays the quarterly number of the 19 OTH events that occurred during the 16-quarter period. Because OTH events do not fit a defined criteria that ensures consistency within the data, trending is not performed on this data.

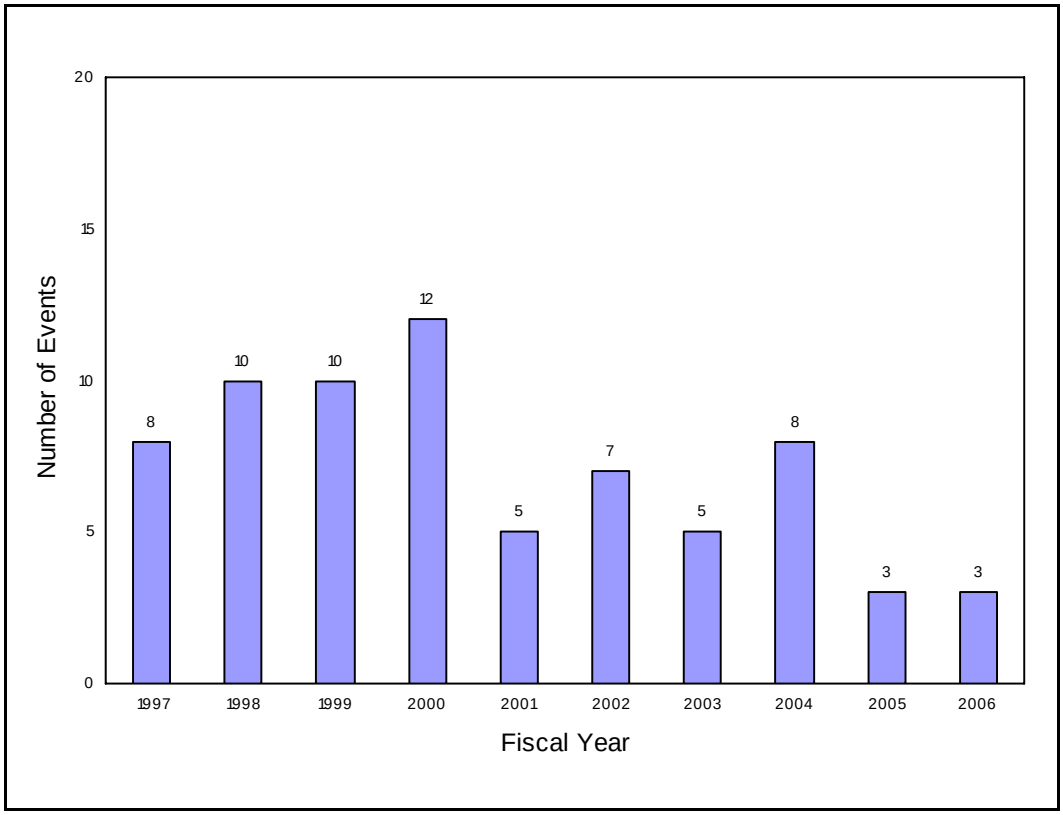


Figure 37. Long-Term Display of Other Events (71 total)

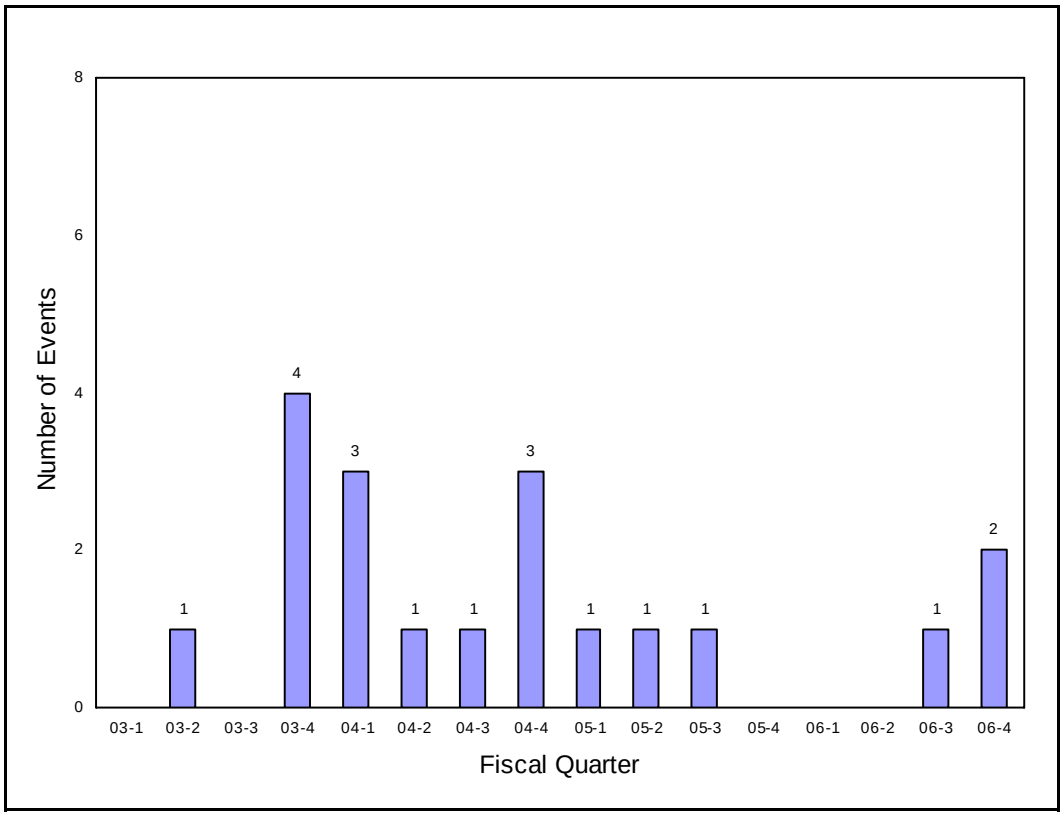


Figure 38. Short-Term Display of Other Events (19 total)

Two OTH events occurred in Fiscal Quarter 06-4 and are summarized below:

