POLICY ISSUE
(Information)

March 31, 2006 SECY-06-0076

FOR: The Commissioners

FROM: Luis A. Reyes
Executive Director for Operations /RA/

SUBJECT: FY 2005 RESULTS OF THE INDUSTRY TRENDS PROGRAM FOR OPERATING POWER REACTORS AND STATUS OF THE ONGOING DEVELOPMENT OF THE PROGRAM

PURPOSE:

To inform the Commission of the FY2005 results of the U.S. Nuclear Regulatory Commission's (NRC's) Industry Trends Program (ITP) for operating power reactors and the status of its ongoing development.

SUMMARY:

This report documents NRC's analysis of the FY 2005 industry-level performance indicators and summarizes the status of the ongoing development of the ITP. Based on the information currently available from the industry-level indicators and the Accident Sequence Precursor (ASP) Program, no statistically significant adverse industry trends have been identified through FY 2005.

In addition to long-term trending of the data to identify statistically significant adverse trends, short-term trending of the data was conducted to identify potential issues before they become long-term trends. The safety system actuations (SSA) indicator exceeded its short-term prediction limit. The staff's analysis of the SSA indicator did not identify any pattern or driving factors behind the increase. Therefore, the staff does not consider the trend of the SSA to be safety significant and will continue to monitor this indicator along with the others.

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301-415-2292

BACKGROUND:

NRC implemented the ITP in calendar year (CY) 2001. The NRC staff uses industry-level indicators to identify adverse trends. Adverse trends are assessed for safety significance, and the NRC responds as necessary to any identified safety issues, including adjustments to the inspection and licensing programs if necessary. One important output of this program 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’s Performance and Accountability Report. In addition, NRC annually reviews the results of the ITP, along with any actions taken or planned, during the Agency Action Review Meeting (AARM) and reports the results to the Commission. This paper is the fifth annual report to the Commission on the ITP.

Details of the ITP, including definitions of indicators monitored and program description, are contained in Inspection Manual Chapter (IMC) 0313, “Industry Trends Program.”

DISCUSSION:

The ITP is intended to monitor trends in industry safety performance so that the NRC can identify and address adverse industry trends. The indicators are comprehensive and based on the best available data. Oversight of plant-specific conditions and events is provided by the Reactor Oversight Process (ROP).

RESULTS OF FY 2005 TREND ANALYSES

Based on the ITP indicators and the ASP Program results, the staff identified no statistically significant adverse trends in industry safety performance through the end of FY 2005. The long-term trends of the indicators are shown in the graphs in Enclosure 1.

To identify potential short-term, year-to-year emergent issues before they become long-term trends, the staff uses a statistical approach based on “prediction limits.” The short-term trends with the prediction limits for each of the indicators are shown in the graphs in Enclosure 2. Only the SSA indicator exceeded its prediction limit in FY 2005. The staff analyzed the SSA indicator to identify possible trends and patterns that would account for the higher number of SSAs (see Enclosure 3). The analysis did not identify any pattern or driving factors behind the increase. The NRC staff will continue to monitor this indicator and take actions, if warranted, for any identified adverse trend or pattern.

Although the ASP indicator did not show a statistically significant adverse trend, the staff previously noted an increasing number of precursors between FY 2000 – FY 2002 when compared to the relatively low number of precursors between FY 1997 – FY 1999. The staff conducted a detailed evaluation of the ASP data to investigate the nature of the trends to determine whether there is an explanation for the disparity. The staff documented this evaluation in SECY-05-0192, “Status of the Accident Sequence Precursor (ASP) Program and the Development of Standardized Plant Analysis Risk (SPAR) Models” and concluded the following:

- A statistically significant increasing trend was detected in the occurrence rate of all precursors with conditional core damage probability (CCDP) or delta core damage probability (ΔCDP) $\geq 1\times10^{-6}$ during FY 1997 – FY 2004. However, no statistically significant trend was detected if initiating events involving loss of offsite power (LOOP) events and degraded conditions involving cracking events in control rod drive mechanism (CRDM) housings are removed from the data. Both precursor groups have a pronounced influence on the increasing trend. No underlying trend was found when LOOP events and CRDM cracking conditions are removed from the data set. The staff is currently addressing the increasing number of LOOP events and the CRDM cracking events through generic communications and other agency actions.

- No statistically significant trend was detected in the occurrence rate of risk-important precursors (i.e., CCDP or ΔCDP $\geq 1\times10^{-4}$) for either the FY 1997 – FY 2004 or FY 2001 – FY 2004 periods. No statistically significant trend was detected in the occurrence rate of all precursors with a CCDP or ΔCDP $\geq 1\times10^{-6}$ during FY 2001 – FY 2004 (if LOOP events are removed from the data, the trend is decreasing). The trend of all precursors has a step increase from FY 1999 to FY 2000 and levels out after FY 2001.

- An increase in scope of the ASP Program over the past 4 to 5 years resulted in the identification and analysis of 23 precursors that would not have been analyzed if they had occurred during the FY 1997 – FY 1999 period.

In summary, LOOP events and conditions involving cracking in CRDM housings influenced the ASP trends between FY 1997 – FY 2004. Because NRC is currently addressing these issues, no other additional actions are planned based on the staff's analysis of ASP trends.

ITP DEVELOPMENT

1. Development of an ITP Inspection Manual Chapter

The staff issued IMC 0313, "Industry Trends Program," to document the details of the ITP. IMC 0313 includes definitions, data sources, calculations, and statistical methods for each indicator.

The Inspection Manual chapter also identifies which indicators have been qualified for use in reporting against the measure of the number of statistically significant adverse trends. As discussed in last year's ITP paper (SECY-05-0069), several industry-level indicators developed from the data submitted by licensees for the plant-level ROP performance indicators have been qualified for use in the ITP. The Inspection Manual chapter will be updated as additional indicators are qualified for use in reporting against this measure.

As also discussed in last year's ITP paper, the staff changed the long-term trending methodology to use fitted trend lines using 10 years of data (the 10-year rolling trend) instead of using data back through 1988. The methodology was changed to ensure that older data do not overly influence the trend determination.

2. Development of Additional, More Risk-Informed Indicators

The staff has continued the development of an index for boiling water reactors that monitors 9 risk-significant initiating events and a similar index for pressurized water reactors that monitors 10 events (the additional event category is steam generator tube rupture), as reported in SECY-04-0052 and SECY-05-0069. Each initiating event is weighted in the index according to its relative contribution to industry core damage frequency. This indicator is called the baseline risk index for initiating events (BRIIE). In FY 2005, the staff updated risk importance measures (to reflect updated Standardized Plant Analysis Risk [SPAR] models) and BRIIE results. Upcoming work includes forming an internal expert panel to establish BRIIE thresholds. The staff's goal is to present BRIIE results and thresholds in the FY 2006 ITP paper (to be issued in early CY 2007) and incorporate BRIIE into the ITP and formally use BRIIE results as an ITP indicator in the FY 2007 ITP paper (to be issued in early CY 2008).

3. Evaluation of Historic Significant Events Data

During the collection of the Significant Events data for FY 2005, the staff noted that a process was not in place to ensure revised or updated data (such as data from inspection findings and ASP results) were included as appropriate in the count of Significant Events. The staff reviewed and updated the data from FY 2000 – FY 2004. The Significant Event Charts in Enclosures 1 and 2 reflect the updated data. Although the data have been revised, the trend continues to indicate improvement. IMC 0313 will be revised to include a process to ensure revised and updated data are included.

<u>COMMITMENTS</u>:

The staff commits to the following activities in this paper:

- Once development is complete, incorporate BRIIE into the ITP and formally use BRIIE results as an ITP indicator in the FY 2007 ITP paper (to be issued in early CY 2008).

- IMC 0313 will be revised to include a process to ensure revised and updated significant events data are included.

<u>RESOURCES</u>:

For FY 2006 and FY 2007, the Office of Nuclear Reactor Regulation (NRR) has budgeted resources of approximately 0.7 full-time equivalent (FTE) and $295,000 for the continued development and implementation of the ITP. For FY 2008 – FY 2009, NRR estimates resource requirements of approximately 0.7 FTE per year, and $350,000 per year and these resources will be considered in the FY 2008 planning, budgeting, and performance management process. RES support to the Industry Trends Program involves operating experience data and models developed and budgeted under other RES programs, such as ASP. RES also directly supports the ITP through the development of BRIIE. For FY 2006, RES has budgeted resources of approximately 0.5 FTE and $150,000 for the continued development of BRIIE. For FY 2007, RES has budgeted resources of approximately 0.1 FTE and $50,000. The resources budgeted in NRR and RES are adequate for ongoing ITP implementation.

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.

