POLICY ISSUE
(Information)

April 10, 2014 SECY-14-0042

FOR: The Commissioners

FROM: Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

SUBJECT: FISCAL YEAR 2013 RESULTS OF THE INDUSTRY TRENDS PROGRAM FOR OPERATING POWER REACTORS

PURPOSE:

The purpose of this paper is to inform the Commission of the results of the U.S. Nuclear Regulatory Commission's (NRC's) Industry Trends Program (ITP) for fiscal year (FY) 2013. This paper also provides a response to a staff requirements memorandum (SRM) issued by the Commission on June 13, 2013, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13164A337) in response to the May 29, 2013, "Briefing on the results of the Agency Action Review Meeting (AARM)" (ADAMS Accession No. ML13155A441). This paper does not address any new resource implications.

BACKGROUND:

The NRC staff implemented the ITP in 2001 to monitor for adverse trends in safety performance based on industry-level indicators. After the NRC assesses statistically significant adverse trends for safety significance, it responds, as necessary, to any identified safety issues, including adjustments to the inspection and licensing programs. One important output of the ITP is the annual agency performance measures reported to Congress on the number of statistically significant adverse industry trends in safety performance. This outcome measure is part of the NRC Performance and Accountability Report (PAR). In addition, the NRC annually

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reviews the results of the ITP and any actions taken or planned during the AARM. The NRC reports the findings of this review to the Commission. This paper is the 14th annual report to the Commission on the ITP.

NRC Inspection Manual Chapter (IMC) 0313, “Industry Trends Program,” dated May 29, 2008 (ADAMS Accession No. ML080860540) contains details of the ITP, including definitions of monitored indicators and program descriptions.

DISCUSSION:

Using the ITP, the staff monitors industry safety performance to identify and address any statistically significant adverse industry trends. The ITP indicators are based on the best available data. A statistically significant adverse trend exists if the slope of the regression line fitted to the long-term indicator data has a positive value and the fit of the regression line is statistically significant.

The ITP also uses precursor events identified by the Accident Sequence Precursor (ASP) Program to assess industry performance. The staff analyzes the occurrence rate of precursors to determine if an adverse trend exists. The staff uses results from the ASP program as one of the agency’s safety-goal performance measures reported in the NRC Performance and Accountability Report.

In addition to the long-term indicators, the ITP uses a statistical approach based on prediction limits to identify potential short-term year-to-year emergent issues before they become long-term trends. The short-term prediction limits are determined from a predictive distribution derived using information from an established baseline period. These prediction limits are reevaluated each year.

The ITP complements the Reactor Oversight Process (ROP). The ITP monitors industry level performance, whereas the ROP provides oversight to individual plants commensurate with their safety performance.

The Office of Nuclear Regulatory Research (RES) provides indirect support to the ITP in the areas of operating experience data and models that are developed and budgeted under other RES programs, such as the Standardized Plant Analysis Risk Model Development Program, the ASP Program, and the Reactor Operating Experience Data Collection and Analysis Program. The ITP uses the results of RES work in the ASP Program to assess industry performance, although the funding and performance of RES work are separate from the ITP.

FY 2013 LONG-TERM INDUSTRY TRENDS:

Based on the ITP indicators and the ASP program results, the staff did not identify any statistically significant adverse trends in industry safety performance. The graphs in Enclosure 1 show the long-term ITP indicator trends and the ASP data. The staff removed the trendlines from the graphs in Enclosure 1 that did not have a statistically significant trend. The staff evaluated both linear and exponential trendlines for each set of data and used the trendline showing the highest degree of statistical significance. The staff observed that a number of indicators displayed a statistically significant improving trend. The staff considers this improvement of industrywide performance to be reflective of a number of industry initiatives as well as the ROP's effectiveness in inspecting, measuring, assessing, and responding to plant performance.

The ASP Program considers an event with a conditional core-damage probability (CCDP) or an increase in core-damage probability (ΔCDP) greater than or equal to 1×10^{-6} to be a precursor. The RES staff evaluated precursor data from FY 2003 through FY 2012 and identified no statistically significant trends for the occurrence rate of all precursors during that period (Figure 14 of Enclosure 1). Additional information can be found in Section 4.1 of Enclosure 1 of SECY-13-0107, "Status of the Accident Sequence Precursor Program and the Standardized Plant Analysis Risk Models," dated October 4, 2013 (ADAMS Accession No. ML13232A092). The evaluation of FY 2013 precursor data is still ongoing and not included in this paper.

The ASP Program also provides the basis for the safety performance measure of zero *significant* precursors of a nuclear reactor accident. This is one measure that is associated with the safety goal in the NRC's annual PAR (ADAMS Accession No. ML13350A620). A *significant* precursor is an event that has a probability of at least 1 in 1,000 (i.e., CCDP or ΔCDP greater than or equal to 1×10^{-3}) of leading to a reactor accident. The RES staff is completing preliminary analyses on precursor events and anticipates no *significant* precursors in FY 2013.

The RES staff identified five precursors that might meet the criteria for *significant* events (i.e., a *significant* event in the ITP is one that has a CCDP or ΔCDP greater than or equal to 1×10^{-5}). The RES staff will complete its evaluation of FY 2013 precursors to obtain final results. The staff will update the FY 2013 precursor data and will report any changes to the ITP analysis in a memorandum to the Commission after receiving the final ASP results from RES. The staff recognizes that a statistically significant adverse trend in the *significant* events indicator will exist if the final ASP results for these five precursor events indicate that these meet the ITP *significant* events criteria.

FY 2013 SHORT-TERM INDUSTRY PERFORMANCE:

The staff uses a statistical approach based on prediction limits to identify potential short-term year-to-year emergent issues before they become long-term trends. Enclosure 2 shows the short-term results and the prediction limits for each of the ITP indicators. None of the indicators exceeded its prediction limit in FY 2013. Short-term FY 2013 data did not reveal any emerging trends that warranted additional analysis or significant adjustments to the nuclear reactor safety inspection or licensing programs. However, the staff observed that the short-term data for the safety system failures indicator was close to exceeding its short-term prediction limit. The staff noticed an increase in the reporting of safety system failures after issuing NUREG-1022, Rev. 3, "Event Report Guidelines: 10 CFR 50.72 and 50.73," (ADAMS Accession No. ML13032A220), which clarified the criteria for event reporting.

FY 2013 RESULTS OF BASELINE RISK INDEX FOR INITIATING EVENTS:

In 2008, the NRC staff implemented the Baseline Risk Index for Initiating Events (BRIIE) as part of the ITP. The BRIIE (1) tracks several types of events that could potentially initiate a challenge to a plant's safety systems, (2) assigns a value to each initiating event (IE) according to its relative importance to the plant's overall risk of damage to the reactor core, and (3) calculates an overall indicator of industry safety performance.

The BRIIE concept provides a two-level approach to industry performance monitoring. The first level (referred to as Tier 1 performance monitoring) tracks and counts the number of times that the IEs that affect plant safety occur in nuclear power plants during the year. Nine IE categories are monitored for boiling-water reactors and 10 for pressurized-water reactors. The number of times that each event occurs is compared to a predetermined number of occurrences for that event. The predetermined number of occurrences is calculated from a predictive distribution derived using information from an established baseline period; it is reevaluated on an annual basis. If the predetermined number is exceeded, one can infer the possible degradation of industry safety performance. This annual tracking allows the NRC to intervene and engage the nuclear industry before any long-term adverse trends in performance emerge.

The second level (referred to as Tier 2 performance monitoring) addresses the risk to plant safety and core damage that each of the initiating events contributes. Each event is assigned an importance value, a ranking based on its relative contribution to overall risk to plant safety. The greater the contribution of the event to overall risk, the higher the importance value it is assigned. Using statistical methods, the importance values are combined with the number of times the events occur during the year to calculate a number that indicates how much the overall industry risk of damage to the reactor core has changed from a baseline value. If the BRIIE-combined industry value reaches or exceeds a threshold value of 1×10^{-5} per reactor critical year, the NRC informs Congress of this performance outcome, along with actions that have already been taken or are planned in response, in the NRC Performance and Accountability Report.

Enclosure 3 includes Tier 1 and Tier 2 BRIIE results. None of the IEs tracked in Tier 1 exceeded its prediction limit in FY 2013. For Tier 2, Figure 15 of Enclosure 3 shows that the combined industry BRIIE value for FY 2013 (-2.52×10^{-6} per reactor critical year) is negative, which indicates that industry performance was better than baseline. The combined industry BRIIE value is below the established reporting threshold of $\Delta CDF = 1.0\times10^{-5}$ per reactor critical year.

PROGRAM REVIEW:

On June 13, 2013, the Commission issued an SRM (ADAMS Accession No. ML13164A337) in response to the May 29, 2013, "Briefing on the results of the Agency Action Review Meeting (AARM)" (ADAMS Accession No. ML13155A441). In this SRM the Commission directed the staff to perform a review of the ITP as follows:

As part of the Reactor Oversight Process (ROP) Self-Assessment for calendar year (CY) 2013, the staff should review implementation of the Industry Trends Program over its history for lessons learned and inform the Commission of any program enhancements and/or resource reductions that may be warranted.

The staff focused its review in the following areas: (1) program objectives, (2) indicators used in the program, (3) long-term analysis, (4) short-term analysis, (5) implementation of the BRIIE, and (6) additional considerations. The staff completed its review of the implementation of the ITP for lessons learned and concluded that:

- No changes to or a realignment of the ITP objectives (as listed in the program guidance) are warranted.

- An indicator representative of the Public Radiation Safety cornerstone and the Security cornerstone of the ROP should be included in the ITP.

- The potential use of ROP Performance Indicators (PIs) to supplement or replace ITP indicators and unnecessary duplication among ITP indicators should be evaluated. This may offer an opportunity for the NRC to achieve better resource efficiencies.

- The ASP outcomes should not be replaced with Management Directive (MD) 8.3, “NRC Incident Investigation Program” (ADAMS Accession No. ML031250592), results for ITP purposes.

- The significant events indicator data before FY 2007 do not reflect the same definition for the indicator, but no adjustments to the data or its sources are warranted at this time.

- No changes to the ITP long-term analysis process are warranted.

- No changes to the ITP short-term analysis process are warranted.

- No changes to the BRIIE process are warranted.

- The staff should explore ways to incorporate industrywide performance of new reactors in the ITP.

The staff’s review of the program, conclusions, and commitments for addressing its conclusions are discussed in more detail in Enclosure 4 of this paper.

<u>COMMITMENTS</u>:

The staff commits to the following:

- Consider the use of the Public Radiation Safety cornerstone ROP performance indicator (i.e., Radiological Effluence Occurrence) in the ITP.

- Consider the use of the Security cornerstone ROP performance indicator (i.e., Protected Area Security Equipment Performance Index) in the ITP.

- Evaluate the possibility of supplementing and/or replacing ITP indicators with ROP PIs where applicable.

- Evaluate the use of performance data for new reactors in the ITP, as applicable.

The staff intends to report to the Commission on its progress towards meeting these commitments in future ITP SECY papers.

<u>CONCLUSION</u>:

As discussed in this paper, for FY 2013, the staff identified no statistically significant adverse trends in industry safety performance. Specifically, no ITP indicator exceeded its prediction limit, and the BRIIE value remained below the threshold for a report to Congress. The staff will update the FY 2013 *significant* events data after receiving the final ASP results from RES and will report any changes to the ITP analysis in a memorandum to the Commission.

RESOURCES:

For ITP activities, resources are included in the FY 2014 enacted budget of 0.5 full-time equivalent (FTE) and $595K; and in the FY 2015 Request of 0.5 FTE and $595K. These resources are to conduct ongoing ITP implementation in FY 2014 and FY 2015. No additional funds beyond those already budgeted will be required for the program. Any additional resources required in the future years will be addressed during the Planning, Budgeting, and Performance Management process.

COORDINATION:

The Office of the Chief Financial Officer has reviewed this paper and concurs. The Office of the General Counsel has reviewed this paper and has no legal objection.

/RA/

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Enclosures:
1. Fiscal Year 2013 Long-Term Industry Trend Results
2. Fiscal Year 2013 Short-Term Industry Performance
3. Summary of Baseline Risk Index for Initiating Events: Annual Graphs through Fiscal Year 2013
4. Staff's Review of the Industry Trends Program

FISCAL YEAR 2013 LONG-TERM INDUSTRY TREND RESULTS

The staff of the U.S. Nuclear Regulatory Commission did not observe any statistically significant adverse trends in the Industry Trends Program performance indicator data from the most recent 10 years (fiscal years 2004–2013), as indicated by the figures below.