Event 060431 involved a Troxler moisture/density gauge (model 3411, serial #10942) that was damaged when it was run over by a bulldozer at the Rydal-Waters construction site in Abington Township, Montgomery County, Pennsylvania. The gauge contained a 1.44 GBq (38.8 mCi) Am-Be source (serial #47-6341) and a 0.2 GBq (5.4 mCi) Cs-137 source (serial #40-8387). The gauge was left unattended and uncontrolled for approximately five minutes when the gauge operator went to retrieve his vehicle that was parked approximately 600 feet away. Part of the gauge casing was crushed, the index rod was broken, and part of the index rod and the source rod were detached from the gauge. The radiation levels near the detached source rod were as high as 50 mR/hr and existed for several hours in the unrestricted area around the damaged gauge. The source rod was placed back inside the gauge and the gauge was placed inside its case. Surveys of the surrounding area showed background levels. The gauge was transported to the licensee's office in Allentown, Pennsylvania. The sources were leak tested and deemed suitable for transport to Troxler for disposal. This event was also classified as an EQP event.

Event 060590 involved During an NRC inspection, the inspector noted that a licensee technologist failed to identify several areas of radioactive contamination during end-of-the-day surveys in the stress-testing area and in the imaging room. These areas are accessible after normal working hours to non-radiation workers. The decay characteristics of the radioactive contamination, as determined by the inspector at the time of the inspection, indicated that the isotope was Tc-99m. However, the activity of the contamination in the area was not quantified. Corrective actions taken by the licensee included all personnel received training on survey techniques, use of the dose calibrator, and the new policy of closing off the camera and treadmill rooms when authorized personnel are gone for the day. In addition, the RSO will be present during personnel and area surveys for contamination when nuclear studies are performed.

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.

Medical (MED)

10 CFR 35 was revised effective October 24, 2002. For events that occurred after this date, medical events are defined as follows:

1. Any event, except for an event that results from patient intervention, in which the administration of byproduct material or radiation from byproduct material results in:

   a) A dose that differs from the prescribed dose or dose that would have resulted from the prescribed dosage by more than 0.05 Sv (5 rem) effective dose equivalent, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) shallow dose equivalent to the skin; and
   - the total dose delivered differs from the prescribed dose by 20% or more;
   - the total dosage delivered differs from the prescribed dosage by 20% or more or falls outside the prescribed dosage range; or
   - the fractionated dose delivered differs from the prescribed dose, for a single fraction, by 50% or more.

   b) A dose that exceeds 0.05 Sv (5 rem) effective dose equivalent, 0.5 Sv (50 rem) to an organ or tissue, or 0.5 Sv (50 rem) shallow dose equivalent to the skin from any of the following:
   - an administration of a wrong radioactive drug containing byproduct material;
   - an administration of a radioactive drug containing byproduct material by the wrong route of administration;
   - an administration of a dose or dosage to the wrong individual or human research subject;
   - an administration of a dose or dosage delivered by the wrong mode of treatment; or
   - a leaking sealed source.

   c) A dose to the skin or an organ or tissue other than the treatment site that exceeds by 0.5 Sv (50 rem) to an organ or tissue and 50% or more of the dose expected from the administration defined in the written directive (excluding, for permanent implants, seeds that were implanted in the correct site but migrated outside the treatment site).

10 CFR 35 was revised effective October 24, 2002. For events that occurred prior to this date, medical events are defined as follows:

1. A radiopharmaceutical dosage greater than 30 microcuries of either sodium iodide I-125 or I-131:
   - Involving the wrong individual, or wrong radiopharmaceutical; or
   - When both the administered dosage differs from the prescribed dosage by more than 20% of the prescribed dosage and the difference between the administered dosage and prescribed dosage exceeds 30 microcuries.

2. A therapeutic radiopharmaceutical dosage, other than sodium iodide I-125 or I-131:
   - Involving the wrong individual, wrong radiopharmaceutical, or wrong route of administration; or
   - When the administered dosage differs from the prescribed dosage by more than 20% of the prescribed dosage.

3. A gamma stereotactic radiosurgery radiation dose:
   - Involving the wrong individual, or wrong treatment site; or
   - When the calculated total administered dose differs from the total prescribed dose by more than 10% of the total prescribed dose.

4. A teletherapy radiation dose:
   - Involving the wrong individual, wrong mode of treatment, or wrong treatment site;
   - When the treatment consists of three or fewer fractions and the calculated total administered dose differs from the total prescribed dose by more than 10% of the total prescribed dose;
   - When the calculated weekly administered dose exceeds the weekly prescribed dose by 30% or more of the weekly prescribed dose; or
   - When the calculated total administered dose differs from the total prescribed dose by more than 20% of the total prescribed dose.

5. A brachytherapy radiation dose:
   - Involving the wrong individual, wrong radioisotope, or wrong treatment site (excluding, for permanent implants, seeds that were implanted in the correct site but migrated outside the treatment site);
   - Involving a sealed source that is leaking;
   - When, for a temporary implant, one or more sealed sources are not removed upon completion of the procedure; or
   - When the calculated administered dose differs from the prescribed dose by more than 20% of the prescribed dose.

6. A diagnostic radiopharmaceutical dosage, other than quantities greater than 30 microcuries of either sodium iodide I-125 or I-131, both:
   - Involving the wrong individual, wrong radiopharmaceutical, wrong route of administration, or when the administered dosage differs from the prescribed dosage; and
   - When the dose to the individual exceeds 5 rem effective dose equivalent or 50 rem dose equivalent to any individual organ.

Events are not considered MED events if they involve:

1. Only accelerator produced radiopharmaceuticals.

2. Only a linear accelerator.

3. A dose calculation error made by the prescribing physician that was administered as (incorrectly) prescribed.

4. Patient intervention.

Events are considered MED events if they involve:

1. A radiopharmaceutical containing by-product material was prescribed, but a radiopharmaceutical containing accelerator produced material was administered.

2. A radiopharmaceutical containing accelerator produced material was prescribed, but a radiopharmaceutical containing by-product material was administered.

