United States Government Accountability Office

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Report to Congressional Requesters

September 2006

NUCLEAR REGULATORY COMMISSION

Oversight of Nuclear Power Plant Safety Has Improved, but Refinements Are Needed

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GAO-06-1029

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Highlights

Highlights of GAO-06-1029, a report to congressional requesters

September 2006

NUCLEAR REGULATORY COMMISSION

Oversight of Nuclear Power Plant Safety Has Improved, but Refinements Are Needed

Why GAO Did This Study

The Nuclear Regulatory Commission (NRC) is responsible for overseeing the nation's 103 commercial nuclear power plants to ensure they are operated safely. The safety of these plants has always been important, since an accident could release harmful radioactive material. NRC's oversight has become even more critical as the potential resurgence of nuclear power is considered. NRC implemented a new Reactor Oversight Process (ROP) in 2000 to address weaknesses in its oversight of nuclear plant safety.

In this report, GAO reviewed (1) how NRC oversees nuclear power plants, (2) the results of the ROP over the past several years, and (3) the status of NRC's efforts to improve the ROP. To complete this work, GAO analyzed programwide information, inspection results covering 5 years of ROP operations, and detailed findings from a nonprobability sample of 11 plants.

What GAO Recommends

GAO recommends that NRC aggressively monitor; evaluate; and, if needed, implement additional measures to increase the effectiveness of its safety culture changes and make publicly available more information on nuclear power plants' safety culture. In commenting on a draft of this report, NRC generally agreed with GAO's findings, conclusions, and recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-06-1029.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

What GAO Found

NRC uses various tools and takes a risk-informed and graded approach to ensure the safety of nuclear power plants. These tools consist of physical inspections of plants and quantitative measures or indicators of plant performance. They are risk-informed in that they focus on the aspects of operations considered most important to plant safety. On the basis of the results of this information, NRC takes a graded approach to its oversight, increasing the level of regulatory attention to plants where safety is declining. NRC assesses overall plant performance and communicates the results to the public, including providing detailed results of its oversight process through a Web site devoted to the ROP.

Since 2001, the ROP has resulted in more than 4,000 inspection findings concerning plants' failure to fully comply with safe operating procedures, and NRC has subjected more than 75 percent (79) of the 103 plants to increased oversight for varying periods. Almost all of the inspection findings were for actions NRC considered important to correct but of low significance to safe plant operations. While the majority of plants received some level of increased oversight, only 5 plants were subjected to NRC's highest level of oversight. Plants in this category were generally subjected to this higher oversight for long periods due to the more systemic nature of their performance problems.

NRC has improved its oversight process in various areas, but it has been slow to act on needed improvements, particularly in improving the agency's ability to identify and address early indications of declining safety performance. NRC is improving its oversight process on the basis of feedback from stakeholders, including better focusing inspections on areas most important to safety. NRC also is addressing what GAO believes has been a significant shortcoming by modifying the ROP to improve its ability to address plants' safety culture—that is, the organizational characteristics that ensure issues affecting nuclear plant safety receive the attention their significance warrants. GAO and others, including some stakeholders, believe these changes could enable NRC to better identify safety culture issues and thus provide earlier indications of declining plant safety performance. However, some in the industry have opposed the changes because they believe the changes could introduce undue subjectivity to NRC's oversight, given the difficulty in measuring these often intangible and complex concepts. NRC has been reluctant to incorporate safety culture into the ROP because it considered this type of activity as a management function, and NRC did not believe that it should be directly involved in managing licensees' plants. NRC program officials view the current changes as the beginning of an incremental approach and acknowledge that they will need to assess their effectiveness at identifying declining safety performance at plants before significant safety events occur.

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Abbreviations

ACRS	Advisory Committee on Reactor Safeguards
ECP	Employee Concerns Program
ERB	Executive Review Board
INPO	Institute of Nuclear Power Operations
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
PRA	Probabilistic Risk Assessment
ROP	Reactor Oversight Process
RPS	Reactor Program System
SALP	Systematic Assessment of Licensee Performance
SCWE	safety-conscious work environment
SDP	Significance Determination Process
UCS	Union of Concerned Scientists

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United States Government Accountability Office
Washington, D.C. 20548

September 27, 2006

Congressional Requesters

The Nuclear Regulatory Commission (NRC) is responsible for overseeing the safe operation of the nation's 103 operating commercial nuclear power plants, which provide about 20 percent of U.S. electricity. The safety of these plants, which are located at 65 sites in 31 states, has always been important, since an accident could result in the release of radioactive material and potentially harm public health and the environment. NRC's oversight has become even more critical as the Congress and the nation consider the potential resurgence of nuclear power in helping to meet the nation's growing energy needs. No new orders for plants have been placed since the 1979 accident at the Three Mile Island plant in Pennsylvania. However, in the face of concerns about energy security, global warming, aging plants, and the ever increasing need for energy to fuel the nation's economy, nuclear power is resurfacing as a principal option. An accident, even on a relatively small scale, could threaten public confidence in nuclear power just as it begins to emerge from the shadows of the Three Mile Island accident. It is critical that NRC be able to ensure that nuclear power plants are operated safely and that public confidence about their safety is high.

NRC is responsible for issuing regulations, licensing and overseeing plants, and requiring necessary actions to protect public health and safety, up to and including shutting down a plant, if it is not meeting licensing conditions and it poses an undue risk to public health and safety. Plant operators are responsible for safely operating their plants in accordance with their licenses. Prior to 2000, NRC's oversight of plants' compliance, which is a critical part of the agency's regulatory program, was criticized because it did not always focus on the most important safety issues, and because some activities were redundant, inefficient, and overly subjective. While its new process—which NRC refers to as the Reactor Oversight Process (ROP)—is similar to its prior process in that the oversight activities largely consist of physical plant inspections, the inspections now focus on more important safety issues. NRC's goal is to ensure that its oversight of plants' safety performance is objective, predictable, understandable, and conducted openly to inform the public and maintain confidence about plant safety. The unexpected discovery in March 2002 of extensive corrosion and a pineapple-size cavity in the reactor vessel head—one of the vital barriers preventing a radioactive release—at the Davis-Besse nuclear power plant in Ohio led NRC to reexamine its safety oversight and other regulatory processes to determine how such corrosion could have been missed. On the basis of the lessons learned from that event, NRC made several changes to the ROP. NRC also has assessed the ROP annually since it was implemented in 2000 by obtaining feedback from the industry and other stakeholders, such as public interest groups.

In this report, we examined (1) how NRC oversees nuclear power plants to ensure that they are operated safely, (2) the results of the ROP over the past several years, and (3) the status of NRC's efforts to improve the ROP.[1] In addition, this report provides details on recent safety-related events at the Salem and Hope Creek nuclear power plants in New Jersey and on NRC's and the licensee's actions in response to these events (see app. I).

To examine how NRC oversees plants, we reviewed the various tools and processes that comprise the ROP. In this regard, we reviewed NRC's policies, inspection manuals, and other guidance documents; interviewed NRC headquarters and regional program officials and regional and on-site inspectors; visited the Salem and Hope Creek nuclear power plants; and attended several public meetings covering various nuclear power plant oversight topics. To examine the results of the ROP over the past several years, we reviewed the number and types of inspection findings NRC issued, along with other performance measures or indicators it collected from the plants, and the level of oversight it provided as a result of its findings. We analyzed NRC data on nuclear plant safety for 2001 through 2005, the years since implementation of the ROP for which data were available for the full year, and discussed our analysis with NRC program officials. We assessed the reliability of these data and determined that they were sufficiently reliable for the purposes of our report. To examine the status of NRC's efforts to improve the ROP, we analyzed NRC documents, including annual self-assessment reports; interviewed officials from NRC, including a former Commission Chairman who is largely credited with leading the development of the ROP, and outside stakeholder groups, including the Nuclear Energy Institute (NEI), the Union of Concerned Scientists (UCS), and Greenpeace; and attended several key public meetings covering proposed changes to oversight procedures. We also reviewed various external evaluations of the ROP, including our prior

[1]Physical security, which is also covered by the ROP, is not included in this review. For information on NRC's physical security, see GAO, *Nuclear Power Plants: Efforts Made to Upgrade Security, but the Nuclear Regulatory Commission's Design Basis Threat Process Should Be Improved*, GAO-06-388 (Washington, D.C.: Mar. 14, 2006).

reports and those of the Advisory Committee on Reactor Safeguards (ACRS)[2] and the NRC Office of the Inspector General. In addition, we selected a nonprobability sample of 6 nuclear power sites (totaling 11 plants, including Salem and Hope Creek) that spanned each of NRC's four regions and represented varying levels of plant performance and NRC oversight since 2000. We reviewed relevant inspection reports and assessment documents and interviewed NRC and industry officials at each site to examine how NRC applies the ROP to identify and correct safety problems. Appendix II presents a detailed discussion of our scope and methodology. We conducted our work from July 2005 through July 2006 in accordance with generally accepted government auditing standards.

Results in Brief

NRC uses various tools and takes a risk-informed and graded approach to ensuring the safety of nuclear power plants. These tools include physical inspections of plants' equipment and records and quantitative measures or indicators of plant performance, such as the number of unplanned reactor shutdowns and the reliability of alert and notification system sirens that notify residents living near the plant in the event of an accident. NRC uses a risk-informed approach—that is, an approach that considers safety significance in selecting the equipment or operating procedures to be inspected—to apply these tools. NRC inspectors conduct baseline inspections of plant operations almost continuously at each nuclear power plant site. When NRC becomes aware of a performance problem at a plant, it uses a process to assign the inspection finding one of four colors to reflect the finding's risk significance, which is set on the basis of measures that reflect the potential health effects that could occur from radiological exposure. Green inspection findings equate to very low risk significance, while white, yellow, and red colors represent increasing levels of risk, respectively. In response to greater-than-green (white, yellow, or red) inspection findings, NRC conducts supplemental inspections, which expand the scope of baseline inspections and review (1) the extent of the problem, (2) the sufficiency of the licensee's evaluation of the root cause of

[2]The Advisory Committee on Reactor Safeguards is an independent committee, mandated by the Atomic Energy Act of 1954, as amended, which provides advice on nuclear facility safety-related topics, among other topics. The ACRS is currently composed of 11 individuals with a wide variety of engineering and technical expertise, including nuclear engineering; risk assessment; chemistry; and mechanical, civil, and electrical engineering, as well as many others. The ACRS is structured to provide a forum where these experts can provide independent advice that can then be factored into NRC's decision-making process. Each year, the ACRS produces several reports, many of them related to the ROP.

the problem, and (3) the licensee's proposed corrective actions in response to the identified performance problem. NRC conducts special inspections to investigate specific safety incidents or events—such as reactor shutdowns due to equipment failures—that are of particular interest to NRC because of their potential significance to safety. Nuclear power plants also self-report on their safety performance, using performance measures or indicators in quarterly reports that they submit to NRC. The plants' reports are verified by NRC's on-site inspectors. On the basis of the number and risk significance of inspection findings and performance indicators, NRC places each plant into one of five oversight categories on its action matrix, which correspond to graded or increasing levels of oversight, largely consisting of supplemental inspections that increase in the breadth and depth of issues covered as plants move into higher oversight categories. NRC provides an overall assessment of each plant's performance through assessment letters issued to plants at the end of each 6-month period describing their specific performance and the level of oversight that will result. In addition, NRC has other mechanisms to make available its oversight results, such as an Internet Web site devoted to the ROP that provides detailed summaries of each plant's performance.

Since 2001, the ROP has resulted in more than 4,000 inspection findings concerning nuclear power plant licensees' failure to fully comply with NRC regulations and industry standards for safe plant operation, and NRC has subjected more than 75 percent (79) of the 103 operating plants to increased oversight for varying periods. (See app. III for additional site-specific plant data.) About 97 percent of the inspection findings were green, meaning they were for actions or failures NRC considered important to correct but of very low significance to overall safe plant operations. For example, a finding of very low risk significance was issued at one plant after a worker failed to wear the proper radiation detector, and at another plant because the operator failed to properly evaluate and approve the storage of flammable materials in the vicinity of safety-related equipment. The other 3 percent (98) of the inspection findings were greater-than-green. Most of these findings (86 of the 98) were white, meaning they were considered to be of low-to-moderate risk significance. The other 12 inspection findings, or less than 1 percent, were of the highest levels of significance to safety (yellow and red). For example, NRC issued a finding of the highest risk significance (red) at one plant after a steam generator tube failed, causing an increased risk of the release of radioactive material. In the area of performance indicators, there were 156 instances out of more than 30,000 reports, or less than 1 percent, in which data reported for individual indicators were outside of NRC's acceptable performance category. On the basis of greater-than-green inspection findings and performance indicators, NRC has subjected more than 75 percent (79) of the 103 operating plants to oversight beyond the baseline inspections for varying periods. Most of these plants received the lowest level of increased oversight, consisting of a supplemental inspection to follow up on the corrective actions taken for performance problems identified through the issuance of 1 or 2 white inspection findings or performance indicators. Over the past 5 years, 5 plants have been subjected to the highest level of NRC oversight that still allows continued operations. Plants in this category were generally subjected to this higher oversight for long periods due to the more intensive supplemental inspections conducted by NRC and the more systemic nature of the plants' performance problems and subsequent corrective actions NRC expected the licensees to take. NRC inspectors at the plants we reviewed indicated that when plant performance declines, it is often the result of ineffective corrective action programs, problems related to human performance, or complacent management. In assessing the results of the ROP between 2001 and 2005, we found an association between poorer performing plants and deficiencies in the plants' human performance and problem identification and resolution programs.

NRC has improved its oversight process in various areas, but continued efforts will be needed to address other shortcomings or opportunities for improvement, particularly in improving the agency's ability to identify and address early indications of declining plant safety performance. NRC has made several improvements, largely in response to independent reviews and feedback from stakeholders, including its regional and on-site inspectors, usually obtained during NRC's annual self-assessment of its oversight process. These improvements include better focusing its inspections on those areas most important to safety, reducing the time needed to determine the risk significance of inspection findings, and modifying the way that some performance indicators are measured to improve their quality. NRC also is assessing whether it needs to modify its oversight, including developing additional inspection procedures, as a result of some problems that have surfaced in areas not fully inspected by NRC, such as the recent discovery of groundwater contamination from radioactive materials at a number of sites. For the most part, NRC considers these efforts to be refinements to its oversight process, rather than significant changes. One important shortcoming in the ROP that we and others have found is that it is not as effective as it could be in identifying and addressing early indications of deteriorating safety at nuclear power plants before problems develop. In response to this concern, NRC recently undertook a major initiative to improve its ability to address plants' safety culture—that is, the organizational characteristics that ensure issues affecting nuclear plant safety receive the attention their significance warrants. NRC and others have long recognized that safety culture attributes, such as attention to detail, adherence to procedures, and effective corrective and preventative actions, have a significant impact on a plant's safety performance, and that the lessening of these attributes can indicate a decline in safety performance before safety problems occur. However, NRC has been somewhat slow to react and only recently modified its oversight process by redefining and increasing its focus on cross-cutting safety issues—issues that comprise many of the elements of safety culture—and developing new requirements under the ROP to more directly assess safety culture at poorer performing plants. However, some of NRC's changes have been controversial. While some industry officials have expressed concern that the changes could introduce undue subjectivity to NRC's oversight, given the difficulty in measuring these often intangible and complex concepts, other stakeholders believe the changes will provide NRC with better tools to identify safety culture issues at plants and thus provide earlier indications of declining safety performance. NRC has been reluctant to incorporate safety culture into the ROP because it considered this type of activity a management function, and NRC did not believe that it should be directly involved in managing licensees' plants. NRC program officials view these changes as the beginning step in an incremental approach and acknowledge that they will need to assess the changes they made to the ROP to determine their effectiveness in better allowing inspectors to detect deteriorating safety conditions at plants before significant safety events occur.

Given the importance of this initiative to the ROP's effectiveness, we are recommending that NRC aggressively monitor; evaluate; and, if needed, implement additional measures to increase the effectiveness of its safety culture changes. In line with NRC's desire to make the ROP an open process, we are also recommending that the agency make available additional information on plants' safety culture to the public and its other stakeholders to provide a more comprehensive picture of plant performance. In commenting on a draft of this report, NRC generally agreed with our findings, conclusions, and recommendations. Appendix IV contains a reproduction of NRC's letter.