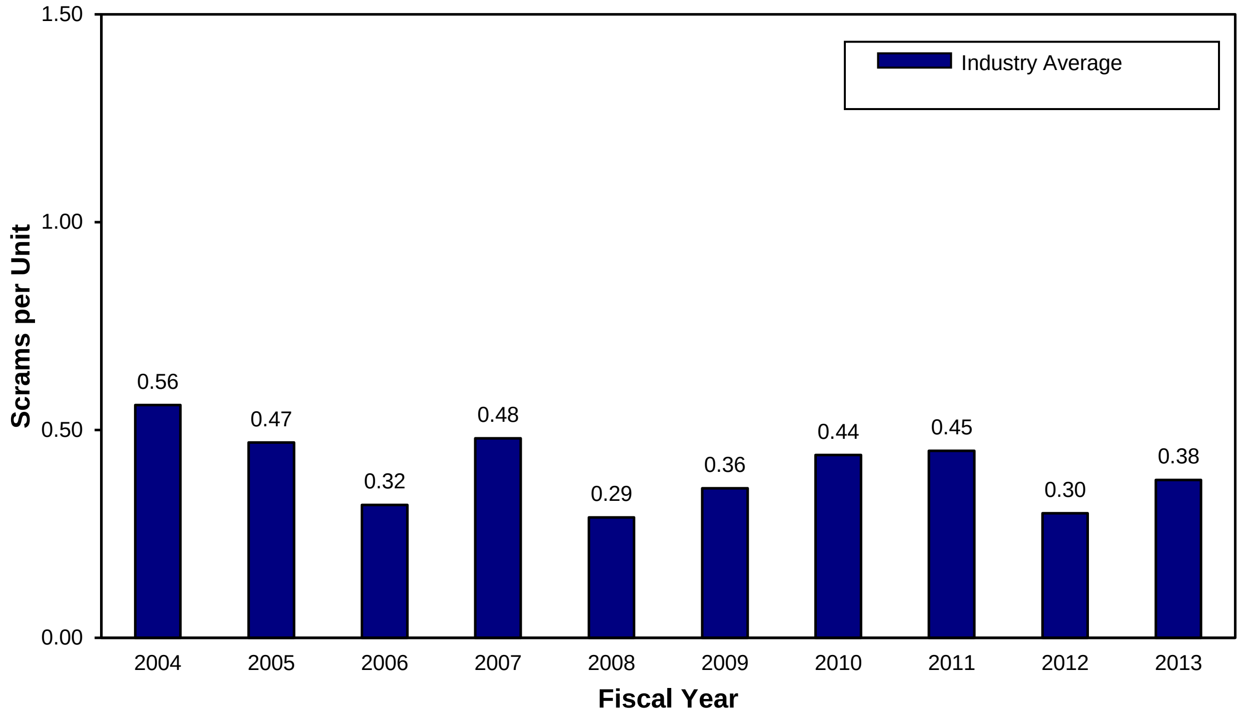


Figure 1. Automatic scrams while critical

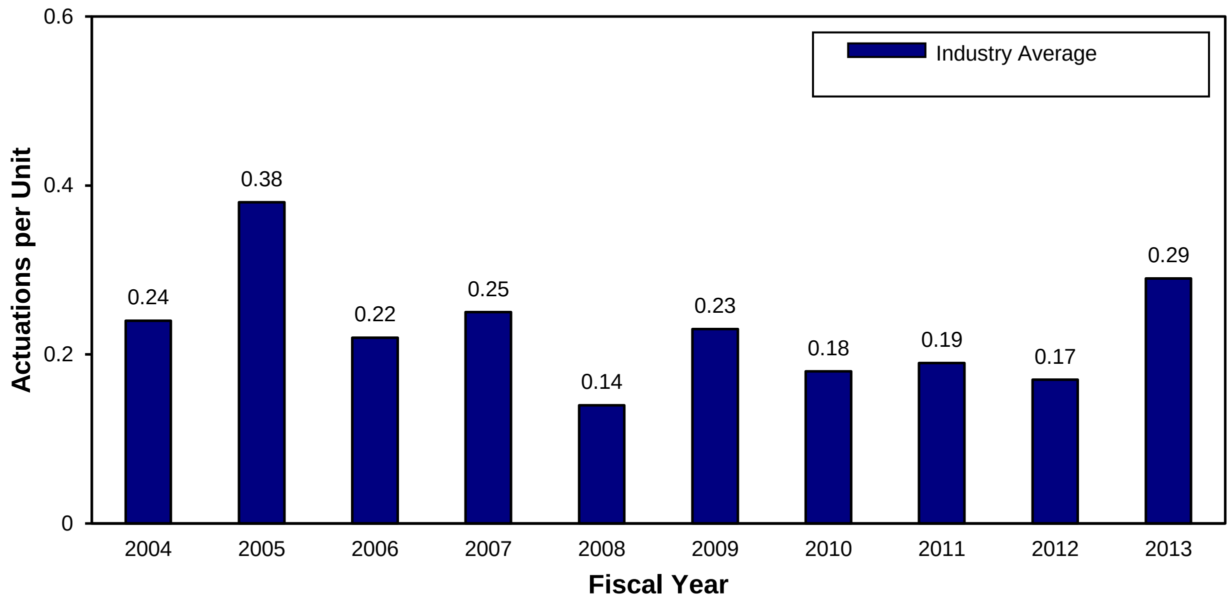


Figure 2. Safety-system actuations

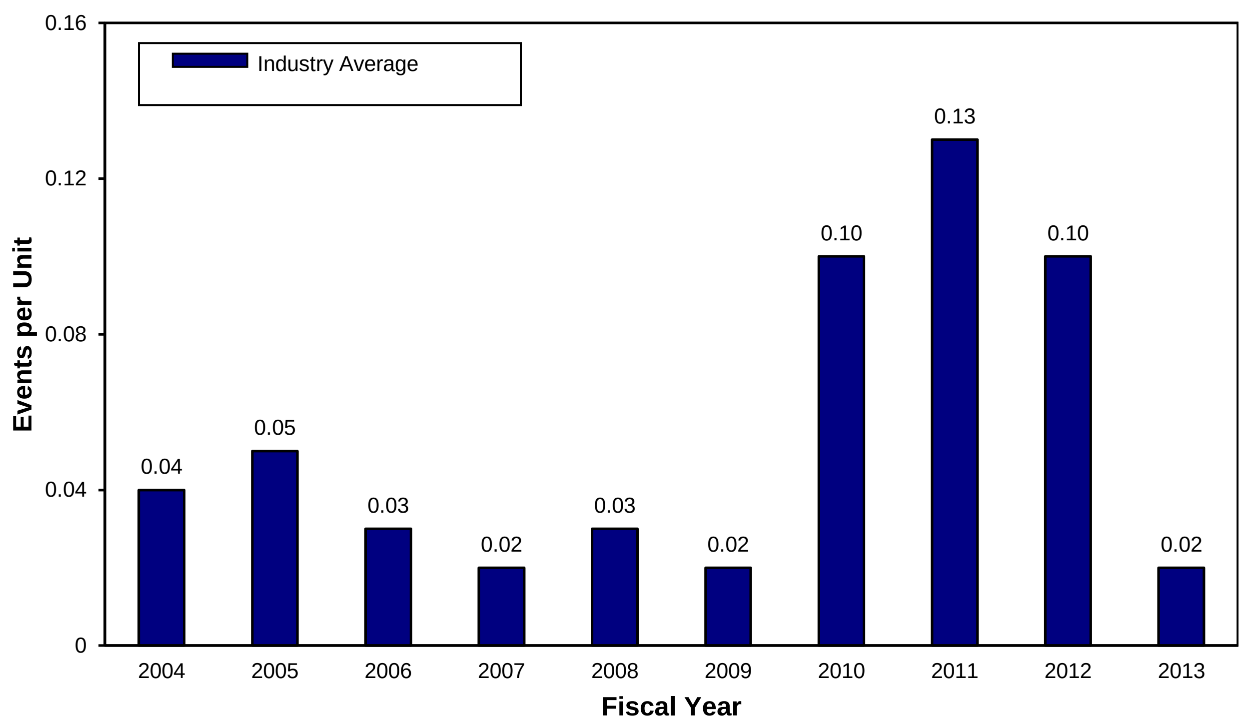


Figure 3. Significant events

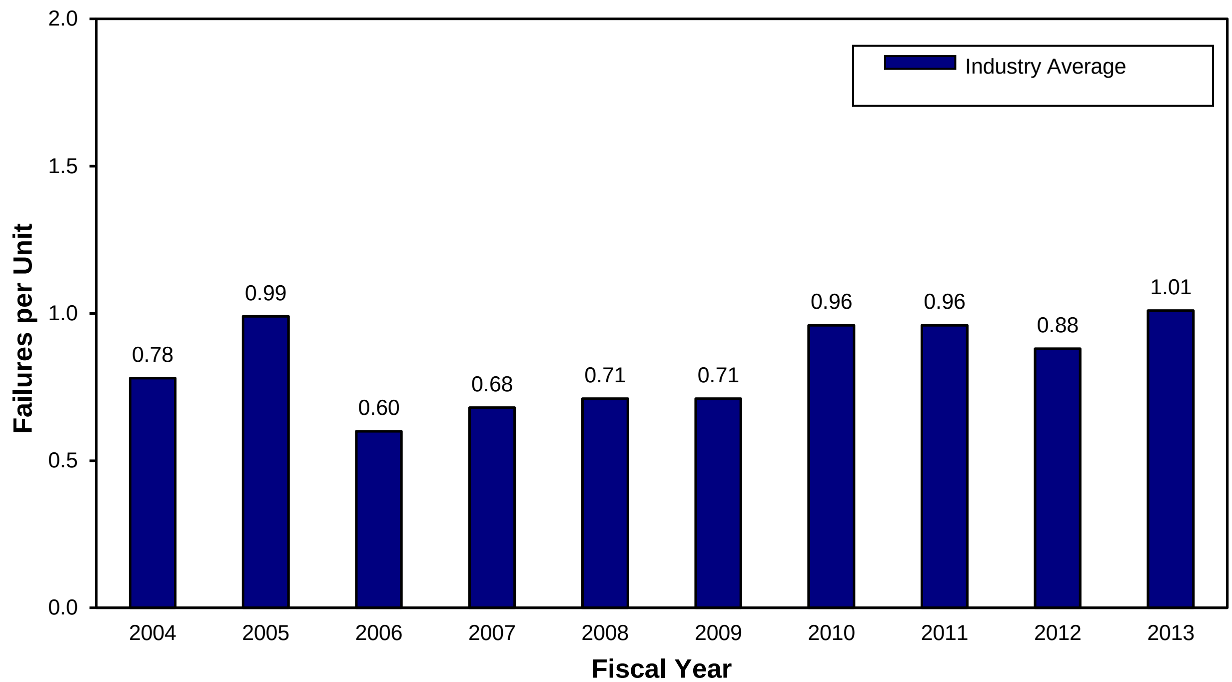


Figure 4. Safety-system failures

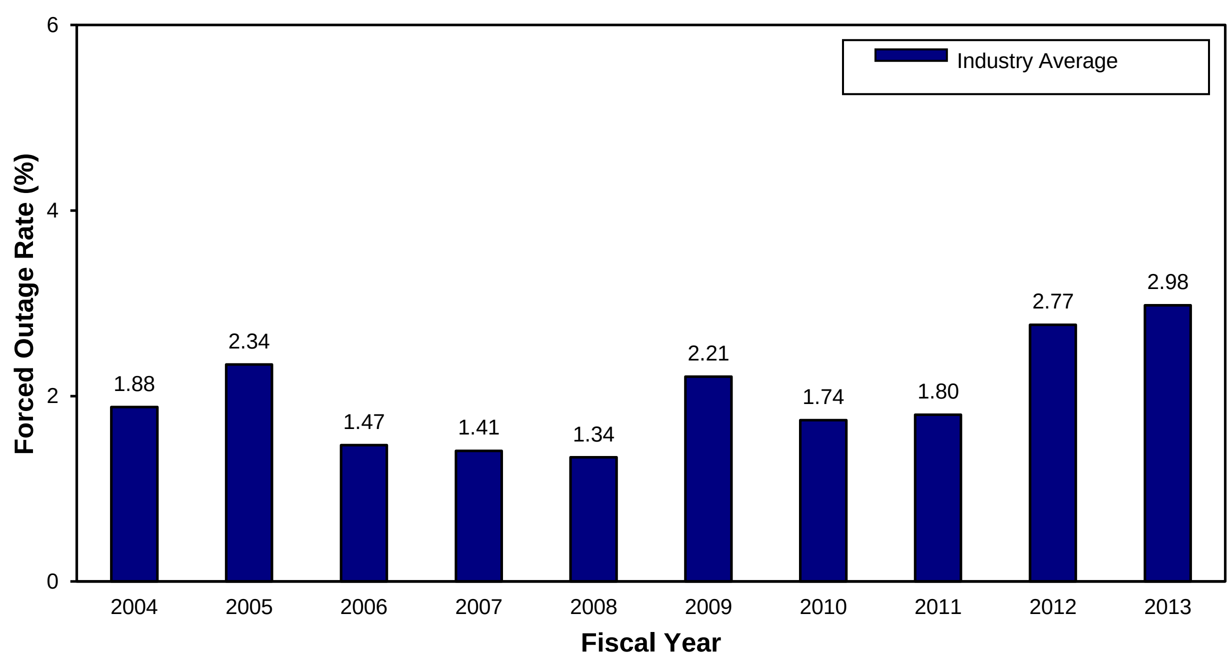


Figure 5. Forced outage rate

As discussed in this paper, Figures 1 through 5 do not display a trendline because these graphs do not have a statistically significant trend.

