POLICY ISSUE
INFORMATION

June 22, 2001 SECY-01-0111

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: DEVELOPMENT OF AN INDUSTRY TRENDS PROGRAM FOR OPERATING POWER REACTORS

PURPOSE:

To inform the Commission of the NRC staff's plans to develop a program to (1) monitor, assess, and respond to trends in industry-wide performance indicators (PIs) for operating power reactors, and (2) communicate the results to Congress and other stakeholders. The industry trends program is intended to support the NRC's strategic goals of maintaining safety and enhancing public confidence in NRC's regulatory processes.

SUMMARY:

The staff is developing an industry trends program as a means to confirm that the safety of operating power plants is being maintained by the nuclear industry and to increase public confidence in the efficacy of NRC processes. The NRC will use indicators to identify adverse trends, evaluate them, and take appropriate actions. One important output of this program is to report to Congress each year on the measure "no statistically significant adverse industry trends in safety performance" as part of the NRC's Performance and Accountability Report. No statistically significant adverse trends have been identified to date based on the information currently available from the industry-wide indicators developed by the former Office for Analysis and Evaluation of Operational Data (AEOD) and the Accident Sequence Precursor (ASP) program implemented by the Office of Nuclear Regulatory Research (RES). The staff plans, for the near term, to continue to use these indicators to monitor industry trends and use them as the basis for the report to Congress. The staff is also developing additional indicators that are more risk-informed and aligned with the cornerstones of safety for use in the industry trends program. These additional indicators will be derived from the plant-level PIs of the Reactor Oversight Process (ROP) and from operating experience information collected by RES. They will be developed and qualified for use in the industry trends program and the report to Congress in phases. In determining its response to adverse trends, the staff will use a graded

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approach based on the safety significance of the underlying issues. The staff is considering a more objective and risk-informed approach to assessing the safety significance of changes to indicators, including the possibility of establishing thresholds for agency response. The results of this program, along with any actions taken or planned, will be reviewed annually during the Agency Action Review Meeting (AARM) and reported to the Commission.

BACKGROUND:

The staff implemented the revised ROP at all operating nuclear plants except D.C. Cook on April 2, 2000. As discussed in SECY-99-007, “Recommendations for Reactor Oversight Process Improvements,” an important impetus for revising the ROP was that commercial nuclear power plants had been operated safely, and that overall plant safety performance, as indicated by trends in both NRC and industry indicators, had improved over the last 10 years. The improvements in safety performance could be attributed both to the nuclear industry’s efforts and to successful regulatory oversight.

In the Nuclear Reactor Safety arena of the NRC’s Strategic Plan (NUREG-1614 series), one of the performance goal measures is that there should be “no statistically significant adverse industry trends in safety performance.” The NRC reports on this measure to Congress in March of each year as part of its “Performance and Accountability Report, Fiscal Year 200X” (NUREG-1542 series). In late CY 2000, as part of its overall responsibilities in the Reactor Safety arena, the Office of Nuclear Reactor Regulation (NRR) assumed responsibility from RES for reporting on this measure. The current bases for assessing performance against this measure are trends in the industry indicators developed by the former AEOD (these will be referred to as the “ex-AEOD” indicators in the rest of this paper) and trends identified by the ASP program. Of note is the fact that these indicators were among those cited as demonstrating improvements in industry safety performance that contributed to the Agency’s decision to revise the ROP.

The ex-AEOD indicators have been previously published in January of each year in the NUREG-1187 series, “Performance Indicators for Operating Commercial Nuclear Power Plants,” the AEOD Annual Report (NUREG-1272 series)(no longer published), the NRC Annual Report (NUREG-1145 series)(no longer published), and the NRC’s Information Digest (NUREG-1350 series) published in the summer/fall of each year. The results of the ASP program have been published in the NUREG/CR-4674 series, “Precursors to Potential Severe Core Damage Accidents,” in about December of each year and reported annually to the Commission since 1994, most recently in SECY-01-0034, “Status Report on Accident Sequence Precursor Program and Related Initiatives.” Analyses of abnormal occurrences are published in the NUREG-0090 series, “Report to Congress on Abnormal Occurrences Fiscal Year 200X,” published in about Spring of each year. In addition, RES intends to continue its independent assessment of operational events using the ASP program as well as updates to various studies of operating experience. Both NRR and RES are evaluating the efficacy of consolidating some of these reports as well as publishing them on the NRC’s web site.

DISCUSSION:

Program Purpose and Objectives

The NRC currently provides oversight of plant safety performance on a plant-specific basis using both inspection findings and plant-level PIs as part of its ROP. Individual issues that are identified as having generic safety significance are addressed using other existing NRC processes, including the generic communications process and the generic safety issue process. NRR has initiated a program that complements these processes by monitoring and assessing industry-wide trends in safety performance. The purpose of the program is to provide a means to confirm that operating reactor safety performance is maintained by the nuclear industry and to increase stakeholder confidence in the efficacy of NRC processes. The program includes developing industry indicators to augment or replace those previously developed by the former AEOD and RES using the data from the plant-level ROP PIs and the operating experience data available in various NRC and industry databases. These indicators are intended to be more risk informed and aligned with the ROP than the ex-AEOD indicators. The objectives of the industry trends program are as follows:

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

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

(3) Communicate industry-wide information to Congress and other stakeholders in an effective and timely manner.

Structure, Concepts and Approach

The staff structured the industry trends program to provide information consistent with the framework used by the ROP. This framework consists of three strategic safety areas derived from the mission of the NRC: reactor safety, radiation safety, and safeguards. These areas are further broken down into seven cornerstones of safety. In developing the industry trends program, the staff used the following general concepts for its approach.

(1) The indicators were developed using available information from current NRC programs. Indicators will be developed in the future in stages, and will provide information for each cornerstone of safety.

(2) Industry trend information is from quantitative, industry-wide data.

(3) Trends are identified on the basis of long-term data rather than short-term data. This minimizes the impact of short-term variations in data due to factors such as operating cycle phase, seasonal variations, and random fluctuations.

(4) Trends and contributing factors are assessed for safety significance; Agency response is commensurate with the significance. The results of inspections, analyses of significant events and abnormal occurrences, and other analyses may be used to facilitate an evaluation of the trends.

(5) A broad, hierarchal set of indicators may be used within the framework of the cornerstones of safety. Trends may be assessed within each strategic area (reactor

safety, radiation safety, and safeguards), including consideration of interdependencies of indicators between the cornerstones.

(6) As additional indicators are being developed, a subset of high-level indicators may be used for the report on adverse trends to Congress in the NRC's Performance and Accountability Report. For reporting on the performance measure of "no statistically significant adverse industry trends in safety performance," indicators will be qualified for use in phases. Until they are qualified, the staff will continue to use the ex-AEOD indicators and ASP results. Additional indicators from the industry trends program will be incorporated for use in accordance with the controlled process for making such changes to the NRC's Performance Plan. In addition, the staff intends to consider refinements to the performance measure as the indicators and more risk-informed methods of assessing their significance are developed.

Development Efforts to Date

A steering committee provided overall guidance for the development of the industry trends program, and three working groups evaluated the data from the ex-AEOD indicators, the ROP PIs, and industry operating experience. The steering committee consisted of operating level managers in NRR and RES with inspection program, risk analysis, and event analysis responsibility. The working groups comprised staff from NRR and RES with expertise in performance indicators, risk analysis, operating experience, event analysis, and statistical methodologies. The working groups examined the sources of data for various indicators, reviewed analyses of the data, and reported on the suitability of the data for providing industry trend information to the steering committee.

Indicators were selected for industry trending using the following criteria: the source of information was publically available (or could extracted from non-publically available databases and made publically available); there was confidence in the validity of the data (accuracy, timeliness, reporting guidelines, consistency of data reporting, etc.) as well as the calculations used to compile the data into industry trends information; and the data was reported by the entire industry.

To communicate its development efforts to stakeholders and receive feedback, NRR gave briefings on its progress in developing the industry trends program during monthly public meetings with industry, including the Nuclear Energy Institute (NEI). No significant issues were identified during these briefings. In addition, NRR briefed the Initial Implementation Evaluation Panel (IIEP), a Commission advisory panel that evaluated the efficacy of the first year of implementation of the ROP. The IIEP highlighted implementation of the industry trends program as a key aspect of establishing a structured, ongoing process to evaluate long-term program effectiveness and to test program assumptions.

The staff desires additional feedback from external stakeholders on the industry trends program, and will seek it as part of ongoing interactions on the ROP program. This feedback is typically received in periodic meetings with industry and public workshops on the ROP.

Available Information

The staff used information currently available from existing NRC programs to develop an initial set of indicators for identifying adverse industry trends, which consisted of the 7 indicators in the ex-AEOD indicator program and the results of the ASP program. In addition, the staff is developing more risk-informed industry-wide indicators using data from the 18 plant-level indicators submitted by licensees for the ROP PI program. The staff also identified potential indicators for initiating events and mitigating systems that are anticipated to be available from RES operating experience data within the next 1-3 years. The results of the developmental efforts to date are described in the attachments to this paper, and will be discussed at the first AARM in June 2001.

Attachment 1 is a summary of the indicators available in each of the cornerstones of safety. As shown, the ex-AEOD indicators and the ASP program provide long-term data since these programs have been maintained for many years, but do not provide insights in all cornerstones. The ASP program provides safety performance indications for both the initiating events and mitigating systems cornerstones, and also provides a measure of the overall significance of events within the reactor safety arena. The ROP PIs provide indicators in each cornerstone, but there is not yet sufficient data from these indicators to provide meaningful long-term trend information in all cases. RES is developing additional risk-informed indicators in the initiating events and mitigating systems cornerstones using operating experience data.

Identification of Statistically Significant Trends

For purposes of assessing whether there are any statistically significant adverse industry trends, only long-term data will be used. The trending of long-term data minimizes reacting to potential “false positive” indications that may emerge in short-term data. Short-term was elected to be less than four years to ensure that sufficient data (i.e., data for at least two typical nuclear plant operating cycles) is available so that valid trends can be distinguished from operating cycle effects such as refueling outages and from random fluctuations in the data, and to allow sufficient data for the use of statistical methods. The staff expects that any variations beyond these will result from plant-specific issues which can be addressed under the ROP.

The staff will apply common statistical techniques to the long-term indicator data to identify trends. These techniques have been previously adapted and used extensively by the former AEOD and RES in reactor operating experience analyses over the past several years, and are described in more detail in Attachment 2. In general terms, a trendline will be fit to each indicator using regression techniques. Once a statistically significant fit of a trendline is made to each indicator, the slope of the trendlines will be examined. Improving or flat trendlines are not considered adverse and need not be investigated further. Degrading trendlines are considered adverse.

Adverse trends in indicators that are qualified for use will be reported to Congress as part of the NRC’s Performance and Accountability Report, along with an initial analysis of its significance, the factors contributing to the trend, and the Agency’s response, if appropriate. To date, no statistically significant adverse trends have been identified using the ex-AEOD indicators and ASP results. Any changes to this set of indicators will be made as part of the annual update of the NRC’s Performance Plan. However, regardless of the set of indicators qualified for use in this report, the staff intends to evaluate adverse trends in all indicators in the industry trends program to assess the safety significance of the underlying issues.

In addition, to ensure that a trend is addressed appropriately at an early stage, the staff will investigate a single data point if it is above a statistically predicted range for each indicator. Both the trendlines and the predicted range will be recalculated each year as the data is accumulated. Furthermore, should very obvious adverse trends emerge in the short-term data, the staff will not wait until the end of the annual reporting period to initiate a review.

Evaluating the Significance of Adverse Trends

The staff plans to analyze any statistically significant adverse trends to determine if they represent issues that require an Agency response. The approach is intended to facilitate structured, risk-informed decisions and actions that are commensurate with the safety significance of the issues that are identified. The staff will continue to refine its process as experience is gained with the industry trends program, feedback is received from external stakeholders, and improved risk analysis tools become available.

Once an adverse trend is identified, the staff will conduct an initial analysis of information readily available in the databases used to compile the indicator data to determine whether the trend is unduly influenced by a small number of outliers and to identify any contributing factors. If the trend is the result of outliers, then it will not be considered a trend requiring generic actions, and the Agency will consider any appropriate plant-specific actions using the ROP. For example, the affected plant(s) unduly influencing the adverse trend may have already exceeded plant-level thresholds under the ROP, and the NRC regional offices would conduct supplemental inspections at these plant(s) to ensure the appropriate corrective actions have been taken. If the plant(s) did not exceed any thresholds, while the NRC would not take regulatory actions beyond the ROP, the NRC would gather additional information regarding the issue within the scope of the ROP using risk-informed baseline inspections. The results of these inspections would be examined to determine if a generic issue exists requiring additional NRC review or generic inspections.

