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UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Reactor Oversight Process

December 2006

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NRC
REACTOR OVERSIGHT PROCESS

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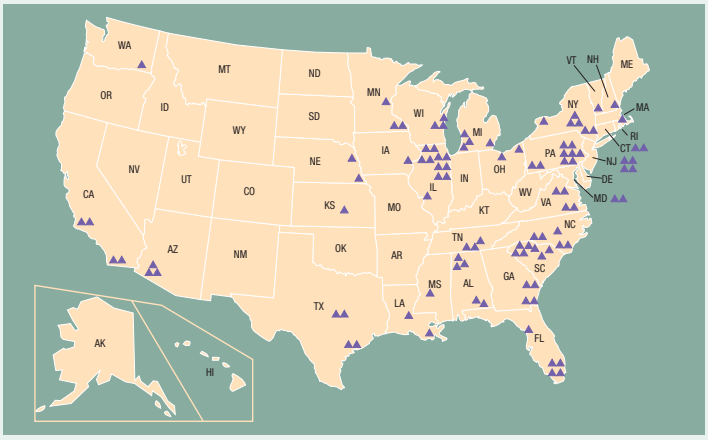
INTRODUCTION

The Nuclear Regulatory Commission's mission is to ensure adequate protection of public health and safety in the peaceful uses of nuclear materials, including nuclear power plants. The agency does not operate the plants. Rather it regulates the safe operation of commercial nuclear power plants by mandating requirements for the design, construction and operation of such plants.

The safety of these plants has always been important as 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 important as the U.S. considers the potential resurgence of nuclear power in helping to meet the nation's growing energy needs.

The NRC conducts a rigorous process for licensing plants to allow them to operate, as well as licensing individual plant operators. The agency provides continuous oversight of plant operations to verify they are being conducted in accordance with regulations.

The NRC also establishes plant-specific technical specifications which plant operators (i.e., licensees) must follow to ensure that the proper combination of safety-related equipment is available to safely shut down the plant in the event of an accident. The NRC has full authority to take whatever action is necessary to protect public health and safety and may demand immediate licensee actions, up to and including a plant shutdown.



commercial nuclear power plants

The commercial nuclear power industry in the United States is a mature industry with 104 operating reactors under NRC oversight. More than two-thirds of the plants have been operating for more than 20 years, and all have operated for 10 years or more. All the evidence suggests that the safety and reliability of the nuclear industry has improved markedly since the late 1980's and early 1990's. The number of automatic shutdowns, the number of significant safety problems, and the number of unplanned outages caused by equipment problems have all decreased since 1990. (See Glossary for definitions of terms).

Additional information about the NRC is available on its website: **http://www.nrc.gov**

nuclear power plant

REACTOR OVERSIGHT PROCESS

The NRC's Reactor Oversight Process is the agency's program to inspect, measure, and assess the safety performance of commercial nuclear power plants and to respond to any decline in performance. It reflects the Commission's strategic goals for safety, security, openness, and effectiveness.

The process spells out clearly what a nuclear plant operator and the public — can expect from the NRC with good plant performance and what can be expected from the NRC if performance declines.

The oversight process calls for:

- Focusing inspections on activities where the potential risks are greater.
- Applying greater regulatory attention to nuclear power plants with performance problems, while maintaining a normal level of regulatory attention on facilities that perform well.
- Using objective measurements of the performance of nuclear power plants.
- Giving both the public and the nuclear industry timely and understandable assessments of plant performance.
- Responding to violations of regulations in a predictable and consistent manner that reflects the potential safety impact of the violations.

CORNERSTONES OF SAFE OPERATION

The Reactor Oversight Process is, of course, anchored in the NRC's mission to ensure public health and safety in the operation of commercial nuclear power plants. The objective is to monitor performance in three key areas —

- **Reactor Safety**—avoiding accidents and reducing the consequences of accidents if they occur;
- **Radiation Safety**—for both plant workers and the public from unnecessary radiation exposure during routine operations; and
- **Safeguards**—protection of the plant against sabotage or other security threats.

To monitor and measure plant performance, the oversight process focuses on seven "cornerstones" which support the safety of plant operations in the three key areas. These are described below.

Reactor Safety Area

#1 Initiating Events—Any potential occurrence that could disrupt plant operations and challenge safety functions is an initiating event. This cornerstone focuses on limiting the occurrence of these type of events. These events could include equipment failures leading to a plant shutdown, shutdowns with unexpected complications, or large changes in the plant's power output.