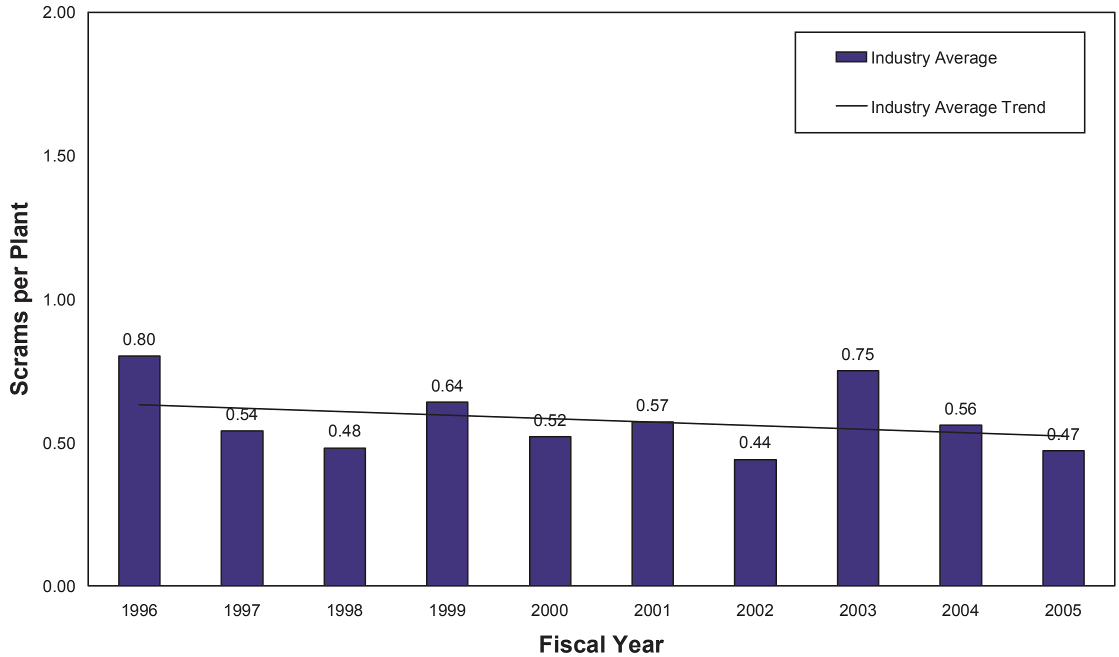
/RA/

Luis A. Reyes
Executive Director
for Operations

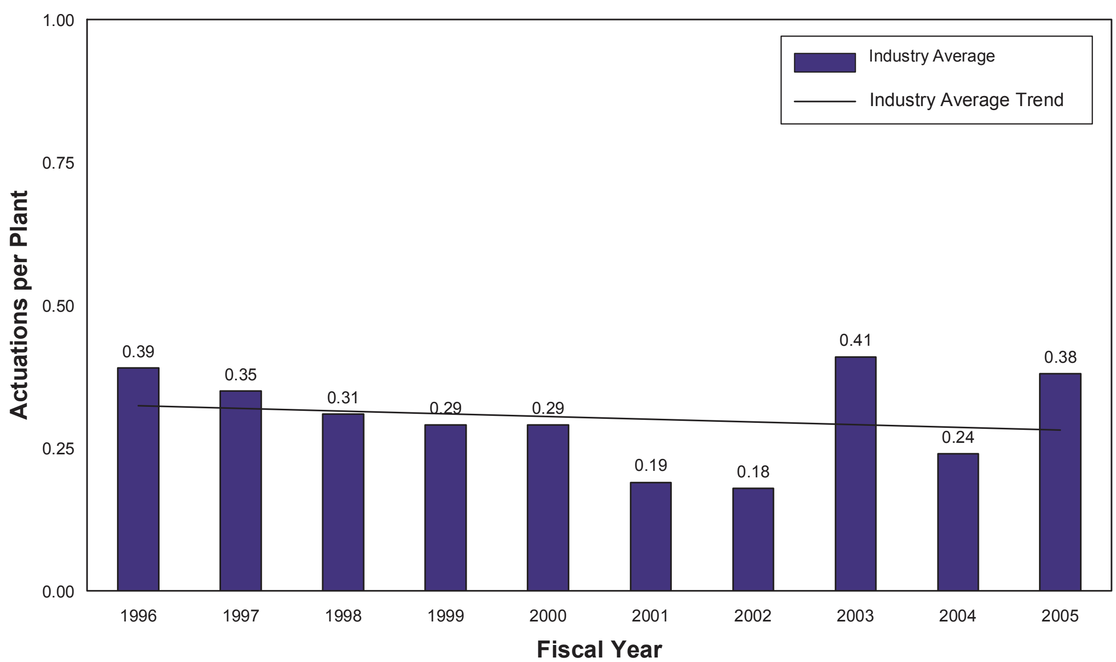
Enclosures:
1. FY 2005 Long-Term Industry Trend Results
2. FY 2005 Short-Term Industry Trend Results
3. Safety System Actuations (SSA) Analysis

