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Equipment Reliability Implementation Strategy

A Strategy for Identifying and Prioritizing Nuclear Power Plant Equipment Reliability Improvement Opportunities and Actions

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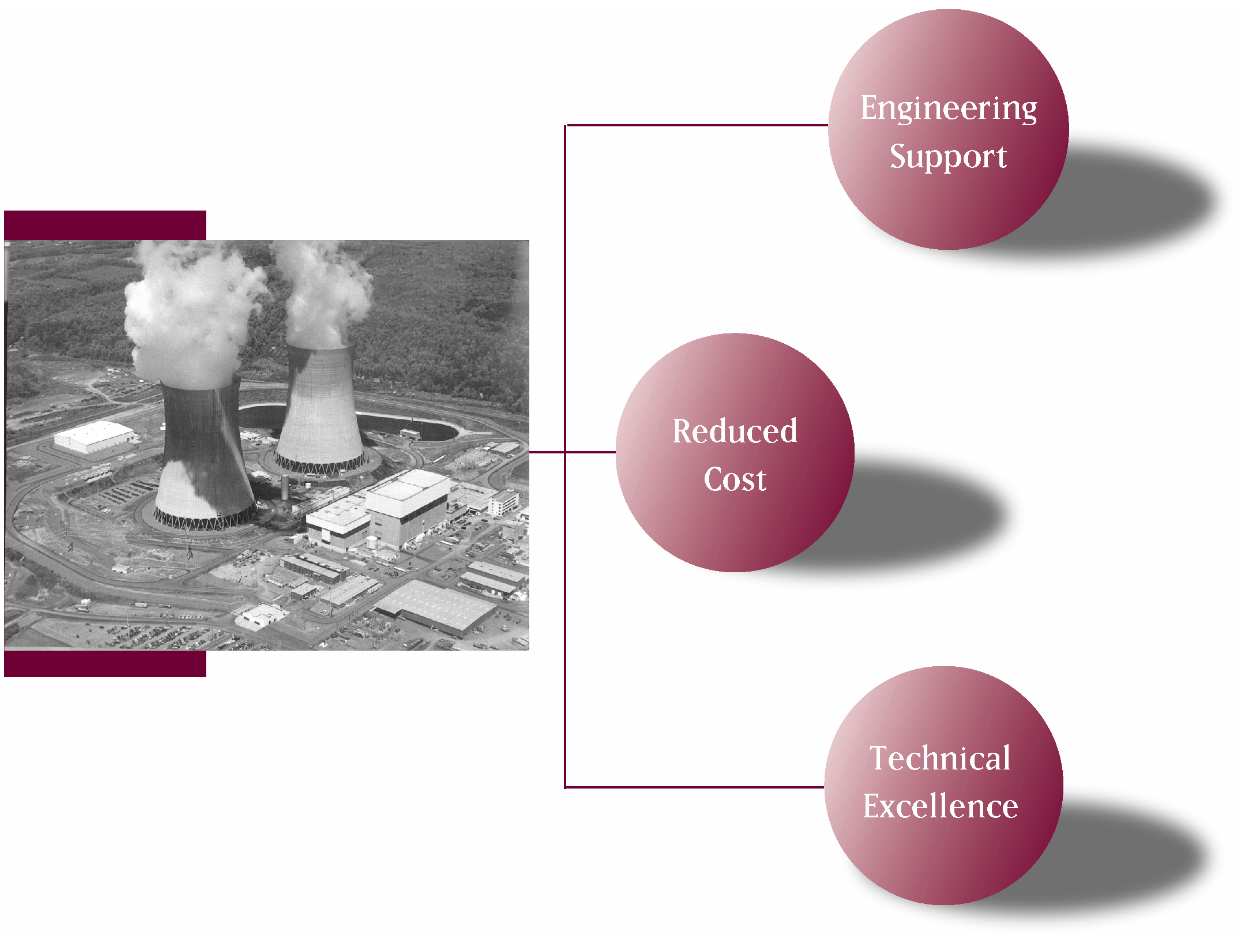

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1009615

Technical Update, April 2004

EPRI Project Manager

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REPORT SUMMARY

Background

In the past 10 years, the nuclear electrical generation industry has made a concerted effort to improve performance. Multiple aspects of nuclear power plant performance—safety, cost and revenue, reliability, and public perception—have been and are being addressed. In the past several years, equipment reliability (ER) has emerged as a significant aspect of performance because of the renewed recognition of several factors: plant reliability depends on plant equipment performance; cost and revenue often depend on the ability to manage plant equipment outages; and many cost and revenue improvement strategies (such as power uprates, reduced refueling, and maintenance outage changes) can challenge the reliability of plant equipment.

Objective

- To provide a strategy that assists nuclear power plants in determining which ER activities should merit focus in order to improve their plant's performance and what information resources and tools are available to implement those activities

Approach

The strategy leverages knowledge and information, typically available through plant staff and performance metrics, to establish the overall state of the plant's ER activities. Based on the overall state, focused improvement areas are identified with associated evaluation measures. Using the evaluation results, specific opportunities are disclosed; using references contained within the document, potential action elements are identified.

The strategy was prepared using the Institute of Nuclear Power Operations' (INPO's) "Equipment Reliability Process Description," AP-913, as a common denominator for definitions of ER activities because of its widespread familiarity and use. Guidance for implementing the strategy is contained within that document. The document also includes focused guidance on the use of specific tools that support ER improvements.

Results

This report presents a strategy to support the implementation of a site's ER process based on AP-913. The strategy involves three phases:

1. Phase I: Determine the equipment reliability state.

2. Phase II: Conduct a focused gap evaluation.

3. Phase III: Recommend actions to address gaps.

EPRI Perspective

Because ER is encompassing (involving the activities from multiple plant organizations) and is a continuous improvement process, with no single starting or ending point, implementing the process has been a challenge to some plants. The challenge has appeared in two aspects: how to get started and how to proceed if aspects of the process are already in place. Industry experts

point out, however, that to be effective, one simply has to "just do it." Yet this simple mandate can be difficult to accomplish among multiple competing priorities.

This document provides a strategy that assists plants in determining:

- Which ER process areas should be focused on, based on the state of the plant's current ER activities
- How to identify specific activities that will provide the most benefit within these process areas
- What information resources and tools are available to support the implementation of the specific activities

One goal of the strategy is to minimize the effort associated with studying the plant's current ER state so that resources can be directed toward actions. This goal is achieved by leveraging staff knowledge of the plant's current ER state with key indicators of ER process performance.

A second goal of the strategy is to quickly identify the process areas and key subactivities that will yield the most benefit to the plant. Associating process areas and key subprocess activities with different states of implementation of the ER process achieves this goal. The associations are based on the logic contained within the ER process itself and industry experience.

It is anticipated that this strategy will further evolve as experience with the ER process expands and the strategy is applied to a wider variety of plant situations. Seven members of utility and industry organization staff with responsibilities directly associated with ER in their companies have reviewed the strategy and provided input to its construction. The strategy has also been piloted with a multiunit company where selected aspects of the strategy were exercised with all the company's plants, with major pilot efforts focused at one plant. Recommendations from the fundamentals review and the pilot have been incorporated into the strategy.

Keywords
Equipment reliability
Nuclear power plants

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The following individuals also made significant contributions to the development of the strategy described in this document by providing review and input to the fundamentals of the strategy:

Gary Boles	Tennessee Valley Authority
Bryan Griner	Southern Nuclear Operating Company
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Susan Korn	Exelon Corporation
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Vince Roppel	Institute of Nuclear Power Operations

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Pete Arthur	FirstEnergy Nuclear Operating Corporation
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Angela Krainik	Arizona Public Service Company
Bob Paley	PPL Susquehanna, LLC

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ABSTRACT

This report provides a strategy that assists nuclear power plants in determining which equipment reliability (ER) activities merit focus in order to improve their plant's performance and what information resources and tools are available to implement those activities.

The strategy described in this report leverages knowledge and information, typically available through plant staff and performance metrics, to establish the overall state of a plant's ER activities. Based on the overall state, focused improvement areas are identified with associated evaluation measures. Using the measures can disclose specific opportunities, and using references contained within the document can identify potential action elements.

The strategy was prepared using INPO's "Equipment Reliability Process Description," AP-913, as a common denominator for definitions of ER activities because of its widespread familiarity and use. Guidance for implementing the strategy is contained within that document, which also includes focused guidance on the use of specific tools that support the implementation of strategy elements.

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1 BACKGROUND

In the past 10 years, the nuclear electrical generation industry has made a concerted effort to improve performance. Multiple aspects of nuclear power plant performance, including safety, cost and revenue, reliability, and public perception, have been and are being addressed. In the past several years, equipment reliability (ER) has emerged as a significant aspect of performance because of the renewed recognition of several factors: plant reliability depends on plant equipment performance; cost and revenue frequently depend on the ability to manage plant equipment outages; and many cost and revenue improvement strategies (such as power uprates, reduced refueling, and maintenance outage changes) can challenge the reliability of plant equipment.

As part of the Advanced Light Water Reactor program, the Institute of Nuclear Power Operations (INPO) produced a number of guidelines, including one entitled “Equipment Reliability Process Description.” This process description, often referred to simply as AP-913 (its INPO document reference number), is an encompassing treatment of an ER process applicable to nuclear power plants. It was most recently revised in November 2001 and is used extensively by nuclear power plant owners and operators in North America. It is used as a reference point in this document because it provides a viable common denominator to most plant situations even though all plants’ ER activities might not be structured exactly as depicted in AP-913.

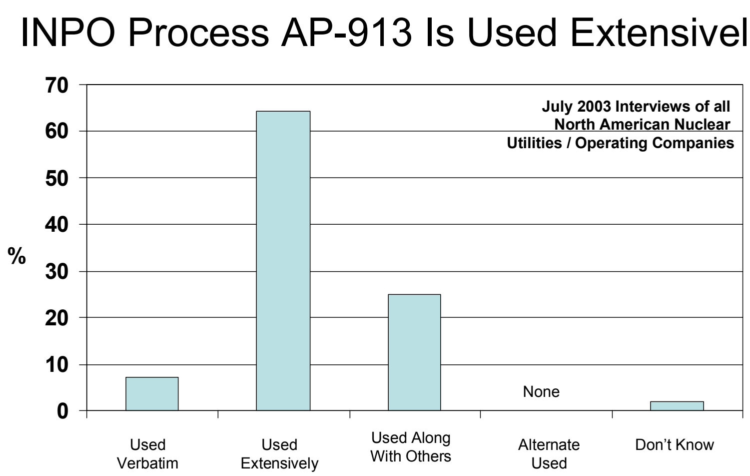

Figure 1-1
AP-913 Utilization

Because the process is encompassing, involving the activities from multiple plant organizations, and is a continuous improvement process, with no single starting or ending point, implementing the process has been a challenge to some plants. The challenge has appeared in two aspects: how to get started and how to proceed if aspects of the process are already in place. Industry experts point out, however, that to be effective, one simply has to “just do it.” Yet this simple mandate can be difficult to accomplish among multiple competing priorities.

This document provides a strategy that assists plants in determining:

- Which ER process areas should be focused on, based on the state of the plant’s current ER activities
- How to identify specific activities that will provide the most benefit within these process areas
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One important goal of the strategy is to minimize the effort associated with studying the plant’s current ER state so that resources can be directed toward actions. This goal is achieved by leveraging staff knowledge of the plant’s current ER state with key indicators of ER process performance.

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It is anticipated that this strategy will evolve further as experience with the ER process expands and the strategy is applied to a wider variety of plant situations. Seven members of utility and industry organization staff with responsibilities directly associated with ER in their companies have reviewed the strategy and provided input to its construction. The strategy has also been piloted with a multiunit company where selected aspects of the strategy were exercised with all the company’s plants, with major pilot efforts focused at one plant. Recommendations from the fundamentals review and the pilot have been incorporated into the strategy.