#2 Mitigating Systems—These are safety systems designed into each plant which alleviate the effects of initiating events. Mitigating systems can prevent an accident or reduce the consequences of a possible accident. This cornerstone monitors the function of these safety systems through periodic testing and actual performance.

#3 Barrier Integrity—There are three important barriers between the highly radioactive fuel inside the reactor and the public and the environment outside the plant. These barriers are: (1) the sealed rods containing the fuel pellets, (2) the heavy steel reactor vessel and associated piping, and (3) the reinforced concrete containment structure surrounding the reactor. The integrity of the fuel rods, the vessel, and the piping is continuously checked for leakage, while the ability of the containment structure to prevent leakage is measured on a regular basis.

#4 Emergency Preparedness—Each nuclear plant is required to have comprehensive emergency plans to effectively respond to a possible accident. This cornerstone measures the effectiveness of the plant staff in carrying out emergency plans. Such emergency plans are tested every two years involving plant staff as well as local, state, and, in some cases, federal agencies. The plant staff itself conducts emergency exercises even more frequently.

Radiation Safety Area

#5 Occupational Radiation Safety—NRC regulations set a limit on radiation doses received by plant workers. Exposures could be from poorly con-

trolled or uncontrolled radiation areas or radioactive materials located at the plant. This cornerstone monitors the effectiveness of the plants' program to control and minimize those doses.

#6 Public Radiation Safety—NRC regulations are designed to protect public health and safety from exposure to radioactive materials that may be released into the public domain. This cornerstone measures the procedures and systems designed to minimize radioactive releases from a nuclear plant during normal operations and to keep those releases within federal limits.

Safeguards Area

#7 Physical Protection—Nuclear plants are required to have well-trained security personnel and a variety of protective systems to guard vital plant equipment, as well as programs to assure that employees are constantly fit for duty through drug and alcohol testing. This cornerstone measures the effectiveness of the security and fitness-for-duty programs.

Although the NRC actively oversees the security and safeguards activities and facilities at nuclear plants, the inspection and assessment information is not publicly available to ensure that potentially useful information is not provided to a possible adversary (only the cover letter is publicly available).

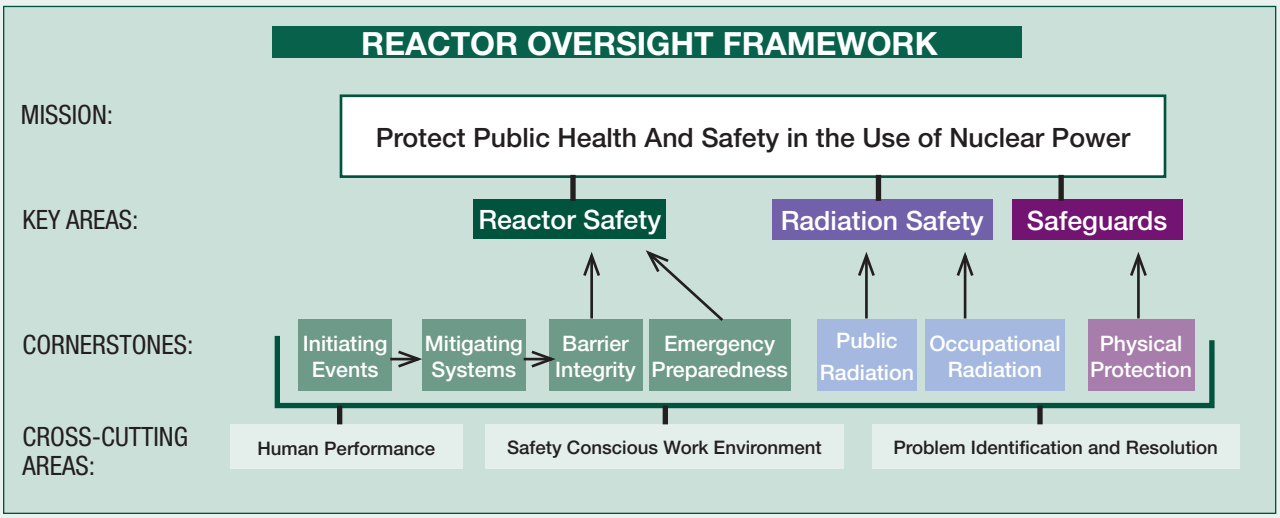
CROSS-CUTTING AREAS

In addition to the cornerstones, the Reactor Oversight Process features three "cross-cutting" areas, so named because they can affect each of the cornerstones across all the key areas.