3. A linear accelerator is used for therapy by mistake instead of a teletherapy unit or a teletherapy unit instead of a linear accelerator.

MED events occur to patients only. Hospital patients are always considered to be patients, rather than members of the general public, for purposes of determining whether to categorize an event as an MED or EXP event. For example, if a patient was administered a radiopharmaceutical that was prescribed for another patient, the event would be categorized as an MED event (radiopharmaceutical given to the wrong patient) rather than an EXP event.

Radiation Overexposure (EXP)

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 classified into the NMED Event Table 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 events are categorized as follows:

1. A total effective dose equivalent of 0.25 Sv (25 rem) or more.

2. A total effective dose equivalent exceeding 0.05 Sv (5 rem) in a period of 24 hours.

3. An eye dose equivalent of 0.75 Sv (75 rem) or more.

4. An eye dose equivalent exceeding 0.15 Sv (15 rem) in a period of 24 hours.

5. A shallow-dose equivalent to the skin or extremities of 2.5 Gy (250 rad) or more.

6. A shallow-dose equivalent to the skin or extremities exceeding 0.5 Sv (50 rem) in a period of 24 hours.

7. A dose in excess of the occupational dose rate for adults in 20.1201.

8. A dose in excess of the occupational dose limits for a minor in 20.1207.

9. A dose in excess of the limits for an embryo/fetus of a declared pregnant woman in 20.1208.

10. A dose in excess of the limits for an individual member of the public in 20.1301

11. A dose in excess of any applicable limit in the license.

Release of Licensed Material or Contamination (RLM)

The RLM event category includes two types of events. The first type is a radioactive release to air or water exceeding the old 10 CFR Part 20 appendix governing maximum permissible concentrations (MPCs) or the new 10 CFR Part 20 appendix containing annual limit on intakes (ALIs). 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, or air, or water) or areas of contamination associated with the release, this information is classified individually into the NMED Event Table. RLM events are categorized as follows:

1. An unplanned contamination event that requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the area.

2. An unplanned contamination event that involves a quantity of material greater than five times the lowest ALI specified in Appendix B of 10 CFR 20.

3. An unplanned contamination event that has access to the area restricted for a reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination.

4. The release of radioactive material, inside or outside of a restricted area, such that had an individual been present for 24 hours, the individual could have received an intake five times the ALI (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

5. The release of radioactive material, inside or outside of a restricted area, such that had an individual been present for 24 hours, the individual could have received an intake in excess of one ALI (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

6. Levels of radiation or concentrations of radioactive material in a restricted area in excess of any applicable limit in the license.

7. Levels of radiation or concentrations of radioactive material in an unrestricted area in excess of 10 times any applicable limit set forth in 10 CFR 20 or in the license (whether or not involving exposures of any individual in excess of the limits in 10 CFR 20.1301).

8. For licensees subject to the provisions of the Environmental Protection Agency’s (EPA's) generally applicable environmental radiation standards in 40 CFR 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

9. An event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body.

10. An unplanned fire or explosion damaging any licensed material or any device, container, or equipment containing licensed material when the quantity of material involved is greater than five times the lowest ALI specified in Appendix B of 10 CFR 20.

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. Abandoned well logging sources are included in this category. LAS events are categorized as follows:

1. Any lost, stolen, or missing licensed material in an aggregate quantity greater than or equal to 1,000 times the quantity specified in Appendix C to 10 CFR 20 under such circumstances that it appears to the licensee that an exposure could result to persons in unrestricted areas.

2. Any lost, stolen, or missing licensed material in a quantity greater than 10 times the quantity specified in Appendix C to 10 CFR 20.

3. An irretrievable well logging source.

4. An attempt made, or believed to have been made, to commit a theft or unlawful diversion of more than 10 Ci of H-3 at any one time or more than 100 Ci in any one calendar year.

5. An attempt made, or believed to have been made, to commit a theft or unlawful diversion of more than 15 pounds of source material at any one time or more than 150 pounds of source material in any one calendar year.

6. An attempt made, or believed to have been made, to commit a theft or unlawful diversion of special nuclear material.

7. Any loss (other than normal operating loss), theft, or unlawful diversion of special nuclear material.

Leaking Sealed Source (LKS)

The LKS event category includes events involving leaking sealed 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. 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 30. Some specific reporting criteria are also listed in 10 CFR 31 (generally licensed material), 10 CFR 34 (radiography), and 10 CFR 35 (medical use of byproduct material).

Equipment (EQP)

The EQP event category includes all types of radiological equipment problems, including generally licensed device problems covered in 10 CFR 31; radiography equipment problems covered in 10 CFR 34; irradiator problems covered in 10 CFR 36; well logging problems covered in 10 CFR 39, and other types of equipment covered in 10 CFR 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 material as an integral part, or whose function is to interact with such material.

Examples of these problems include such things as a radiography source disconnect, a moisture density gauge being run over by a bulldozer, an irradiator source rack drive cable breaking, a well logging source being ruptured during a source recovery attempt, a fan motor failure in an exhaust hood used to store radioiodine, failure of a glove box connector gasket, or a damaged Type B shipping container. The radioactive material or source need not be damaged or leaking for the event to be considered an EQP event. Damage to a device housing, shutter, operation controls, or even a version of a software containing an error are covered in this category.

1. A defect or non-compliance involving the construction or operation of a facility or an activity that is subject to the licensing requirements under 10 CFR Parts 30, 40, 50, 60, 61, 70, 71, or 72.

2. A defect or non-compliance involving a basic component that is supplied for a facility or an activity that is subject to the licensing requirements under 10 CFR Parts 30, 40, 50, 60, 61, 70, 71, 72 or 76.

3. A piece of equipment that is disabled or fails to function as designed when the equipment is required by regulation or license condition to prevent releases exceeding regulatory limits, to prevent exposures to radiation and radioactive material exceeding regulatory limits, or to mitigate the consequences of an accident.

4. A piece of equipment that is disabled or fails to function as designed when the equipment is required to be available and operable.