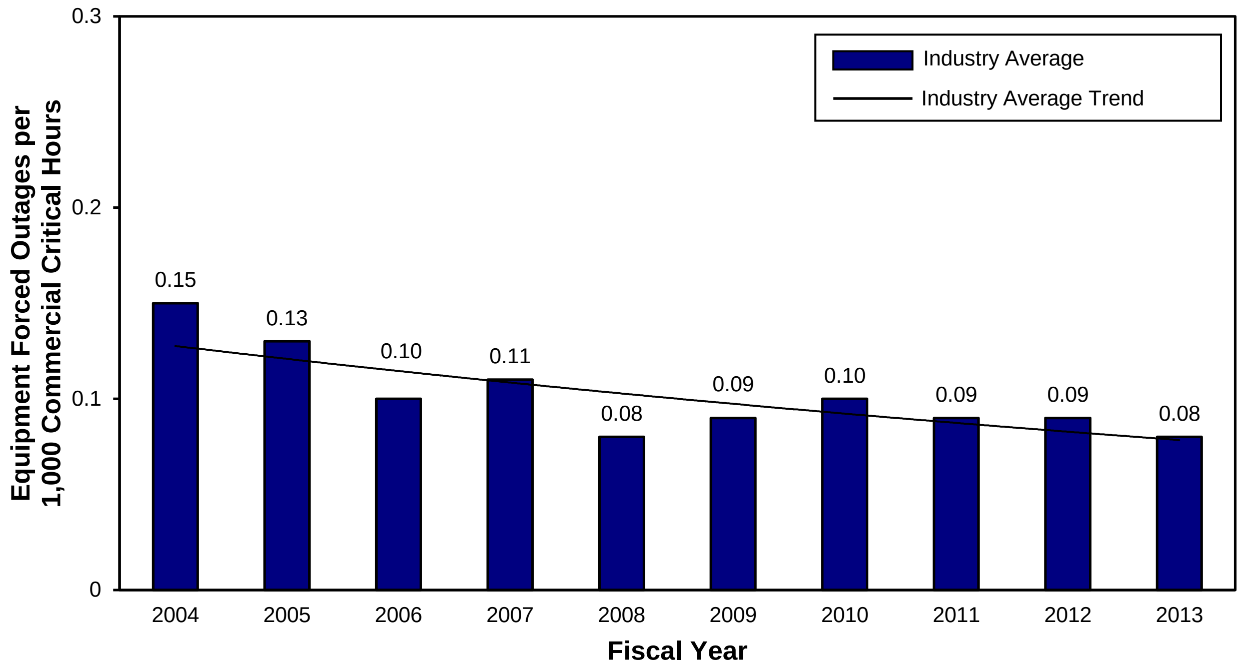


Figure 6. Equipment forced outages

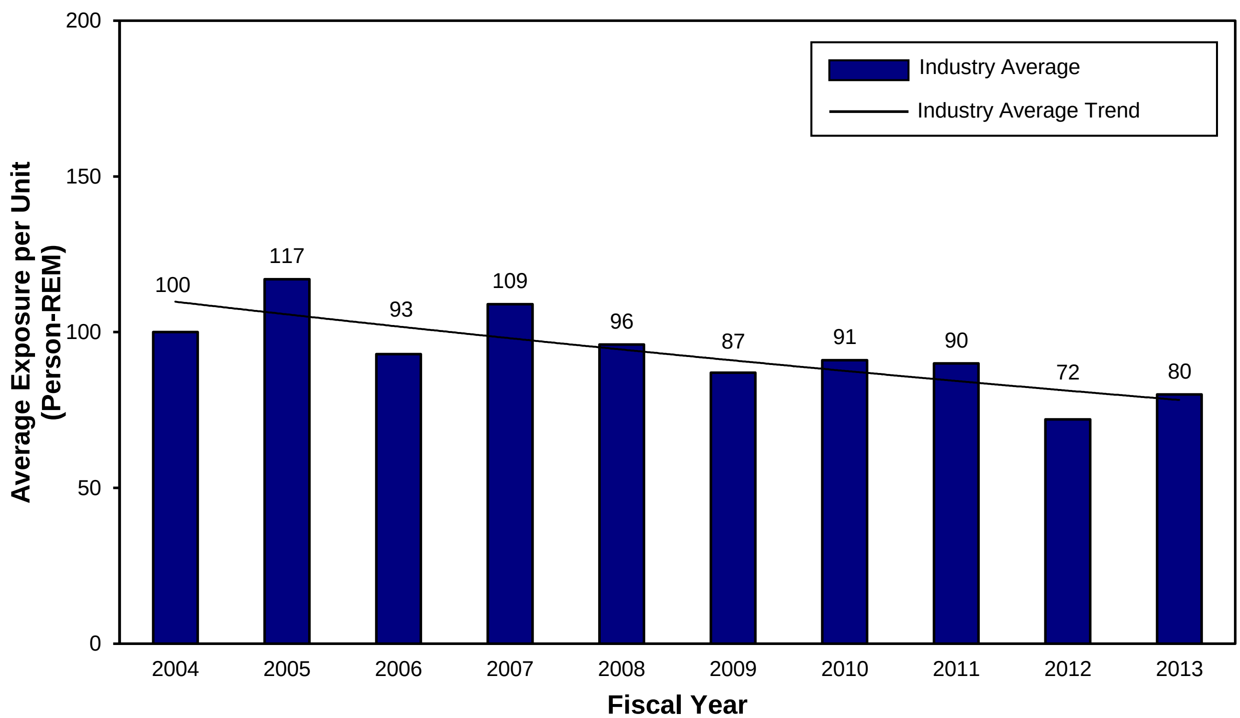


Figure 7. Collective radiation exposure

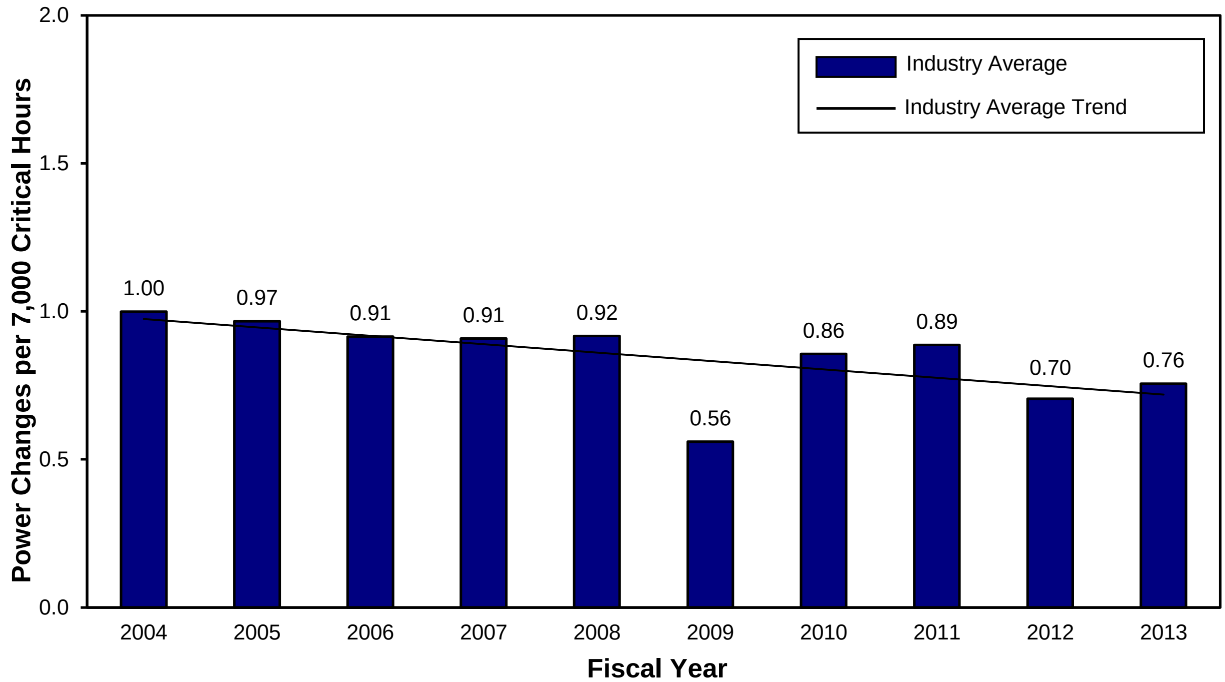


Figure 8. Unplanned power changes

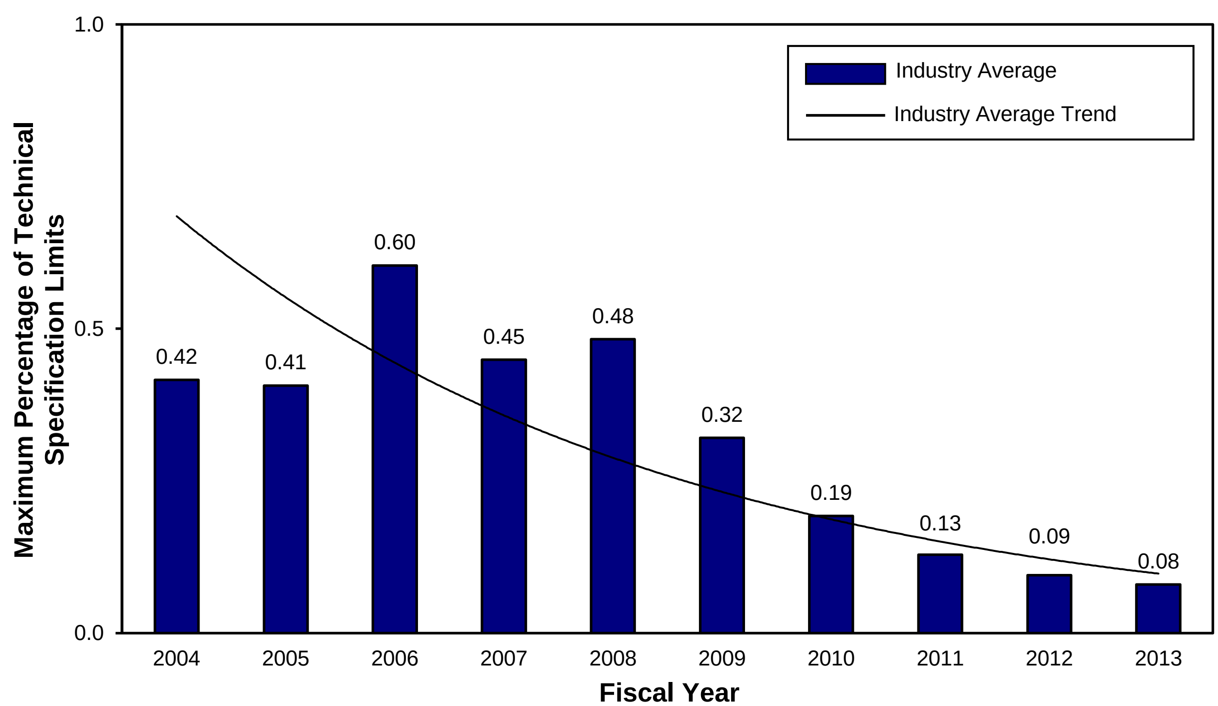


Figure 9. Reactor coolant system activity

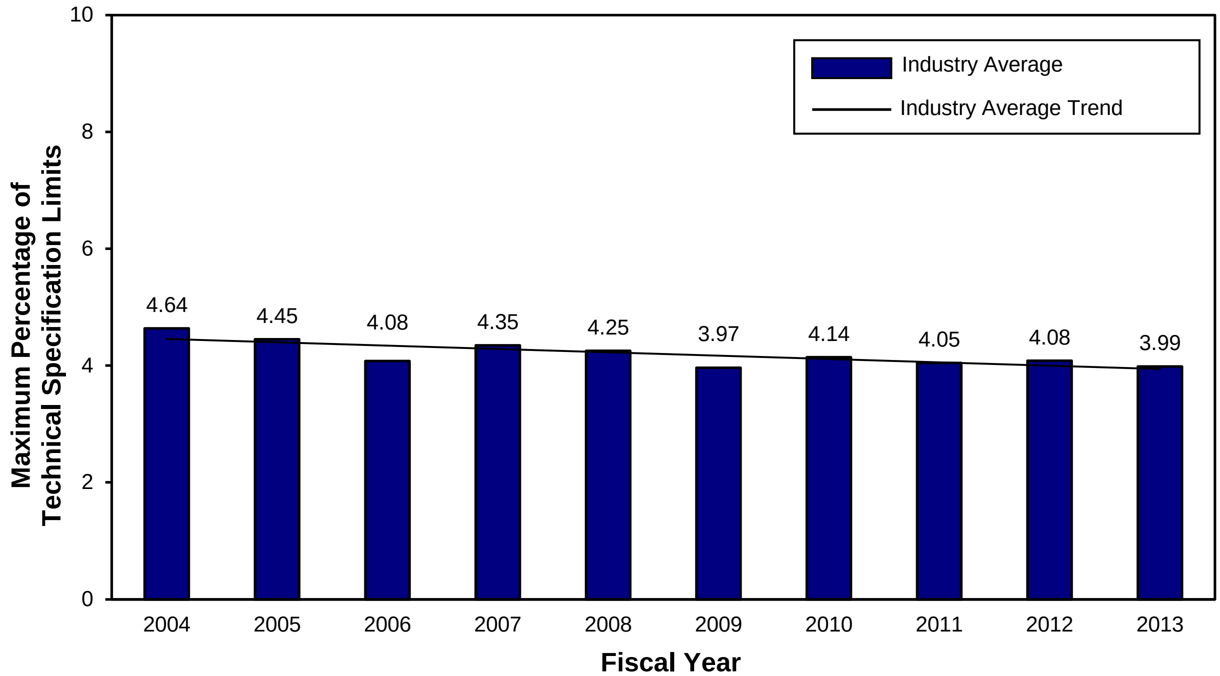


Figure 10. Reactor coolant system leakage

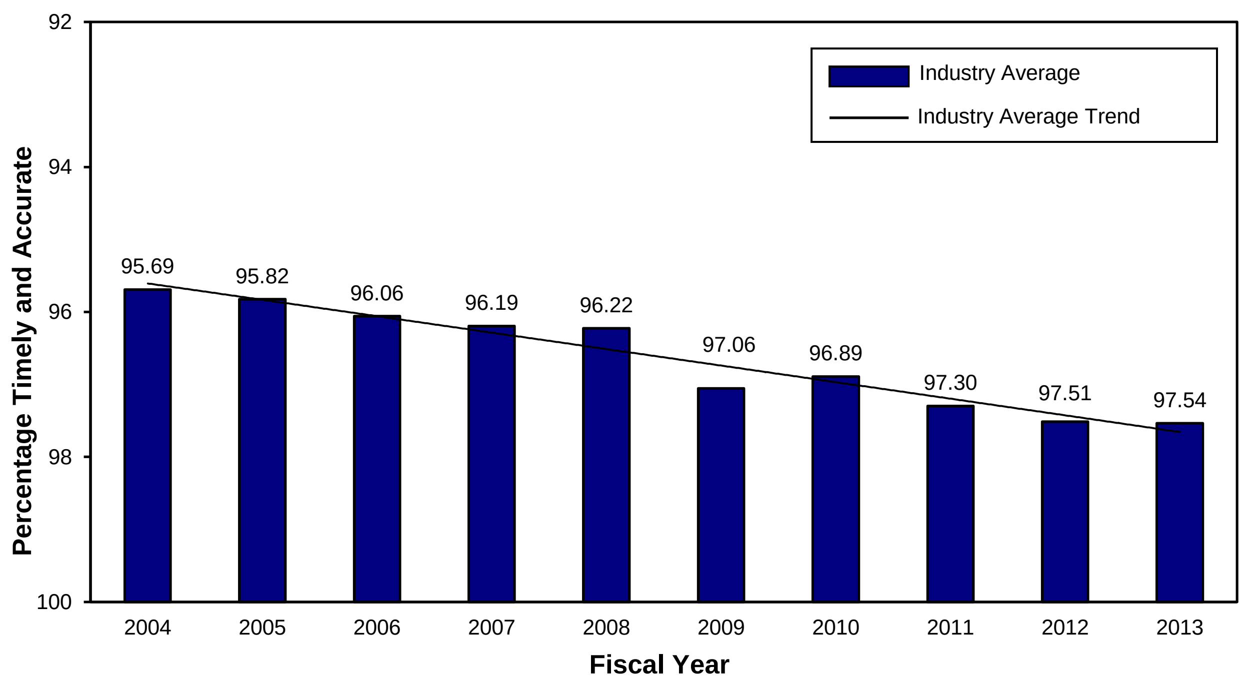


Figure 11. Drill and exercise performance

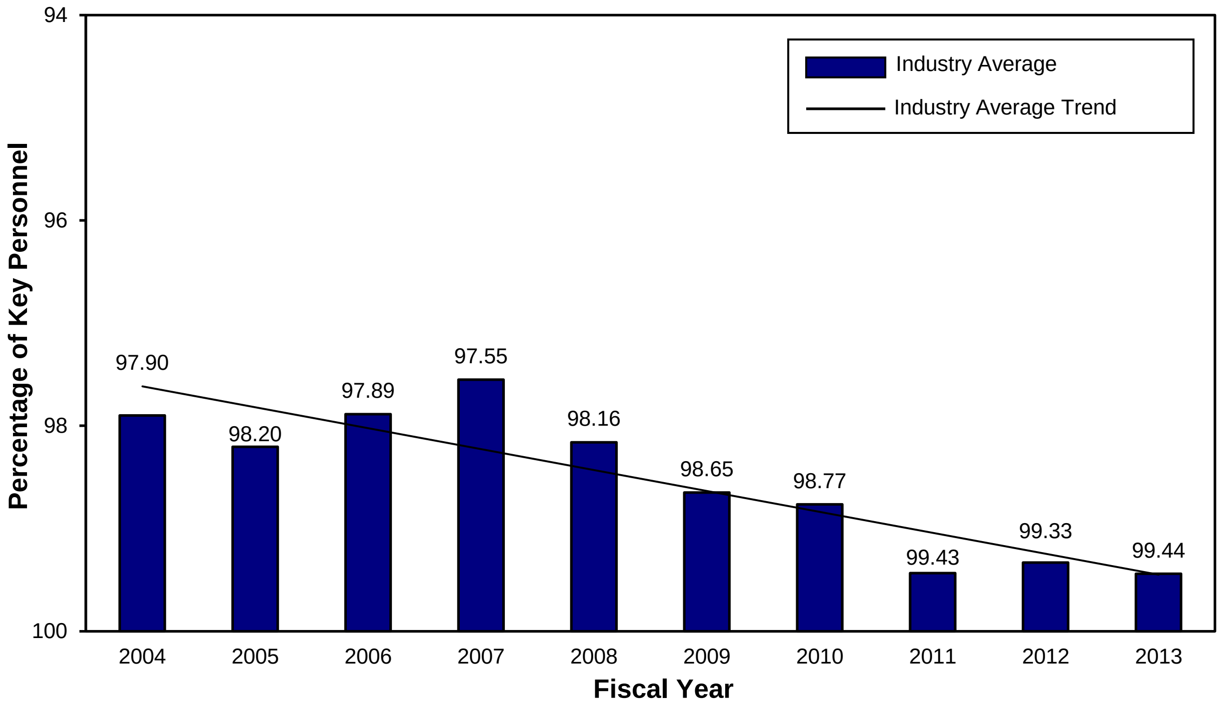


Figure 12. Emergency response organization drill participation

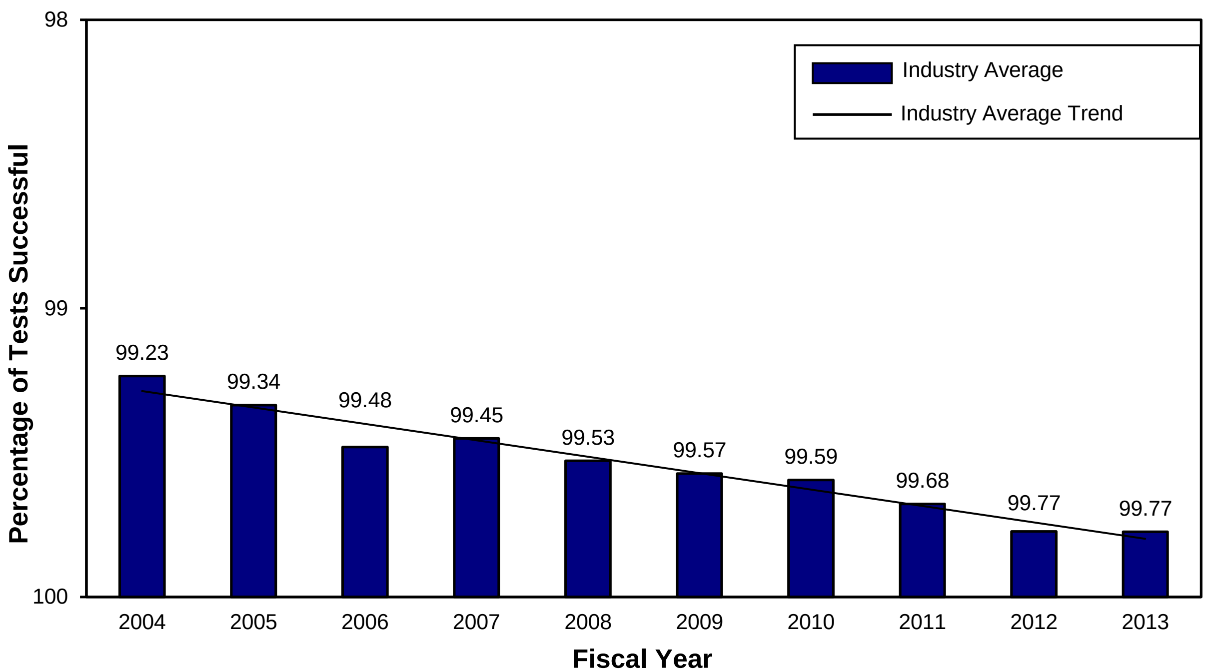


Figure 13. Alert and notification system reliability

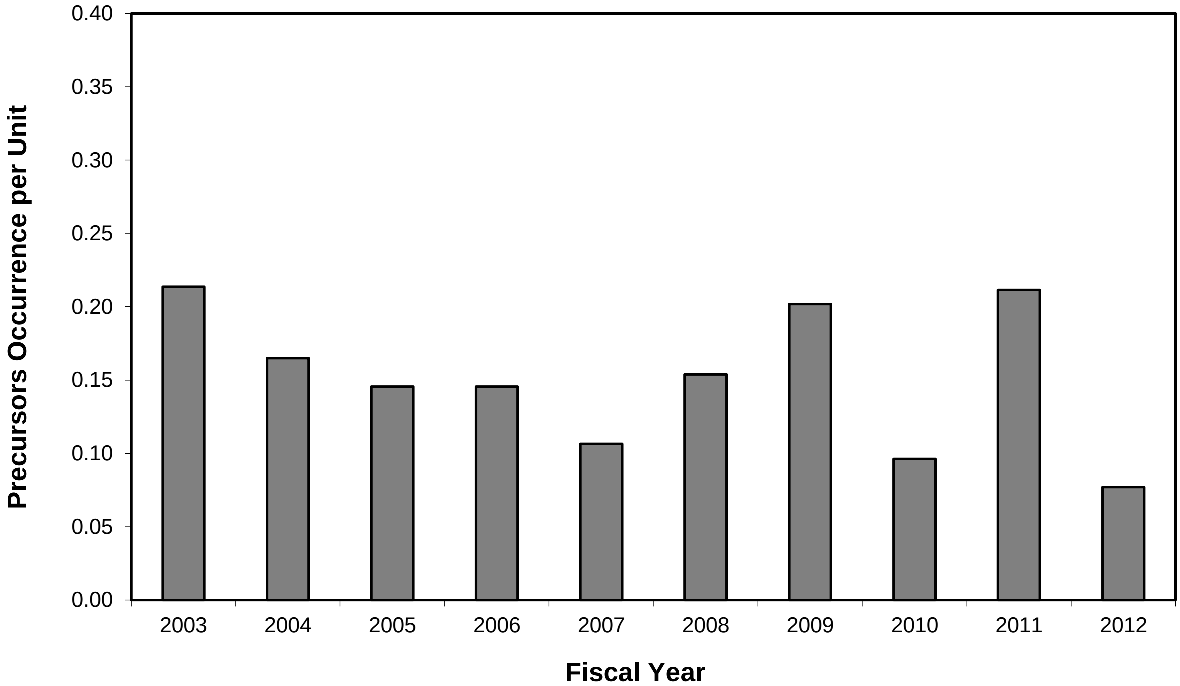
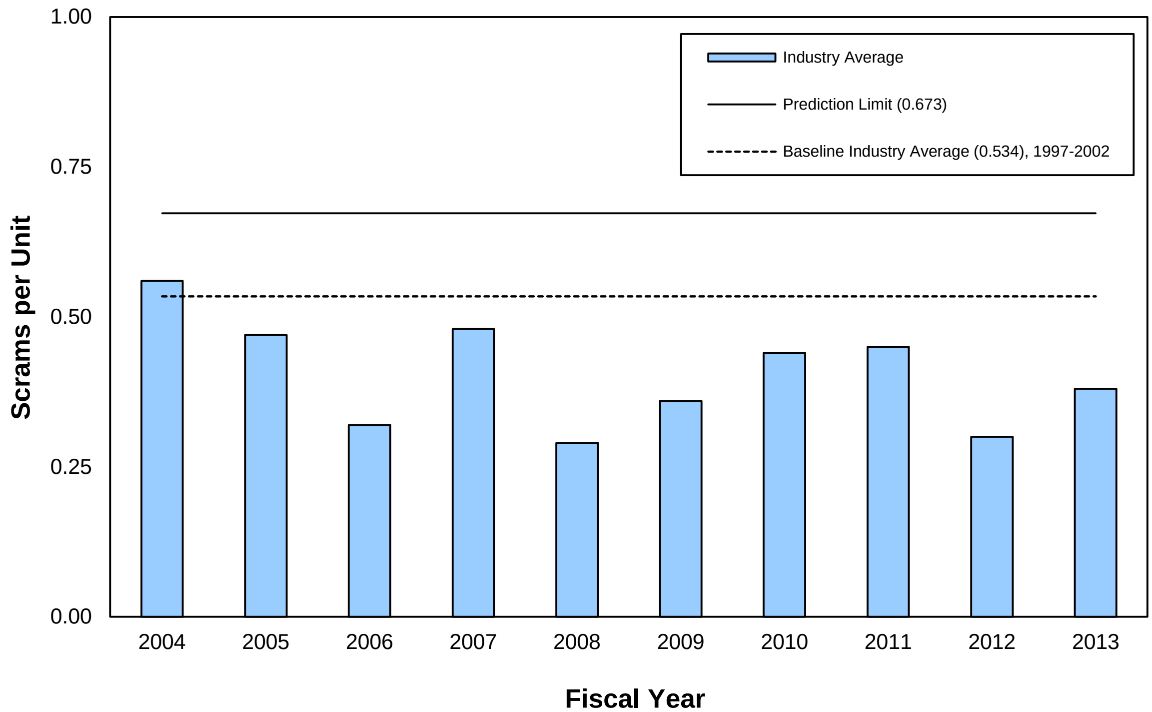


Figure 14. Accident sequence precursors

FISCAL YEAR 2013 SHORT-TERM INDUSTRY PERFORMANCE

The annual industry trend analysis compares data for the most recent year to established short-term "prediction limits." The prediction limits are 95th percentiles of predictive distributions for the data. The predictive distributions are statistical probability distributions that describe expected future performance. They are derived from performance during "baseline" periods for each performance indicator (PI). Baseline periods are periods for each PI during which the data can be regarded as fairly constant and indicative of "current" performance.

The results of the evaluation for fiscal year (FY) 2013 Industry Trends Program PIs, using the established prediction limits, indicate that no PI exceeded its associated prediction limit in FY 2013, as shown in the following figures for each PI with its FY 2013 data and associated prediction limit.