If no outliers are identified, the staff will conduct a broader review to assess whether larger groups of facilities are contributing to the decline, and to assess any contributing factors and causes. For example, the data review will be expanded to include a review of various plant comparison groups, contributing factors such as the operational cycle stage of the facilities (shutdown, at-power, startup from refueling, etc.), and the apparent causes for the data (equipment failures, procedure problems, etc.). The staff will also conduct a more detailed review of applicable licensee event reports. Should a group of plants be identified, the staff will examine the results of previously conducted inspections at these plants, including any root causes and the extent of the conditions.

Once this information is reviewed, the staff will assess the safety significance of the underlying issues. The staff is mindful that trends in individual indicators must be considered in the larger context of their overall risk significance. For example, a hypothetical increase in automatic scrams from 0.4 to 0.7 per plant per year over several years may be a statistically significant trend in an adverse direction. However, it may not represent a significant increase in overall risk since the contribution of a small number of scrams is relatively low, and it is possible that overall risk may actually have declined if there were reductions in the frequency of more risk-significant initiating events or the reliability and availability of safety systems had improved. Depending on the issues, the staff may perform an additional evaluation using the most current risk analysis tools or an evaluation by the ASP program.

The staff recognizes that this assessment of safety significance relies to some degree on staff judgement. NRR and RES are working to develop a more objective, predictable approach to be used in the future that would establish risk-informed thresholds, to the extent practicable, which would be used to assess any trends in indicators and to determine the appropriate Agency response. This enhanced approach will be consistent with the principles contained in NRC regulatory guidance such as Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," and NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission." This approach is described further in the section of this paper discussing future developments.

Agency Response

Until this enhanced approach is developed, should a statistically significant adverse trend in safety performance be identified, the staff will determine the appropriate response using the NRC's established processes for addressing and communicating generic issues. These processes are described in SECY-99-143, "Revisions to Generic Communications Program." In general, the issues will be assigned to the appropriate branch of NRR for initial review. This sponsoring organization will engage NRC senior management and initiate early interaction with the nuclear power industry. Depending on the issue, the process could include requesting industry groups such as NEI or various owners groups to provide utility information. As discussed in SECY-00-0116, "Industry Initiatives in the Regulatory Process," industry initiatives, such as the formation of specialized working groups to address technical issues, may be used in lieu of, or to complement, regulatory actions. This can benefit both the NRC and the industry by identifying mutually satisfactory resolution approaches and reducing resource burdens. Depending on the issues, the adverse trend may also be addressed as part of the generic safety issue process by RES. After this interaction, the NRC may consider additional regulatory actions as appropriate, such as issuing generic correspondence to disseminate or gather information, or conducting special inspections for generic issues. The process also includes consideration of whether any actions proposed by the NRC to address the issues constitute a backfit.

The industry trends program, results, and Agency response will be reviewed annually during the AARM. In general, the AARM is intended to review the appropriateness and effectiveness of staff actions already taken, rather than to make decisions on Agency actions. NRC senior managers will review the industry trends information and, if appropriate, recommend any additional actions beyond those implemented by the staff.

Results to Date

The information that will be reviewed during the first AARM to be held June 26-28, 2001, is summarized in Attachment 3. The results show that no statistically significant adverse trends in industry safety performance have been identified to date. Through FY 2000, all of the ex-AEOD indicators showed a declining or steady trend. Prediction limits were established on the indicators for the first time, so by definition no prediction limits were exceeded and no further investigation was required. For the ROP PIs, there was insufficient data (<4 years) for long-term trending, although no significant short-term trends have emerged from the limited short-term data. The ASP program shows that there were no significant precursors in FY 2000 (defined as events that have a 1/1000 (10^{-3}) or greater probability of core damage), and that there were declining overall trends in the frequency and significance of these precursors during the period 1993-1999.

In addition, NRR staff reviewed summary results of the ROP for its first year of implementation to assess the information that will be available should there be an adverse trend in the industry-wide indicators, and to provide possible feedback for the ROP. While only limited data was available, no trends in the number of plants in each Action Matrix column were identified, and no generic issues were identified during a review of significant inspection findings. NRR intends to continue to monitor ROP summary results for trends and issues in the future. The staff may also review the results of significant events and abnormal occurrences, as well as significant international events for their generic implications for U.S. operating power reactors.

Communications

In NRC's Performance and Accountability Report to Congress, the staff will continue to report trends using the current set of ex-AEOD PIs and the ASP program. Additional indicators, including the ROP PIs and the indicators from operating experience, are being developed and will be qualified for use in phases. As these additional indicators and an improved method for assessing the safety significance of the indicators are developed, the staff plans to evaluate whether changes to the reporting criteria are appropriate.

The timing of licensee's reporting data to the NRC affects its reporting to Congress. The data supporting the industry indicators is derived from Licensee Event Reports (LERs) that are required to be submitted within 60 days after certain events and from Monthly Operating Reports (MORs). Counting the 30 days required to analyze the LERs and MORs, the data is available one quarter after the fiscal year has ended. The staff's input to the Performance and Accountability report is currently required in early January of each year for reporting of data for the previous fiscal year. This means that there is little time to conduct an extensive investigation of adverse trends prior to publication of the report. However, as stated previously, the staff will review quarterly data for obvious trends to anticipate any adverse trends in long-term data. The report to Congress will indicate what is known and how the Agency is investigating the trend. The following year's report will provide the results of the NRC's actions in response to the trend. More detailed information will be sent to the Commission each year as part of an annual paper on industry trends published in the same time frame as the AARM.

As discussed earlier, the industry indicators from the former AEOD were published annually in several NUREGs. In general, these reports were published several months after the fiscal year or calendar year had ended. While industry trends information will continue to be published as appropriate in these NUREGs, the staff intends to make the industry indicators available in a more timely and accessible manner by publishing them quarterly on the ROP portion of the NRC's web site. NRR believes that the current industry-wide information, when added to the information on individual plants, can significantly enhance public confidence in the NRC's oversight of the nuclear industry.

FUTURE DEVELOPMENT EFFORTS:

The staff will report on the status of the industry trends program as part of an annual Commission paper on the industry trends program, which will be sent to the Commission in the same time frame as the AARM.

Incorporation of Additional Industry Operating Experience

RES is continuing to develop operational experience data that has the potential to be used for more risk-informed industry indicators to enhance the industry trends program. As shown in Attachment 1, these indicators would be organized into a hierarchy consistent with the ROP framework and cornerstones of safety. In approximately one year, RES plans to update the data and related analyses that were most recently published in NUREG-5750, "Initiating Events at U.S. Nuclear Power Plants: 1987-1995," for use in the initiating events cornerstone. Within about 2-3 years, RES plans to update the data that has been published in various NUREGs for system reliability studies, component reliability studies, common-cause failure studies, and other special studies where industry-wide trends were reported, for use in the mitigating systems cornerstone. As a means of providing greater access to this information for stakeholders, RES is planning a web-based system to replace the current paper-based system of NUREG reports and specialized databases.

Risk-informed Response Thresholds and Performance Measures

NRR and RES are working to develop a more objective and risk-informed method to assess the safety significance of changes in individual industry-wide indicators, including the development of thresholds and pre-defined Agency responses to these thresholds. The staff's efforts may result in revisions or enhancements to the performance goal measure of "no statistically significant adverse industry trends in safety performance." This effort would use NRC risk analysis tools such as the Standardized Plant Analysis Risk (SPAR) models that are currently being improved by RES. The staff intends to seek external stakeholder input while developing this approach over the next 1-3 years.

Improved Data Collection and Reporting

The staff recognizes that licensees report similar indicator data to the NRC and other organizations such as the Institute of Nuclear Power Operations (INPO). Both RES and NRR intend to continue to seek improvements and efficiencies in data reporting by industry for both the industry trends program and the ROP to reduce unnecessary burdens placed on licensees. For example, the staff is working with the Industry Consolidated Data Advisory Committee of INPO to develop common reporting of data elements for industry operating experience data that can be used by both NRC and INPO. In addition, NRR is examining the feasibility of having licensees report data electronically rather than on paper.

RESOURCES:

NRR budgeted $215K/3.0 FTE in FY 2001; $300K/3.0 FTE in FY 2002; and 2.5 FTE for FY 2003 and 2004 for the development and implementation of the industry trends effort. Estimated contract assistance funding for FY 2003 and 2004 is approximately $200K in each year. This FY2003 and FY 2004 funding is not currently budgeted and will be reprogrammed from within the current budget using the Planning, Budgeting, and Performance Management (PBPM) process. RES resources for development of operational experience data and risk models have been budgeted as part of existing programs. The RES resource estimates for improving the significance assessment process total are approximately $100-200K/0.5 FTE in both FYs 2002 and 2003 and $50-100K/0.25 FTE in FY 2004. The contract resources are not currently budgeted, and this work will be addressed as part of the PBPM process.

COORDINATION:

The Office of Public Affairs has reviewed this paper and concurs with the approach to communicating the industry-wide indicators to stakeholders.

The Office of the Chief Financial Officer has reviewed this paper and concurs with the resource estimates and methods for addressing the Strategic Plan performance measure.

/RA/

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for Operations

Attachments:
1. Matrix of Indicators Using the Hierarchy of the ROP Framework
2. Statistical Methods
3. Summary of Industry Trend Results for the AARM

Matrix of Indicators Using the Hierarchy of the ROP Framework

	Reactor Safety				Radiation Safety		Safeguards
Data Source	Initiating Events	Mitigating Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Physical Protection
Ex-AEOD Indicators	Automatic Scrams While Critical	Safety System Actuations			Collective Radiation Exposure		
Ex-AEOD Indicators		Safety System Failures					
Ex-AEOD Indicators		Forced Outage Rate					
Ex-AEOD Indicators		Equipment Forced Outage Rate					
ROP PIs	Automatic Scrams per 7000 Hours	Emergency AC Power System Unavailability	Reactor Coolant System (RCS) Activity	Drill/Exercise Performance			
ROP PIs	Scrams with Loss of Normal Heat Removal	High Pressure Injection System Unavailability	Reactor Coolant System (RCS) Leakage	Emergency Response Organization (ERO) Drill Participation			
ROP PIs	Unplanned Power Changes	BWR Heat Removal System/PWR Auxiliary Feedwater System Unavailability		Alert and Notification System Reliability	Occupational Exposure Control Effectiveness	Radiological Effluent Technical Specifications/ Offsite Dose Calculation Manual (RETS/ODCM) Effluents	Protected Area (PA) Equipment

	Reactor Safety				Radiation Safety		Safeguards
Data Source	Initiating Events	Mitigating Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Physical Protection
ROP PIs		Residual Heat Removal System Unavailability					Personnel Screening Program
ROP PIs		Safety System Functional Failures					Fitness-For-Duty (FFD)/Personnel Reliability Program
ASP Program	Selected Accident Sequence Precursors	Selected Accident Sequence Precursors					
Operating Experience Data (Future Development)	Internal Floods	Data from System Reliability Studies (AFW/EFW, RPS, HPCI, EDG, IC, RCIC, HPCS, and HPSI)					
Operating Experience Data (Future Development)	General Transients	Data from Component Reliability Studies (TDP, MDP, AOV, MOV)					
Operating Experience Data (Future Development)	Stuck Open Safety/Relief Valve	Data from Common Cause Failure Studies					
Operating Experience Data (Future Development)	Loss of Feedwater	Data from other Special Studies					

	Reactor Safety				Radiation Safety		Safeguards
Data Source	Initiating Events	Mitigating Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Physical Protection
Operating Experience Data (Future Development)	Loss of Heat Sink						
Operating Experience Data (Future Development)	Loss of Instrument/ Control Air						
Operating Experience Data (Future Development)	Loss of Offsite Power						
Operating Experience Data (Future Development)	Loss of Vital AC Bus						
Operating Experience Data (Future Development)	Loss of Vital DC Bus						
Operating Experience Data (Future Development)	Small/Very Small LOCA						

	Reactor Safety				Radiation Safety		Safeguards
Data Source	Initiating Events	Mitigating Systems	Barrier Integrity	Emergency Preparednes s	Occupational Radiation Safety	Public Radiation Safety	Physical Protection
Operating Experience Data (Future Development)	Steam Generator Tube Rupture						

<u>Event Analysis</u> - These event analyses and inspection findings would be reviewed as appropriate for insights to supplement the industry indicators.
- ASP results for specific events
- ROP inspection findings
- Abnormal Occurrences and Significant Events

Statistical Methods

The discussion provided below is a summary description of the statistical methods used to determine industry trends. The trendline models have been previously used in analyses in several NUREGs, including NUREG-5750, "Initiating Events at U.S. Nuclear Power Plants: 1987-1995." The statistical analyses are documented in much greater detail in several technical reports prepared by the Idaho National Engineering and Environmental Laboratory, including INEL-95/0234, "Practical Guidance for Statistical Analysis of Operational Event Data," October 1995.