FY2005 Long-Term Industry Trend Results

Automatic Scrams While Critical

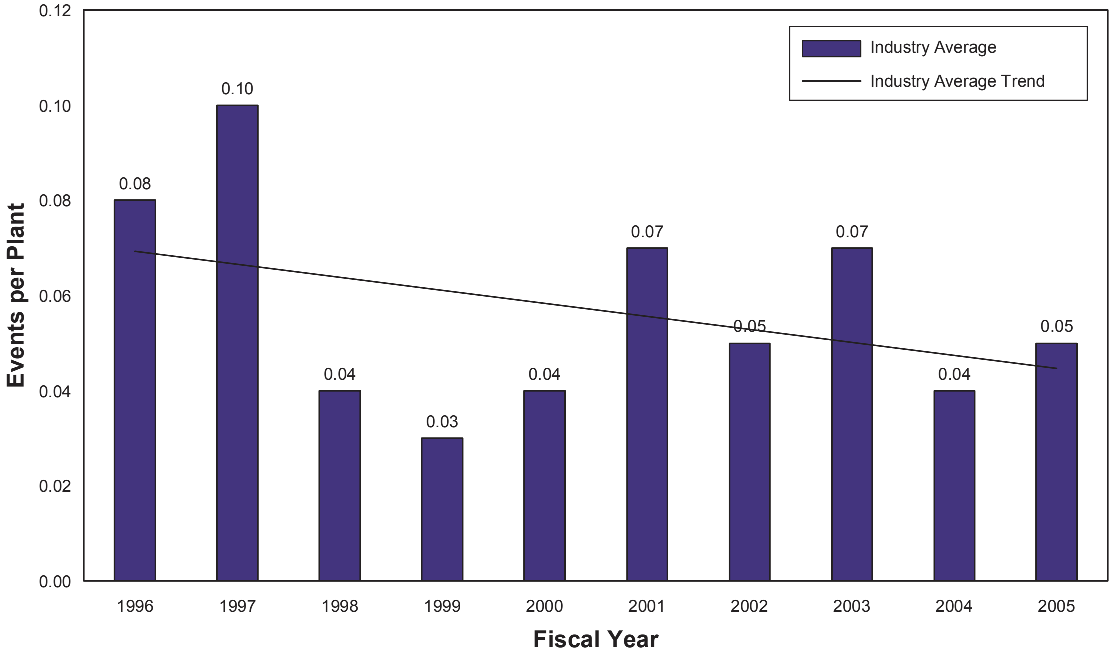


Safety System Actuations

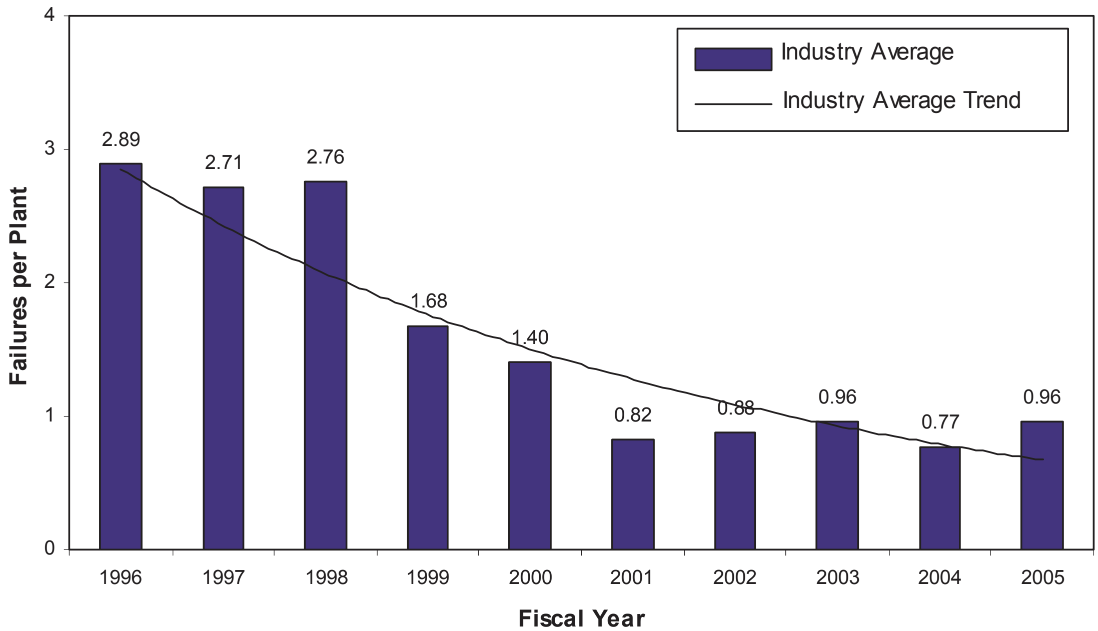


Enclosure 1

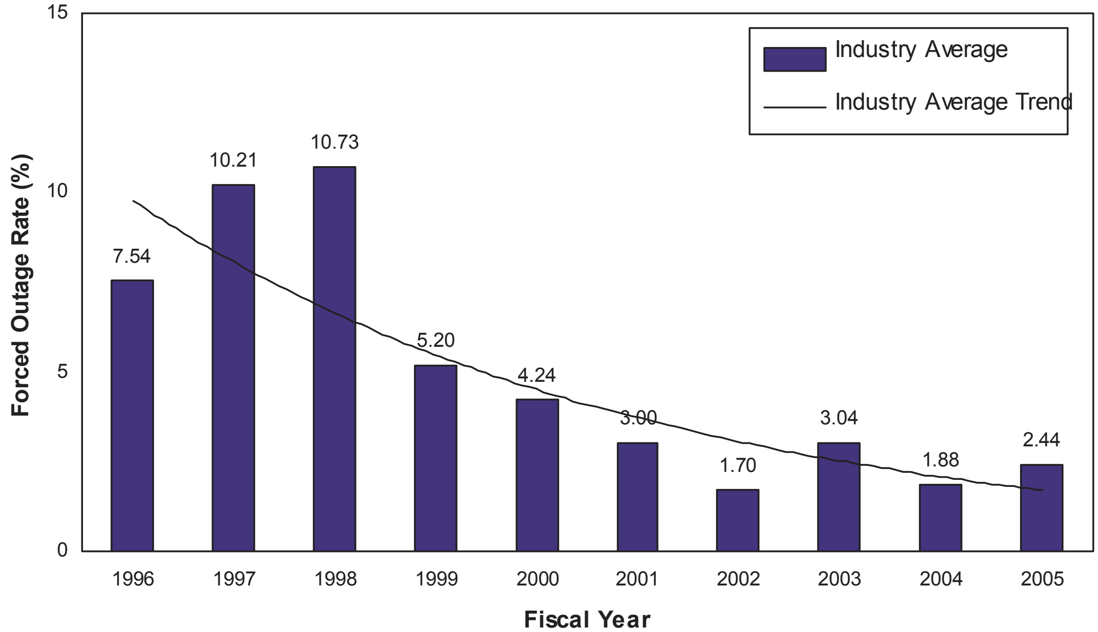
Significant Events



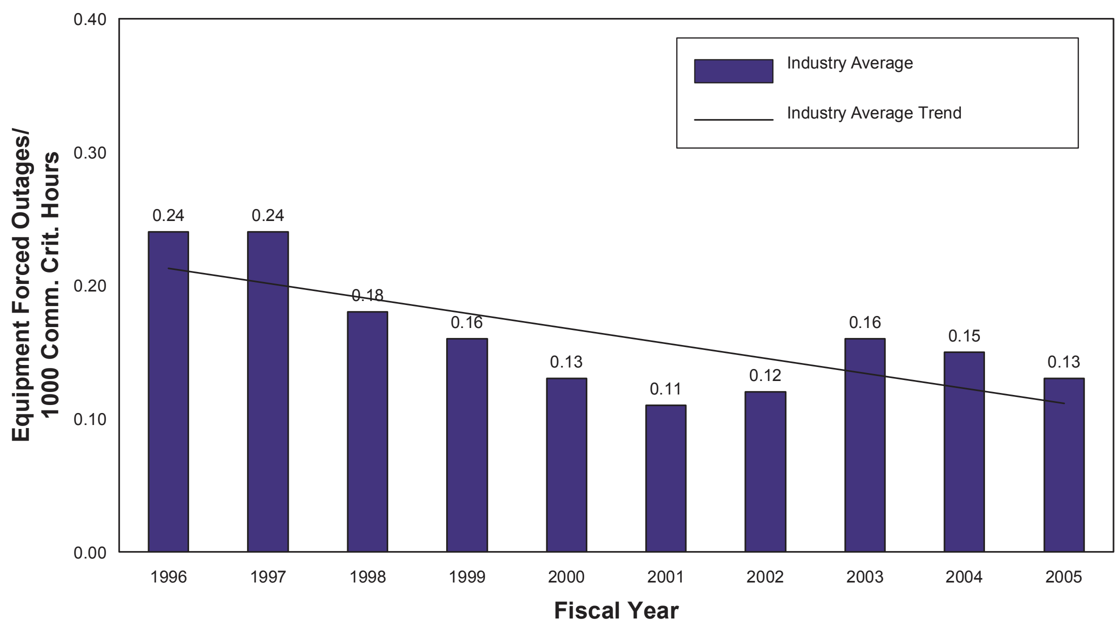
Safety System Failures



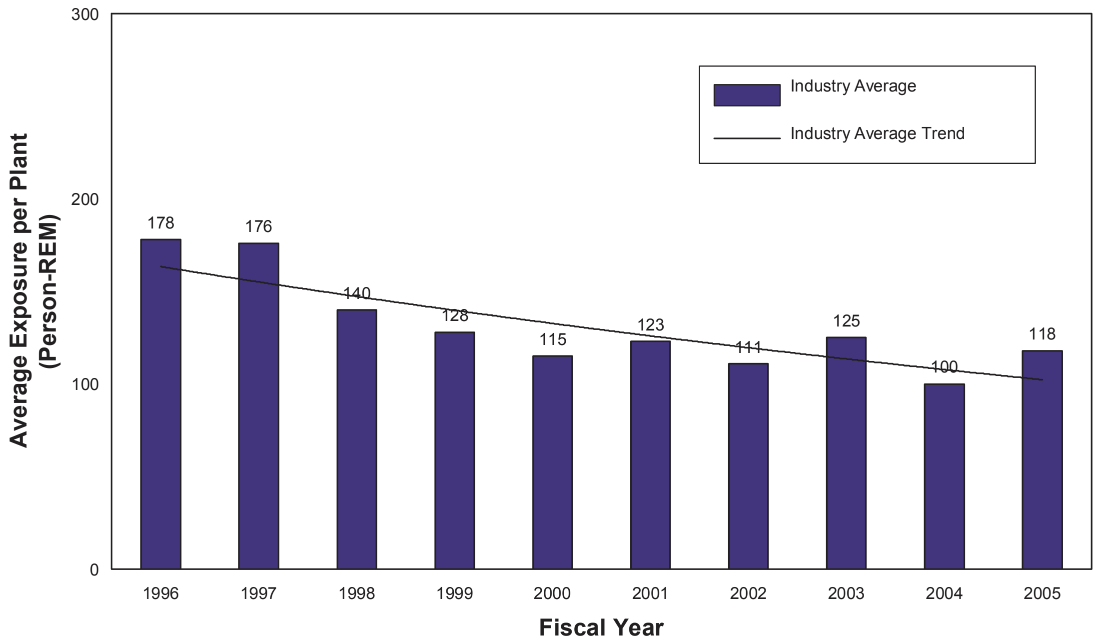
Forced Outage Rate (%)



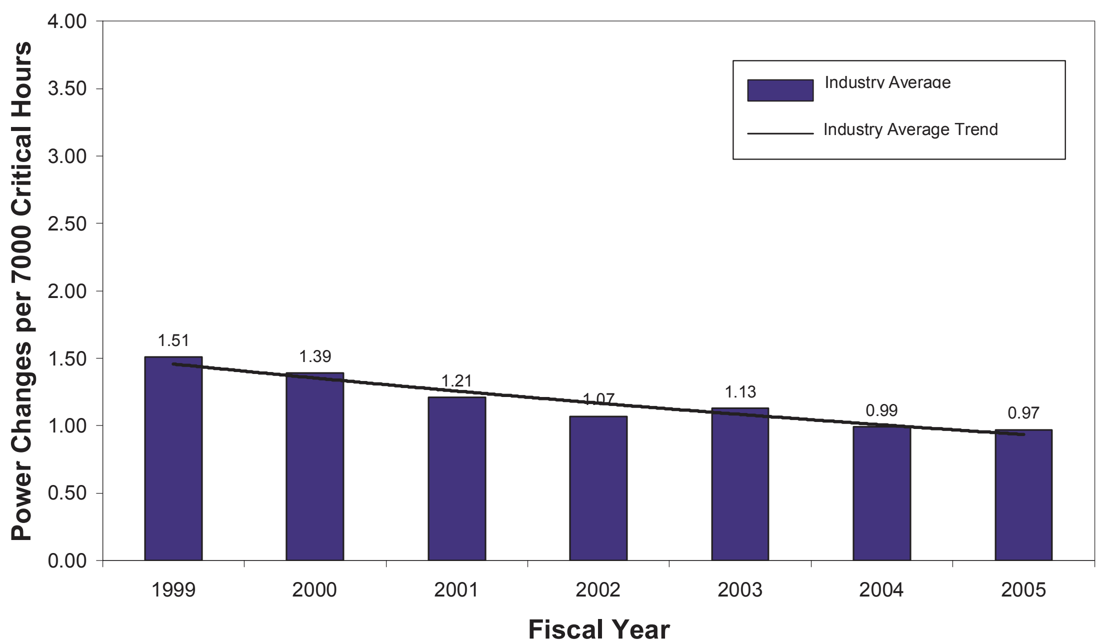
Equipment Forced Outages/ 1000 Commercial Critical Hours