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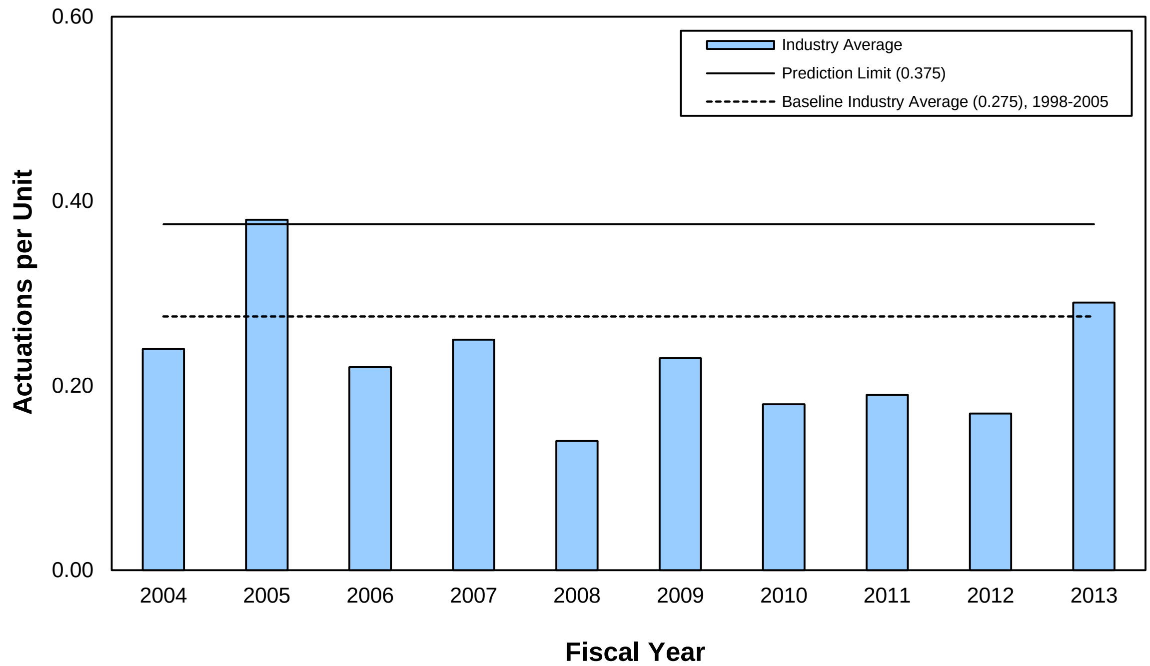


Figure 2. Safety-system actuations

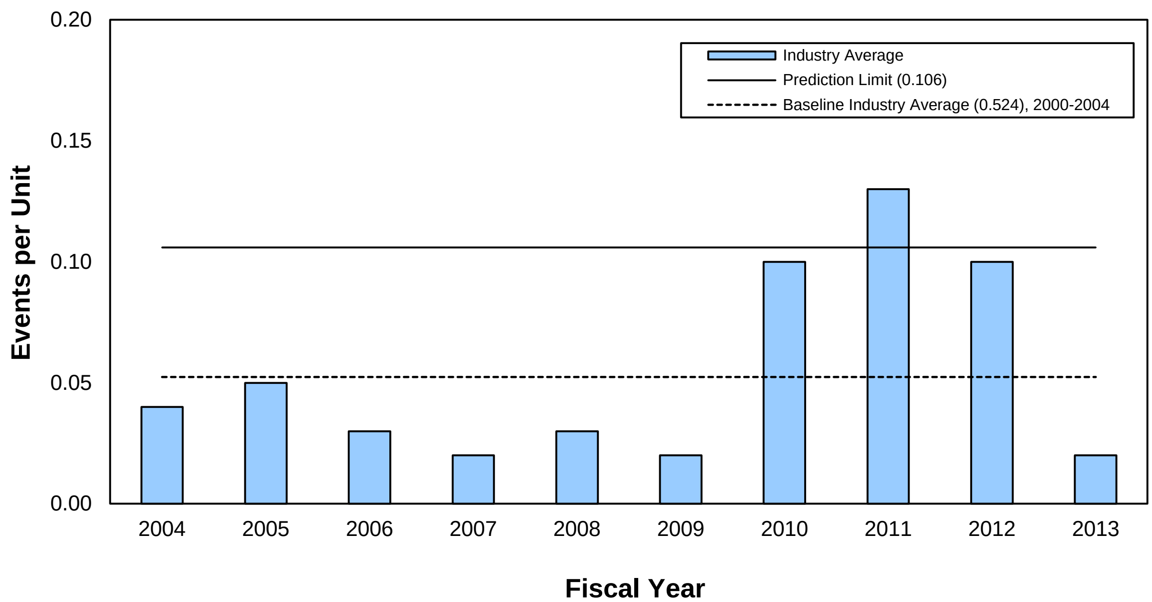


Figure 3. Significant events

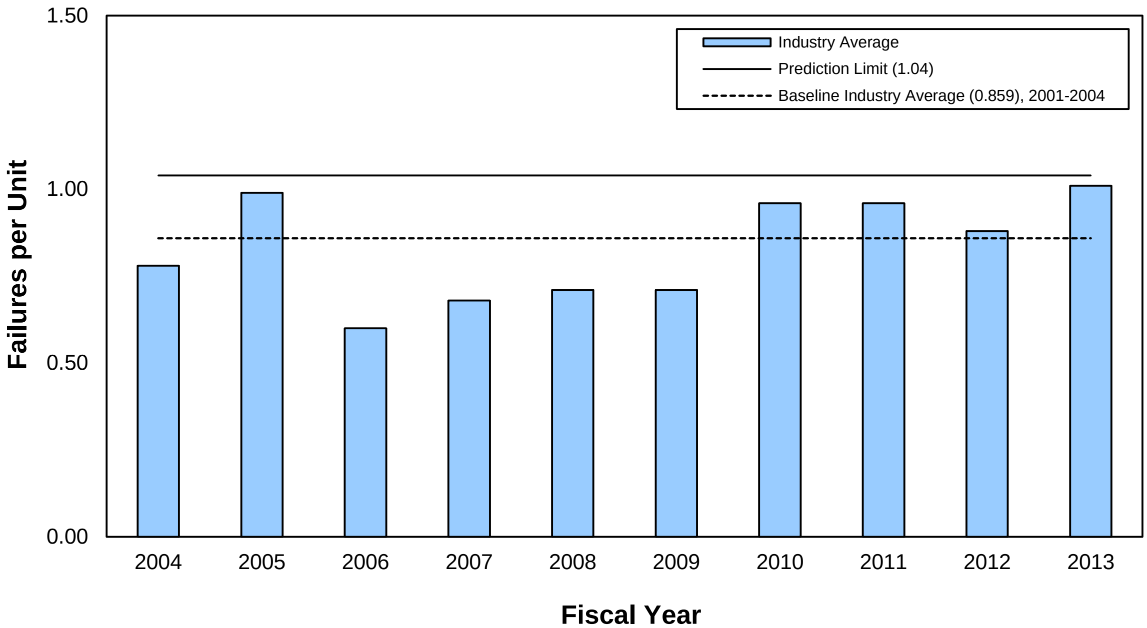


Figure 4. Safety-system failures

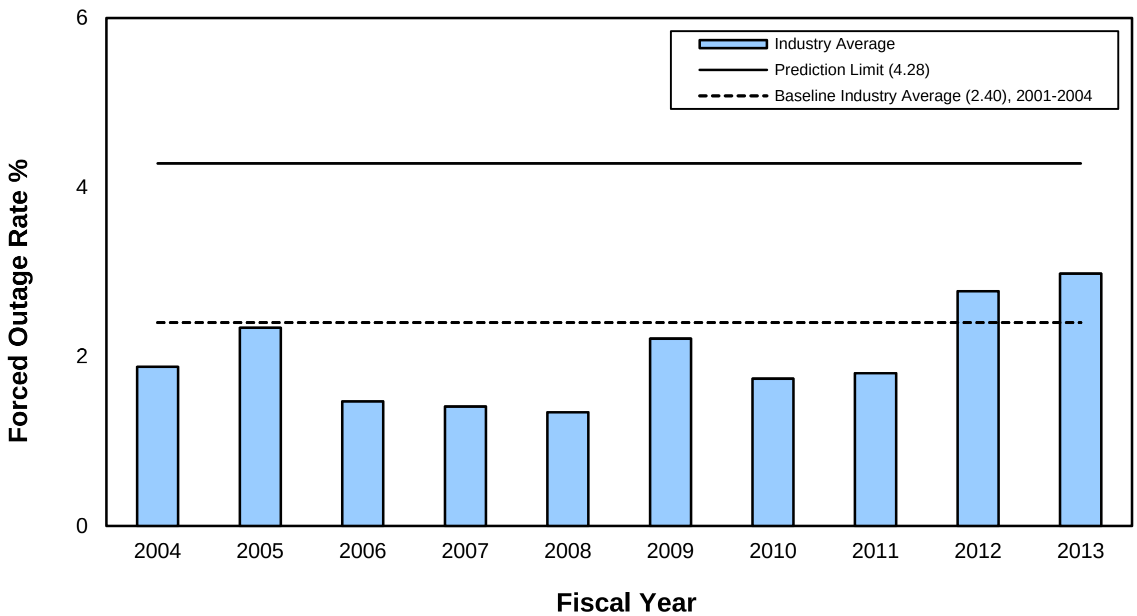


Figure 5. Forced outage rate

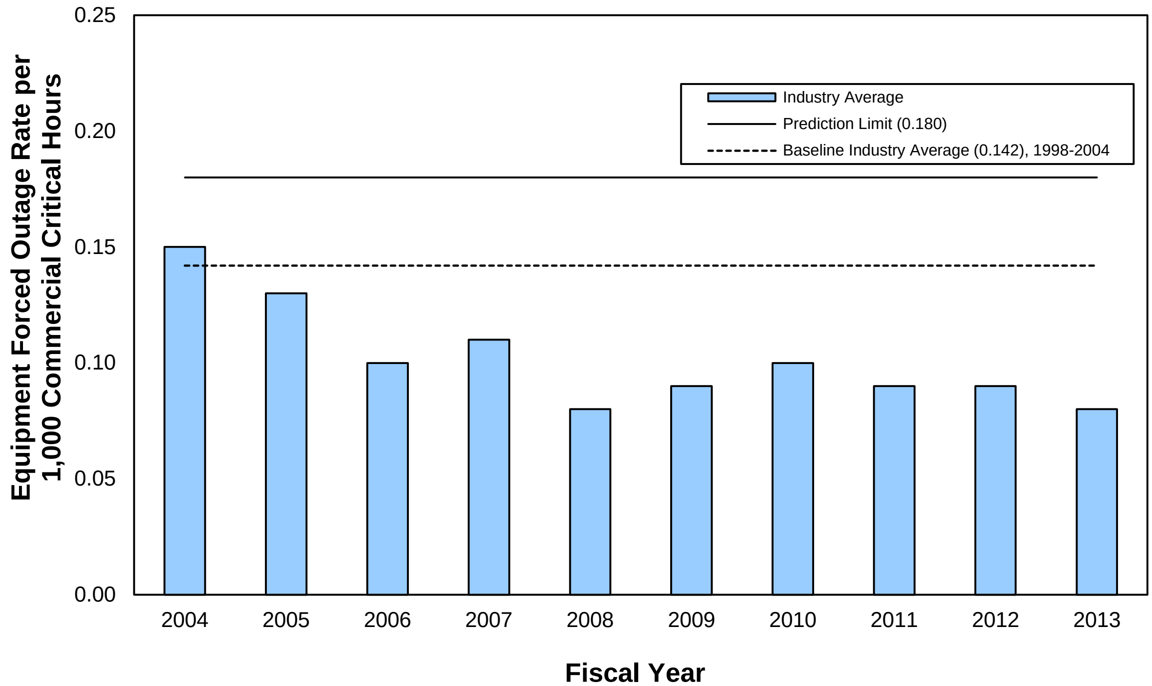


Figure 6. Equipment forced outages

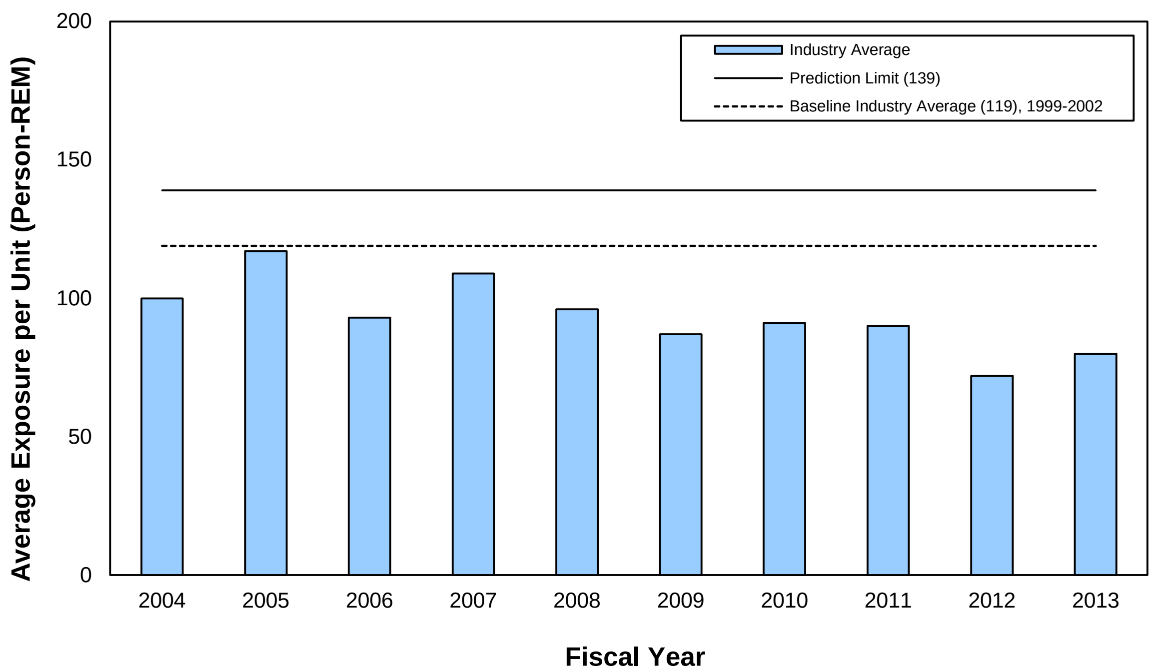


Figure 7. Collective radiation exposure

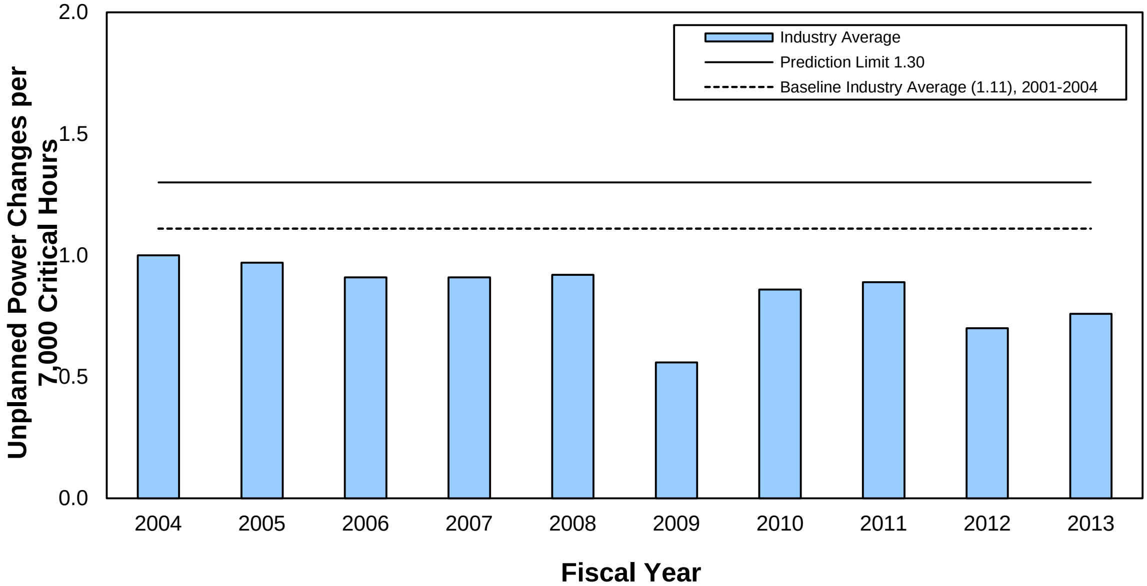


Figure 8. Unplanned power changes per 7,000 critical hours

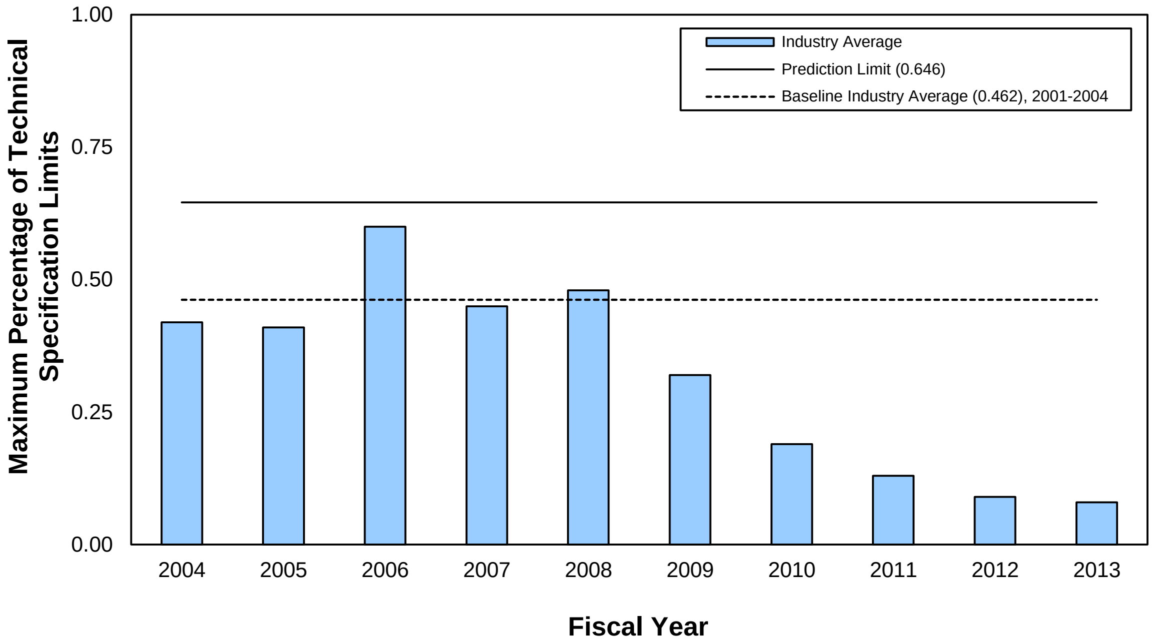


Figure 9. Reactor coolant system activity

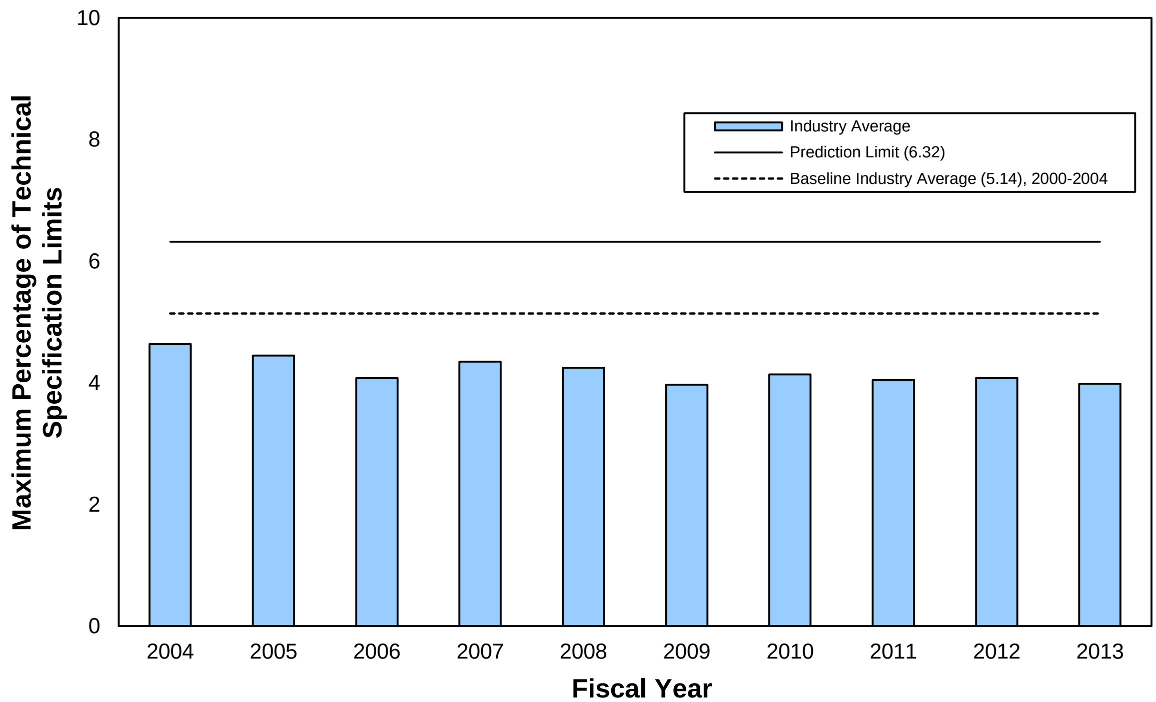


Figure 10. Reactor coolant system leakage

Note that the 2000 steam generator tube rupture event at Indian Point Nuclear Generating Unit 2 was not included in the short-term data for determining prediction limits in Figure 10. This event was excluded from the development of the prediction limit models because it was considered as an outlier that could overly influence the statistical analysis of the industrywide data. This treatment results in a more conservative prediction limit.