Choosing a Trendline Model - The first step in determining if a statistically significant trend exists is to fit a trendline model to a set of indicator data and assessing the goodness of the fit. Figure 1 illustrates this using scram data from 1988 through 2000. The figure shows an exponential trendline model fitted to data in a scatter diagram. Deciding which model is the best to fit is not a trivial matter, but can be accomplished by using some common regression techniques. The regression model that yields the best fit, typically at the 95% confidence level, is selected as the trendline model for the data set. It should be noted that this is the only step required to assess whether statistically significant trends exist in indicators, since the slope of the trendline determines whether the statistically fit trendline is adverse.

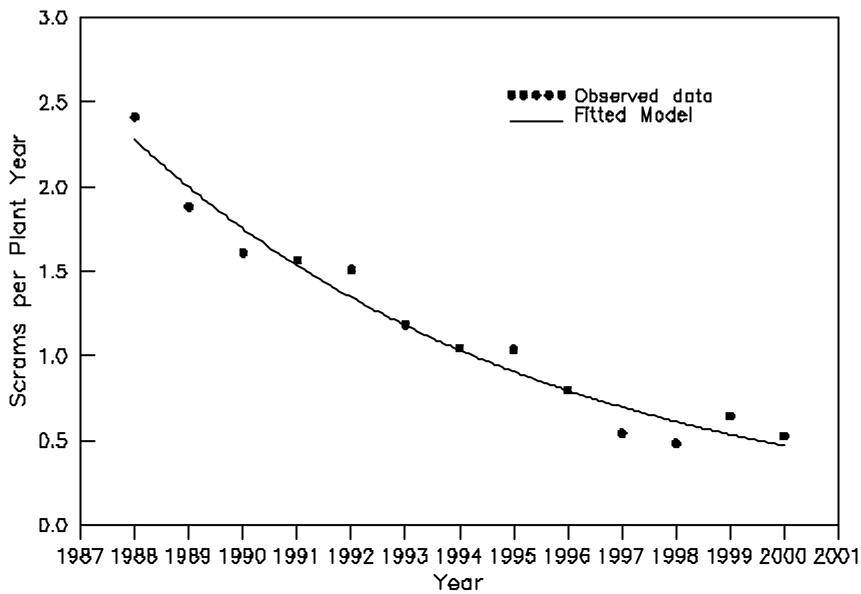


Figure 1: Exponential model fitted to scram data

Analyzing Deviations From the Model - A trendline may not be a sensitive enough tool to recognize changes in the most recent annual data. Stated differently, would a single point that is an outlier constitute a trend? The exact answer to this question would be determined by a combination of statistical testing and qualitative analysis, and the answer would likely differ for each of the different PIs.

For example, suppose reactor scrams begin to increase in 2001. At the end of 2001, the annual scram rate will show a deviation from the trendline model, which is based on a number of preceding years of data. If the increase in scrams continues in 2002 and subsequent years, a trendline would eventually show a statistically significant adverse trend. However, if the deviation in 2001 from the trendline is "significant," the NRC would still want to evaluate the recent increase to determine whether any generic safety issues existed, and a statistical methodology should be capable of raising a warning flag based on the degree of deviation from the trendline model.

Prediction limits provide a reasonable way to decide if a future abrupt increase in a PI is of sufficient magnitude to conclude that it is statistically significant. In other words, we have modeled the historical data with regression methods, and if future behavior is consistent with past behavior, then it is possible to compute an upper limit that will contain a future value of the dependent variable with a specified degree of confidence (i.e., 95 percent). If the following year's observed result exceeds this limit, then one might conclude that a statistically significant adverse *change* has occurred. This is illustrated in Figures 2 and 3.

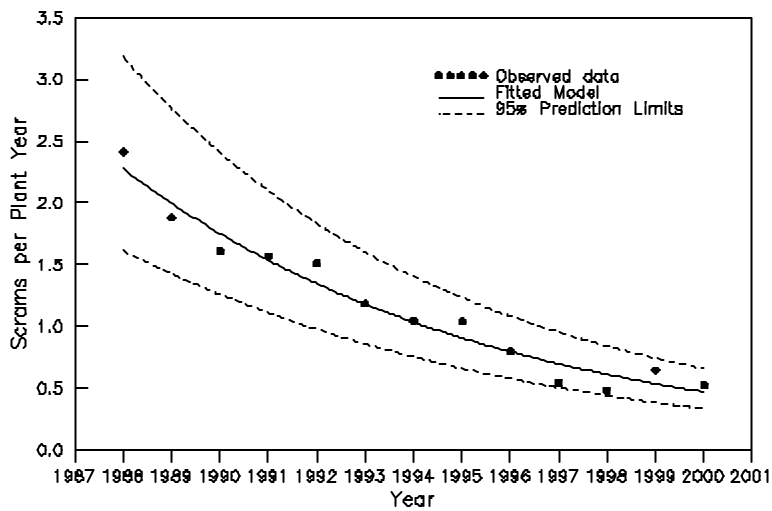


Figure 2: Fitted exponential model with 95 percent prediction limits

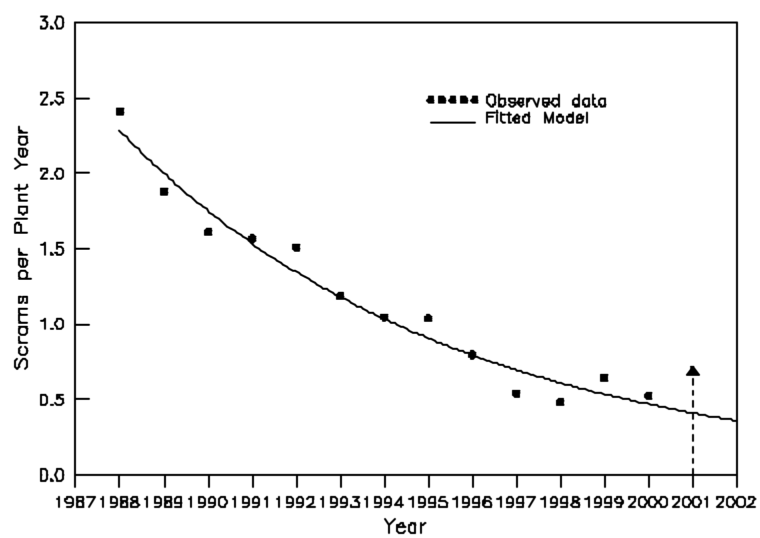


Figure 3: Upper 95 percent prediction limit for the number of scrams in 2001

Summary of Industry Trend Results
for the AARM

This section provides a summary of the industry trends information that will be presented to NRC senior managers for review at the AARM, as listed below. Detailed supporting information may also be presented.

1. Ex-AEOD Indicators (long-term graphs only)

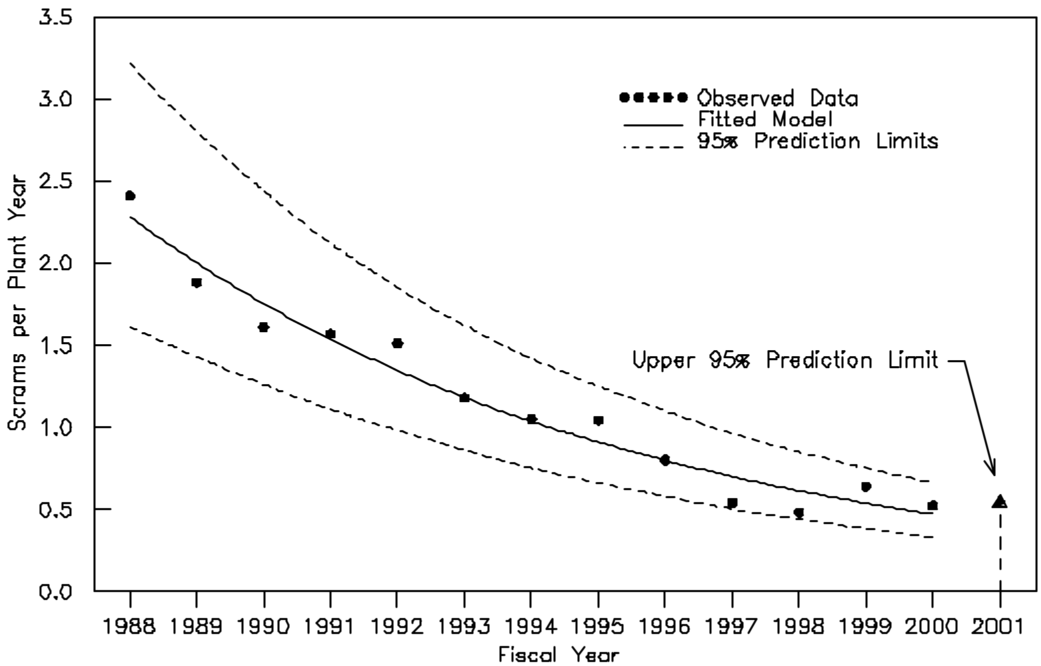
2. ROP Performance Indicators (short-term graphs only)

3. ASP Program Results

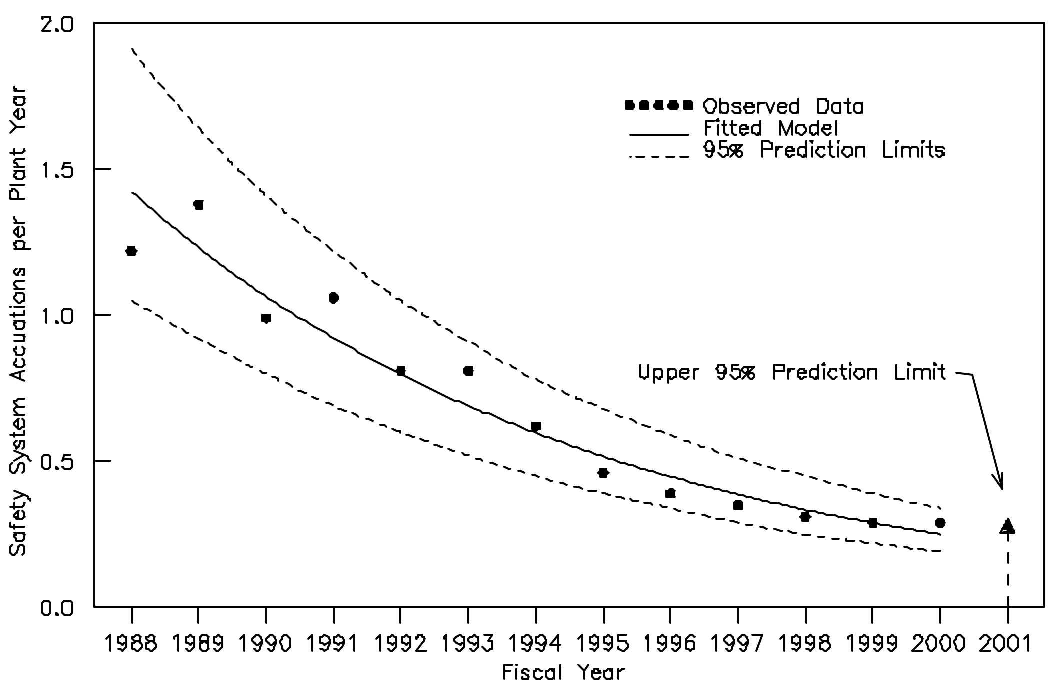
4. ROP Program Information
    A. Action Matrix Trends
    B. Audit of Significant ROP Inspection Findings

