RECOMMENDATIONS TO IMPROVE THE SENIOR MANAGEMENT MEETING PROCESS

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This report presents the results of a study we conducted to ascertain how the Nuclear Regulatory Commission can improve the timeliness and thoroughness of its plant-safety assessments. In compliance with the statement of work, we looked at the dominant and recurring characteristics of plants placed on the Watch List for safety concerns and the process that culminates in the Watch List --the semi-annual Senior Management Meeting (SMM). We made findings and have developed recommendations based on a primary goal of improving the decision-making process of the SMM. If carried out, our recommendations should not only improve the consistency and objectivity of this process, but will make it more discernible to the industry and public, while also ensuring more expedient identification of problem plants.

The NRC continuously monitors and assesses the performance of power plant licensees to verify that plants are operating safely. To do this, the NRC uses various methods including: regulations, technical specifications, license conditions, and orders. The NRC also has the authority to inspect licensee facilities to gain independent assurance that licensees are operating safely. A part of the performance assessment process is the SMM, which was established following a 1985 nuclear reactor incident. The NRC established the SMM as a forum for senior managers to assess operational safety performance and to identify declining trends in operational safety.

In this executive summary, we will highlight some of the more significant findings and recommendations of the Watch List and SMM processes. First, it is important to lay out some general observations about the NRC, its culture and the environment for making decisions. The NRC culture is highly structured and homogeneous; it puts a high premium on technical knowledge and experience, particularly NRC experience. However, these characteristics can both help and hinder decision-making. The culture is risk averse due to the safety implications of an error in this environment. The organization is also hierarchical, which creates situations wherein expressing a contrary viewpoint does not seem a highly rewarded behavior. With this is mind, we designed many of the recommendations to maximize the culture's positive aspects and to minimize the negatives, particularly as they affect decision-making.

Although virtually all key participants in the Senior Management Meeting process are highly trained and technically proficient individuals who thrive on facts, subjectivity heavily influences Watch List decisions. Furthermore, the proverbial playing field is uneven, with regional administrators dominating the process. Seldom do their views not prevail, whether the issue is to discuss a problem plant or to place it on the Watch List. Of course, a strong case may be made that their dominant role is appropriate, given the regional administrators' knowledge of and proximity to the plants. On the other hand, the form, structure and purpose of the process are intended to foster participation. Further, tremendous time and expense go into collecting objective data, particularly data regarding problem plants. On balance, however, we believe that NRC senior managers underutilize these data; by almost any measure, the decision-making process is highly subjective and minimally values objective indicators. NRC decision-making strives to achieve zero defects when it comes to safety. To attain this certainty, the decision-making process, as well as the indicators used, must be highly effective and closely comply with best practices. This report is designed to help the NRC achieve these best practices.

Arthur Andersen's findings and recommendations address both performance and process issues involved in making decisions. These were derived utilizing the Arthur Andersen Business Improvement Model (shown in Chapter 1 as Figure 1), which emphasizes the value and benefit of integration and holistic thinking. It consists of four main parts: strategy, structure, process, and information and technology. In the center of the model, representing their importance to the process, are people and culture. Surrounding the model are the NRC's stakeholders, such as the public, Congress and the utility industry. We use the four main categories (strategy, structure, process, and information and technology) to organize our report and to show how these areas must be integrated to improve performance.

Strategy

Findings

- The NRC considered characteristics relating to safety and risk in past Watch List decisions.
- Based on the Integrated Performance Model, the NRC appears to react to problems rather than anticipate them.

Recommendations

- Link the SMM decision-making process more closely with objective performance indicators instead of retrospective assessments.
- Shift the strategy from assessing the management and operational causes of events to assessing management and operational factors in order to improve performance.

Structure

Findings

- The NRC's decision-making process is dominated by the regional administrators, allowing little room for dissenting or contradictory information or viewpoints.
- The roles and responsibilities of some of the senior managers are not clear.
- Presentation of information is not balanced and structured which can lead to a lack of objectivity and unevenness.

Recommendations

- Attain a better balance in the SMM decision-making process so that all participants' opinions are heard.
- Sharpen and clarify roles and responsibilities within the SMM decision-making process. Re-invent the process to engage various disciplines and points of view within the organization. Use of the recommended model (see Strategy and Process) will help, but change in some structural relationships and roles may be advisable.
- Shift the basis of decision-making from subjective to objective criteria.
- Design the structure of the SMM to ensure greater participation in the decision-making process for all those attending.
- Consider using consensus decision-making techniques, such as a facilitator at screening meetings or Senior Management Meetings.

Process

Findings

- The current SMM process provides a viable framework for decision-making. In fact, our analysis of the process maps indicates the process is logical. However, inconsistencies exist in the implementation of this process.
- The current SMM process identifies most of the poor-performing plants for discussion.
- With respect to the SMM decisions, the NRC's actions sometimes have been slow. The criteria used for this assessment include: (1) the opinions of NRC senior managers and (2) an analysis of lag times between poor-performance indicators relative to NRC actions.
- There are not clear criteria for various SMM actions. As a result, the major stakeholders do not fully understand how the SMM works, the importance and balance applied to a range of data and indicators, or the criteria used for Watch List decisions. Interviews with licensees revealed they do not have a clear understanding of what gets them on or off the Watch List.
- The outcomes of the SMM have not been consistent. Outcomes have been added to the process over the years. Some, such as Trending Letters, have been formally added through a Commission decision. Others, such as meetings with the Board of Directors, have evolved informally.
- Deregulation may create economic stresses that have the potential to affect safety performance.

Recommendations

- Reduce reliance on subjective judgments by increasing the focus on objective performance data. Develop and implement the Integrated Performance Model. Present the indicators in a more rigorous and structured way and systematically assess leadership and operations factors to illuminate performance trends and facilitate Watch List decisions. The following should characterize initial discussions of each plant.
  - ◊ Consensus on indicators
  - ◊ Consistent presentations and formats
  - ◊ Clear Criteria
  - ◊ Rebuttable presumptions based on criteria
  - ◊ Formal use of performance indicators

- Use new economic indicators to assess economic pressures on the industry, with the intent of predicting and increasing the awareness of potential problems with plants' operations. We have recommended several indicators after consulting with financial and utility industry experts.

- The NRC should also develop a better process for compiling the public record of SMMs. Specifically, the minutes should be more complete, accurate, and precise. One way to do this would be to begin to provide actual transcripts of the meeting.

Information and Technology

Findings

We found that, due to the following factors, the NRC has difficulty absorbing much of the data which serve as inputs to the SMM process:

- A great deal of unprioritized data gathering and reporting inundates the senior managers;
- Information for making performance assessment decisions, such as plant discussions and SALP, remains inconsistent despite steps to improve it;
- The NRC uses a great deal of manual effort to assimilate the information used throughout its decision-making processes. Thus, there is inadequate availability of information upstream, downstream, and across offices due to a reliance on traditional paper-oriented documentation. The NRC is revamping its document handling system and building an inspection database. When completed, these initiatives should both improve the NRC's information-sharing capability and reduce the time inspectors spend producing reports.

Recommendations

- Re-engineer the current performance information to better support the SMM and other NRC processes.
- Improve the consistency of performance assessments by establishing and enforcing the use of consistent criteria.
- Continue to work toward providing timely access to relevant information through increased automation.
- Restrict the content and volume of the information SMM participants are required to absorb. Also, format and display the provided information in a manner that is easy to comprehend.

Conclusion

The problems that our findings and recommendations address here and in the report tend to be systemic. Their roots lie in the type of decision-making used; the roles involved in the process; and a reliance on subjective judgments. Ultimately, more discipline and rigor, expanded participation, and greater independence and objectivity should enter the process. The fact that the NRC is willing to take a hard look at itself shows its commitment to improve. Building upon its many strengths, the NRC should maintain its commitment to continuous improvement.

Next Steps

Upon review of our report by the NRC and its senior officials, any accepted recommendations should form a plan of action. The NRC may carry out many of the recommendations by introducing a model and process for Watch List decision making. During the time between the submission of this report and full implementation, important steps to follow include:

- Approval and adoption of recommendations by the NRC;
- Development of an action plan and implementation timeline;
- Decisions on model and data to be used; and
- Sessions to train and familiarize NRC SMM process participants with the new process.

In addition to the recommended model, the Commission and staff should develop indicators of success for the whole process. In part, this effort would involve developing a continuous improvement mechanism to better assess the NRC's success in its mission.

Other decisions the NRC should make include the following:

- Revising roles and responsibilities in the SMM decision-making process;
- Strengthening the role of independent analysis;
- Recognition of improvements in the performance of Watch List plants; and
- Initiate a broad study of NRC information needs and the introduction of technologies.

We recommend that a key NRC official take overall responsibility for carrying out the approved recommendations. This official should report to the Commission on progress and any impediments.

Introduction

The mission and scope of the NRC are addressed in the following organizational mission statement: "to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the use of nuclear materials in the United States. The NRC's scope of responsibility includes the regulation of commercial nuclear power reactors; non-power research, test, and training reactors; fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and the transport, storage, and disposal of nuclear materials and waste."[1]

In undertaking its mission, the NRC utilizes a budget of $473 million and a full-time staff of 3,000, dispersed between the headquarters in Washington, DC and its four regional offices. The NRC recovers the vast majority of its regulatory support costs through licensee fees, although the NRC budget authority is shrinking. A large portion of the NRC staff and budget are utilized to oversee the operations of 109 nuclear utilities, whose electrical supply constitutes 20 percent of the electricity consumed in the United States.

The NRC is currently in the process of an organizational and structural transformation. Given this, it is interesting to note that throughout the history of the nuclear industry, the NRC has transformed its regulatory focus on several occasions. Each of the past transformations have developed based on an improved understanding of the elements of risk and safety, often as a result of a significant operational incident at a U.S. nuclear power plant. Three most notable incidents are the Browns Ferry Fire (1975), Three Mile Island (1979), and the Davis Besse Loss-of-Feedwater Accident (1985).

At its inception, the NRC focused on safety by regulating the engineering, design, and construction of new plants. The primary regulatory tool was the licensing process, which forced a utility to meet stringent design and construction criteria in order to earn an operating license. In those days, less emphasis was placed on oversight of operational safety, hence the onus was left on the utility to operate safely. As new insights have been gained from analyzing the incidents cited above, the NRC's mission has evolved to concerning itself with both the safe operation of nuclear power plants and the licensing of plants. The oversight of plant safety is primarily concerned with the risk of damage to public or environmental health.

One watershed event, marked by the Davis Besse Loss-of-Feedwater incident in June, 1985, led to the creation of the Senior Management Meeting (SMM). The SMM was established in order to provide a forum for the NRC's upper-management to evaluate the operational safety performance of nuclear power plants.[2] The SMM has become an increasingly important NRC tool in the evaluation of plant operations and safety. However, external confusion over the purpose and outcome of the SMM

[1] U.S. Nuclear Regulatory Commission. "Mission and Organization", World Wide Web site, 10 December, 1996, p. 1.
[2] U.S. Nuclear Regulatory Commission. "Guidance for Senior Management Meeting and Plant Evaluation Processes", SECY-96-093. 1 May 1996, p. 1.

decision-making process has led to intense scrutiny. This recent scrutiny has come in the form of critical media coverage, as well as pressure from Congress.

With the heightened public, congressional and internal criticism of the NRC, the NRC has recognized the importance of improvement. Therefore, it has embarked upon a variety of efforts to bring about change. First, the NRC began reorienting its mission and strategy. Included in this initiative is an organization-wide strategic assessment and rebaselining. Second, this study was commissioned to support the transformation of the SMM process. Finally, the recent announcement of the reorganization of the NRC's upper levels demonstrates further changes.

The reorganization, announced December 2, 1996, may facilitate improving the SMM decision-making process. Based on the announcement (effective as of January 5, 1997) the NRC is organized along the following lines:

- *The Commission*, heads the NRC and consists of five commissioners appointed by the President and approved by the Senate for five year terms.
- The *Executive Director of Operations, Chief Financial Officer, and Chief Information Officer* each report directly to the Commission and are responsible for the day-to-day management of the NRC and its staff.
- The *Deputy Executive Director for Regulatory Effectiveness, Program Oversight, Investigations, and Enforcement* directly oversees the Office for Nuclear Regulatory Research, the Office for Analysis and Evaluation of Operational Data, the Office of Investigations, and the Office of Enforcement.
- The *Deputy Executive Director for Regulatory Programs* oversees the Office for Nuclear Reactor Regulation, the Office for Nuclear Material Safety and Safeguards, the Office of State Programs, and all regional offices.
- The *Deputy Executive for Management Support* oversees the Office of Administration, the Office of Personnel, and the Office of Small Business and Civil Rights.

The NRC's Mission of Safety

The Atomic Energy Act of 1954, as amended, authorized the NRC to license, regulate, and inspect the design, construction and operation of domestic nuclear power plants. The NRC has performed all of these functions, while shifting the agency's focus from regulating construction to monitoring the plants' operations for safety. Both the NRC and the utilities play integral roles in improving the safety of the industry. Based on the NRC's Performance Indicators, which are consistent with industry's data, the ability of nuclear power plants to protect public health and safety has significantly improved over the last ten years.[3]

The NRC's safety philosophy permeates its licensing and regulatory functions. Formally, its philosophy is comprised of several closely interrelated elements:

[3] Towers Perrin. "Nuclear Regulatory Review Study - Final Report", October 1994, p. 5.

- *Defense in Depth.* Ensure that successive measures are incorporated into the design and operating procedures of nuclear installations to protect against failures that could have serious public or national security consequences. For example, the NRC requires nuclear reactors to have multiple safety systems to control and contain the radioactive materials used.[4]

- *Licensee Responsibility.* The licensees are ultimately responsible for the safe operation of their facilities; the NRC relies on them to identify and report problems.

- *Regulatory Effectiveness.* Since safety is paramount, certain standards and practices will be required, whatever the cost, to ensure adequate protection. Over and above this baseline, additional safety upgrades will be required only if their benefits justify the additional cost.[5] In a past report by Towers Perrin, licensees viewed the NRC's efforts in this area positively: "The NRC's formal rules and technical specifications were unanimously reported by licensees to be effective in supporting safe plant operations. Licensees not only consider them important to safety, but they also consider compliance with formal rules and orders generally straightforward and achievable."[6]

- *Safety Culture.* The NRC recognizes each licensee's responsibility to establish and maintain a set of attitudes that ensure safety.

- *Accountability to the Public.* " Just as the licensees are accountable to the public, so is the NRC accountable to the American people and their elected representatives. For the NRC, part of accountability entails being candid with the public about what it is doing and why, as well as acknowledging the public's interest in safety issues and its right to know."[7]

The NRC continuously monitors and assesses the performance of power plant licensees to verify that plants are operating safely. The NRC uses several methods including: regulations, technical specifications, license conditions, and orders. The NRC also has the authority to inspect licensee facilities to gain independent assurance that licensees are operating safely. To accomplish this it has established a formal inspection program. Although the licensees are ultimately responsible for the safe operation of their facilities, the NRC inspection program is also "... intended to anticipate and preclude significant events and problems by identifying underlying safety problems."[8]

The NRC's upper-management conducts a semi-annual assessment of plant performance during the Senior Management Meeting (SMM). The SMM represents only one of several processes intended to facilitate the early identification of plants posing a safety concern and reallocation of NRC resources to address these concerns.

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[4] NRC Strategic Assessment and Rebaselining, Strategic Planning Framework. "NRC's Mission, Vision, and Goals", 1996. p. 8.

[5] NRC Strategic Assessment and Rebaselining, Strategic Planning Framework."NRC's Mission, Vision, and Goals", 1996. p. 8.

[6] Towers Perrin. "Nuclear Regulatory Review Study - Final Report", October 1994, p. 6.

[7] NRC Strategic Assessment and Rebaselining, Strategic Planning Framework. "NRC's Mission, Vision, and Goals", 1996. p. 23.

[8] U.S. General Accounting Office, Nuclear Regulation: Weaknesses in NRC's Inspection Program at a South Texas Power Plant, (RCED-96-10) 3 October 1995, Appendix I:1, citing NRC's 1994 Annual Report.

The Senior Management Meeting

Following a 1985 nuclear reactor incident, the NRC established the SMM to provide a forum for senior managers to assess operational safety performance.[9] "The primary goal of the SMM is to identify declining trends in the operational safety performance of individual plants so that early corrective actions can be implemented."[10] If a plant's safety performance appears to be declining significantly or is engendering concerns, the upcoming SMM may discuss it. The NRC places plants whose performance warrant the most concern on its Watch List.