These are:

- Human performance
- Workers' ability to raise safety issues (Also known as "safety-conscious work environment")
- Finding and fixing problems (plant owners corrective action program)

The review and assessment of these cross-cutting areas have an important role in the Reactor Oversight Process. They are considered during all NRC inspections and are covered during periodic plant assessments.



MEASURING AND INSPECTING NUCLEAR PLANT PERFORMANCE

Nuclear plant performance is measured and assessed by a combination of objective performance indicators reported by the licensee and by NRC inspection findings. They are both closely focused on those plant activities having the greatest impact on safety and overall risk. While performance indicators can provide insights into plant performance for selected areas, the NRC's inspection program provides greater depth and breadth of information for consideration by the NRC in assessing plant performance.

Inspection Findings + Performance Indicators = Plant Assessment

In addition, the NRC conducts both periodic and annual reviews of the effectiveness of each utility's programs to identify and correct problems. These programs, and their inputs and products, are described in more detail in the following sections.

Performance Indicators

Each performance indicator has criteria for measuring acceptable performance. As in all industrial activities, nuclear power plants are not error-free or risk-free. Equipment problems and human errors will occur. Each performance indicator determines acceptable levels of operation within substantial safety margins. The criteria are designed to be objective and reflect risk according to established safety margins. Performance indicators for each cornerstone are shown in the following table.

Safety Cornerstone	Performance Indicators
#1 Initiating Events	• Unplanned reactor shutdowns (automatic and manual) • Loss of normal reactor cooling system following unplanned shutdown • Unplanned events that result in significant changes in reactor power
#2 Mitigating Systems	• Safety system availability and reliability • Safety system failures
#3 Barrier Integrity	• Fuel cladding (measured by radioactivity in reactor cooling system) • Reactor cooling system leak rate
#4 Emergency Preparedness	• Emergency response organization drill performance • Readiness of emergency response organization • Availability of notification system for area residents
#5 Occupational Radiation Safety	• Compliance with regulations for controlling access to radiation areas in plant • Uncontrolled radiation exposures to workers greater than 10 percent of regulatory limit
#6 Public Radiation Safety	• Effluent releases requiring reporting under NRC regulations and license conditions
#7 Physical Protection	• Security system equipment availability • Personnel screening program performance • Employee fitness-for-duty program effectiveness

Use of Performance Indicators

Each indicator is measured against the criteria using a color-coded system for safety performance.

Green indicates performance within an expected performance level where the associated cornerstone objectives are met.

White represents performance outside an expected range of nominal utility performance but related cornerstone objectives are still being met.

Yellow indicates related cornerstone objectives are being met, but with a minimal reduction in the safety margin.

Red signals a significant reduction in safety margin in the area measured by the performance indicator.

The performance indicator data is evaluated and integrated with findings of the NRC inspection program to provide a broad assessment of the plant's safety performance.

The indicators are compiled by the licensee and reported to the NRC on a quarterly basis. Following compilation and review by the NRC staff, the quarterly performance indicators are posted on the NRC's web site: **http://www.nrc.gov**.

The Reactor Oversight Process includes inspections by NRC staff with a variety of backgrounds and skills – among them are plant operations, engineering, radiation protection, emergency preparedness, and security.

The inspection program is founded on "baseline" inspections common to all nuclear plants. The baseline inspection program, based on the cornerstones, focuses on activities and systems that are "risk significant," that is, those activities and systems that have a potential to trigger an accident, can mitigate the effects of an accident, or increase the consequences of a possible accident. Additionally, inspections beyond the baseline program are set for plants with performance below established thresholds, as assessed through information gained from performance indicators and NRC inspections.

The inspection program uses a "risk-informed" approach to select areas to inspect within each cornerstone. The inspection areas were chosen because of their importance to potential risk, past operational experience, and regulatory requirements.

The baseline inspection program has three parts:

1) Inspection of areas not covered by performance indicators or where a performance indicator does not fully cover the inspection area;
2) Inspections to verify the accuracy of a licensee's reports on performance indicators; and
3) A thorough review of the licensee's effectiveness in finding and resolving problems on its own.