1. Ex-AEOD Indicators (long-term graphs only)

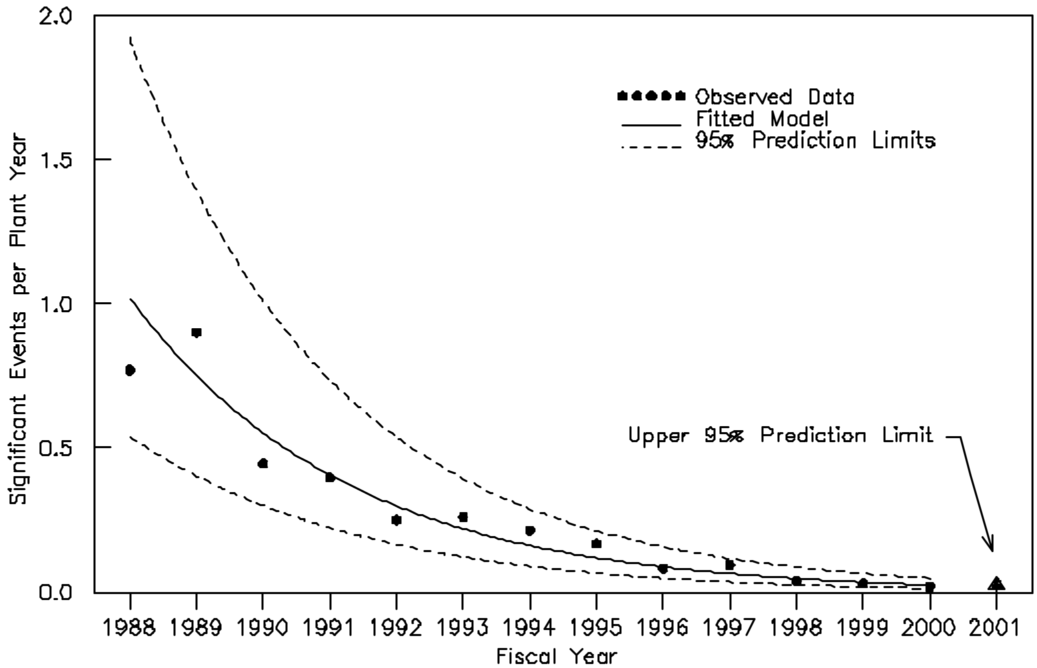
Automatic Scrams While Critical



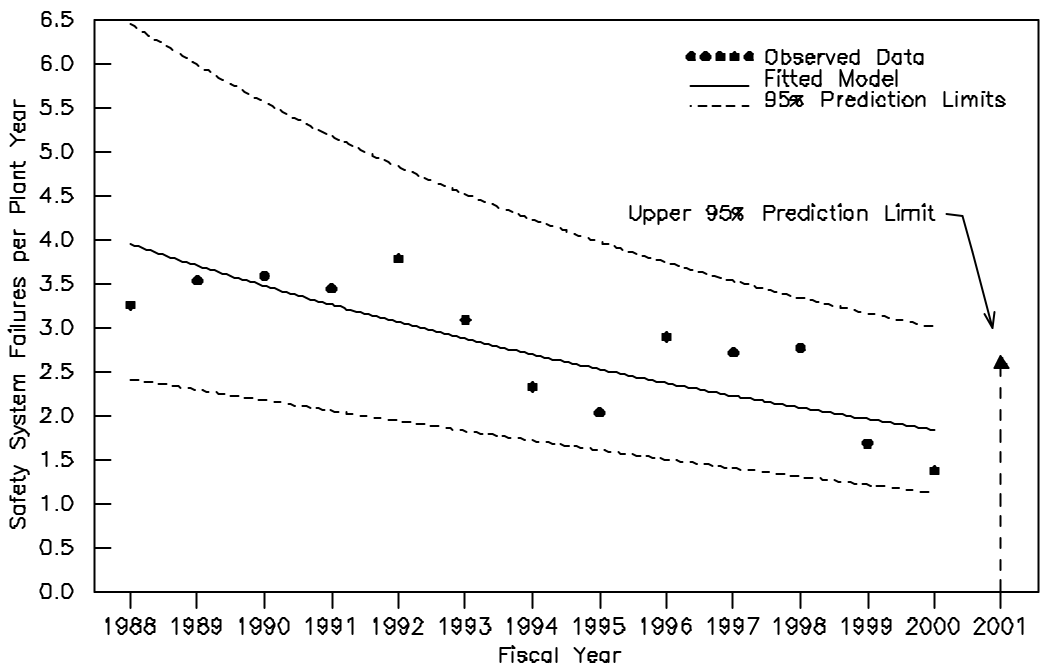
Safety System Actuations



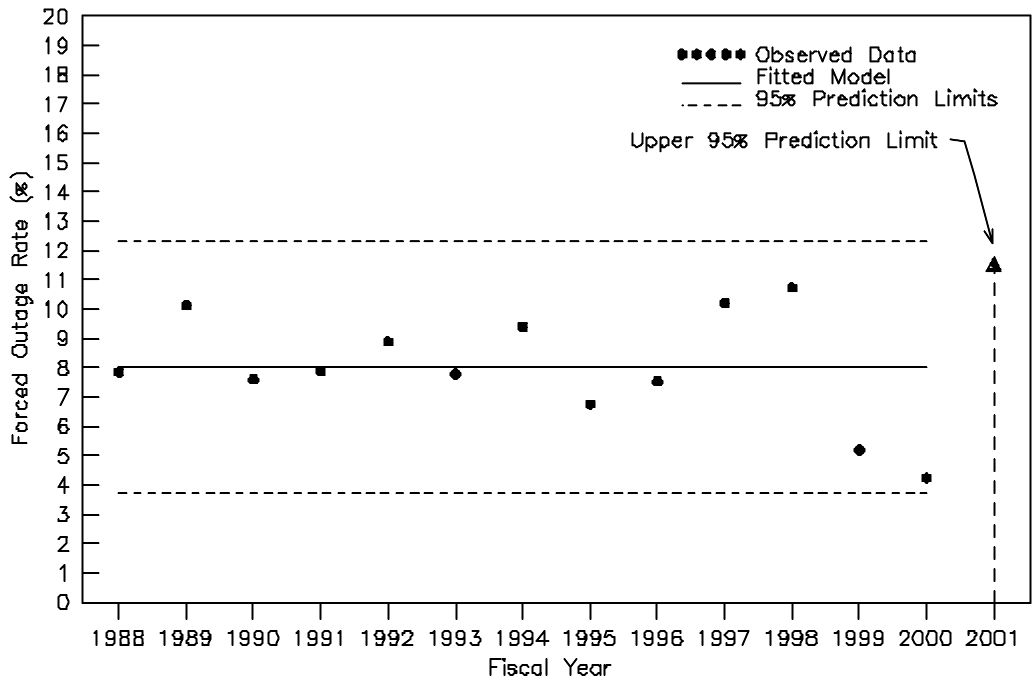
Significant Events



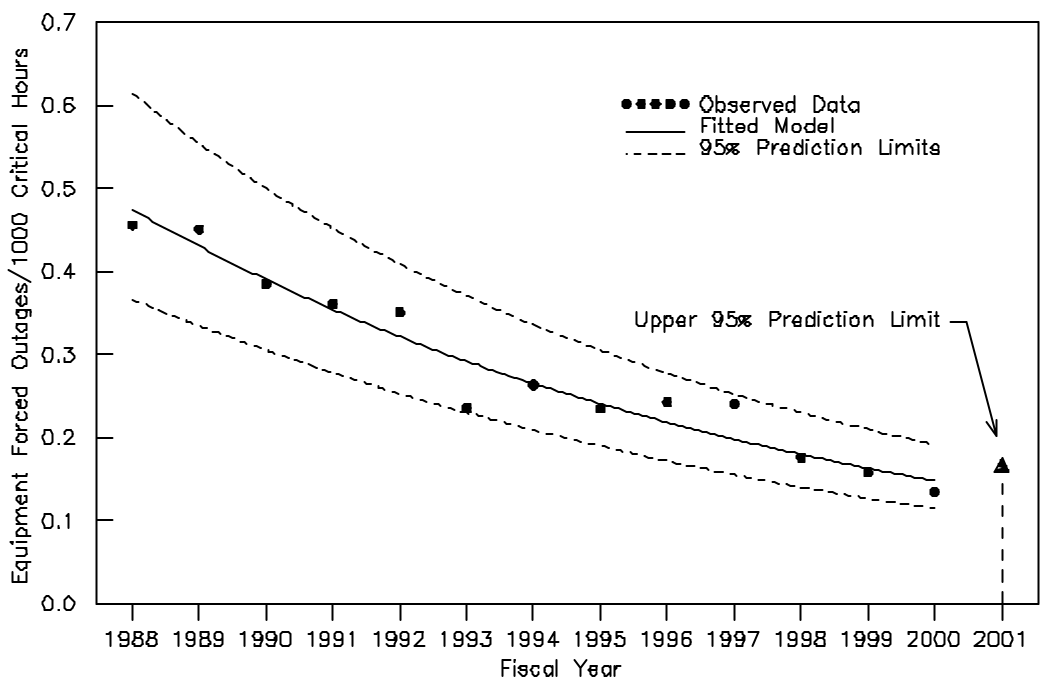
Safety System Failures



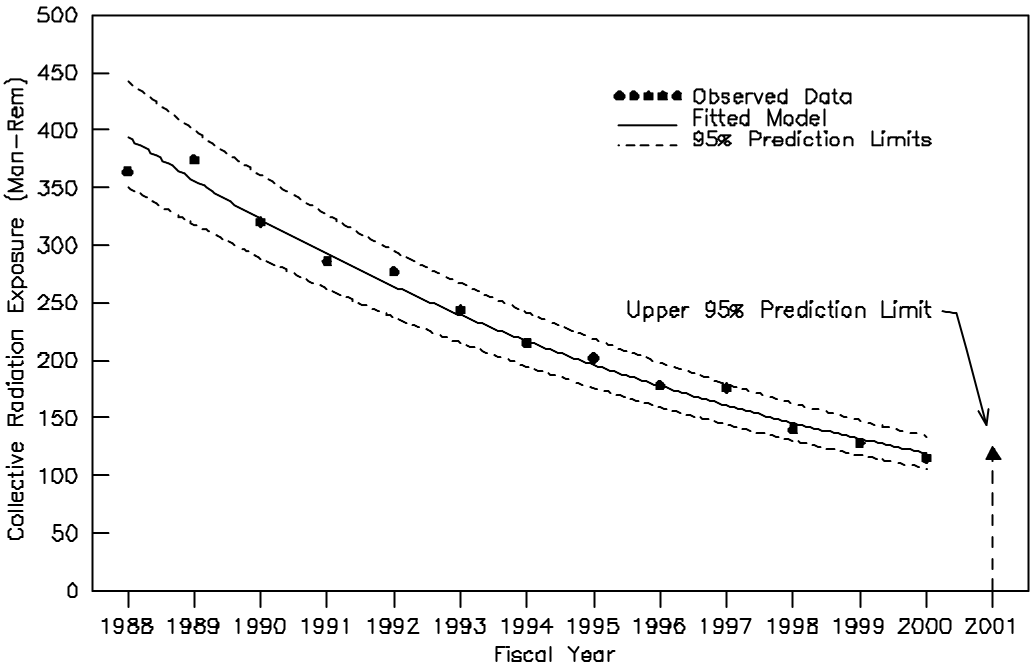
Forced Outage Rate



Equipment Forced Outages



Collective Radiation Exposure

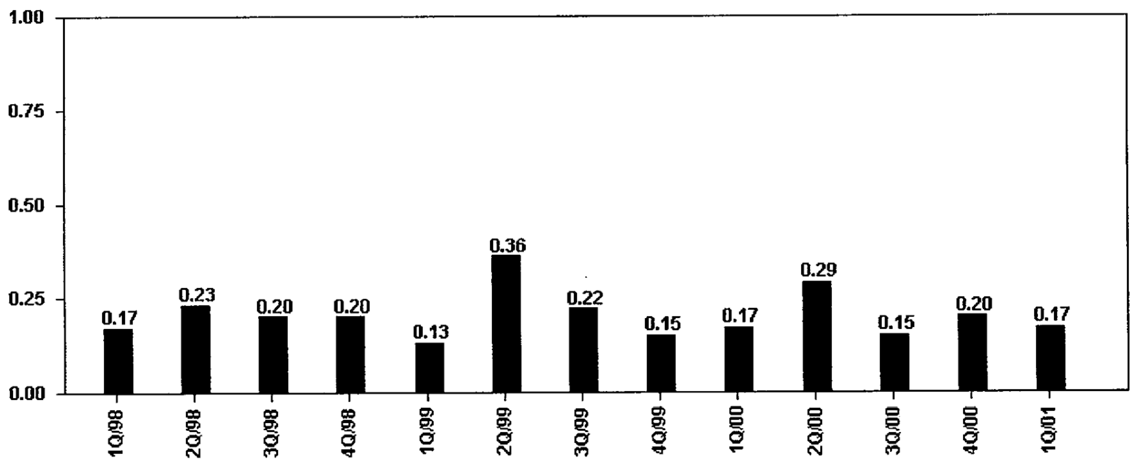


Page #s 6 - 19 can be found under Accession # ML011570251.