Watch List Categories

- Category 3--Shutdown plants that require NRC authorization to operate and that the NRC will monitor closely.
- Category 2--Plants authorized to operate, but with close NRC monitoring. For plants that are having or have had weaknesses warranting increased NRC attention, a period of demonstrated improvement is required.
- Category 1--Previously Category 2 plants that have corrected identified weaknesses, which no longer warrant special NRC attention.

The Executive Director of Operations leads the SMMs, which include the participation of regional administrators and NRC office directors. The senior NRC managers discuss plants that have demonstrated superior performance, but concentrate primarily on developing agency actions for those whose performance is of the greatest concern. Senior managers also may decide to: (1) not take any action regarding the plant, (2) place the plant in one of the three Watch List categories, (3) send a "Trending Letter" to the licensees of plants whose performance is significantly declining or (4) take other steps to demonstrate their concern. "The performance assumptions used by senior managers to place plants on the Watch List are also used to determine whether a Trending Letter should be sent to a licensee."[11] Trending Letters are generally reserved for licensees with declining operations, but whose performance is not inferior enough to warrant placement on the Watch List. Note, however, that the guidance also allows the SMM to take other steps. For example, the NRC has held meetings with a utility's board of directors and has issued letters asking the licensee to respond with its intended actions for improvement, rather than place the utility on the Watch List or send a Trending Letter.

The SMM process uses this flexibility to devise an appropriate response to each plant. The NRC has an array of data available from which to make decisions, as well as many decision points within the process, and can discuss the information deemed relevant in the manner it considers to be most effective. Flexibility without structure, however, creates inconsistent outcomes that are difficult to explain to outside observers of the process, such as the utilities and Congress. In recognition of

[9] SECY-96-093, p.1.
[10] SECY-96-093, p. 1.
[11] SECY-96-093, p. 3.

this problem, the Commission requested that the NRC staff conduct a study of the Senior Management Meeting and its associated decision-making process.

Context of the Study

SMM variability and flexibility make for a process that is opaque to observers (i.e. the public, the utilities, the Commission itself) and thus provides the context of this study. The NRC has expressed a desire to explore opportunities for making the process more scrutable. Therefore, this report concentrates on two major discussions:

- The major steps in the SMM process (the inputs, how the SMM process functions, recommendations for improvement) and
- How the NRC Performance Indicators have been used in the past, how they correlate with past SMM decisions, and how they may be used in the future.

The Commission has asked that the issue of scrutability be addressed through an analysis of the SMM process and an analysis of the use of performance indicators in Watch List decisions.[12] In response to this, the NRC staff has presented the Commission with written guidance that is meant to do the following:

- Improve the staff's process for performing integrated assessments of licensee performance;
- Enhance the consistency in regulation among headquarters and the regions, and
- Reinforce the objectivity of the SMM process, including the identification of supplemental actions that the NRC should consider when a plant remains on the Watch List for an extended period of time.[13]

NRC Chairman Shirley Jackson has stated that, while the written guidance will make the process more transparent to licensees, the methodology for handling problem plants should include trigger points for NRC action. There should be consequences – including possible shutdown – for a plant remaining on the Watch List for an extended period. The Chairman suggested the staff should consider establishing an *independent group* to develop indicators to further address dominant and recurring characteristics among problem plants.[14] The NRC contracted with Arthur Andersen in response to this consideration.

Statement of Work

This project follows a statement of work that outlines what the NRC wants to accomplish and the material to be covered. Specifically, the statement of work requires Arthur Andersen to identify the following:

[12] NRC Memo (#M960625) 28 June 1996.
[13] SECY-96-093, p. 2.
[14] Transcript of Commission Briefing held June 4 - 5, 1996, pp. 18-19.

- The characteristics, measures and indicators that have been, could be and should be used for placing plants on and removing them from the Watch List;
- The major components of the process that have been, could be and should be used for Watch List decisions; and
- The characteristics, measures and indicators that relate systematically to nuclear safety and result in an improvement in the *objectivity, consistency, quantification and timeliness* of the Watch List plant identification process. (Emphasis added)

Arthur Andersen is also required to integrate other relevant materials into its discussion and analysis of the SMM process. The statement of work required the incorporation of a technical analysis of performance indicators and a definition of the relationship between indicators and risk. A technical contractor, Idaho National Energy Labs (INEL), was hired to perform a statistical analysis of possible performance indicator correlation to poor performance. A synopsis of preliminary results is included in our discussion on the use of performance indicators and how indicators may improve the objectivity, consistency, and timeliness of the process. The NRC has drafted a performance model that demonstrates the relationship between characteristics, measures and indicators with plant safety – the "Risk-Based Performance Model." Arthur Andersen's review has been focused on achieving each requirement and providing the NRC with a functional analysis of the SMM process.

Arthur Andersen's Methodology

To familiarize ourselves with the NRC's culture and processes, we attended a number of information sessions. The NRC staff was very generous with its time, providing us with extensive resources for use in learning about the SMM process, specifically, which characteristics, measures and indicators the agency has developed or tracked for evaluating licensee compliance and safety performance. The analysis of this and other data gathered throughout the project fall into three main parts:

- Building and analyzing the databases and matrices for characteristics, measures and indicators (including information gathering and extensive interviewing);
- Analyzing the Performance Indicators; and
- Building and analyzing an SMM process map and input analysis.

The Characteristics, Measures and Indicators Databases and Matrices

After organizing our project around characteristics, measures and indicators databases, Arthur Andersen developed and tested a template for tracking the information provided in the SMM Executive Summaries. Using this template, Arthur Andersen developed an extensive database to track the attributes mentioned most often in the written record. The database covers the information contained in the SMM Executive Summaries that encompasses: the plant discussion section (used at the Screening Meeting); the SMM minutes, and the transcript of the Periodic

Briefing on Operating Reactors and Fuel Facilities, where the SMM findings are presented to the Commission and to the general public.

The following products of the database mentioned above were contained in the first deliverable to the NRC:

- *Discussion/Representative Plant Frequency Analysis* provides a comprehensive analysis of criteria mentioned most often in the written record for: selecting plants for discussion, including plants on the Watch List, removing plants from the Watch List, or issuing a Trending Letter;
- *The Discussion Plant Matrix* includes summary information of plants discussed at the SMM (using information from the January and June SMM Executive Summaries for 1994 and 1995);
- *The Representative Plant Matrix* provides a close-up of the NRC process for changing the status of a licensee, that is, placed on the Watch List, removed from the Watch List or issued a Trending Letter;
- *The Superior Performer Matrix* identifies the criteria for recognizing a licensee as a Superior Performer and contrasts them with the criteria used to identify a Discussion Plant; and
- *The Interview Matrix* provides a preliminary evaluation of information about characteristics, measures and indicators derived from senior-management interviews.

The information gathered for the first deliverable became the steppingstone to the next two stages of the project: evaluating the SMM process through more interviews and documentation, as well as analyzing current and future performance indicators to determine their ability to contribute to a more scrutable, consistent, objective and timely process.

Interviews

In accordance with the statement of work and to increase the information with which to analyze the SMM process and its inputs, we interviewed senior NRC staff (headquarters and the regions), resident inspectors, regional staff and licensee management. The list of individuals interviewed and the locations visited can be found in Appendix V. To prepare for the interview schedule, Arthur Andersen provided the NRC with a list of topics likely to be discussed. The senior NRC staff interviews focused on the following:

- What information they value in making performance decisions; and
- How they felt about the Watch List process; and
- What role each individual plays in the process.

Inspector and regional staff interviews focused on these components:

- What they consider to be critical performance factors and how they communicate this to the NRC;
- What inputs they provide for the SMM process; and
- How they perform their duties.

Utility management interviews focused on these components:

- Their understanding of the SMM process;
- Critical factors they use to assess plant performance; and
- Their suggestions for performance indicators.

Performance Indicator Analysis

The purpose of this analysis is to discern whether or not performance indicators can be used as the primary tool in the decision-making process. We looked at the trends of the performance indicators for nine-and-a-half years to assess the relationship of the performance indicators to the SMM process.[15] All of the NRC's Performance Indicators, except for cause codes, are included, along with allegations and enforcement actions.[16]

Individual plant performance was measured against the average performance of all plants and compared to the SMM activities. The SMM actions include: Plants not discussed at the SMM, Category 1 plants, Discussion plants with no action taken against them, Trending Letter plants, Category 2 plants, and Category 3 plants.

Senior Management Process Map

A process map illustrates how a decision works and what its inputs are. We evaluated various options for the process map in order to find the format that would best demonstrate the flow of the SMM, the players and their respective roles, and the source of decision-making. The main steps taken to draft the process map were these:

- Information gathering (written documents and interviews);
- Input analysis; and
- Mapping the SMM process (Screening Meeting, SMM, Commission briefing).

To begin this task, the team reviewed formal guidance (for example, Management Directive 8.13). From this review, a list of inputs, such as inspection reports and enforcement action information, to the Screening Meeting and the SMM was created. The analysis shows not only where information originates, but also where that information is incorporated into the process and which players use it. It can also point to gaps in information, duplicative information, or where the information is used most. The results of the input analysis can be found in Appendix IV. As the inputs were being researched, the steps in the process were put into a flow chart. This involved using the written guidance to determine: major decision steps, key players, and the timing of the steps (order of process).

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[15] The period of assessment is from the first quarter of 1987 to the second quarter of 1996. It should be noted that data beginning in 1991 may be more comprehensive and meaningful because: it is more current; the senior management meetings settled into its current pattern in 1991; and because the allegations and enforcement data used in this analysis only dates back to 1991. Additionally, the allegations and enforcement data is not covered in the first two quarters of 1996.

[16] Performance Indicators: The performance indicators analyzed include automatic scrams while critical, safety system actuation's, significant events, safety system failures, forced outage rate (summed over four quarters), collective radiation exposure, and equipment forced outage rate per 1000 commercial critical hours. Cause Codes were not included in the set of performance indicators analyzed.

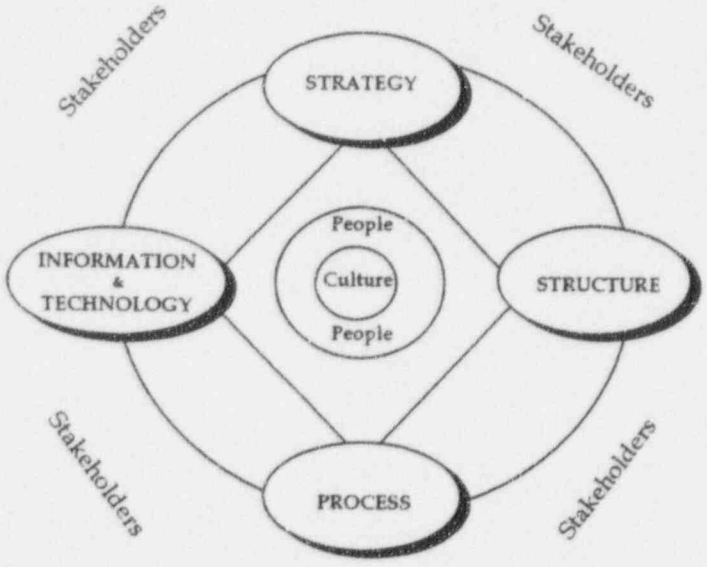
To enhance the maps, NRC staff reviewed them for accuracy and terminology and met with the team to make corrections and suggestions. The completed process maps are located in Appendix III. Additionally, the team conducted resident-inspector interviews and attended portions of the November, 1996 Screening Meeting.

Business Improvement Model

Arthur Andersen's experience indicates that process changes will not be successful and effective unless they are designed, built, and executed in a holistic framework. Therefore, to provide such a framework for the analysis of the SMM decision-making process, we use our Business Improvement Model. This model places considerable value on understanding and strengthening the linkages among four key areas: strategy; structure; process; and information and technology.

Accordingly, we have organized our report to resemble the Business Improvement Model by separating our findings and recommendations into the four key areas. The model, shown in Figure 1, illustrates the holistic approach to problem solving. Notice that each subset within the model is interconnected to and influenced by all other subsets. This model is effective because it offers a ground-up framework to achieve change, from the establishment of goals, to processes by which to implement them. Therefore, this model is important to the SMM decision-making process because it assists the NRC in analyzing whether its current procedures meet its goals, and if not, how to proceed so its procedures will do so.

Figure 1 Business Improvement Model



The following definitions describe each subset of the Business Improvement Model, including the model's four key areas:

Strategy: Strategy is the approach employed to attain a specific goal. To further its mission of safety, the NRC is looking to make the SMM process more objective, consistent and timely. Strategies are suggested to assist the NRC in making the SMM process more scrutable and to meet these specified goals.

Structure: Structure is the facilitating agent between strategy and process. Once a strategy is decided upon, structure organizes the players, their roles and responsibilities, and even their dynamics. Structure inherently allocates -- and, ideally, balances -- power. As important as it is to put a plant on the Watch List, it is best to make the decision based on the best possible information, varied as it may be.

Process: This section of the model incorporates the steps needed to implement the strategy. Process improvements are made to strengthen decisions and to improve their timing. When a process works systematically, consistency and objectivity improve. The process section of this report is especially important to improving the SMM decision-making scrutability.

Information and Technology: Information and technology represents the data organizations need to make key decisions regarding strategy, resources and actions. As technology advances, the speed at which organizations must make decisions increases. Organizations must develop mechanisms to identify requirements, collect information, analyze data and distribute the analysis to those who need it.

People and Culture: People and culture form the core of this model and are interconnected to each of the four cornerstones. The cornerstones cannot be enacted without the assistance and involvement of the NRC's people. Likewise, unless the NRC culture is oriented toward accepting positive change, improving the SMM decision-making process will be very difficult.

Stakeholders: Existi ,g on the fringe of the model are NRC stakeholders, which include the general public, Congress, utilities, customers, and the financial community. Although stakeholders do not play an integral role in the model, they do play an integral part in the evaluation of the adequacy of NRC products and results. The adequacy of results has a direct relationship with the effectiveness of the model or the framework producing those results.

Definitions of Terms

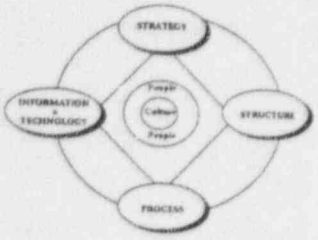
Table 1 provides definitions of terms used throughout this report. The purpose of this list is to clarify any vagueness surrounding the use of defined terms.

Table 1 Definitions of Terms

Term	Definition used in this report
Characteristic	Aspects of a plant's behavior that are important to safety performance. (Statement of work)
Indicators	Quantitative combinations or arrangements of measures that suggest or predict a characteristic that affects performance. (Statement of work)
Lagging Indicators	Indicators that reveal past characteristics.
Leading Indicators	Indicators that predict future characteristics.
Measures	Aspects of plant operation that are directly observable through data collection or inspection. (Statement of work).
Performance Indicators	The NRC's Performance Indicators: automatic scrams while critical; safety system actuations; significant events; safety system failures; forced outage rate; equipment forced outages per 1,000 commercial critical hours; collective radiation exposure; and cause codes.
Scrutable	Capable of being deciphered; comprehensible.
Senior Management Meeting Process	Generally, the inputs to the SMM, the Screening Meeting, the SMM itself and the Commission briefing.
Site, also Plant	Location of one or more nuclear reactors.
Transparent	Readily understood.
Unit	Nuclear reactor.

Conclusion

The NRC, in its desire to improve, finds itself with an opportunity to significantly enhance its performance assessment methods. By implementing the recommendations cited in this report, the NRC can achieve an increasingly consistent, timely, and objective decision-making process. Such a process will provide scrutable performance assessments that will improve the NRC's credibility with stakeholders, such as the public, utilities, and Congress.