Background

NRC is an independent agency of over 3,200 employees established by the Energy Reorganization Act of 1974 to regulate civilian—that is, commercial, industrial, academic, and medical—use of nuclear materials. NRC is headed by a five-member Commission. The President appoints the Commission members, who are confirmed by the Senate, and designates one of them to serve as the Chair and official spokesperson. The Commission as a whole formulates policies and regulations governing nuclear reactor and materials safety, issues orders to licensees, and adjudicates legal matters brought before it. NRC's staff work out of its headquarters office in Rockville, Maryland; out of its four regional offices; and at each of the operating commercial nuclear power plant sites (see fig. 1). NRC's Office of Nuclear Reactor Regulation provides overall direction for the oversight process and the Office of Enforcement is responsible for ensuring that appropriate enforcement actions are taken when performance issues are identified. NRC's regional offices are responsible for implementing the ROP, along with the inspectors who work directly at each of the nuclear power plant sites.

Figure 1: NRC Regions and Operating Nuclear Power Plant Sites in the United States

Sources: NRC and Map Resources (map).

Nuclear power plant licensees have the primary responsibility for safely operating their plants in accordance with their licenses and NRC regulations. The plants have many physical structures, systems, and components, and licensees have numerous activities under way 24 hours a day to ensure that plants operate safely. NRC relies on, among other things, its on-site inspectors to assess plant conditions and the licensees' quality assurance programs, such as those required for maintenance and problem identification and resolution. Given the numerous activities going on during complex plant operations, NRC can inspect only a relatively small sample of the plants' activities. According to NRC, its focus on the more safety-significant activities is made possible because safety performance at plants has improved as a result of more than 25 years of operating experience, and because improvements have been made in the risk assessment tools available to NRC inspectors.

Commercial nuclear power plants are designed according to a "defense-in-depth" philosophy revolving around redundant, diverse, and reliable safety systems. For example, two or more key safety components are put in place so that if one fails, there is another to back it up. Plants have numerous built-in sensors to monitor important indicators, such as water temperature and pressure. Plants also have physical barriers to contain radiation and provide emergency protection. For example, nuclear fuel is contained in a ceramic pellet to lock in the radioactive byproducts, the fuel pellets are sealed inside rods made of special material designed to contain fission products, and the fuel rods are placed in reactors housed in containment buildings made of several feet of concrete and steel.

In addition, the nuclear power industry formed an organization, the Institute of Nuclear Power Operations (INPO), whose mission is to "promote the highest levels of safety and reliability, to promote excellence, in the operation of nuclear electric generating plants." INPO provides a system of personnel training and qualification for all key positions at nuclear power plants, and workers undergo both periodic training and assessment. INPO also conducts periodic evaluations of operating plants, focusing on plant safety and reliability, in the areas of operations, maintenance, engineering, radiological protection, chemistry, and training. Licensees make the results of these evaluations available to NRC for review, and NRC staff use the evaluations as a means to determine whether its oversight process has missed any performance issues.

Prior to the ROP, NRC conducted Systematic Assessment of Licensee Performance (SALP) evaluations. SALP evaluations were largely based on physical plant inspections conducted at each operating plant. Every 12 to 24 months, NRC provided an overall assessment of plant safety performance. As part of the assessment process, NRC's senior management met to evaluate plants' performance and develop a "watch list" of those plants requiring increased regulatory attention. The SALP process was heavily criticized by the industry and other internal and external stakeholders, however, for being inconsistently applied among NRC regions and for lacking clear and consistent responses once issues were identified. In 1997 and 1998, we reported that NRC's oversight needed substantial revisions to achieve its purpose as an early-warning tool, and that NRC did not consistently apply the SALP across the industry.[3] We found the inconsistency could be attributed, in part, to a lack of specific criteria, the subjective nature of the process, and an ineffective process for ensuring that the licensees maintain competent management at their plants.

To address these concerns, NRC undertook a major effort to revise its oversight process. NRC held a series of public meetings and workshops and formed several task groups to involve its internal and external stakeholders, including NEI, UCS, state agencies, and others. In 1999, NRC conducted a 6-month pilot program to implement the ROP at various sites across the country. On the basis of the input it received from its stakeholders and the results from the pilot program, NRC finalized its new process and implemented the ROP at all plants in April 2000, which was a significant departure from its prior SALP process.

Soon after the ROP was implemented, NRC faced a number of unanticipated events— including the attacks of September 11, 2001, and the discovery of the Davis-Besse reactor vessel head degradation in 2002— that challenged its ability to complete its baseline inspection activities at all plants in 2002 and 2003. Therefore, NRC staff implemented "coping strategies," which consisted of increasing the use of overtime and scheduling flexibility for its inspectors, reducing the level of effort for some of its inspection procedures, reducing some of the inspection preparation time, and deferring some inspections, among other things. A 2004 audit by the NRC Office of the Inspector General found that the resource challenges were largely due to changes in NRC's staffing policy, a hiring policy change, an increase in inspection activities due to unanticipated events such as Davis-Besse, and a loss of qualified inspectors.[4] NRC increased its inspection resources by 9 percent in 2004, and then by another 5 percent in 2005, and reported that it was able to fully implement its baseline inspection program at all plants for both years. NRC reports show that resources expended in 2005 were almost 20 percent higher than those

[3]GAO, *Nuclear Regulatory Commission: Preventing Problem Plants Requires More Effective Action by NRC*, GAO-T-RCED-98-252 (Washington, D.C.: July 30, 1998); and *Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action*, GAO/RCED-97-145 (Washington, D.C.: May 30, 1997).

[4]NRC, Office of the Inspector General, *US Nuclear Regulatory Commission: Audit of NRC's Baseline Inspection Program*, OIG-05-A-06 (Dec. 22, 2004).

expended in 2002, the lowest level of inspection resources devoted to the ROP since its inception in 2000. According to NRC, the additional resources expended in 2005 were due, in part, to increased oversight that was based on lessons learned from the Davis-Besse incident and on the increased focus on security and emergency preparedness. With its current resource levels, NRC program officials believe they will be able to continue to implement all program requirements without the need to employ coping strategies.

NRC Uses Various Tools and Takes a Risk-Informed and Graded Approach to Ensuring the Safety of Nuclear Power Plants

NRC's tools to oversee the safe operation of nuclear power plants generally consist of physical inspections of the various complex plant equipment and operations, reviews of plant records, and quantitative measures or indicators of plant performance. These tools are risk-informed in that they focus on the aspects of operations considered most important to plant safety. NRC bases its oversight process on the principle and requirement that licensees have programs in place to routinely identify and address performance issues without NRC's direct involvement. Thus, an important aspect of NRC's inspection process is ensuring the effectiveness of licensee programs designed to identify and correct problems. On the basis of the number and risk significance of inspection findings and performance indicators, NRC places each plant into one of five performance categories on its action matrix, which corresponds to graded, or increasing, levels of oversight. NRC assesses overall plant performance and communicates the results to licensees and the public on a semiannual basis.

NRC Collects Information about Plant Performance from Physical Inspections and Quantitative Measures Reported by the Licensees

Physical plant inspections are the main tool NRC uses to oversee plant safety performance. NRC defined specific inspection areas by developing a list of those elements most critical to meeting the overall agency mission of ensuring nuclear power plant safety. These safety elements—or key plant inspection areas—are known as cornerstones. Table 1 summarizes the objectives of each cornerstone.

Table 1: Key ROP Plant Inspection Areas, or Cornerstones

Cornerstone	Objective
Initiating events	Limit the frequency of those events that upset plant operating stability and challenge critical safety functions.
Mitigating systems	Ensure the availability, reliability, and capability of systems that mitigate initiating events to prevent reactor accidents.
Barrier integrity	Ensure that physical barriers, such as fuel cladding and containment structures, protect the public from radioactive releases caused by accidents.
Emergency preparedness	Ensure that actions taken by the emergency plan would provide protection of the public health and safety during a radiological emergency.
Occupational radiation safety	Ensure adequate protection of worker health and safety from exposure to radioactive material during routine civilian nuclear reactor operation.
Public radiation safety	Ensure adequate protection of public health and safety from exposure to radioactive material released into the public domain as a result of routine civilian nuclear reactor operations.
Physical protection[a]	Provide assurance that the physical protection system can protect against radiological sabotage.

Source: NRC.

[a]The physical protection cornerstone consists of physical security issues and, therefore, is outside the scope of this review.

During fiscal year 2005, NRC reported that inspectors spent 411,490 hours (an average of 77 hours per week at each plant) on plant inspections, which consist of baseline, supplemental, and special inspections. About 73 percent of this time was devoted to baseline inspections, which are the minimum level of inspections that all plants receive regardless of performance, and are conducted on an almost continuous basis. Baseline inspections are conducted by the two or three NRC inspectors located at each site and specialists who travel to each site from NRC's regional offices. These inspections are designed to detect declining safety performance in each of the cornerstones, and to review licensee effectiveness at identifying and resolving its safety problems. There are more than 30 baseline inspection procedures conducted at intervals that range from quarterly to triennially. These procedures involve both physical observations of plant activities and reviews of plant reports and data. Each of the baseline procedures specify a range of sample activities to inspect. Inspectors then select the type and number of activities to review on the basis of factors such as the sample activities available; their risk significance; the amount of time since a particular system or component was last inspected; and the inspector's judgment, which is based on information such as reviews of the licensee's corrective action program, allegations, or plant employee interviews. Risk is factored into the baseline inspection procedures in the following four ways: (1) areas of inspection are included in the set of baseline procedures, in part, on the basis of their risk importance; (2) risk information is used to help determine the frequency and scope of inspections; (3) the selection of activities to inspect within each procedure is informed with plant-specific risk information; and (4) the inspectors are trained in the use of risk information in planning their inspections. In addition to the more than 30 baseline inspection procedures, inspectors spend an average of 750 to 1,100 hours per year (14 to 21 hours per week), depending on the size of the site, conducting plant status reviews. These reviews are to ensure that inspectors are aware of plant conditions on a routine basis and include such activities as reviewing control room activities and status, attending licensee meetings, and conducting walk-downs of various plant areas.

When NRC inspectors identify a finding they consider to be more than minor,[5] they use a significance determination process (SDP) to assign the finding one of four colors to reflect the finding's risk significance. The SDP assesses how an identified inspection finding increases the risk that a nuclear accident could occur, or how the finding affects the ability of the plant safety systems or personnel to prevent such an accident. Risk thresholds for each color were set on the basis of measures that reflect the potential health effects that could occur from radiological exposure.[6] Green inspection findings equate to very low risk significance, while white, yellow, and red colors represent increasing levels of risk, respectively. For greater-than-green (white, yellow, or red) inspection findings, NRC issues a preliminary color determination after an initial analysis. It then analyzes any readily available information from the licensee pertinent to the finding to ensure that the final determination of risk significance is made with the best available information.

[5]"Minor issues" are defined by NRC as those that have little actual safety consequences, little or no potential to impact safety, little impact on the regulatory process, and no willfulness. For example, if a licensee missed providing an hourly update to a state agency during a declared unusual event that resulted in no actual safety consequences, it would be considered minor if it did not detract significantly from the state agency's ability to function during the emergency. Also, if a licensee failed to record one section of a surveillance test, but the test was performed and the last completed surveillance test revealed that the equipment adequately performed its safety function, the finding would be considered minor.

[6]The measures used for the characterization of risk are core damage frequency and large early release frequency. In some situations, risk calculations cannot be made using these measures, such as in the case of measuring the risk for emergency preparedness inspection findings. In these cases, thresholds were determined by panels of experts on the basis of operating experience and a determination of what the appropriate response would be.

When NRC issues one or more greater-than-green inspection findings at a plant, it conducts supplemental inspections. Supplemental inspections, performed by regional staff, expand the scope beyond baseline inspection procedures and focus on diagnosing the cause of the performance deficiency. There are three levels of supplemental inspections that are increasingly expansive in the breadth and depth of their analysis. The level of supplemental inspection to be carried out depends on the number and type of performance problem identified. The lowest level of supplemental inspection assesses the licensee's corrective actions to ensure they were sufficient in both correcting the problem and identifying and addressing the root and contributing causes to prevent recurrence. The second level of supplemental inspection has an increased scope that includes independently assessing the extent of the condition for both the specific and any broader performance problems. The highest level of supplemental inspection is even more comprehensive and includes determining whether the plant can continue to operate and whether additional regulatory actions are necessary. The highest level of supplemental inspection is usually conducted by a multidisciplinary team of NRC inspectors and may take place over several months. Also, as a part of this supplemental inspection, NRC inspectors assess the adequacy of the licensee's overall programs for identifying, evaluating, and correcting its performance issues, among other things.

NRC conducts special inspections at plants when specific events occur that are of particular interest to NRC because of their potential safety significance at the plant or because of potential generic safety concerns important to all plants. Special inspections determine the cause of the event and assess the licensee's response to the event. For special inspections, a team of experts is often formed and an inspection charter issued that describes the scope of the inspection efforts. At one plant we reviewed, for example, a special inspection was conducted to investigate the circumstances surrounding the discovery of leakage from a spent fuel storage pool.[7] Among the objectives of this inspection were to assess the adequacy of the plant licensee's determination of the source and cause of the leak, the risk significance of the leakage, and the proposed strategies to mitigate leakage that had already occurred and repair the problem to prevent additional leakage.

[7]Spent fuel storage pools are typically 40-foot deep, steel-lined, concrete vaults filled with water to store spent fuel rods no longer capable of being used for nuclear power generation. The water is to provide shielding from radiation that is left in the rods.

As part of its inspection process, NRC evaluates all of its findings to determine if certain elements of plant performance, referred to as cross-cutting aspects, were a contributing cause to the performance problem. Cross-cutting aspects represent licensee performance elements that extend across all of the cornerstones of safety. There are three cross-cutting aspect areas: (1) problem identification and resolution, (2) human performance, and (3) a safety-conscious work environment. For example, in analyzing the failure of a valve to operate properly at one plant, NRC inspectors determined that plant employees had not followed the correct maintenance procedures. Thus, NRC concluded that the finding was associated with the human performance cross-cutting area. Every 6 months, NRC analyzes all findings issued at each plant during a 12-month assessment period. If more than three findings have similar causes within the same cross-cutting area and if NRC is concerned about the licensee's progress in addressing these issues, it determines that the licensee has a "substantive" cross-cutting issue. NRC notifies the licensee that it has opened a substantive cross-cutting issue, and it may ask the licensee to respond with the corrective actions it plans to take. Also, NRC inspectors said they provide additional focus on any substantive cross-cutting issues open through their baseline inspection efforts. For example, one regional official said that if a substantive cross-cutting issue in the problem identification and resolution area is identified, it is the region's practice to increase the frequency of certain baseline inspections that focus on the licensee's problem identification and resolution processes.

In addition to its various inspections, NRC also collects plant performance information through its performance indicator program, which it maintains in cooperation with the nuclear power industry. On a quarterly basis, each plant submits data for 15 separate performance indicators[8]—quantitative measures of plant performance related to safety in the different aspects of plant operations. For example, one indicator measures the number of unplanned reactor shutdowns during the previous four quarters, while another measures the capability of alert and notification systems that notify residents living near the plant in the event of an accident. Working with the nuclear power industry, NRC set thresholds for acceptable performance and assigned colors to each of the indicators to reflect increasing risk. In contrast to inspection findings, a green indicator does not indicate a performance deficiency but instead reflects performance

[8]There also are 3 performance indicators in the area of physical security, and, therefore, they are outside the scope of this review.