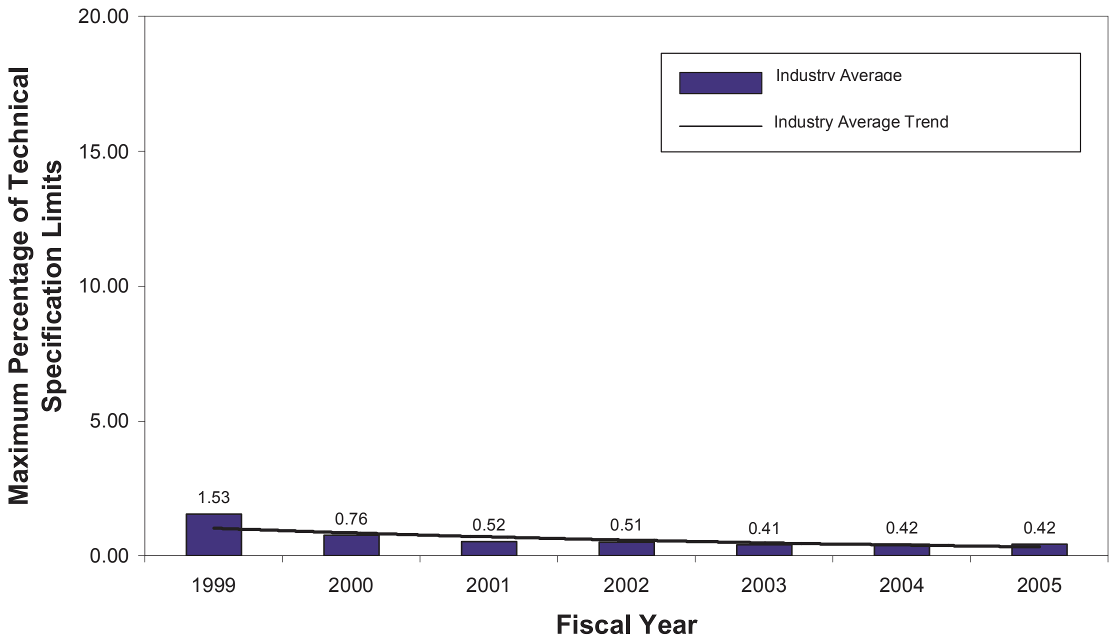
Collective Radiation Exposure



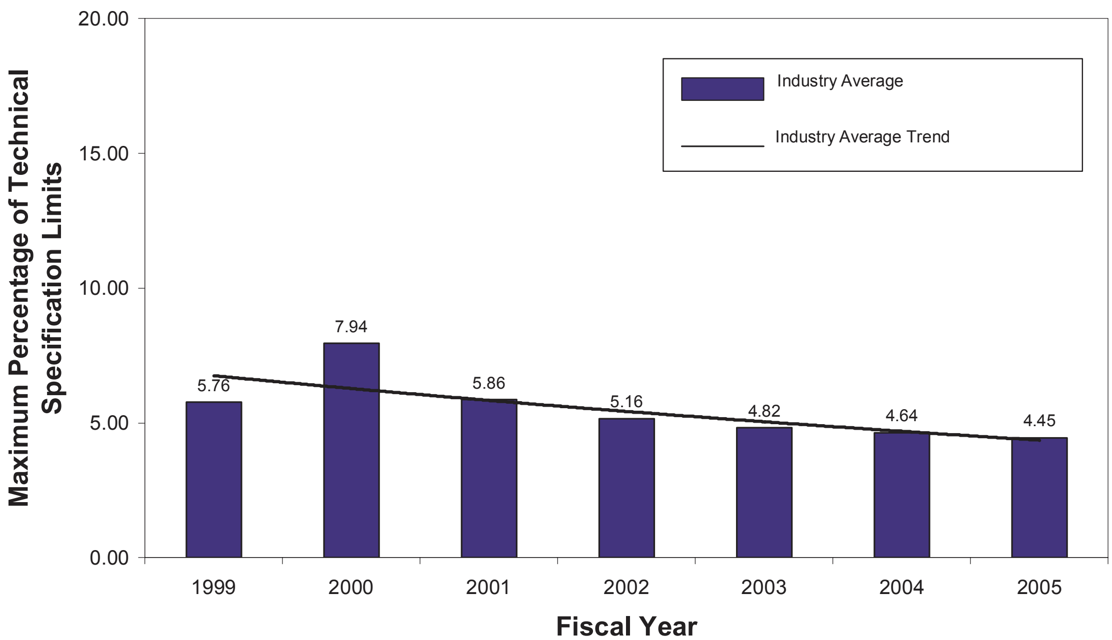
Unplanned Power Changes



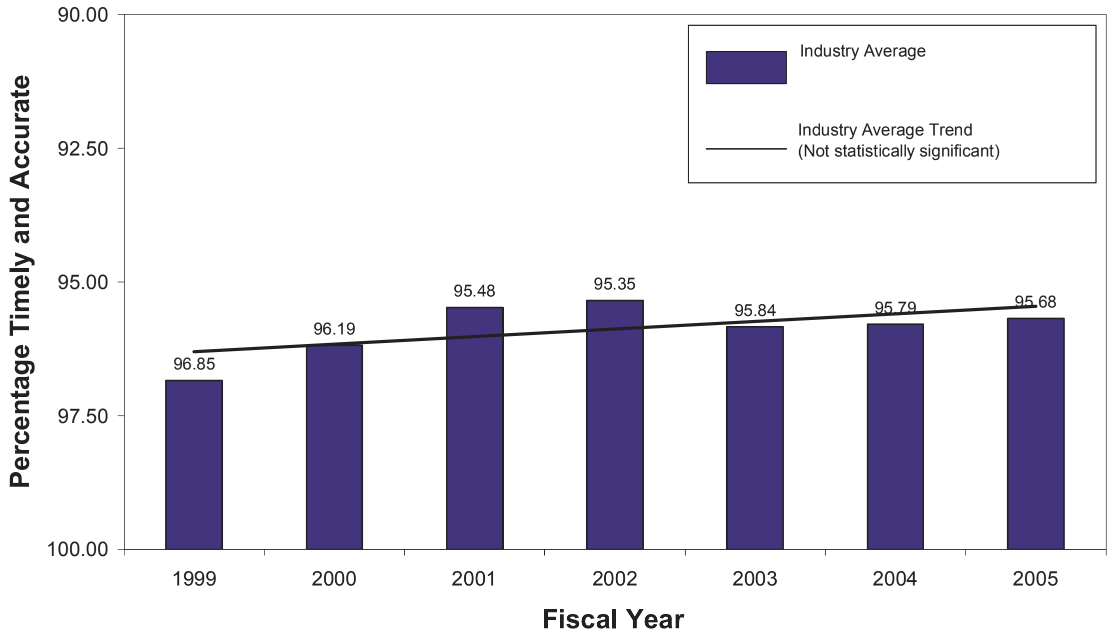
Reactor Coolant System Activity



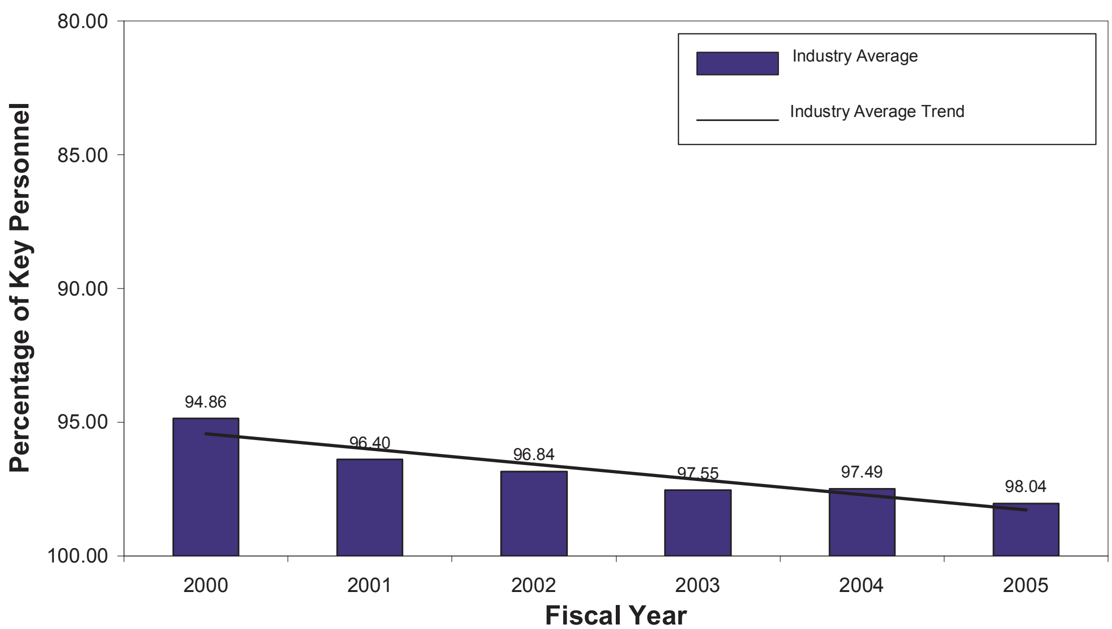
Reactor Coolant System Leakage



Drill/Exercise Performance

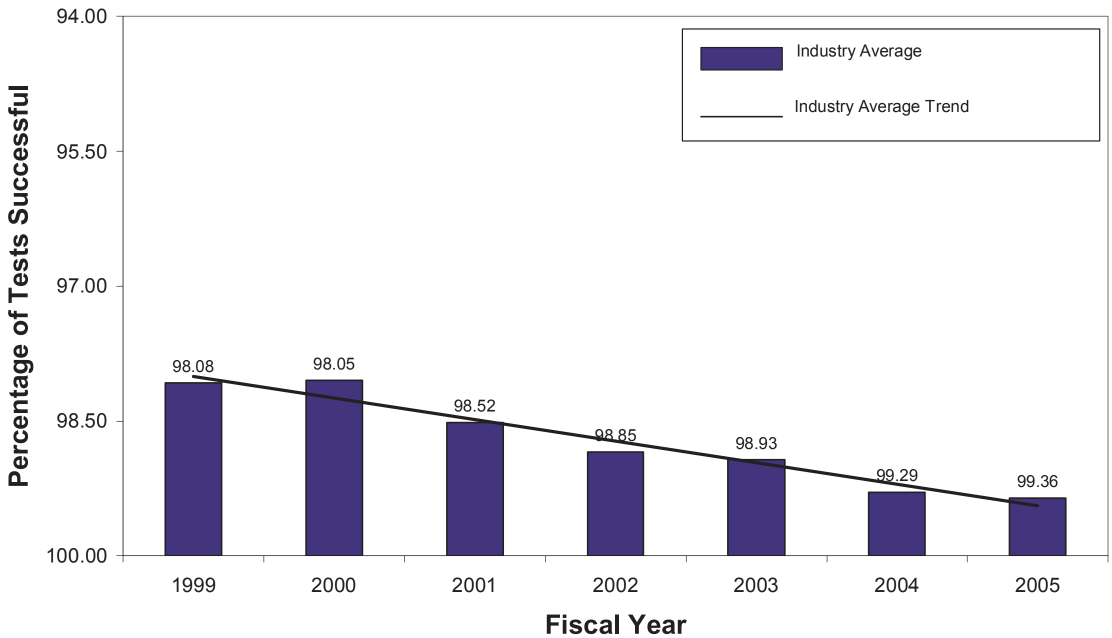


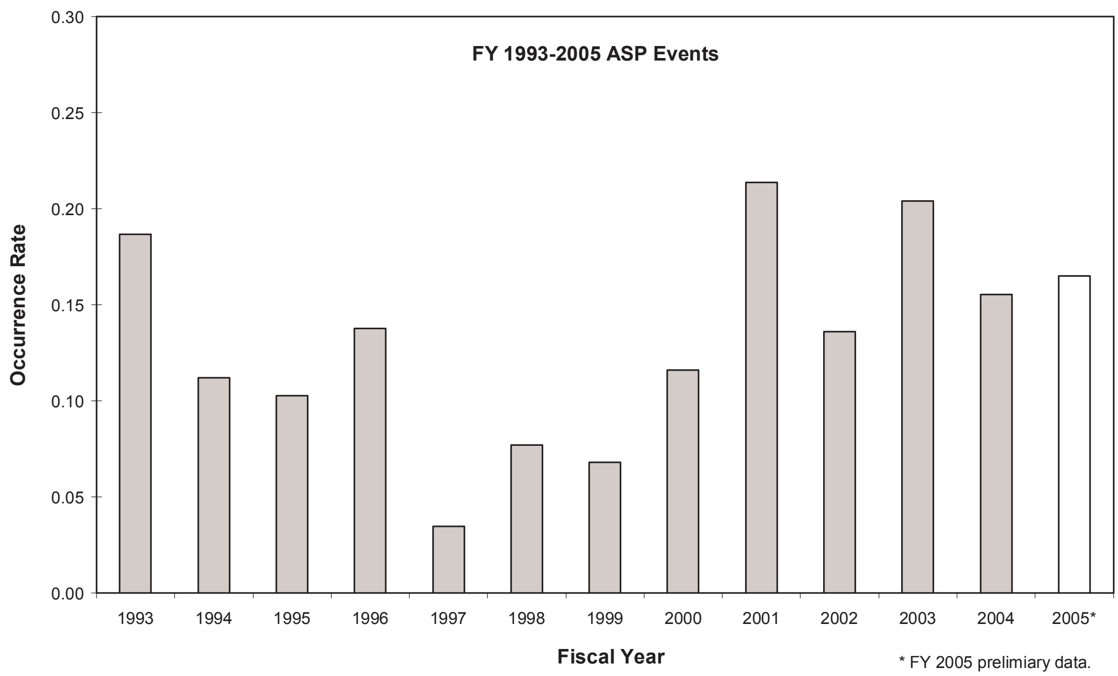
ERO Drill Participation



Note: Complete Fiscal Year 1999 Data not Available

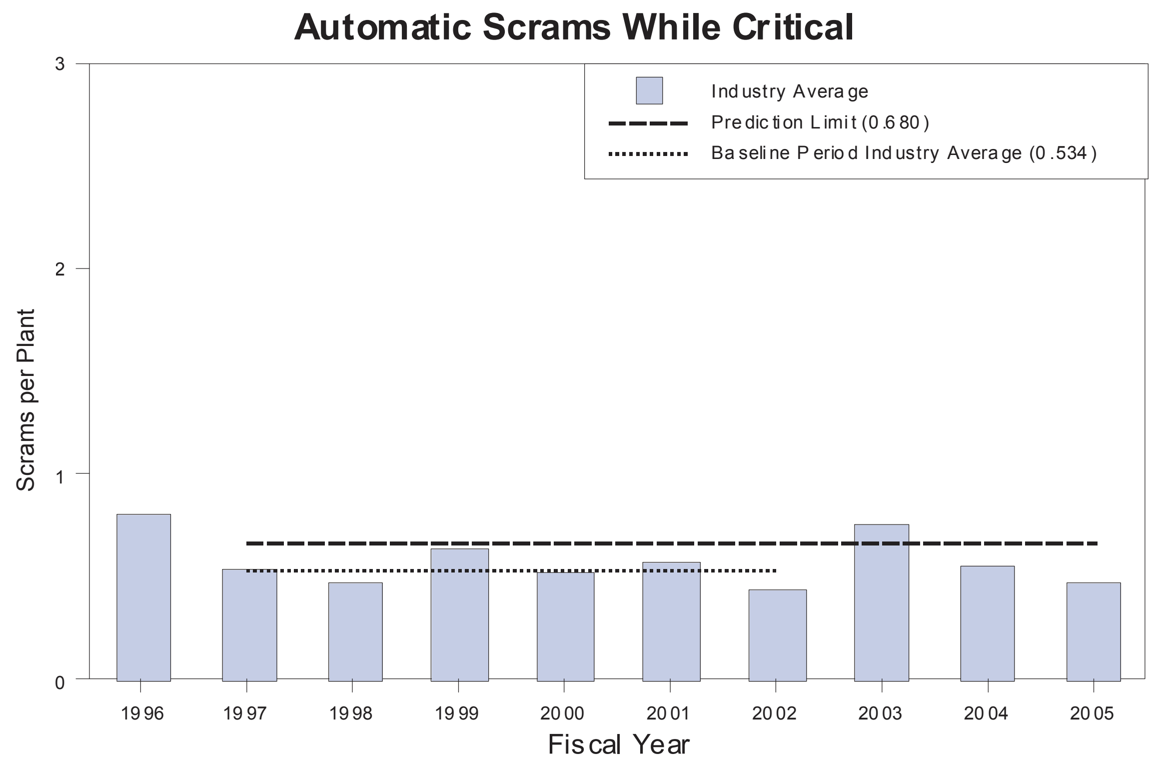
Alert and Notification System Reliability