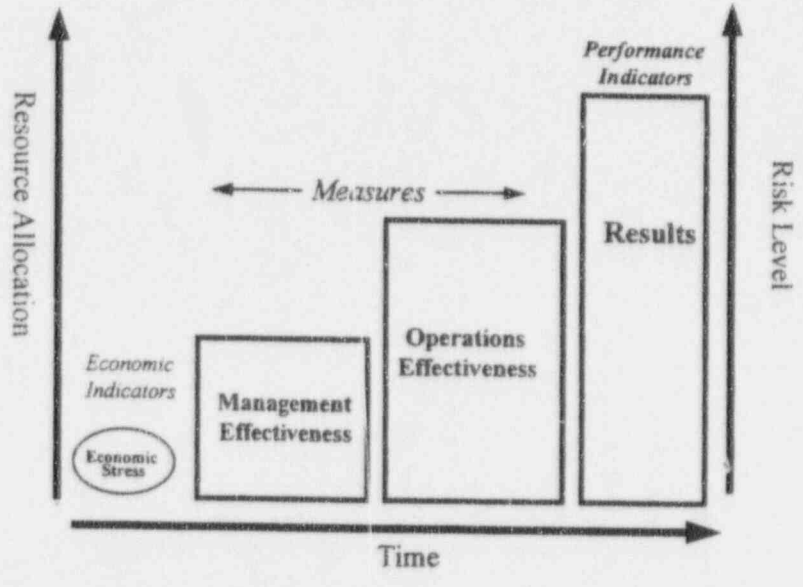
Strategy

The top of the improvement model involves building a successful strategy -- the approach to achieving overall goals. In this section, we examine the NRC's strategic focus relative to an Integrated Performance model developed by Arthur Andersen for this assignment. After two months of examining documents and interviewing those involved in the SMM decision-making process, the model coalesced into our findings.

Integrated Performance Model

In order to analyze the NRC's strategic focus and put any recommended changes in context, it is helpful to provide a highly simplified conceptual framework. This framework called the Integrated Performance Model, , shown in Figure 2, highlights the interrelationships between several key elements including: (1) indicators or measures of economic, management, operations and results; (2) resource allocation; and (3) risk.

Figure 2 Integrated Performance Model



This simple model illustrates the continuum of factors that can be used to assess plant performance. When integrated, the four main categories—economic stress, management effectiveness, operations effectiveness and results—could provide the NRC with not only the ability to understand where potential problems might exist,

but also, an avenue for action with the licensee before the licensee ever becomes a formal discussion plant.

As one moves along the continuum from left to right, poor performance takes more resources to reverse and implies a higher risk to safety. Since this model is conceptual, the size of the bars merely denotes relative risk and resource needs, rather than proportionality. Still, it is clear that plants with poor results are likely to have the highest safety risk and will need the most resources to turn around. Conversely, plants that are just beginning to feel economic stress have a relatively low risk and require fewer resources. The importance of actual plant performance should not be overlooked. Although the ability to predict future plant performance is essential in an efficient regulatory framework, the results of plant performance are determinants of whether or not a plant is placed on the Watch List.

As one moves right along the bottom axis, each category influences the outcomes of the next, starting with economic stress and ending with results. As an illustration, one could imagine that a licensee is under tremendous cost pressures due to deregulation. By itself, this economic stress does not have an immediate safety risk. This economic stress influences management effectiveness since management must decide how to respond. The management response will then affect operations, either positively or negatively, which will later appear in the results. Clearly, it takes time for changes in one area to affect the next. If the economic stress causes management to make a poor decision, the risk increases, along with the resources required to turn around poor performance.

Recognizing the importance of risk to NRC's primary safety mission, we incorporated risk into the Integrated Performance Model. The model includes most of the primary, secondary and tertiary characteristics in the Risk-Based Performance Model provided by the NRC for this project (see Appendix I). We outline the relationship between the two models below.

Table 2 Integrated Performance Model: Relationship to Risk-Based Performance

Integrated Performance		**NRC Risk-Based Performance**[17]
Results	⟶	Primary Characteristics
Operational Factors	⟶	Secondary Characteristics
Management Factors	⟶	Tertiary Characteristics
Economic Stress	⟶	Tertiary Characteristics

The Risk Level axis in the Integrated-Performance Model illustrates that, as one moves right along the time-axis, the risk of a safety significant event increases. This is because the later the NRC is able to predict performance trends, the less likely it is the NRC will be able to encourage sound plant performance. Thus, if the NRC focuses its attention solely on the results stage of the model, it will be unable to prevent impending downturns. The effect illustrated by the Risk Level arrow correlates directly to the Risk-Based Performance Model. By devoting more resources to proactive analysis, the NRC may significantly reduce risk by communicating issues of concern early enough to allow

[17] Appendix I, p. 2.

the licensee time to reverse an adverse trend. In the context of the Risk-Based Model, this would translate to increased attention to the early warning signals evident when observing secondary or tertiary performance characteristics i.e., organizational factors and economic stress.[18]

Findings

Chiefly, we found that rather than strategically anticipate—and therefore mitigate or avoid—events, the NRC comes to terms with them in their aftermath. This is where the NRC focuses its considerable analytical powers. In short, we found that the NRC must change its strategy from one that reacts to one that anticipates; from retrospection that ultimately conveys few enduring lessons to proactivity that takes advantage of the NRC's strengths.

The NRC's Current Strategic Focus

Our analysis of past Senior Management Meetings shows that the NRC has considered, to some degree, each of the four factors in the Integrated Performance Model.[19] The NRC also found a correlation between safety, risk, and the characteristics considered in past Watch List decisions.[20] However, these factors tend to be evaluated retrospectively -- in the context of an event that has occurred -- rather than prospectively.

Figure 3 Factors Considered in Past Senior Management Meetings

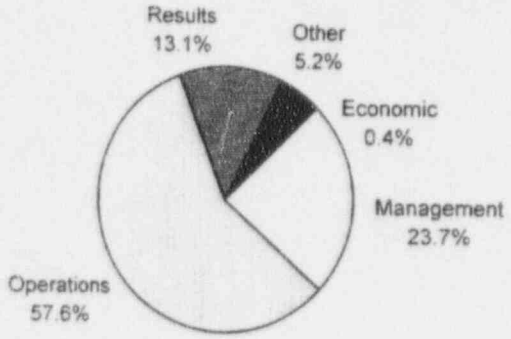


Figure 3 shows factors included in the material that SMM participants read before their deliberations. The issue is not so much that factors *are* discussed as *how*.

Results—Documents reveal that in preparing for SMMs the NRC analyzes each plant, relative to its peer group, using eight Performance Indicators. These indicators include: automatic scrams while critical, safety system actuations, significant events, safety system failures, forced outage rate, equipment forced outages per 1,000 commercial critical hours, collective radiation exposure, and cause

[18] Appendix I, pp. 3-5.
[19] Characteristics, Measures & Indicators Used in Watch List Determinations, Arthur Andersen Interim Deliverable to the NRC. 11 October 1996.
[20] Appendix I, p. 2.

codes. In practice, however, these quantifiable, objective indicators tend to be peripheral. None of the senior managers we interviewed mentioned the Performance Indicators as a primary decision criteria.

Operations – Based on our analysis of SMM documents, most of the NRC's focus is on operational events, that is, safety breakdowns. Based upon this observation, it may seem as if the NRC is following the Integrated Performance Model; however, plant performance assessments, found in the SMM Executive Summaries, tend to focus on analyzing the operational causes of particular events rather than attempting predict performance through a systematic assessment of operations effectiveness. Such a retrospective analysis is not likely to be timely. Therefore, the NRC is not following the Integrated Performance Model since its assessment of operational factors tends to follow, rather than precede, events.

Management – Although management proved to be a significant factor, our review revealed that assessments of leadership generally fell into two categories. First, many of the SMM Executive Summaries highlighted personnel changes and management's improvement plans. However, these assessments often did not evaluate the results of improvement plans. The second type of management assessment that occurred was an evaluation of management's actions in response to an event.

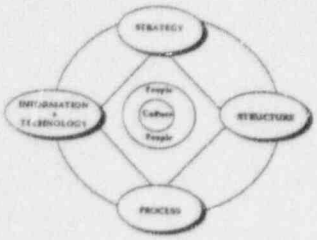
Economic Stress – Economic factors are a relatively new consideration for the NRC. As a result, as documented, senior managers have seldom considered them.

Recommendations

The NRC might change its strategic focus and improve its timeliness by instituting the following two-step process:

1. *Focus on Performance Indicators* – The NRC now relies little on its set of Performance Indicators to assess and compare plant performance. In our analysis, discussed fully in Chapter IV, we found that the NRC could take more systematic action against problem plants by simply analyzing trends using the performance indicators. Our suggested approach to using performance indicators is discussed in detail in Chapter IV.

2. *Become more proactive* – Instead of evaluating the leadership and operational causes of past events, the NRC should evaluate economic, management and operational factors in order to prevent future events. Given the economic forces behind production and safety, assessing indicators of economic stress and management's response to them ahead of time should allow the NRC to achieve these improvements:
   - Earlier identification of problems;
   - Fewer safety risks to the public; and
   - Earlier and less costly resolution of problems.



Structure

We now move to the structure subset in our Business Improvement Model. Structure is the facilitating agent between strategy and process. Once a strategy has been decided upon, structure organizes the players, their roles and responsibilities, and even their dynamics. Structure inherently allocates -- and, ideally, balances -- power. As important as it is to place a plant on the Watch List, it is best to make the decision based on the best possible information, as varied as it may be. Therefore, we have aimed for a structure that encourages both participation and inclusion.

Findings

We have found the NRC's decision-making process to be dominated by the regional administrators' views. This is well-illustrated in the process maps, located in Appendix III, where a myriad of the process steps are completed by the regions. In a hierarchical environment, such as the NRC's, it may be difficult for other key players to challenge them. For example, several interviewees described the Office of Analysis and Evaluation of Operational Data's (AEOD) role as providing an independent voice. During our recent observations of the Screening Meetings however,[21] the regional administrators were able to act as gatekeepers when it came to presenting AEOD information on the Performance Indicators.

Typically, during the Screening Meeting, the regional administrator presents each plant in the region. Interviewees stated and our observations of the most recent Screening Meetings confirmed, that other offices or divisions routinely present neither contradictory nor supporting information about plants, a time-honored pattern. In addition, some of the senior managers we interviewed felt that their role had not been clearly defined. Because of this, a lack of objectivity or unevenness may result.

While participants in the SMM described the decisions as consensus, they did not feel as if all voices were heard. One senior manager, while describing the meeting as collegial, stated that the managers participate little, if at all. Some even described the discussion as "controlled," with questions and opinions being indirectly discouraged. As a result, the knowledge and experience of the entire group are not brought to bear on its decisions.

This process can impede timeliness and objectivity by downplaying such alternative tools and sources of insight as the Performance Indicators. Based on our observations of the Screening Meeting and analysis of past SMM documents, it seems as though the Performance Indicators were mentioned but rarely focused upon. Formal oral presentation of the Performance Indicators and other information

[21] Arthur Andersen attended the SMM Screening Meetings at NRC headquarters on November 13 and 20, 1996.

such as allegations were not provided in a structured manner. However, the Performance Indicators were available in supplied documents. We should note that, based on our observations of the most recent SMM Screening Meetings, the use of alternative tools was somewhat apparent.

Recommendations

Roles and responsibilities in the SMM decision-making process require clarification and sharpening. We believe that the NRC should even the playing field by redefining the roles of individuals in SMM decision-making. This would create a more robust process by engaging various disciplines and points of view from within the organization. Difficult decisions will be made easier and will appear more objective by incorporating alternate and independent sources of information into the evaluation. Additionally, information foundations will be broadened and greater support will be aligned among members of the agency once decisions are made. True consensus is no small benefit.

Arthur Andersen believes it is advisable to elevate the importance of independent information in the decision-making process. Several NRC offices, such as AEOD, Allegations, Enforcement and Research, utilize their time and resources collecting independent information on plant performance. The SMM discussion and decision-making process should be restructured to allow for formal presentation of this independent information. Indeed, the reorganization of the upper levels of the NRC, recently announced by the Chairman on December 2, may help to accomplish increased independence for several offices and divisions. The creation of the position of Deputy Executive Director of Operations for Regulatory Effectiveness, Program Oversight, Investigations and Enforcement appears to emphasize an improved balance of information. The Chairman described her intent in her address to the NRC staff: "The genesis for this grouping of NRC offices is the Commission's belief that the NRC needs to establish a high-level program evaluation focal point, independent of the line organizations with responsibility for the day-to-day regulatory programs." [22]

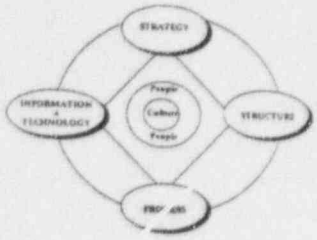
The NRC should consider using a professional facilitator to achieve a more interactive, participatory process. A facilitator could also support a more systematic approach to structuring and presenting information and could promote widespread participation. Everyone involved in the SMM Process should have a well-defined role and should be expected to actively participate in the discussion, thereby taking ownership in the resulting decisions. Despite the added complexity, the process would benefit both in vitality and strength.

In both the Screening and the Senior Management Meetings, the basis for making decisions should shift from the subjective to the objective. A systematic discussion of plant performance would be the best way to begin. Relevant data would be presented in a uniform format, including recent information and longer term trends. Supporting and conflicting information would be actively solicited from the regional

[22] U.S. Nuclear Regulatory Commission. "Remarks To All Nuclear Regulatory Commission Employees By Dr. Shirley Ann Jackson, Chairman U.S. Nuclear Regulatory Commission ", World Wide Web site, 2 December 1996.

administrators, the Office of Nuclear Reactor Regulation (NRR), and any other departmental members.

In the next chapter, we describe the process we advocate for analyzing and interpreting data. Additionally, we offer a sample format illustrating both the short-term results, as well as the long-term trend.



Process

The process section of the framework involves how work is accomplished. It includes how people, within the structure, provide direction, do work, interact, influence each other, make decisions, and use information and technology. This section reviews NRC's current SMM decision-making processes and offers recommendations for their improvement. Our recommendations focus on devising a systematic decision-making process in order to enhance timeliness, objectivity, and consistency.

Findings

In general, we believe that the individuals involved, the data available, and the breadth of areas discussed are in place to make effective decisions during the Senior Management Meeting. The SMM process appears to identify most of the poorly performing plants, but is inconsistent in placing them on the Watch List. However, we have a number of concerns regarding the process including:

- The inconsistency in the decisions, or outcomes, of Watch List determinations relative to timing or even severity of action.
- The lack of clear criteria from which to make decisions.
- The lack of clarity as to the value and use of Trending Letters or other tools short of placing plants on the Watch List.

Our analysis of the SMM process reveals that the outlined structure of the process is logical. This is illustrated by the process maps, provided in Appendix III, which shows that the correct questions are asked, representatives of most offices are present, and the information inputs are sufficient to make the necessary decisions. Statistical analyses by the Idaho National Engineering Laboratory revealed that focusing on certain already existing NRC data contributes to identifying plants that should be discussed at the Screening Meetings.[23] Additionally, our analysis shows that the senior managers discussed each of the 20 plants with the worst performance.

However, inconsistencies appear during the execution of the process. Most of the NRC senior managers and utility representatives we interviewed stated that all the plants on the Watch List were appropriately placed. Questions have arisen

[23] Idaho National Engineering Laboratory. Senior Management Meeting Performance Data Additions (forthcoming), January 1997.

concerning some plants that were not placed on the Watch List. Our review of the performance indicators found that 10 of the 20 plants with the worst performance on the performance indicators were not placed on the Watch List. NRC officials we interviewed named a number of these 10 plants as likely candidates for the Watch List. Our analysis shows that the senior managers discussed each of the 20 plants with the worst performance.

We found that the NRC identified numerous plants well after plant performance had begun to decline. Therefore, we wanted to test if currently available, quantifiable data would illustrate performance trends well enough to identify problem plants more efficiently. We graphed the number of times a plant performed below par on the indicators against the mean for all plants and the SMM's actions.[24] These graphs demonstrated that the SMM process is slow to identify Watch List plants.