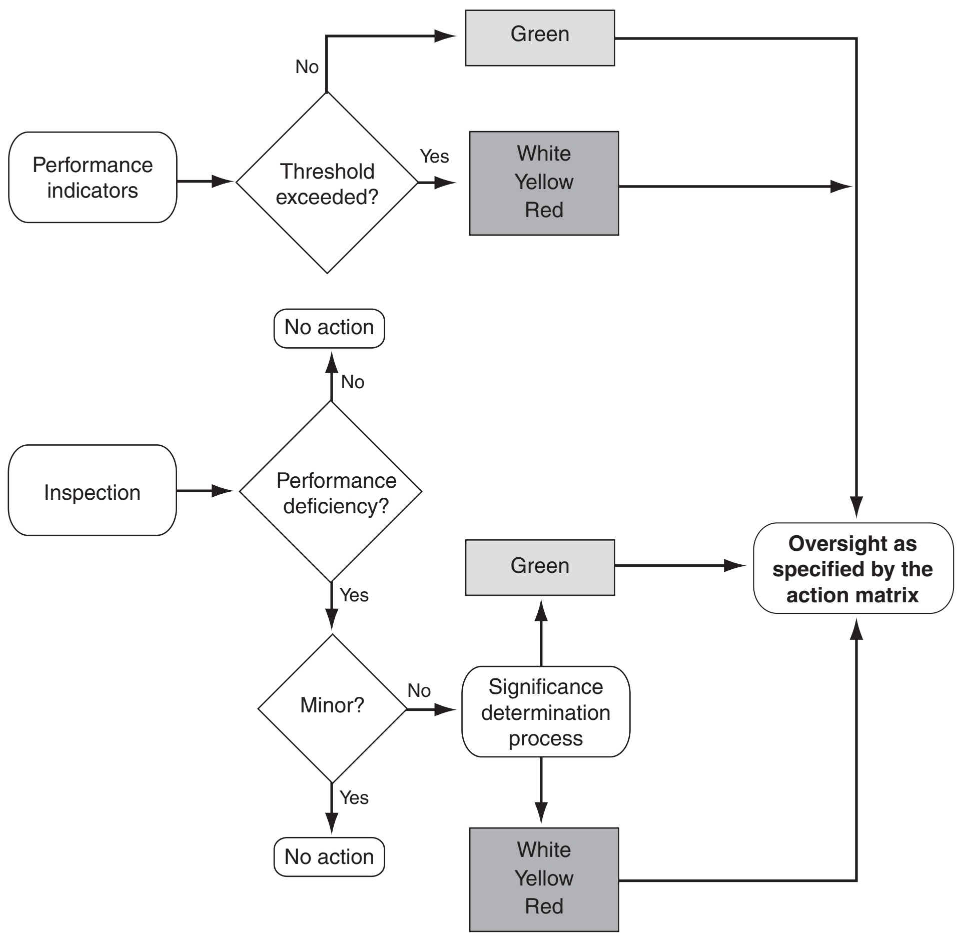
within the acceptable range, while white, yellow, and red represent decreasing levels of plant performance. NRC inspectors review and verify the data submitted for each performance indicator annually through their baseline inspections. If questions arise during the review and verification process about how to calculate a particular indicator or what the correct value should be, there is a formal feedback process to resolve the issue. Similar to its process for conducting supplemental inspections when greater-than-green inspection findings are identified, NRC conducts supplemental inspections in response to any greater-than-green performance indicators.

NRC Uses Its Action Matrix to Categorize Plant Performance and Apply Increased Oversight in a Graded Fashion

Under the ROP, NRC places each nuclear power plant into one of five performance categories on its action matrix, which corresponds to graded, or increasing, levels of oversight.[9] The action matrix is NRC's formal method of determining how much additional oversight—mostly in the form of supplemental inspections—is required on the basis of the number and risk significance of inspection findings and performance indicators. (See fig. 2 for an overview of the process that leads to plant placement on the action matrix.)

[9]While NRC formally places plants into performance categories on its action matrix on a quarterly basis, NRC assesses plant performance on a continuous basis and takes actions in accordance with the action matrix as performance issues are identified.

Figure 2: NRC's Oversight Process in Determining Plant Placement on the Action Matrix



Source: GAO analysis of NRC guidance.

The definitions for the categories of the action matrix indicate more pervasive and systematic declines in licensee performance as a licensee moves from left to right on the action matrix (see table 2). Also, as the licensee moves to the right on the action matrix, NRC's response and the corrective actions it expects of the licensee become more extensive. In determining a plant's placement on the action matrix, greater-than-green inspection findings are considered for additional oversight for a minimum of four quarters, regardless of whether the licensee corrected the problem, to allow sufficient time to identify additional findings that may indicate more pervasive performance problems. If a licensee fails to correct the performance problem within the initial four quarters, the finding may be held open and considered for additional oversight. NRC regional officials, with the approval of the Executive Director for Operations, can also increase or decrease oversight beyond the actions specified by the action matrix through deviations to the ROP. Deviations are for rare instances when the regulatory actions dictated by the action matrix are not appropriate and a more tailored approach is warranted.

Table 2: NRC Reactor Oversight Process Action Matrix

Oversight category	Lowest level	Second level	Third level	Highest level (while allowing continued operations)	Unacceptable performance (plant shutdown)
Plant performance	All green findings and performance indicators	One white finding or performance indicator, or two white findings or performance indicators in different cornerstones	Two or more white findings or performance indicators in one cornerstone, or one yellow finding or performance indicator, or any three white findings or performance indicators	Two white findings or performance indicators or one yellow finding or performance indicator in one cornerstone for five or more quarters, or multiple yellow or one red finding or performance indicator	Overall unacceptable performance due to unacceptable margin of safety
NRC oversight actions	Baseline inspections only	Baseline inspections and first level, or least intensive, supplemental inspection	Baseline inspections and second level, or more intensive, supplemental inspection	Baseline inspections and third level, or most intensive, supplemental inspection.[a]	Order to modify, suspend, or revoke licensed activities

Source: NRC.

Note: In addition to the actions listed in this table, increasingly higher levels of NRC management will meet with the licensee as it moves to the right on the action matrix.

[a]For plants at this oversight level, at a minimum, the licensee and NRC are to document agreement on the corrective actions the licensee will take through a performance improvement plan. NRC may also take actions including making a demand to the licensee for information or issuing an order up to and including a plant shutdown.

Whether NRC takes enforcement actions in response to plant performance problems depends on whether there is a violation of a specific regulatory requirement.[10] Some findings can have risk significance without violating a regulatory requirement because the ROP is a risk-informed process, while the underlying regulations are not all risk-informed. For example, regulatory requirements govern plants' safety-related equipment, which licensees define when their licenses are granted as equipment that would be employed to mitigate the effects of an accident. NRC's risk-informed oversight process considers the condition of all of the equipment at a plant, not necessarily just that included in its definition of safety-related equipment. As such, performance deficiencies could be identified through inspection findings that were not associated with safety-related equipment and, thus, were not violations of a regulatory requirement. More specifically, fire pumps are not typically defined as safety-related equipment under the regulations defining safety-related equipment, but they could be employed to provide water to cool the reactor in the event of an accident. If a licensee specified the use of fire pumps as part of its strategy to mitigate the effects of an accident, a performance problem associated with the pumps would not necessarily violate regulatory requirements, but the problem could be determined to be an inspection finding. Even though there is not a regulation requiring the licensee to correct such a problem, the finding would be considered for additional oversight under the ROP, thus providing an incentive for the licensee to correct it. NRC program officials acknowledge that applying the risk-informed ROP to regulations that are not risk-informed allows for these types of situations. The officials said NRC has efforts under way to risk-inform some of its regulations, which should reduce the likelihood of these types of situations occurring.

[10]In some cases, a violation of regulatory requirements can occur that results in an inspection finding, but the finding is not assigned a color because the issue associated with the violation is not amenable to a risk calculation. For these types of findings, a severity level is assigned to reflect the significance of the finding, ranging from I for the most significant, to IV for the least significant. In assigning a severity level to the finding, NRC assesses the following: (1) the actual safety consequences; (2) the potential safety consequences; (3) the potential for impacting NRC's ability to perform its regulatory function (e.g., failure to provide complete and accurate information); and (4) any willful aspects of the violation. Severity levels I and II violations generally involve actual or high-potential consequences to public health and safety. Severity level III violations are cause for significant concern, and severity level IV violations are less serious but are of more than minor concern.

On the basis of the results of its oversight process, NRC provides plant licensees and the public with an overall assessment of each plant's performance. At the end of each 6-month period, NRC issues an assessment letter to each plant to describe what level of oversight the plant will receive according to its placement on the action matrix, what actions NRC is expecting the plant licensee to take as a result of the performance issues identified, any specific enforcement actions NRC has taken, and any documented substantive cross-cutting issues. If a substantive cross-cutting issue is identified, the letter will describe what actions NRC intends to take to monitor the issue and how the licensee is expected to respond to NRC with the corrective actions it intends to take. NRC also holds an annual public meeting at or near each site to review its performance and address questions from members of the public and other interested stakeholders. In addition, NRC reviews the conclusions of independent plant assessments, such as those conducted by INPO. The purpose of this review is to self-assess the NRC inspection and assessment process to ensure that NRC is identifying similar performance issues.

NRC communicates the results of much of its oversight process to members of the public through an Internet Web site devoted to the ROP. This Web site makes available plants' inspection reports and assessment letters, and other general materials related to NRC's oversight process. NRC also provides a quarterly summary of every plant's performance, consisting of its inspection findings, the color of each performance indicator, and its placement on the action matrix. NRC also provides a short description of each inspection finding issued during the quarter. While each description contains information about whether the finding was associated with a cross-cutting issue, the Web site itself does not provide information on those plants that have open substantive cross-cutting issues. This information can only be found on the Web site by linking to each plant's individual assessment letters. NRC program officials acknowledge that, without having the information available in summary form, it is difficult to determine which plants have substantive cross-cutting issues open. They said that they may look at the possibility of including such information on the Web site, although doing so is not part of their current plans.

In addition to its plant-level assessments, NRC assesses the results of its oversight process on an industry-level basis. NRC management holds an annual meeting to (1) discuss any significant performance issues identified at specific plants and (2) analyze the overall results of its inspection and performance indicator programs and compare them with other industry-collected and reported performance data. NRC program officials said that if they identified any negative trends or inconsistencies, they would take action to better understand and address the cause.

NRC Has Identified Low Risk Problems at Nuclear Power Plants, Resulting in Increased Oversight for Varying Periods

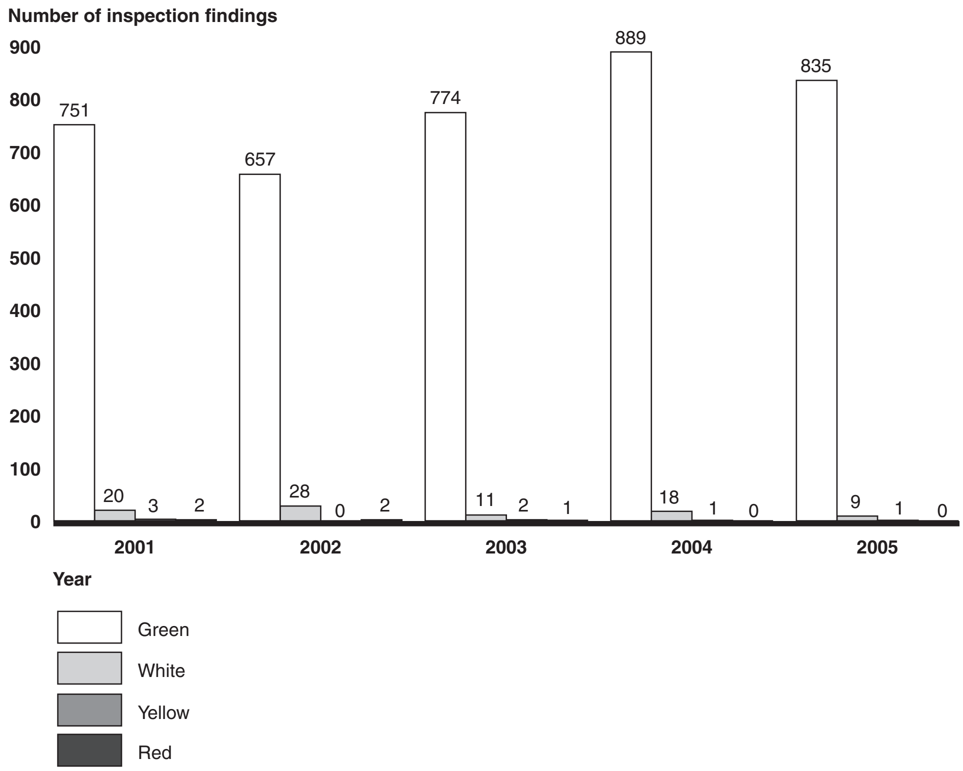
The ROP has identified thousands of performance deficiencies through inspection findings at nuclear power plants between 2001 and 2005, but most of these findings were considered to be of very low risk to safe plant operations. In the performance indicator program, there have been very few instances in which performance indicator data were below acceptable standards during this period. While the majority of plants received some level of increased oversight due to greater-than-green inspection findings and performance indicators, only 5 plants were subjected to NRC's highest levels of oversight. Plants in this category were generally subjected to this higher oversight for long periods due to the more intensive supplemental inspections conducted by NRC and to the more systemic nature of the plants' performance problems and subsequent corrective actions NRC expected the licensees to take. In assessing the results of the ROP between 2001 and 2005, we found an association between poorer performing plants and deficiencies in the cross-cutting areas of human performance and problem identification and resolution.

Of the more than 4,000 inspection findings identified between 2001 and 2005, 97 percent were green. (See app. III for additional site-specific inspection findings data.) The number of green findings ranged from 15 at one site to 141 at another site, with an overall site average of 59 for the 5-year period. While green findings are considered to be of very low safety significance, they represent a performance deficiency on the part of the licensee and it is important that they be corrected. Green findings consist of such things as finding that a worker failed to wear the proper radiation detector, or finding that a licensee did not properly evaluate and approve the storage of flammable materials in the vicinity of safety-related equipment. NRC does not follow up on the corrective action taken for every green finding; rather, it relies on the licensee to address and track the finding's resolution through the plant's corrective action program. NRC does, however, periodically follow up on some of the actions taken by the licensee to address green findings through an inspection specifically designed to evaluate the effectiveness of the licensee's corrective action program. NRC program officials stated that even though they do not increase oversight as a result of green findings, green findings are assessed for the presence of cross-cutting aspects and provide useful information on plant performance. NRC inspectors told us they use green findings to identify performance trends in the various safety areas and these findings help inform their selection of future inspection samples.

The other 3 percent of the inspection findings identified between 2001 and 2005, or 98 of the more than 4,000, were greater-than-green (see app. III). Eighty-six findings were white, meaning they were considered to be of low to moderate risk significance. The white findings were well-distributed among the sites, with only 11 sites receiving more than 2 white findings during the period. Twenty-three sites were not issued any white (or greater) findings during this period. White findings were issued for such things as (1) a licensee's failing to correct a condition in which the auxiliary service water pump could not be aligned in sufficient time to mitigate the loss of feedwater during a simulated tornado exercise and (2) a licensee's having an improper validation process for its licensed operator requalification examinations, which compromised the integrity of the exams. Less than 1 percent of the inspection findings issued since 2001 were of the highest risk significance—yellow or red. During this time, NRC issued 7 yellow findings and 5 red findings. The 7 yellow findings were in the mitigating systems and emergency preparedness cornerstones and included issues such as the failure to develop and maintain emergency plans at one plant, the failure to ensure that safety-related equipment was adequately protected from flooding at another plant, and the failure to pass an annual licensed operator requalification examination by over half of the operator crews at one plant. Of the 5 red findings, 1 was issued for the degradation of the reactor vessel head at the Davis-Besse plant, 1 was issued for a steam generator tube failure at another plant, and the remaining 3 red findings were issued at 2 other plants for problems related to their auxiliary feedwater pumps.

NRC's inspection results have remained relatively consistent from 2001 to 2005. During this time frame, the number of green findings at all plants ranged from 657 to 889 per year, and the number of other findings ranged from 10 to 30 per year, with no strong trend (see fig. 3).