2
SUMMARY

This report presents a strategy to support the implementation of a site's ER process based on AP-913. The strategy involves three phases:

1. Phase I: Determine the equipment reliability state.
2. Phase II: Conduct a focused gap evaluation.
3. Phase III: Recommend actions to address gaps.

The activities in the three phases are described in this section.

Determine the Equipment Reliability State

This phase begins with two activities: 1) conducting a short survey of staff members to obtain information about the plant's ER process activities/interfaces and 2) collecting typically available performance indicator data about key ER-related activities. The staff survey is given to both management and individual contributors to establish perceptions about the current ER process and to compare those perceptions. The performance indicator data covering key attributes of a site's ER activities are used with the survey information to establish the ER state.

The ER states are given letter designations and generally reflect the following:

Table 2-1
Equipment Reliability States

ER States	General Performance Characteristics
A	The major emphasis is on quickly fixing equipment that breaks that impacts plant operation or safety, reducing maintenance backlog, and accomplishing planned outage maintenance activities.
B	The major emphasis is on preventive actions to keep equipment from breaking.
C	The major emphasis is on strategies to address vulnerabilities to long-term viability, through contingencies or planned changes.

Conduct a Focused Gap Evaluation

The state characterization is used to focus a gap evaluation on aspects of specific AP-913 elements and interfaces. An ER focus matrix that guides the selection of focus areas has been developed. This approach avoids wasting effort evaluating elements that do not directly contribute to near-term improvement and focuses attention on areas that will provide maximum benefit given the site's ER state. In addition, experience has shown that certain activities are prerequisites to others, and these are emphasized first. The focus areas can be used for self-evaluation using the material in this document or for other tasks (such as directing peer evaluations or identifying INPO assistance topics). The focused gap evaluation involves interviews of key staff and as-needed review of site documents and compares site practices and activities to industry-recommended practice. Templates for conducting this evaluation specific to the strategy are included in this document.

Recommend Actions to Address the Gaps

Gaps in activities and in interfaces between activities are prioritized using lead plant case study results and input from the original staff surveys. Recommended actions to address high-priority gaps are developed using the Industry AP-913 Capabilities Database, maintained by EPRI, as well as other information resources.

Summary

Initial applications of the strategy are being conducted through EPRI by assisting plants in their implementation to gain valuable feedback on the strategy.

The EPRI ER implementation strategy involves EPRI's assistance in first determining the ER state for a site. This determination is made by combining a staff survey and performance indicator data to highlight the current level of ER performance: the ER state. The ER state is then used to focus a gap evaluation on the elements of AP-913 that are important for that performance level. EPRI assists the site in recommending actions to address the gaps using EPRI's Industry AP-913 Capabilities Database and other information.

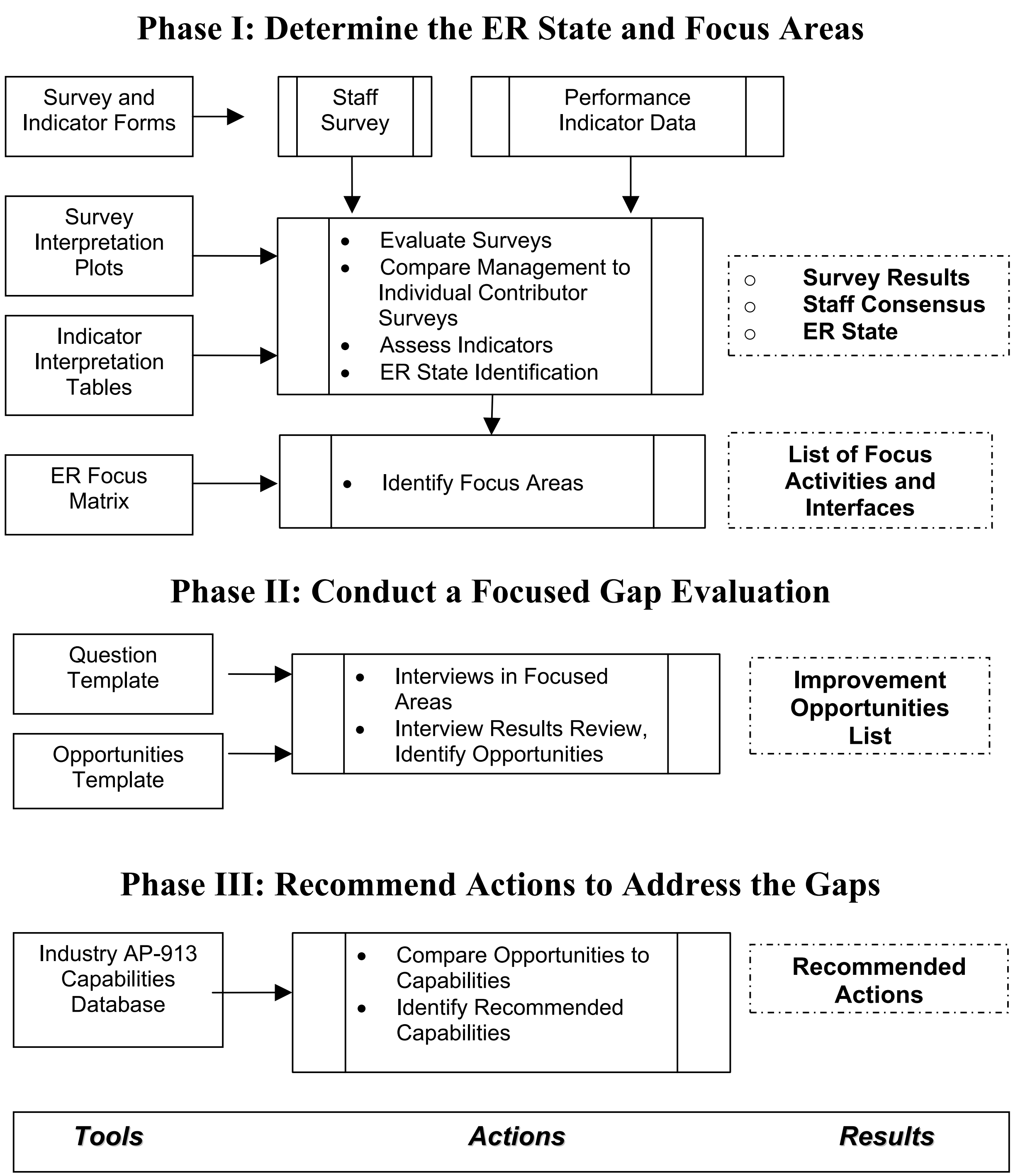

Figure 2-1
Equipment Reliability Implementation Strategy Flow Chart

3
EQUIPMENT RELIABILITY STATE

This section describes the characterization of a plant's ER state. Two data sources—a staff survey and a set of performance indicators—are used to perform the characterization.

Staff Survey

The staff survey, contained in Appendix A, is given to plant staff who have direct knowledge of the plant's ER activities. Individual contributors as well as management should be included as survey participants. Because ER encompasses many plant activities, the survey participants typically include staff representing the following functions: maintenance craft supervisors, maintenance engineers, work management supervisors, system engineers or managers, component engineers, engineering supervisors and managers, technical program managers or leaders, and corrective action staff. In addition, if the plant's ER activities emphasize these additional areas, survey participants can include "fix it now" (FIN) team leaders, staff responsible for specialized activities such as predictive maintenance (PdM), long-term planning staff, and others. There is no recommended upper limit to the number of staff surveyed, keeping in mind that those surveyed must have direct knowledge of ER activities. It is generally expected that at least 8 to 10 staff must participate in the survey in order to obtain a balance of individual contributor and management representation and to include sufficient input to compensate for any subject-specific bias.

Although this survey extensively uses ER terminology common to AP-913, care has been taken to formulate the survey questions so that AP-913-specific context is avoided (therefore, extensive knowledge of the AP-913 process is not necessary). In administering the survey, similar care should be taken to ensure that questions are properly understood.

The survey content is made up of four parts: General Characterization, Expectations, Equipment Reliability Activities, and Equipment Reliability Activity Interfaces.

General Characterization, intentionally placed at the start of the survey, prompts survey participants to select from three characterizations of a plant's ER activities (summarily: reactive, preventive, proactive).

Expectations determines why ER is of interest to the survey participant.

Equipment Reliability Activities provides the survey participant with the opportunity to grade performance in the six ER areas contained within AP-913.

Equipment Reliability Activity Interfaces provides the survey participant with an opportunity to grade performance in important interfaces between activities contained within AP-913.

Indicators

The performance indicators provide a quantitative check and balance to the staff survey input, which is qualitative and more subjective in nature. The performance indicators, contained in Appendix B, are intraprocess indicators intended to measure the performance of the process elements within AP-913. Care was taken in selecting indicators that, to the extent possible, measure performance of the process element rather than an assumed characteristic of the process element thought to be a positive attribute. Where it is not clear that this was achieved and a process element attribute might have been identified, the indicator has been shaded. Multiple indicators are provided, and in any plant application, it is not expected that the plant will have available all the indicators provided. Consequently, a long list of potential indicators was provided to increase the probability of matches in individual plant applications. In addition to the indicators, quantitative reference values are provided to help in judging performance. The sources of the reference values are cited so that the user can determine which are industry consensus values, which are derived based on industry statistics, which are example plant values, and so on.

Several indicators were identified that are used in the industry that have somewhat different definitions. Rather than attempt to decide which definition is most appropriate, more than one definition was included in some cases. Because indicators are not necessarily standardized across the industry, plant-specific definitions can vary from those provided. Some judgment might be necessary in these situations. The indicators are grouped in the reactive, preventive, and proactive (A, B, and C) categories. If the plant's values for the indicators in a category generally meet or exceed the reference values for the indicators in that category, the plant's ER state is considered to be at or above the category. Comparisons reflect progression from reactive to preventive to proactive (A to B to C).

Survey and Indicator Information Use

This portion of the report discusses suggested ways of performing the following tasks:

- Displaying data collected from the staff survey
- Using the plant's indicator data
- Comparing the two data sets
- Comparing information based on data sources (management versus individual contributors)
- Determining the state of a plant's ER activities

Data used in this portion of the report were obtained from pilot surveys of plant staff and the collection of pilot plant indicator information.

Survey Use

The plant staff's expectations of the benefits of improved ER are established directly from the staff survey data and can be displayed in a bar chart as shown in Figure 3-1. Appendix C, "Survey Chart Preparation Formulas," contains a listing of survey questions used for each chart described in this section.

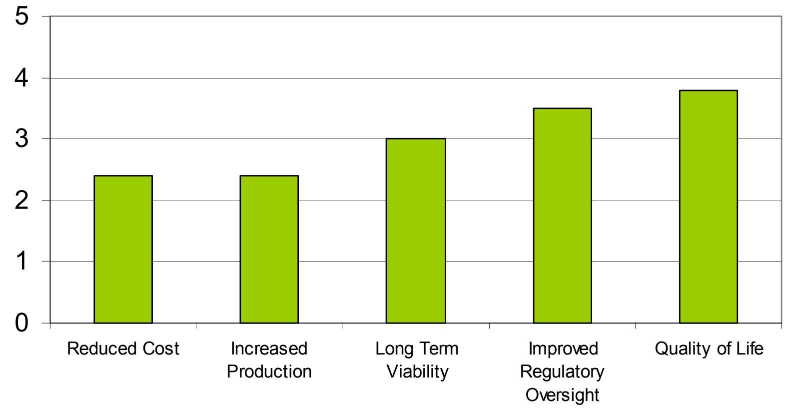

Figure 3-1
Staff Expectations

The plant staff's self-characterization of their ER activities state is developed directly from the staff survey data and can be displayed in a bar chart as shown in Figure 3-2.