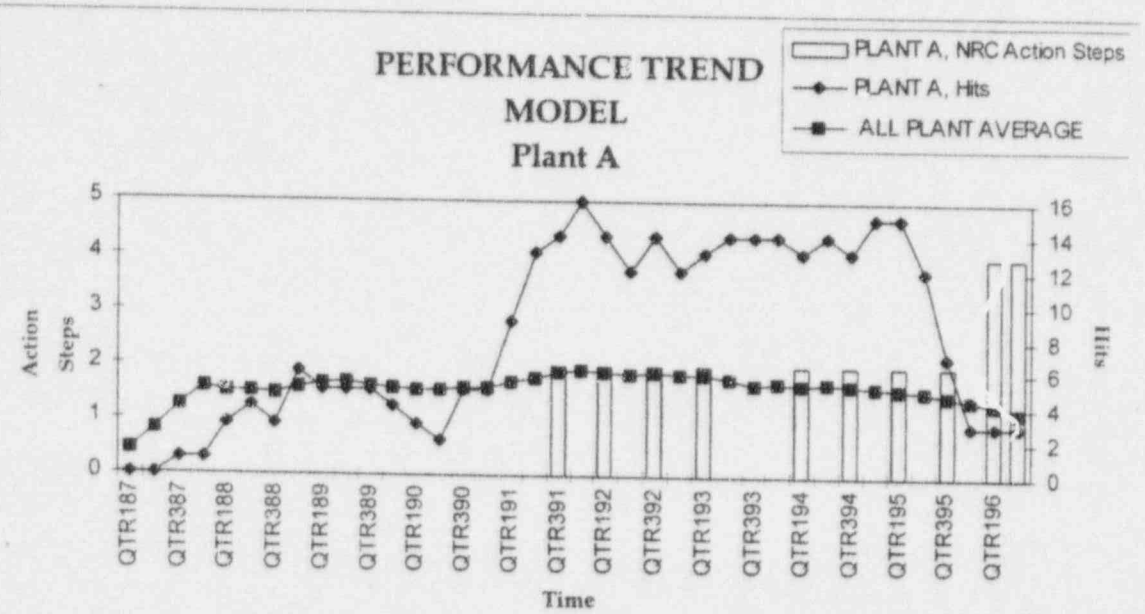
The purpose of this analysis is, also, to discern if performance indicators can be used as the primary tool in the decision-making process. We looked at the trends of the performance indicators for nine-and-a-half years to assess the relationship between the performance indicators and the SMM process (see Appendix II for a more detailed discussion). All of the NRC's Performance Indicators, with the exception of cause codes, are included along with allegations and enforcement actions. [25]

[24] A comprehensive description of our methodology and the assumptions we made can be found in Appendix II.

[25] In an attempt to evaluate plants when they are performing badly, all plants exceeding twice the mean for an individual indicator were given a "hit." Equal weighting was applied to each indicator. A threshold of twice the mean was chosen in order to isolate plant performance at a level well below average. The "hits" for each plant during a quarter were then tallied and compared to the average number of times all plants exceeded twice the mean for all indicators. Each point on the graph represents a four quarter moving total (period) of "hits." Fourth quarter 1987 is the first period containing four quarters worth of data. An additional idea, not undertaken in this report, is to base a "hit" off a fixed standard, rather than the mean of all plants.

Figure 4 illustrates the performance of a plant that is widely considered a "missed plant." Although the plant was discussed many times during its lengthy period of poor performance, it was not placed on the Watch List until its performance had actually begun to improve.

Figure 4

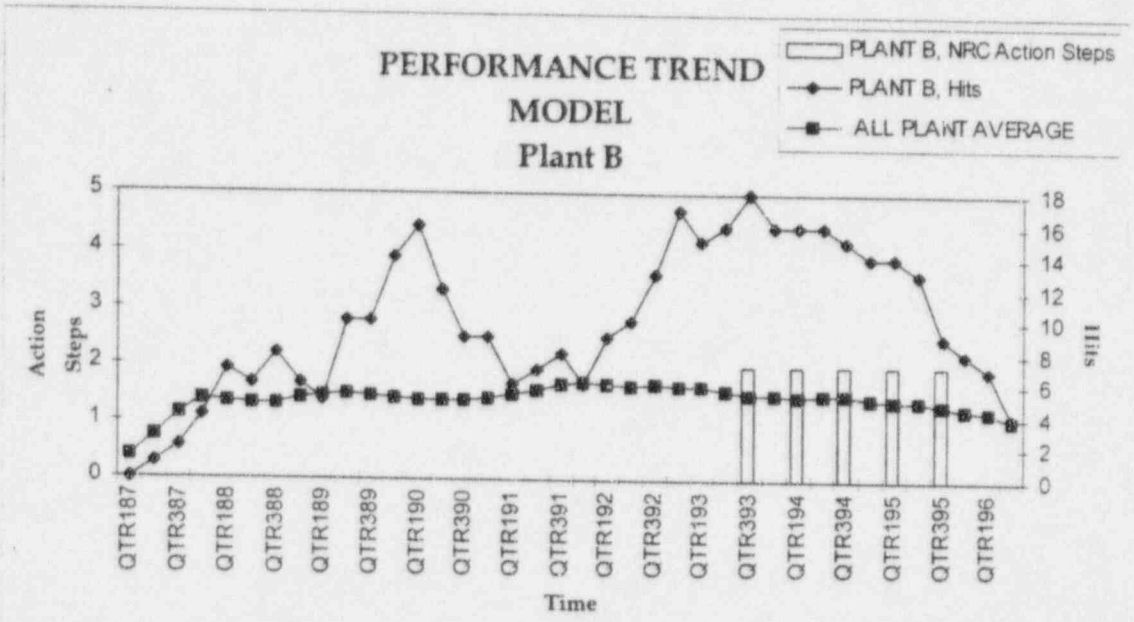


KEY TO ACTION STEPS[26]		
0 - Not Discussed	1 - Category 1	2 - Discussed but No Action Taken
3 - Trending Letter	4 - Category 2	5 - Category 3

[26] The left axis of the chart shows the possible NRC actions, as reflected in the key above, while the bars in the chart illustrate the NRC actions taken. The right axis shows the "hits." A hit is counted when performance exceeds twice the mean for any of the nine performance indicators. The "plant hit" line represents the four quarter moving total of hits. The "all plant average" line shows the mean of the four quarter moving total for all plants.

Figure 5 illustrates one specific case where the NRC was late in discussing a plant. The plant, a less than average performer since 1988, exhibited particularly low performance levels from 1992 to 1993. The SMM did not discuss it until late 1993.

Figure 5



KEY TO ACTION STEPS[27]		
0 - Not Discussed	1 - Category 1	2 - Discussed but No Action Taken
3 - Trending Letter	4 - Category 2	5 - Category 3

Applying Inconsistent Criteria

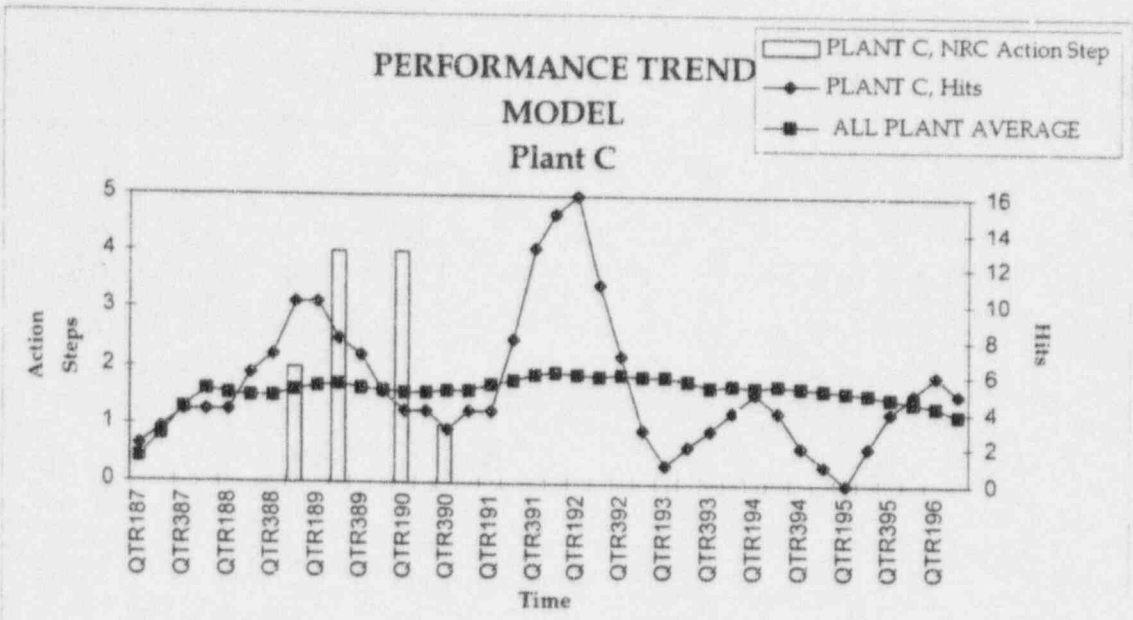
Our analysis showed inconsistencies in the SMM process due to a lack of clear, objective criteria because NRC guidance is not a specific decision-making criterion. Handbook 8.13 gives this guidance: "Generally, if the trend of a plant's performance appears to be declining significantly or there are significant concerns regarding its performance, the plant will require discussion at the upcoming SMM."[28] Although this is the most specific guidance available, it does not ensure consistent application.

Thus, decisions are influenced by subjective analysis, leading to less consistency. Plotting plant performance on graphs reveals no apparent single-period threshold of performance or trend over time that matches SMM categories. Figure 6 shows the performance of a plant placed on the Watch List after one period of performance decline. Later, however, after some improvement, performance again declined, yet the NRC did not take action.

[27] The left axis of the chart shows the possible NRC actions, as reflected in the key above, while the bars in the chart illustrate the NRC actions taken. The right axis shows the "hits." A hit is counted when performance exceeds twice the mean for any of the nine performance indicators. The "plant hit" line represents the four quarter moving total of hits. The "all plant average" line shows the mean of the four quarter moving total for all plants.

[28] Handbook 8.13. p.10.

Figure 6



KEY TO ACTION STEPS[29]		
0 - Not Discussed	1 - Category 1	2 - Discussed but No Action Taken
3 - Trending Letter	4 - Category 2	5 - Category 3

Neither how a plant performs in a single period nor its performance trend appears to mark it for discussion. In addition, the level of oversight and scrutiny appears to differ from plant to plant; some may roll off the discussion list more quickly than others even though, based on the performance indicators, the plants have similar performance. A previous NRC analysis has addressed this same issue.[30]

Detailed analysis of the SMM Executive Summaries and the SMM Minutes showed similar inconsistencies. The descriptions of plant performance within the documents would not always mesh with the conclusion of the SMM. In addition, when we compared several plants with similar performance profiles, we were unable to find consistency in the SMM decisions. Some of these inconsistencies can be attributed to aspects of the SMM process. Those interviewed told us that the regional administrators' presentations do not always emphasize the same factors as the SMM Executive Summaries.

Inconsistent Outcomes

Originally, discussion of a plant at an SMM was to result in one of three determinations for a plant: No Action; Category 2; or Category 3. These three possibilities have evolved into a series of intermediate measures meant to accommodate special circumstances. Examples of these intermediate steps include

[29] The left axis of the chart shows the possible NRC actions, as reflected in the key above, while the bars in the chart illustrate the NRC actions taken. The right axis shows the "hits." A hit is counted when performance exceeds twice the mean for any of the nine performance indicators. The 'plant hit" line represents the four quarter moving total of hits. The "all plant average" line shows the mean of the four quarter moving total for all plants.

[30] U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. Millstone Lessons Learned: Task Group Report, Part 1: Review and Findings, September 1996, p.19.

Trending Letters and meetings with the plants' Boards of Directors. Trending Letters have actually evolved into a more structured process with matching guidance. Unfortunately, no structure exists to guide the application of these intermediate steps. Some of the inconsistency has occurred because senior managers involved in the SMM have attempted to respond to recommendations from the Commission, but in their desire to do so, they have continually changed the way the SMM judges performance and acts on plants. Although these intermediate steps have value, their unsystematic use weakens the consistency of the Watch List process and partially dilutes the effectiveness of the formal action steps.[31]

Economic Trends

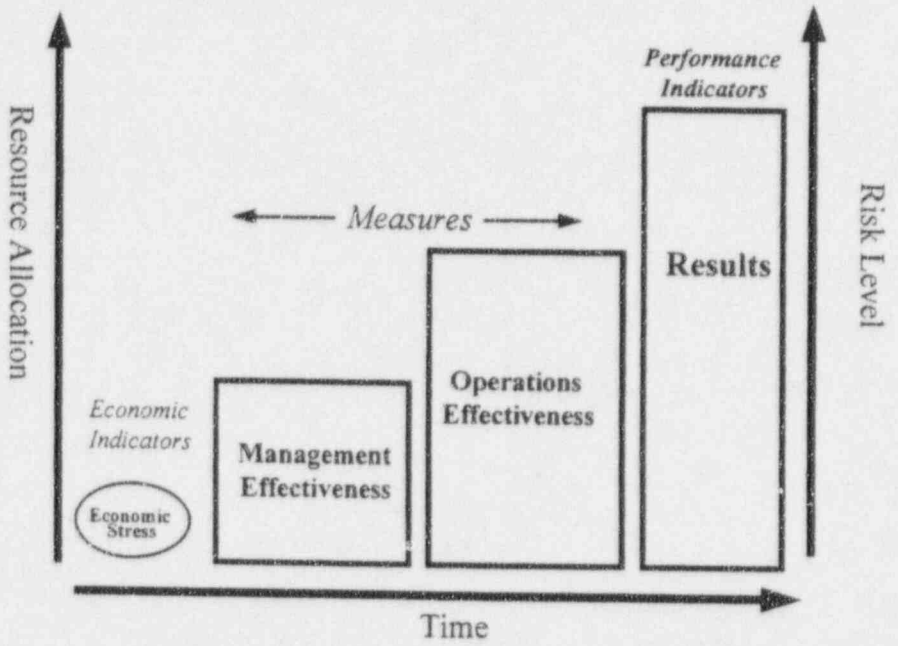
Given the pending deregulation of the utilities industry, the need for more forward-looking indicators becomes more important. Indicators of economic stress may become a guide to the future operational performance of the nuclear utilities. Increased competition brought on by deregulation may force nuclear utilities to become more cost-conscious in both operations and output. Although observers have differing outlooks,[32] the threat exists that nuclear utilities, in their desire to cut costs and increase competitiveness, will be forced to impair their operational safety and increase risk. Therefore, given the economic forces behind production and safety, economic and financial indicators may provide an early warning flag for operating performance.

[31] Management Directive 8.13. Senior Management Meeting, (Draft), p. 9.

[32] Revkin, Andrew C. "Altered Economics in Connecticut Leads to A-Plant Closing", New York Times, 5 December 1996, p. A1.

Recommendations

Figure 7 Integrated Performance Model



This section's recommendations trace the steps required to achieve the Integrated Performance strategy shown in Figure 7 and described in Chapter Two. In developing our recommended redesign of the Senior Management Meeting process, we focused on:

(1) Using the objective indicators to assess plant performance results;

(2) Systematically assessing management and operations effectiveness measures; and

(3) Selecting a set of economic indicators to enable the NRC to anticipate likely results of deregulation.

These recommendations are intended to support a consistent, objective process to identify plant performance trends early enough to prevent further problems and to reduce risk.

The integrated approach provides many potential benefits, but will require time to implement due to the complexity of the approach. The process and tools described in this section are designed to alleviate many of the conditions noted in the findings and provide the following features:

- Consistent criteria
- Ease of review
- Timely identification of problems
- Clear performance trends

- Decreased dependence on individuals' judgment
- Increased predictability
- Discussion focus
- Increased efficiency

The Process

Arthur Andersen's recommended process reduces the NRC's reliance on subjective factors by increasing the focus on objective performance data. An examination of the NRC's performance assessment process validates this shift: "NRC has an objective performance measurement system that is capable of identifying the low-end performers without the need for heavy reliance on qualitative assessments."[33] We outline the revised Watch List decision process below, italicizing any tools we describe in the next section.

I. Select Discussion Plants.

A. Use Performance Indicator data, along with enforcement and allegations, to prepare *performance trend charts*.

B. Prepare a list of potential discussion plants based on *decision criteria*. This list is used as a basis for the Screening Meeting. Discussion should focus on whether the plants identified by the model should be discussed and whether additional plants should be added. Once the NRC has adequately refined the model through the continuous improvement mechanism outlined in Step V, the agency may be able to look toward eliminating the Screening Meeting. This is not to say that the NRC should take such a radical step immediately, since work still needs to be performed on the decision-making criteria before they are deemed reliable. Instead, the NRC should first emphasize the construction and implementation of a prototype process. After instituting a prototype, the NRC can rely on continuous improvement to modify and perfect the process.

II. Prepare Senior Management Meeting Material.

A. Provide *evaluation sheets, performance trend charts,* and a list of proposed actions to SMM participants and the Commission. The proposed actions listed are prescribed according to the prototype performance criteria. (The performance criteria we used in the prototype model are outlined in Appendix II. We expect that the NRC may wish to refine the model and criteria.)

[33] Nuclear Energy Institute. Perception of the 'Gap' in Nuclear Power Plant Performance (Draft version), January 1995, p. 17.

B. Organize the information according to the severity of each proposed action: Watch List candidates, Trending-Letter candidates, discussion plants, removal candidates.