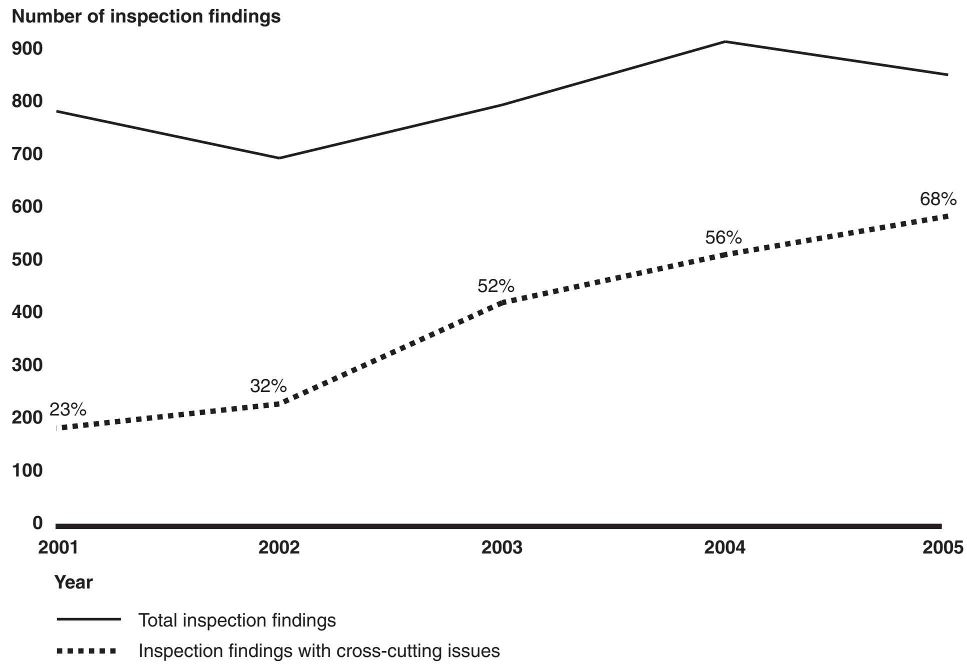
Figure 3: Number of Inspection Findings at All Plants, 2001 Through 2005



Source: GAO analysis of NRC data.

Only in the area of inspection findings for which one or more cross-cutting aspect was associated, is an increasing trend evident (see fig. 4). According to NRC, the increase in findings with cross-cutting aspects is due, in part, to the recent development of additional guidance for inspectors on the identification and documentation of cross-cutting aspects. The number of plants where the existence of cross-cutting aspects resulted in NRC's opening a substantive cross-cutting issue is shown in figure 5. (See app. III for additional data on plant-specific, substantive cross-cutting issues.)

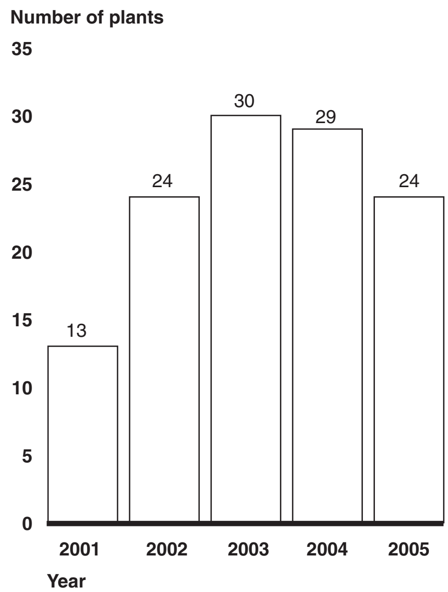
Figure 4: Number of Inspection Findings and Inspection Findings with Cross-Cutting Aspects at All Plants, 2001 Through 2005



Source: GAO analysis of NRC data.

Note: Almost all inspection findings with cross-cutting aspects were in the areas of human performance and problem identification and resolution; only 5 out of 1,890 inspection findings were assigned to the safety-conscious work environment cross-cutting area.

Figure 5: Number of Plants with Substantive Cross-Cutting Issues, 2001 Through 2005



Source: GAO analysis of NRC data.

Note: The totals include those plants that had one or more substantive cross-cutting issue open during at least some portion of the year. If a plant had more than one substantive cross-cutting issue open, only one was counted.

In the performance indicator program, almost all of the indicator data were reported to be within the acceptable levels of performance (green). Only 156, or less than 1 percent of over 30,000 indicator reports from 2001 to 2005, did not meet the acceptable performance threshold. (See app. III for additional plant-specific performance indicator data.) Four of the 15 performance indicators have always been reported within acceptable performance levels. These 4 indicators include 1 that measures the amount of time that the residual heat removal safety system is unavailable, 1 that monitors the integrity of a radiation barrier, 1 that measures the participation of emergency response organizations in emergency drills or exercises, and 1 that monitors radiological releases. In addition, 46 plants have never had a performance indicator fall outside of the acceptable performance level, and no yellow or red indicators were reported during the period.

On the basis of the greater-than-green inspection findings and performance indicators, NRC has subjected more than three quarters (79) of the 103 operating plants to at least some level of increased oversight for varying periods. (See app. III for additional plant-specific oversight level data.)[11] Most of these plants received the lowest level of increased oversight, consisting of the least intensive supplemental inspection, due to the identification of one or two white inspection findings or performance indicators. In most of these instances, the licensees did not accumulate additional greater-than-green findings, so oversight did not have to be increased to higher levels on the action matrix. For example, at one plant, NRC issued a white finding after a degraded valve resulted in the failure of a drain line from a moisture separator. After allowing time for the licensee to analyze the root cause, NRC completed a supplemental inspection to assess the licensee's evaluation and concluded that the licensee's actions were adequate. As a result, NRC did not require any further actions of the licensee, and NRC inspectors did not conduct further inspections beyond the baseline procedures. In some cases, however, either the licensee was not able to sufficiently correct the performance problem, thus triggering increased oversight, or additional greater-than-green inspection findings or performance indicators were identified, also triggering increased oversight. For example, a white finding was issued at one plant because the licensee's fire response procedures were not effective in ensuring a safe shutdown of the reactor during a postulated severe fire. Because this finding was issued during the same time that one of the plant's performance indicators was white, the plant was moved from the second to the third highest level of oversight and NRC conducted a second-level, more-intensive supplemental inspection. In this case, NRC determined that the licensee's corrective actions were sufficient to resolve the deficiencies related to both the inspection finding and performance indicator and thus reduced its oversight back to baseline inspections only.

While more than three quarters of nuclear power plants received some level of increased oversight from 2001 through 2005, only 5 plants were placed into NRC's highest oversight category on the action matrix that still allows continued operations, and no plants were placed into NRC's

[11]During this period, NRC also requested and received approval to deviate from its oversight process at 6 plants, with 1 of the plants subjected to increased oversight from a deviation on two separate occasions. At 4 of the plants, the deviation resulted in increased oversight, while at 2 plants it resulted in decreased oversight.

unacceptable performance category.[12] Plants subject to the highest level of NRC oversight generally remain in this category for longer periods of time than the other performance categories on the action matrix. It usually takes NRC longer to conduct the more intensive supplemental inspections and the licensees longer to implement the actions that NRC expects to correct the broader and more systemic performance issues that led to their placement in the highest oversight category. For example, one plant was subject to NRC's highest oversight level for approximately 2 years because of several greater-than-green inspection findings and performance indicators, including a red inspection finding for the failure of a steam generator tube. In this case, NRC conducted its most intensive supplemental inspection 2 months after the final significance of the red inspection finding was determined. NRC inspectors found a number of underlying problems with the licensee's programs for design control, human and equipment performance, problem identification and resolution, and emergency preparedness. The licensee prepared a plan to address its performance deficiencies, as is required for all plants placed into this oversight category, and determined that a multiyear effort was necessary to adequately develop and implement all corrective actions. Once the corrective actions were in place, NRC inspectors conducted follow-up inspections to examine the adequacy of the licensee's efforts in implementing its corrective actions. NRC inspectors at the plants we reviewed explained that plants subjected to the highest oversight levels typically have underlying problems that can take longer periods to resolve. It is important for them to ensure that the corrective actions taken by the licensee are effective before oversight is reduced. Therefore, inspectors try to allow a sufficient amount of time to pass after the licensee has taken a corrective action, to be able to examine not only the corrective action itself but also whether it is working as intended, which requires it to have been in place for awhile.

NRC inspectors at the plants we reviewed also said that a decline in plant performance is often the result of ineffective licensee corrective action programs, problems related to human performance, or complacent management, which often results in deficiencies in one or more of the

[12]While it was not placed into NRC's unacceptable performance category on the action matrix, the Davis-Besse plant was subjected to a special oversight process due to its significant performance problems related to the reactor-vessel head degradation that occurred in 2002. On the basis of this event, NRC placed the plant, which was already in a shutdown condition, into an oversight process outside of the ROP and conducted by a special oversight panel consisting of region and headquarters NRC officials.

cross-cutting areas. In assessing the results of the ROP data, we found an association between plants that had been subjected to increased levels of oversight and the presence of substantive cross-cutting issues. For instance, all plants subjected to NRC's highest level of oversight also had a human performance and/or problem identification and resolution substantive cross-cutting issue open either prior to or during the time that they were subjected to increased oversight.

NRC Is Addressing Weaknesses in Various Areas of Its Oversight Process, but More Effort Is Needed

NRC has taken a proactive approach to constantly improving its oversight process over its first 6 years of implementation, but additional improvements are needed. NRC has several mechanisms in place to incorporate feedback from both external and internal stakeholders, and it is currently working on improving several areas of its oversight process by, for example, better focusing inspections on areas most important to safety, improving the timeliness and quality of determining the risk significance of its inspection findings, and modifying some of the performance indicators to improve their quality. NRC is also assessing whether it needs to modify its oversight, including developing additional inspection procedures, as a result of some problems that have surfaced in areas not fully inspected by NRC, such as the recent discovery of groundwater contamination from radioactive releases at a number of sites. In addition, NRC is working to address what we believe has been a significant shortcoming by making changes to its oversight process to improve its ability to better identify and address early indications of deteriorating safety at plants before performance problems develop. Some of its changes have been controversial, however, and NRC officials acknowledge the need to carefully assess the effectiveness of the changes.

NRC Is Taking Action to Improve Various Areas of Its Oversight Process

According to NRC, the ROP was implemented with the understanding that it would be an evolving process and improvements would be made as lessons were learned. Each year NRC conducts a self-assessment of its oversight process to compile feedback from various internal and external sources and to outline the changes it intends to make. As a part of its self-assessment, NRC developed numerous performance metrics for its various oversight components, including its inspections and performance indicator program, to provide quantitative insights into the timeliness, efficiency, and overall effectiveness of the ROP. The metrics are based on program data, such as the number and color of inspection findings, and feedback received from external and internal stakeholders. Each fall, NRC solicits feedback from external stakeholders through a survey published in the *Federal Register*. In 2005, NRC received 21 responses from the industry, industry organizations, public interest groups, state or local agencies, and members of the public. NRC also biannually surveys NRC management, program staff, and regional and site inspectors on the effectiveness of the ROP. In the most recent survey, which was conducted in 2004, NRC received responses from about 50 percent of the surveyed staff. In addition, NRC has a formal feedback mechanism whereby NRC staff can submit recommendations for improving various oversight components, and NRC staff meet with industry officials on a monthly basis—in addition to holding various meetings, workshops, and conferences—to discuss the ROP. Through NRC's self-assessment process, its staff also incorporates direction provided by the NRC commissioners and recommendations from independent evaluations, such as from the ACRS, GAO, and the NRC Office of the Inspector General.

According to NRC program officials, the changes made to the ROP since its inception in 2000—including those made in response to the Davis-Besse incident—have generally refined the existing oversight process, rather than significantly changing it. In the case of Davis-Besse, NRC formed a task force to review the agency's regulatory processes. The task force's report, issued in September 2002, contained more than 50 recommendations, many associated with its oversight process. Among the more significant ROP-related recommendations were those to (1) enhance the performance indicator that monitors unidentified leakage; (2) develop specific guidance to inspect licensee boric acid control programs and vessel head penetration nozzles; (3) modify the inspection program, including modifying an inspection procedure to better follow up on long-standing plant performance issues; and (4) enhance the guidance for managing plants that are shut down as a result of significant performance problems. NRC program officials told us that the task force's most significant recommendations were in areas outside of the ROP, such as improving the agency's operating experience program. According to NRC, it has implemented almost all of the task force's recommendations.

Other modifications NRC has recently made or is in the process of making include the following:

- NRC recently revised 7 of its baseline inspection procedures to better focus the level and scope of its inspection efforts on those areas most important to safety. These revisions resulted from a detailed analysis in 2005 of its more than 30 baseline inspection procedures. For example, NRC staff analyzed the number of findings resulting from each of its inspection procedures to better understand the areas where performance deficiencies were occurring, and compared the time that inspectors were spending directly observing plant activities as opposed to reviewing licensee paperwork to achieve a balance between the two. For this effort, NRC held constant the level of resources devoted to its baseline inspection effort and did not assess whether more or fewer inspection resources overall should be applied. NRC is now formalizing this analysis and making it a regular part of its yearly assessment so that it can continually refine its inspections to direct resources to the most critical performance areas.

- NRC has efforts under way to improve its SDP. An audit by the NRC Office of the Inspector General, a review by a special task group formed by NRC, and feedback from other stakeholders such as NEI and UCS have pointed to several significant weaknesses with the SDP. Also, other internal and external stakeholders, including NRC inspectors and plant managers, have raised concerns about the amount of time, level of effort, and knowledge and resources required to determine the risk significance of some inspection findings. Industry officials commented that because most inspection findings are green, one white finding at a plant can place it in the "bottom quartile" of plants from a performance perspective. Therefore, industry officials explained, licensees try to avoid this placement and will expend a great deal of effort and resources to provide additional data to NRC to ensure that the risk level issued for the finding is appropriate. This can add significant time to the process because licensees may use their own technical tools, including models, data, and assumptions, to analyze the issue. NRC then considers this information in its own analysis. At the plants we reviewed, the time it took NRC to determine the final significance of risk-significant inspection findings ranged from 24 days to over 200 days. The delay in assigning a color to a finding while the new information is being considered could affect a plant's placement on NRC's action matrix, essentially delaying the increased oversight called for if the finding is determined to be greater-than-green. NRC program officials said that even though there may be a delay in determining the final risk significance of the finding, the licensee takes immediate action to fix the identified problem. However, supplemental inspections are designed to uncover additional associated problems, if they exist, and delaying these inspections could delay NRC's ability to discover additional performance problems, potentially allowing performance to worsen.

NRC developed a plan in 2002 to improve the timeliness of its decision-making process, enhance the quality of its various SDP tools, and track its progress in implementing key changes. For example, NRC introduced a new process aimed at improving timeliness by engaging decision makers earlier to more quickly identify the scope of the evaluation to be used to determine the inspection finding's risk significance, the resources needed, and the schedule to complete the evaluation.

As a part of the SDP, NRC uses probabilistic risk assessment (PRA) methods, which overall has improved its ability to assess the performance and safety of nuclear power plants. PRA is an analytical tool for estimating the probability that a potential accident might occur by examining how physical structures, systems, and components, along with employees, work together to ensure plant safety. Using PRA tools, NRC and the plant licensees can estimate the likelihood that different accident scenarios at plants will result in reactor core damage and a release of radioactive materials. NRC often uses PRA tools to help it determine the risk significance of its inspection findings. However, we and others have found weaknesses with NRC's use of PRA.[13] For instance, in our May 2004 report on the Davis-Besse reactor vessel head incident, we found that NRC used some incomplete and faulty PRA analyses in deciding whether to allow the licensee to delay shutdown of the reactor for inspection.[14] While NRC program officials acknowledge they can improve their current PRA tools, they said the tools are adequate for factoring risk into the oversight process and do achieve their intended purpose. NRC has several initiatives under way to improve its use of PRA in its decision making, many of which it plans to complete by June 2007. For example, NRC recently revised its models to assess events that occur at plants during at-power situations to better capture individual plant characteristics, and it is in the process of developing new models to assess events that occur at plants during low-power or shutdown conditions. NRC is also developing guidance to address broader PRA issues, including establishing overall quality requirements for risk information; providing specific instructions for

[13]Currently, the NRC Office of the Inspector General is also completing a review, through a contract with technical experts, to assess NRC's use of PRA in its regulation of licensees given the current state of the art in the technology.

[14]GAO, *Nuclear Regulation: NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown*, GAO-04-415 (Washington, D.C.: May 17, 2004).

documenting the decision process and conclusions; and developing improved methods for calculating risk, such as its practices for implementing human reliability analysis.