5. A piece of equipment that is disabled or fails to function as designed when no redundant equipment is available and operable to perform the required safety function.

6. An unplanned fire or explosion damaging any licensed material or any device, container, or equipment containing licensed material when the damage affects the integrity of the licensed material or its container.

7. The actual or possible failure of, or damage to, the shielding of radioactive material or the on-off mechanism or indicator on a generally licensed device.

8. An unintentional disconnection of a radiography source assembly from the control cable.

9. The inability to retract a radiography source assembly to its fully shielded position and secure it in this position.

10. The failure of any radiography component (critical to safe operation of the device) to properly perform its intended function.

11. An irradiator source stuck in an unshielded position.

12. Damage to an irradiator's source racks.

13. Failure of the cable or drive mechanism used to move an irradiator's source racks.

14. Inoperability of an irradiator's access control system.

15. Structural damage to an irradiator's pool liner or walls.

16. Abnormal water loss or leakage from an irradiator's source storage pool.

17. Irradiator pool water conductivity exceeding 100 microsiemens per centimeter.

18. A licensee knows, or has reason to believe, that a well logging sealed source has been ruptured.

Transportation (TRS)

The TRS category includes a variety of transportation related events as follows:

1. The presence of removable surface contamination that exceeds the limits of Section 71.87(I).

2. The presence of external radiation levels that exceed the limits of Section 71.47.

3. Any significant reduction in the effectiveness of any approved Type B or fissile packaging during use.

4. Any defects with safety significance in Type B or fissile packaging after first use with the means employed to repair the defects and prevent their recurrence.

5. The conditions of approval in the certificate of compliance were not observed in making a shipment.

6. An accident involving a vehicle carrying licensed material regardless of whether the licensed material is damaged or spilled as a result of the accident.

7. Fire, breakage, spillage, or suspected contamination involving shipment of radioactive material.

Other (OTH)

The OTH event category includes a broad range of reportable events that do not specifically fit into one of the previous categories. This event type may also include events not reportable to the NRC but are included in the NMED program for informational purposes.

Appendix B

Statistical Trending Methodology

Appendix B

Statistical Trending Methodology

Trending - 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 scrams per plant year, then we could use regression methods to study whether there is a relationship between time and scram 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

$$f(x) = \alpha + \beta x \qquad (1)$$

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 y_i is an observed value of a random quantity that is normally distributed [with mean $f(x_i)$], and
- All the observations y_i are of variables with a common variance, σ^2.

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

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

$$\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x} .$$

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

$$\hat{y} = \hat{\alpha} + \hat{\beta}x ,$$

and an estimate of σ is

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

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,* appears in the numerator of *s*. It is defined as

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

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,* defined by the following equation.

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

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

$$SSE + SSR = SST ,$$

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

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

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 do 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-square, and is defined by:

$$r^2 = \frac{SSR}{SST}.$$

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 1.0 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

$$F = \frac{(n-2)r^2}{1-r^2}$$

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 β=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. The calculations were made both for an 9-year time period, and for a shorter 16-quarter time period. When the calculated F exceeded the 95th percentile, the trend line was shown on the graph and identified as being statistically significant. Otherwise, a horizontal line was plotted at the average of the associated data.

In future quarterly reports, trending the data is expected to continue. We may employ slightly different methods than the one explained above because the NMED data in many cases do not follow the assumptions listed above for the data. 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.

- Variation in counts tends 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 methods 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 least squares 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

Revision of Data Contained in the Third Quarter Fiscal Year 2006 Report

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Revision of Data Contained in the Third Quarter Fiscal Year 2006 Report

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 events class(es)
- Changes between fiscal quarters due to event date changes on individual events
- Record additions or subtractions due to changes to events from non-reportable to reportable (and vice versa)
- 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 C-1 through C-9 below show net numerical differences to the 16-quarter data previously published in the Third Quarter Fiscal Year 2006 report. A positive value indicates that the data has increased from that published in the previous report, while a negative value indicates a decrease from the previous report.

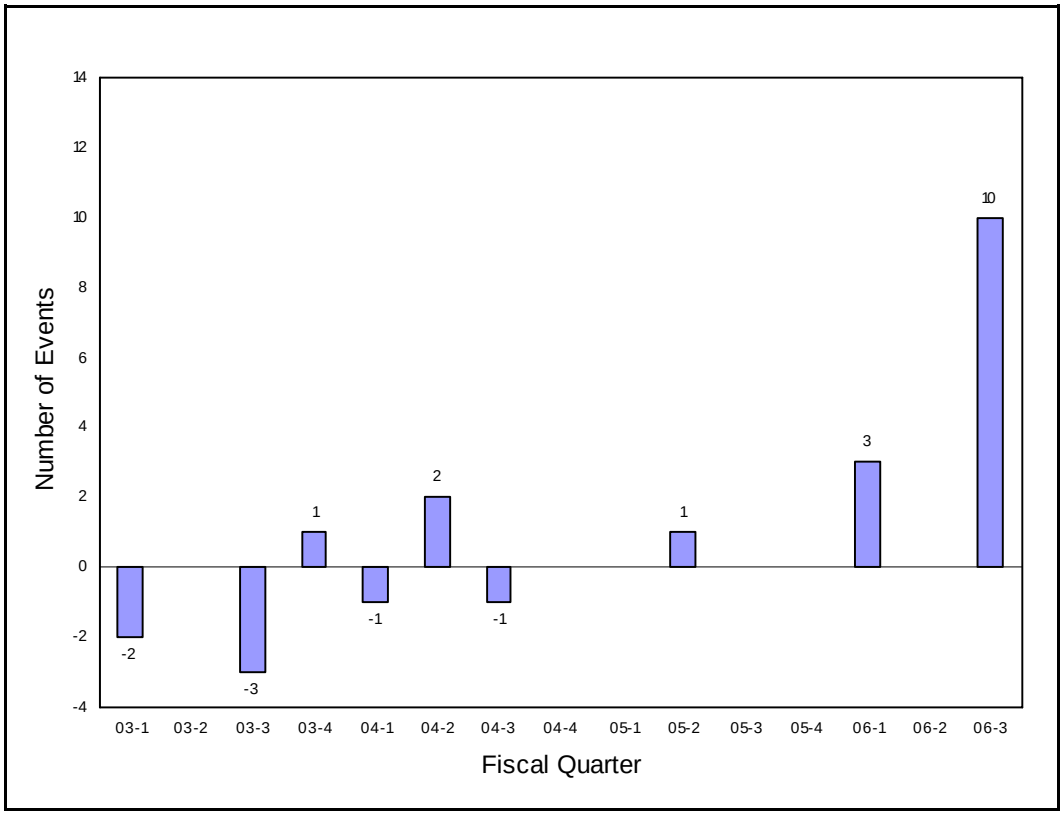

Figure C-1. Net Changes to All NMED Event Data (short-term display)