III. Conduct the Senior Management Meeting.

A. Discuss plants in order of the severity of proposed action. Thus, all the Watch List candidates are discussed first, then the Trending Letter candidates, etc. This provides consistency by allowing various plants with similar performance trends to be discussed together and in turn, compared.

B. The discussion should be focused on rebutting the presumptions outlined in the model. If a plant has been proposed to be placed on the Watch List, the discussion should be focused on why it should not and what action, if any, should be taken instead. Examples and arguments are presented to rebut the proposed action. In order to ensure consistency however, rebuttals are limited to the critical areas outlined in the evaluation sheets.

C. Reach consensus on the decision. We recommend a facilitator be used to test the strength of the consensus regarding each plant and to poll each participant to ascertain if he or she supports the decision.

IV. Brief the Commission.

A. Present the final list of plants discussed and decisions made.

B. Provide the rationale for all accepted rebuttals (where proposed action was taken, rationale is implicit in the decision-making criteria outlined in the Integrated-Performance Model).

V. Documenting the SMM's Results.

A. Document the SMM decisions including the accepted rebuttals and their rationale.

VI. Continuously Improve the Senior Management Meeting.

A. Analyze the number, proportion and pattern of accepted rebuttals to determine the effectiveness of the model.

B. Assess the completeness and usefulness of the information provided, the comprehensiveness of the evaluation measures, and the adequacy of the evaluation criteria to recognize if changes are necessary.

C. Recommend possible revisions to the information provided, evaluation measures, and criteria.

Process Tools

Several process tools are integral to the redesigned Watch List decision-making process.

Performance Trend Charts--The trend charts are designed to enable easy identification of below standard performance. We built prototype trend charts based on the current NRC Performance Indicators along with allegations and enforcement action. We made a number of assumptions, setting standards for performance at *twice* the mean for each indicator ("hit"), in an attempt to evaluate below average performance. We counted the number of times each quarter a plant performed below standard and used a moving total to show the trends. The resulting graphs provide a powerful picture of the improvement or deterioration in plant performance. Given that the NRC's current Performance Indicators may not provide an all-encompassing picture of plant performance, the NRC should review potential indicators for use in this model.

Performance Trend Model--We used the prototype trend charts to set criteria for each step in the SMM process. The criteria are outlined below.

I. To be discussed:

- A. A plant must exhibit five consecutive periods (each period consists of four quarters of data) with "hits" greater than or equal to the mean of all plants; or
- B. A plant must exhibit three consecutive periods of "hits" with deteriorating performance; or
- C. A plant must exhibit twice the mean of all plants in a single period.

II. Heightened Action Step:

- A. A plant must exhibit two consecutive periods without any improvement; or
- B. A plant must exhibit four consecutive periods above the mean of all plants; also,
- C. A plant may only receive a Trending Letter for two consecutive periods; and
- D. Category 1 plants exhibiting the characteristics of II. A. or II. B. should be moved to the Discussion Category.

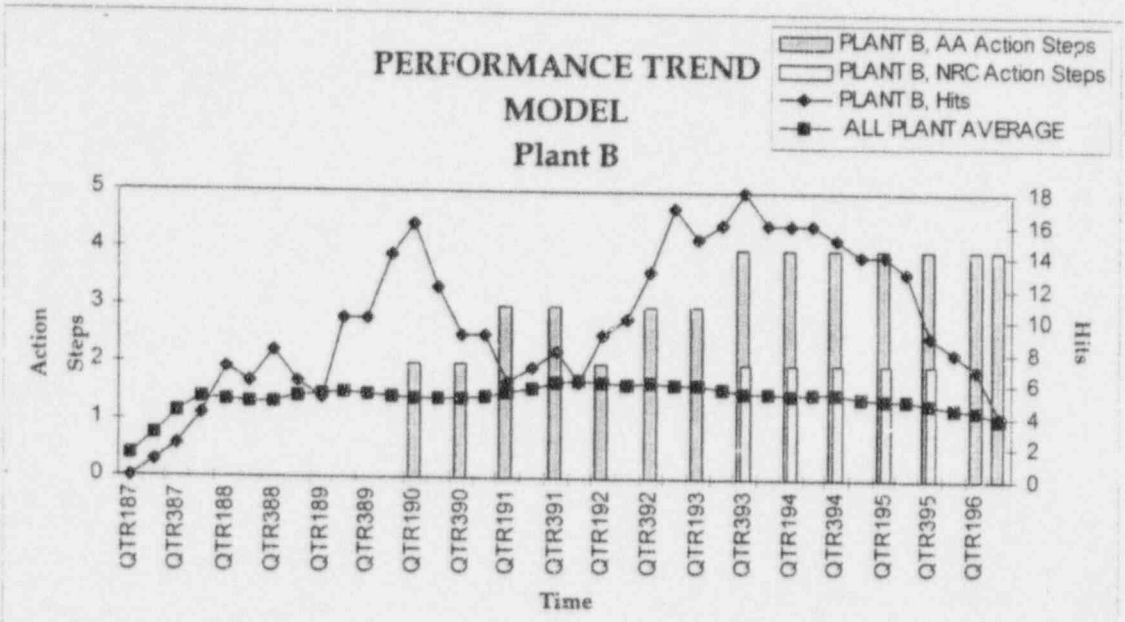
III. Removal from Discussion List:

- A. A plant must exhibit three consecutive periods below the mean to be taken from Category 2 to Category 1; then,
- B. A plant must exhibit two consecutive periods below the mean to be removed from Category 1 to Not Discussed.

These decision-making criteria we developed tends to identify poor performing plants earlier than the current NRC process.

Figure 8 shows a comparison of the results of our model with NRC actions, using Plant B. The process shown here is a recommendation to the NRC.

Figure 8



KEY TO ACTION STEPS[34]		
0 - Not Discussed	1 - Category 1	2 - Discussed but No Action Taken
3 - Trending Letter	4 - Category 2	5 - Category 3

As mentioned previously, the NRC discussed Plant B but did not place it on the Watch List. Our model would discuss the plant three-and-a-half years before the NRC did and would place it on the Watch List, which the NRC did not do. It should be noted that the plant's performance began to improve after the NRC began to discuss it at the SMM. We assume that the decline would have been arrested much sooner if our model had been used.

Evaluation Sheets--Although the Performance Trend Model is an excellent tool to enable more timely identification of problem plants, it is not predictive. And so, the NRC should focus on analyzing the management and operations factors that are precursors of poor performance. The analysis of these factors comprises the second segment of our Integrated Performance Model.

[34] The left axis of the chart shows the possible NRC actions, as reflected in the key above, and the bars in the chart illustrate the NRC actions taken. NRC actions are shown by the white bars, while the shaded bar reflects the actions defined by the AA model (see Appendix II). The right axis shows the "hits." A hit is counted when performance exceeds twice the mean for any of the nine performance indicators. The "plant hit" line represents the four quarter moving total of hits. The "all plant average" line shows the mean of the four quarter moving total for all plants.

We have noted that the NRC already considers many of the important management and operations factors in assessing organizational effectiveness. However, the proper structure to analyze each area and the expertise to understand management are lacking. The SMM's review is not done systematically so that the implications of changes in each factor can be fully understood. Instead, the SMM identifies changes in management or operations, but does not scrutinize their potential impact. A more structured presentation of data and a forward-looking assessment would assist in this endeavor. We offer the following recommendations to improve objectivity, consistency and forethought in the NRC's evaluation of the management and operations factors.

Use the template, shown in Table 3, to facilitate the Screening Meeting discussions. The template will provide consistency by measuring the same factors for each plant, on the same scale. Plant performance for these factors can be compared and systematically applied to all plants. The characteristics are intended to reflect the Risk-Based Performance Model developed by the NRC. To fully implement this tool, the NRC should develop operational definitions for each management and operations measure to provide the foundation for evaluation. The definitions should clearly delineate the differences between Excellent, Good, Fair, and Poor, while the presentation should encompass two years' worth of data so that trends can be easily distinguished. Definitions are delineated in the template based on quartiles for plant comparisons. Another possibility is to base the definitions on set benchmarks, rather than plant comparisons.

rating scale (BARS) and structured interviews. A study of organizational factors completed for the NRC. discusses these techniques fully.[35]

Finally, we recommend formal standards for presenting Senior Management Meeting information and documenting the results. First, the NRC should continue to work toward developing and enforcing a consistent standard for providing inputs to the Screening Meeting and SMM. Furthermore, we offer these recommendations:

- To improve the scrutability of the process, make transcripts of the meeting rather than writing most of the minutes in advance. The EDO's office would maintain the right to edit sensitive information from the transcripts, following a predetermined standard. The edited transcripts should be available for review by the Commission and other NRC employees. This would provide an incentive to the senior managers to adhere to consistent indicators and criteria.
- Have the Deputy EDO for Regulatory Effectiveness, Program Oversight, Investigations and Enforcement analyze these assessments, including their objectivity and consistency, in reviews of NRR and regional programs.

Getting Ahead of the Curve with Economic Stress Indicators

Due to deregulation's likely far-reaching effects, the NRC should round out its assessment of plant performance by analyzing economic stress indicators. It is important to note that these factors do not predict plant performance. Economic stress' effect on plant performance depends on plant management. Significant economic stress can lead to either performance improvements or declines. As a result, great care must be taken to use these economic stress indicators differently than the indicators of performance or the measures of management and operations.

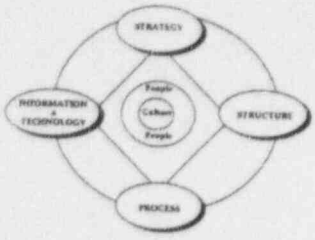
After interviewing NRC officials about the agency's needs and its goals, discussing economic stress factors with nuclear plant officials, and consulting Arthur Andersen's utility experts and Wall Street analysts, the following economic indicators are recommended:

- **Operating Cost per Kilowatt Hour** – This measure shows the operating cost effectiveness of the unit. In theory, the lower the cost per unit the more competitive is the operation. According to the licensees we interviewed, this is considered the best financial indicator of the operating effectiveness of their nuclear power plants and is used by most licensees as one of their few performance indicators.
- **Debt-to-Equity Ratio** – This is a general indicator of financial strength or leverage for public companies. An increase in the ratio over time can flag a potential deterioration of financial health and an associated increase in financial stress.

[35] Deborah Shurberg, Sonja B. Haber, and Rick Jacobs. "Techniques to Assess Organizational Factors: Progress to Date", BNL Technical Report A-3976-1-7/94, July 1994.

- **Operating Cost Trend** -- Recommend at least a three year trend. This would show either increases or decreases in spending over time. Substantial changes in spending should be understood within the context of management initiatives.
- **Capital Spending Trend** -- Recommend at least a three year trend. Capital spending reflects how organizations reinvest in their asset base. Cuts in capital spending, for sustained operations, can be a signal of financial pressure as this is usually one of the first areas cut when financial pressure increases.
- **Percent Nuclear Generating Capacity of Total Utility Capacity** -- The Wall Street analysts we interviewed stated that they believe that the financial stress of a utility increases as a function of the percent nuclear capacity of its total capacity increases, regardless of the cost effectiveness of its nuclear capacity.

There are many potential indicators of economic stress. However, we limited the recommendation to five because we believe they provide the breadth of information required by NRC. Also, they can be analyzed with readily available data. Analysis of the indicators would better enable the NRC to understand the economic changes for a company in the context of any potential safety or risk impact. We recommend someone within the NRC, independent of NRR, develop and trend this economic data. It is important that the economic data be evaluated outside the SMM process since changes in the indicators do not necessarily predict changes to operating results or risk.



Information & Technology

Information and Technology represents the data organizations need to make key decisions regarding strategy, resources and actions. As technology advances, the speed at which organizations must make decisions increases. Effective organizations must develop mechanisms to identify requirements, collect information, analyze data and distribute the analysis to those who need it.

Findings

In the past few years, the NRC has fielded some criticism for its late identification of poorly performing plants. Several studies by external parties, as well as the NRC, have validated these assertions. For example, the General Accounting Office found that, in the case of a South Texas plant, the NRC had not adequately integrated information gathered over a period of years to, "determine whether the problems indicated systemic weaknesses in the licensee's performance."[36] In analyzing the lessons learned from experiences with another plant, NRC officials recognized that because, "the NRC had been documenting a decline in performance at the site" for several years, the agency was slow to place the plant on the Watch List.[37] Factors that have contributed to this situation include these:

- The volume of information,
- Inconsistencies in information, and
- Difficulties in sharing information effectively.

Volume of Information

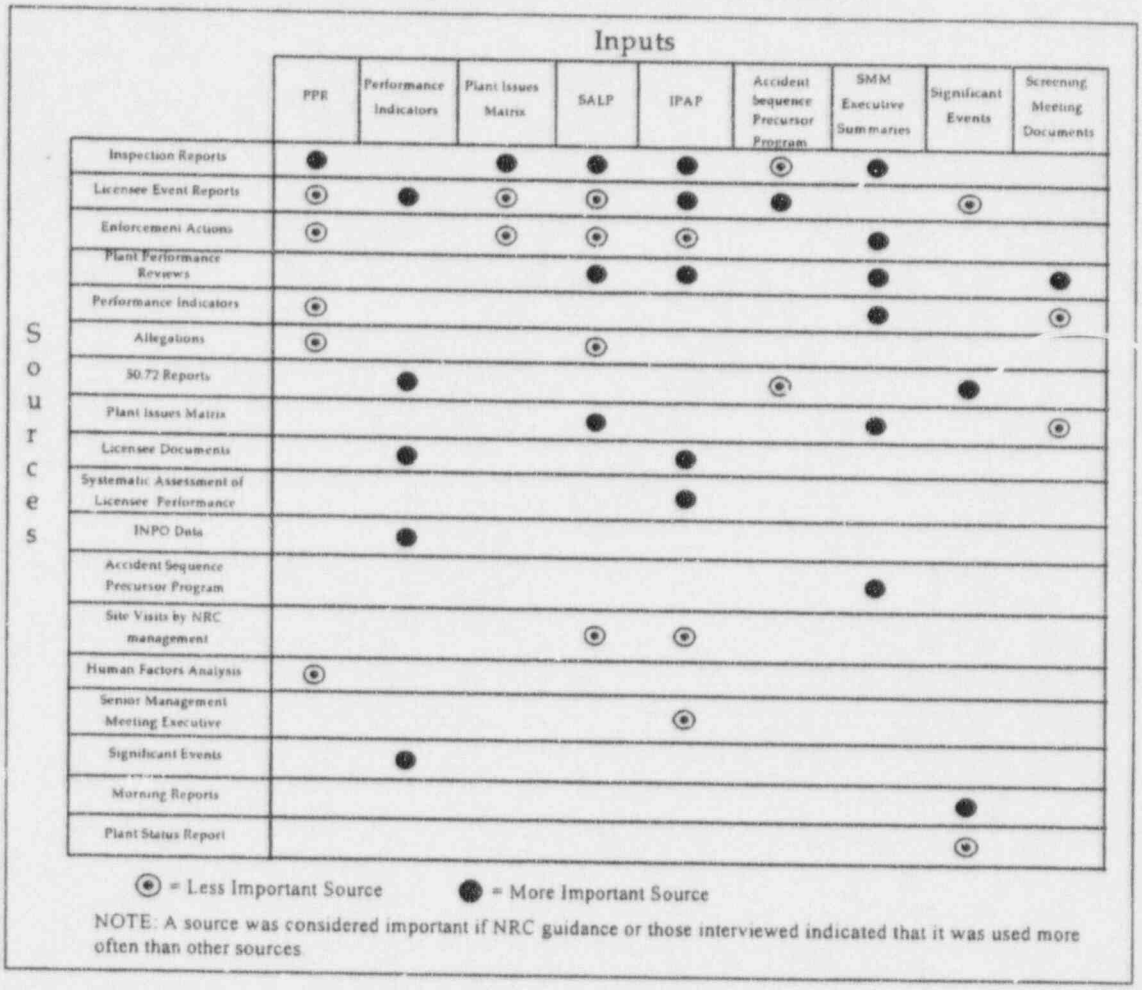
Our analysis shows that, despite the filtering that occurs as information makes its way up to the SMM, NRC managers are inundated with a great deal of information. Senior managers and regional officials stated in interviews that, "we probably have too much information." It made it very difficult for them to sift through the information and, "decide what was important."[38] Senior managers we interviewed described the information presented at the SMM as a numbing "blizzard" or "drumbeat." Several felt that it was difficult to assess this amount of information in the time allotted for the SMM.