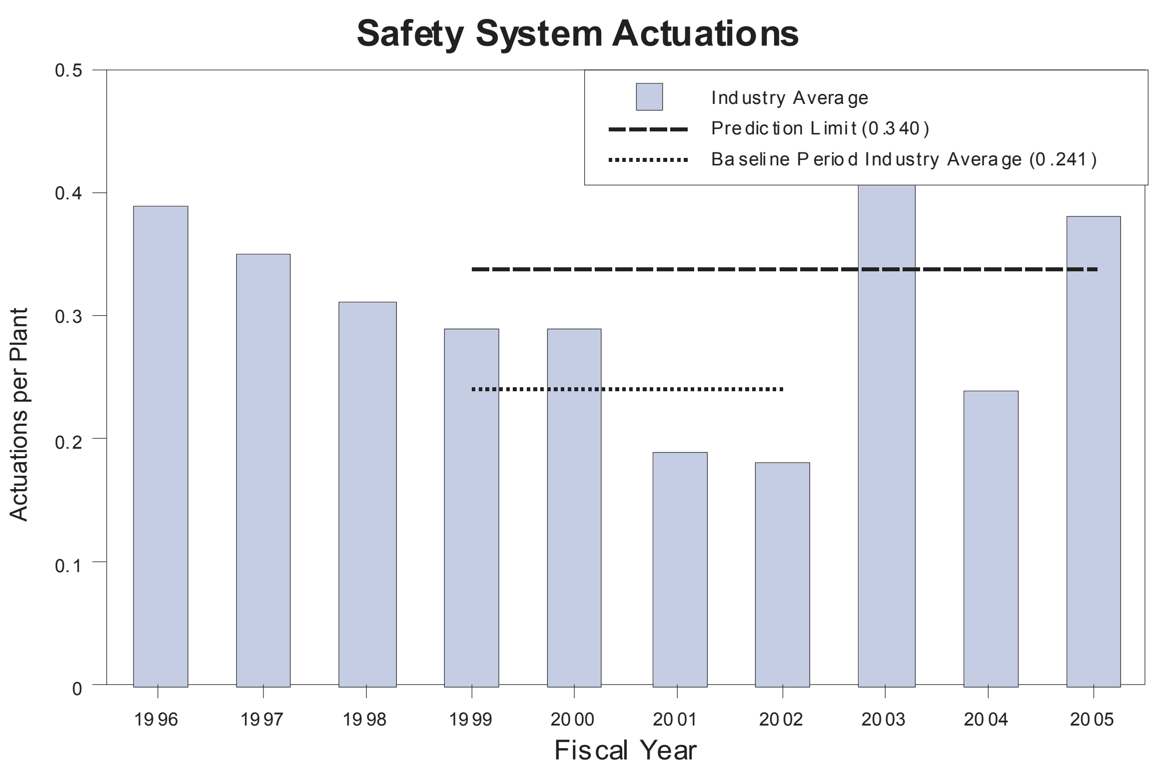




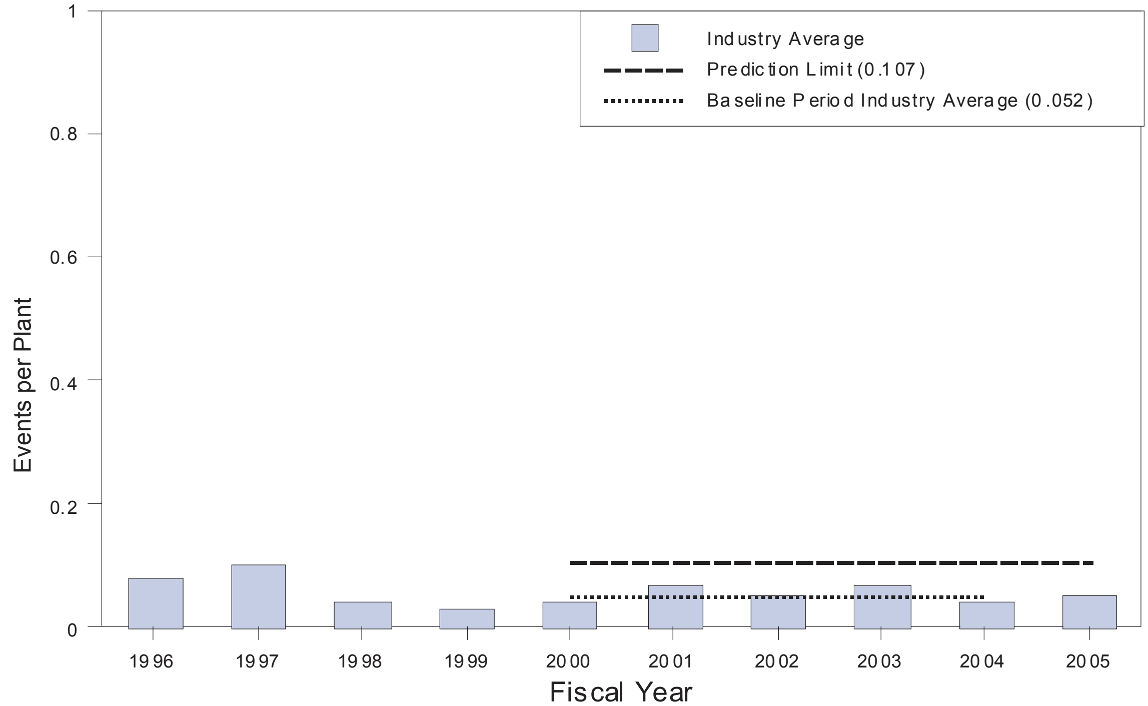
Total Precursors - occurrence rate by fiscal year. No trend line is shown because no trend was detected that was statistically significant.