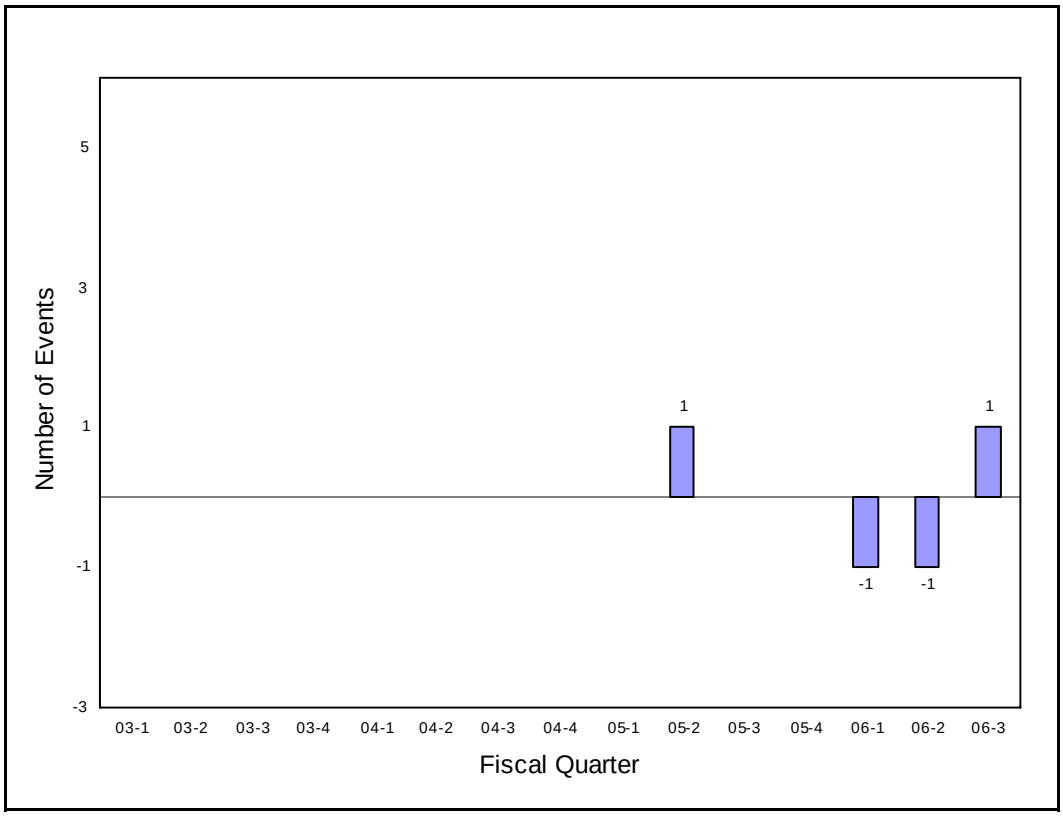

Figure C-2. Net Changes to MED Data (short-term display)

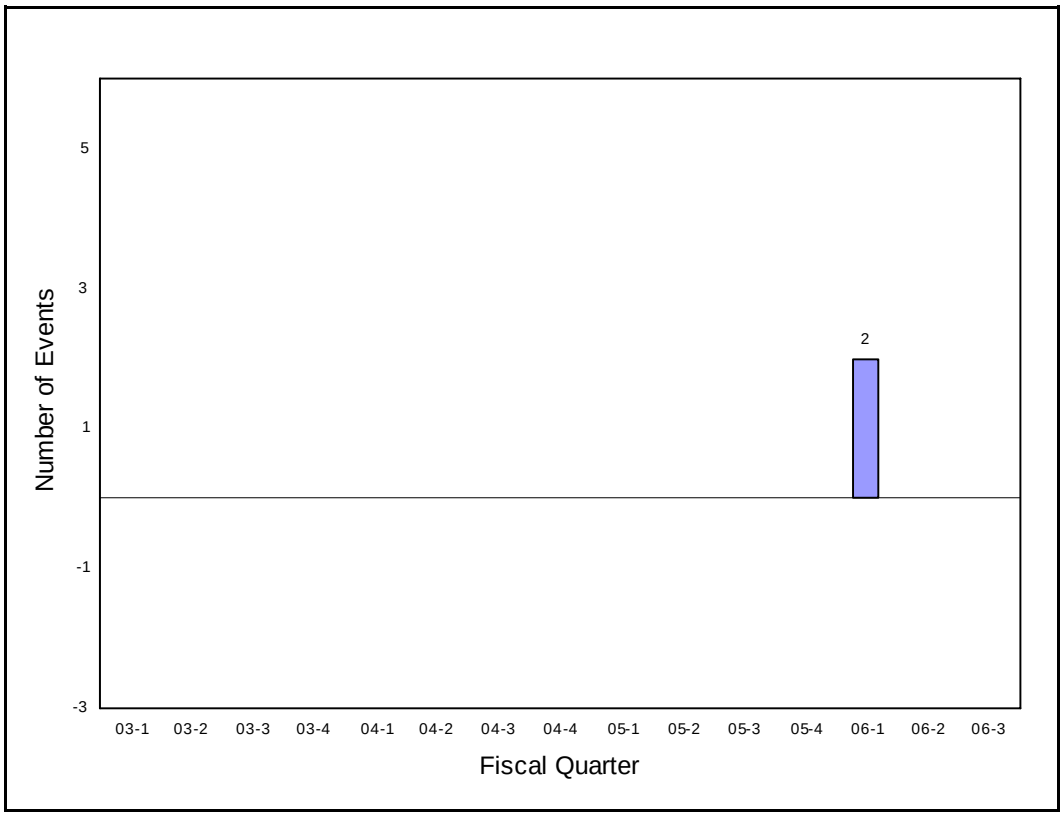

Figure C-3. Net Changes to EXP Event Data (short-term display)