Inspections beyond the baseline program are performed in response to specific events at a plant or changes in the plant's performance. For example, if a performance indicator or inspection finding shows increased safety significance, the NRC may conduct a special or supplemental inspection to review the situation and assess the effectiveness of the plant operator's response. For more complicated situations, the agency may dispatch an "augmented" inspection team, bringing in added experts from other NRC regions or headquarters staff. For more serious

Plant	IE 01	IE 02	IE 03	MS 05	MS 06	MS 07	MS 08	MS 09	MS 10	BI 01	BI 02	EP 01	EP 02	EP 03	OR 01	PR 01
Brunswick 1	G	G	G	G	W	G	G	G	G	G	G	G	G	G	G	G
Brunswick 2	G	G	G	G	W	G	G	G	G	Y	G	G	G	G	G	G

Example of Performance Indicators on the Web

events, a high-level "Incident Investigation Team" may be formed.

The inspection program also includes review of cross-cutting areas of human performance, the "safety-conscious work environment," and how the plant operator finds and fixes problems. The Reactor Oversight Process was revised in July 2006 to enhance the ability of the NRC to detect a declining safety culture. Adjustments were also made to selected baseline, event response and supplemental inspection procedures.

The inspections are performed by NRC resident inspectors stationed full time at each nuclear power plant and by inspectors based in one of the four NRC regional offices or in NRC headquarters in Rockville, Maryland. The regional offices are located in King of Prussia, Pennsylvania; Atlanta, Georgia; Lisle, Illinois; and Arlington, Texas.

Inspection reports are issued for all inspections. Baseline inspection reports, compiled by the resident inspectors and inspection specialists are issued at the close of each calendar quarter. Special and supplemental inspection reports are issued several weeks after completion of those inspections. The inspection reports are available on the NRC web site's "Library" link, in the NRC's online document collection called "ADAMS," and from the Public Document Room at NRC headquarters.

ASSESSMENT OF PLANT PERFORMANCE

Significance Determination Process

The inspection staff uses a process, called the "Significance Determination Process," to help inspectors determine the safety significance of inspection findings. This process provides an initial screening to identify those inspection findings that do not result in a significant increase in plant risk and thus need not be analyzed further (a "green" finding).

Green	indicates a finding of very low safety significance;
White	represents a finding of low to moderate safety significance;
Yellow	indicates a finding of substantial safety significance; and
Red	is a finding of high safety significance.

Remaining inspection findings — which may have an effect on plant risk — are subjected to a more thorough risk assessment, using the next phase of the Significance Determination Process. This more detailed assessment may involve NRC risk experts from the appropriate regional office and further review by the utility's plant staff. The final outcome of the review — evaluating whether the finding is green, white, yellow, or red — is used to determine further NRC actions that may be needed.

Quarterly Plant Assessments

Each calendar quarter, the resident inspectors and regional inspection staff review the performance of all nuclear power plants in that region, as measured by the performance indicators and by inspection findings. Every six months this review involves a more detailed assessment of plant performance that includes staff from NRC headquarters, the regions, and resident inspectors as well as preparation of a performance report. Also every six months, based on plant performance reviews, NRC inspection plans for each reactor are determined for the following 18-month period.

Annual Performance Reports and Public Meetings

Annual performance reports are available on the agency's web site at: **http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/index.html#plantassess.** In addition, each year the NRC staff holds a public meeting with the licensee at each plant to discuss the previous year's performance. This provides individuals living near the plant an opportunity to find out the status of a plant's safety performance and talk with NRC staff.

Additionally, NRC senior management reviews the adequacy of agency actions for plants with significant performance problems. The managers also take a wider view both of the overall industry performance and of the performance of the agency's regulatory programs. The performance of plants requiring heightened agency scrutiny is then discussed during a public meeting with the NRC Commissioners at the agency's Rockville, Maryland, headquarters.

NRC RESPONSE TO PLANT PERFORMANCE

The quarterly reviews of plant performance, using both the plant operator's reported performance indicators and NRC inspection findings, determines what additional action, if any, the NRC will take if there are signs of declining performance. This approach to enforcement is intended to be more predictable than previous practices by linking regulatory actions to performance criteria. The process uses five levels of regulatory response with NRC regulatory review increasing as plant performance declines. The first three levels involve response by the appropriate regional office. The next two levels call for an agency response, involving senior management attention from both headquarters and regional offices.