Table 4 below displays the NRC products that are considered inputs to the SMM process and their sources, may best illustrate the senior managers' point. As can be

[36] U.S. General Accounting Office. "Nuclear Regulation: Weaknesses in NRC's Inspection Program at a South Texas Power Plant", (RCED-96-10), 3 October 1995, p. 4.
[37] U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. Millstone Lessons Learned: Task Group Report, Part 1: Review and Findings, September 1996, p. 19.
[38] Regional and Resident Inspector interviews conducted by Arthur Andersen, November 12-14, 1996.

seen, the number of information sources is relatively large, their use and importance are not consistent, and most sources are used infrequently.

Table 4 Use and Importance of Information Sources[39]



In order to make distinctions among the various inputs to the SMM process, we analyzed them by reviewing the guidance, reading sample documents, and interviewing the appropriate NRC officials regarding preparation and review.

We summarized this information in an input analysis, provided in Appendix IV. We paid particular attention to documents identified as critical to the performance assessment process that culminates in the Senior Management Meeting. These

[39] Definitions of each of these inputs and sources are provided at the end of Appendix IV.

critical inputs include the following:

- Systematic Assessment of Licensee Performance (SALP),
- Plant Performance Review (PPR),
- Integrated Performance Assessment Process (IPAP), and
- Plant Issues Matrix (PIM).

We compared the value added by each of these critical inputs against their similarities, tabulating them in this way:

Table 5 Critical SMM Inputs: Value Added vs. Similarities

INPUT	VALUE ADDED	SIMILARITIES
Systematic Assessment of Licensee Performance	• Information is communicated to the licensee and the public. • Performance is scored.	• Purpose: Thoroughly assess licensee performance. • Mainly prepared by regions. • SALP and PPR used for resource allocation. • Inspection Reports used as a primary source.
Plant Performance Review	• Review is completed more often. • Completing PPRs for all plants at the same time allows for easier comparison of plant performance.	
Integrated Performance Assessment Process[40]	• Review provides a check since it is completed by people not directly involved with the plant.	
Plant Issues Matrix	• Matrix of plant performance characteristics is simple to read.	

Although each item does provide some distinctive value, their similar purposes and sources may outweigh the value. In reality, although the guidance lists a variety of information that is used to prepare these reports, the regional inspectors told us that they prepared the SALP, PPR and PIM by summarizing the inspection reports' executive summaries. In addition, regional officials told us that preparing these inputs takes a great deal of time and that the constant cutting and pasting seemed inefficient. Those interviewed also noted that the recent addition of IPAP and the PIM to their workload had no corresponding elimination of duties. The regional branch chiefs and residents interviewed felt that each report was "another burden" and it would be beneficial to "give up something" before adding new work.[41] The pressure is all the greater because of downsizing.

Consistency

Although improvements are under way, inconsistencies persist in the information reported in some performance assessments. We noted significant improvements in the consistency of the format of the information presented in the SMM Executive Summaries prepared for the June 1996 meeting. This improved consistency made it much easier for us to identify the characteristics, measures and indicators identified

[40] According to NRC officials, the IPAP will no longer be mandatory.

[41] Regional and Resident Inspector interviews conducted by Arthur Andersen, November 12-14, 1996.

in the written records of the SMM. Despite this change, the focus of performance assessments still differed by region and even by plant. In particular, some assessments focused primarily on enumerating plant events, while others analyzed the underlying causes of plant events.

Additional information used to assess plant performance also exhibits inconsistencies. In particular, many of those interviewed noted significant differences in the SALP reports. Although the composition of the SALP boards and the score categories have changed over the years, those interviewed attributed most of the scoring differences to the SALP board's tendency to determine a plant's score by comparing its performance from one SALP period to the next, and then adjusting the score to reflect changes. Since the performance is not compared with that of other plants, there can be significant differences in the scores of plants with similar performance profiles. For example, in the most recent Screening Meeting, a number of the plants considered to be poor performers had SALP scores (ones and twos) that were very similar to those of plants considered to be better performers. Additionally, SALP scores for particular plants are often old and out-of-date relative to their time of discussion. The differences in scoring are particularly important since the SALP is the only assessment report where a score is assigned, as well as one of the main vehicles the NRC uses to formally communicate its performance assessments to the licensee and to the public.

Sharing Information

For many years, the NRC has been struggling to effectively integrate and disseminate the volume of information collected. Recognizing the critical need for NRC staff to retrieve accurate information easily, the NRC developed a document handling system early on, called NUDOCS. By now however, this system is antiquated, unwieldy and it creates difficulties in retrieving information. For example, during a recent review at a site on the Watch List, inspectors had to rely on licensee information because they were unable to retrieve key design basis and licensing basis information from NUDOCS.[42] Efforts are under way to upgrade the document handling system to redress these inefficiencies.

Despite steps to improve NRC information sharing, plant performance information is still largely shared via paper reports. At the most recent Screening Meeting, for example, the performance information distributed to the participants was hundreds of pages long and more than a foot high. Attempting to read and absorb all of these documents in such a short time is very difficult. In addition, the reliance on paper reports can delay NRC management's identification of problems and trends in performance. To improve this situation, the NRC is developing an "Automated Inspection Reporting System," a database for all inspection findings. Those responsible for its development reported that the system would automate the

[42] U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. Millstone Lessons Learned: Task Group Report, Part 1: Review and Findings, September 1996, p. 19.

production of many reports and would allow electronic information sharing and analysis. The system has been pilot-tested and is expected to be in place in about 12 months.

Recommendations

Re-engineering involves rethinking information development, production and dissemination. The first step is to determine critical information needs. Due to the strain on management and staff resources, these needs should be clearly prioritized according to their linkages to public risk. The NRC Risk-Based Performance Model, provided in Appendix I, was developed for this project to illustrate the linkages among characteristics, measures and indicators, and risk. This model can be the starting point to develop information priorities.

Once these information needs are identified, the next step is to rethink the information development, production and dissemination processes and procedures to ensure that scarce resources cover the information priorities. Essentially, each information requirement developed should have a distinctive purpose and value in line with the organizational priorities and the resources needed to produce it. Information currently produced that does not fit these criteria should be eliminated. Completing such an effort focuses the scarce resources on value-adding activities.

In Chapter 4, we recommended an SMM approach that relies heavily on objective performance indicator information; however, the need to assess other factors will continue to be essential. Some of these factors, identified as secondary and tertiary risk characteristics in the NRC's Risk-Based Performance Model, are the following:

- Problem Identification and Resolution
- Design Changes
- Material Condition
- Management Oversight
- Communications
- Safety Value/Culture
- Configuration Control
- Procedural Discipline

Since each individual's approach to assessing these factors can differ greatly, the NRC should clearly define these factors and the criteria for assessing them. Four basic steps will underlie success:

1. Prioritizing a `laundry list' of criteria and selecting only the most vital;
2. Applying the same criteria to every plant;
3. Developing and observing a systematic approach to assessing the criteria; and
4. Identifying when a criterion is not applicable and spelling out the reasons why it is not.

Workshops and training should underpin these initiatives so that resident inspectors, senior residents, project managers and regional administrators understand the standards and methodology. Managers should reinforce the message by reviewing all plant performance assessments for adherence to the four steps.

Information such as the inspection findings and the Performance Indicators should be readily available to everyone who needs it – in "real time." This is vital for

improving performance assessments' timeliness and objectivity. Also important is ensuring that the databases and systems the NRC is developing do not exacerbate the unwieldy volume of information that staff and managers now receive. Therefore, before any technological projects are endorsed, the NRC should ensure that the information systems are clearly aligned to collect, store and retrieve only information that is clearly linked to the identified organizational priorities.

For the Commission to be effective in their oversight role, they need to receive adequate information. Most importantly, they should receive it in a format that will enable coherent decisions. Each presentation on a plant should consider similar types of data and reflect the same general priorities. Anything less hampers the Commission.

To improve the effective presentation of information, we recommend a working session between the Commission and senior NRC staff to address the following items:

- The Commission's clearly stated information needs,
- Agreed-upon formats for data,
- The strengths and weaknesses of previous staff presentations,
- The level of specificity necessary, and
- Agreement on key factors in decision-making.

The staff should view the Commission as its ultimate customer and tailor their presentations accordingly.

APPENDIX I: Risk-Based Performance Model

The NRC supplied the following risk-based performance model in accordance with the statement of work for this project.

Performance Model

An objective of this study is to define a coherent framework within which information regarding performance can be assessed. Such a framework can be referred to as a "performance model." The following discussion outlines the structure of such a framework, delineates how the model relates to the primary safety mission of the NRC, and defines a set of performance-related characteristics. The characteristics are quite similar to the factors most often cited in past senior management meeting documentation as being important to assessing performance.

Public Risk

The principal mission of the NRC is to protect the public from exposure to radiation. Operating experience and analytical studies have shown that public risk is dominated by the possibility of core melt accidents accompanied by containment failure and large releases of radioactive material. Such accidents are believed to be very unlikely, because of the multiple levels of defense-in-depth built into these plants.

The ingredients required to cause a core damage accident are initiating events, safety system failures, common-cause failures and human errors. Initiating events are transients which put the plant in an abnormal condition requiring operation of safety systems and actions by the plant staff. The accident can be greatly complicated by the failure of one or more safety systems to respond properly. A particularly damaging situation is a common-cause failure, which refers to any condition that can simultaneously disable more than one safety train or system. While human actions can have the effect of terminating the accident, it is also true that human errors can worsen the situation.

Figure 1 shows schematically that the probability of a serious accident, the core damage frequency, depends on the likelihood or frequency of initiating events, safety system reliability and capability, common-cause failure probability and human error probability. All of these likelihoods depend to a great extent on how well a plant is performing.

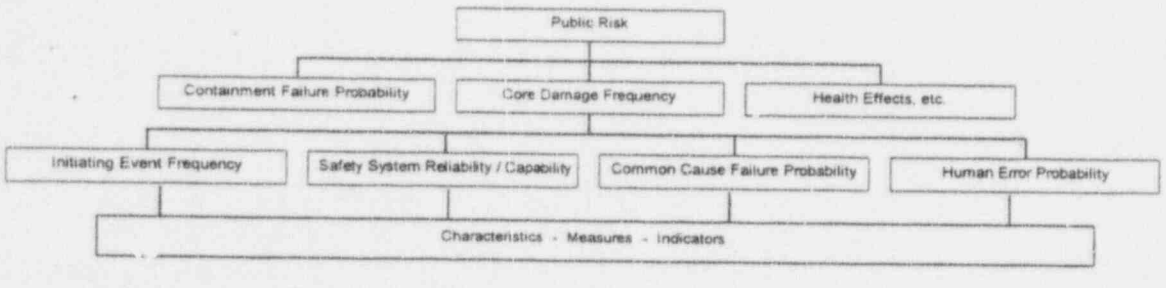


Figure 1: Relationship of Characteristics, Measures and Indicators to Public Risk

Analytical studies of serious accidents, such as Probabilistic Risk Assessments (PRA), conclude that serious accidents can generally be expected to exhibit all of these components. The serious accidents which have occurred to date have generally confirmed that conclusion.

Primary Performance Characteristics

Operating events occur every day at nuclear power plants. Federal regulations require that such occurrences be formally reported to the NRC. The NRC tracks these events to discern trends and patterns in operational problems, and to determine when new safety standards are required. In most cases the events involve a reactor "scram" with no further complications. In some cases, however, these events can involve significant combinations of initiating events, system failures, common cause failures and human errors. These more serious events are designated as "significant events" or "accident sequence precursors."

When a particular plant begins to experience repeated events, such as scrams, significant events or accident sequence precursors, the NRC becomes concerned about safety performance. Excessive numbers of safety system failures and human errors which contribute to operating events may also represent safety performance problems of concern.

Figure 2 shows that initiating events, safety system failures, common cause failures and human errors are direct indications of the potential for an increase in the core damage frequency and an increase to public risk due to performance problems. For that reason, these are referred to as Primary Performance Characteristics. However, such indicators tend to show up when a plant is already experiencing significant performance problems.

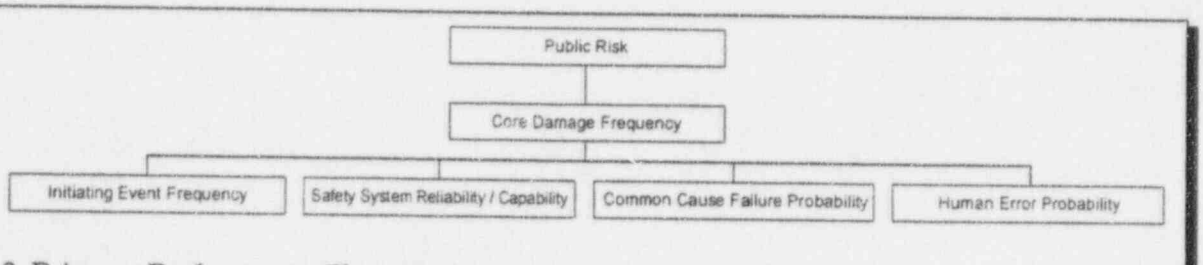


Figure 2: Primary Performance Characteristics

In order to get an earlier warning of impending performance problems, the agency needs to examine the more fundamental factors that influence performance in the near term and in the longer term. These are referred to as Secondary and Tertiary Performance Characteristics. They are more difficult to measure than the primary factors, but they give earlier warning of impending problems.

Secondary Performance Characteristics

To get more leading indicators of impending performance problems, one has to look more deeply at the underlying causes influencing safety system reliability/capability, common cause

failures and human errors. The NRC monitors several plant programs which directly influence these items.

As seen in Figure 3, there are three factors influencing safety system reliability/capability and common cause failure probability: design, material condition and configuration control.

Plant design is validated at the time of licensing, through numerous reviews, inspections and tests. However, during the life of the plant there are changes which can improve or degrade the design. The quality of such changes relies on two programs in the plant; engineering and licensing. Engineering assures that every aspect of a design change has been carefully considered in the modification. Licensing assures that the design basis of the plant is maintained at all times, and that modifications do not undermine that safety basis.

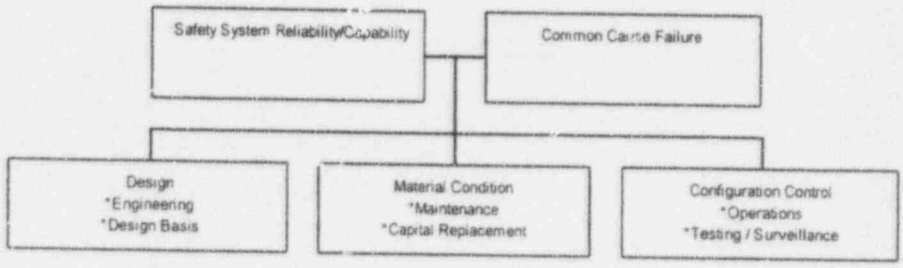


Figure 3: Characteristics Affecting Safety System Reliability/Capability and Common Cause Failure Probability

Material condition refers to how well the equipment has been maintained. This characteristic of plant performance is determined primarily through maintenance. However, another important factor is the timeliness with which worn out equipment is replaced. Capital replacement can have a significant impact on safety system reliability and capability.

Configuration control refers to assuring that the status of plant systems and components is in accordance with design. Examples of problems in this area include misalignment of valves, failure to test equipment following maintenance, and failure to restore equipment to operation following maintenance. Another class of issues related to configuration is technical specification compliance. These problems can result from errors on the part of operational, maintenance and engineering personnel.

Human error probability, as shown in Figure 4, is affected by a wide variety of influences. Operational performance factors influencing human errors include personnel performance, training, work processes, and procedures. These factors are discussed in Reference 1, an NRC sponsored report on the impact of organizational factors on plant safety.

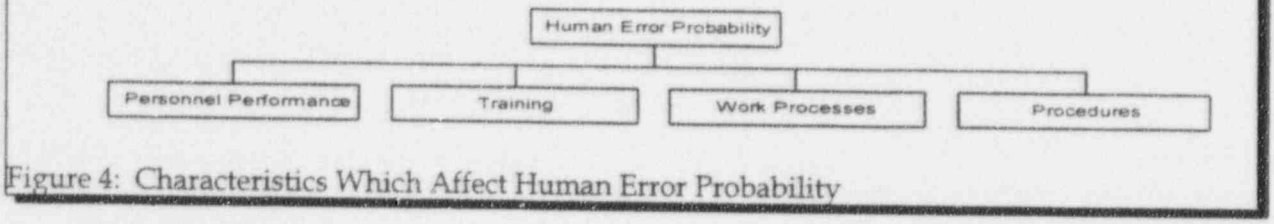


Figure 4: Characteristics Which Affect Human Error Probability

The NRC staff believes that performance problems in these secondary areas are a useful warning sign to developing performance problems that can eventually affect safety.