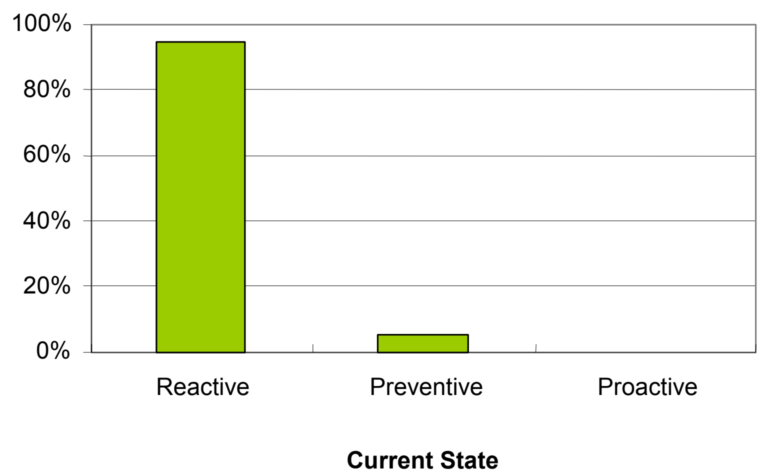

Figure 3-2
Staff Equipment Reliability State Self-Characterization

Reactive (A):	The major emphasis is on quickly fixing equipment that breaks that impacts plant operation or safety reducing maintenance backlog and accomplishing planned outage maintenance activities.
Preventive (B):	The major emphasis is on preventive actions to keep equipment from breaking.
Proactive (C):	The major emphasis is on strategies to address vulnerabilities to long-term viability, through contingencies or planned changes.

The plant staff's self-characterization of the plant's performance of ER activities is developed directly from the staff survey data and can be displayed in a spider (sector) chart as shown in Figure 3-3. Strengths are represented by plotted positions near the circumference of the chart, and weaknesses are presented as plotted positions near the center of the chart. The numeric scale that determines plotted positions on the chart corresponds to the following survey response options.

Survey Response Options and Chart Scale

1 = Not performing the activities in the area

2 = Performing the activities in the area but with room for significant improvement

3 = Performing the activities in the area but with room for improvement

4 = Effectively performing the activities in the area with room for minor improvement

5 = Very effectively performing the activities in this area with little or no room for improvement

The activities contained in the chart correspond to the six major elements in AP-913.

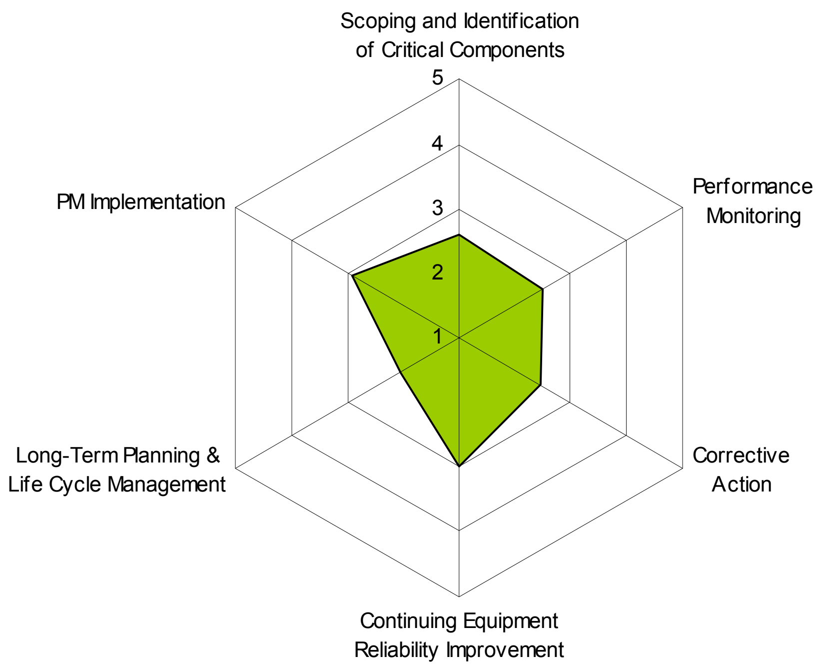

Figure 3-3
Self-Characterization of Process Activities

The plant staff's self-characterization of the plant's performance of interfaces among ER activities is developed directly from the staff survey data and can be displayed in a spider (sector) chart similar to the activities chart shown in Figure 3-4. The strengths are represented by plotted positions near the circumference of the chart, and weaknesses are presented as plotted positions near the center of the chart. The numeric scale that determines plotted positions on the chart corresponds to the survey response options shown for the chart shown in Figure 3-3.

The interfaces contained in the chart correspond to important interfaces among elements in AP-913.

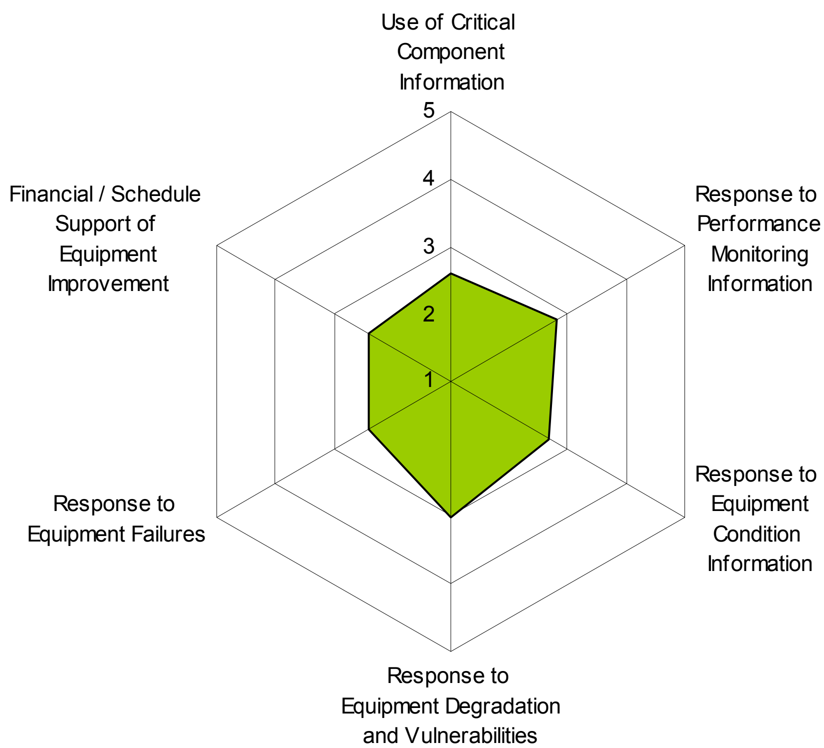

Figure 3-4
Self-Characterization of Process Activity Interfaces

The plant staff's self-characterization of the plant's performance on ER activities and interfaces can also be used as a measure of the degree of the plant's emphasis on preventive and proactive activities. Appendix C, "Survey Chart Preparation Formulas," provides guidance on how to combine responses to selected activity and interface questions to determine the degree of the plant's emphasis on preventive and proactive activities. These results can be used as an internal confirmation of the staff's self-characterization of the plant's ER state. An example of this interpretation of the data is shown in Figure 3-5 and is indicative of a reactive state because both the preventive and proactive scores are relatively low.

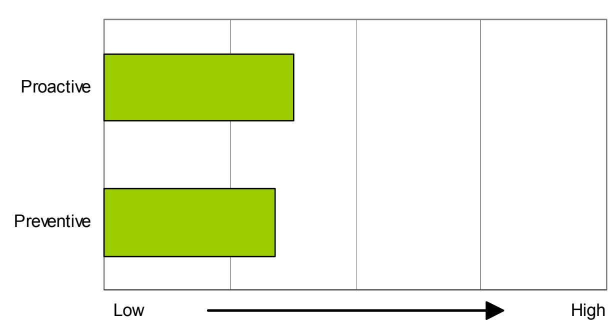

Figure 3-5
State Characterization Using Survey Questions

Interpretation of the ER state from Figure 3-5 can be accomplished using Table 3-1 for the more likely chart outcomes. Low preventive with low proactive scores correspond to a reactive state, high preventive scores with low proactive scores correspond to a preventive state, and high preventive and high proactive scores correspond to a proactive state. Inconsistent results are also possible. These results indicate performance characterized primarily by one state with efforts underway to move toward another.

Table 3-1
Equipment Reliability State Interpretation Table

State	Preventive		Proactive	
	Low	High	Low	High
Reactive	X		X	
Preventive		X	X	
Proactive		X		X

An often revealing comparison can be made by separating and comparing the survey data of plant management from plant individual contributors. Similar results imply a shared understanding and assessment of the plant's ER activities. Differences can indicate scenarios such as different interpretations of the survey questions, management not cognizant with day-to-day events, differences in the understanding of ER fundamentals, and differences in standards or expectations. Independent of the specific reason for the differences, exploration and resolution of the differences are probably worthwhile.

The management/individual contributor comparison is easily accomplished in graph form by producing the charts described in the preceding paragraphs with two sets of data plotted (management and individual contributors). Figures 3-6 through 3-10 illustrate this comparison.

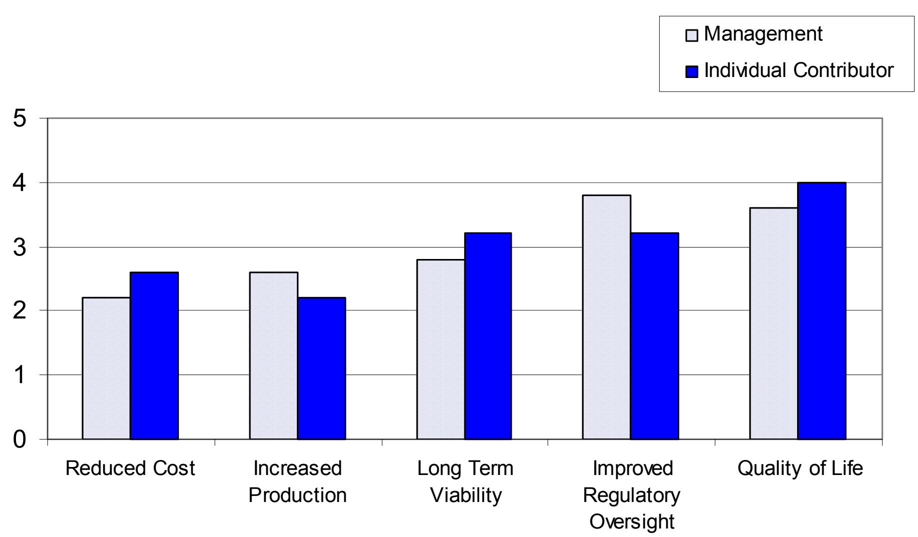

Figure 3-6
Staff Expectations (Staff Comparison)

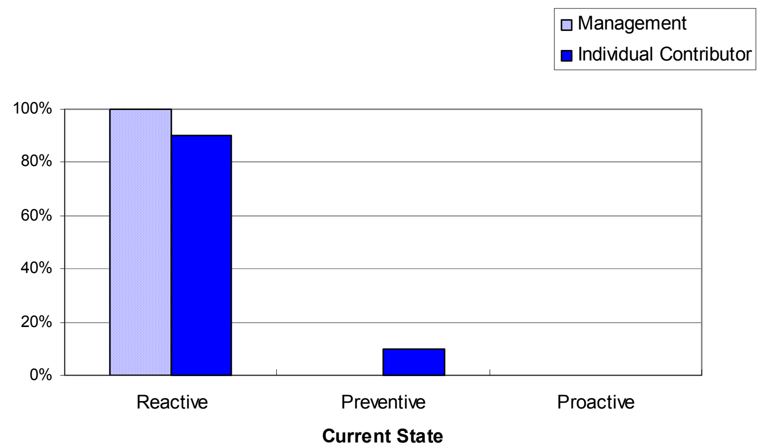

Figure 3-7
Staff Equipment Reliability State Self-Characterization (Staff Comparison)