The Reactor Oversight Process uses various tools for dealing with declining plant performance and violations. These tools are used in a predictable manner that is commensurate with the decreased safety performance. NRC actions may include meetings with the plant operator, additional inspections, and required stronger action by the agency, including a civil order or even the suspension of the operating license. (See NRC Response Plan)

NRC Response Plan or "Action Matrix"

Assessment of Plant Performance (in order of increasing safety significance)	NRC Response
I. All performance indicators and cornerstone inspection findings GREEN • Cornerstone objectives fully met	**Normal Regional Oversight** • Routine inspector and staff Interaction • Baseline inspection program • Annual assessment public meeting
II. No more than two WHITE inputs in different cornerstones • Cornerstone objectives fully met	**Response at Regional Level** • Public meeting with NRC and plant management • Plant operator corrective actions to address WHITE inputs • NRC inspection follow up on WHITE inputs and corrective action
III. One degraded cornerstone (two WHITE inputs or one YELLOW input or three WHITE inputs in any strategic area) • Cornerstone objectives met with minimal reduction in safety margin	**Response at Regional Level** • Public meeting with NRC and senior regional management and plant management • Plant operator self-assessment with NRC oversight • Additional NRC inspections focused on cause of degraded performance
IV. Repetitive degraded cornerstone, multiple degraded corner stones, or multiple YELLOW inputs, or one RED input • Cornerstone objectives met with longstanding issues or significant reduction in safety margin	**Response at Agency Level** • Public meeting with NRC Executive Director for Operations and senior plant management • Plant operator improvement plan with NRC oversight • NRC team inspection focused on cause of degraded performance • Demand for Information, Confirmatory Action Letter, or Order
V. Unacceptable Performance	**Response at Agency Level**

VIOLATIONS OF NRC REQUIREMENTS

Each violation of NRC requirements found during NRC inspections is evaluated to determine its effect on plant safety and risk. If the violation is of very low safety significance, it is discussed in NRC's inspection report with no formal enforcement action. Through its corrective action program, the plant operator is expected to deal with the violation correcting the violation and taking steps to prevent a recurrence. The issue may also be reviewed during future NRC inspections.

If the NRC risk evaluation finds that the violation has higher safety significance, a Notice of Violation will be issued. A Notice of Violation may also be issued if the licensee fails to correct a violation of low safety significance in a reasonable period of time or if a violation is found to be willful.

The Notice of Violation requires the plant operator to respond formally to the NRC identifying its actions to correct the violation and what steps it will take to prevent the violation from occurring again. The agency then reviews the operator's actions in a later inspection.

Normally, these violations are not the subject of a fine. However, some violations may warrant a fine because of their unusual significance. These violations are likely to be uncommon. Possible examples include exceeding a safety limit specified in a reactor license or the inadvertent startup of a reactor.

In addition, some violations call for the traditional enforcement approach, including the possible issuance of fines.

Examples include:

- Discrimination against workers for raising safety issues or other willful violations.
- Actions that may adversely affect the NRC's ability to monitor utility activities, including failure to report required information, failure to obtain NRC approval for plant changes, failure to maintain accurate records, or failure to provide the NRC with complete and accurate information.
- Incidents with actual safety consequences, including radiation exposures above NRC limits, releases of radioactive material above NRC limits, or failure to notify government agencies when emergency response is required.

PERFORMANCE INFORMATION AVAILABLE TO THE PUBLIC

Information on plant performance is updated each quarter on the NRC's web site where performance histories and inspection findings are also available. Full inspection reports are available on the web site, in the NRC's online document collection called "ADAMS," and from the NRC's Public Document Room.

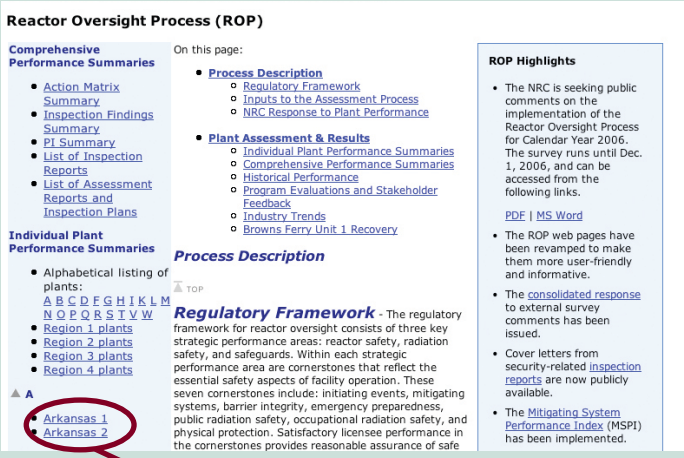
The performance indicators and the assessment of inspection findings are placed on the NRC web site using the color notation of their significance green, white, yellow, or red. The statistics and NRC inspection findings which underlie the color notation are also posted on the web site.