- NRC is working with the nuclear power industry to improve several of its performance indicators, including making the definitions of some indicators more concise to improve their quality and to reduce the number of discrepancies between licensees and NRC inspectors. Because NRC inspectors verify indicator data only once a year, a potential disagreement with a licensee over these data might not surface for up to 1 year after it is reported, and it may take even longer to resolve the disagreement. Similar to delays with the SDP, a delay in assigning a color while the disagreement is being resolved could affect a plant's placement on NRC's action matrix, and delay the increased oversight called for if the indicator is determined to be greater-than-green. To date, NRC's efforts to improve the performance indicator program have largely centered on developing a key indicator to address known problems with the indicators that measure the unavailability of safety systems. NRC has been working jointly with the nuclear industry since 2001 to develop the indicator, which is now risk-informed and intended to provide a more accurate indication of the risks associated with changes in the availability and unreliability of important safety systems. This indicator, referred to as the mitigating systems performance index, was implemented in April 2006, and the first plant reports were submitted in July 2006. NRC is also in the process of changing the definition for several other indicators, in addition to considering the feasibility of new indicators.

  In addition, NRC program officials said they are taking a broad look at the performance indicator program to assess how they might increase its overall value to the ROP. The effort is intended, in part, to address concerns that performance indicators have not contributed to the early identification of poorly performing plants to the degree originally envisioned, since all of the indicators are almost always within acceptable performance levels (green). When the program was developed, thresholds were set using industry performance data such that about 5 percent of the plants were expected to exceed the green-white threshold—that is, be designated either white, yellow, or red—for each of the performance indicators. However, from 2000 through 2005, less than 1 percent exceeded it. Furthermore, there have been several cases where plants reported an acceptable performance indicator and performance problems in the area were subsequently identified. For example, NRC inspectors at one plant noted that while performance indicator data related to its alert and notification system for emergency preparedness had always been reported green, the system did not always function properly. On the other hand, industry officials believe that the high percentage of green indicators is indicative of plants' good performance. Several plant managers told us that they closely monitor and manage to the acceptable performance thresholds established for each indicator, and that they will often take action to address performance issues well before the indicator crosses the acceptable threshold. To assess issues within the performance indicator program, NRC developed a standing working group, with representatives from both the industry and NRC, that meets on a monthly basis. This group, along with senior NRC and industry management, plans to explore overall program improvements to better identify declining plant performance.

In addition to the previously mentioned efforts, NRC is assessing whether it needs to modify its oversight, including developing additional inspection procedures, as a result of some problems that have surfaced in areas not fully inspected by NRC. For example, NRC has reported that there have been inadvertent, unmonitored releases of radioactive liquids containing tritium at a number of nuclear power sites in the past few years.[15] To date, NRC reports show that the measured levels of tritium discovered were low enough that they do not appear to pose a public health hazard. According to NRC, the releases were due to equipment failures or structural degradation at the plants. At one of the plants we reviewed, for example, elevated levels of tritium in the on-site groundwater were discovered during the licensee's testing of its monitoring wells. NRC reports suggest that this radioactive release was most likely due to leakage from the spent fuel pool's support structures. Shortly after the licensee reported the contamination, NRC initiated a special inspection to further investigate the source and cause of the leakage and the licensee's actions for mitigation. On the basis of this and other discoveries of contaminated groundwater, in March 2006, NRC formed a lessons-learned task force to evaluate NRC's regulatory processes related to the radioactive releases and to recommend areas for improvement. For example, NRC is reviewing related regulations

[15]Tritium is a mildly radioactive type of hydrogen that occurs both naturally and during the operation of nuclear power plants. Water containing tritium and other radioactive substances is normally released from nuclear plants under controlled, monitored conditions that NRC mandates to protect public health and safety.

and guidance, inspection program requirements, and its communications with external stakeholders and the public. In addition, the nuclear industry recently undertook an initiative to improve its groundwater protection, and intends to develop site-specific action plans at all plants and improve the industry's data collection, reporting, and protocols for sharing lessons learned.

NRC is also taking action to improve its requirements for licensees to control and account for their spent nuclear fuel, that is, the used fuel periodically removed from reactors in nuclear power plants. NRC requires licensees to control and account for all of their spent fuel materials because of the hazardous nature of spent nuclear fuel.[16] However, reviews by both GAO and the NRC Office of the Inspector General found weaknesses with NRC's oversight of licensees' spent fuel control and tracking programs.[17] Between 2000 and 2004, several plants experienced instances of missing or unaccounted-for spent fuel, and NRC reported weaknesses in the material control and accounting programs at various other plants. In investigating these issues, we and the NRC Office of the Inspector General determined that NRC's inspections did not adequately ensure that all licensees properly controlled and accounted for their spent nuclear fuel. From the late-1980s through implementation of the ROP, NRC did not conduct routine material control and accounting inspections; instead it looked at these activities indirectly through other inspections, such as those of licensee operations during refueling of the reactor. We also found that while NRC requires plants to maintain an accurate record of all their spent fuel and its location, NRC regulations did not specify how licensees are to conduct physical inventories or how they are to control and account for loose spent fuel rods and fragments. NRC is currently in the process of revising several of its guidance documents and developing inspection procedures to better assess the effectiveness of licensee material control and accounting programs. NRC reports that most of these efforts will be completed by the end of 2007.

[16]While spent nuclear fuel is too inefficient to power a nuclear reaction, it is still intensely radioactive and continues to generate heat for thousands of years. Thus, the potential health and safety implications make the control of spent nuclear fuel of great importance.

[17]GAO, *Nuclear Regulatory Commission: NRC Needs to Do More to Ensure that Power Plants Are Effectively Controlling Spent Nuclear Fuel*, GAO-05-339 (Washington, D.C.: Apr. 8, 2005); and NRC, Office of the Inspector General, *US Nuclear Regulatory Commission: Audit of NRC's Regulatory Oversight of Special Nuclear Materials*, OIG-03-A-15 (May 23, 2003).

NRC Is Taking Its First Major Step to Address a Significant ROP Weakness in the Area of Safety Culture

One significant shortcoming in the ROP that we and others have found is that it has not been as effective as it could be in identifying and addressing early indications of deteriorating safety performance at nuclear power plants before problems develop. NRC and others have long recognized that a safety culture—the organizational characteristics that ensure that issues affecting nuclear plant safety receive the attention their significance warrants—can have a significant impact on a plant's safety performance. The identification of a weak safety culture—or weaknesses in the attributes that make up a safety culture, such as attention to detail, adherence to procedures, and effective corrective and preventative actions—can point to early signs of deteriorating safety performance before conditions become so serious that a safety accident occurs. As early as 1989, NRC recognized the importance of developing a safety culture at each nuclear power plant that ensures safe plant operations, but NRC's policy stated that it was the licensee's duty and obligation to monitor and maintain a strong safety culture.

Despite the recognition of the importance of a safety culture and several external groups' recommendations to better incorporate safety culture aspects into NRC's oversight process, NRC did not include specific measures to comprehensively assess plant safety culture when it implemented the ROP in 2000. As its new oversight process was being developed, external stakeholders, including the ACRS, concluded that additional oversight measures were needed to characterize licensees' human performance and safety culture. The 2002 Davis-Besse reactor vessel head incident highlighted that this was a significant weakness in the ROP. Our May 2004 report concluded that the event occurred, in part, because NRC did not have an effective means to identify and address early indications of deteriorating safety at plants before performance problems develop.

NRC did not take immediate action, however, contending that direct safety culture evaluations would cross the line from a regulatory function to a licensee management function. In August 2004, the NRC Commission directed the staff to improve the ROP by more fully addressing safety culture. In response, NRC staff formed a safety culture working group in early 2005 to lead the agency's efforts to make changes to the ROP to better incorporate safety culture into its oversight process. As a part of this initiative, the working group obtained the input of external stakeholders through a series of public meetings held in late 2005 and early 2006. The group also incorporated lessons learned from events that occurred at the Salem and Hope Creek site during this same period. In 2004, NRC confirmed there were problems with aspects of the site's safety culture. In addressing the problem, NRC concluded that the ROP did not provide adequate tools to monitor the situation or the sufficiency of the licensee's corrective actions. As a result, NRC deviated from the ROP to increase its oversight at the site, which included conducting special inspections and forming a team with expertise in the area to review the licensee's corrective actions. (See app. I for additional information on the events at Salem and Hope Creek.)

In February 2006, NRC issued proposed changes to some of its inspection procedures and guidance documents to incorporate safety culture into the ROP, and implemented the changes in July 2006. NRC used the following two overall approaches: first, it developed additional guidance for identifying and addressing cross-cutting aspects, and, second, it developed a structured way to determine the need to evaluate plants' safety culture. Several inspection procedures were also modified to direct inspectors to be sensitive to and take into consideration safety culture components when planning and conducting their inspections. Although the three cross-cutting aspects (problem identification and resolution, human performance, and a safety conscious work environment) did not change, NRC developed new definitions for them to more fully encompass safety culture aspects. Also, NRC developed additional guidance on the treatment of cross-cutting aspects once they have been identified. For example, the problem identification and resolution cross-cutting area now has several components—a corrective action program, operating experience, and self and independent assessments. The human performance cross-cutting area is composed of decision making, resources, work control, and work practices. NRC inspectors are required to assess every inspection finding to determine if it is associated with one or more of the components that make up each of the cross-cutting areas. While the process for assessing inspection findings for the existence of cross-cutting aspects and substantive cross-cutting issues remains largely unchanged, now the definitions for the cross-cutting areas are more detailed and track more closely with those elements that comprise safety culture.[18] In addition, under NRC's new guidance, if the same substantive cross-cutting issue is

[18]NRC also defined four additional components—accountability, continuous learning environment, organizational change management, and safety policies—that are not associated with the cross-cutting issues, but when combined with them, comprise all components that make up safety culture. While these additional components are not considered in relation to baseline inspection findings, they would be considered during the conduct of supplemental inspections.

identified in three consecutive assessment periods, NRC may request that the licensee evaluate its safety culture. The intent is to provide an opportunity to diagnose a potentially declining safety culture before significant safety performance problems occur. NRC program officials said they consider the identification and treatment of substantive cross-cutting issues the most proactive element of the ROP, because all other oversight actions are taken only when more significant performance problems have been identified.

NRC's changes to the ROP now also include a structured way for NRC to determine the need for a safety culture evaluation. NRC's new guidance calls for the licensees of plants with more than one white finding in the same cornerstone or one yellow finding to evaluate whether the performance issues were caused by any safety culture components, and NRC may request the licensee to independently evaluate its safety culture, if the licensee does not identify a safety culture component. Any safety culture deficiencies are expected to be entered into the licensee's corrective action program. Regional officials would discuss the licensee's proposed corrective actions with the licensee, and NRC may hold a public meeting to discuss the issues. For plants where more significant or multiple findings have been identified, NRC will not only independently assess the adequacy of the licensee's independent evaluation of safety culture, but may also conduct its own evaluation. Following the completion of any evaluations, regional and headquarters officials together determine whether additional agency actions are warranted, and, at a minimum, the licensee will be required to document its plan to make improvements and a public meeting will be held to discuss the licensee's performance. According to an NRC official familiar with the Salem and Hope Creek situation, had these requirements been in place at the time, they would have been adequate to address the concerns at Salem and Hope Creek without the need to deviate from the ROP.

NRC's approach to incorporating safety culture into the ROP has been controversial, and some stakeholders disagree with certain changes. For example, some in the nuclear power industry have expressed concern that the changes could introduce undue subjectivity to NRC's oversight, given the difficulty in measuring these often intangible and complex concepts. Several of the nuclear power plant managers at the sites we reviewed said that it is not always clear why a cross-cutting aspect is associated with a finding, or what it will take to clear themselves once they have been identified as having a substantive cross-cutting issue. Some industry officials worry that the changes will further increase the number of findings that have cross-cutting aspects associated with them, and, if all of the findings have these aspects, whether the process will lose its value. Industry officials also warn that if the changes are not implemented carefully, resources could be diverted away from other important safety issues. Other external stakeholders, such as an official from UCS, on the other hand, suggest that this effort is an important step toward improving NRC's ability to identify performance issues at plants before they result in safety problems. Importantly, there are now additional tools in place for NRC to use when it identifies potential safety culture concerns. In reviewing NRC's proposed approach in April 2006, the ACRS concluded that the approach was appropriate and will enhance the agency's ability to address safety culture issues; although after gaining some experience with the process, it stated that NRC should reassess the adequacy of some procedures.

NRC program officials acknowledged that they will need to assess the changes they made to the ROP to determine if they better allow inspectors to detect deteriorating safety conditions at plants before significant safety events occur. Some at NRC view these changes as the beginning step toward an incremental approach. For its current efforts, NRC also acknowledged that additional training for its inspectors on safety culture is needed. NRC provided computer-based and regional training to its inspectors as the changes were being finalized, and it is currently working to incorporate aspects of its safety culture changes into its more permanent training programs. NRC plans to evaluate stakeholder feedback—both through its normal processes, such as its monthly meetings, and potentially through specific industry-sponsored workshops dedicated to the issue—and make additional changes on the basis of the lessons learned as part of its annual self-assessment process for 2007.

Conclusions

NRC is devoting considerable effort to overseeing the safe operation of the nation's commercial nuclear power plants, and its process for doing so appears logical and well-structured. NRC's oversight process is finding safety problems and is getting the industry to constantly improve. However, weaknesses with its inspection and performance indicator programs have been identified—in particular, the timeliness of the process used to determine the risk significance of inspection findings, and the ability of performance indicators to contribute to the early identification of poorly performing plants. Importantly, NRC is demonstrating that it is aware of these weaknesses and is actively making changes to improve its oversight. NRC's proactive approach is demonstrated by the important progress it is making in several key areas, including making efforts to improve the timeliness and quality of its significance determination process, redefining some of its performance indicators, and assessing the need for additional inspection procedures based on careful analysis. Its efforts to continuously consider the need to improve and obtain feedback from both internal and external stakeholders are critical as nuclear power plants age and the nation considers building new plants. In this regard, it is also important that the ROP continue to be a very open process in which NRC provides the public and its other stakeholders with considerable information on its oversight activities and findings related to plant safety performance.

Although NRC has been working to improve its oversight in several key areas, its efforts to incorporate safety culture into the ROP may be its most critical future change. More than 4 years have passed since Davis-Besse highlighted that a significant weakness in NRC's oversight was its inability to identify deteriorating safety conditions at plants before they resulted in performance problems. NRC has been reluctant to regulate in the area of safety culture because it did not want to be directly involved in managing the licensees' plants. However, NRC is now taking concrete actions to begin incorporating safety culture into the ROP, although it acknowledges that regulating the often complex and intangible aspects of safety culture is challenging, and that its recent changes are simply a first step. As a result, it will be important to closely monitor this effort to ensure that it is achieving the goal of objectively assessing safety culture, while providing an early indication of declining safety performance. An additional challenge for NRC will be how to provide information to the public and other stakeholders on this important but complex area of plant performance. Given that it may take some time for NRC to develop performance metrics for safety culture, data on substantive cross-cutting issues, which provide insight into aspects of plants' safety culture, could be useful to the public and other stakeholders as they look for assurances that plants are operated safely. Summary-level information on plants with substantive cross-cutting issues is not currently available to the public through NRC's Web site.

Recommendations for Executive Action

Given its importance to improving NRC's ability to identify declining safety performance at nuclear power plants before significant safety problems develop, we recommend that the NRC commissioners take the following two actions:

- Aggressively monitor; evaluate; and, if needed, implement additional methods or processes to increase the effectiveness of its efforts under the ROP to assess safety culture at plants.

- In addition to periodically evaluating the effectiveness of its safety culture efforts, NRC may also be able, through its performance indicator program, to develop specific indicators to measure important aspects of plants' safety culture. Trends in these performance indicators could be useful feedback to NRC on its safety culture activities. The indicators could also provide useful information to the public and other NRC stakeholders on the safety culture at plants.