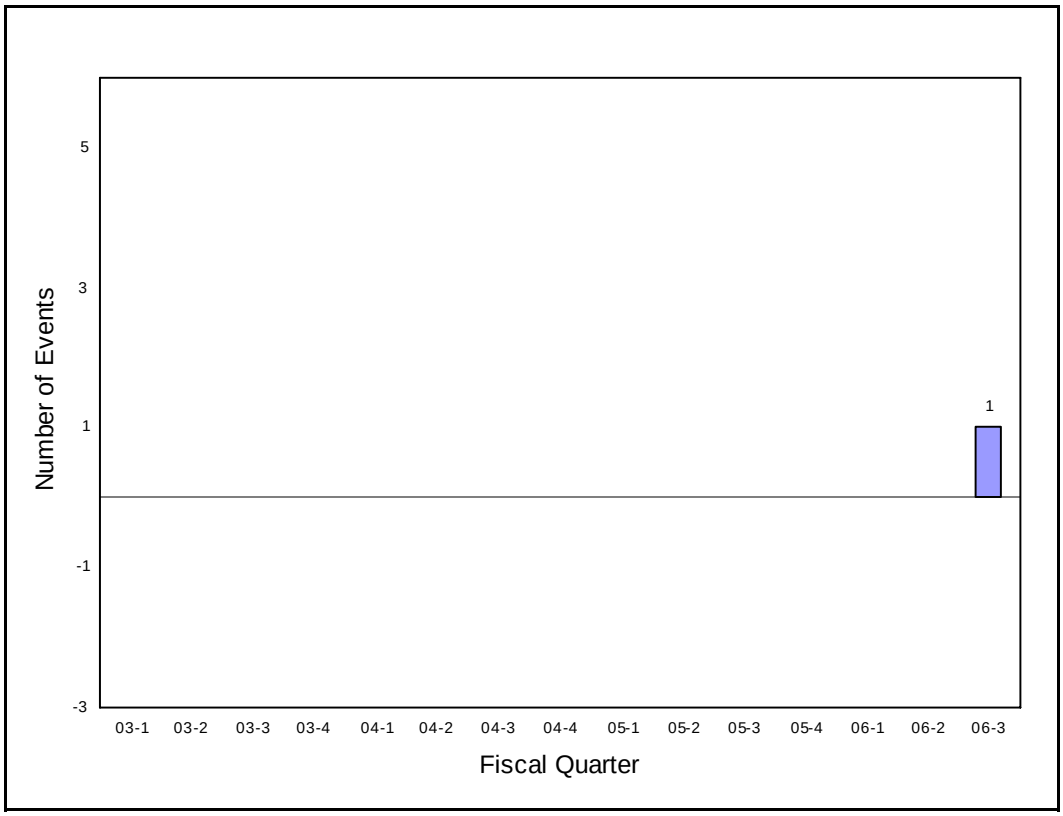

Figure C-4. Net Changes to RLM Event Data (short-term display)

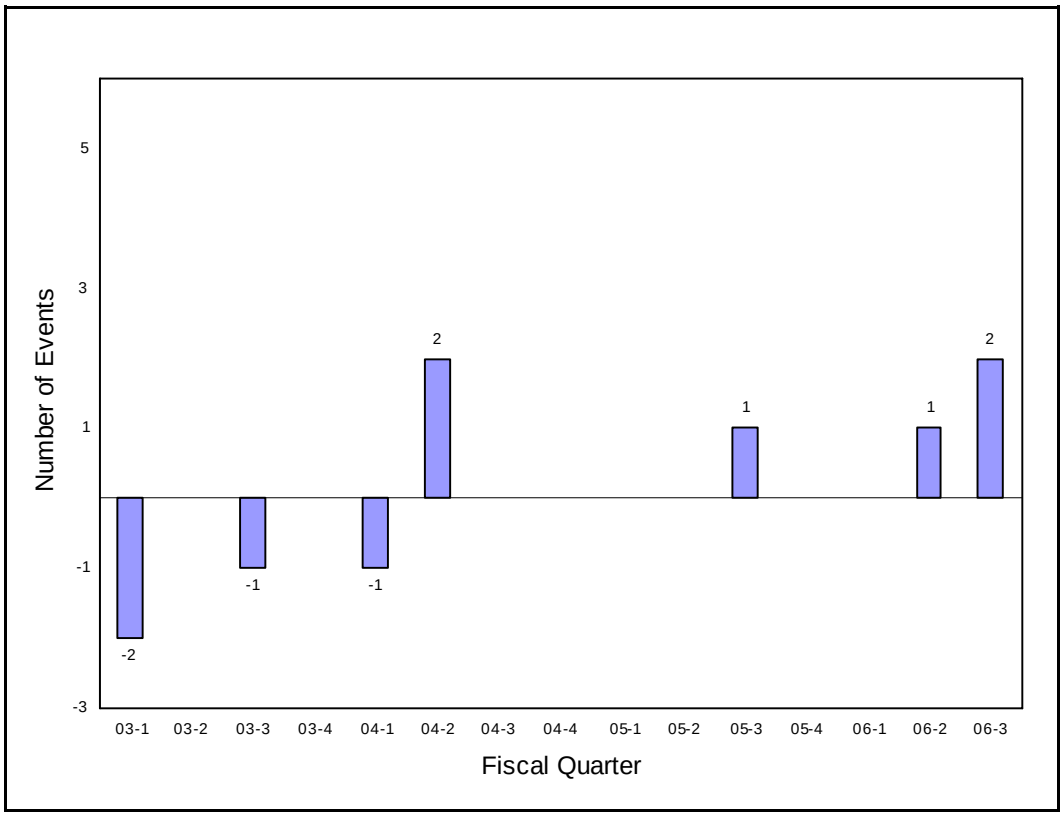

Figure C-5. Net Changes to LAS Event Data (short-term display)