2. ROP Performance Indicators (short-term graphs only)

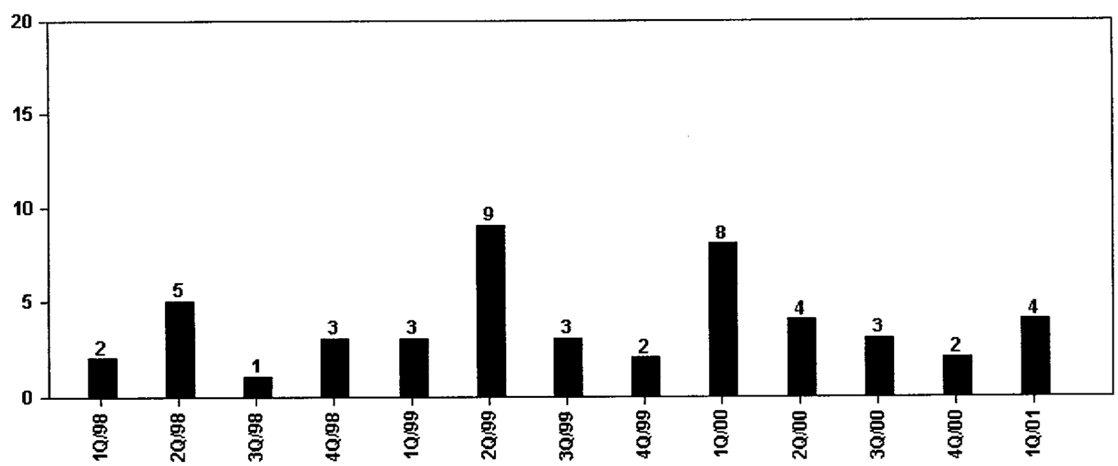
Initiating Events Cornerstone - Industry Trends 1Q/2001

Unplanned Scrams per 7000 Annual Critical Hrs



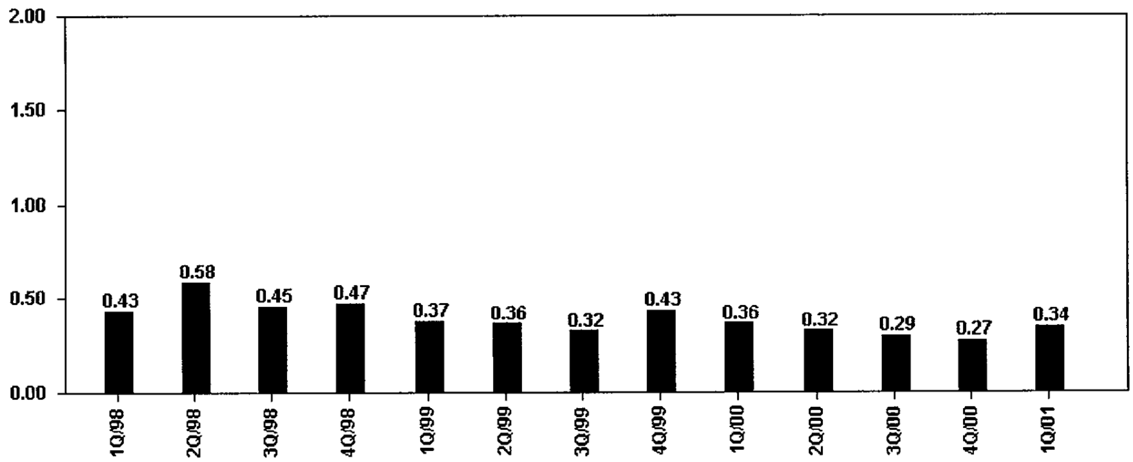
Descriptions

Scrams with Loss of Normal Heat Removal



Descriptions

Unplanned Power Changes per 7000 Annual Critical Hrs

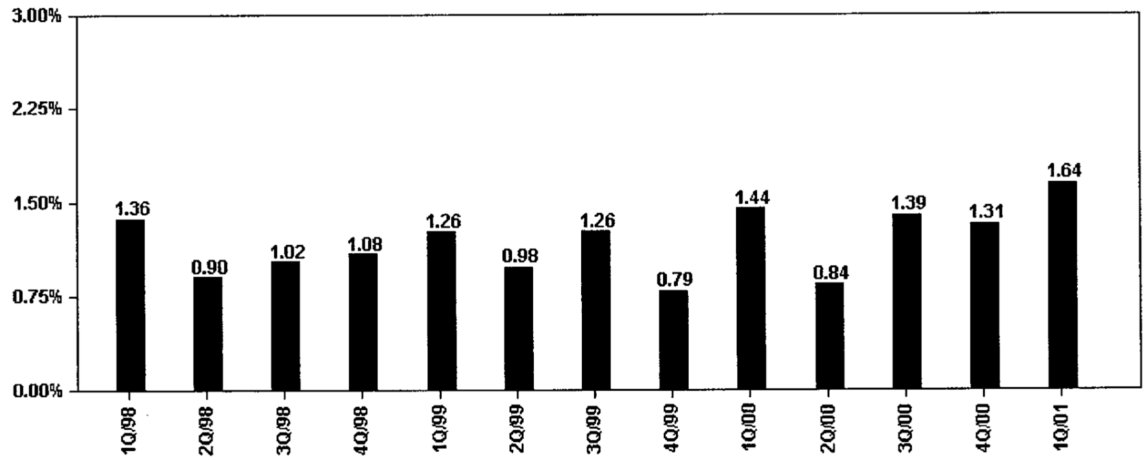


Descriptions

Mitigating Systems Industry Trends

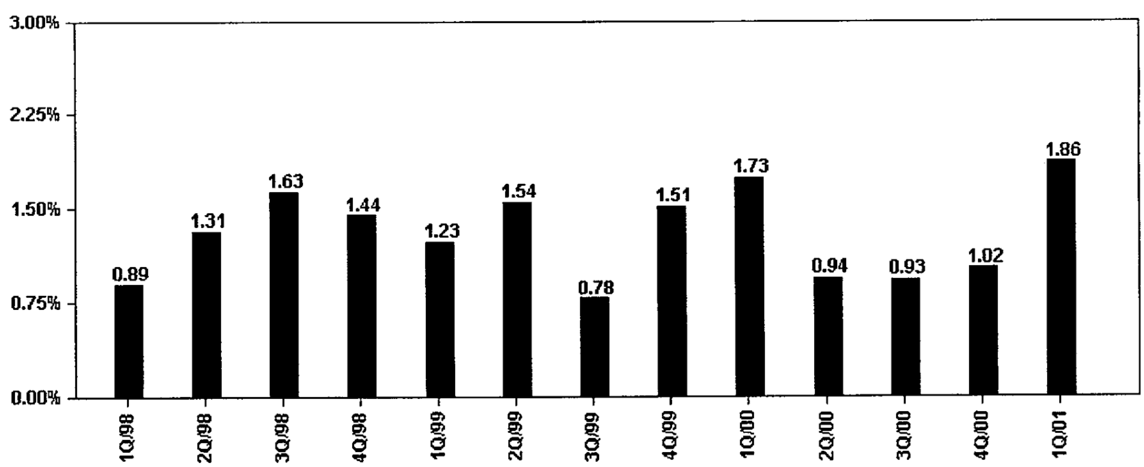
Last Modified: May 20, 2001

Safety System Unavailability, Emergency AC Power



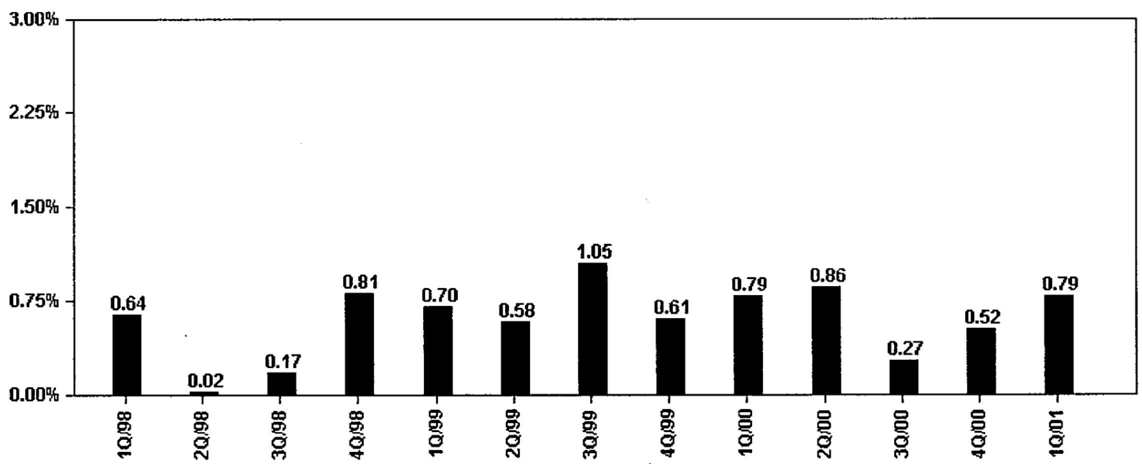
Descriptions

Safety System Unavailability, High Pressure Injection System (HPCI)



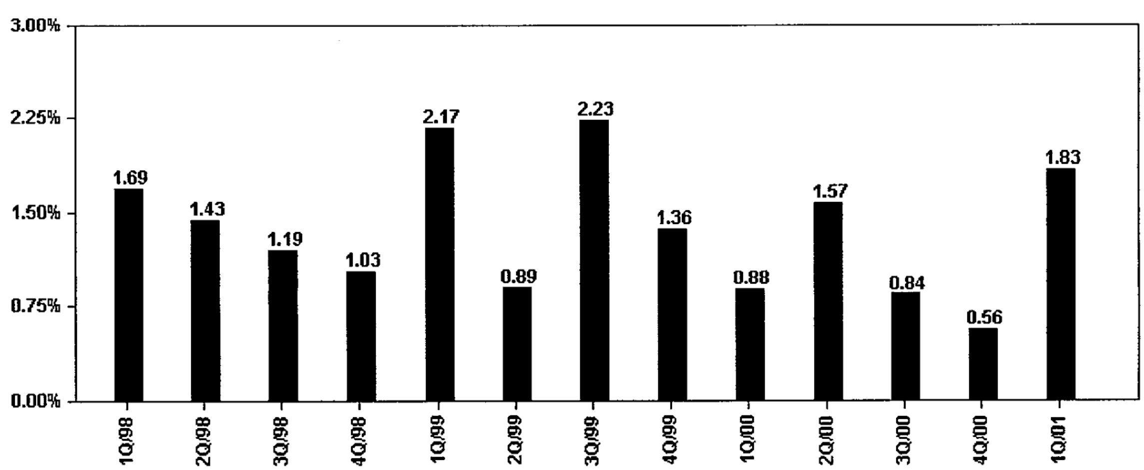
Descriptions

Safety System Unavailability, High Pressure Injection System (HPCS)



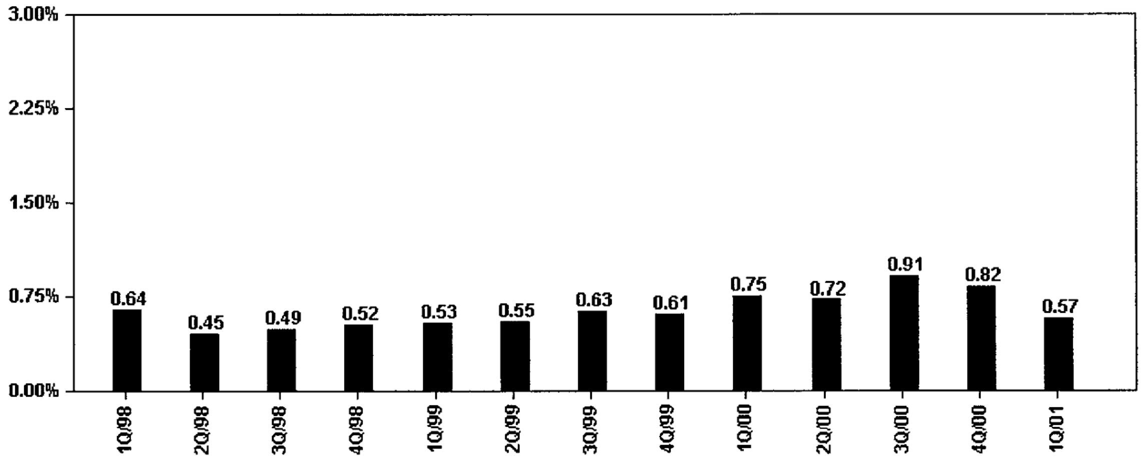
Descriptions

Safety System Unavailability, Heat Removal System (RCIC)



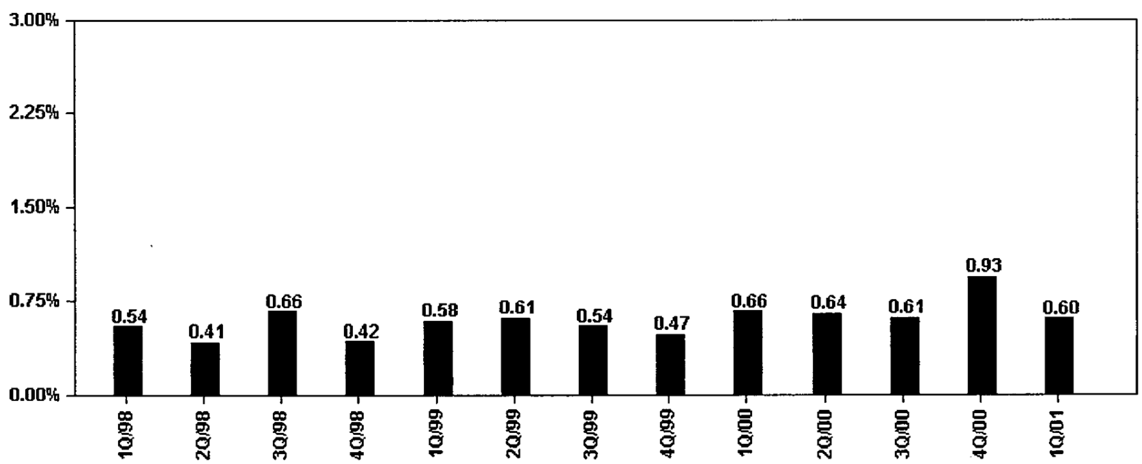
Descriptions

Safety System Unavailability, Heat Removal System (AFW)