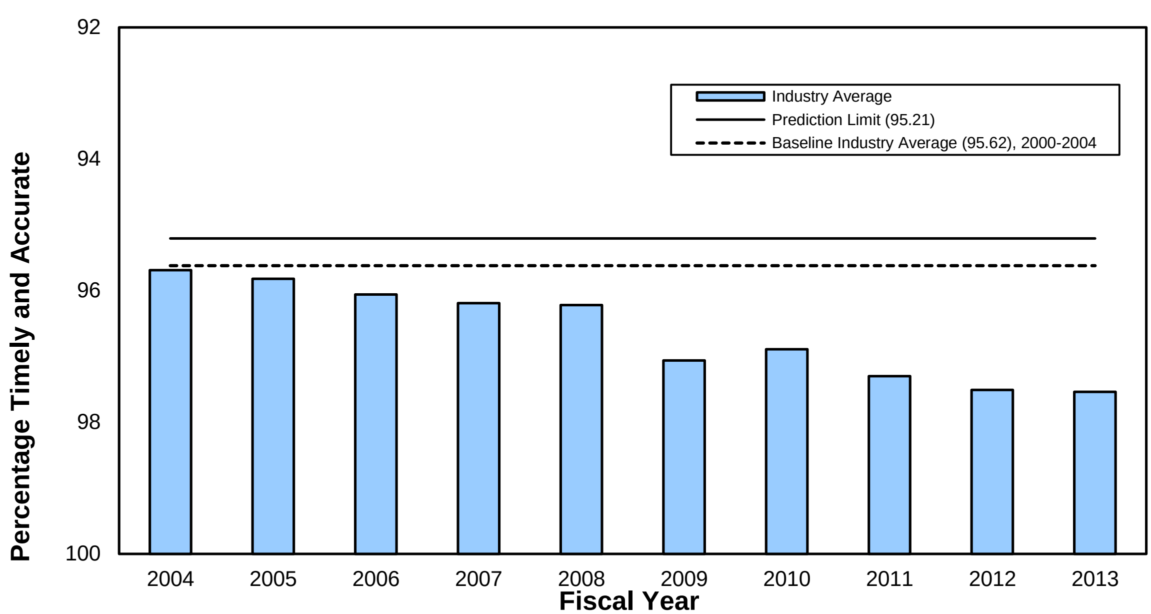


Figure 11. Drill and exercise performance

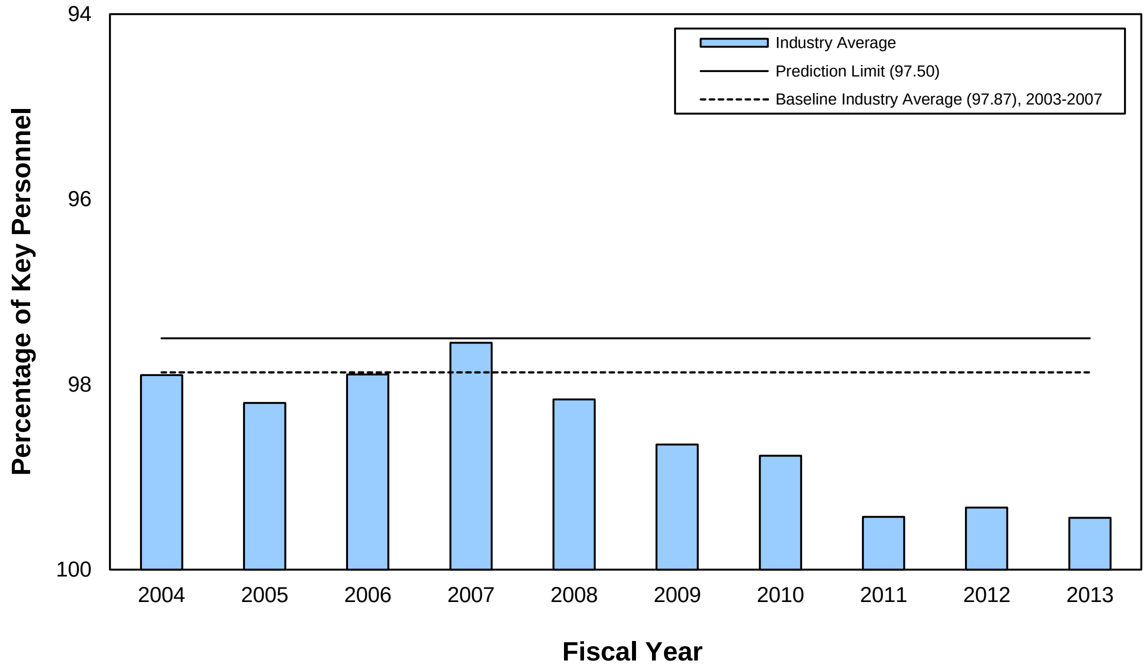


Figure 12. Emergency response organization drill participation

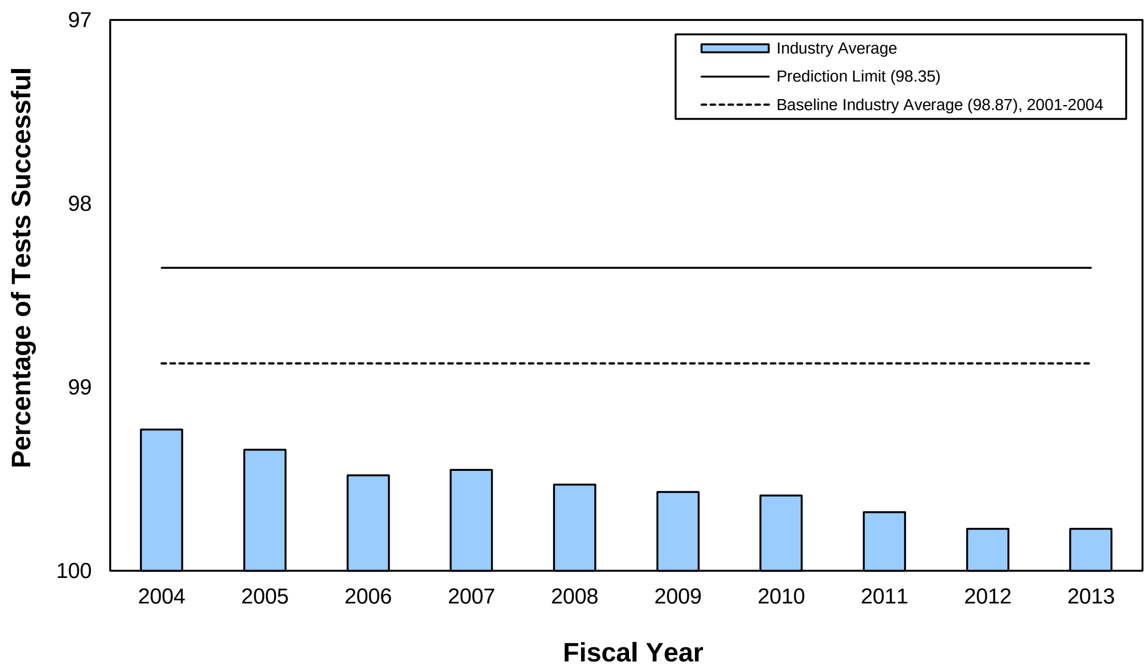


Figure 13. Alert and notification system reliability

SUMMARY OF BASELINE RISK INDEX FOR INITIATING EVENTS: ANNUAL GRAPHS THROUGH FISCAL YEAR 2013

The Baseline Risk Index for Initiating Events (BRIIE) addresses the initiating event (IE) cornerstone in the U.S. Nuclear Regulatory Commission's (NRC's) Reactor Oversight Process (ROP) for monitoring commercial nuclear power plants. It is based on plant performance for the 10 initiator events listed in the table below.

INITIATOR	ACRONYM	APPLICABLE PLANTS
General transient	TRAN	Both plant types, separately
Loss of condenser heat sink	LOCHS	Both plant types, separately
Loss of main feedwater	LOMFW	Both plant types
Loss of offsite power	LOOP	Both plant types
Loss of vital alternating current bus	LOAC	Both plant types
Loss of vital direct current bus	LODC	Both plant types
Stuck-open safety or relief valve	SORV	Both plant types, separately
Loss of instrument air	LOIA	Both plant types, separately
Very small loss-of-coolant accident	VSLOCA	Both plant types
Steam generator tube rupture	SGTR	Pressurized-water reactors (PWRs) only

The BRIIE program, described in NUREG/CR-6932, "Baseline Risk Index for Initiating Events (BRIIE)," issued June 2007, consists of two levels or tiers. The first tier considers individual IEs and evaluates performance based on statistical prediction limits. This evaluation is for the ongoing monitoring and early detection of possible industry-level deficiencies. A second tier is a risk-based integrated measure evaluated for each plant type. Because four of the initiators have separate data for each plant type, there are a total of 14 Tier 1 graphs.

The units for the Tier 1 IE frequency graphs are event counts for a fiscal year divided by the industry critical time for the year. The Tier 1 graphs also show the average frequency for an established "baseline period" and 95-percent prediction limits for a future year if occurrences continue at the same rate as in the baseline period. If industry data shift as time progresses, the baseline periods used to determine the prediction limits might no longer be relevant. The periods originally were developed to describe, roughly, calendar years 1998–2002.

The prediction limits depend on the expected critical years of reactor operation in the upcoming year and the baseline occurrence rate for each indicator. A rate can exceed a limit by having more events than expected or by having the same number of events and less critical time than expected. In recent years, U.S. nuclear power plant availability has been approximately 90 percent at the industry level. This figure enters into the calculations that determine the bounds on the number of events that might be expected.

None of the fiscal year (FY) 2013 occurrence rates exceeded their prediction limits.

The Tier 2 integrated index includes, for each plant type, the relative contribution of each initiator to the risk of core damage, based on the events that occurred in each fiscal year.

The event frequencies are converted to core-damage frequency (CDF) estimates by multiplying by Birnbaum risk coefficients. These coefficients are industry averages of the contribution to core damage from each initiator as reflected in the industry's standardized plant analysis risk models.

Figure 15 shows annual differences in estimated industry CDF compared to the established baseline levels of these quantities. The combined industry BRIIE value for FY 2013 (-2.52×10^{-6} per reactor critical year) indicates better than baseline industry performance. The combined industry BRIIE value is below the established reporting threshold of $\Delta CDF = 1.0\times10^{-5}$ per reactor critical year.

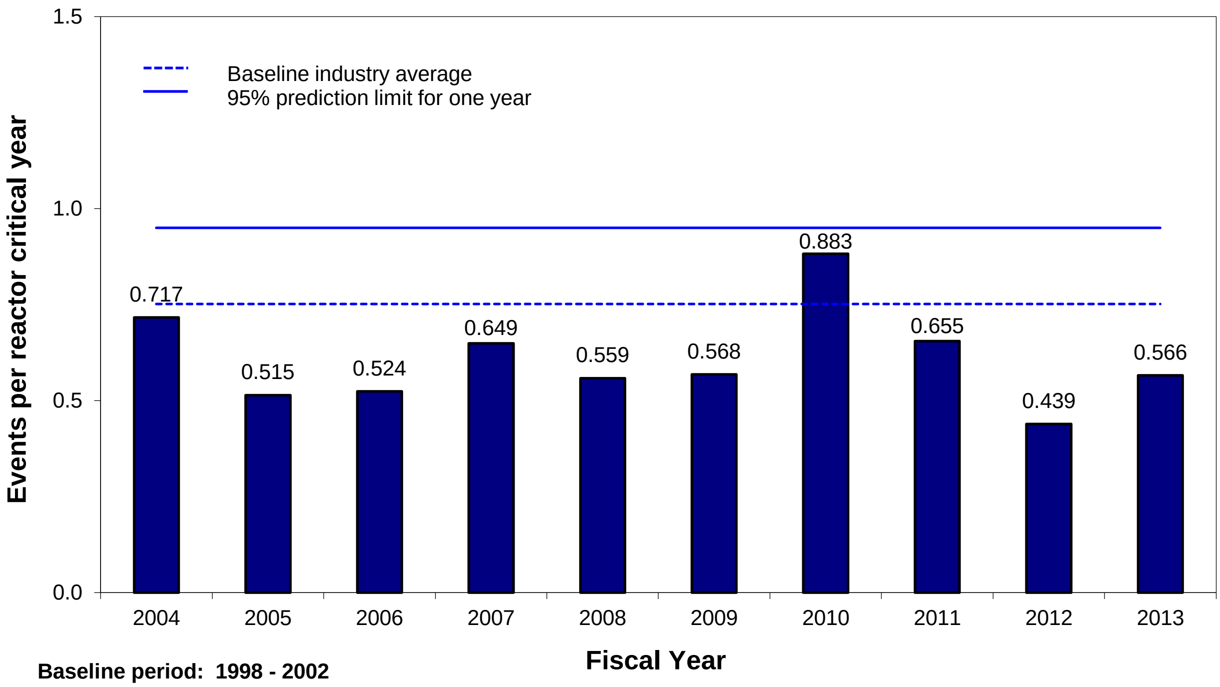


Figure 1. Pressurized-water reactor (PWR) general transients

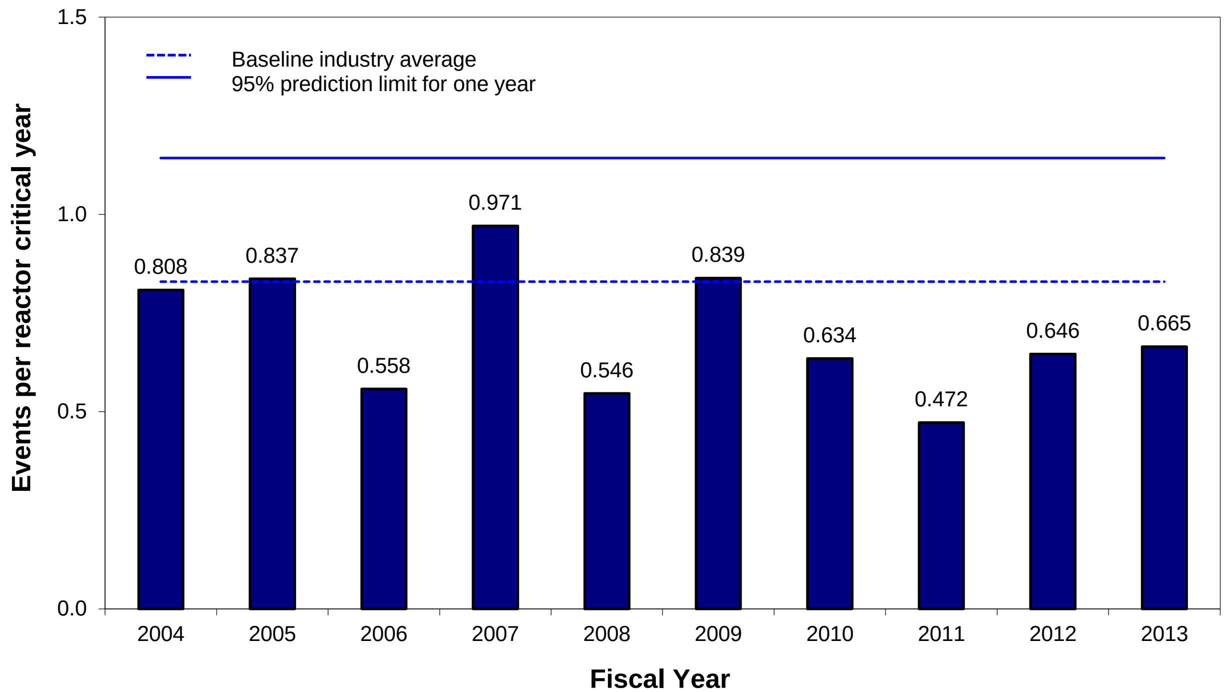
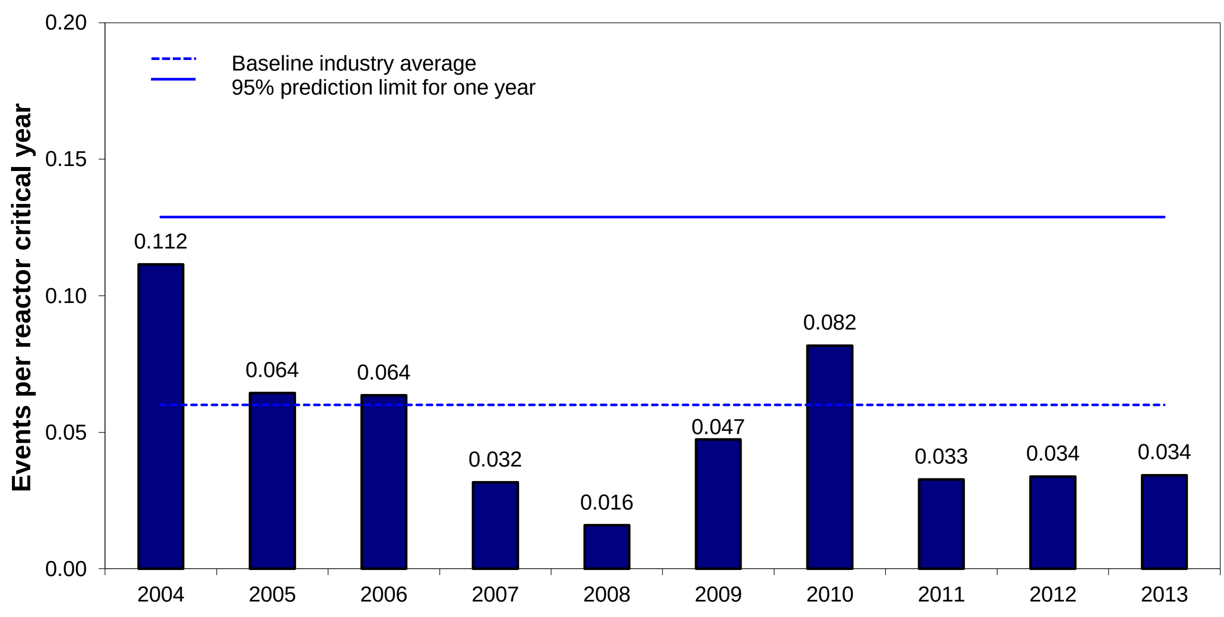