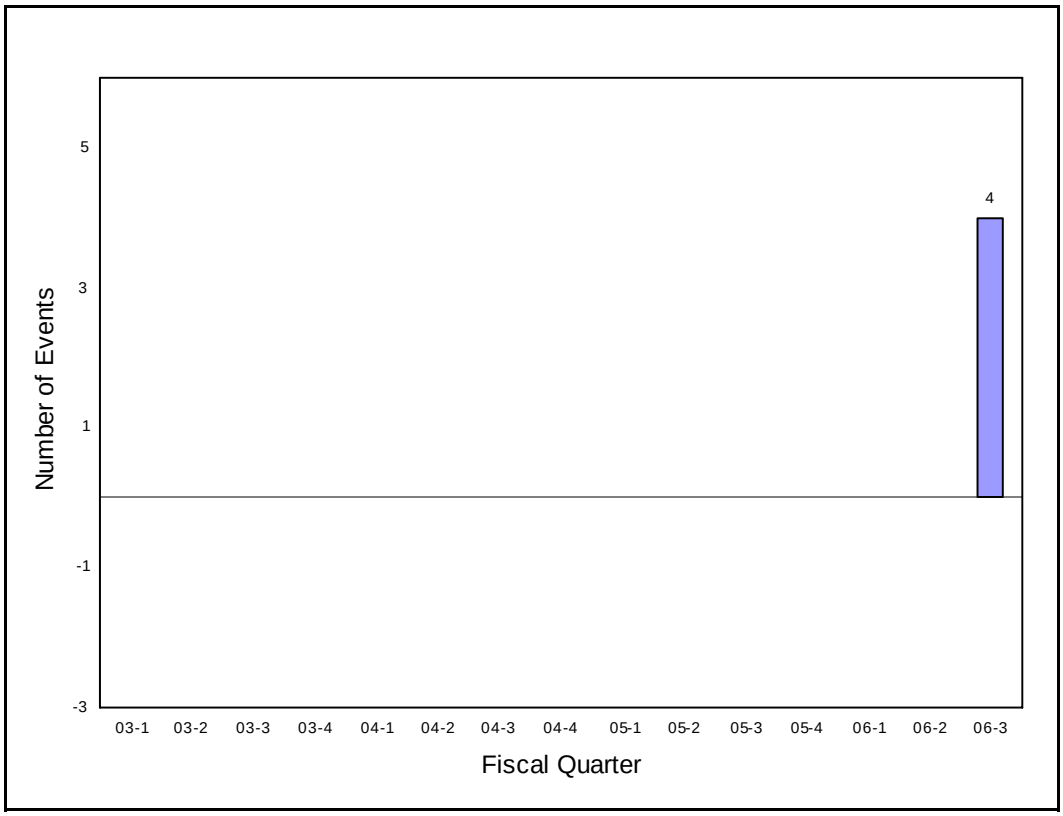

Figure C-6. Net Changes to LKS Event Data (short-term display)

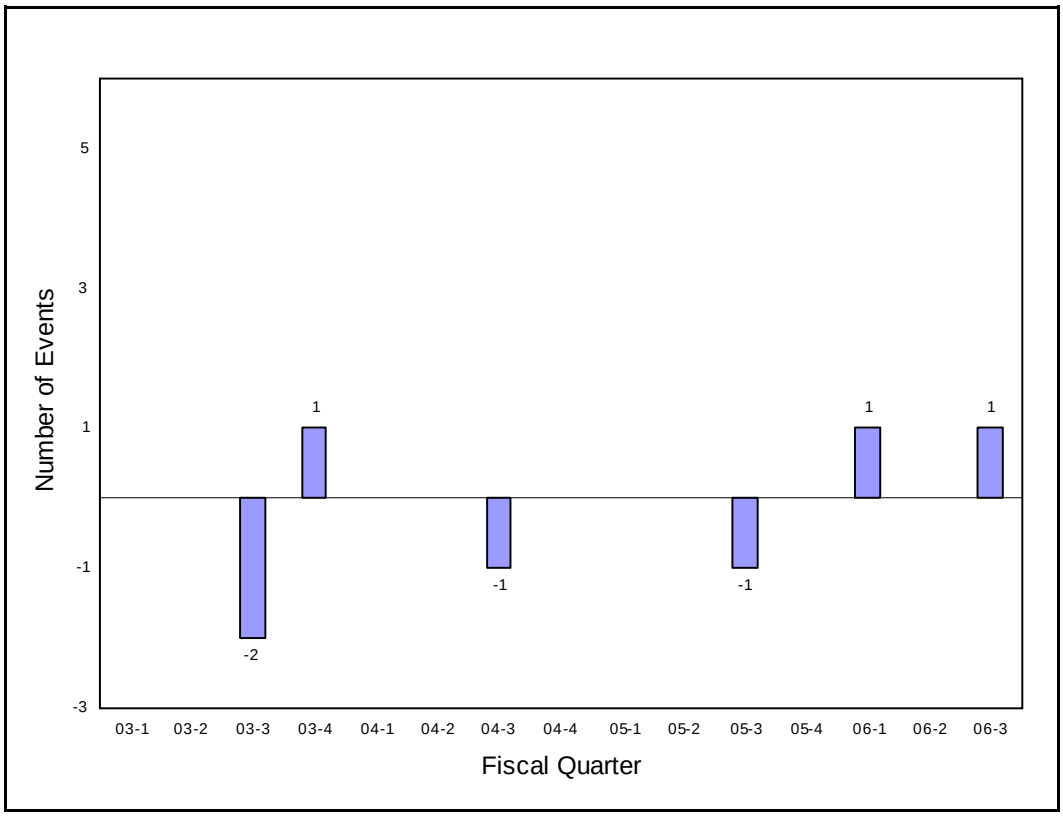

Figure C-7. Net Changes to EQP Event Data (short-term display)