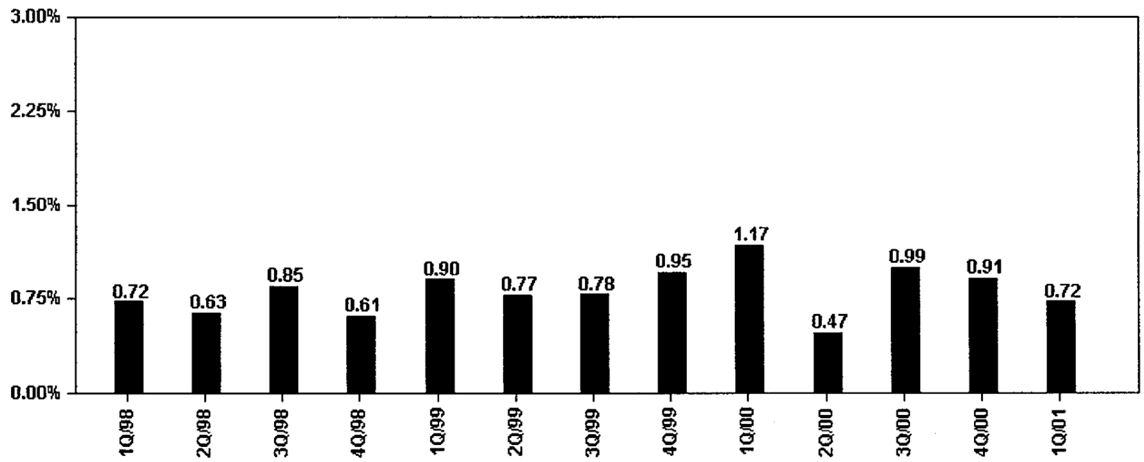
Descriptions

Safety System Unavailability, Residual Heat Removal System (PWR)



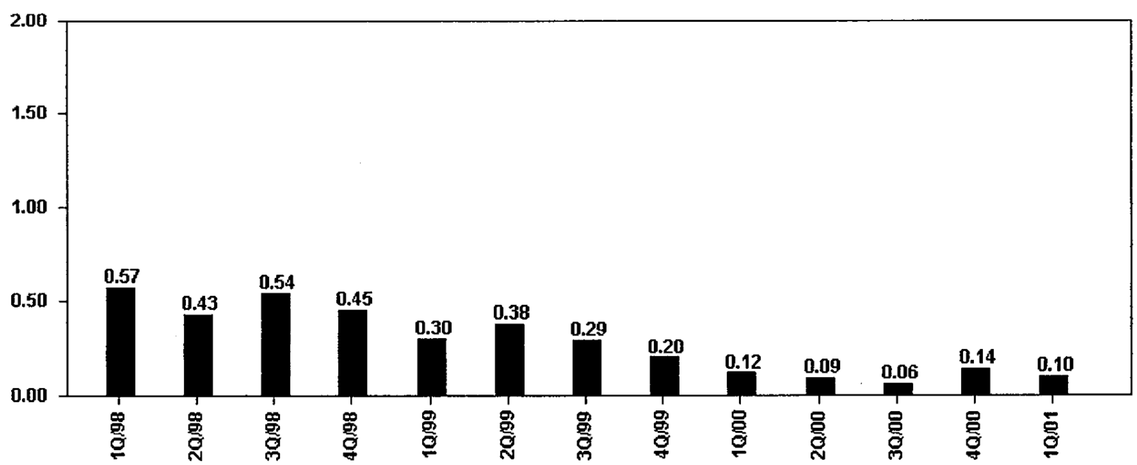
Descriptions

Safety System Unavailability, Residual Heat Removal System (BWR)



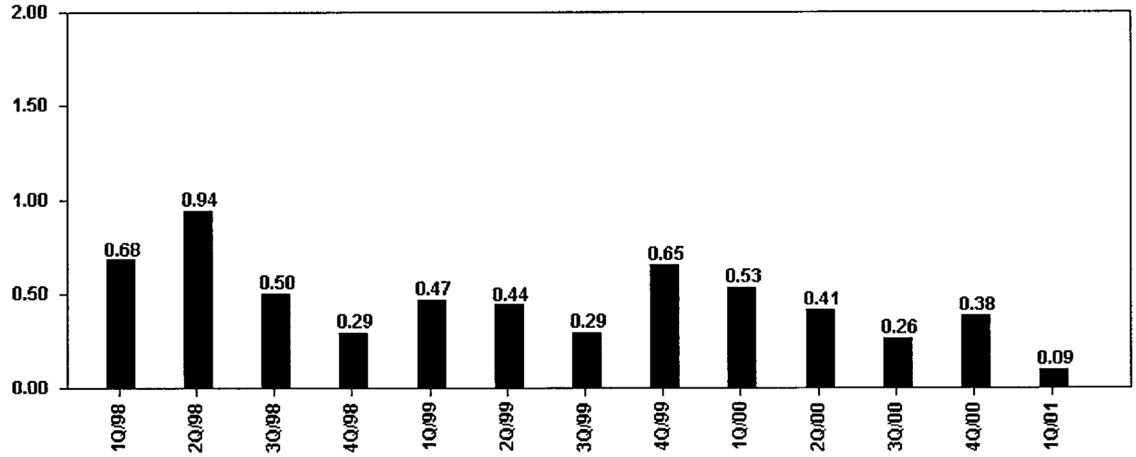
Descriptions

Safety System Functional Failures (PWR)



Descriptions

Safety System Functional Failures (BWR)

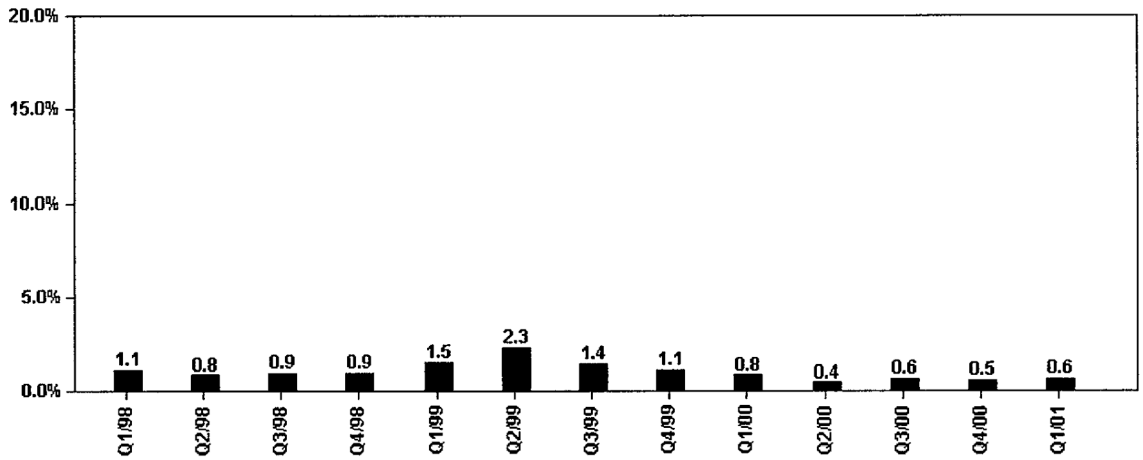


Descriptions

Initiating Events Industry Trends *Barrier Integrity Industry Trends*

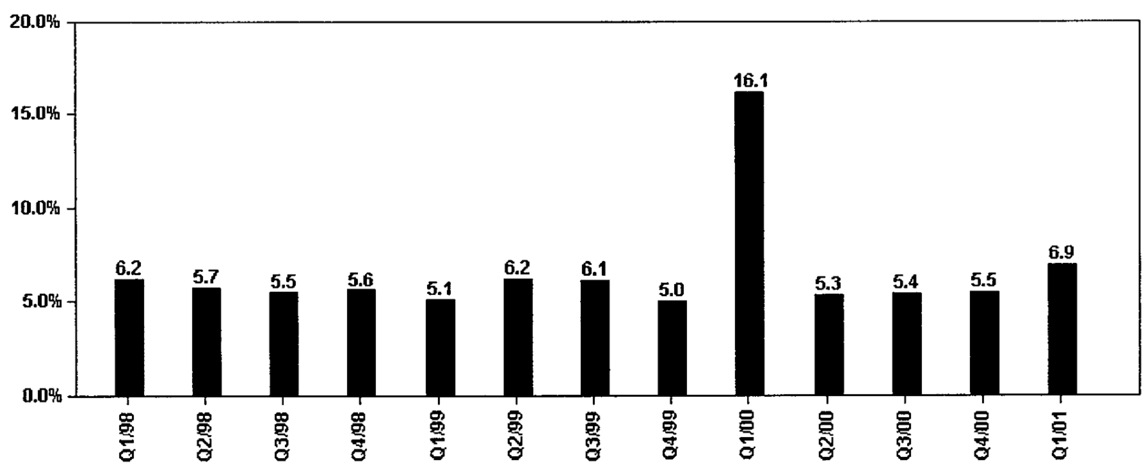
Last Modified: May 20, 2001

Reactor Coolant System Activity
(Max % of Technical Specification Limits)



Descriptions

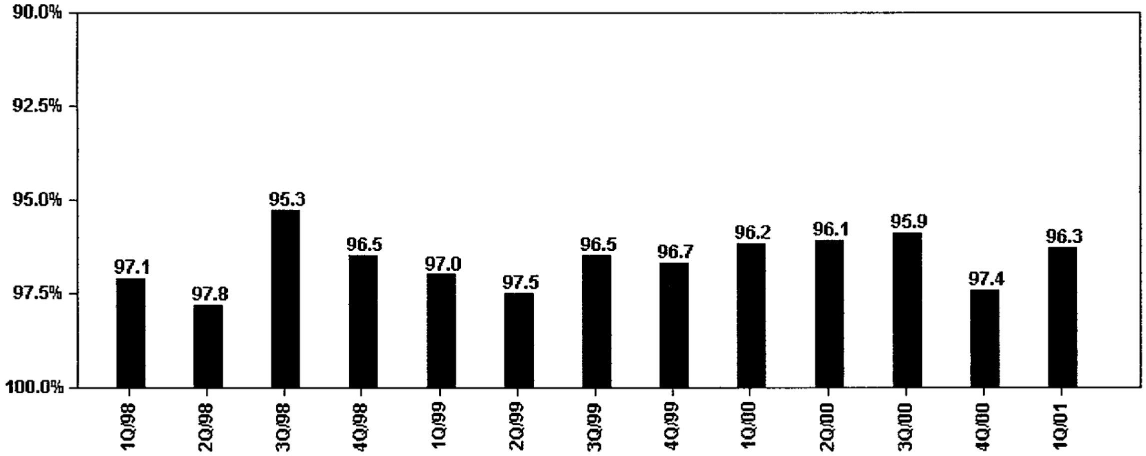
Reactor Coolant System Leakage
(Max % of Technical Specification Limits)



Comments: Q1/00 - Steam generator tube rupture event at Indian Point 2

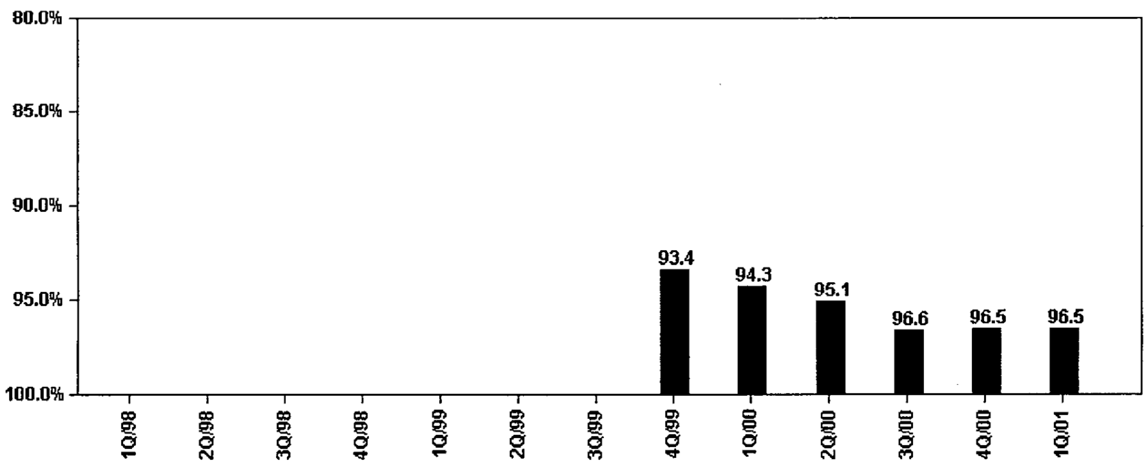
Descriptions

Drill/Exercise Performance
(% Timely and Accurate)