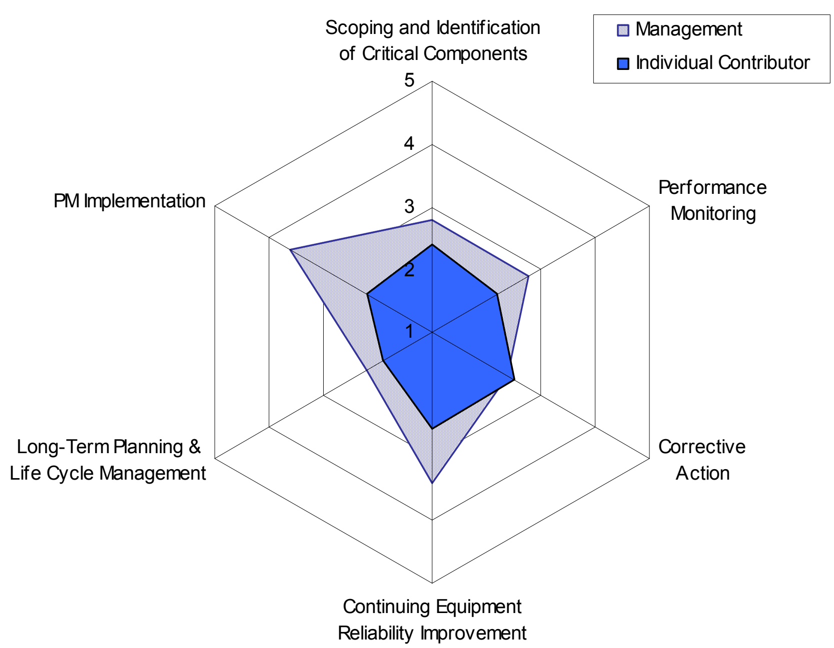

Figure 3-8
Self-Characterization of Process Activities (Staff Comparison)

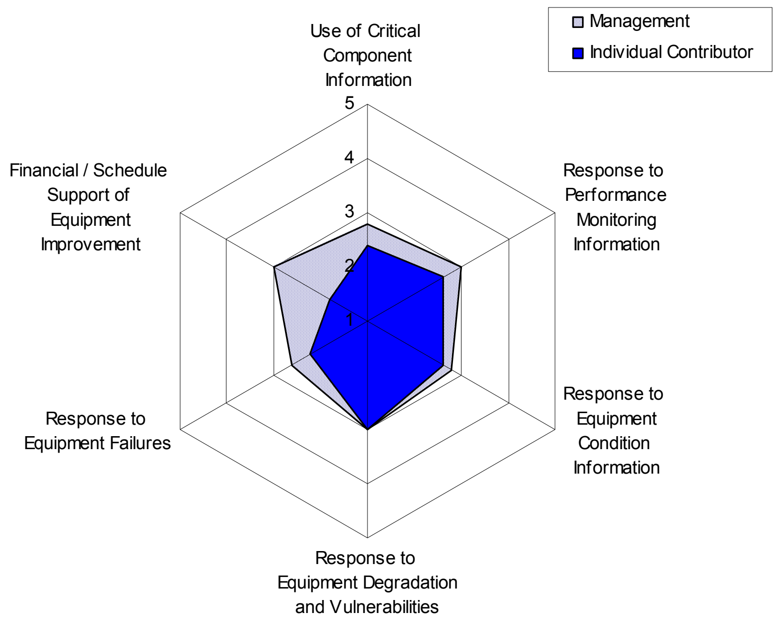

Figure 3-9
Self-Characterization of Process Activity Interfaces (Staff Comparison)

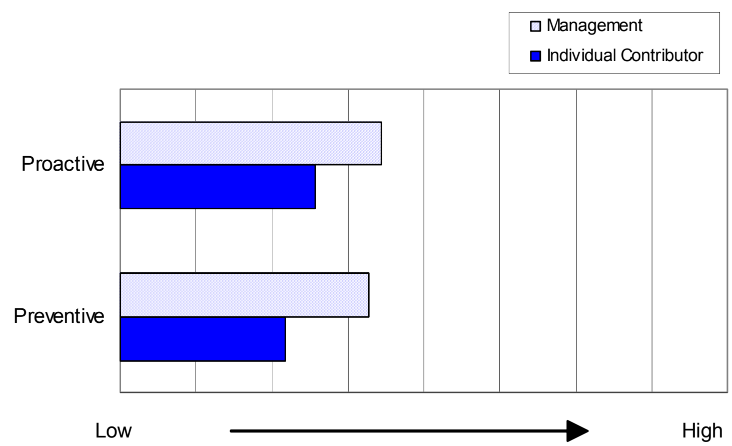

Figure 3-10
State Characterization Using Survey Questions (Staff Comparison)

Indicator Use

The performance indicators, contained in Appendix B, provide a quantitative check and balance to the staff survey input, which is qualitative and more subjective in nature. However, because indicators are not standardized throughout the industry and individual indicators can provide contradictory input, judgment is still required in order to interpret them. The indicators are grouped in the reactive, preventive, and proactive (A, B, and C) categories. Starting with the reactive category (A), the plant's indicator values are compared to the reference values. A table is provided in Appendix D, "Indicator Comparison Form," that can be used to systematically perform this comparison. At a given plant, it is unlikely that the plant will maintain information on all of the indicators. If no indicator data are available, it should be determined if the activity associated with the indicator is not being performed (interpreted the same as if the indicator is not met) or if the activity is being performed but the data are not available (usually not included in the evaluation). It is recommended that all indicator comparisons in the reactive category are made, followed by a judgment based on all of the indicators in the reactive category; the indicator reference values are typically met or are not met in the reactive category. This process is followed for the remaining indicator categories, preventive and proactive (B and C). A reasonable picture of plant performance should be obtained through the indicators, but it is not expected that all indicators will be able to be evaluated. Table 3-2 can serve as a tally sheet that summarizes the number of indicators met and not met that can support the judgments for each state. Pilot plant indicator data have been used to prepare the table.

Table 3-2
Indicator Results Table

Reactive (A)		Preventive (B)		Proactive (C)	
Met	Not Met	Met	Not Met	Met	Not Met
3	2	2	6	0	4

The results of the indicator comparisons described in this section can be evaluated using Table 3-3, which represents the most likely outcomes from the indicator comparisons.

Table 3-3
Indicator Evaluation Table

Interpreted State	Reactive (A)		Preventive (B)		Proactive (C)	
	Met	Not Met	Met	Not Met	Met	Not Met
Reactive		X		X		X
Reactive attempting Preventive	X			X		X
Preventive	X		X			X(1)
Preventive attempting Proactive	X		X			X(2)
Proactive	X		X		X	

(1) No Proactive (C) indicators are met

(2) Some Proactive (C) indicators are met

State Determination Guidance

The ER state determination is based on an assimilation of the processed survey and indicator information described previously. At this point, the information has been reviewed from multiple perspectives in order to provide an integrated view. Table 3-4, which supports this, is populated from Figures 3-7 and 3-10 and Table 3-3. Interpretation of the information in Table 3-4 is simply an assessment of the “preponderance of evidence” presented in the table. Aspects of multiple states can be present in a plant’s ER activities. Because of factors such as prior projects or programs that have advanced certain areas, aspects of multiple states can be present in a plant’s ER activities. For example:

- Earlier use of reliability-centered maintenance approaches and preventive maintenance (PM) optimization activities
- Organizational strengths, such as a strong corrective action (CA) function or highly effective predictive maintenance (PdM) practices

In these situations, it is recommended that primary (most dominant) and secondary states are identified, because later in the strategy development, actions are guided by recognition of the state of ER activities. Pilot plant data were used to populate Table 3-4.

Table 3-4
Comparison of Survey Results and Indicators

	Overall Assessment	Activity and Interface Input
Individual contributors	Reactive.	Reactive.
Management	Reactive.	Reactive.
Indicators	Reactive attempting preventive.	This comparison block is not applicable.

Focus Matrix

Implementation of an ER process can present challenges, such as how to get started and how to proceed if aspects of the process are already in place. The Focus Matrix helps to determine the answer to the question, “What ER process areas should be focused on, based on the state of the plant’s current ER activities?” The Focus Matrix identifies the process areas and key subactivities that will yield the most benefit to the plant given the plant’s state of implementation of the ER process. AP-913 is used as a reference point for process areas and key subactivities because of the industry’s widespread familiarity with it.

The Focus Matrix uses the state of the plant’s ER activities (described in detail earlier) with AP-913 activities that will yield the most benefit given the state identified. The state-to-benefit associations are based on the logic contained within the process itself and industry experience.

Numerous sources provided industry experience (see References 2–13 in Appendix H).

In addition, input was provided by several individuals with significant firsthand knowledge of industry and plant ER activities, based on a combination of their responsibilities with their company as well as experience in industry ER efforts (for example, benchmarking teams, workshop participation and leadership roles, and peer evaluations). These individuals are identified on the Acknowledgments page at the beginning of this report. Their input was obtained through a combination of a group web cast meeting and individual interviews.

Table 3-5 shows a summary of the logic contained in the focus matrix. This table relates the state of the plant's ER activities to associated AP-913 areas and then to the most appropriate improvement opportunities that are also usually subactivities of the AP-913 area. The improvement opportunities are stated in lay terminology. For example, in a reactive state, certain *scoping and identification of critical components* activities are most appropriate because they support *knowing what is important and why* (italicized text associated with material in the table). This table explains in general terms the focus for future improvement efforts.

Table 3-5
Focus Matrix Opportunities

State	Primary AP-913 Area	Improvement Opportunities
Reactive (A)	**Scoping and identification of critical components**	• Know what is important and why.
	Other	• Keep reactive actions from interfering with planned actions.
	PM implementation	• Perform needed maintenance in a timely manner.
	Corrective action	• Understand equipment failures. • Use understanding to determine appropriate actions.
	Performance monitoring	• Anticipate problems. • Know what to react to.
Preventive (B)	**Continuing ER improvement**	• Focus failure prevention actions on high payoff items. • Understand the purpose of prevention actions. • Use equipment condition information to "head off" degradation.
	Performance monitoring	• Pay attention to equipment trends (not just incidents). • Apply all of the equipment information and knowledge available.
	PM implementation	• Use equipment condition information to optimize maintenance actions or strategy.
Proactive (C)	**Corrective action**	• Build a consensus of what must be improved.
	Continuing ER improvement	• Direct reliability improvements toward basic plant design issues and equipment issues not effectively addressed by maintenance.
	Long-term planning, life-cycle management (LCM)	• Planning must consider future issues. • Ensure that plans are practical and realistic.

Associated with these improvement opportunities are specific activities or attributes typically subactivities of the AP-913 process area. These are contained in the focus matrix as specific activities where focused gap evaluation is appropriate and stated as goals of an evaluation. Following through the example for reactive state – *scoping and identification of critical components – knowing what is important and why,* the associated goal of the focused gap evaluation is *to determine if components are classified by functional importance (critical, noncritical, run-to-failure, or similar) and the basis is documented* (italicized text associated with material in the table).