In addition, in the absence of performance indicators or other performance metrics for plants' safety culture, we recommend that the NRC commissioners make publicly available, through the ROP Web site, consolidated and comprehensive data on the plants that have substantive cross-cutting issues open. These data would provide a more comprehensive picture of plant performance and provide insights into aspects of the plants' safety culture that otherwise are not readily available on the Web site.

Agency Comments

We provided a draft of this report to NRC for its review and comment. In a letter from NRC's Executive Director for Operations, NRC generally agreed with the report's findings, conclusions, and recommendations (see app. IV). NRC also commented that the report is comprehensive, fair, and balanced. In addition, NRC provided minor, technical comments, which we have incorporated into the report, as appropriate.

We are also sending copies of this report to interested congressional committees, the Chairman of NRC, and other interested parties. We also will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or wellsj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.

Jim Wells
Director, Natural Resources and Environment

List of Requesters

The Honorable James M. Inhofe
Chairman
Committee on Environment and Public Works
United States Senate

The Honorable George V. Voinovich
Chairman
Subcommittee on Clean Air, Climate Change,
and Nuclear Safety
Committee on Environment and Public Works
United States Senate

The Honorable Ed Whitfield
Chairman
Subcommittee on Oversight and Investigations
Committee on Energy and Commerce
House of Representatives

The Honorable Joseph R. Biden, Jr.
United States Senate

The Honorable Tom Carper
United States Senate

The Honorable Michael N. Castle
House of Representatives

The Honorable Edward J. Markey
House of Representatives

Key Safety-Related Events at the Salem and Hope Creek Nuclear Power Plants from 2000 to 2006

This appendix summarizes key safety-related events at the Salem and Hope Creek nuclear power plants and the Nuclear Regulatory Commission's (NRC) and licensee's actions to follow up on and correct them. This information is presented to enhance the public's understanding of the events and timing of NRC's actions. We did not conduct an independent audit or assessment of the events, other than to help illustrate how NRC is using its oversight process to ensure plant safety.

The Salem and Hope Creek plants are located at one site in Hancocks Bridge, New Jersey, 18 miles southeast of Wilmington, Delaware, on the Delaware River. The two Salem plants (Salem 1 and Salem 2) consist of two pressurized water reactors, and the Hope Creek plant is a boiling water reactor. The three plants produce a combined 3,237 megawatts of electricity. Salem 1 began operating in the late-1970s and Salem 2 and Hope Creek began operating in the 1980s. PSEG Nuclear LLC is licensed to operate all three plants, with their current licenses expiring roughly 40 years after the start of their operations. In January 2005, PSEG entered into a nuclear operating services contract with Exelon, the first step of a planned merger between the two companies. Under the terms of this contract, Exelon manages operations at Salem and Hope Creek.

From 2000 through 2006, there were several safety-related events at the site that affected the plants' performance. As a result, NRC increased its oversight to include supplemental and special inspections, and required the licensee to take specific actions to address its performance issues. NRC also deviated from its normal oversight process from August 2004 through 2006 to increase its oversight and address problems with the licensee's ability to provide an adequate safety-conscious work environment (SCWE). A SCWE is defined by NRC as an environment in which employees feel free to raise safety concerns, both to their management and to NRC, without fear of retaliation. During this period, NRC and the licensee held several public meetings to discuss performance issues related to the site's safety work environment, or the SCWE, and the actions the licensee was taking to improve it.

The following summary provides details on the key safety-related events at Salem and Hope Creek, along with NRC's and the licensee's responses to the events, from the initial implementation of NRC's reactor oversight process in April 2000 to June 2006.

Summary of Key Safety-Related Events at Salem and Hope Creek, April 2000 to June 2006

White Performance Indicator for Unplanned Scrams

During the fourth quarter of 2000, Salem 1 reported a white color for the unplanned scrams performance indicator, an indicator that monitors the number of unplanned scrams—reactor shutdowns—that occurred during the previous four quarters. During 2000, Salem 1 had four scrams, which is one more than the acceptable performance level. NRC conducted a supplemental inspection in March 2001 to follow up on why such a high number of scrams occurred and on the corrective actions the licensee was taking to address the problem. In conducting its inspection, NRC determined that the licensee had performed a comprehensive common cause analysis of the associated performance deficiencies, which identified human performance, equipment failure, and procedure and preventive maintenance program issues as root causes of the performance problems. The licensee documented these issues in its corrective action program and developed a plan to outline the actions it would take to address them. NRC concluded this effort was sufficient and did not require the licensee to take any additional corrective actions beyond what it had outlined in its plan.

White Performance Indicator for Unplanned Changes in Reactor Power

During the first quarter of 2002, Salem 1 reported a white color for the performance indicator that monitors unplanned changes in reactor power that could have challenged safety functions during the previous four quarters. Salem reported a total of seven power changes, which exceeded the acceptable performance threshold by one. NRC conducted a supplemental inspection in October 2002 and concluded that the licensee's implementation of several programs to address the underlying causes of the unplanned power changes, such as the replacement of certain pieces of equipment, sufficiently addressed the performance problem. NRC did not require the licensee to take any additional corrective actions.

Substantive Cross-Cutting Issue in Problem Identification and Resolution

In March 2003, NRC opened a substantive cross-cutting issue in the problem identification and resolution area at all three plants on the basis of the identification of a number of green inspection findings that documented ineffective problem evaluations and untimely, ineffective corrective actions by plant employees, including recurring equipment failures. Upon opening this substantive cross-cutting issue, NRC stated that it would closely monitor the licensee's performance in this area. This substantive cross-cutting issue remained open until March 2006, when NRC concluded that the licensee's efforts to improve its ability to identify and resolve performance problems were sufficient.

White Inspection Finding for Failure of a Part on an Emergency Diesel Generator

In May 2003, NRC determined that the failure of a part on an emergency diesel generator at the Salem 1 plant that occurred in September 2002 would result in a white inspection finding. NRC conducted a supplemental inspection in October 2003 and concluded that although the licensee had adequately fixed the emergency diesel generator, it would need to take additional action to address broader performance problems. Specifically, NRC had concerns with the licensee's ability to ensure that the controls and procedural requirements determined to be necessary on the basis of evaluations of equipment failures, were reliably tracked and implemented. The licensee implemented procedural changes to more effectively track its corrective actions to prevent recurrence. NRC conducted a second, follow-up supplemental inspection in September 2004 and, on the basis of this inspection, concluded that the licensee's corrective actions were sufficient.

White Inspection Finding for the Failure of a Rotating Screen That Is Part of the Station Service Water System at Hope Creek

In May 2004, NRC determined that the failure in July 2003 of a rotating screen that is part of the station service water system at Hope Creek would result in a white inspection finding. NRC determined that the failure resulted from the licensee's inadequate maintenance procedures and its failure to adhere to procedural instructions. In September 2004, NRC conducted a supplemental inspection to follow up on the corrective actions that licensee had taken. It determined that the licensee's corrective actions, which included revising relevant maintenance procedures, were sufficient and did not require additional actions from the licensee.

White Inspection Finding for the Failure of a Drain Line in the Moisture Separator System at Hope Creek

In February 2005, NRC determined that the licensee's failure to properly evaluate and correct a degraded valve, which resulted in the failure of a drain system at Hope Creek in October 2004, would result in a white inspection finding. NRC conducted a supplemental inspection in June 2005 to follow up on the licensee's corrective actions, which included the development of new guidance; revisions to relevant plant operating procedures; inspections of pipe hangers, one of which was determined to be the initiator of the degraded valve; and the development of a new procedure for additional monitoring of degraded equipment. NRC determined that these actions were sufficient and did not require additional actions from the licensee.

Increased Oversight to Address Safety-Conscious Work Environment Problems

In late 2003, NRC initiated a special review of the site's SCWE on the basis of allegations concerning its SCWE, plant events and inspection findings that indicated problems with its SCWE, insights from NRC interactions with the licensee, observations made by NRC inspectors, and the presence of a substantive cross-cutting issue in problem identification and resolution. NRC's special review consisted of (1) in-depth interviews by NRC experts of more than 60 current and former plant employees, (2) an analysis of the site's inspection and assessment record over the previous several years, and (3) information from plant employees' allegations related to the SCWE. NRC provided the interim results of its review to the licensee in January 2004. Although NRC did not identify any serious safety violations, the information led to concerns about the site's SCWE, particularly as it related to the handling of emergent equipment issues and associated operational decision making. The review accumulated information about a number of events that, to varying degrees, called into question the openness of management to concerns and alternative views, strength of communications, and effectiveness of the licensee's corrective action and feedback processes. There were several differences of opinion among operators and senior managers on plant operating decisions, particularly as they might impact continuing plant operation and outage schedules. On the basis of these interim results, NRC requested that the licensee conduct an in-depth assessment of its SCWE.

NRC issued the final results of its special review in July 2004, confirming many of the concerns it identified through its interim review. In its final results, NRC concluded that there were weaknesses in the licensee's leadership and management approaches, leading to a perception among some staff and mangers that the company emphasized production over safety. NRC also determined that licensee management was not consistent in its support of staff identifying concerns and providing alternate views, and cited examples of unresolved conflicts and poor communication between management and staff.

In May 2004, the licensee submitted an independent assessment of its SCWE. The assessment included interviews of employees, and reviews of the licensee's inspection record and employee concerns program, among other things. Among the findings of the assessment were that (1) some plant employees were hesitant to raise issues; (2) management was not receptive to or effective at addressing some employee concerns, such as those surrounding long-standing equipment problems; (3) a significant number of employees did not view the employee concerns program as a viable means to raise concerns; and (4) management was not effective at understanding or addressing the potential for a "chilling" effect—that is, an environment that discourages workers from raising safety concerns—in response to highly visible employee concerns and actions associated with operational events.

As a result of the assessment, the licensee submitted to NRC in June 2004 an action plan to improve its overall safety work environment. The plan addressed the licensee's corrective action program, work management program, and safety-conscious work environment. For example, to improve the licensee's corrective action program, the plan identified actions to improve monitoring, such as developing and implementing an integrated corrective action training program and developing performance indicators. The plan also included a number of actions to improve the licensee's management alignment, prioritization, support for and awareness of the workweek schedule, and communication and training strategies to support work management improvements. In addition, the plan included actions to improve the willingness of plant employees to raise concerns, improve the effectiveness of policies and procedures for resolution of issues, enhance key elements of the employee concerns program, and improve management effectiveness in detecting and preventing retaliation or a chilled environment. The licensee's action plan included 17 metrics designed to measure safety work environment improvements. The licensee provided the results of these metrics to NRC on a quarterly basis.

In August 2004, NRC regional officials received approval from headquarters to deviate from the normal oversight process to increase oversight at the site to monitor the licensee's actions to improve its safety work environment. NRC's increased oversight consisted of (1) reviewing the results of the specific actions the licensee took as a part of its action plan, (2) creating an NRC team with expertise in the area to assist with coordinating and focusing these review efforts, and (3) conducting additional special inspections and enhancing existing inspections by adjusting their focus and scope. NRC determined that it could reduce its oversight to baseline levels once the licensee completed a self-assessment of its SCWE that concluded that it had made substantial, sustainable progress, and NRC confirmed the licensee's conclusion.

NRC also opened a substantive cross-cutting issue in the SCWE area at all three plants in August 2004, on the basis of the results of its special review of the site's SCWE completed that July. Upon opening this substantive cross-cutting issue, NRC requested that the licensee discuss its progress in improving its SCWE and the effectiveness of its corrective action program in a public meeting planned for late 2004. This substantive cross-cutting issue remained open in the 2005 annual assessment letter, issued in March 2006. NRC will consider closing this substantive cross-cutting issue after the licensee provides the results of an assessment that concludes that it has made substantial, sustainable progress, and NRC has completed a review that confirms these results.

In June 2005, NRC issued the results of an inspection of the licensee's employee concerns program (ECP) conducted as a part of its increased oversight to monitor the site's safety work environment. NRC inspectors did not identify any findings of safety significance and concluded that the ECP provided a framework for investigating concerns, maintaining the confidentiality of personnel who use the program, and protecting employees who use the program against retaliation. They also concluded, however, that it was too early to fully assess the effectiveness of recent program improvements and initiatives. The inspectors observed that a statistically significant portion of the personnel interviewed indicated that they would not use the ECP due to a perception that the process did not take adequate measures to protect users' confidentiality. NRC inspectors cited a section of the ECP that appeared to affirm this perception. The licensee emphasized that it was making efforts to protect confidentiality, and acknowledged that the ECP should reflect these efforts.

NRC also provided the preliminary results of its review of the licensee's executive review board (ERB) process in June 2005. The ERB was established to improve the site's safety work environment and management's effectiveness in detecting and preventing retaliation and a chilled work environment. NRC inspectors determined that lapses in the licensee’s use of the ERB process constituted a green inspection finding, although it did not represent a violation of regulatory requirements. NRC requested that the licensee reassess the review of the ERB in the broader context of the work environment, identify additional actions planned or taken to address negative worker perceptions, and provide a written response to NRC within 30 days. The licensee responded with planned corrective actions, including developing and implementing continuing training on the SCWE, and developing and implementing a plan to improve its corrective action program.

In July 2005, NRC headquarters extended regional officials’ permission to deviate from the normal oversight process and provide increased oversight at Salem and Hope Creek. The extension was necessary because the licensee had not yet met the criteria to move back to normal, or baseline levels of oversight. Increased oversight included (1) continued management meetings and site visits to review the implementation of the licensee’s corrective actions; (2) increased efforts, including using more inspectors and samples than what would typically be used, to conduct a baseline inspection of the site’s effectiveness at identifying and resolving problems; and (3) an additional inspection to monitor the licensee’s progress in resolving the substantive cross-cutting issue in the SCWE.

In November 2005, NRC issued the results of the special inspection on the site’s SCWE. The inspection included assessing the licensee’s progress and plans for making improvements to its SCWE, its metrics to monitor the effectiveness of the improvements made, and effectiveness of the licensee’s corrective actions and self assessment initiatives. NRC inspectors did not identify any findings of safety significance and determined that the licensee had made progress in improving its SCWE. For example, NRC inspectors concluded that workers’ willingness to raise safety concerns had increased. In addition, the licensee had taken a significant number of actions to improve the corrective action and work management programs and had implemented several corrective actions for the employee concerns program. They also concluded that the licensee had made progress in preventing and detecting retaliation. However, NRC inspectors also observed that some issues required additional action and focused attention, such as the need for the licensee to fully evaluate and address negative perceptions about its work environment in certain work groups. The licensee initiated actions to address these observations.

In May 2006, the licensee submitted to NRC an independent peer assessment that concluded that it had made substantial improvements to its SCWE, and a solid foundation existed to sustain them. The assessment included interviews with site personnel; observations of station activities and meetings; and reviews of the licensee's programs, procedures, policies, and other relevant information. Among the assessment's conclusions were that personnel throughout the organization exhibited a willingness to engage in open-and-candid discussions and raise safety and quality issues, the corrective action and work management programs had improved, management had been effective at detecting and preventing retaliation and addressing chilling effects in response to the raising of safety concerns, and management provided high-visibility and strong and continuous reinforcement of good work environment principles. In response, NRC began a review of the effectiveness of the licensee's actions to improve its safety work environment. The results of this review will be a key input into NRC's midcycle assessment of the site's overall safety performance to be completed in August 2006; through the midcycle assessment NRC will determine any changes in the level of oversight for Salem and Hope Creek.

Scope and Methodology

To examine how NRC oversees plants, we reviewed the various tools and processes that comprise the Reactor Oversight Process (ROP). In this regard, we analyzed NRC's documentation of its oversight process, conducted interviews with NRC program staff and other officials, visited one NRC regional office, and visited one nuclear power plant site that was of specific interest to our requesters. In particular, we reviewed NRC's policies, inspection manuals, and other guidance documents outlining its various oversight process components—including reports discussing the ROP design basis; inspection and reporting requirements; performance indicator program guidance; and other requirements, such as those related to its enforcement and assessment processes. We interviewed NRC headquarters and regional officials and regional and on-site inspectors responsible for implementation of the ROP and visited the Salem and Hope Creek nuclear power plants to observe firsthand how the ROP is implemented by the resident inspectors located at each power plant. To learn more about how ROP results are communicated to the public, we attended the annual public meeting held at the Indian Point nuclear power plant. We also reviewed the information NRC makes available to the public on a Web site devoted to ROP topics, which includes both detailed plant-specific information and general program information and guidance. In addition, we interviewed external stakeholder individuals and groups about their experiences with the ROP, including the NRC Commission Chairman from 1995 to 1999, who is largely credited with leading the development of the ROP; officials from the NRC Office of the Inspector General, the Nuclear Energy Institute (NEI), the Union of Concerned Scientists (UCS), and Greenpeace; and nuclear power plant managers at six sites.