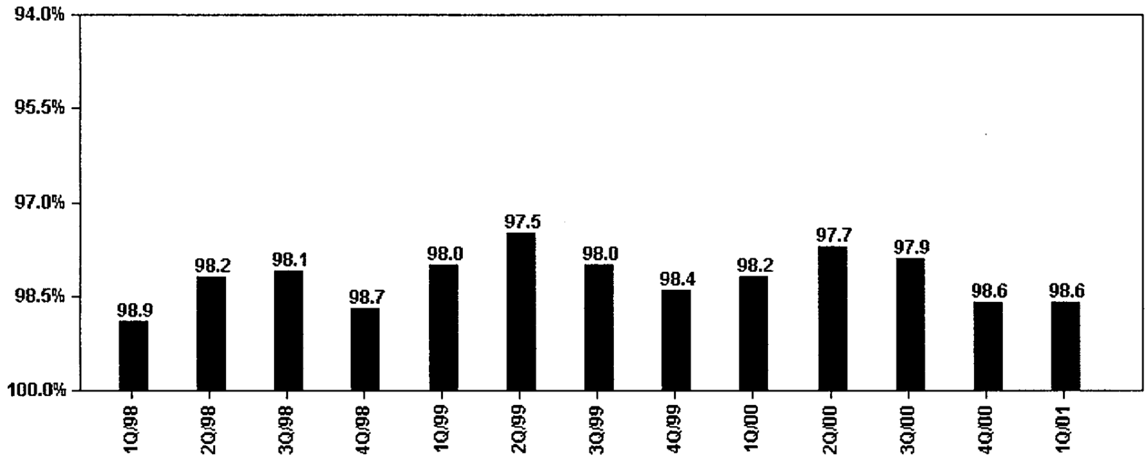
Descriptions

ERO Drill Participation
(% Key Personnel)



Descriptions

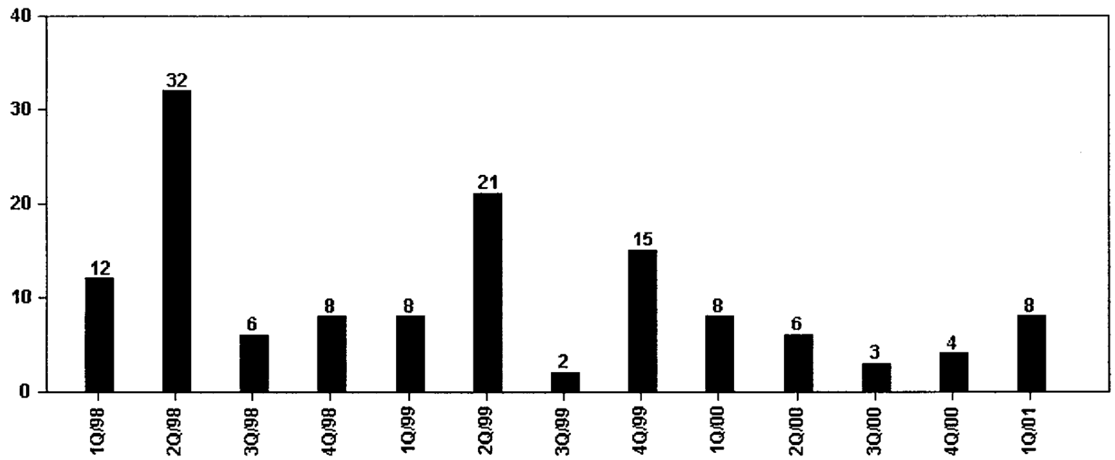
Alert & Notification System Reliability (% Successful Tests)



Descriptions

Barrier Integrity Industry Trends *Occupational Radiation Safety Industry Trends*

Occupational Exposure Control Effectiveness



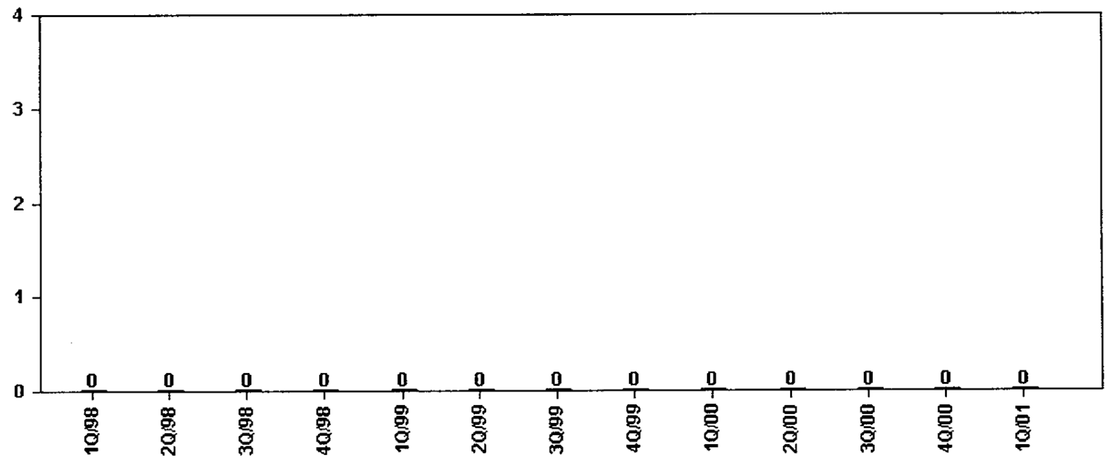
Descriptions

Emergency Preparedness Industry Trends

Public Radiation Safety Industry Trends

Last Modified: May 20, 2001

RETS/ODCM Radiological Effluent Occurrences



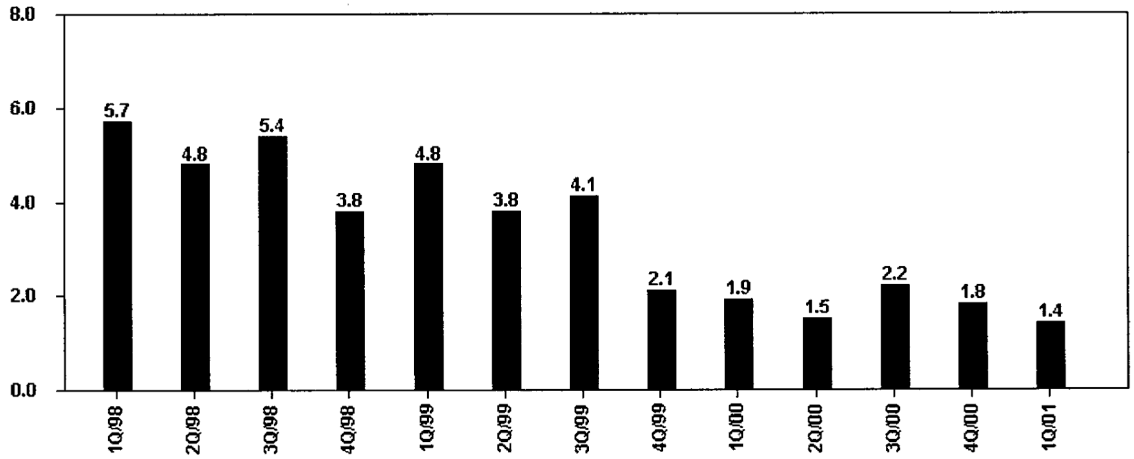
Descriptions

Occupational Radiation Safety Industry Trends

Physical Protection Industry Trends

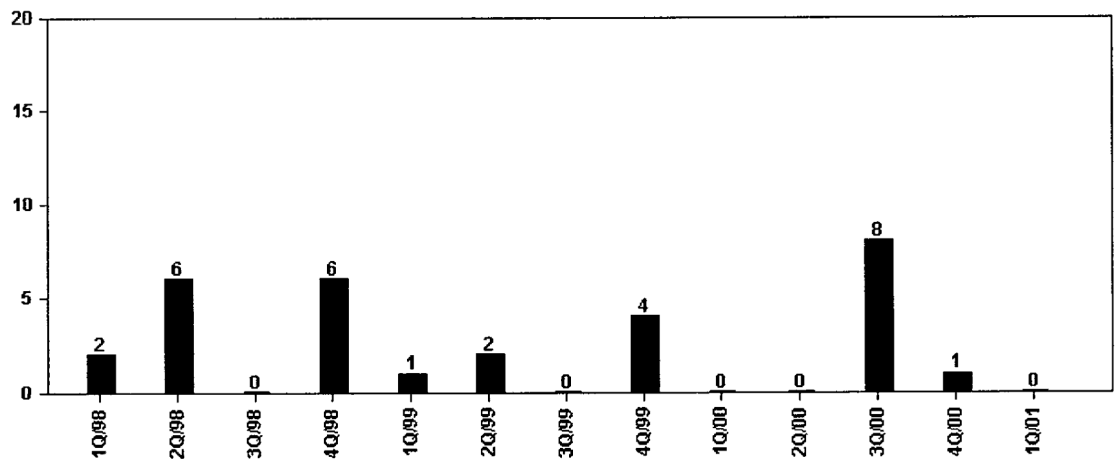
Last Modified: May 20, 2001

Protected Area Security Equipment Performance Index



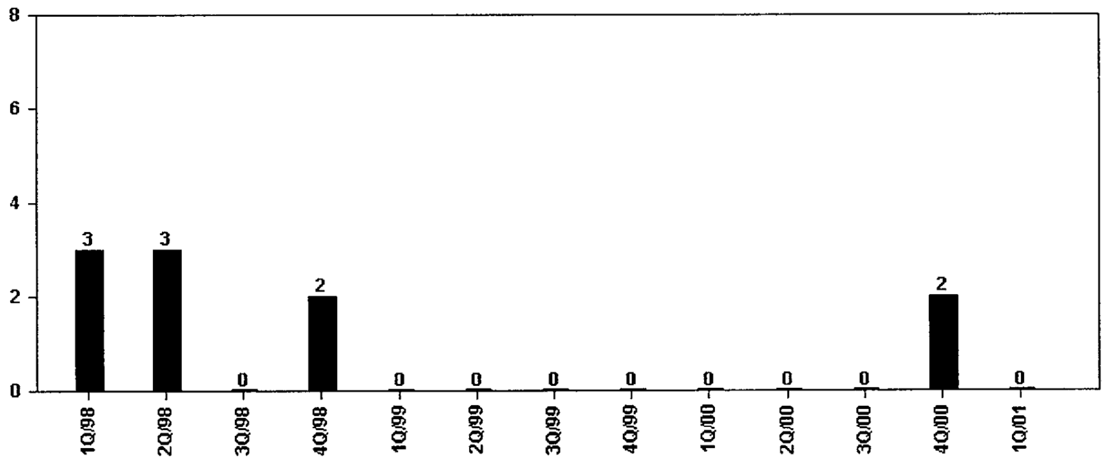
Descriptions

Personnel Screening Program Performance



Descriptions

FFD/Personnel Reliability Program Performance



Descriptions

Public Radiation Safety Industry Trends

Last Modified: May 20, 2001

3. ASP Program Results

The below graphs are provided for illustration only. A detailed explanation is contained in SECY-01-0034, “Status Report on Accident Sequence Precursor Program and Related Initiatives.”