Table 3-6
Evaluation Focus Matrix

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -
Reactive (A)	**Scoping and identification of critical components**	• components are classified by functional importance (critical, noncritical, run-to-failure, or similar) and the basis is documented.
	Other	• scheduled work is protected from emergent work through supplemental activities such as FIN teams.
	PM implementation	• work is managed with a strong priority system. • work is scheduled to ensure that manpower is available for important work.
	Corrective action	• systematic troubleshooting is applied and expectations are defined. • repetitive equipment issues are identified and addressed. • critical equipment failures initiate reviews of PMs, monitoring plans, and so on.
	Performance monitoring	• monitoring focuses on critical components and attributes. • indicators of degrading performance or condition are detected and acted on.
Preventive (B)	**Continuing ER improvement**	• component classification is used to prioritize ER strategy improvements. • basis for PMs is established. • industry operating experience (OE) is incorporated through changes to PMs. • PdM is applied to identify degradation trends.
	Performance monitoring	• trending is performed to predict unacceptable equipment degradation. • walkdowns and operator rounds identify early indicators of degradation. • cross-system common component trending is used.
	PM implementation	• as-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization.
Proactive (C)	**Corrective action**	• a site-wide management list of key equipment issues is used to prioritize equipment improvements and planning.
	Continuing ER improvement	• ER strategies are effected to address: - equipment-related plant vulnerabilities - significant ER issues not improved by PM actions
	Long-term planning, LCM	• long-term plans (stand-alone or contained in health reports) address equipment issues, including aging and obsolescence. • long-term equipment plans are reconciled with the plant's budget and schedule.

Relationships exist between the ER activities state, the focused gap evaluation areas, survey questions, and the indicators. These relationships, represented in Table 3-7, can be used to cross check information for consistency. This can be done by a review of the responses to survey questions and indicators in the focus areas. The responses to survey questions and indicators in Table 3-7 should show room for improvement (potential for benefit) in the focus areas associated with the plant's ER state. In addition, a plant might exhibit characteristics of more than one state. Table 3-7 can be used to determine which focused gap evaluation goals are the most important. Focus areas where the survey question responses and/or indicators show performance is strong can then be omitted from consideration and those where less than desired performance is indicated are good candidates for performance improvement and benefit.

Table 3-7
Relationships Between Focus Matrix Elements, Survey Results, and Indicators

State	Primary AP-913 Area	Goal of the Evaluation	Related Survey Questions	Related Indicators
Reactive (A)	**Scoping and categorization of critical components**	• Components are classified by functional importance (critical, noncritical, run-to-failure, or similar) and the basis is documented.	1, 7	None
	Other	• Scheduled work is protected from emergent work through supplemental activities such as FIN teams.	None	
	Corrective action	• Work is managed with a strong priority system. • Work is scheduled to ensure that manpower is available for important work.	None	A1, A2, A3, A10
	PM implementation	• Systematic troubleshooting is applied and expectations are defined. • Repetitive equipment issues are identified and addressed. • Critical equipment failures initiate reviews of PMs, monitoring plans, and so on.	3a, 9, 10a	None
	Performance monitoring	• Monitoring focuses on critical components and attributes. • Indicators of degrading performance or condition are detected and acted on.	8a	B5, B7, B9
Preventive (B)	**Performance monitoring**	• Component classification is used to prioritize ER strategy improvements. • Basis for PMs is established. • Industry OE is incorporated through changes to PMs. • PdM is applied to identify degradation trends.	4d, 7	B4, B7
	Continued ER improvement	• Trending is performed to predict unacceptable equipment degradation. • Walkdowns and operator rounds identify early indicators of degradation. • Cross-system common component trending is used.	2	B11, B14
	PM implementation	• As-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization.	6, 8b, 12	B3, B6
Proactive (C)	**Continued ER improvement**	• A site-wide management list of key equipment issues is used to prioritize equipment improvements and planning.	3b	C4
	Corrective action	• ER strategies are effected to address: - equipment-related plant vulnerabilities - significant ER issues not improved by PM actions	4a, 4b, 4c, 5b	None
	Long-term planning and life-cycle management	• Long-term plans (stand alone or in health reports) address equipment issues, including aging and obsolescence. • Long-term equipment plans are reconciled with the plant's budget and schedule.	5a, 10b, 11	C1, C2, C3

4
FOCUSED GAP EVALUATION

Goals and Evaluation Process

The evaluation of the staff surveys and performance indicators with the focus matrix provides a basis for which ER process activities represent areas of ER improvement opportunities or potential benefit given the state of the plant's ER activities. This basis allows one to quickly identify the areas where improvement will yield the most benefit, in contrast to an overall assessment of all ER activities. This is valuable to plants just initiating ER activities; because in many cases, they might be functioning in a reactive state and the resource needs to conduct an overall assessment compete with needs to support current operations. This stalemate can be resolved through the use of the focus matrix guidance. Plants with ER initiatives already in place benefit in a different way. They might have already completed an overall assessment and have advanced certain areas but might not be sure where future efforts should be directed or might not be sure of the results of prior efforts. This strategy supports their needs by helping them to gauge their status and define new areas of opportunity.

In order to identify specific actions that will yield benefit in the areas defined by using the focus matrix, an evaluation of the plant's activities in these areas—called here a *focused gap evaluation*—is a practical approach. A focused gap evaluation can be conducted in several ways, including:

- Self-evaluation
- Independent evaluation
- INPO assistance visit
- "Table-top" review of documentation
- Interviews of cognizant staff
- Examination of specific plant practices and activities
- Review of process structure and results

Independent of the methodology chosen to perform the focused gap evaluation, the specifics of what to evaluate is a common consideration. Because many plants have conducted overall assessments of ER activities, usually using AP-913 as a reference basis, there are examples of approaches that can be used. In situations where staff deeply conversant with ER process activities are available, evaluations are often simply directed toward general subject areas, and the subject matter expert follows his or her instincts and expertise in identifying strengths and potential improvement opportunities. Often, however, an approach with more structure is used. Appendix B of AP-913 provides this type of structure at the process area level within AP-913; INPO 01-004, "Achieving High Equipment Reliability – A Leadership Perspective," contains success factors observed at stations achieving high levels of ER; and the INPO Nuclear Exchange NX-1036, “Fermi 2 Equipment Reliability Surveys,” provides a combination of the content from both of these.

To support the focused gap evaluation associated with the strategy outlined in this document, evaluation guidance for the specific topics in the focus matrix has been developed. This guidance differs from other references by focusing on more specific topics than found in other references. Provision of this guidance is intended to reduce the effort required to prepare for and conduct the focused gap evaluations. The guidance has been compiled from a number of sources and is contained in Appendix E, “Question Templates,” in a format similar to that used in EPRI 1003103, “EPRI-lite, An Equipment Reliability and Obsolescence Evaluation Tool.” The evaluation guidance material is organized by ER state—Reactive (A), Preventive (B), Proactive(C)—and focus matrix evaluation goals associated with each state. The instrument for conducting the gap evaluation consists of a template containing questions, an area available for recording individual question responses (and/or comments), and a set of check boxes for each question. The check boxes can be used to indicate whether the responses reflect meeting the goal associated with the question. The template was constructed so that it could be used as an interview notes collection form, a self-check form, or a survey form. Figure 4-1 shows the template for one evaluation goal.

			Generally Meets	Partially Meets	Does not Meet
AP-913 Area:	**Scoping and Identification of Critical Components**				
Plant:					
Date:					
Name:					
Goal	**Question**	**Response**			
Determine if components are classified by functional importance (critical, non-critical, run-to-failure or similar) and the basis is documented.	1. Does the plant have a single accepted definition of functional importance?				
	2. Is the definition of functional importance based on industry standard documents? Does the definition of functional importance include critical, non-critical, run-to-failure or similar definitions?				
	3. Are components classified in accordance with the definitions of functional importance?				
	4. Does the classification include a documented basis for the classification? Is all information available in a single location?				
	5. Is there a process for reviewing functional importance and classification? Is it clear how to make changes?				
	6. Do plant changes initiate reviews of functional importance and changes in classification if needed?				

Figure 4-1
Sample Question Template

Interpretation of Focused Gap Evaluation Results

Interpretation of the results of a focused gap evaluation entails reviewing the evaluation results to determine the opportunities for improvement. The approach in this strategy consists initially of concentrating on each evaluation goal and interpretation of the associated results, followed by comparison of the results from multiple evaluation goals, identifying any common themes.

Appendix F, "Opportunity Templates," consists of a convenient template for interpretation of the results of the evaluation of each goal, and a sample is shown in Figure 4-2. This template is very similar to the template in Appendix E, "Question Templates," that is used to perform the focused gap evaluation. The second template (Appendix F), however, is used to convert comments collected during the focused gap evaluation into statements of gaps or opportunities for improvement.

AP-913 Area:	**PM Implementation**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if as-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization.	1, Do all work orders (CM, PM, etc.) require the recording of as found conditions?	
	2. Does guidance exist for what information is important when recording as found condition?	
	3. Is there a mechanism for as found condition information to be reported back to the responsible person or personnel (component engineer, system engineer, PM coordinator)?	
	4. Are as found conditions on components trended?	
	5. Are post maintenance critiques used to identify improvement opportunities?	

Figure 4-2
Sample Gaps/Opportunities Template

The interpretation of the focused gap evaluation results is intended to disclose focused, largely technical opportunities. The review elements conducted to identify these specific opportunities and the opportunities themselves also provide a basis for identification of common themes that are more general in nature. A tool that can be used to collect these observations is a *bubble chart*, which is defined as a diagram containing the names of elements (usually circled, thus within a bubble) connected by lines that show general relationships between elements. This diagram is more conceptual in nature than a process diagram where the relationships between elements are necessarily more rigorously logical. The bubble chart is a convenient tool for collecting observations because the element categories are fairly encompassing. An applicable bubble chart for use in this application has been published by INPO on their October 2003 Equipment Reliability Digest web page.

5
GAP SOLUTIONS IDENTIFICATION

Convenient tools exist for identifying solutions for gaps identified during the interpretation of the focused gap evaluation results. Some of the more useful tools for this purpose are described in this section of the report.

Industry AP-913 Capabilities Database

In 2002, EPRI produced a database consisting of EPRI products and capabilities cross-referenced to the areas and elements in AP-913. In 2003, this was expanded to include additional industry capabilities such as major INPO, owners group, and utility capabilities. The database is available in two forms: a CD (EPRI Product 1008252) with multiple search functions (by AP-913 area and element, type of capability, key word, and source of information) and a web site (http://www.epriweb.com/epriweb2.5/ecd/np/equip-reliability/index.html) that is organized by AP-913 areas and elements. Cross-referencing the information in this database to the areas and elements of AP-913 is convenient for identifying solutions to the gaps described in Section 4, because the gaps are largely developed based on evaluation of areas and elements in AP-913. Figure 5-1 is a screen shot of the web site.