The Reactor Oversight Process is instrumental to the NRC's highest priority and commitment to the day-to-day business of overseeing operating reactors to make sure they continue to operate safely.

Additional information on the Reactor Oversight Process is available at NRC's web site at: **http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/index.html.**

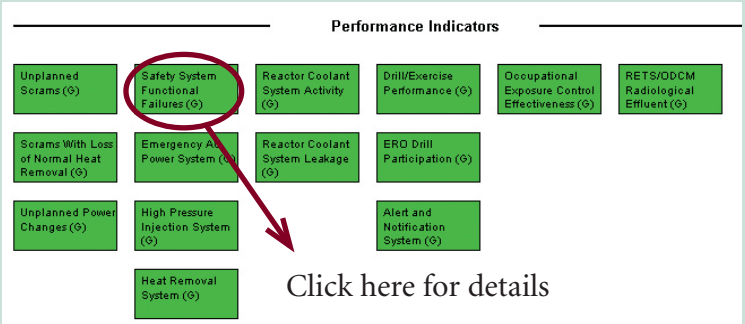
PERFORMANCE INFORMATION ON NRC WEBPAGES

http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/index.html



Step 1
Click here on plant name

Step 2



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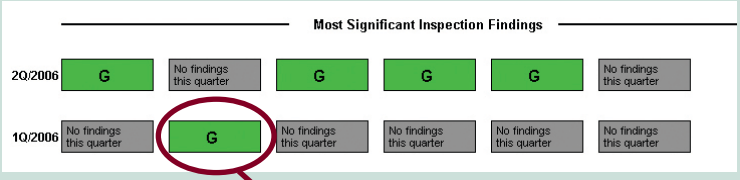

Click here for details

GLOSSARY

ADAMS—Agencywide Document Access and Management System.

Baseline Inspection Program—The normal inspection program performed at all nuclear power plants. The program will focus on plant activities that are not adequately measured by performance indicators, on the corrective action program, and on verifying the accuracy of the performance indicators.

Cornerstone of Safety—Nuclear plant activities that are essential for the safe operation of the facility. These cornerstones are grouped under the categories of reactor safety, radiation safety, and safeguards.

Corrective Action Program—The system by which a utility finds and fixes problems at the nuclear plant. It includes a process for evaluating the safety significance of the problems, setting priorities in correcting the problems, and tracking them until they have been corrected.

Cross-cutting Area—Nuclear plant activity that affects most or all safety cornerstones. These include the plant's cornerstone action program, human performance, and "safety-conscious work environment."

Inspection Reports—Reports are issued periodically to document inspection findings. These may cover a specific time period for the baseline inspection or a particular event or problem examined in a reactive inspection. All inspection reports are public documents and, when issued, are posted to the NRC's internet web site.

Performance Indicator—Objective data which records performance in a specific cornerstone of safety at a nuclear power plant.

Reactive Inspection—An inspection to examine the circumstances surrounding an operational problem or event occurring at a nuclear plant.

Reactor Oversight Process—The NRC's program to inspect, evaluate, and assess the safety performance of commercial nuclear power plants.

Regulatory Conference—A meeting between the NRC staff and a utility to discuss potential safety issues or to discuss a change in performance as indicated by a declining performance indicator or inspection finding. These meetings are open to public observation unless they cover security issues, NRC investigation findings, or similar sensitive topics.

Resident Inspector—An NRC inspector assigned to a nuclear plant on a full-time basis. Each site has at least two resident inspectors.

Risk-informed—Incorporating an assessment of safety significance or relative risk in NRC regulatory actions.

Safety Conscious Work Environment—An environment in which employees feel free to raise safety concerns, both to their management and to the NRC, without fear of retaliation and where such concerns are promptly reviewed, given the proper priority based on their potential safety significance, and appropriately resolved with timely feedback to employees.

Safety Culture—the assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.

Significance Determination Process—The process used by the NRC staff to evaluate inspection findings to determine their safety significance. This involves assessing how much the inspection findings increase the risk of nuclear operations.

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11. ABSTRACT *(200 words or less)*

The Nuclear Regulatory Commission has an established oversight process to inspect, measure, and assess the safety performance of commercial nuclear power plants and to respond to any decline in plant performance. The Reactor Oversight Process focuses inspections on areas of greatest risks, applies greater regulatory attention where there are plant performance problems, uses objective measurements of performance, gives the public timely and understandable assessments of plant performance, and provides responses to violations in a predictable and consistent manner that corresponds to the safety significance of the problem.

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