Tertiary Performance Characteristics

Figure 5 shows that tertiary characteristics can have a far reaching and long term impact or. performance. Two principal ones are organizational factors and economic stress. These factors are not as easy to assess as the ones discussed previously. Moreover, it is not necessarily possible to correlate observations in these areas with past examples of poor plant performance. Nevertheless, these factors may provide early warning of impending performance problems.

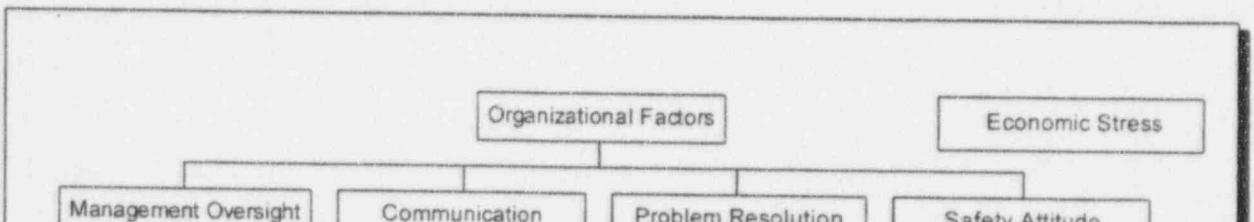


Figure 5: Tertiary Performance Characteristics

It is clear from the record of past senior management meetings that the NRC believes the performance of nuclear power plants can ultimately be affected by the way in which the plant is managed.

A great deal of research has been done to determine the types of organizational factors and management behaviors that affect performance. As an example, the results of NRC research conducted by the Brookhaven National Laboratory (BNL), in the area of organizational effectiveness are documented in Reference 1. This research has identified seventeen areas which affect performance. Several of these areas, including training, work coordination and procedures, have been discussed previously.

Other more fundamental factors include the quality of management oversight, communication, problem resolution, and safety attitude.

An additional tertiary determinant of plant performance is economic stress. Although it is difficult to draw direct links between these indicators and the direct performance factors, the

NRC staff nevertheless believes that such indicators should be watched, because they may provide early warning of impending problems.

Summary

The performance model that emerges from this analysis is shown in Table 1. It includes Primary, Secondary and Tertiary Performance Characteristics in Column 1. Column 2 compares these characteristics with the characteristics which have been important in past senior management meeting decisions. Column 3, shows the correlation of the characteristics with the dimensions and factors found in the BNL research on organizational factors. A majority of the BNL factors are included in the model.

References

1. "Results of a Pilot Application for Rating Organizational Performance Factors Based on Analysis of existing Documentation," Brookhaven National Laboratory Letter Report, July, 1995.

Performance Characteristics	Characteristics Cited In Past SMMs	Organizational Areas
Initiating Events	Scrams	
Safety System Reliability/ Capability and Common Cause Failure Probability	Safety Systems Equipment Reliability	
Design		
Engineering	Engineering	
Design Basis		
Material Condition	Material Condition	
Maintenance	Maintenance	
	Housekeeping	
Capital Replacement		
Configuration Control		
Operations	Operations	
Testing/Surveillance		
Human Error Probability	Employee Performance	
Personnel Performance	Accountability	Performance Quality
	Procedural Adherence	
Training	Training	Training
Work Processes	Work Processes	Work Processes
	PI: Admin Control	
Procedures	Procedure Quality	Formalization
Organizational Factors	Management Oversight	Management Oversight
Management Oversight	Management Involvement	Resource Allocation
	Regulatory Compliance	Goal Prioritization
	Plant Support	
	Radiation Protection	
	Occupational Safety	
Communication		Communication
Problem Resolution	Safety Assessment	Problem Identification
	Self Assessment	Organizational Learning
	Quality Programs	
	Root Cause Analysis	
	Corrective Actions	
Safety Attitude	Questioning Attitude	Culture
	Safety Assessment	Safety Culture
	Self Assessment	
	Performance Initiatives	
	Procedure Adherence	
	Allegations	
Economic Stress	Economic Hardship	

APPENDIX II: Performance Trend Model

Performance Trend Charts

The purpose of this analysis is to discern if performance indicators can be used as the primary tool in the decision process. We looked at the trends of the performance indicators for nine and one-half years to assess the relationship of the performance indicators to the SMM process. All of NRC's performance indicators, with the exception of cause codes, are included along with allegations and enforcement actions.

In an attempt to evaluate plants when they are performing badly, all plants exceeding twice the mean for an individual indicator were given a "hit." A threshold of twice the mean was chosen in order to isolate plant performance at a level well below average. The "hits" for each plant during a quarter were then tallied and compared to the average number of times all plants exceeded twice the mean for all indicators. Each point on the graph represents a four quarter moving total (period) of "hits." Fourth quarter 1987 is the first period containing four quarters worth of data.

Plant performance for individual plants was measured against the average performance of all plants and compared to the SMM plant category decisions. To do this, the moving total of "hits" for performance indicators is plotted against the SMM category for the plant. The numbers on the left y-axis connote the following SMM plant categories:

- 0 - Plants not discussed at the SMM
- 1 - Category 1 plants
- 2 - Discussion plants with no action taken against them
- 3 - Trending Letter plants
- 4 - Category 2 plants and
- 5 - Category 3 plants.

There exists a problem with plants getting stuck on the Watch List. Consideration needs to be given to why this occurs and how it can be prevented. Analysis should be conducted on such plants to discern if objective data, such as the above discussed analysis, shows improvement, and that qualitative data or other information, such as reputation, are keeping the plants on the Watch List. Additionally, the NRC should explore potential incentives or actions to enhance the performance of continual Watch List participants.

Performance Trend Model

The genesis of our recommended methodology for categorizing plants is the NRC's desire for an objective, consistent and timely process. The systematic method, discussed below, constructs an easily understandable and scrutable method to categorize and assess discussion plants. This process is constructed to provide a timely method of monitoring plant performance. Guidance is given on when to taken action on plants

whose performance is beginning to deteriorate, deteriorating further, or improving. With such a process, plants will understand their role and objective in increasing their performance. *NOTE: The stress of our recommendations lies in the methodology, not in the numbers purported in the methodology. NRC should first conduct a review of the selected performance indicators to be used when analyzing performance trends, then turn its attention to formalizing a methodology, such as the one proposed, to categorize plants.*

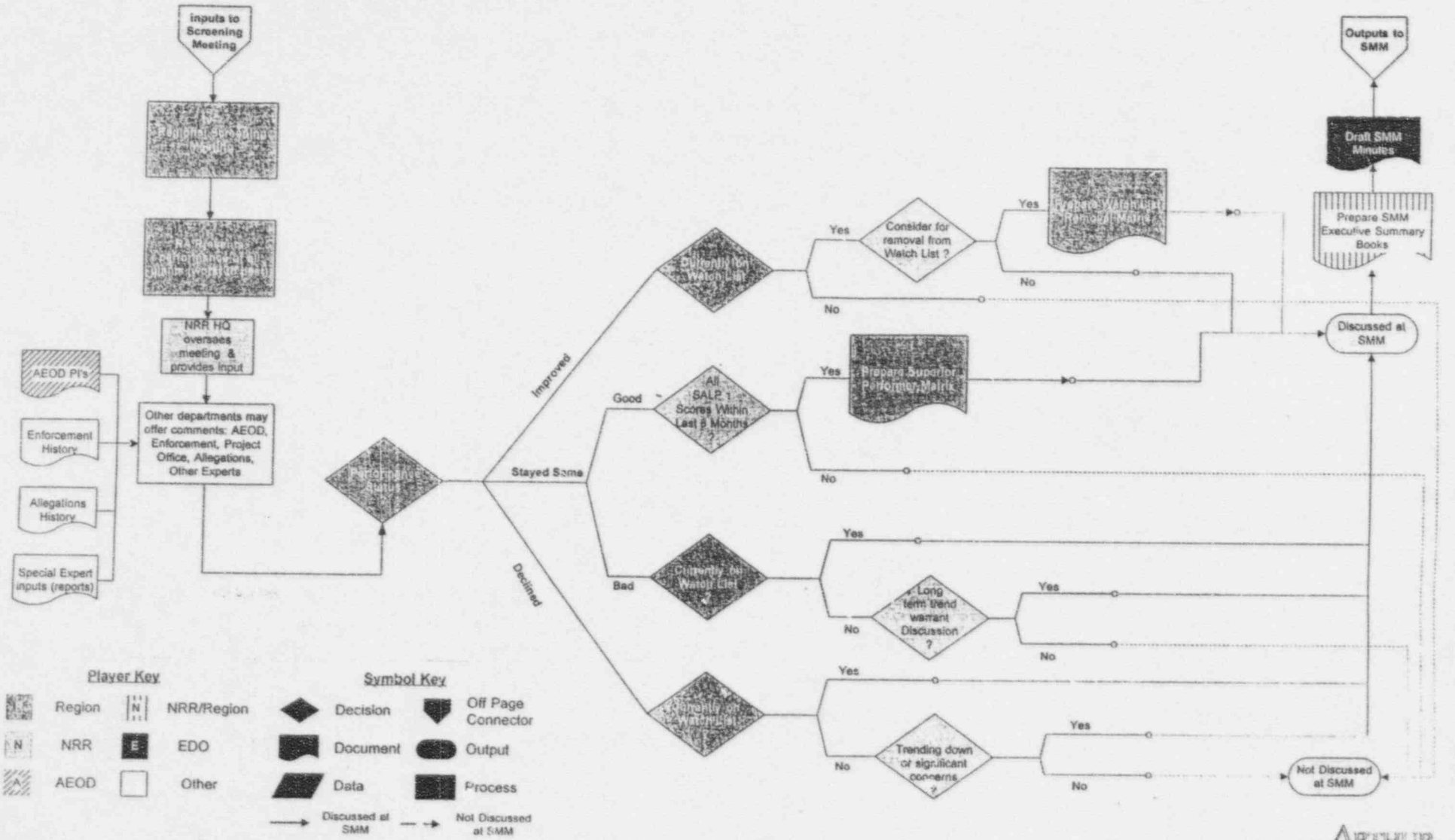
I. To be discussed:
   A. A plant must exhibit 5 consecutive periods (each period consists of four quarters of data) with hits greater than or equal to the mean of all plants; or
   B. A plant must exhibit 3 consecutive periods of hits with deteriorating performance; or
   C. A plant must exhibit twice the mean of all plants in a single period.

II. Increasing Category Severity:
   A. A plant must exhibit 2 consecutive periods without any improvement; or
   B. A plant must exhibit 4 consecutive periods above the mean of all plants; also,
   C. A plant may only receive a Trending Letter for 2 consecutive periods; and
   D. Category 1 plants exhibiting the characteristics of II. A. or II. B. should be moved to the Discussion Category.

III. Removal from Discussion List:
   A. A plant must exhibit 3 consecutive periods below the mean to be taken from Category 2 to Category 1; then
   B. A plant must exhibit 2 consecutive periods below the mean to be removed from Category 1 to Not Discussed.

The point of this process is not to reduce the inspection capacity or inputs of the inspectors or the regions. The process simply gives the NRC and its inspectors an additional and helpful tool in their inspection process. Additional information should not be ignored in favor of the above process, but instead should be included with the discussion of each plant. This method forces the regions, in cases of dissension with the performance indicators, to offer a thorough critique of the plants in question. Also, NRC's performance indicators do not currently provide a comprehensive measure of plant performance.[1] Therefore additional indicators, such as economic indicators, additional operational and leadership indicators, and the indicators tested by INEL, may be considered.

[1] Nuclear Energy Institute. Perception and Reality of the 'Gap' in Nuclear Power Plant Performance (Draft version). January 1995, p. 19.



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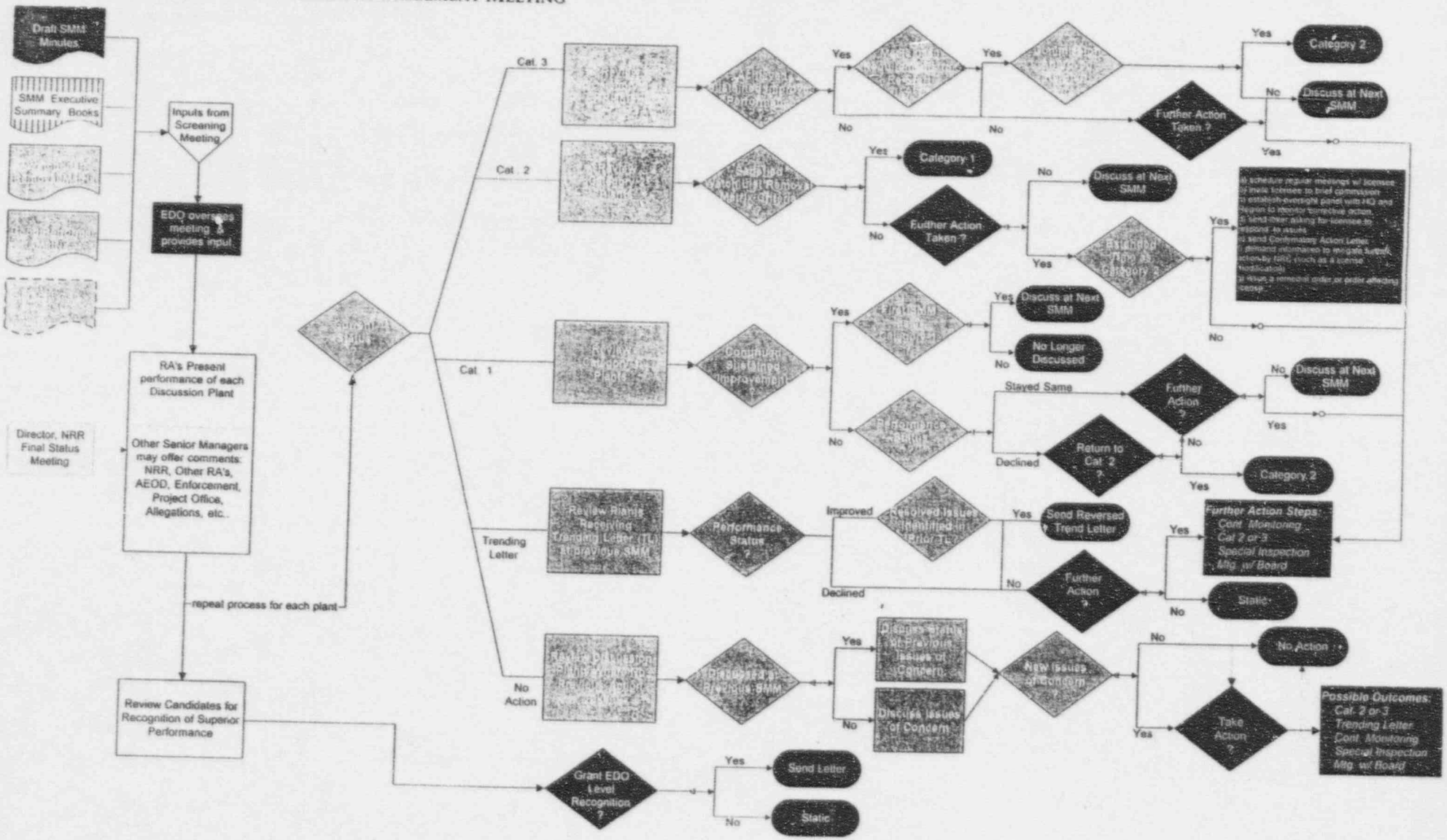
APPENDIX III: PROCESS MAP -- SENIOR MANAGEMENT MEETING



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APPENDIX IV: Senior Management Meeting Input Analysis

Senior Management Meeting Input Analysis

A key component to analyzing any process is an assessment of the inputs to the process. This appendix summarizes the results of our analysis of the inputs to the Senior Management Meeting (SMM). The purpose, key players, sources of data, timing, and filters/review for each major input are provided.

For ease of understanding, the following conventions were used in this appendix.

- The appendix is organized according to which items are primary inputs to the SMM. Therefore the SMM Executive Summaries are analyzed first.
- Each input shaded according to which NRC office has primary control over that input.
- Asterisks highlight the principal sources.

This analysis revealed some interesting patterns.