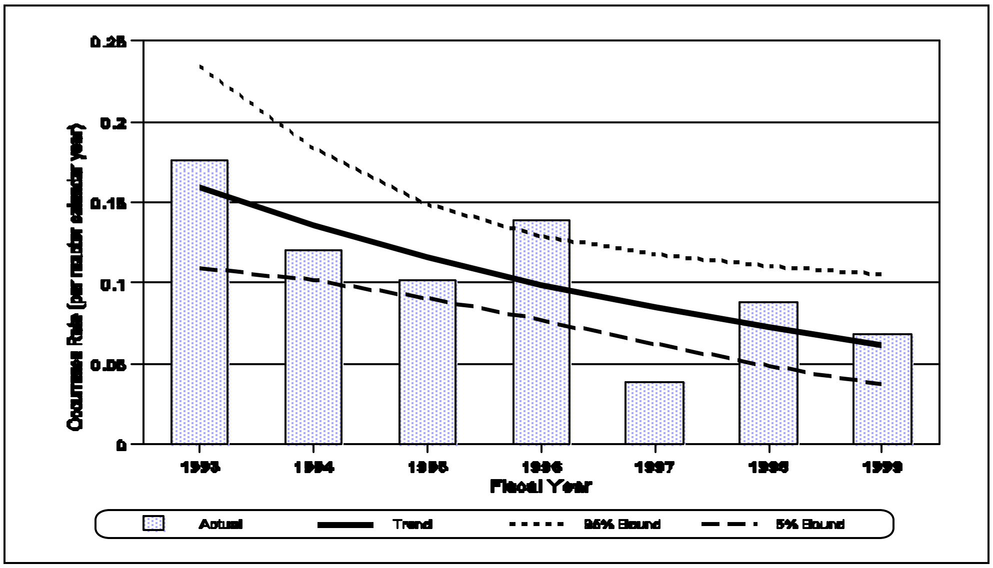


Figure 1. Precursor occurrence rate for 1993-1999 plotted against fiscal year. The trend is statistically significant (p-value = 0.0068). The result for 1999 is preliminary.

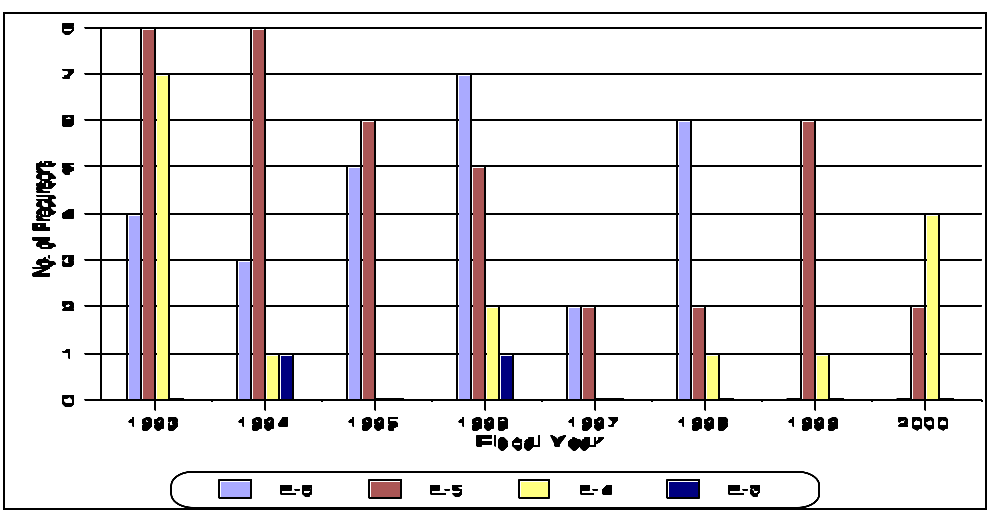
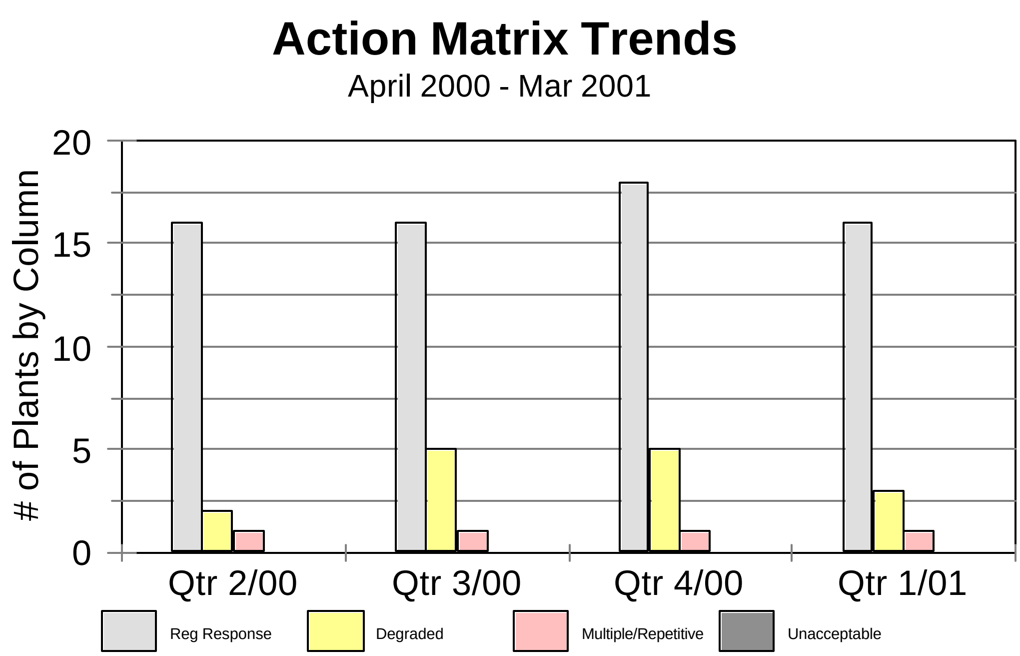


Figure 2. Conditional core damage probability results from ASP Program (1993-2000) for each of the CCDP bins (*E-3*: $\geq 1 \times 10^{-3}$; *E-4*: 9.9×10^{-4} to 1.0×10^{-4}; *E-5*: 9.9×10^{-5} to 1.0×10^{-5}; *E-6*: 9.9×10^{-6} to 1.0×10^{-6}). Results for FYs 1999 and 2000 are preliminary.

4. ROP Program Information

The industry-wide indicators are quantitative and derived from licensee data. However, the ROP relies on both inspection findings and plant-level indicators. The staff examined summary results of its ROP to assess the information that is available should there be an adverse trend in the quantitative industry-wide indicators, and for possible program feedback for the ROP. The results are provided below for the first year of ROP implementation.

A. Action Matrix trends. The NRC provided oversight of 101 plants using the ROP (DC Cook units 1 and 2 were under the IMC 0350 process during the first year, although they have recently been placed under the ROP). The majority of the plants were in the licensee response column of the ROP Action Matrix, which corresponds to the baseline level of NRC oversight. The below chart shows trends in the number of plants that are in the regulatory response, degraded cornerstone, multiple/repetitive degraded cornerstone, and unacceptable performance columns of the Action Matrix, which correspond to increasing levels of regulatory engagement with the licensee. A trend of degrading performance would be one that showed a migration of plants from the licensee response column to one of the other columns in the Action Matrix. For the first year of ROP implementation, this chart does not show any trends.



B. ROP Inspection Findings. IIPB performed an audit of significant inspection findings (final other-than-green SDP determinations) in inspection reports during the first year of implementation of the ROP (April 2, 2000 - March 31, 2001). The audit was intended to illustrate the information available to supplement the industry-wide indicators in each cornerstone. The results, summarized below, demonstrate a wide variety of issues in each cornerstone.

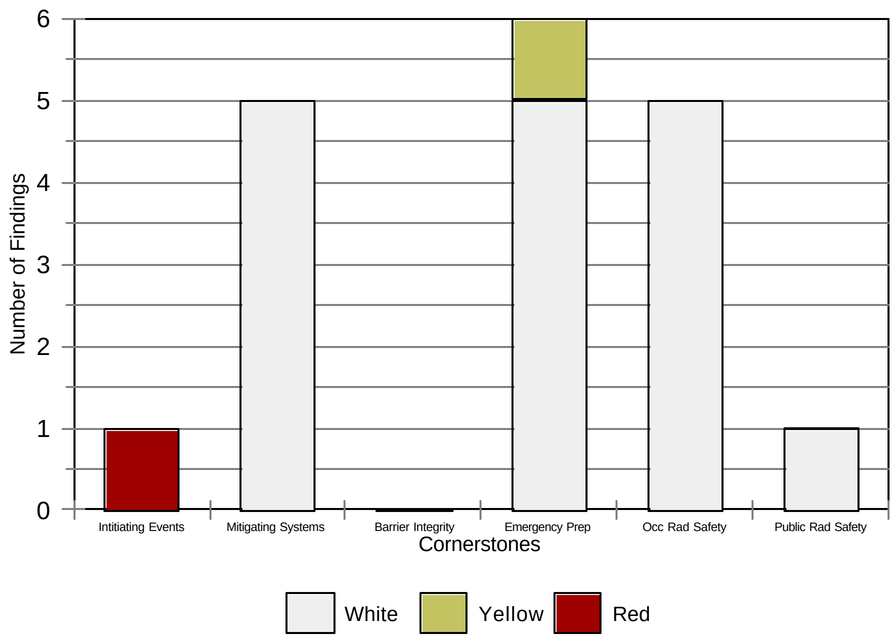
Plant	Cornerstone	Color	SSC/Program Affected	Apparent Cause
INITIATING EVENTS CORNERSTONE				
Indian Point 2	Initiating Events	Red	Steam Generator Tubes - February 2000 SGTF	Failure to take adequate corrective actions regarding 1997 SG tube inspection results
MITIGATING SYSTEMS CORNERSTONE				
Oconee 1	Mitigating Systems	White	High Pressure Injection Pump - HPI may not be able to draw suction from SFP following tornado	Pressure, temperature or hydraulic requirements not adequately considered and SFP as a suction source for HPI was not assured following tornados
Millstone 2	Mitigating Systems	White	AFW - Speed control for TDAFW pump was unresponsive and erratic	Inadequate evaluation of degraded condition and untimely corrective actions.
Summer	Mitigating Systems	White	AFW - Discharge isolation valve for TDEFW pump shut for 48 days.	Failure to follow procedures
Harris	Mitigating Systems	White	Safety Injection Pump - Failed thrust bearing on C CSIP	
Prairie Island 1&2	Mitigating Systems	White	Service Water Pumps	Design deficiency in that the filter backwash water pumps were powered from non-Class 1E power vice Class IE
BARRIER INTEGRITY CORNERSTONE (NO FINDINGS)				
EMERGENCY PREPAREDNESS CORNERSTONE				
Indian Point 2	Emergency Preparedness	White	Emergency Plan Implementation - Failure of ERO to respond in 60 minutes	Program structure or design problems contributed to the failure to meet emergency planning standards

Plant	Cornerstone	Color	SSC/Program Affected	Apparent Cause
Indian Point 2	Emergency Preparedness	White	Emergency Plan Implementation - Failure to establish accountability in 30 minutes	Program structure or design problems contributed to the failure to meet emergency planning standards
Indian Point 2	Emergency Preparedness	White	Emergency Plan Implementation - Inadequate communications to the public	Program structure or design problems contributed to the failure to meet emergency planning standards
Kewaunee	Emergency Preparedness	White	Emergency Plan Implementation - Deficiencies identified with staffing ERO during off-hours staff augmentation drills	Inadequate corrective actions taken for previous deficiencies
Cooper	Emergency Preparedness	White	Emergency Plan Implementation - Failure to identify incorrect PARs in a post EP drill critique.	Failure of licensees EP critique process to identify deficiency with PARs
Kewaunee	Emergency Preparedness	Yellow	Emergency Plan Implementation - Alert and notification siren availability	Root cause evaluation was not performed at the depth necessary to identify the causes of the siren performance problems
OCCUPATIONAL RADIATION SAFETY CORNERSTONE				
Callaway	Occupational Radiation Safety	White	ALARA - Scaffolding activities which accrued actual doses greater than 25 person-rem	Poor planning and preparation, failure to properly train workers in dose reduction, failure to ensure good communications
Callaway	Occupational Radiation Safety	White	ALARA - SG eddy current/robotic plugging/stabilizing/electrosleeving activities accrued actual doses greater than 25 person-rem.	Poor planning and preparation, failure to properly train workers in dose reduction, failure to ensure good communications
Callaway	Occupational Radiation Safety	White	ALARA - Each of four jobs (SG manway cover and inserts removal and installation, foreign object search and retrieval, RCP seal replacement) accrued actual doses greater than 5 person-rem.	Poor planning and preparation, failure to properly train workers in dose reduction, failure to ensure good communications
Quad Cities 1&2	Occupational Radiation Safety	White	ALARA - Increased dose for SRV replacement job	Poor planning and preparation, higher than expected source term, and high heat stress environment

Plant	Cornerstone	Color	SSC/Program Affected	Apparent Cause
Susquehanna 1&2	Occupational Radiation Safety	White	Hot Particle	Failure to conduct adequate radiation surveys for hot particles

Plant	Cornerstone	Color	SSC/Program Affected	Apparent Cause
PUBLIC RADIATION SAFETY CORNERSTONE				
Peach Bottom Units 2 & 3	Public Radiation Safety	White	Radwaste Shipping - Misclassification of radwaste shipment	Licensee did not collect representative resin samples for the purpose of analysis and classification of the waste
PHYSICAL PROTECTION CORNERSTONE				
Quad Cities 1&2	Physical Protection	White	OSRE Contingency Response	

Inspection Findings by Cornerstone



Inspection Findings By SSC/Program