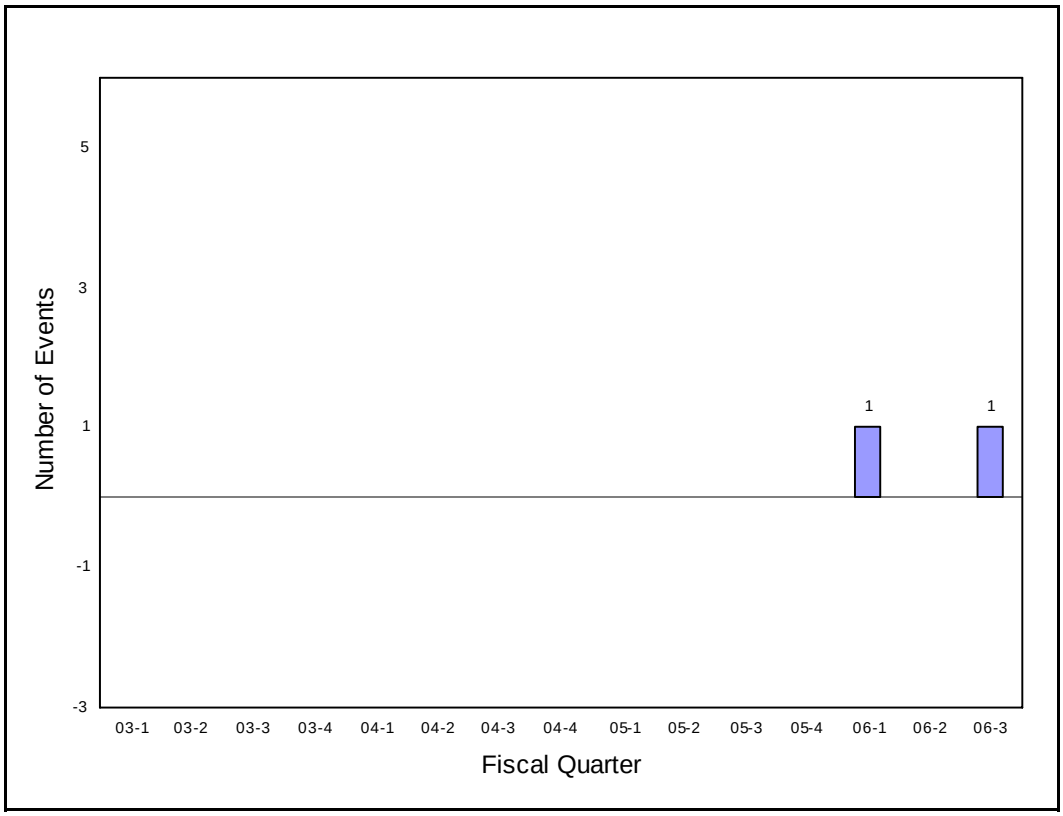

Figure C-8. Net Changes to TRS Event Data (short-term display)

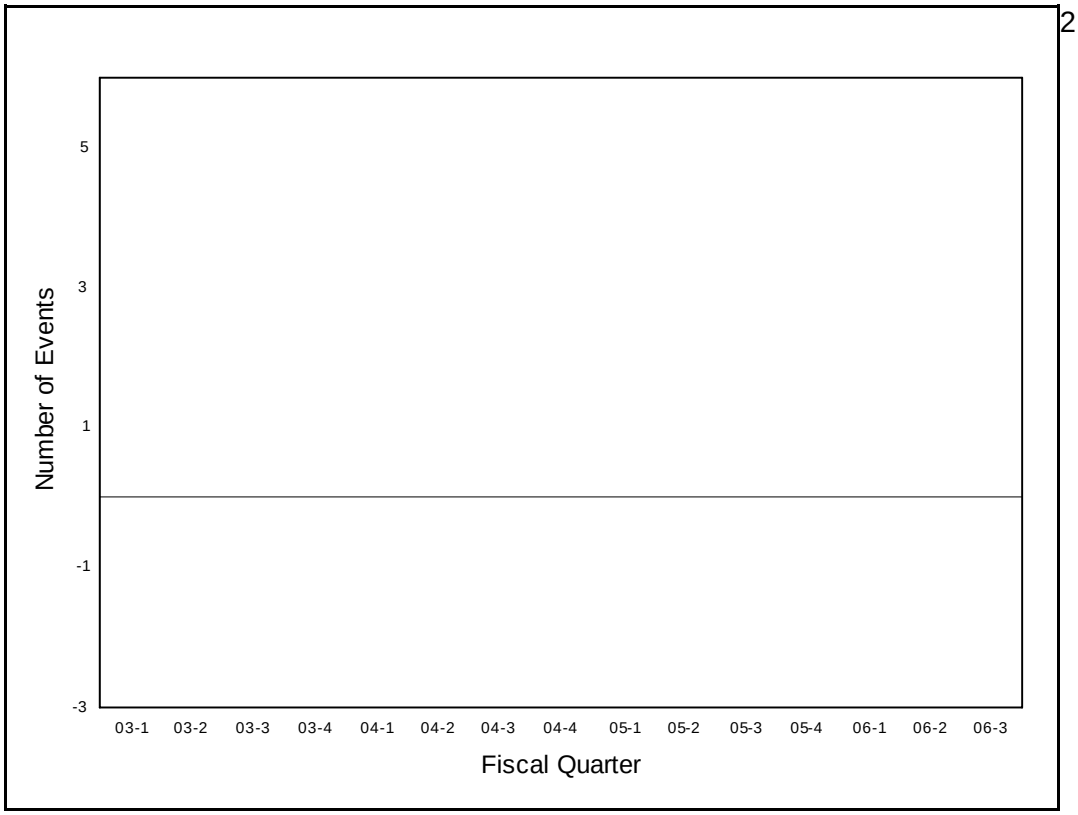

Figure C-9. Net Changes to OTH Event Data (short-term display)