FY 2005 Short-Term Industry Trend Results

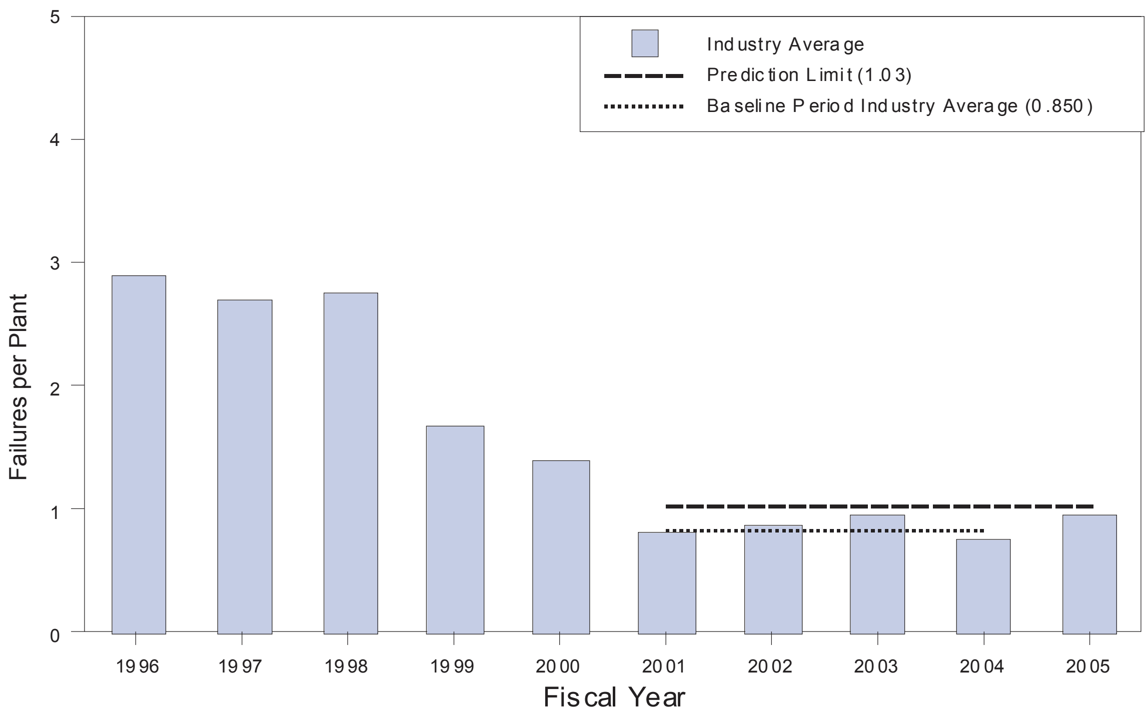


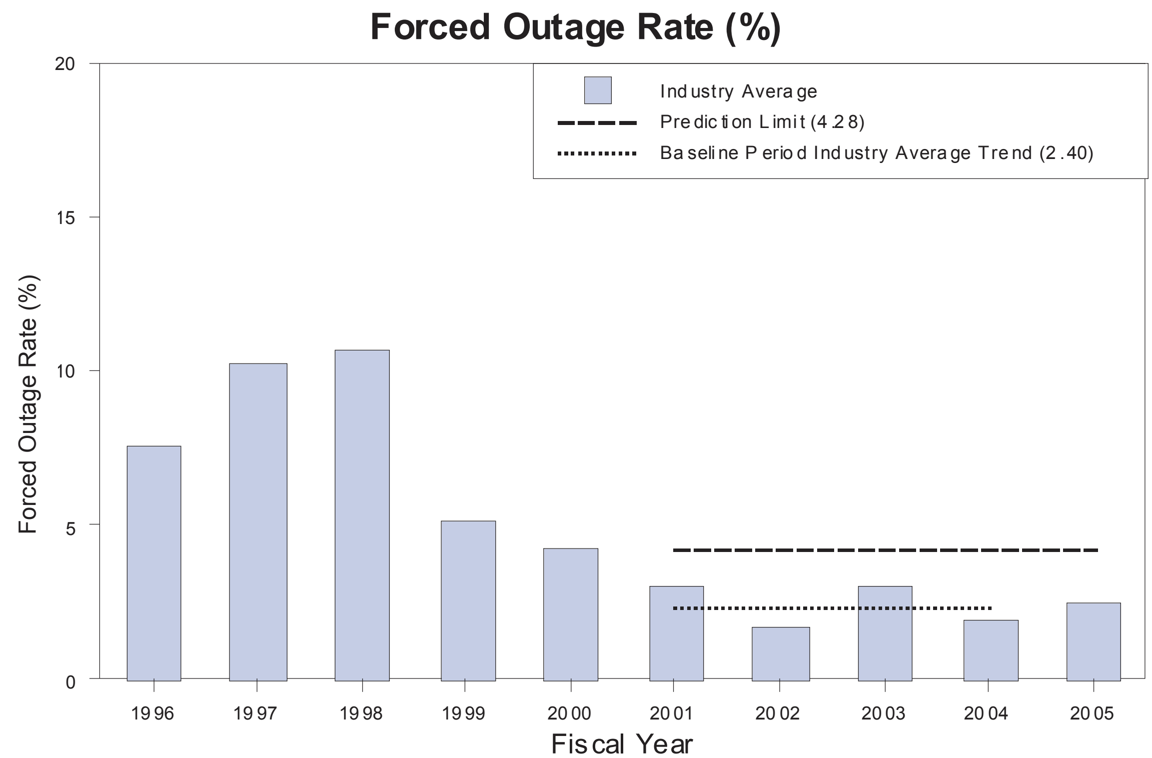


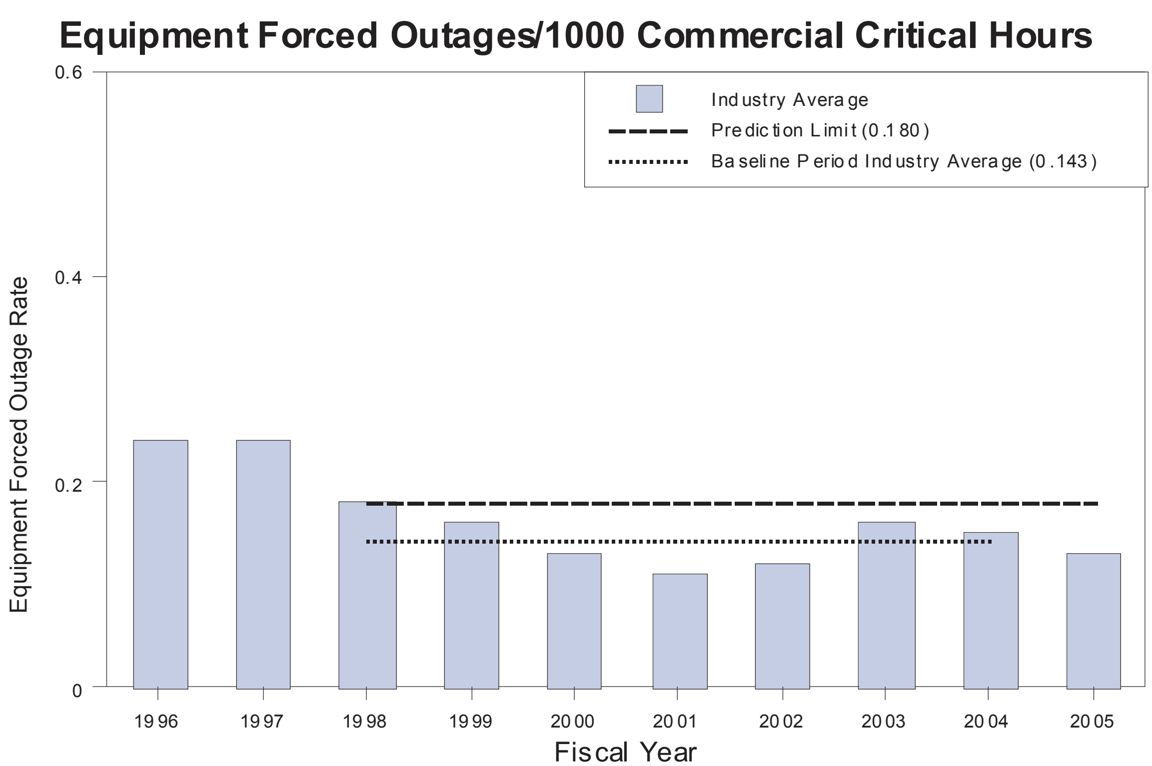
Significant Events

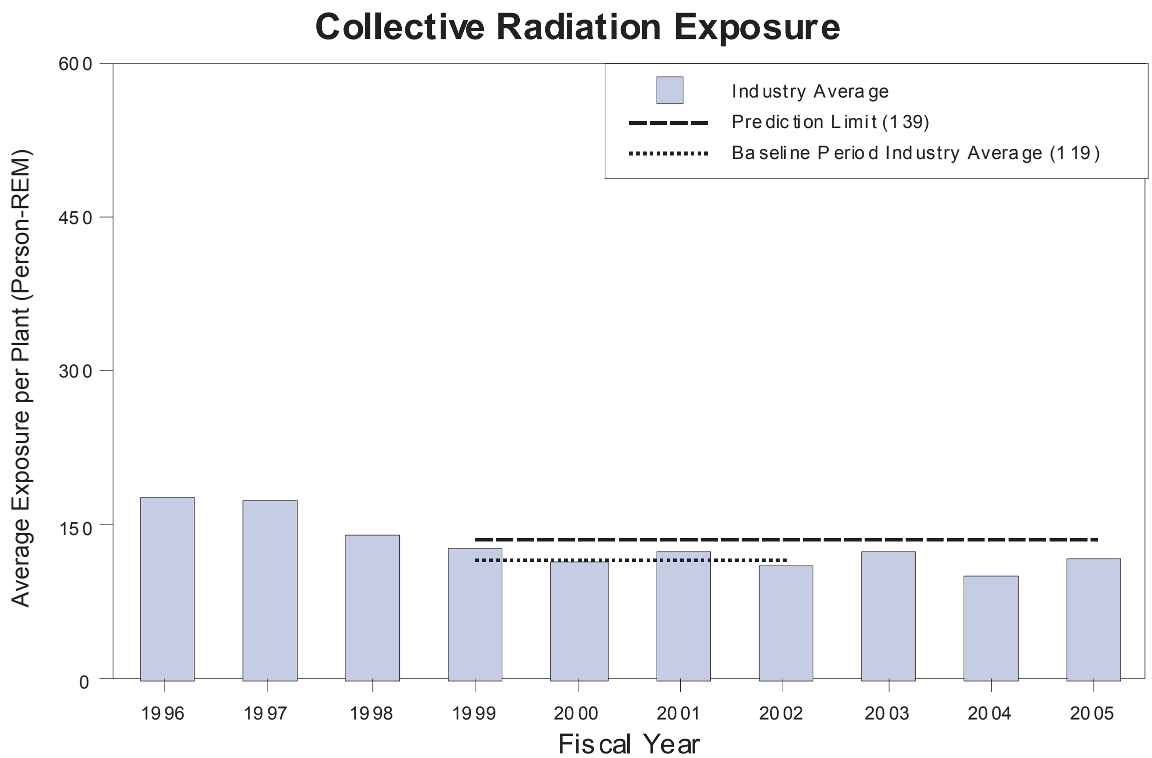


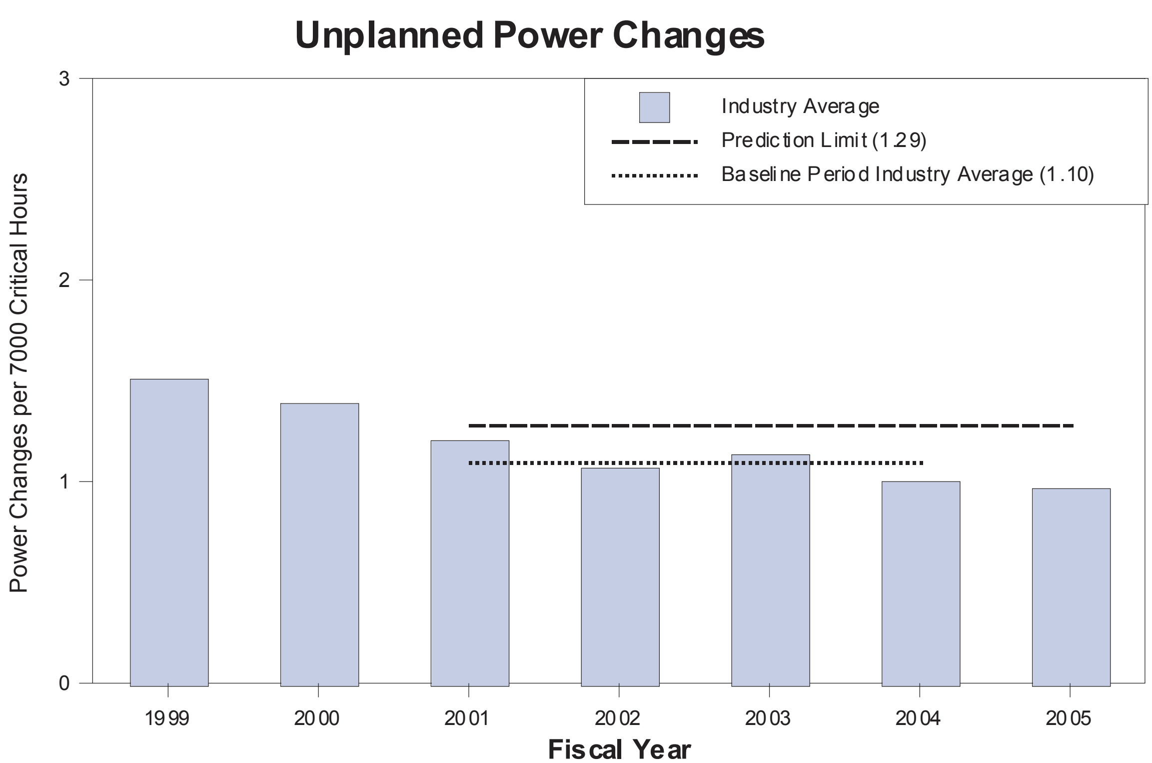
Safety System Failures

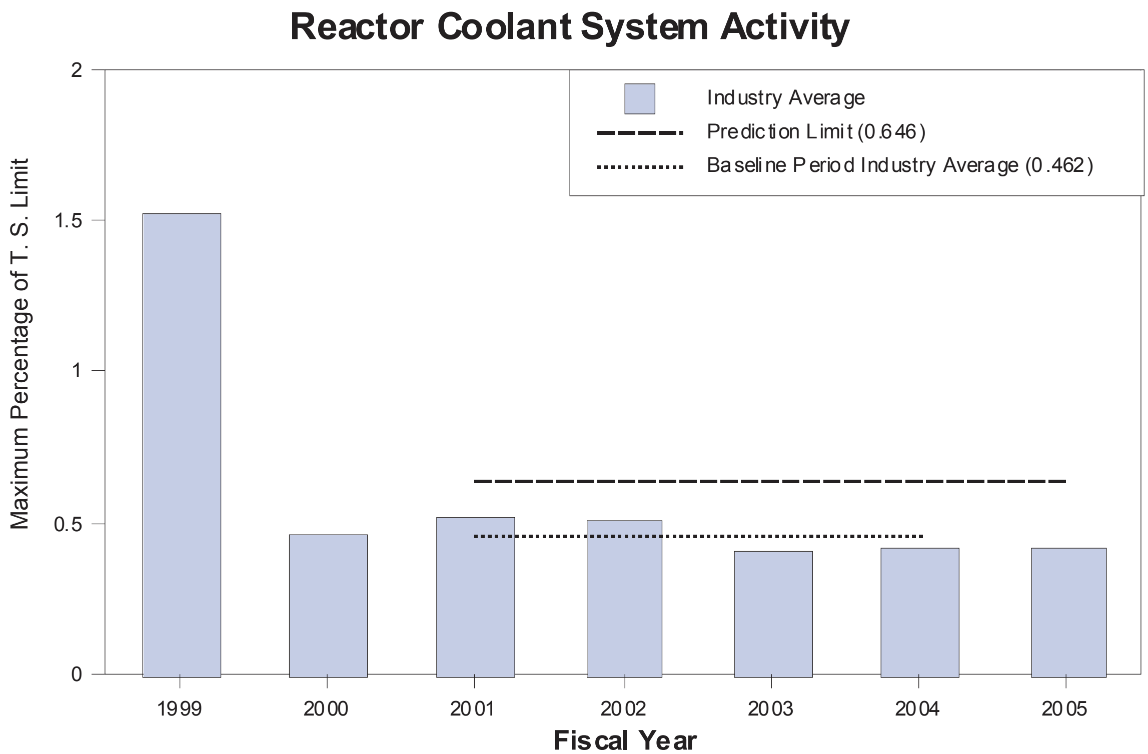


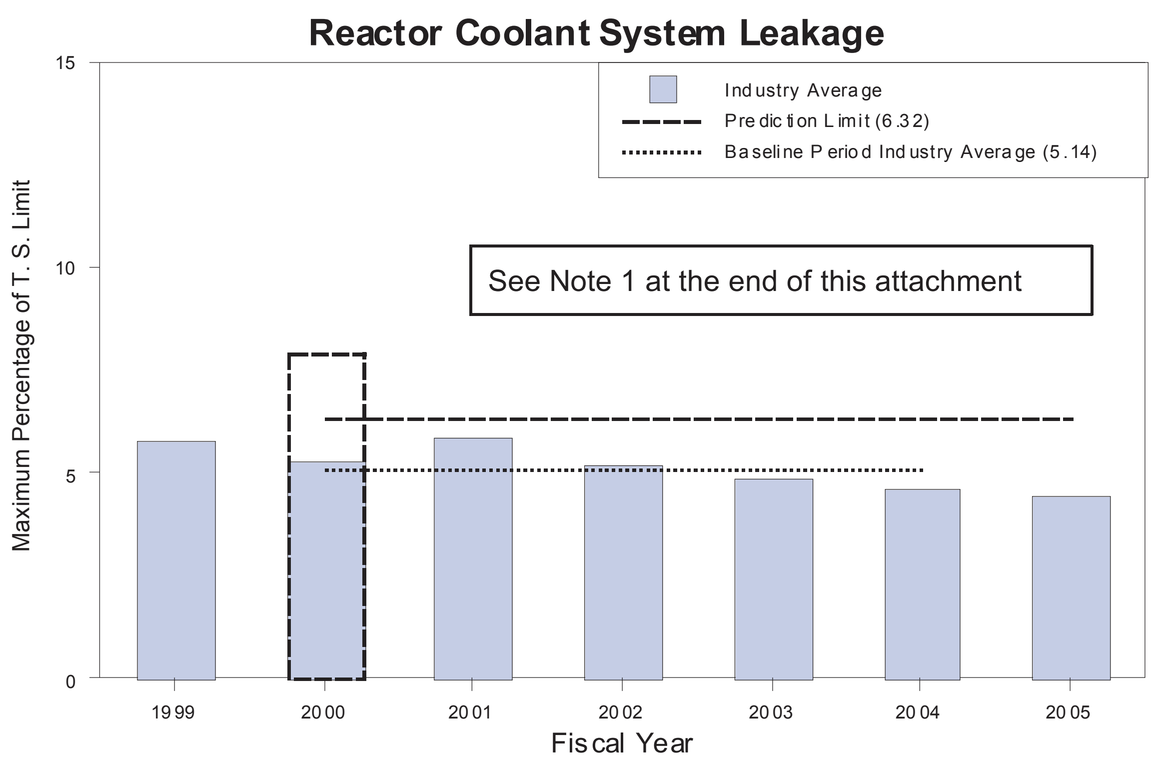

Forced Outage Rate (%)
Industry Average
Prediction Limit (4.28)
Baseline Period Industry Average Trend (2.40)
Forced Outage Rate (%)
20
15
10
5
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Fiscal Year


Equipment Forced Outages/1000 Commercial Critical Hours
Industry Average
Prediction Limit (0.180)
Baseline Period Industry Average (0.143)
Equipment Forced Outage Rate
0.6
0.4
0.2
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Fiscal Year

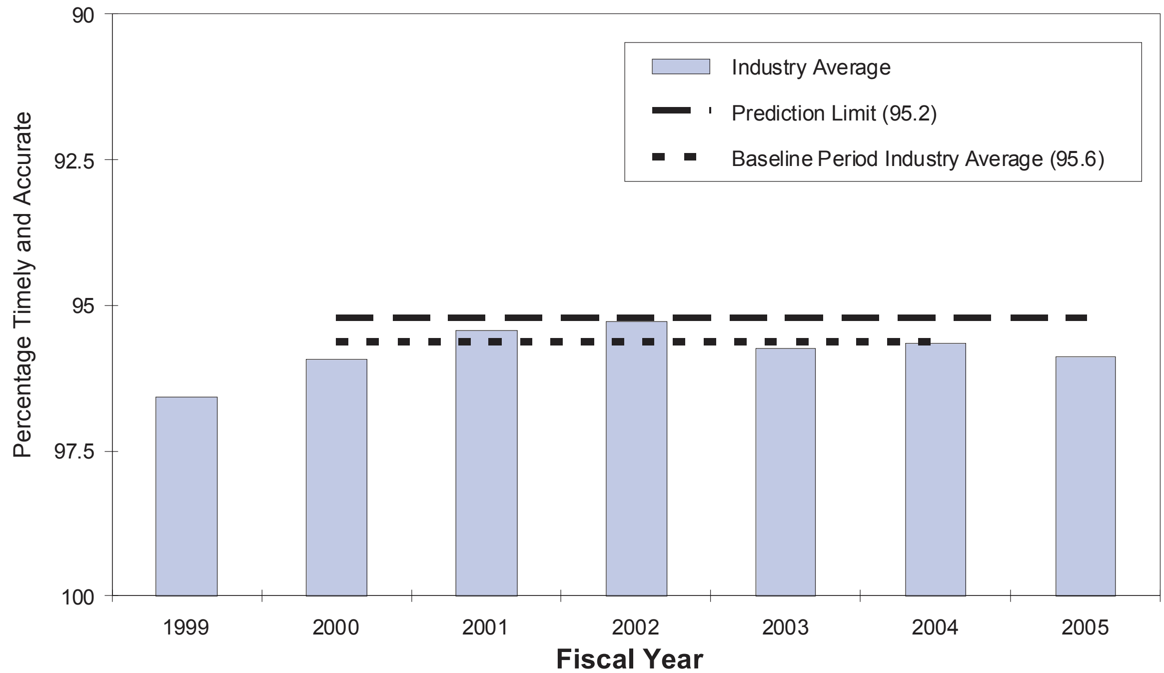

Collective Radiation Exposure
600
450
300
150
0
Average Exposure per Plant (Person-REM)
Industry Average
Prediction Limit (139)
Baseline Period Industry Average (119)
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Fiscal Year


Unplanned Power Changes
3
2
1
0
Power Changes per 7000 Critical Hours