Figure 2. Boiling-water reactor (BWR) general transients



Baseline period: 1995 - 2002

Figure 3. PWR loss of condenser heat sink

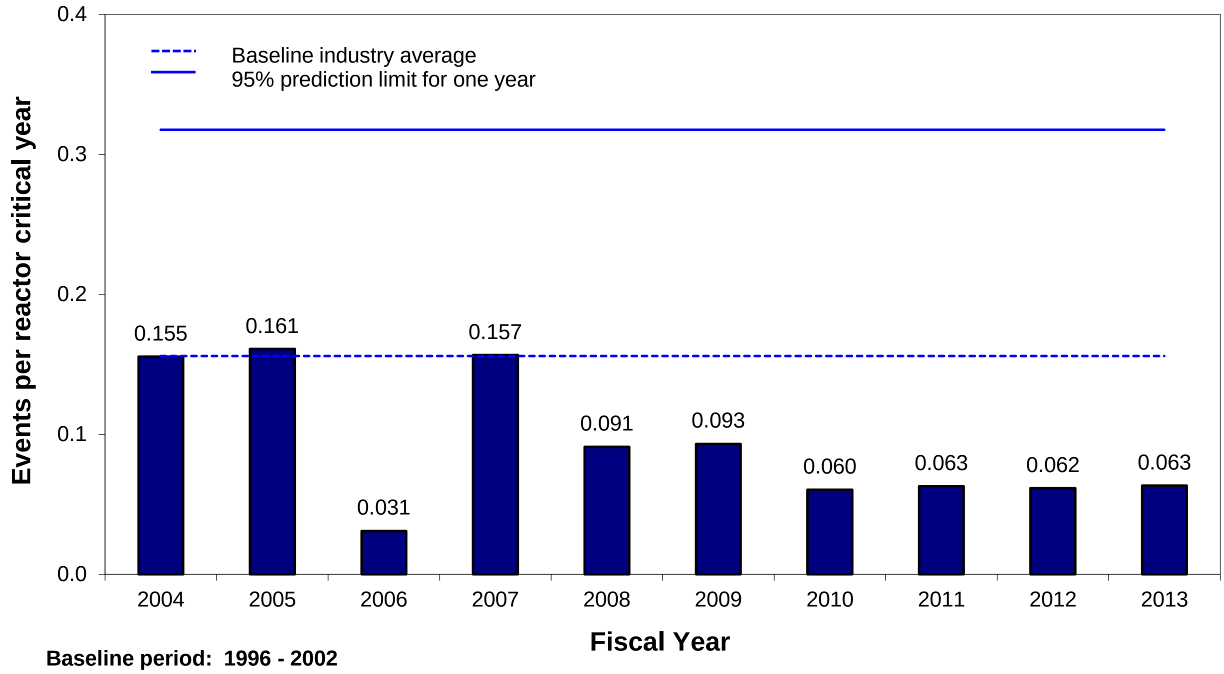


Figure 4. BWR loss of condenser heat sink

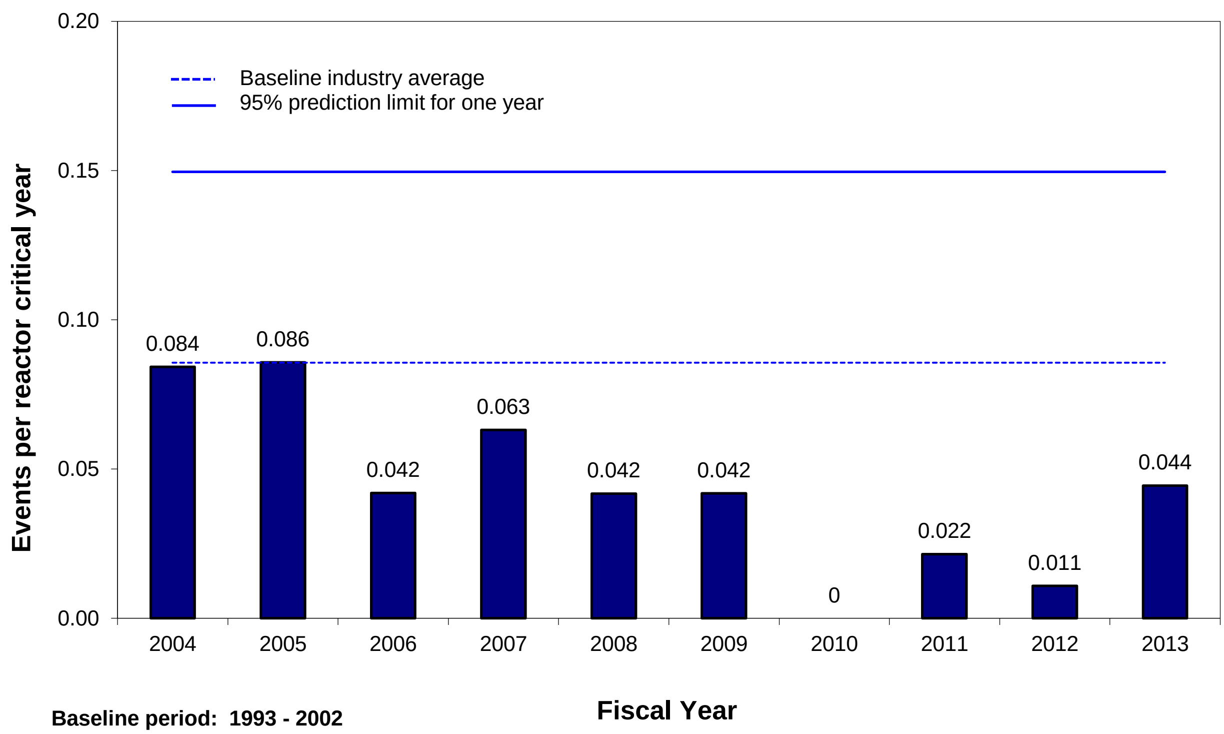


Figure 5. Loss of main feedwater

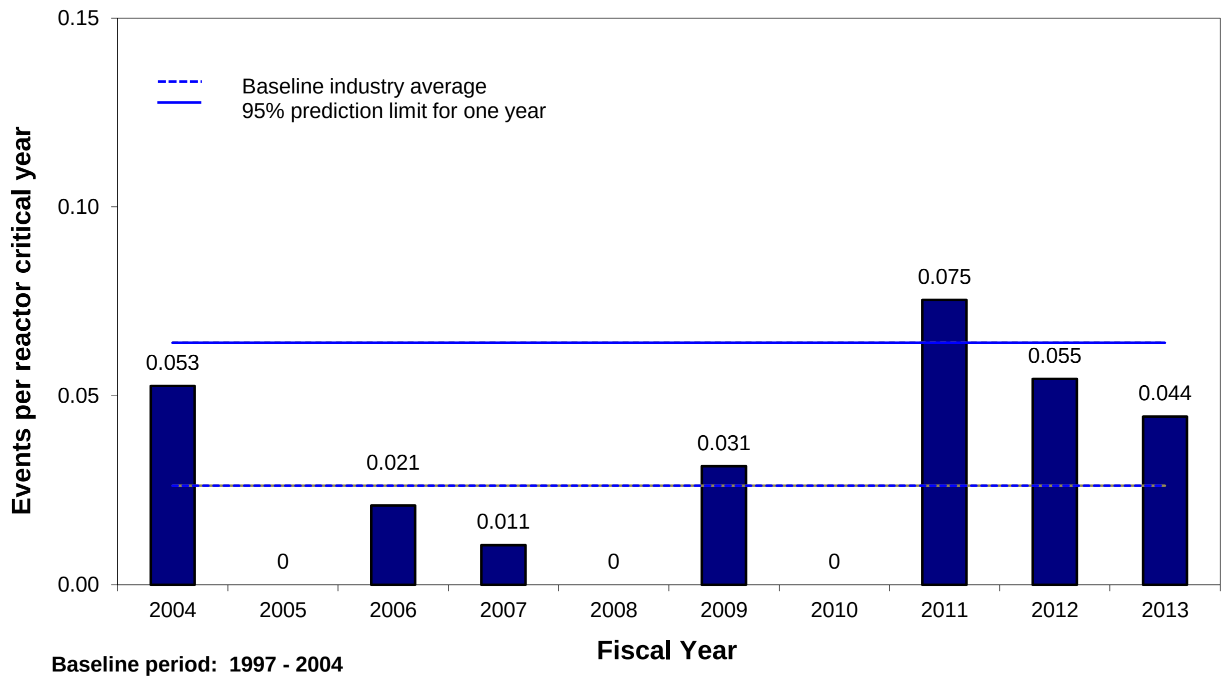


Figure 6. Loss of offsite power

The prediction limit for loss of offsite power was calculated under the assumption that the eight at-power events that occurred during the 2003 blackout were a single event. This treatment results in a more conservative prediction limit.