1. Much of the information is controlled by the regions. Six of the twelve inputs analyzed were controlled primarily by the regions.
2. The purposes of several inputs are not distinctive. Themes are repeated in the purposes including: assessing performance, integrating performance information, identifying trends; and allocating resources. Resident inspectors we interviewed corroborated this analysis when they told us that many of the documents, including SALP, PPR, IPAP, and PIM, were created by cutting and pasting from the executive summaries of the inspection reports.
3. The inputs do not flow up to the SMM in a recognizable pattern. We developed several different types of diagrams to map the flow of the inputs. No matter which method we tried, the result was a tangled web that was very difficult to decipher.

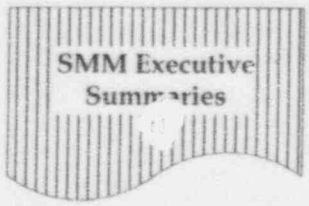
Purpose
Prepare material for NRR and the regions to decide which plants should be discussed at the SMM.

Key Players
- Inspectors
- Regional Branch Chiefs
- Regional Division Directors
- Regional Administrator

Sources of Data
* PPR
- Plant Issues Matrix
- Performance Indicators

Timing
- Every 6 months, approximately 2 months before the Senior Management meeting.

Filters/Review
- Inspectors condense material from PPR.
- Division Director gives branch chiefs the ranked list of plants from the year before for them to revise.
- PPR process conducted and plant ranking is revised.
- Regional administrators visit plants and may revise Screening Meeting summary.
- AEOD also prepares a list of proposed discussion plants, along with detailed analysis of each, based on the performance indicators. This analysis may or may not be included in the screening meeting material.
- Regional administrator usually presents material at the screening meeting.



Purpose
Provide integrated plant performance information in a written document for the Senior Management Meeting.

Key Players
- NRR is assigned responsibility
- Regional and Headquarters senior staff prepare the material.

Sources of Data
- Inspections
- Enforcement Data
- Performance Indicators
- Insights from RES on examination results
- Accident Sequence Precursors

Timing
- After screening meetings.

Filters/Review
- Senior Management

Primary Responsibility Key

R	Region
N	NRR
A	AEOD
N	NRR/Region
E	EDO
	Other

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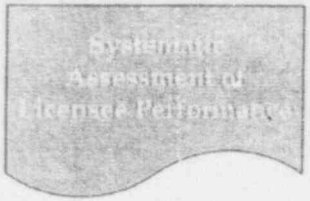


Purpose
Documents NRC observations and insights on licensee performance and communicates them to the licensee and the public. Provides information for resource allocation.

Key Players
- Inspectors
- Project Engineers
- SALP Board: DRS Director, NRR Project Director, DRP Director
- Regional Administrator - veto power.

Sources of Data
* Inspection reports
* PPR
* PIM
- SALP Board impressions from site visit
- Enforcement Results
- Allegations
- LER

Timing
- 18 month interval
- 24 month interval for superior performers.
- as little as 12 months for poor performers.
- can be adjusted in special circumstances.

Filters/Review
- Check assessment against inspection reports.
- DRP Director suggests wording changes to preliminary package.
- After SALP Board meets, Chairman revises assessment to reflect discussion.
- Implementation procedures contained in regional procedures and NRR office letters.

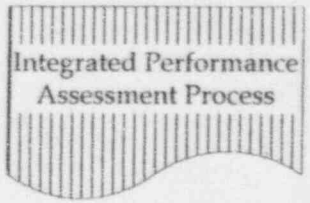
Purpose
Provide thorough assessment of licensee performance more frequently than SALP, to detect and pursue performance trends. Provide information for resource allocation.

Key Players
- Resident Inspectors (maintenance & operations)
- DRS Inspectors (plant support and engineering)
- Regional DRP Director
- Regional DRS Deputy Director
- Regional DRP branch chief
- NRR project manager
- Regional Administrator attends for portions

Sources of Data
* Primary source: Summarized executive summaries from NRC Inspection reports.
- Open Items list
- Status of allegations
- Enforcement history
- Licensee Event Reports
- Performance Indicators
- Human Factors Information Systems

Timing
- Every 6 months

Filters/Review
- Branch chief reviews package.
- Meeting held with **Key Players** to assess performance.



Purpose
Develop and integrated perspective of licensee strengths and weaknesses based on and independent review of objective information.

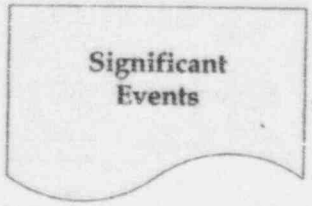
Key Players
- Regions periodically conduct IPAPs at selected plants
- NRR HQ conducts one IPAP per year in each region
- Team should not be involved with that plant to preserve independence.

Sources of Data
1. Data Review
   * Inspection results
   * PPR
   * LER
   * SALP
   * Licensee documents
   - SMM Results
   - Enforcement history
2. IPAP Inspection

Timing
- Periodically

Filters/Review
* SALP board members briefed. Senior reg. mgrs briefed if no SALP board assigned
* NRR director briefed for those IPAP done by NRR.

Notes
- Process provides check against resident inspectors.
- Very few competed
- Not popular with most regional inspectors and managers interviewed.



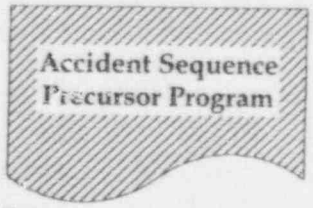
Purpose
Identify events or programmatic weaknesses that pose an actual or potential threat to the health and safety of the public.

Key Players
- Events Assessment Branch - NRR
- Events Assessment Panel - NRR, AEOD, RES

Sources of Data
* 50.72 reports
* Morning Reports
- Plant Status Reports
- LER

Timing
- Events Assessment Branch screens item daily.
- Events Assessment Panel meets weekly.

Filters/Review
- Events Assessment Branch uses criteria to review operating reactor events from the daily morning call and identifies events that require further evaluation.
- Review event - Assigned staff gather more information and produce a package for the Significant Events Panel.
- Significant Event Panel - Conducts further review to determine if there was an actual or potential threat to the health and safety of the public. They issue a preliminary determination and, after further review, they may close out the event and make a final determination. Sometimes the panel closes out events based on initial information. Items may sometimes be reclassified as significant events later, based on subsequent information.



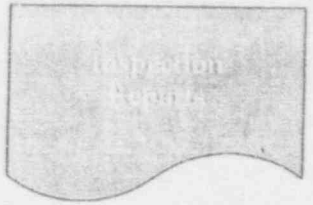
Purpose
Determine and rank the risk significance of operational events by applying probabalistic risk techniques.

Key Players
- AEOD
- Oak Ridge National Laboratory

Sources of Data
* LER (make up about 95% of the source data)
- 50.72 reports
- Inspection reports
- Incident Inspection teams
- Accident Inspection teams

Timing
- Report published annually

Filters/Review
- NRR completes prompt assessment on daily events, applies probabalistic risk criteria.
- Oak Ridge National Laboratory screens events and analyses them using a algogarithm.
- Engineering review of events screened in by Oak Ridge.
- Oak Ridge does a detailed review of most events which pass Engineering screening. Calculates conditional core damage probability.
- AEOD management reviews analysis package before it is sent to Sandia & the licensee.
* Analysis checked through review by Sandia Laboratory.
* Analysis sent to the licensee for comment and guidance.
- NRR and Research may review.
- Events may be re-analyzed based on licensee comments and information.
- Items that are considered precursors are published in the annual report.



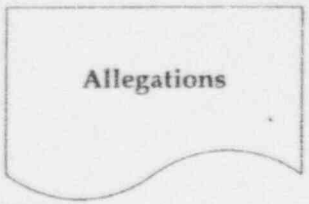
Purpose
Document the findings and conclusions of the principal continual process of collecting information related to licensee performance.

Key Players
- Resident Inspectors
- HQ Inspectors
- Other regional inspectors

Sources of Data
- Routine Inspections
- Special inspections to follow-up on allegations, enforcement, or emerging issues.

Timing
- Inspections - continual
- Inspection reporting - every 8 weeks

Filters/Review
- Reviewed and signed by branch chief



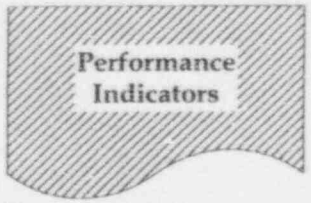
Purpose
Ensure that safety concerns brought up by individuals are reviewed for validity and safety significance and appropriate follow-up action is taken.

Key Players
- Allegation coordinator
- Allegation review panel
- Branch Chief
- Inspectors

Sources of Data
- plant employee or other individual calls with allegation.

Timing
- Continuous

Filters/Review
- allegations interview
- summary of concerns presented to allegations review panel by Chief responsible for plant.
- inspection to determine if allegation is substantiated



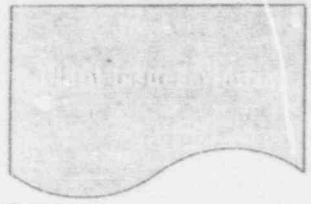
Purpose
Identify areas of poor or declining performance.

Key Players
- AEOD
- Idaho National Engineering Laboratory completes analysis.

Sources of Data
* Licensee Event Reports
* One hour/Four Hour Reports 50.72
* Monthly Operating Reports
* Significant Events
* INPO - Radiation Exposure

Timing
- Quarterly

Filters/Review
- Selection of significance level
- Peer groupings
- Definitional changes over time.



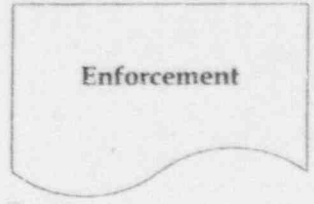
Purpose
Provide objective information for use in assessing plant performance.

Key Players
- Regional Inspectors

Sources of Data
* Executive Summaries of Inspection reports.
- Licensee Event Reports
- Enforcement and Non-cited Violations

Timing
- Updated every 8 weeks

Filters/Review
- Very little review
- Regional Inspector codes performance data as strengths or weaknesses.
- Little guidance on criteria



Purpose
Describe the circumstances leading to violations of NRC regulations.

Key Players
- Regional Inspectors
- Headquarters Inspectors
- Regional Enforcement Specialist
- Enforcement Officer
- Branch Chief
- Deputy Division Director
- HQ Enforcement Staff

Sources of Data
- Inspection reports, primarily

Timing
- Enforcement conferences held every 8 weeks.
- Resident inspectors will prepare special inspection report for serious issues occurring within the 8 week inspection report cycle.

Filters/Review
- Enforcement panel debates facts and determines the seriousness of the issue.
- Enforcement panel asks licensee to present their side.
- Matrix/checklist used to determine if civil penalties/escalated enforcement is appropriate.
- Results written up in region.
- Sent to HQ for review.

Glossary of Inputs and Sources

50.72 Reports - Licensee reporting of certain events, within one or four hours, as required by regulations.

Accident Sequence Precursor Program - A forma program in which nuclear power plant events are analyzed using probabilistic risk assessment techniques to evaluate the conditional core damage probabilities associated with the events.

Allegations - A declaration, statement, or assertion of impropriety or inadequacy associated with NRC-regulated activities brought to the NRC's attention by individuals or organizations.

Enforcement Actions - Enforcement actions are designed to be deterrents which emphasize the importance of compliance with regulatory requirements. Enforcement actions can be taken in response to violations of regulatory requirements and are meant to support the NRC's overall safety mission in protecting the environment.

Human Factors Analysis - An inspection process to determine the root causes and contributing factors of events involving human performance and to identify and analyze those conditions that contribute to human errors.

Inspection Reports - Reports generated to document plant inspection results.

Integrated Performance Assessment Process (IPAP) - A periodic, long-term integration of objective information to arrive at conclusions regarding licensee performance and provide site-specific recommendations for future inspections. This process is done by a group not normally involved with inspecting the plant. Thus, the IPAP provides feedback on the effectiveness of the inspection program.

Licensee Documents - Any documents provided by the licensee to NRC staff.

Morning Reports - Oral briefing of NRC headquarters staff by regional officials on any events which occurred in their region overnight.

Performance Indicators - A set of quantitative indicators, analyzed by the NRC, which are used to track nuclear power plant safety performance.

Plant Issues Matrix - A database summary of plant performance information derived primarily from inspection reports. Each issue is coded as a strength or weakness by the regional inspector. These matrices have become important inputs to the screening meeting and the Senior Management Meetings.

Plant Performance Review - Semiannual process conducted by the regional offices to provide a short-term evaluation of objective information and insights to arrive at a current summary of overall plant performance. Plant Performance Reviews are used to

adjust resource allocations and are a primary input to the Senior Management Meeting process.

Plant Status Reports

Screening Meeting Documents - Summary assessments of plant performance prepared to assist NRC managers in deciding which plants should be selected for discussion at the Senior Management Meeting.

Significant Events - Those events or programmatic weaknesses that the NRC staff identifies as an actual or potential threat to the health and safety of the public.

SMM Executive Summaries - A summary assessment of the performance of each of the plants to be discussed at the Senior Management Meeting. This material is provided to each SMM participant for their review prior to the meeting.

Systematic Assessment of Licensee Performance (SALP) - Principal periodic method for assessing licensee safety performance. Multiple sources are reviewed. The assessment culminates in a determination of a score in 4 general areas. The results are presented to the licensee in a public meeting.

APPENDIX V: List of Individuals Interviewed and Sites Visited

Interviewees: Nuclear Regulatory Commission[1]

Baker, Ed. Agency Allegations Coordinator.

Barrett, Richard. Office for the Analysis and Evaluation of Operational Data.

Beach, A.B., Regional Administrator, Region III.

Borchardt, Richard W. Chief, Inspection Program Branch, Office of Nuclear Reactor Regulation.

Castleman, Patrick I. Division of Inspection and Support Programs, Office of Nuclear Reactor Regulation.

Caputo, Guy P. Director of the Office of Investigations.

Cowgill, Curtis III. Chief Projects Branch 2, Division of Reactor Projects, Region I.

Crlenjak, Jack. Acting Deputy Director for Reactor Projects.

Cyr, Karen D. General Counsel, Office of General Counsel.

Doerflein, Lawrence T. Chief Projects Branch 1, Division of Reactor Projects, Region I.

Ebnetter, Stewart D. Regional Administrator, Region II.

Evans, Michelle. Senior Resident Inspector, Three Mile Island Nuclear Station.

Hansell, Samuel. Resident Inspector, Three Mile Island Nuclear Station.

Hickman, Donald E. Safety Programs Division, Office for Analysis and Evaluation of Operational Data.

Jackson, Shirley J. Chairman, Nuclear Regulatory Commission.

Jordan, Edward L. Director of the Office for Analysis and Evaluation of Operational Data.

Kane, William F. Deputy Regional Administrator, Region I.
Lieberman, James. Director of the Office of Enforcement.

[1] Note: These entries reflect the interviewee's titles at the time we interviewed them. Since then, several organizational changes have occurred.

Lorson, Raymond L. Resident Inspector, Peach Bottom Atomic Power Station.

McCree, Victor M. Regional Operations Staff Chief.

Milhoan, James L. Deputy Director for Nuclear Reactor Regulation, Regional Operations and Research.

Miller, Hubert J. Regional Administrator, Region I.

Miraglia, Frank J. Deputy Director Office of Nuclear Reactor Regulation.

Morrison, Dr. David L. Director of the Office of Nuclear Reactor Research.

Paperiello, Carl J. Director of the Office of Nuclear Materials Safety and Safeguards.

Rasmuson, Dale M. Reliability and Risk Assessment Branch, Safety Programs Division, Office for Analysis and Evaluation of Operational Data.

Reyes, Luis A. Deputy Administrator, Region II.

Russell, William T. former Director of the Office of Nuclear Reactor Regulation.

Schmidt, Wayne L. Senior Resident Inspector, Peach Bottom Atomic Power Station.

Taylor, James M. Executive Director for Operations.

Thadani, Ashok. Associate Director for Technical Review, Office of Nuclear Reactor Regulation.

Zimmerman, Roy P. Associate Director for Projects, Office of Nuclear Reactor Regulation.

Interviewees: Utilities

Baltimore Gas & Electric, Mr. George Creel. Executive Vice President.

Carolina Power & Light, Mr. Andersen and William S. Orser, Executive VP for Nuclear Generation.

Entergy Operations Inc, Donald C. Hintz, President and Chief Executive Officer - Nuclear.

Florida Power & Light, Mr. T. F. Plunkett. President, Nuclear Division.

Power Authority of the State of New York, J. J. Kelly and William J. Cahill Jr., Chief Nuclear Officer.

Plants Visited

Peach Bottom Atomic Atomic Power Station, Peco Energy Company

Three Mile Island Nuclear Station, GPU Nuclear Corp & Jersey Central Power & Light