Industry Average
Prediction Limit (1.29)
Baseline Period Industry Average (1.10)
1999
2000
2001
2002
2003
2004
2005
Fiscal Year

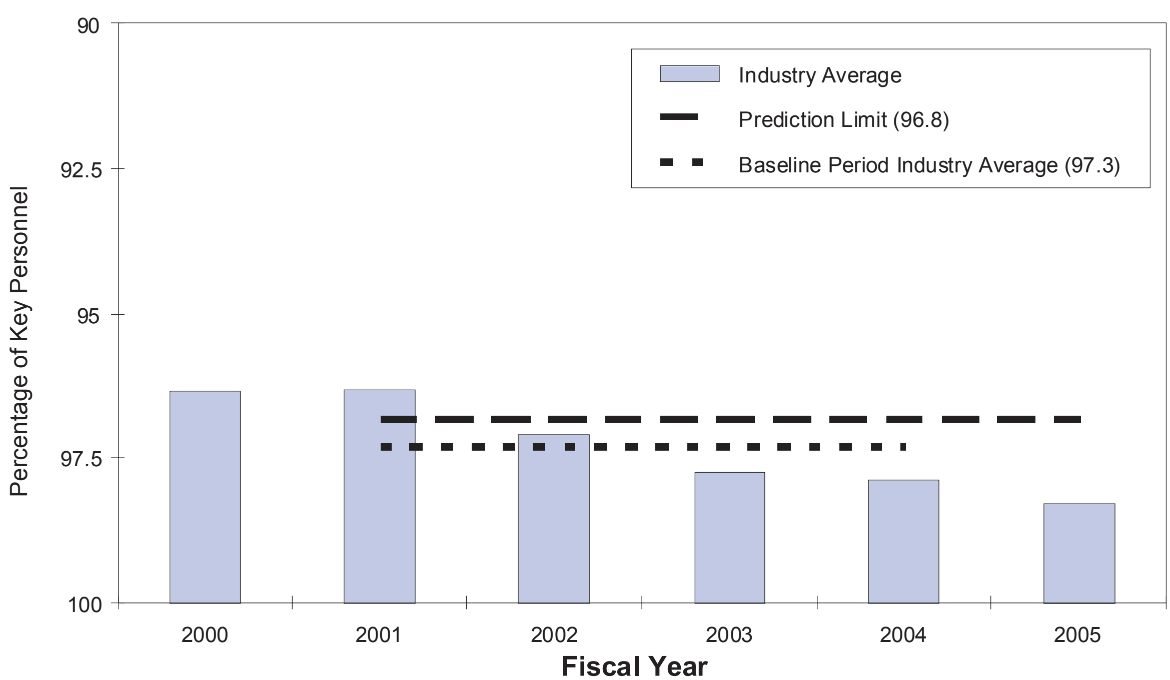

Reactor Coolant System Activity
Industry Average
Prediction Limit (0.646)
Baseline Period Industry Average (0.462)
Maximum Percentage of T. S. Limit
2
1.5
1
0.5
0
1999
2000
2001
2002
2003
2004
2005
Fiscal Year


Reactor Coolant System Leakage
Industry Average
Prediction Limit (6.32)
Baseline Period Industry Average (5.14)
See Note 1 at the end of this attachment
Maximum Percentage of T. S. Limit
15
10
5
0
1999
2000
2001
2002
2003
2004
2005
Fiscal Year

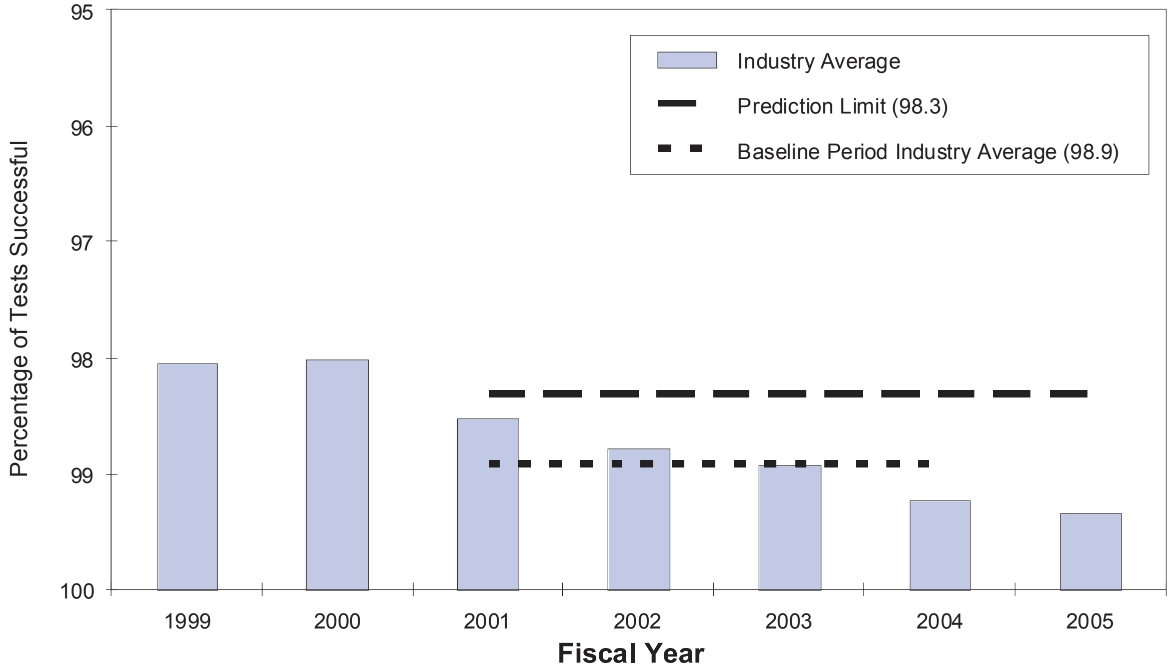
Drill/Exercise Performance



ERO Drill Participation



Alert and Notification System Reliability



<u>Reactor Coolant System Leakage</u>

Note 1: The Indian Point 2 steam generator tube rupture event was removed from FY2000 industry trend data for the purpose of determining the short term prediction limit. The event was removed because it was an occurrence at a single unit that overly influenced the statistical analysis of the industry wide data. Removing this event resulted in a lower prediction limit.