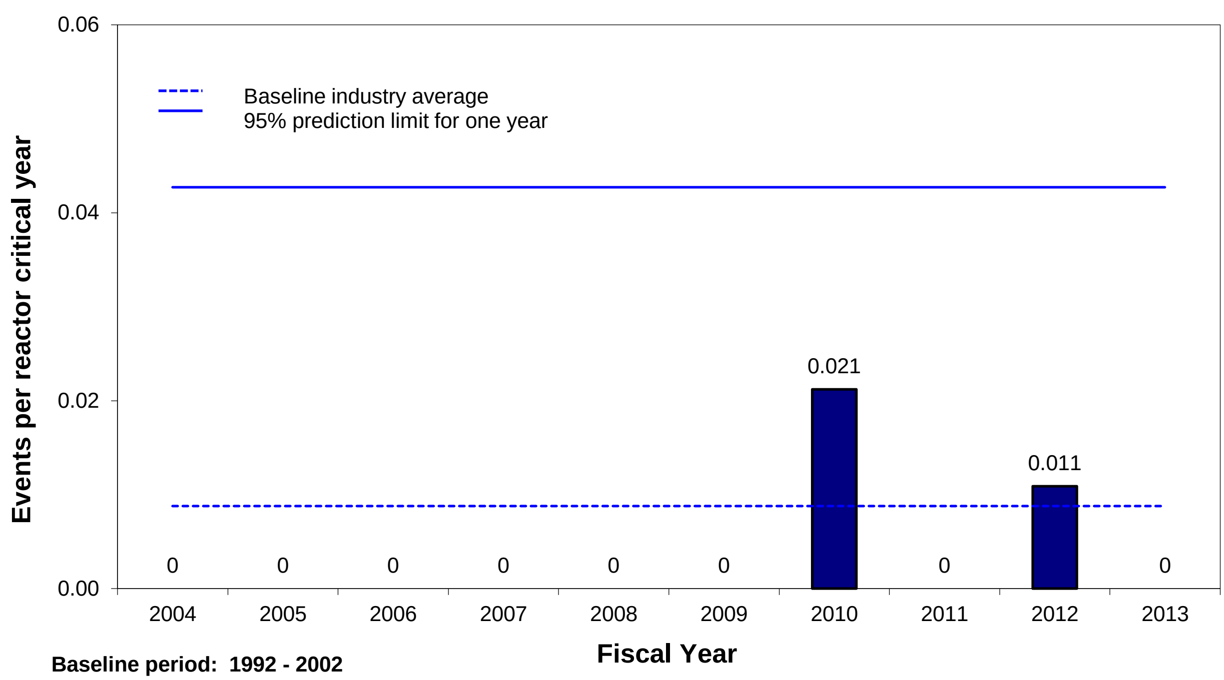


Figure 7. Loss of vital alternating-current bus

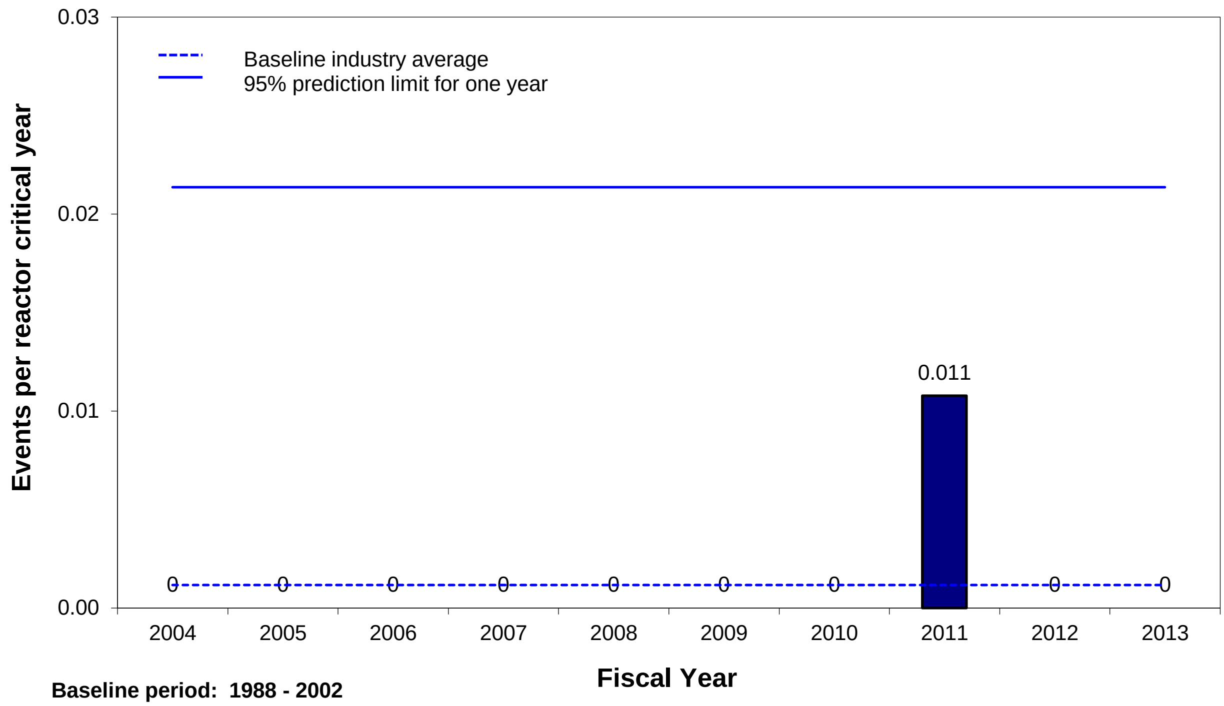


Figure 8. Loss of vital direct-current bus

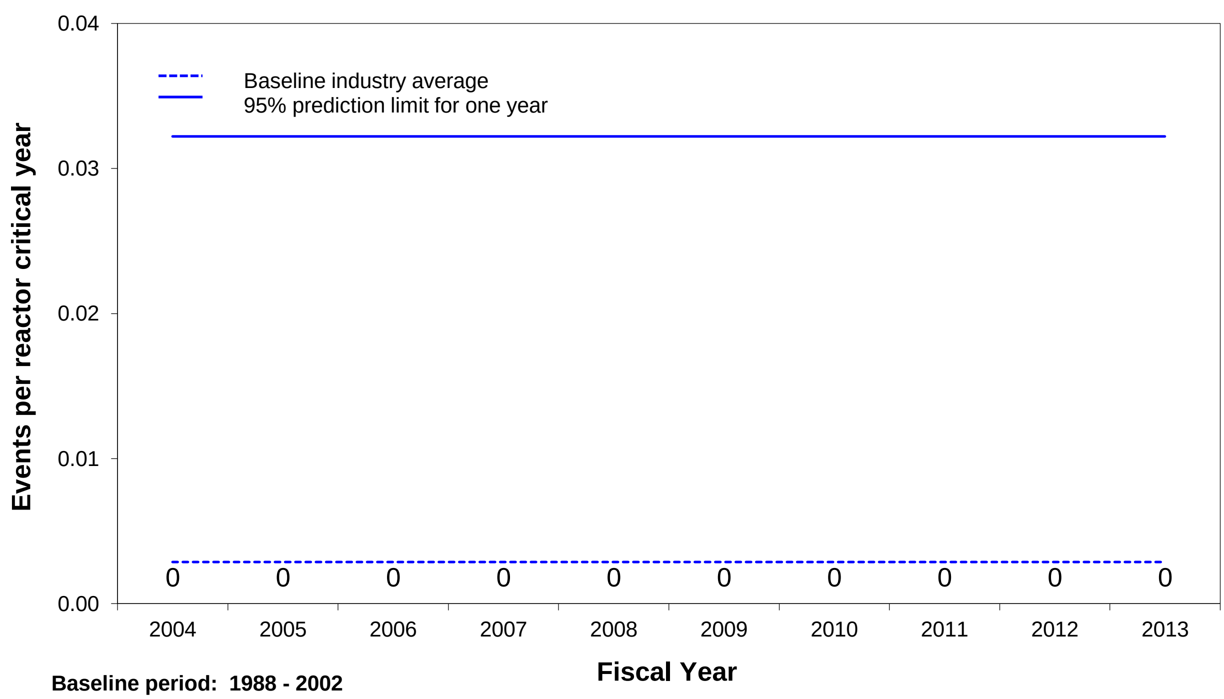


Figure 9. PWR stuck-open safety or relief valve

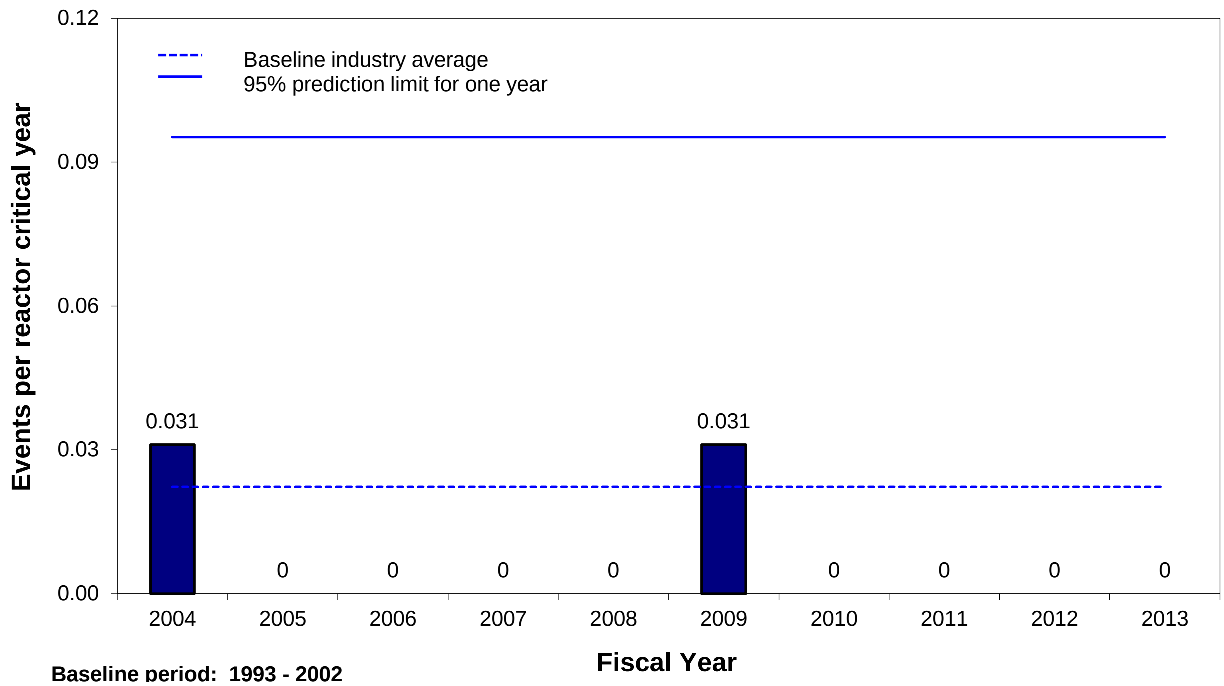


Figure 10. BWR stuck-open safety or relief valve

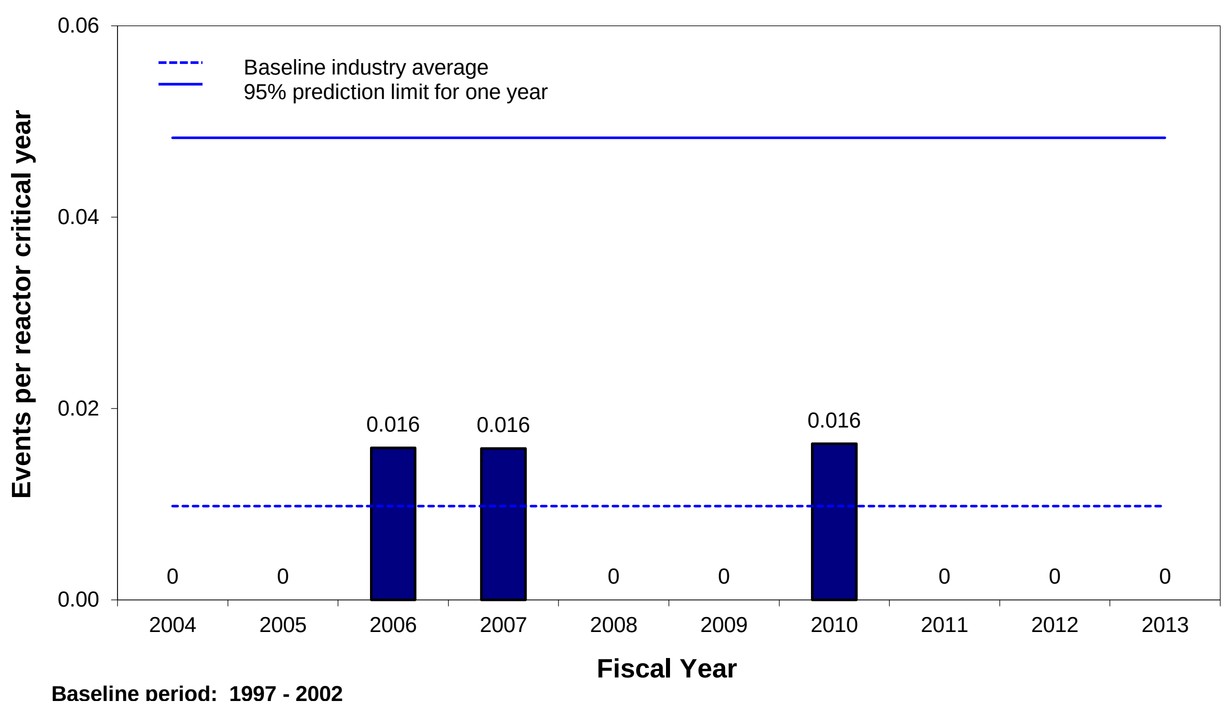


Figure 11. PWR loss of instrument air

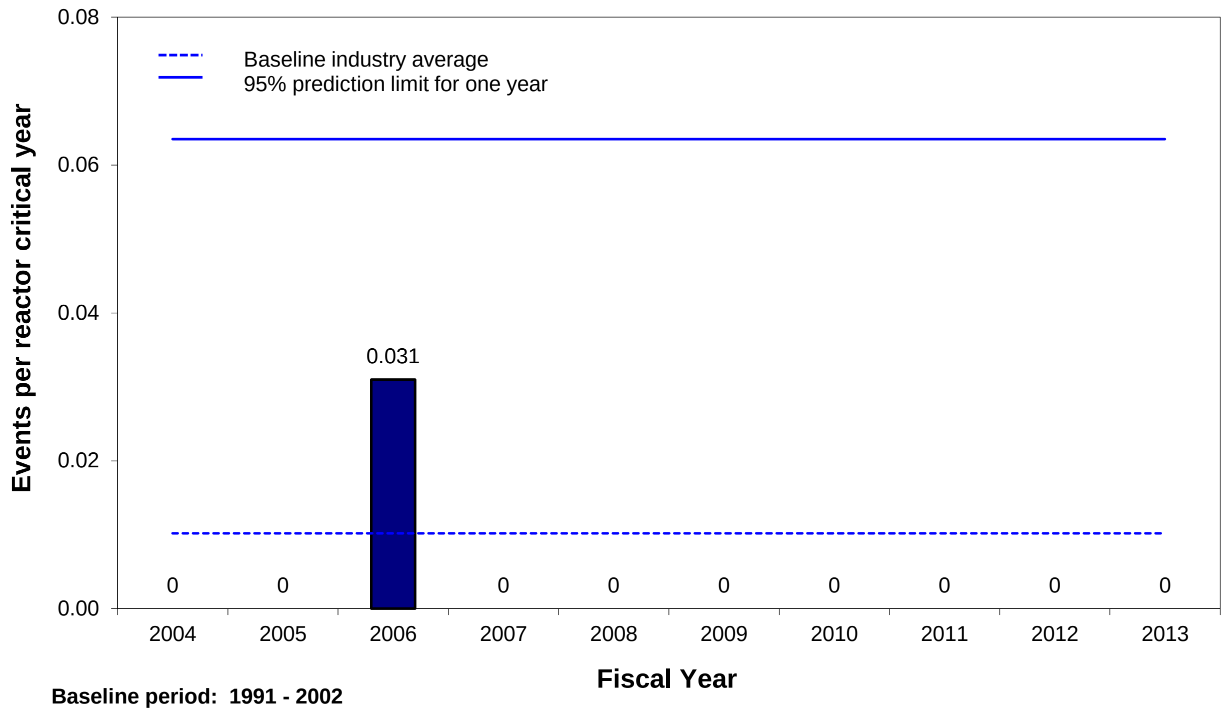


Figure 12. BWR loss of instrument air

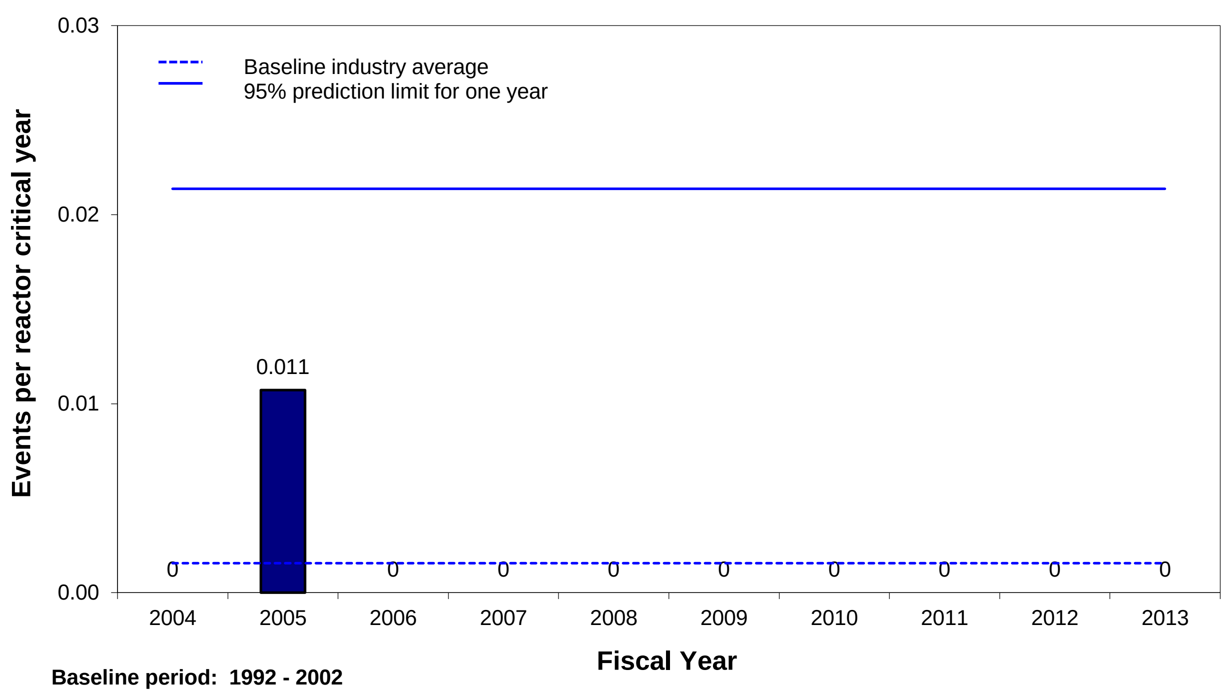


Figure 13. Very small loss-of-coolant accident

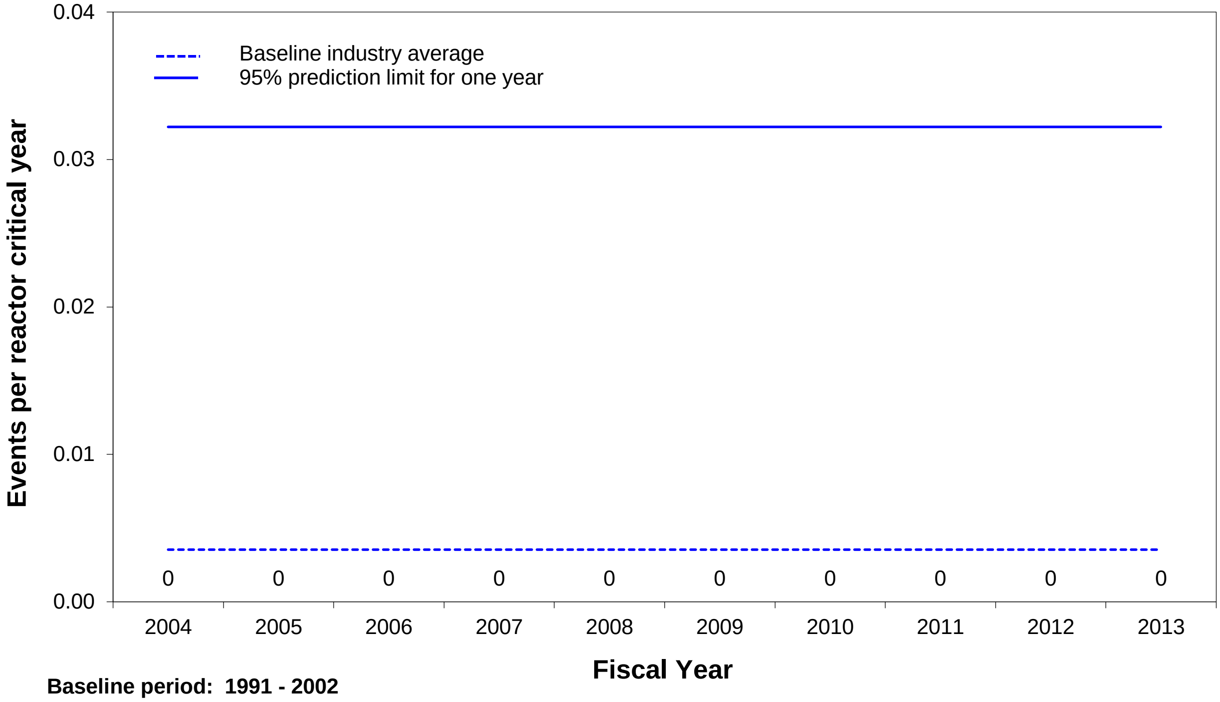


Figure 14. PWR steam generator tube rupture

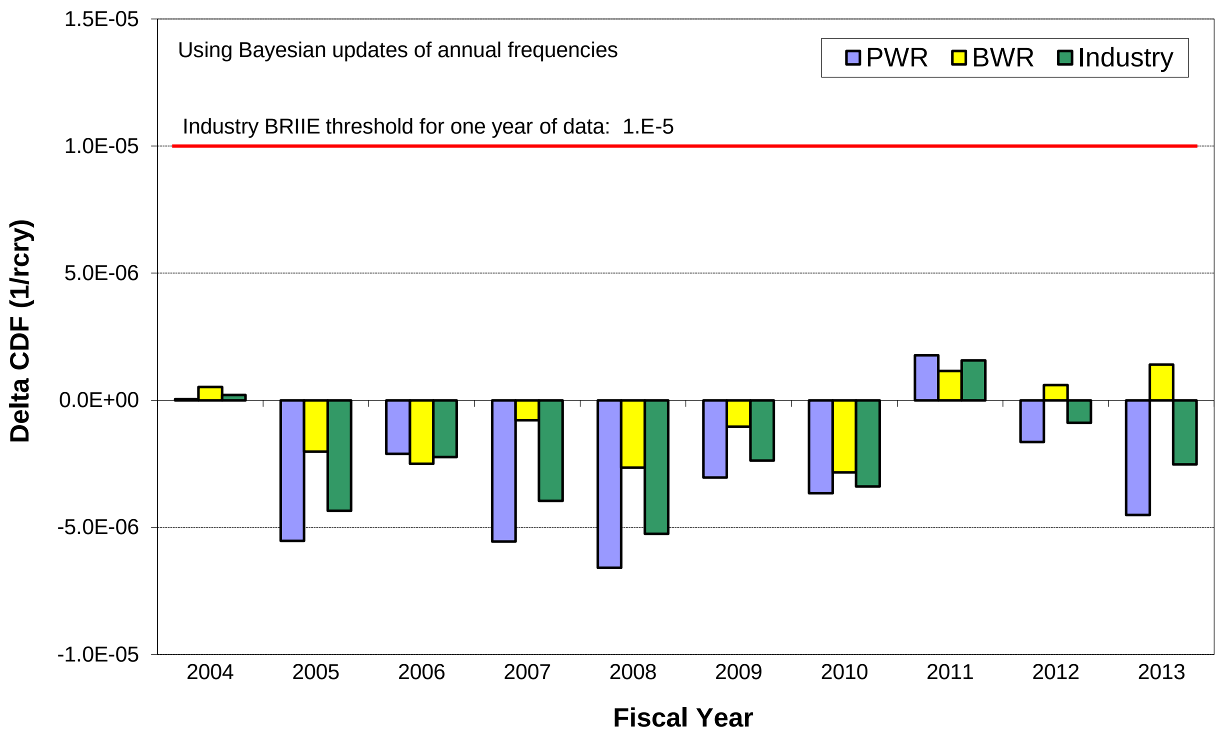


Figure 15. BRIIE Tier 2 (ΔCDF)

STAFF'S REVIEW OF THE INDUSTRY TRENDS PROGRAM

BACKGROUND:

The U.S. Nuclear Regulatory Commission (NRC) staff developed and implemented the Industry Trends Program (ITP) in 2001 to (1) monitor, assess, and respond to trends in industrywide performance indicators (PIs) for operating power reactors and (2) communicate the results to Congress and other stakeholders. The program is also used to provide an agency performance measure on the number of statistically significant adverse trends in nuclear safety performance. The staff reports the results of the program to the Commission annually. The reporting of the ITP results is preceded by annual reports developed by the former Office for Analysis and Evaluation of Operational Data (AEOD) such as the NUREG-1187, "Performance Indicators for Operating Commercial Nuclear Power Plants," and NUREG-1272, "AEOD's Annual Report," series.

On June 13, 2013, the Commission issued a staff requirements memorandum (SRM) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13164A337) in response to the May 29, 2013, "Briefing on the results of the Agency Action Review Meeting (AARM)" (ADAMS Accession No. ML13164A337), directing the staff to perform a review of the ITP as follows:

As part of the Reactor Oversight Process (ROP) Self-Assessment for calendar year (CY) 2013, the staff should review implementation of the Industry Trends Program over its history for lessons learned and inform the Commission of any program enhancements and/or resource reductions that may be warranted.

This enclosure provides the staff's review of the ITP in response to the Commission's June 13, 2013, SRM.

HISTORICAL REVIEW PROCESS AND FOCUS AREAS:

The staff reviewed Commission papers on the results of the ITP and program guidance for lessons learned in the implementation of the program. The staff consulted previous ITP program managers and other internal stakeholders in the development of its conclusions and recommendations. As part of its review, the staff summarized the results presented in previous ITP SECY papers to support the evaluation of the program and to document that information as a knowledge-management resource (ADAMS Accession No. ML14087A279). SECY-01-0111, "Development of an Industry Trends Program for Operating Power Reactors" (ADAMS Accession No. ML011570324), describes the development of the program, and Inspection Manual Chapter (IMC) 0313, "Industry Trends Program" (ADAMS Accession No. ML080860540), contains guidance governing the program.

The staff focused its review of the ITP based on the areas discussed in both the annual reporting of the ITP results and IMC 0313 guidance. The staff evaluated the following focus areas to identify lessons learned, and potential enhancements or resource reductions:

- Program objectives,
- Indicators used,
- Long-term analysis,
- Short-term analysis,
- Baseline Risk Index for Initiating Events (BRIIE) implementation, and

- Additional considerations.

PROGRAM OBJECTIVES:

The staff developed the ITP as a means to confirm the safety performance of operating nuclear power plants and to increase public confidence in the efficacy of NRC processes. The ITP complements the ROP plant-specific oversight of safety performance by monitoring and assessing industry-wide trends in safety performance. The specific program objectives described in SECY-01-0111 are as follows:

- Collect and monitor industrywide data that can be used to assess whether operating plant safety performance is being maintained and provides feedback for the ROP.

- Assess the significance and causes of any statistically significant adverse industry trends, determine whether they represent an actual degradation in overall industry safety performance, and respond appropriately to any safety issues that may be identified.

- Communicate industrywide information to Congress and other stakeholders in an effective and timely manner.

The ITP objectives are defined in IMC 0313 as follows:

- Collect and monitor industrywide data that can be used to assess whether the nuclear industry is maintaining the safety performance of operating plants and provide NRC feedback to its nuclear reactor safety inspection and licensing programs.