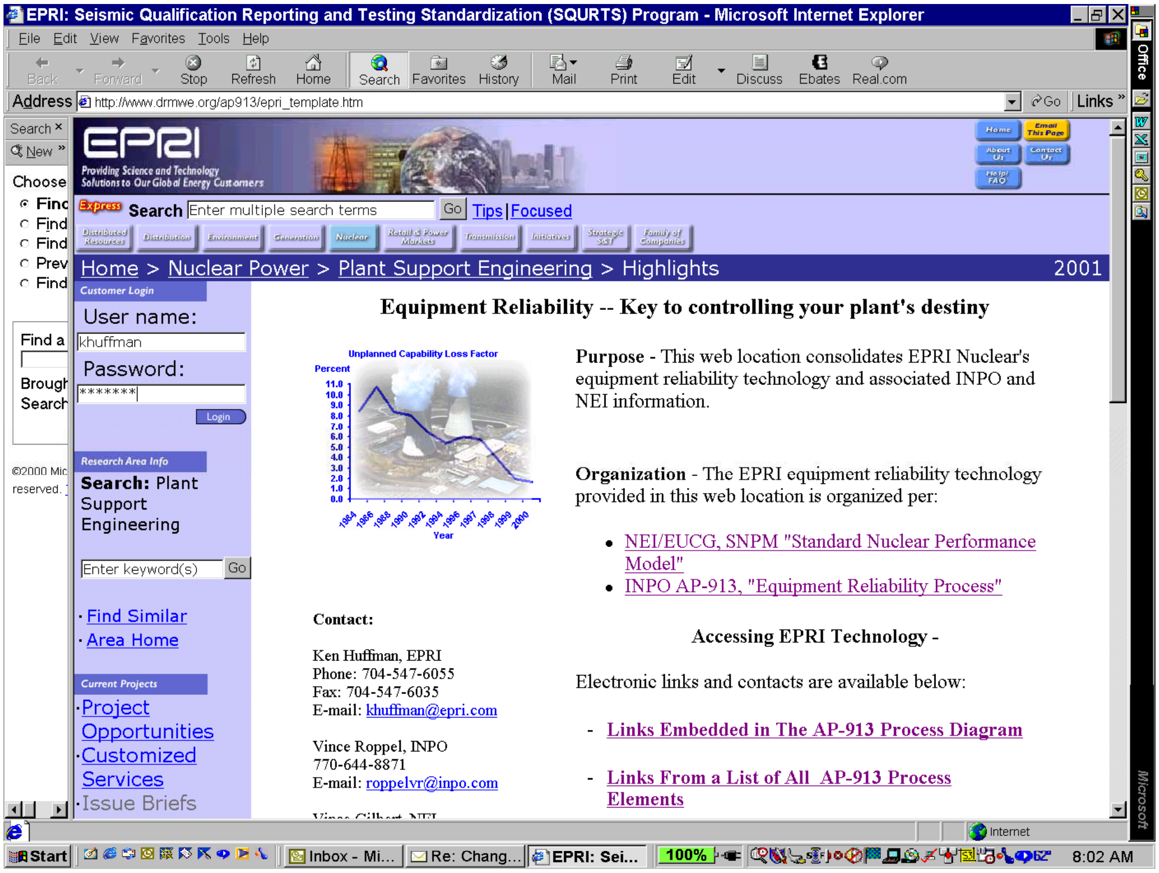

Figure 5-1
EPRI Equipment Reliability Web Page

Selected EPRI Information

Selected EPRI information has been extracted from the database that directly relates to the areas contained in the focus matrix. This information is contained in Appendix G, “Gap Solutions Table.”

EPRI and INPO Web Sites

Because the database is updated periodically, there are times when the information in the database is not current. Using information from EPRI’s and INPO’s web sites can help in addressing this issue because these web sites are updated on an essentially ongoing basis. The EPRI and INPO web sites both have topical search capabilities that can be used to help in identifying capabilities that can address gaps. The INPO web site has an ER web page that has technical references organized by AP-913 areas. The technical references include INPO, EPRI, and utility information. The EPRI and INPO web sites are open to members of each organization and require an ID and password to enter them. The EPRI web site URL is www.epri.com, and the INPO web site URL is www.inpo.org.

A
Staff Survey

PLANT LEADERSHIP AND INDIVIDUAL CONTRIBUTOR STAFF SURVEY

General Characterization

Select from the following statements the one that most closely characterizes your plants equipment reliability situation. ______

A. Major emphasis is on - quickly fixing equipment that breaks that impacts plant operation or safety, reducing maintenance backlog and accomplishing planned outage maintenance activities.

B. Major emphasis is on - preventive actions to keep equipment from breaking.

C. Major emphasis is on – strategies to address vulnerabilities to long-term viability, through contingencies or planned changes.

Expectations

Rank 1 through 5, 1 most important and 5 least important your expectations of what improved equipment reliability will accomplish as it relates to your responsibilities:

_____ A. Reduced cost associated with reactive activities.

_____ B. Increased production and predictability of plant availability

_____ C. Improved regulatory and oversight position

_____ D. Greater focus on long-term plant viability considerations

_____ E. More fulfilling “quality of life” for plant staff

Performance Rankings

Please rank your plant’s performance in the items listed below using a scale of 1 – 5:

1 = not performing the activities in the area

2 = performing the activities in the area but with room for significant improvement

3 = performing the activities in the area but with room for improvement

4 = effectively performing the activities in the area with room for minor improvement

5 = very effectively performing the activities in this area with little or no room for improvement

Equipment Reliability Activities

_____ 1. Plant equipment is systematically reviewed and critical equipment is identified based on functional importance to safety, reliability, and power generation capability.

_____ 2. Performance criteria and monitoring parameters for important system functions and critical components are established; relevant data associated with the monitoring parameters is collected, trended and compared to the performance monitoring criteria. Results are evaluated to identify equipment degradation or better than expected situations.

_____ 3a. Equipment performance degradation and failures are evaluated to determine appropriate actions including apparent cause or root cause determination in accordance with the plant's corrective action program.

_____3b. Equipment issues are identified and prioritized using cross-discipline, inter-department management input to support a common station focus on key equipment problems and high-risk equipment vulnerabilities.

_____ 4.a An ongoing equipment reliability improvement strategy to improve preventive maintenance (PM) tasks and adjust PM frequencies is in place.

_____4.b Opportunities to apply strategies such as additional predictive techniques, preventive replacement, etc. are evaluated as alternatives to normal PM task and frequency adjustments.

_____4.b Design and configuration changes are evaluated to address situations where PM tasks are not effective or are too costly.

_____4.c Industry operating experience and industry maintenance standards are used to augment plant experience when considering alternate strategies and changes.

_____ 5.a Periodic, forward-looking assessments of system and component health and vulnerabilities are performed that includes longer term considerations such as aging and obsolescence effects.

_____5.b Long-term equipment improvement strategies such as revised maintenance plans, scheduled refurbishments, replacements and upgrades, design changes and modifications are developed.

_____ 6. Preventive maintenance implementation incorporates as-found equipment condition documentation that captures the degree of degradation actually observed by the worker.

Equipment Reliability Activity Interfaces

_____ 7. A consistent set of defined critical equipment is a common input to continuing equipment reliability improvement activities such as:

- PM task and frequency optimization,
- Determining the basis for performance monitoring activities such as establishing equipment performance criteria,
- Determination of whether corrective actions should incorporate root cause evaluations or apparent causes,
- Plant equipment upgrade decisions, etc.

_____ 8.a Adverse equipment performance monitoring trends or observations are identified for action to functions such as the plant's corrective action program.

_____8b. Better than expected performance results are input for consideration to activities such as maintenance optimization.

_____ 9. Equipment failures are identified and communicated so that they can be evaluated to determine if they were anticipated (run to failure) or not and if appropriate evaluated so that future failures can be prevented.

_____10.a Equipment degradation and failure cause evaluation results and associated actions, such as corrective actions, are communicated to responsible plant organizations for implementation.

_____10.b Critical equipment problems and high-risk equipment vulnerabilities are communicated and incorporated into long-term equipment reliability improvement strategy planning.

_____11. Long-term equipment reliability improvement plan actions are reconciled with the plant's business plan to ensure station budgetary support and with the station long-term outage plan to ensure schedule support.

_____ 12. As-found equipment conditions identified during PM activities are communicated as feedback to equipment performance monitoring for use in equipment performance trending and for adjusting performance criteria; and as feedback to PM task and frequency optimization.

B
Performance Indicators

State	Indicator	Description	Comparison Information	Notes
A	Backlog 1	Work scheduled for performance during a specified time/window that was not done, could not be done, or was not rescheduled for whatever reason and is more than 30 days overdue.	Benchmark: 50 work orders overdue > 30 days at any given time; Goal: <20	Description and benchmark from EPRI TR-1007604 (Feb 2003)
A	Backlog 2	Those items that can be worked on line that restore equipment or components affecting nuclear or personnel safety or plant reliability that have failed, are degraded or do not conform to their original design, configuration, or performance criteria. Includes minor maintenance and FIN team items, does not include elective maintenance.	Palisades: <75 meets, <50 exceeds, 2002 - 94 avg., 2003 ~ 40; Robinson typically ~ 108; Susquehanna Goals - 60 (top quartile); currently 21 - 2 for both Susquehanna units	AP-928 recommends on-line corrective maintenance backlog; Robinson information - remarks by Jim Adams at 2003 ANS Utility Conf.; Susquehanna information - remarks by Bob Paley at 2003 ANS Utility Conf. 2002 NEI ER Benchmarking Report sites reported CM backlog levels for two unit sites between 77 and 396 (not clear what definition was used).
A	Backlog 3	CM backlog: maintenance priority work orders and work requests (excluding outage, mods, non-plant work)	APS: 2003 3 unit site goal that ramps down during the year from 392 to 300, in 2002 was 358	APS goals are total for three units. 2002 NEI ER Benchmarking Report sites reported CM backlog levels for two unit sites between 77 and 396 (not clear what definition was used).
A	Capacity Factor		Industry Average Capacity Factors: 2002 - 91.9%, 2000 ~ 90%; Top Quartile Unit Capability Factor 2001 - 2003 ~ 93%	Equipment Caused Capacity Losses changed to Capacity Factor. Capacity Factor data from NEI web page, Unit Capability Factor from Ron Davis (Entergy South) 7/03 ER Forum presentation.

State	Indicator	Description	Comparison Information	Notes
A	CM/PM Ratio on Critical Components	Total number of work orders serviced per year by the maintenance department	Benchmark: 30% / 70% (Note - Benchmark # of work orders: 12,008 per year). Most 2002 NEI ER Benchmarking project sites had CM/PM ratios between 12% / 88% and 29% / 71%.	Note - some plants do not initiate a work order for certain routine periodic and/or predictive maintenance items controlled outside of maintenance management systems (i.e., task cards) the intent of the benchmark is to include these tasks. Benchmark from EPRI TR-1007604 (Feb 2003); other information from NEI ER Benchmarking Report 9/2002.
A	Equipment Cased Power Changes	Number of failures of equipment causing downpowers per year	APS Goal: 34 or less per year	APS is a 3 unit site and their goal is for site based on # of high risk sig functional failures and failures causing downpowers >10%. In 2002 APS had 23 functional failures and 0 downpowers, through July 2003 12 failures and 1 downpower.
A	Forced Outage Rate	Avg % of time each unit was unavailable due to forced events compared to the time planned for generation.	APS Goal: 1%	APS cites UDI Test Quartile as 1.25 %, in 2002 total nuclear was).3 and YTD through July was 1.7. Note - APS thermal performance goal is 99.8% (actual heat rate / design heat rate).
A	LERs	Licensee Event Reports	Industry had 814 LERs in 1999, ~100 units or about 8 per unit per year	Better measure would be equipment caused LERs, but this data may not be as readily available.

State	Indicator	Description	Comparison Information	Notes
A	Maintenance Rework	Work re-performed within the specified period because work performed the first time was inadequate, incorrect or performed using deficient parts an/or materials. Recommended period is six months or 1/2 of the PM interval, whichever is shorter.	Benchmark: 24 work orders per year for the maintenance department as a whole. Palisades: Meets - 0% Level I, 2% equip / 1% 50-200 hrs Level II, 2% Level III; Exceeds- 0%, 0%, 0%, 1%; 2002 ~ 1.5% Level III, other Levels not available	Definition, benchmark criteria and goal criteria from EPRI TR-1007604 (Feb 2003). The benchmark is stated as conservative because of data inconsistencies, etc. For Palisades definition of Levels not available at time of preparation.
A	PM Schedule Performance	The number of delinquent PM tasks and the number of deferred PM tasks.	Palisades: Meets - 95% prior to due date, 5% within 10% grace period, 0% following grace period; Exceeds >95%, <5% and 0%; 2002 ~70%, ~20%, ~5%; PPL Susquehanna Goal - 90%	PM Schedule Performance changed to PM Implementation to be consistent with AP-928 PM indicators. AP-928 indicators used. Note AP-928 defines delinquent PM as beyond 25% of scheduled interval but notes that some program-driven PMs do not permit a 25% grace period.
A	Unplanned LCOs		Surry: 76 - 2002, 39 - Jan thru June 2003; Shearon Harris: 133 - 2001, 58 - 2002, 28 - Jan thru July 2003; Palisades Goal (Meets): 24 (2002 - 27) for deficient or malfunctioning equipment only	Better measure would be equipment caused LCOs, but this data may not be as readily available.
B	PM Effectiveness	Number of CM work orders on components with PMs	Surry 1 & 2 Experience: non-outage months 5 - 20, outage months ~ 40; 2002	Sum of both units 1 and 2.
B	PM Effectiveness	Number of CM work orders on critical components (non-run to failure)	Surry 1 & 2 Experience: non-outage months 15 - 50, outage months 90 - 110; 2002	Sum of both units 1 and 2.