To examine the results of the ROP over the past several years, we reviewed the number and types of inspection findings NRC issued, the performance indicators reported by the plants, and the level of oversight NRC provided to the plants. Specifically, we obtained and analyzed NRC data on its inspection findings for 2001 through 2005, the years since implementation of the ROP for which the data were available for the full year, and discussed our analysis with NRC program officials. We obtained inspection findings data from the NRC Reactor Program System (RPS) database and assessed the reliability of the RPS data by (1) performing electronic and manual testing of required data elements; (2) reviewing existing information about the data and the system that produced them; (3) reviewing an audit of the RPS database performed by the NRC Office of the Inspector General in 2005, and documents related to NRC's implementation of the audit's recommendations; and (4) interviewing agency officials knowledgeable about these data. We determined that these data were sufficiently reliable for the purposes of this report. Data elements included a breakout of inspection findings identified at each nuclear power plant, including information on their risk significance, or color; cornerstone; date; cross-cutting aspects; a brief description of the problem identified; and other related information. We also obtained and analyzed ROP data provided on NRC's Web site, including a list of performance indicator data broken out by plant and by quarter and a list of the plants in each column of the action matrix by quarter since inception of the ROP in 2000. We assessed the reliability of these data by interviewing the appropriate agency officials about how these data are reported on the Web site and compared the data with source information contained in inspection reports and assessment letters for sample plants. We determined that these data were sufficiently reliable for the purposes of this report. In addition, we reviewed every assessment letter issued to each of the 103 plants since the inception of the ROP to document the plants that had one or more substantive cross-cutting issue open and the length of time that the issue was held open. We discussed the results of our data analysis with NRC headquarters program officials and compared the results of the ROP with other industry-collected and reported performance data, including data collected through NRC's industry trends program, to identify any inconsistencies in trends or industry safety performance indicators.

To examine the status of NRC's efforts to improve the ROP, we reviewed specific components of the ROP where weaknesses had been identified and recent and current staffs' efforts to improve them. We analyzed NRC documents, including all annual self-assessment reports issued by NRC since 2001; interviewed officials from NRC headquarters, regional, and site offices and outside stakeholder groups, including NEI and UCS; and attended two public meetings covering proposed changes to incorporate safety culture into its oversight process. In reviewing the annual self-assessment reports, we analyzed comments submitted by both internal and external stakeholders that were collected during recent surveys. We analyzed responses submitted by internal staff, including management, program staff, and regional and site inspectors, and responses from external stakeholders, including industry, industry organizations, public interest groups, state and local agencies, and members of the public. We examined all proposed and final documents related to NRC's safety culture changes, including inspection manuals, training documents, and other guidance documents. We also reviewed public comments submitted to NRC on its safety culture changes, such as those submitted by NEI, UCS, and meetings held on the topic by the Advisory Committee on Reactor

Safeguards (ACRS). In addition, we assessed various external reports and evaluations related to the ROP or specific aspects relevant to NRC's oversight, such as issues surrounding safety culture, including our prior reports, those of the NRC Office of the Inspector General and of the ACRS. We met with NRC program officials responsible for assessing and implementing changes to the ROP to obtain a clear understanding of the actions they were taking and the status of their efforts.

Additionally, we selected a nonprobability sample[1] of 6 nuclear power sites (totaling 11 of the 103 operating plants)[2] that provided coverage of each of NRC's four regional offices and varying levels of plant performance and NRC oversight since 2000. The following nuclear power sites were included in our review: Cooper (1 plant) located near Nebraska City, Nebraska; Indian Point 2 (1 plant) located near New York, New York; Oconee (3 plants) located near Greenville, South Carolina; Perry (1 plant) located near Painesville, Ohio; Salem and Hope Creek (3 plants) located near Lower Alloways Creek, New Jersey; and Surry (2 plants) located near Newport News, Virginia. Our selection criteria was designed to represent geographic diversity, a variety of safety problems in which inspection findings or performance indicators of higher risk significance (white, yellow, and red) were issued, trends reflecting both improving and declining safety performance, and plants that have been subjected to at least some level of increased oversight since the ROP was implemented. The purpose of our review was to understand how performance problems were identified by NRC's oversight process, what caused them, actions taken by NRC and the licensee in response to the problems, and how NRC documented their resolution. We analyzed all publicly available inspection reports and assessment documents covering years 2000 through 2005 for each site to examine how NRC applied the ROP to identify and correct safety problems.[3] We analyzed each green and greater-than-green inspection finding documented through the inspection reports and

[1]Because these plants represent a nonprobability sample, results cannot be used to make inferences about the population, or nuclear power industry as a whole. This is because in a nonprobability sample, some elements of the population being studied have no chance or an unknown chance of being selected as part of the sample.

[2]The 6 sites are out of a total possible of 65. Oftentimes, there are 2 or 3 operating plants located at each nuclear power site, often operated and licensed by the same company, and therefore combined for NRC oversight purposes.

[3]Physical security inspection reports were not included in our analysis because physical security issues were not within the scope of this review.

collected data associated with each finding, including how it was identified, which cornerstone it was assigned to, whether the finding was associated with a violation of regulatory requirements, and whether there were any cross-cutting elements associated with the finding. For the greater-than-green inspection findings, we collected additional information to determine the length of time it took the licensee to correct the performance problem, the length of time and level of effort NRC inspectors took to follow up on the issue, and the actions it required the licensee to take. Additionally, for each of the sites, we reviewed NRC reports and documentation showing that all baseline inspection procedures were completed (for 2004 and 2005), and that inspectors verified the licensees' reporting of the performance indicator data (for 2000 through 2005). We also interviewed NRC branch chiefs and resident inspectors and industry management officials at each site to learn more about NRC's implementation of the ROP at the site. We conducted our work from July 2005 through July 2006 in accordance with generally accepted government auditing standards.

Nuclear Power Plant Performance Data on the Basis of the Results of NRC's Reactor Oversight Process, 2001 Through 2005

Table 3: Commercial Nuclear Power Plants Licensed to Operate in the United States

Nuclear power plant	City	State	NRC region
Arkansas Nuclear 1	Russellville	AR	IV
Arkansas Nuclear 2	Russellville	AR	IV
Beaver Valley 1	McCandless	PA	I
Beaver Valley 2	McCandless	PA	I
Braidwood 1	Joilet	IL	III
Braidwood 2	Joilet	IL	III
Browns Ferry 1	Decatur	AL	II
Browns Ferry 2	Decatur	AL	II
Browns Ferry 3	Decatur	AL	II
Brunswick 1	Southport	NC	II
Brunswick 2	Southport	NC	II
Byron 1	Rockford	IL	III
Byron 2	Rockford	IL	III
Callaway	Fulton	MO	IV
Calvert Cliffs 1	Annapolis	MD	I
Calvert Cliffs 2	Annapolis	MD	I
Catawba 1	Rock Hill	SC	II
Catawba 2	Rock Hill	SC	II
Clinton	Clinton	IL	III
Columbia Generating Station	Richland	WA	IV
Comanche Peak 1	Glen Rose	TX	IV
Comanche Peak 2	Glen Rose	TX	IV
Cooper	Nebraska City	NE	IV
Crystal River 3	Crystal River	FL	II
D.C. Cook 1	Benton Harbor	MI	III
D.C. Cook 2	Benton Harbor	MI	III
Davis-Besse	Toledo	OH	III
Diablo Canyon 1	San Luis Obispo	CA	IV
Diablo Canyon 2	San Luis Obispo	CA	IV
Dresden 2	Morris	IL	III
Dresden 3	Morris	IL	III
Duane Arnold	Cedar Rapids	IA	III
Edwin I. Hatch 1	Baxley	GA	II
Edwin I. Hatch 2	Baxley	GA	II
Fermi 2	Toledo	MI	III

(Continued From Previous Page)

Nuclear power plant	City	State	NRC region
Fort Calhoun	Omaha	NE	IV
Ginna	Rochester	NY	I
Grand Gulf 1	Vicksburg	MS	IV
H.B. Robinson 2	Florence	SC	II
Hope Creek 1	Lower Alloways Creek	NJ	I
Indian Point 2	New York	NY	I
Indian Point 3	New York	NY	I
James A. FitzPatrick	Oswego	NY	I
Joseph M. Farley 1	Dothan	AL	II
Joseph M. Farley 2	Dothan	AL	II
Kewaunee	Green Bay	WI	III
La Salle 1	Ottawa	IL	II
La Salle 2	Ottawa	IL	II
Limerick 1	Philadelphia	PA	I
Limerick 2	Philadelphia	PA	I
McGuire 1	Charlotte	NC	II
McGuire 2	Charlotte	NC	II
Millstone 2	New London	CT	I
Millstone 3	New London	CT	I
Monticello	Minneapolis	MN	III
Nine Mile Point 1	Oswego	NY	I
Nine Mile Point 2	Oswego	NY	I
North Anna 1	Richmond	VA	II
North Anna 2	Richmond	VA	II
Oconee 1	Greenville	SC	II
Oconee 2	Greenville	SC	II
Oconee 3	Greenville	SC	II
Oyster Creek	Toms River	NJ	I
Palisades	South Haven	MI	III
Palo Verde 1	Phoenix	AZ	IV
Palo Verde 2	Phoenix	AZ	IV
Palo Verde 3	Phoenix	AZ	IV
Peach Bottom 2	Lancaster	PA	I
Peach Bottom 3	Lancaster	PA	I
Perry 1	Painesville	OH	III
Pilgrim 1	Plymouth	MA	I

(Continued From Previous Page)

Nuclear power plant	City	State	NRC region
Point Beach 1	Manitowoc	WI	III
Point Beach 2	Manitowoc	WI	III
Prairie Island 1	Minneapolis	MN	III
Prairie Island 2	Minneapolis	MN	III
Quad Cities 1	Moline	IL	III
Quad Cities 2	Moline	IL	III
River Bend 1	Baton Rouge	LA	IV
Salem 1	Lower Alloways Creek	NJ	I
Salem 2	Lower Alloways Creek	NJ	I
San Onofre 2	San Clemente	CA	IV
San Onofre 3	San Clemente	CA	IV
Seabrook 1	Portsmouth	NH	I
Seqouyah 1	Chattanooga	TN	II
Seqouyah 2	Chattanooga	TN	II
Shearon Harris 1	Raleigh	NC	II
South Texas Project 1	Bay City	TX	IV
South Texas Project 2	Bay City	TX	IV
St. Lucie 1	Ft. Pierce	FL	II
St. Lucie 2	Ft. Pierce	FL	II
Summer	Columbia	SC	II
Surry 1	Newport News	VA	II
Surry 2	Newport News	VA	II
Susquehanna 1	Berwick	PA	I
Susquehanna 2	Berwick	PA	I
Three Mile Island 1	Harrisburg	PA	I
Turkey Point 3	Miami	FL	II
Turkey Point 4	Miami	FL	II
Vermont Yankee	Battleboro	VT	I
Vogtle 1	Augusta	GA	II
Vogtle 2	Augusta	GA	II
Waterford 3	New Orleans	LA	IV
Watts Bar 1	Spring City	TN	II
Wolf Creek 1	Burlington	KS	IV

Source: NRC.

Table 4: Total Number of Green Inspection Findings, 2001 Through 2005

	Number of green inspection findings, by year					
Nuclear power site[a]	2001	2002	2003	2004	2005	Total
Arkansas Nuclear	12	9	15	23	23	**82**
Beaver Valley	14	10	10	8	9	**51**
Braidwood	11	12	5	5	7	**40**
Browns Ferry	5	5	4	10	8	**32**
Brunswick	4	4	3	6	9	**26**
Byron	13	9	16	14	19	**71**
Callaway	17	11	15	17	17	**77**
Calvert Cliffs	18	4	6	19	6	**53**
Catawba	10	6	7	5	8	**36**
Clinton	8	10	5	16	8	**47**
Columbia Generating Station	11	5	21	17	10	**64**
Comanche Peak	6	12	3	9	11	**41**
Cooper	32	23	29	23	34	**141**
Crystal River	5	4	5	5	5	**24**
D.C. Cook	14	27	24	7	16	**88**
Davis-Besse	4	16	24	46	12	**102**
Diablo Canyon	11	14	22	25	23	**95**
Dresden	20	19	22	26	13	**100**
Duane Arnold	1	7	22	12	19	**61**
Farley	8	5	5	4	11	**33**
Fermi	6	6	11	14	18	**55**
FitzPatrick	12	7	8	5	8	**40**
Fort Callhoun	7	18	11	15	21	**72**
Ginna	4	11	14	9	10	**48**
Grand Gulf	13	9	6	10	11	**49**
Harris	5	5	5	5	6	**26**
Hatch	11	8	4	2	4	**29**
Hope Creek	18	24	19	25	16	**102**
Indian Point 2	44	21	20	25	13	**123**
Indian Point 3	13	3	14	6	8	**44**
Kewaunee	12	9	14	24	20	**79**
La Salle	9	13	7	11	20	**60**
Limerick	15	11	13	8	4	**51**

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	Number of green inspection findings, by year					
Nuclear power site[a]	2001	2002	2003	2004	2005	Total
McGuire	5	9	8	14	9	**45**
Millstone	20	13	8	12	17	**70**
Monticello	17	8	12	13	9	**59**
Nine Mile Point	16	9	15	19	8	**67**
North Anna	4	4	5	9	12	**34**
Oconee	16	11	13	11	19	**70**
Oyster Creek	11	12	7	15	12	**57**
Palisades	23	13	13	10	8	**67**
Palo Verde	16	3	4	46	29	**98**
Peach Bottom	14	13	18	7	9	**61**
Perry	7	10	18	16	59	**110**
Pilgrim	8	4	9	6	7	**34**
Point Beach	15	10	28	24	23	**100**
Prarie Island	4	6	5	10	16	**41**
Quad Cities	6	21	15	14	11	**67**
River Bend	19	6	17	18	7	**67**
Robinson	4	1	4	3	3	**15**
Saint Lucie	13	7	6	10	9	**45**
Salem	17	14	26	24	25	**106**
San Onofre	4	9	9	16	13	**51**
Seabrook	10	6	10	9	8	**43**
Sequoyah	11	16	9	7	4	**47**
South Texas	14	7	15	13	12	**61**
Summer	13	9	10	10	9	**51**
Surry	6	5	7	3	7	**28**
Susquehanna	11	17	11	13	7	**59**
Three Mile Island	19	8	7	12	12	**58**
Turkey Point	6	2	9	13	9	**39**
Vermont Yankee	11	9	9	14	3	**46**
Vogtle	4	8	6	8	3	**29**
Waterford	5	14	15	17	15	**66**

(Continued From Previous Page)

	Number of green inspection findings, by year					
Nuclear power site[a]	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Watts Bar	4	13	10	8	8	**43**
Wolf Creek	5	3	7	9	6	**30**
Total	**751**	**657**	**774**	**889**	**835**	**3,906**
Site average	**11**	**10**	**12**	**13**	**13**	**59**
Range (for each column)	**1-44**	**1-27**	**3-29**	**2-46**	**3-59**	**15-141**

Source: GAO analysis of NRC data.

[a]NRC reports these data by nuclear power site as opposed to by individual plant. Oftentimes, there are 2 or 3 plants located at each site. Therefore, data for all 103 plants are included here, but at the site level.