Safety System Actuations (SSA) Analysis

Introduction

Exceeding a single early-warning threshold is not uncommon, because this threshold is based on a 95% prediction limit. For each indicator and each year, there is a 1 in 20 chance of exceeding an early-warning threshold with no change in the factors that influence the underlying performance indicator (PI) occurrence rate. When unforseen events occur, such as the August 2003 blackout event, a “spike” may be observed in one or more indicators. This occurred with scrams and safety system actuations (SSAs) in FY 2003.

The SSA indicator exceeded its prediction limit in FY 2005. The FY 2005 data were reviewed to identify possible trends and patterns that would account for the higher number of events, but no pattern was found. The events occurred at many sites and were caused by many different factors. No trend was observed in the proportion of the events involving emergency diesel generator (EDG) actuations rather than emergency core cooling system (ECCS) actuations. The only notable trend observed in the data is that, among the ECCS actuations, a statistically significant increasing incidence of events involving scrams was observed for the FY 1996 – FY 2005 period.

There appears to be no single driving factor behind this unexpected increase from FY 2004 levels, especially since there was no corresponding increase in scrams. This enclosure illustrates the various trends and patterns associated with this increase and offers some possible causes.

SSA Trends and Patterns

Figure 1 displays the number of SSAs per year for the last 10 fiscal years. As can be seen, there were sharp spikes in the number of SSAs in FY 2003 and FY 2005. The FY 2003 spike had a single driving factor behind it and a corresponding spike in scrams; numerous electrical grid problems caused both indicators to increase dramatically.

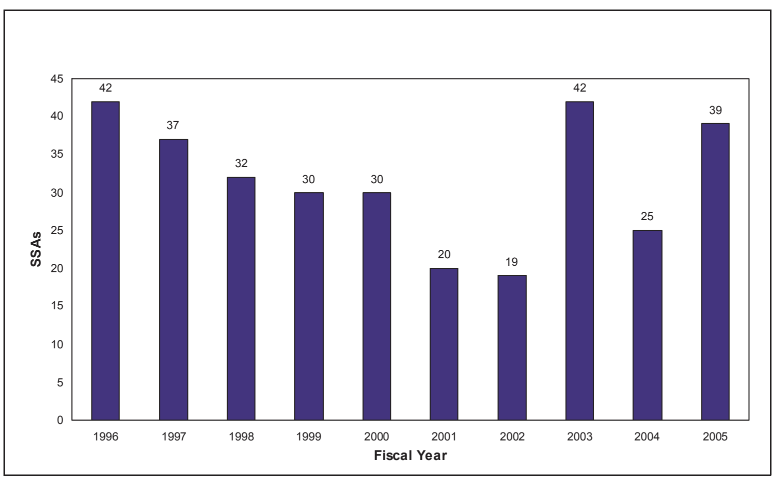


Figure 1. Safety System Actuations

There are two types of SSAs: EDG actuations and ECCS actuations. Figure 2 displays the number and approximate proportion of each type. As can be seen from Figure 2, neither type was predominantly responsible for the FY 2005 increase. Many SSAs are associated with scrams. This occurs either from the cause of the scram (e.g., losses of offsite power often actuate EDGs and scram the reactor) or, in the case of ECCS, are triggered by the scram transient. Figure 3 displays the percentage of SSAs that were associated with scrams. As can be seen, the percentage of FY 2005 SSAs associated with scrams is not unusual, which explains why there was no corresponding spike in FY 2005 scrams.

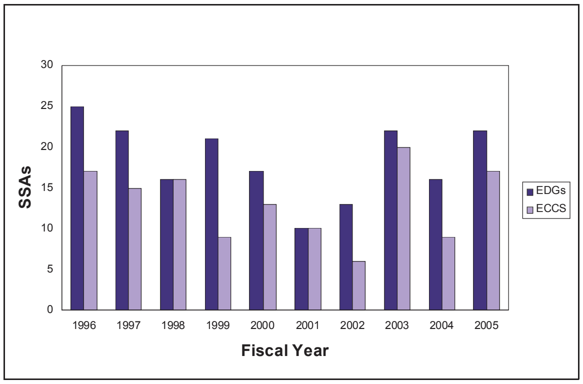


Figure 2. EDG and ECCS SSAs

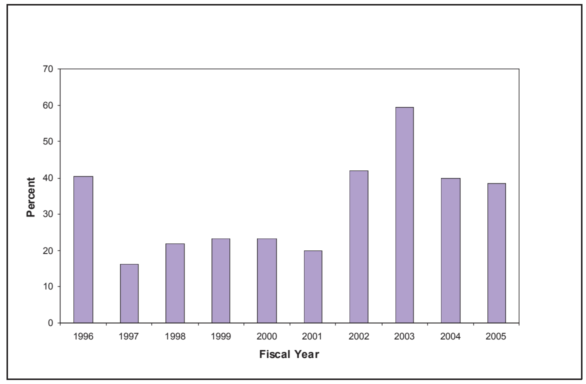


Figure 3. Percentage of SSAs associated with scrams

When the two types of SSAs are separated and the percentages of each type associated with scrams are reviewed, the picture becomes more informative. Figure 4 displays the percentage of EDG and ECCS SSAs that are associated with scrams.

The FY 2001 – FY 2005 period displays first an increase and then a decrease in EDG SSAs associated with scrams, with a peak in FY 2003. Grid-related scrams caused both scrams and SSAs to exceed their prediction limits in FY 2003.

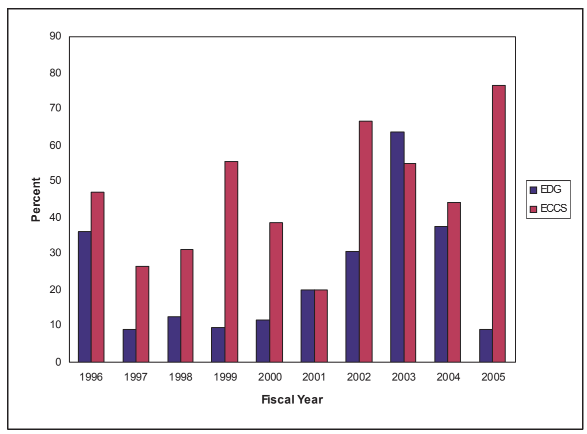


Figure 4. Percentage of EDG and ECCS SSAs associated with scrams

ECCS SSAs associated with scrams show another interesting pattern. Despite a lot of scatter in the data, the percentage of ECCS SSAs associated with scrams has been increasing. In fact, an analysis of the 10-year period shows that the increase is statistically significant. The driving factor behind this increase is not apparent.

Overall, there may be another explanation to the FY 2003 and FY 2005 spikes. It is possible that, other than the contribution to FY 2003 SSA from the single August 2003 blackout event, the FY 2003 and FY 2005 spikes are not anomalous in themselves. Instead, it is possible that the numbers for FY 2001 and FY 2002 were anomalously low. Figure 5 displays the number of SSAs for the last 10 fiscal years, excluding the 12 SSAs associated with the August 2003 blackout event.

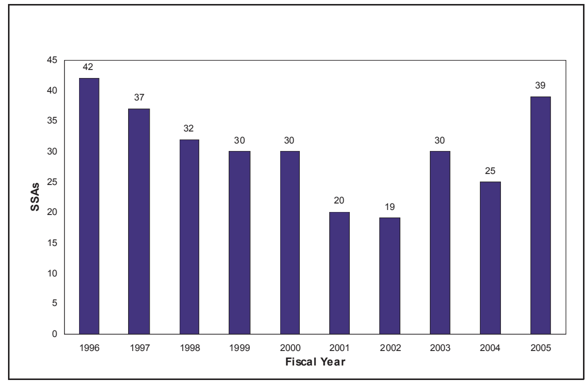


Figure 5. SSAs excluding the 12 SSAs associated with the FY 2003 blackout event

Figure 5 shows that the SSAs from FY 2003 to FY 2005 fall within the range of the data seen previous to FY 2001 within the 10-year period analyzed. Furthermore, the decrease from FY 2000 to FY 2001 represents a 33% drop within a single year. Such a proportionally large drop is unusual for the industry trend PIs that are not influenced by much subjectivity in reporting or analyses. If FY 2001 and FY 2002 are indeed anomalous, then it can reasonably be expected that future SSAs will continue at FY 2003 – FY 2005 levels.

Another way to attempt to characterize the factors behind the FY 2005 SSA spike is to look at the causes of the SSAs. Figures 6 and 7 display the various cause categories for EDG and ECCS SSAs, respectively. For EDG SSAs, human error, which had been on a downward trend previously, was the large FY 2005 contributor and significantly increased from previous years. These human errors were largely attributed to inattention to detail, including such things as shorting a test lead, contacting the wrong terminals during testing, and operating the wrong train's test switch. For FY 2005 ECCS SSAs, the primary cause was equipment problems.

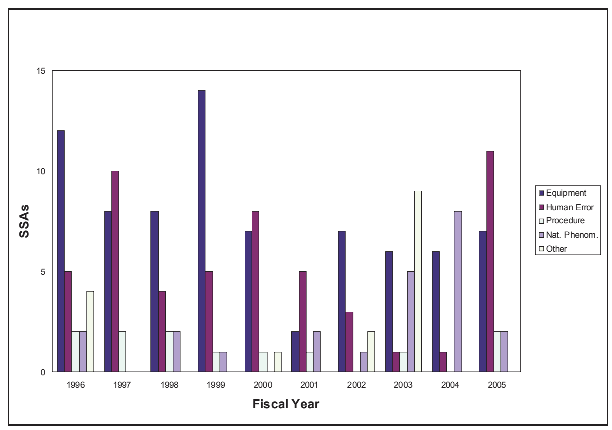


Figure 6. EDG SSA cause categories

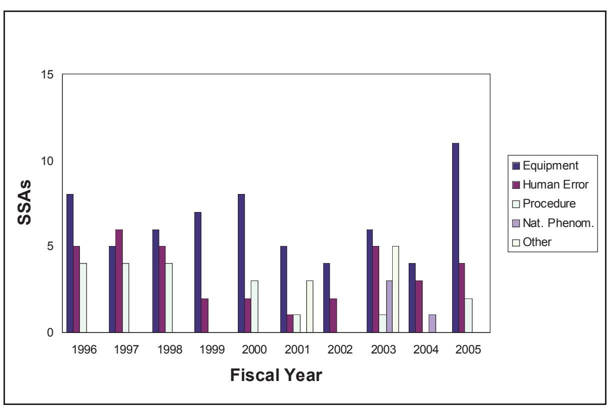


Figure 7. ECCS SSA cause categories

In summary, the analysis did not identify any specific pattern or driving factors behind the increase. The NRC staff will continue to monitor this indicator and take actions, if warranted, for any identified trend or pattern.