State	Indicator	Description	Comparison Information	Notes
B	*As-Found Condition Feedback*	*Worker performing PM documents as-found condition of equipment.*	*Activity is systematically performed. Use of as-found condition coding is preferred but not required.*	*No quantitative measure was identified. Comparison is based on PPL and Exelon good practices presented at the May 2002 EPRI ER Forum.*
B	*As-Found Condition Feedback Evaluation*	*System and component engineers use as-found condition data to adjust PM task / frequencies or make other changes.*	*Activity is systematically performed and includes both trending and individual event observations.*	*No quantitative measure was identified. Comparison is based on PPL and Exelon good practices presented at the May 2002 EPRI ER Forum.*
B	*Predictive Maintenance (PdM) / Condition Based Maintenance is applied to improve equipment reliability*	*The basis for PdM activities are understood.*	*The scope and intervals for PdM tasks are identified and technical basis. Scope and interval basis for all PdM tasks is considered high or above average, coverage of the major PdM techniques (vibration, IR Thermography and lube oil analysis) is considered average.*	*EPRI TR-1001032*
B	*Predictive Maintenance (PdM) / Condition Based Maintenance activities are effective*	*Ongoing actions are taken to ensure that PdM activities are effective.*	*Improvement opportunities are monitored by assessing the following: industry OE, new diagnostics, new applications, and component failures preventable by PdM.*	*EPRI TR-1001032*
B	Technical basis for PMs	% PMs with Documented Technical Basis	All PMs for critical and non-critical components. Additionally there is a feedback process for updating PMs that includes adjustments to the basis for changes.	Comanche Peak good practice contained in the NEI "Industry 2002 ER Benchmarking Report", Exelon good practice presented at the May 2002 EPRI ER Forum.

State	Indicator	Description	Comparison Information	Notes
B	Technical basis for performance monitoring	% Performance Monitoring Parameters with Documented Technical Basis	All direct (quantitatively measured, physical parameters) parameters have a technical basis.	Good practice discussions at November 2001 EPRI ER Forum, EPRI Report TR-107688 and INPO AP-913.
B	Performance Monitoring Application	% Maintenance Rule Systems with Documented Performance Monitoring Plans	100%	EPRI TR-107688 and AP-913. Note if MR systems include only those with safety significance, then non-safety production critical systems should also be addressed.
B	*Performance Monitoring Feedback to PM s*	*Direct feedback of important monitoring observations is provided.*	*There is an expectation that important monitoring observations (degradation of performance of critical system or component functions) result in review of PMs.*	*AP-913*
B	PM Change Backlog	Number of authorized PM Changes Waiting for Review or Implementation	Brunswick - 50, Comanche Peak - 54, Dresden - 206, McGuire - 679, So. Texas Project - 24, Watts Bar - 413	Definition used for "criteria" or reference point was "PM Change Backlog" - 2002 NEI ER Benchmarking Project. All data was for 2001.
B	System Health Reports	Are system health reports developed and maintained.	Yes, for at least all MR systems, update frequency established (may vary with importance of system, typical update frequency is 3 - 4 times per year).	EPRI TR-1001032 and discussions at July 2003 EPRI ER Forum
B	System Health	Number of systems not meeting system health goals (goals and criteria definition not standardized throughout industry)	Palisades: Meets - 2 Red, 8 Yellow; Exceeds - 0 Red, 4 Yellow; 2002 ~ 10 Red, ~ 14 Yellow	Color coding criteria throughout industry not standardized.
B	MR Health	% of MR systems meeting goals	APS Goal: % of MR Systems Meeting Performance criteria - 98%	APS table heading is "High Risk Significant Systems", not clear if this is all MR systems or a subset.

State	Indicator	Description	Comparison Information	Notes
B	*Cross System Like Component Monitoring*	*Performance of cross-system monitoring of component failures and problems using plant history / experience and industry OE.*	*Common components are grouped across systems and performance monitored and reported using common parameters and inputs.*	*McGuire good practice contained in 2002 NEI ER Benchmarking Report.*
B/C	Corrective Action Effectiveness	APS Effectiveness - Have high priority actions been completed as intended and the condition corrected to prevent recurrence.	APS: Goal 95%	
B/C	Corrective Action Effectiveness Timeliness	APS Timeliness - Number of evaluations open over 30 days, and number of "closures" open over 180 days.	APS: Goals - Varies by month with evaluation min of 30 / max of 50; closure min of 75 and max of 115.	Note APS is a 3 unit site, goals are for all 3 units.
C	*Long Term Plan Development*	*Major systems / components and those with unacceptable performance have documented improvement strategies (documentation form of the strategies may vary - robust system health report section on "long term plan", stand alone long term plan or LCM plan, etc.)*	*Minimum of all systems / components consistently (more than one cycle) not meeting performance goals and those where industry OE has demonstrated strong potential for long term performance issues (aging, obsolescence).*	*From AP-913 and author's notes from NEI - ER Benchmarking 2002 (candidate good practice McGuire plant).*
C	*Long Term Planning Actions Incorporation Into Budget and Schedule*	*Financial requirements to support long term plans that are included in the plant's budget and outage scheduling*	*Financial and schedule needs are communicated and acted upon (accepted, rejected or delayed). Rejected or delayed actions result in alternate long term planning strategy development.*	*Comanche Peak good practice contained in 2002 NEI ER Benchmarking Report. (Note: considered for the extent of the financial planning cycle, stability of inclusion in the budget cycle should also be considered to avoid situations where items are approved but then consistently deferred.)*

State	Indicator	Description	Comparison Information	Notes
C	Consensus Top Plant Equipment Issues	One "top plant equipment issue list" exists and represents a consensus supported by plant management and is maintained current.	Plant management consists of all functions associated with equipment reliability (operations, maintenance, engineering, oversight / corrective actions, etc.). Plants using this to drive near term actions update the list weekly or monthly those using it to drive long term actions review this three - four times per year coordinated with updates of system / component health reports.	AP-913 endorses a consensus top equipment list. Other information reflects findings in the 2002 NEI ER Benchmarking Report associated to common contributors among the six plants benchmarked.
C	*Designated Plant Equipment Issues are Resolved*	*Number of CMs on designated plant equipment issues*	*Trending is performed to assess performance. Designated plant equipment issues are issues with equipment on the top plant equipment list (or equivalent).*	*From Surry presentation at July 2003 EPRI ER Forum presentation.*
C	Program Health	Number of systems not meeting program health goals (goals and criteria definition not standardized throughout industry)	Palisades: Meets - 2 Red, 4 Yellow; Exceeds - 0 Red, 2 Yellow; 2002 ~ 2 Red, ~ 4 Yellow	Color coding criteria throughout industry not standardized.

C
Survey Chart Preparation Formulas

Survey Chart Preparation Formulas

The formulas used to construct the figures contained in Section 3 of this report are summarized below. For cases where formulas are not applicable or not needed an explanation of the figure construction is provided. Multiple survey inputs are averaged before using the formulas provided below. All figures were prepared using the chart routines available in Microsoft Excel.

Figure 3-1 Staff Expectations

Data Source:
Plant Leadership and Individual Contributor Staff Survey Expectations

Formula:
The average value of the rankings for each of the expectation options (A – E) is used.

Figure 3-2 Staff Equipment Reliability State Self Characterization

Data Source:
Plant Leadership and Individual Contributor Staff Survey
General Characterization

Formula:
The number of survey inputs associated with each option (A, B or C) is converted to a percentage based on the total number of inputs.

Figure 3-3 Self Characterization of Process Activities

Data Source:
Plant Leadership and Individual Contributor Staff Survey
Equipment Reliability Activities
(Alpha-numeric terms in the formulas below refer to the response values from the survey for the question with the corresponding alpha-numeric designation.)

Formulae:
Scoping and Identification of Critical Components
    Value = 1
Performance Monitoring
    Value = 2
Corrective Action
    Value = (3a + 3b) / 2
Continuing Equipment Reliability Improvement
    Value = (4a + 4b + 4c + 4d) / 4
Long-Term Planning & Life Cycle Management
    Value = (5a + 5b) / 2
PM Implementation
    Value = 6

Figure 3-4 Self Characterization of Process Activity Interfaces

Data Source:
Plant Leadership and Individual Contributor Staff Survey
Equipment Reliability Activity Interfaces
(Alpha-numeric terms in the formulas below refer to the response values from the survey for the question with the corresponding alpha-numeric designation shown.)

Formulae:
Use of Critical Component Information
Value = 7
Response to Performance Monitoring Information
Value = (8a + 8b) / 2
Response to Equipment Condition Information
Value = 9
Response to Equipment Degradation and Vulnerabilities
Value = (10a + 10b) / 2
Response to Equipment Failures
Value = 11
Financial / Schedule Support of Equipment Improvement
Value = 12

Figure 3-5 State Characterization Using Survey Questions

Data Source:
Plant Leadership and Individual Contributor Staff Survey
Equipment Reliability Activities and Equipment Reliability Activity Interfaces
(Alpha-numeric terms in the formulas below refer to the response values from the survey for the question with the corresponding alpha-numeric designation.)

Formulae:
Proactive
Value = {(3b / 2 + (4a + 4b + 4c + 4d) /4 + (5a + 5b) / 2 + 10b / 2 + 11)} / 4
Preventive
Value = {(2 + 3a / 2 + (4a + 4b + 4c + 4d) /4 + 6 + 8a / 2 + 9 + 10a / 2 + 12)} / 6.5

Figures 3-6 through 3-10

These figures use the same formulas as 3-1 through 3-5 respectively, except that management and individual contributor inputs are grouped separately.

