

New Performance Index Provides Closer Look At Nuclear Plant Safety Systems

March 2006

Key Facts

■ The U.S. Nuclear Regulatory Commission provides oversight of nuclear power plant performance in three major areas: reactor safety, radiation safety and security. To assess plant performance, the NRC evaluates the results from 18 performance indicators for each nuclear power plant, in addition to the results from its baseline and supplemental inspection program. The agency posts these evaluations on its public Web site.

■ Since its inception in 2000, the reactor oversight process has relied on safety system unavailability (SSU) performance indicator to assess safety system performance. The NRC and the industry recognized that the SSU indicator had significant shortcomings in that it did not adequately address safety system reliability—that is, how well systems will perform if needed.

■ The NRC and the industry have developed and tested a substitute indicator that provides a more accurate assessment of these systems. The result is the mitigating system performance index (MSPI). The index uses existing equipment perform-

ance data industry baseline performance data, and safety-importance weighting factors derived from plant probabilistic safety assessments to evaluate plant equipment performance.

■ The MSPI has numerous advantages over the previous method. It provides information on both the availability and reliability of safety systems. The data are readily accessible, making it easier and more efficient for the NRC to verify performance data during inspections. In addition, because it uses the latest probabilistic safety information, the MSPI will help the NRC focus its inspection resources on areas important to safety.

■ The industry has developed guidance for plants to use in implementing the MSPI and has conducted industry training. The industry and the NRC have reviewed implementation documents to ensure the guidance is implemented properly at each nuclear plant.

The NRC's Reactor Oversight Process

The NRC is responsible for safety oversight of nuclear power plants and other commercial applications of nuclear

materials. The nuclear energy industry, which operates 103 power reactors, is the agency's largest regulatory sector.

Nuclear power plant oversight has three elements: inspection, assessment and enforcement. The NRC monitors plant performance in seven "cornerstones" of safety pertaining to reactor safety, radiation safety and safeguards (security):

- **initiating events:** the frequency of events that challenge safety functions
- **mitigating systems:** the availability and reliability of equipment used to minimize the effects of challenges to safety functions
- **barrier integrity:** the soundness of structures and systems that block avenues for potential radiation releases in the event of fuel damage
- **emergency preparedness:** plant capabilities for responding to an emergency
- **occupational radiation safety:** effectiveness of controlling worker exposures to radiation



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- **public radiation safety:** performance in meeting regulatory requirements concerning radiation releases
- **physical protection:** effectiveness of security programs.

Within each of these areas, the NRC has established one or more performance indicators—a total of 18 indicators.

The NRC assesses reactor performance through a combination of inspections and data on the 18 indicators. Performance in each indicator is measured quarterly and falls into one of four color-coded bands:

- **Green:** Performance is within expected norms. The plant is maintaining a more than sufficient margin of safety in the area covered by the indicator.
- **White:** There has been a slight reduction in the margin of safety. The NRC increases oversight of corrective actions.
- **Yellow:** If an indicator dips into the yellow band, NRC inspectors will determine what is causing the reduced performance, and the agency will ensure the plant operator takes appropriate corrective actions.
- **Red:** The plant's performance, while technically safe, is

significantly below expectations. The plant's operator faces rigorous NRC scrutiny.

Each reactor reports the indicator results to the NRC quarterly. Resident NRC inspectors at each nuclear power plant site perform inspections to determine if plant personnel are reporting the data properly. The NRC posts the quarterly color-coded results for each performance indicator—along with inspection findings—on its Web site at:

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

If a nuclear plant fully meets its performance objectives, the NRC will apply its baseline inspection resources, which cover all key areas. Plants with declining performance will receive additional NRC regional- or agency-level attention.

New Indicator: A Closer Look at Safety Systems

The NRC is replacing the original indicator of mitigating system performance—SSU—with one that provides a better indication of performance: the MSPI.

What Are Nuclear Plant Mitigating Systems?

Mitigating systems include those that provide emergency cooling water for the nuclear fuel and their support systems, such as emergency AC power and support system cooling. Their basic function is to keep the temperature and pressure

within the reactor's containment structure—which surrounds the reactor—within safe limits.

Limitations of the Previous Safety System Indicator

When the NRC adopted the current reactor oversight process in 2000, the agency used SSU—a World Association of Nuclear Operators (WANO) indicator—to assess safety system performance. The NRC and the industry recognized several problems with this indicator:

- Although it provided an indication of how long the systems were out of service (including maintenance), it did not fully address the reliability of their performance. The capability of a system to perform its safety function includes two components: system availability and system reliability.
- The indicator attempted to address reliability by measuring “fault exposure” time—the number of hours that a mitigating system is unavailable before being detected. However, there is no efficient, objective way to measure this.
- The WANO and NRC definitions used in the SSU differed, requiring system engineers to calculate multiple indicators to measure the same performance.
- The indicator did not reflect current knowledge about the

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safety importance of various plant systems, which the NRC and the industry have gained through 40 years of reactor operations and state-of-the-art probabilistic safety studies.

- The SSU considered only the average performance of several sets of equipment. It did not take into account the relative safety importance of individual equipment sets. This approach could mask safety concerns or overemphasize matters of little safety importance.

During the past several years, the NRC and the industry worked to develop a more accurate assessment tool—the MSPI.

The MSPI obtains information on safety system performance from WANO and the Institute of Nuclear Power Operations. It factors in industry baseline performance data and safety-importance weighting factors and compares the results to baseline plant equipment performance.

Assigning Safety-Importance Weights

The NRC and the industry have extensive experience with probabilistic safety assessment (PSA), and the NRC is incorporating the insights from this tool into its regulations. Adding safety-importance weights to a reactor performance indicator is a

natural next step in NRC oversight.

The industry and the NRC have developed guidance on safety-importance weighting for the MSPI. The industry has held workshops to provide training on applying the guidance, and plant PSA experts have used the guidance to determine the appropriate safety weights for the systems and components in their facilities.

Ensuring Safety-Importance Weights Are Appropriate

Plants routinely use their probabilistic safety assessments in operations and maintenance. They will use these same PSAs in assigning MSPI safety-importance weights. The quality of a PSA is important for all applications.

Industry peer teams have reviewed the PSAs for all U.S. commercial reactors. In addition, the NRC has found that, when it adds plant-specific information to its standardized PSA models, the combination provides consistent information. Following this review, the NRC has determined that current plant PSAs are acceptable for providing the safety-importance weights used in the MSPI.

MSPI Enhances NRC Inspection Effectiveness

Overall, the MSPI will help focus NRC inspection resources on the most safety-significant issues.

The NRC's initial inspection at each reactor will look at system definitions, or scope; component selection; success factors; historical data; and the MSPI safety-weight factors.

Keeping the Public Informed on Safety

The NRC Web site will show color-coded information on the performance of individual reactors. The NRC will provide information on how reactor safety has been affected by the availability of safety systems and the reliability of those systems.

The NRC Web site also includes a link to the performance indicator guideline so those who are interested can learn how the MSPI indicator is calculated.

This fact sheet also is available at www.nei.org.