- Assess the safety significance and causes of any statistically significant adverse industry trends, determine whether the trends represent an actual degradation in overall industry safety performance, and respond appropriately to any safety issues that may be identified.

- Communicate industry-level information to Congress and other stakeholders in an effective and timely manner.

- Support the NRC's performance goal of ensuring safety while enhancing openness in the agency's regulatory processes.

The staff compared the original objectives of the ITP to those that guide program implementation today and concluded that they have remained consistent over the last 13 years. The staff did note that an objective to promote openness in the agency's regulatory processes has existed in IMC 0313 since its inception. The staff also reviewed ITP results over the history of the program and found that the methods and conclusions documented therein have continued to satisfy the stated program objectives. *The staff is not considering any changes to or a realignment of the ITP objectives as listed in the program guidance. No enhancements or resource reductions are warranted in this area.*

INDICATORS USED IN THE ITP:

The staff reviewed the ITP indicators to evaluate their effectiveness, and identify lessons learned and potential enhancements or resource reductions. The staff examined the effectiveness of the ITP indicators by evaluating: (1) their ability to provide feedback to the ROP, (2) the efficiency of their data sources, and (3) the results yielded since the program was implemented.

1. Feedback to the ROP

The staff evaluated all of the ITP indicators to determine whether these can provide feedback to the ROP consistently across all cornerstones and found that the current set of ITP indicators does not provide industry performance insights in either the Public Radiation Safety cornerstone or the Security cornerstone. *To more fully reflect ROP effectiveness, the ITP should include an indicator representative of each of these two cornerstones of the ROP.* The staff recognized that there are ROP PIs for each of these two cornerstones that can be used as industrywide indicators in the ITP and will consider these for use in the ITP as a potential enhancement.

2. Data sources

The staff reviewed the data sources used by the ITP indicators and identified areas where improvements could be made to increase the efficiency of the data-collection process. Six of the ITP indicators use data obtained through the ROP PIs. Three of the ITP indicators use data obtained from Licensee Event Reports (LERs) in accordance with 10 CFR 50.73, “Licensee Event Report System”, and Event Notifications (ENs) in accordance with 10 CFR 50.72, “Immediate Notification Requirements for Operating Nuclear Power Reactors.” Three of the ITP indicators use data from the Institute of Nuclear Power Operations (INPO). Two ITP indicators use other agency processes. The data sources for each indicator can be found in IMC 0313 and are summarized in Table 1 at the end of this Enclosure.

The staff identified two ITP indicators that use LERs and ENs as data sources and for which a related ROP PI exists. These are the *Automatic Scrams while Critical* and *Safety-System Failures* indicators. However, the staff understands that there are differences between the definitions of these ITP indicators and the definitions of their related ROP PIs (*Unplanned Scrams* and *Safety Systems Functional Failures*, respectively). The staff will evaluate the feasibility of replacing or supplementing the data sources for these indicators with the information obtained through the ROP PI program. The staff recognizes this as an opportunity to possibly reduce resources in the ITP data collection and analysis processes. However, this transition would increase the ITP’s dependency on the ROP PI program, which the industry currently supports through voluntary reporting of ROP PI data. *The staff will evaluate whether unnecessary duplication exists among the ITP indicators and will consider the potential use of ROP PIs to supplement or replace ITP indicators where possible.*

The staff also evaluated the data sources used for the significant events indicator. As noted in SECY-09-0048, “Fiscal Year 2008 Results of the Industry Trends Program for Operating Power Reactors and Status of the Ongoing Development of the Program” (ADAMS Accession No. ML090420101), the staff revised IMC 0313 to clarify the definition of the significant events indicator in 2008. The revised definition provided more objective criteria to identify significant events. One of the criteria used in the revised definition is “an event with a Conditional Core Damage Probability (CCDP) or increase in core damage probability (ΔCDP) of 1×10^{-5} or higher.” The staff has historically used the Accident Sequence Precursor (ASP) program results to define the CCDP or ΔCDP of potential significant events. The annual results of the ASP program are issued on a fiscal-year basis, at the end of the following fiscal year. ITP results are reported on a fiscal-year basis, midway through the following fiscal year. Therefore, most of the ASP results are not finalized before the annual ITP reporting, and the staff has had to update the Commission through a separate memorandum when there are any changes in the analysis of the significant events indicator after the ASP analyses are completed.

As part of this review, the staff considered using results from Management Directive (MD) 8.3, "NRC Incident Investigation Program" (ADAMS Accession No. ML031250592), as a data source for CCDP or ΔCDP values for potential significant events. This possibility was considered because the MD 8.3 program provides early risk-significance results that would support more timely ITP analysis. However, the staff noted that not all of the events considered under the ASP undergo an MD 8.3 evaluation. For these events, ASP would continue to be the relied upon data source; however, MD 8.3 results can be used to inform the staff in its evaluation of the significant events indicator. In addition, the ASP analysis is more robust than the MD 8.3 analysis, and it provides more accurate risk significance results. Using a combination of MD 8.3 and ASP program data would introduce data of varying pedigree without the consistent benefit of more timely results. *Therefore, the staff concludes that ASP outcomes should not be replaced with MD 8.3 results for ITP purposes.*

The staff also examined, as part of its review, the significant events data before 2007 and determined that these older data do not reflect the current definition for the indicator, which was clarified in 2008. The staff reviewed the significant events data between FY 2004 and FY 2007 and concluded that realigning these data to reflect the revised definition for significant events would result in a less conservative approach for the long-term trending of this indicator. If the data are updated to reflect the current definition of significant events, the number of significant events required to meet the statistically significant trend threshold would be higher. *The staff concludes that no changes to the significant events indicator data sources are warranted. The staff notes, as a lesson learned, that the significant event indicator data before FY 2007 do not reflect the same definition for the indicator, but is not considering any adjustments at this time.*

3. ITP Indicator Results

The staff also reviewed the historical behavior of each indicator and the staff's actions in response to exceeded short-term prediction limits. The staff observed that most of the indicators exhibit a statistically significant decreasing trend, which represents an overall improvement in industry safety performance. However, the staff noted that the following indicators have exceeded their short-term prediction limits since the program was implemented:

- *Safety-System Actuations:* The short-term prediction limit for this indicator was exceeded in 2003 and 2005. The staff observed that the Northeast blackout of August 14, 2003 was a driver in exceeding the prediction limit in 2003. The staff's analysis did not reveal any safety issue warranting immediate regulatory action, and the staff noted that the agency was addressing this issue through an action plan issued on February 4, 2004, for resolving electrical grid concerns (ADAMS Accession No. ML040160437). The staff also analyzed the indicator's short-term data for 2005, when the short-term prediction limit was exceeded again. As discussed in SECY-06-0076, "FY 2005 Results of the Industry Trends Program for Operating Power Reactors and Status of the Ongoing Development of the Program" (ADAMS Accession No. ML060450235), the staff did not identify any driving factors behind the increase in safety-system actuations. Therefore, the staff concluded that the trend in this indicator was not safety-significant.

- *Automatic Scrams while Critical:* The short-term prediction limit for this indicator was exceeded in 2001 and 2003. The staff analyzed the short-term data for this indicator in both instances and did not identify any safety issues associated with exceeding the prediction limit. The staff also noted that the Northeast blackout of August 14, 2003, was a driver in exceeding the prediction limit in 2003.

- *Collective Radiation Exposure*: The short-term prediction limit for this indicator was exceeded in 2001. The staff reviewed the short-term data for this indicator and did not identify any safety issues associated with exceeding the prediction limit.

- *Significant Events*: The short-term prediction limit for this indicator was exceeded in 2011. The Operating Experience Branch staff reviewed significant events from the previous 5 years to identify any trends of concern. The review revealed that the number of events involving an initiator and subsequent complications increased since 2010, and that nonsafety-related system failures and corrective-action program weaknesses contributed to most of those significant events involving an initiator and complications. The staff's insights were used as input to the ROP enhancement effort.

Based on its review of the results achieved since the ITP's inception, the staff did not identify any analytical flaws or unfounded conclusions. The staff found that the evaluations performed in response to the exceeded short-term prediction limits met program objectives; the evaluations provided reasonable insights into potential safety issues, and agency responses to these occurrences were well supported. *No additional enhancements or resource reductions are warranted with regards to the ITP indicators.*

<u>LONG-TERM ANALYSIS</u>:

Appendix C, "Long Term Trending," to IMC 0313 describes the staff's approach to long-term trending analysis. Appendix C to IMC 0313 indicates that long-term analysis of the ITP indicators is performed on a 10-year basis to ensure that enough data are available for a meaningful statistical analysis. The staff also concluded in SECY-06-0076, "FY 2005 Results of the Industry Trends Program for Operating Power Reactors and Status of the Ongoing Development of the Program" (ADAMS Accession No. ML060450235), that the use of a 10-year period for long-term trending ensures that data more than 10 years old do not overly influence the trend determination. As part of this review, the staff considered the implementation of a shorter timeframe for long-term trending, but concluded that it would result in less conservative thresholds for the statistical significance of long-term trends. The staff reviewed the ITP indicators data for the last two decades and identified a significant improvement in industry performance when comparing the data from the last ten years to the data of the previous decade (i.e., ten to twenty years old data). Including performance data older than ten years in the ITP long-term analysis would reduce the ability of the program to detect any incremental changes in industry performance. The staff maintains its view that using a time period of more than 10 years would not be representative of current industry performance, as intended by the program. In addition, using older data would not yield a reliable, contemporary measure of the agency's safety performance, which is based on the number of statistically significant adverse trends. However, the staff recognizes that data beyond a 10-year period can be used to inform the review of exceeded short-term prediction limits or any emerging statistically significant long-term adverse trends.

The staff also recognizes that it can gain insights on industry performance by completing an additional evaluation of trends in industry performance using a shorter time period; i.e., by evaluating "mid-term trending." The Operating Experience staff in the Office of Nuclear Reactor Regulation (NRR) has broad responsibility to look at adverse data trends including "mid-term" trending and evaluation of industry performance data over a three-to-five year period. These reviews and insights have been and will continue to be integrated into the ITP. *No enhancements or resource reductions are warranted in this area.*

SHORT-TERM ANALYSIS:

As described in IMC 0313, the staff adopted a statistical approach using prediction limits to identify potential short-term emergent issues before they manifest themselves as long-term trends. Appendix B, "Prediction Limits," to IMC 0313 describes the process for developing short-term prediction limits for the ITP indicators. The prediction limits for each indicator are developed using information from a baseline period, which contains at least 4 years of data. A statistical test is performed on groups of data, and the period with the most constant frequency is selected as the baseline period. A predictive distribution is calculated for this period, and the value representing 95 percent of the upper limit of the distribution is defined as the prediction limit for the indicator. Prediction limits are reassessed and updated accordingly on a yearly basis.

As discussed in the "Indicators Used in the ITP" section of this enclosure, some of the ITP indicators have exceeded their short-term prediction limits, and the staff has responded accordingly to identify any safety issues derived from exceeding that limit. The staff concluded that the approach used to determine prediction limits and perform a short-term analysis is reasonable and has provided appropriate results. *No enhancements or resource reductions are warranted in this area.*

BRIIE IMPLEMENTATON:

The staff implemented the BRIIE for the first time in SECY-09-0048, "Fiscal Year 2008 Results of the Industry Trends Program for Operating Power Reactors and Status of the Ongoing Development of the Program" (ADAMS Accession No. ML090420101). The BRIIE was implemented to enhance the ITP by incorporating a mechanism to determine the risk significance in safety performance. The BRIIE concept provides a two-level approach to industry performance monitoring (i.e., Tier 1 and Tier 2). Both Tier 1 and Tier 2 of the BRIIE are explained in the annual reporting of the ITP results to the Commission. The Tier 2 BRIIE value is reported as a change in core-damage frequency (ΔCDF). The staff established a threshold ΔCDF value of 1×10^{-5} for reporting to Congress. The BRIIE Tier 2 threshold value has not been exceeded since the BRIIE was implemented. However, the staff noted that, had BRIIE been established five years earlier, the reporting threshold would have been crossed in 2003 because of the increase in initiating events resulting from the Northeast blackout.

The staff reviewed the BRIIE data since its implementation to identify any instances in which a Tier 1 short-term prediction limit was exceeded. The staff observed that the Loss of Offsite Power BRIIE indicator exceeded its short-term prediction limit in FY 2011. The staff reviewed the FY 2011 data for this indicator in SECY-12-0056, "Fiscal Year 2011 Results of the Industry Trends Program for Operating Power Reactors" (ADAMS Accession No. ML12065A340), and concluded that the events identified by the indicator resulted from natural phenomena occurring at multi-unit sites and were not representative of degraded industry performance. The staff did not recommend program adjustments as a result of this.

The staff concluded that the approach used for evaluating Tier 1 of the BRIIE effectively prompted further analysis when the CY 2011 ITP review was being performed. The staff is confident that the BRIIE will continue to reveal risk-significant changes in industry performance when prediction limits are exceeded. This will lead to further analysis of underlying causes and, if warranted, regulatory actions to effectively address them. *No enhancements or resource reductions are warranted in this area.*

ADDITIONAL CONSIDERATIONS:

The staff recognizes that there is an effort in place to evaluate the appropriateness of ROP PIs for new reactors. The staff issued a commission paper addressing this matter on December 17, 2013: SECY-13-0137, "Recommendations for Risk-Informing the Reactor Oversight Process for New Reactors" (ADAMS Accession No. ML13263A351). The staff should evaluate the results of this effort to determine the impacts of using ROP PI data from new reactors in the ITP. The staff also recognizes that a similar evaluation of applicability of new reactors' performance data for the BRIIE analysis should be performed in the near future. *The staff should explore ways to incorporate industrywide performance of new reactors in the ITP.*

CONCLUSION:

The staff reviewed the implementation of the ITP over its history for lessons learned and concluded that:

- No changes to or a realignment of the ITP objectives (as listed in the program guidance) are warranted.
- An indicator representative of the Public Radiation Safety cornerstone and the Security cornerstone of the ROP should be included in the ITP.
- The potential use of ROP PIs to supplement or replace ITP indicators and unnecessary duplication among ITP indicators should be evaluated. This may offer an opportunity for the NRC to achieve better resource efficiencies.
- The ASP outcomes should not be replaced with MD 8.3 results for ITP purposes.
- The significant events indicator data before FY 2007 do not reflect the same definition for the indicator, but no adjustments to the data or its sources are warranted at this time.
- No changes to the ITP long-term analysis process are warranted.
- No changes to the ITP short-term analysis process are warranted.
- No changes to the BRIIE process are warranted.
- The staff should explore ways to incorporate industrywide performance of new reactors in the ITP.

The staff's proposed plan to pursue these potential enhancements and/or resource reductions is included as Table 2 of this Enclosure.

Table 1. Indicators Used in the Industry Trends Program

ITP Indicator	Origin	Corner-stone	Data Source	Trend Behavior	Prediction Limit Baseline Period	Prediction Limit Crossed
Automatic Scrams while Critical	Ex-AEOD	IE	LERs and ENs	SST: Negative slope	1997-2002	2001 and 2003
Safety-System Actuations	Ex-AEOD	MS	LERs and ENs	SST: Negative slope	1998-2005	2003 and 2005
Significant Events	IMC 0313	ALL	ROP AM, ASP, AO, INES	NSST: Positive slope	2000-2004	2011
Safety-System Failures	Ex-AEOD	MS	LERs and ENs	NSST: Positive slope	2001-2004	No
Forced Outage Rate	Ex-AEOD	MS	MOR	NSST: Positive slope	2001-2004	No
Equipment Forced Outages	Ex-AEOD	MS	MOR	SST: Negative slope	1998-2004	No
Collective Radiation Exposure	Ex-AEOD	ORS	INPO	SST: Negative slope	1999-2002	2001
Unplanned Power Changes	ROP PI	IE	ROP PI	SST: Negative slope	2001-2004	No
Reactor Coolant System Activity	ROP PI	BI	ROP PI	SST: Negative slope	2001-2004	No
Reactor Coolant System Leakage	ROP PI	BI	ROP PI	SST: Negative slope	2000-2004	No
Drill and Exercise Performance	ROP PI	EP	ROP PI	SST: Negative slope	2000-2004	No
Emergency-Response Organization Drill Participation	ROP PI	EP	ROP PI	SST: Negative slope	2003-2007	No
Alert and Notification System Reliability	ROP PI	EP	ROP PI	SST: Negative slope	2001-2004	No
Accident-Sequence Precursor Rate	ASP	ALL	ASP	NSST: Negative slope	N/A	No

Origin: Ex-AEOD = indicators developed by the AEOD Office
ROP PI = ROP performance indicators
IMC 0313 = indicator defined through IMC 0313
ASP = indicator derived from the Accident Sequence Precursor program

Cornerstone: IE = Initiating Events   MS = Mitigating Systems   BI = Barrier Integrity
ORS = Occupational Radiation Safety   EP = Emergency Preparedness

Data Source: LERs = Licensee Event Reports   ENs = Event Notifications
ROP AM = ROP Action Matrix Input   ASP = Accident Sequence Precursor Program
AO = Abnormal Occurrences Report   INES = International Nuclear Event Scale
MOR = Monthly Operating Reports   ROP PI = ROP Performance Indicators
INPO = reported by the Institute of Nuclear Power Operations

Behavior: SST = statistically significant trend   NSST = not statistically significant trend

Table 2. Staff's Plan to Address Conclusions from the Industry Trends Program Review

Review Area	No.	Conclusions	Commitment	Estimated Completion
Objectives	1	No changes are warranted.	N/A	N/A
Indicators	2	Include an indicator reflecting the Public Radiation Safety cornerstone.	Consider using the Public Radiation Safety cornerstone ROP performance indicator (i.e., Radiological Effluence Occurrence).	April 2015 – FY2014 ITP Results SECY
Indicators	3	Include an indicator reflecting the Security cornerstone.	Consider using the Security cornerstone ROP performance indicator (i.e., Protected Area Security Equipment Performance Index).	April 2015 – FY2014 ITP Results SECY
Indicators	4	Consider the potential use of ROP PIs to supplement/replace ITP indicators where possible and evaluate ITP indicators for unnecessary duplication among these.	Evaluate the feasibility of supplementing and/or replacing ITP indicators with ROP performance indicators where applicable.	April 2015 – FY2014 ITP Results SECY
Indicators	5	ASP outcomes for significant events should not be replaced with MD 8.3 results.	N/A	N/A
Indicators	6	No adjustments to the significant events data or its sources are warranted at this time.	N/A	N/A
Long -Term Analysis	7	No changes are warranted.	N/A	
Short-Term Analysis	8	No changes are warranted.	N/A	N/A
BRIIE	9	No changes are warranted.	N/A	N/A
Additional Considerations	10	Explore ways to incorporate new reactors' performance data into ITP.	Evaluate the use of performance data for new reactors in the ITP, as applicable (e.g., ROP PIs for new reactors, BRIIE adequacy).	Within a year of establishment of new reactors PIs.