Table 5: Total Number of Greater-Than-Green Inspection Findings Issued, 2001 Through 2005

	Total number of inspection findings, by color		
Nuclear power site[a]	**White**	**Yellow**	**Red**
Arkansas Nuclear	1		
Beaver Valley	2		
Braidwood	1		
Browns Ferry			
Brunswick	1		
Byron			
Callaway	3		
Calvert Cliffs	3	1	
Catawba			
Clinton	1		
Columbia Generating Station	1	1	
Comanche Peak	2		
Cooper	5		
Crystal River	1		
D.C. Cook	3		
Davis-Besse	4	1	1
Diablo Canyon			
Dresden	2		
Duane Arnold			
Farley			

(Continued From Previous Page)

	Total number of inspection findings, by color		
Nuclear power site[a]	White	Yellow	Red
Fermi	1		
FitzPatrick			
Fort Callhoun	2		
Ginna	1		
Grand Gulf			
Harris	2		
Hatch	1		
Hope Creek	2		
Indian Point 2	2	1	1
Indian Point 3			
Kewaunee	4	1	
La Salle	1		
Limerick	2		
McGuire			
Millstone			
Monticello			
Nine Mile Point	1		
North Anna			
Oconee	7		
Oyster Creek	3		
Palisades	2		
Palo Verde		1	
Peach Bottom	3		
Perry	5		
Pilgrim			
Point Beach	3	1	3
Prarie Island	1		
Quad Cities			
River Bend	2		
Robinson			
Saint Lucie			
Salem	1		
San Onofre			
Seabrook	1		
Sequoyah	1		
South Texas			

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	Total number of inspection findings, by color		
Nuclear power site[a]	White	Yellow	Red
Summer			
Surry	2		
Susquehanna	1		
Three Mile Island	2		
Turkey Point			
Vermont Yankee	1		
Vogtle			
Waterford	1		
Watts Bar	1		
Wolf Creek			
Total	**86**	**7**	**5**

Source: GAO analysis of NRC data.

[a]NRC reports these data by nuclear power site as opposed to by individual plant. Oftentimes, there are 2 or 3 plants located at each site. Therefore, data for all 103 plants are included here, but at the site level.

Table 6: Type of Substantive Cross-cutting Issue Open At Least Some Portion of the Year, 2001 Through 2005

	Type of substantive cross-cutting issue open, by year				
Nuclear power plant	2001	2002	2003	2004	2005
Arkansas Nuclear 1			PIR	PIR	PIR
Arkansas Nuclear 2			PIR	PIR	PIR
Beaver Valley 1					
Beaver Valley 2					
Braidwood 1					
Braidwood 2					
Browns Ferry 2					
Browns Ferry 3					
Brunswick 1					
Brunswick 2					
Byron 1					HP
Byron 2					HP
Callaway		PIR	PIR	HP	HP
Calvert Cliffs 1	PIR	PIR			
Calvert Cliffs 2	PIR	PIR			

(Continued From Previous Page)

	Type of substantive cross-cutting issue open, by year				
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**
Catawba 1					
Catawba 2					
Clinton					
Columbia Generating Station	HP	HP	PIR, HP	PIR, HP	PIR, HP
Comanche Peak 1					
Comanche Peak 2					
Cooper	PIR,HP	PIR,HP	PIR,HP	PIR,HP	PIR,HP
Crystal River 3					
D.C. Cook 1		PIR	PIR		
D.C. Cook 2		PIR	PIR		
Davis-Besse					
Diablo Canyon 1			PIR,HP	PIR,HP	
Diablo Canyon 2			PIR,HP	PIR,HP	
Dresden 2				HP	
Dresden 3				HP	
Duane Arnold					HP
Farley 1					
Farley 2					
Fermi 2				HP	HP
FitzPatrick	PIR				
Fort Callhoun					
Ginna					
Grand Gulf 1					
Harris 1					
Hatch 1					
Hatch 2					
Hope Creek 1		PIR	PIR	PIR, SCWE	PIR,SCWE
Indian Point 2	PIR,HP	PIR,HP	PIR,HP	PIR	PIR
Indian Point 3					
Kewaunee				PIR	PIR
La Salle 1	HP	HP		HP	HP
La Salle 2	HP	HP		HP	HP
Limerick 1					
Limerick 2					
McGuire 1					

(Continued From Previous Page)

	Type of substantive cross-cutting issue open, by year				
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**
McGuire 2					
Millstone 2	PIR,HP		PIR		
Millstone 3					
Monticello					
Nine Mile Point 1			PIR		
Nine Mile Point 2			PIR		
North Anna 1					
North Anna 2					
Oconee 1					
Oconee 2					
Oconee 3					
Oyster Creek	PIR	HP	HP	PIR	PIR
Palisades	PIR, HP	PIR	PIR		
Palo Verde 1				PIR, HP	PIR, HP
Palo Verde 2				PIR, HP	PIR, HP
Palo Verde 3				PIR, HP	PIR, HP
Peach Bottom 2			PIR	PIR	
Peach Bottom 3			PIR	PIR	
Perry 1				PIR,HP	PIR,HP
Pilgrim 1					
Point Beach 1		PIR	PIR, HP	PIR, HP	PIR, HP
Point Beach 2		PIR	PIR, HP	PIR, HP	PIR, HP
Prairie Island 1					
Prairie Island 2					
Quad Cities 1		HP	HP		
Quad Cities 2		HP	HP		
River Bend 1					
Robinson 2					
Saint Lucie 1					
Saint Lucie 2					
Salem 1		PIR	PIR	PIR,SCWE	PIR,SCWE
Salem 2		PIR	PIR	PIR,SCWE	PIR,SCWE
San Onofre 2					
San Onofre 3					
Seabrook 1	PIR	PIR			
Sequoyah 1					

(Continued From Previous Page)

	Type of substantive cross-cutting issue open, by year				
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**
Sequoyah 2					
South Texas 1					
South Texas 2					
Summer					
Surry 1					
Surry 2					
Susquehanna 1		HP	PIR, HP	PIR	
Susquehanna 2		HP	PIR, HP	PIR	
Three Mile Island 1	HP	HP	PIR	PIR	
Turkey Point 3			PIR		
Turkey Point 4			PIR		
Vermont Yankee					
Vogtle 1					
Vogtle 2					
Waterford 3		PIR	PIR		
Watts Bar 1					HP
Wolf Creek 1					

Legend:

HP = human performance
PIR = problem identification and resolution
SCWE = safety-conscious work environment

Source: GAO analysis of NRC data.

Table 7: Total Number of Greater-Than-Green Performance Indicators, 2001 Through 2005

	Number of greater-than-green performance indicators, by year[a]					
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Arkansas Nuclear 1						
Arkansas Nuclear 2						
Beaver Valley 1						
Beaver Valley 2						
Braidwood 1	1	2	3	1		**7**
Braidwood 2						
Browns Ferry 2						

(Continued From Previous Page)

Nuclear power plant	Number of greater-than-green performance indicators, by year[a]					Total
	2001	2002	2003	2004	2005	
Browns Ferry 3						
Brunswick 1						
Brunswick 2					1	**1**
Byron 1						
Byron 2						
Callaway				2		**2**
Calvert Cliffs 1	4	3				**7**
Calvert Cliffs 2						
Catawba 1						
Catawba 2						
Clinton						
Columbia Generating Station					5	**5**
Comanche Peak 1						
Comanche Peak 2						
Cooper			1			**1**
Crystal River 3	1					**1**
D.C. Cook 1	1					**1**
D.C. Cook 2			4	5	2	**11**
Davis-Besse				1	1	**2**
Diablo Canyon 1					1	**1**
Diablo Canyon 2					1	**1**
Dresden 2				1		**1**
Dresden 3		1	4	2		**7**
Duane Arnold						
Farley 1						
Farley 2						
Fermi 2	4		1	4	1	**10**
FitzPatrick	2					**2**
Fort Callhoun			1	2	2	**5**
Ginna						
Grand Gulf 1						
Harris 1		1	3	1		**5**
Hatch 1						
Hatch 2						

(Continued From Previous Page)

Nuclear power plant	Number of greater-than-green performance indicators, by year[a]					Total
	2001	2002	2003	2004	2005	
Hope Creek 1						
Indian Point 2						
Indian Point 3			3			**3**
Kewaunee						
La Salle 1						
La Salle 2	2	1				**3**
Limerick 1						
Limerick 2						
McGuire 1						
McGuire 2						
Millstone 2	2			3		**5**
Millstone 3						
Monticello						
Nine Mile Point 1	4	2				**6**
Nine Mile Point 2	1	1	1			**3**
North Anna 1						
North Anna 2	1					**1**
Oconee 1		2				**2**
Oconee 2						
Oconee 3						
Oyster Creek						
Palisades						
Palo Verde 1						
Palo Verde 2						
Palo Verde 3						
Peach Bottom 2			1	1	3	**5**
Peach Bottom 3						
Perry 1			3	1		**4**
Pilgrim 1						
Point Beach 1	4	1				**5**
Point Beach 2	2					**2**
Prarie Island 1						
Prarie Island 2						
Quad Cities 1						
Quad Cities 2						

(Continued From Previous Page)

Nuclear power plant	Number of greater-than-green performance indicators, by year[a]					
	2001	2002	2003	2004	2005	Total
River Bend 1					2	**2**
Robinson 2				1		**1**
Saint Lucie 1						
Saint Lucie 2			1	1		**2**
Salem 1		2				**2**
Salem 2						
San Onofre 2			1	3	1	**5**
San Onofre 3						
Seabrook 1			1			**1**
Sequoyah 1						
Sequoyah 2		1	2			**3**
South Texas 1						
South Texas 2		1	1			**2**
Summer	3					**3**
Surry 1		3	6	3		**12**
Surry 2	2	4	4	1		**11**
Susquehanna 1						
Susquehanna 2						
Three Mile Island 1						
Turkey Point 3					1	**1**
Turkey Point 4					2	**2**
Vermont Yankee						
Vogtle 1						
Vogtle 2						
Waterford 3						
Watts Bar 1						
Wolf Creek 1						
Total	**34**	**25**	**41**	**33**	**23**	**156**

Source: GAO analysis of NRC data.

Note: Plant licensees report their performance indicator data on a quarterly basis for 15 different indicators (excluding 3 physical security indicators). Yearly totals include a summary for all 15 indicators and the four quarters. Thus, if the same indicator was white for two quarters during the year, it would count twice in the yearly total.

[a]All of the greater-than-green indicators were white during this period, no yellow or red indicators were reported.

Table 8: Highest NRC Oversight Level Applied during at Least Some Portion of the Year, 2001 Through 2005

	Highest level of oversight applied during at least some portion of the year[a]				
Nuclear power plant	2001	2002	2003	2004	2005
Arkansas Nuclear 1				L	
Arkansas Nuclear 2					
Beaver Valley 1		L	L	L	
Beaver Valley 2		L	L	L	
Braidwood 1	L	M	L	L	
Braidwood 2					
Browns Ferry 2					
Browns Ferry 3					
Brunswick 1					
Brunswick 2				L	L
Byron 1					
Byron 2					
Callaway	M	L	L	L	
Calvert Cliffs 1	M	M	L		
Calvert Cliffs 2		L	L	L	
Catawba 1					
Catawba 2					
Clinton	L	L			
Columbia Generating Station	M	M			L
Comanche Peak 1		L		L	
Comanche Peak 2		L			
Cooper	M	H	H	H	
Crystal River 3	L				L
D.C. Cook 1		L	L	L	
D.C. Cook 2		M	M	M	L
Davis-Besse		[b]	[b]	[b]	[b]
Diablo Canyon 1					L
Diablo Canyon 2					L
Dresden 2				L	
Dresden 3		L	L	L	
Duane Arnold					
Farley 1	L				
Farley 2	L				

(Continued From Previous Page)

	Highest level of oversight applied during at least some portion of the year[a]				
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**
Fermi 2	L	L	L	L	L
FitzPatrick	L				
Fort Callhoun		L	L	L	L
Ginna		L	L		
Grand Gulf 1					
Harris 1	L	M	L	L	
Hatch 1					L
Hatch 2					L
Hope Creek 1				L	L
Indian Point 2	H	H	M	L	L
Indian Point 3			L		
Kewaunee	M	L	L		M
La Salle 1					
La Salle 2	L	L			
Limerick 1	L	L			
Limerick 2	L	L			
McGuire 1					
McGuire 2					
Millstone 2	M			L	
Millstone 3					
Monticello					
Nine Mile Point 1	L	L	L		
Nine Mile Point 2	L	L	L		
North Anna 1					
North Anna 2	L				
Oconee 1	M	L	L	M	L
Oconee 2	L		L	M	L
Oconee 3	L	L	L	M	L
Oyster Creek	L	L		L	L
Palisades	L	L	L	L	
Palo Verde 1					M
Palo Verde 2					M
Palo Verde 3					M
Peach Bottom 2	L	L	L	L	L
Peach Bottom 3	L	L	L		

(Continued From Previous Page)

	Highest level of oversight applied during at least some portion of the year[a]				
Nuclear power plant	**2001**	**2002**	**2003**	**2004**	**2005**
Perry 1		L	M	H	H
Pilgrim 1					
Point Beach 1	L	L	H	H	H
Point Beach 2	L	L	H	H	H
Prarie Island 1	L	L			
Prarie Island 2	L	L			
Quad Cities 1	L				
Quad Cities 2	L				
River Bend 1		L			L
Robinson 2				L	
Saint Lucie 1					
Saint Lucie 2			L	L	
Salem 1		L	L	L	
Salem 2					
San Onofre 2			L	L	L
San Onofre 3					
Seabrook 1	L		L		
Sequoyah 1				L	L
Sequoyah 2		L	L		
South Texas 1					
South Texas 2		L	L		
Summer	L				
Surry 1	L	L	L	M	
Surry 2	L	L	L	L	
Susquehanna 1	L	L			
Susquehanna 2	L	L			
Three Mile Island 1	L				L
Turkey Point 3					L
Turkey Point 4					L
Vermont Yankee		M		L	L
Vogtle 1					
Vogtle 2					
Waterford 3				L	
Watts Bar 1					L
Wolf Creek 1					

Legend:

L = 1st or lowest level of increased oversight beyond the baseline
M = 2nd level of increased oversight beyond the baseline
H = 3rd and highest level of oversight that still allows continued plant operations

Source: GAO analysis of NRC data.

[a]All plants receive a baseline level of oversight, regardless of their safety performance. Plants are also placed into performance categories on NRC's action matrix on a quarterly basis, which corresponds to the level of oversight NRC will provide based on the plant's safety performance. The level of oversight reported here corresponds to the highest oversight level the plant received during the year, even if it was only for a portion of the year. Thus, if a plant was placed into a different category each quarter, the highest category in which it was placed is reported here.

[b]Davis-Besse was under a separate oversight category not considered part of the ROP due to the reactor vessel head incident that occurred in 2002.

Comments from the Nuclear Regulatory Commission

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 6, 2006

Mr. James E. Wells, Jr.
Director, Natural Resources
and Environment
U.S. Government Accountability Office
441 G Street, NW.
Washington, DC 20548

Dear Mr. Wells:

Thank you for the opportunity to review and submit comments on the U.S. Government Accountability Office (GAO) draft report, "Nuclear Regulatory Commission Oversight of Nuclear Power Plant Safety has Improved but Refinements are Needed" (GAO-06-1029). The U.S. Nuclear Regulatory Commission (NRC) appreciates the time and effort you and your staff have invested to review the NRC oversight program for commercial nuclear power plants. We also appreciate the willingness of your staff to maintain a continuing dialogue with the NRC to ensure that your report is accurate.

Overall, the NRC considers the draft report to be comprehensive, fair, and balanced. The report is well written and provides an accurate reflection of the review. The NRC generally agrees with the findings, conclusions, and recommendations. We have no substantive comments on the draft report.

The enclosure provides some minor comments for your consideration. Should you have questions about these comments, please contact Ms. Melinda Malloy at (301) 415-1785 or Mr. James Andersen at (301) 415-3565.

Sincerely,

Luis A. Reyes
Executive Director
for Operations

Enclosure:
Minor Comments on Draft Report

GAO Contact and Staff Acknowledgments

GAO Contact

Jim Wells, (202) 512-3841 or wellsj@gao.gov

Staff Acknowledgments

In addition to the individual named above, Raymond H. Smith, Jr. (Assistant Director), Alyssa M. Hundrup, and Dave Stikkers made key contributions to this report. Also contributing to this report were Cindy Gilbert, Carol Kolarik, Alison O'Neill, Ilene Pollack, Keith A. Rhodes, and Barbara Timmerman.

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