D
Indicator Comparison Form

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
A	Backlog 1	Work scheduled for performance during a specified time/window that was not done, could not be done, or was not rescheduled for whatever reason and is more than 30 days overdue.	Benchmark: 50 work orders overdue > 30 days at any given time; Goal: <20	Description and benchmark from EPRI TR-1007604 (Feb 2003)		
A	Backlog 2	Those items that can be worked on line that restore equipment or components affecting nuclear or personnel safety or plant reliability that have failed, are degraded or do not conform to their original design, configuration, or performance criteria. Includes minor maintenance and FIN team items, does not include elective maintenance.	Palisades: <75 meets, <50 exceeds, 2002 - 94 avg., 2003 ~ 40; Robinson typically ~ 108; Susquehanna Goals - 60 (top quartile); currently 21 - 2 for both Susquehanna units	AP-928 recommends on-line corrective maintenance backlog; Robinson information - remarks by Jim Adams at 2003 ANS Utility Conf.; Susquehanna information - remarks by Bob Paley at 2003 ANS Utility Conf. 2002 NEI ER Benchmarking Report sites reported CM backlog levels for two unit sites between 77 and 396 (not clear what definition was used).		
A	Backlog 3	CM backlog: maintenance priority work orders and work requests (excluding outage, mods, non-plant work)	APS: 2003 3 unit site goal that ramps down during the year from 392 to 300, in 2002 was 358	APS goals are total for three units. 2002 NEI ER Benchmarking Report sites reported CM backlog levels for two unit sites between 77 and 396 (not clear what definition was used).		
A	Capacity Factor		Industry Average Capacity Factors: 2002 - 91.9%, 2000 ~ 90%; Top Quartile Unit Capability Factor 2001 - 2003 ~ 93%	Equipment Caused Capacity Losses changed to Capacity Factor. Capacity Factor data from NEI web page, Unit Capability Factor from Ron Davis (Entergy South) 7/03 ER Forum presentation.		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
A	CM/PM Ratio on Critical Components	Total number of work orders serviced per year by the maintenance department	Benchmark: 30% / 70% (Note - Benchmark # of work orders: 12,008 per year). Most 2002 NEI ER Benchmarking project sites had CM/PM ratios between 12% / 88% and 29% / 71%.	Note - some plants do not initiate a work order for certain routine periodic and/or predictive maintenance items controlled outside of maintenance management systems (i.e., task cards) the intent of the benchmark is to include these tasks. Benchmark from EPRI TR-1007604 (Feb 2003); other information from NEI ER Benchmarking Report 9/2002.		
A	Equipment Caused Power Changes	Number of failures of equipment causing downpowers per year	APS Goal: 34 or less per year	APS is a 3 unit site and their goal is for site based on # of high risk sig functional failures and failures causing downpowers >10%. In 2002 APS had 23 functional failures and 0 downpowers, through July 2003 12 failures and 1 downpower.		
A	Forced Outage Rate	Avg % of time each unit was unavailable due to forced events compared to the time planned for generation.	APS Goal: 1%	APS cites UDI Test Quartile as 1.25 %, in 2002 total nuclear was).3 and YTD through July was 1.7. Note - APS thermal performance goal is 99.8% (actual heat rate / design heat rate).		
A	LERs	Licensee Event Reports	Industry had 814 LERs in 1999, ~100 units or about 8 per unit per year	Better measure would be equipment caused LERs, but this data may not be as readily available.		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
A	Maintenance Rework	Work re-performed within the specified period because work performed the first time was inadequate, incorrect or performed using deficient parts an/or materials. Recommended period is six months or 1/2 of the PM interval, whichever is shorter.	Benchmark: 24 work orders per year for the maintenance department as a whole. Palisades: Meets - 0% Level I, 2% equip / 1% 50-200 hrs Level II, 2% Level III; Exceeds- 0%, 0%, 0%, 1%; 2002 ~ 1.5% Level III, other Levels not available	Definition, benchmark criteria and goal criteria from EPRI TR-1007604 (Feb 2003). The benchmark is stated as conservative because of data inconsistencies, etc. For Palisades definition of Levels not available at time of preparation.		
A	PM Schedule Performance	The number of delinquent PM tasks and the number of deferred PM tasks.	Palisades: Meets - 95% prior to due date, 5% within 10% grace period, 0% following grace period; Exceeds >95%, <5% and 0%; 2002 ~70%, ~20%, ~5%; PPL Susquehanna Goal - 90%	PM Schedule Performance changed to PM Implementation to be consistent with AP-928 PM indicators. AP-928 indicators used. Note AP-928 defines delinquent PM as beyond 25% of scheduled interval but notes that some program-driven PMs do not permit a 25% grace period.		
A	Unplanned LCOs		Surry: 76 - 2002, 39 - Jan thru June 2003; Shearon Harris: 133 - 2001, 58 - 2002, 28 - Jan thru July 2003; Palisades Goal (Meets): 24 (2002 - 27) for deficient or malfunctioning equipment only	Better measure would be equipment caused LCOs, but this data may not be as readily available.		
B	PM Effectiveness	Number of CM work orders on components with PMs	Surry 1 & 2 Experience: non-outage months 5 - 20, outage months ~ 40; 2002	Sum of both units 1 and 2.		
B	PM Effectiveness	Number of CM work orders on critical components (non-run to failure)	Surry 1 & 2 Experience: non-outage months 15 - 50, outage months 90 - 110; 2002	Sum of both units 1 and 2.		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
B	*As-Found Condition Feedback*	*Worker performing PM documents as-found condition of equipment.*	*Activity is systematically performed. Use of as-found condition coding is preferred but not required.*	*No quantitative measure was identified. Comparison is based on PPL and Exelon good practices presented at the May 2002 EPRI ER Forum.*		
B	*As-Found Condition Feedback Evaluation*	*System and component engineers use as-found condition data to adjust PM task / frequencies or make other changes.*	*Activity is systematically performed and includes both trending and individual event observations.*	*No quantitative measure was identified. Comparison is based on PPL and Exelon good practices presented at the May 2002 EPRI ER Forum.*		
B	*Predictive Maintenance (PdM) / Condition Based Maintenance is applied to improve equipment reliability*	*The basis for PdM activities are understood.*	*The scope and intervals for PdM tasks are identified and technical basis. Scope and interval basis for all PdM tasks is considered high or above average, coverage of the major PdM techniques (vibration, IR Thermography and lube oil analysis) is considered average.*	*EPRI TR-1001032*		
B	*Predictive Maintenance (PdM) / Condition Based Maintenance activities are effective*	*Ongoing actions are taken to ensure that PdM activities are effective.*	*Improvement opportunities are monitored by assessing the following: industry OE, new diagnostics, new applications, and component failures preventable by PdM.*	*EPRI TR-1001032*		
B	Technical basis for PMs	% PMs with Documented Technical Basis	All PMs for critical and non-critical components. Additionally there is a feedback process for updating PMs that includes adjustments to the basis for changes.	Comanche Peak good practice contained in the NEI "Industry 2002 ER Benchmarking Report", Exelon good practice presented at the May 2002 EPRI ER Forum.		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
B	Technical basis for performance monitoring	% Performance Monitoring Parameters with Documented Technical Basis	All direct (quantitatively measured, physical parameters) parameters have a technical basis.	Good practice discussions at November 2001 EPRI ER Forum, EPRI Report TR-107688 and INPO AP-913.		
B	Performance Monitoring Application	% Maintenance Rule Systems with Documented Performance Monitoring Plans	100%	EPRI TR-107688 and AP-913. Note if MR systems include only those with safety significance, then non-safety production critical systems should also be addressed.		
B	*Performance Monitoring Feedback to PM s*	*Direct feedback of important monitoring observations is provided.*	*There is an expectation that important monitoring observations (degradation of performance of critical system or component functions) result in review of PMs.*	*AP-913*		
B	PM Change Backlog	Number of authorized PM Changes Waiting for Review or Implementation	Brunswick - 50, Comanche Peak - 54, Dresden - 206, McGuire - 679, So. Texas Project - 24, Watts Bar – 413	Definition used for "criteria" or reference point was "PM Change Backlog" - 2002 NEI ER Benchmarking Project. All data was for 2001.		
B	System Health Reports	Are system health reports developed and maintained.	Yes, for at least all MR systems, update frequency established (may vary with importance of system, typical update frequency is 3 - 4 times per year).	EPRI TR-1001032 and discussions at July 2003 EPRI ER Forum		
B	System Health	Number of systems not meeting system health goals (goals and criteria definition not standardized throughout industry)	Palisades: Meets - 2 Red, 8 Yellow; Exceeds - 0 Red, 4 Yellow; 2002 ~ 10 Red, ~ 14 Yellow	Color coding criteria throughout industry not standardized.		
B	MR Health	% of MR systems meeting goals	APS Goal: % of MR Systems Meeting Performance criteria - 98%	APS table heading is "High Risk Significant Systems", not clear if this is all MR systems or a subset.		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
B	*Cross System Like Component Monitoring*	*Performance of cross-system monitoring of component failures and problems using plant history / experience and industry OE.*	*Common components are grouped across systems and performance monitored and reported using common parameters and inputs.*	*McGuire good practice contained in 2002 NEI ER Benchmarking Report.*		
B/C	Corrective Action Effectiveness	APS Effectiveness - Have high priority actions been completed as intended and the condition corrected to prevent recurrence.	APS: Goal 95%			
B/C	Corrective Action Effectiveness Timeliness	APS Timeliness - Number of evaluations open over 30 days, and number of "closures" open over 180 days.	APS: Goals - Varies by month with evaluation min of 30 / max of 50; closure min of 75 and max of 115.	Note APS is a 3 unit site, goals are for all 3 units.		
C	*Long Term Plan Development*	*Major systems / components and those with unacceptable performance have documented improvement strategies (documentation form of the strategies may vary - robust system health report section on "long term plan", stand alone long term plan or LCM plan, etc.)*	*Minimum of all systems / components consistently (more than one cycle) not meeting performance goals and those where industry OE has demonstrated strong potential for long term performance issues (aging, obsolescence).*	*From AP-913 and author's notes from NEI - ER Benchmarking 2002 (candidate good practice McGuire plant).*		
C	*Long Term Planning Actions Incorporation Into Budget and Schedule*	*Financial requirements to support long term plans that are included in the plant's budget and outage scheduling*	*Financial and schedule needs are communicated and acted upon (accepted, rejected or delayed). Rejected or delayed actions result in alternate long term planning strategy development.*	*Comanche Peak good practice contained in 2002 NEI ER Benchmarking Report. (Note: considered for the extent of the financial planning cycle, stability of inclusion in the budget cycle should also be considered to avoid situations where items are approved but then consistently deferred.)*		

State	Indicator	Description	Comparison Information	Notes	Plant Value	Met?
C	Consensus Top Plant Equipment Issues	One "top plant equipment issue list" exists and represents a consensus supported by plant management and is maintained current.	Plant management consists of all functions associated with equipment reliability (operations, maintenance, engineering, oversight / corrective actions, etc.). Plants using this to drive near term actions update the list weekly or monthly those using it to drive long term actions review this three - four times per year coordinated with updates of system / component health reports.	AP-913 endorses a consensus top equipment list. Other information reflects findings in the 2002 NEI ER Benchmarking Report associated to common contributors among the six plants benchmarked.		
C	*Designated Plant Equipment Issues are Resolved*	*Number of CMs on designated plant equipment issues*	*Trending is performed to assess performance. Designated plant equipment issues are issues with equipment on the top plant equipment list (or equivalent).*	*From Surry presentation at July 2003 EPRI ER Forum presentation.*		
C	Program Health	Number of systems not meeting program health goals (goals and criteria definition not standardized throughout industry)	Palisades: Meets - 2 Red, 4 Yellow; Exceeds - 0 Red, 2 Yellow; 2002 ~ 2 Red, ~ 4 Yellow	Color coding criteria throughout industry not standardized.		

E
Question Templates

AP-913 Area:	Scoping and Identification of Critical Components	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	**Question**				
Determine if components are classified by functional importance (critical, non-critical, run-to-failure or similar) and the basis is documented.	1. Does the plant have a single accepted definition of functional importance?				
	2. Is the definition of functional importance based on industry standard documents? Does the definition of functional importance include critical, non-critical, run-to-failure or similar definitions?				
	3. Are components classified in accordance with the definitions of functional importance?				
	4. Does the classification include a documented basis for the classification? Is all information available in a single location?				
	5. Is there a process for reviewing functional importance and classification? Is it clear how to make changes?				
	6. Do plant changes initiate reviews of functional importance and changes in classification if needed?				

ER State - Reactive

AP-913 Area:	Other	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	**Question**				
Determine if scheduled work is protected from emergent work through supplemental activities such as FIN (Fix-It-Now) teams.	1. Is there a separate work team/group to address emergent work?				
	2. Are there teams which are able to complete emergent work? Do the teams include all necessary skills and organizational authorizations?				
	3. Are there daily reviews of emergent work and new issues to ensure proper prioritization? Do these involve all effected departments?				
	4. Is daily emergent work prioritized and scheduled such that critical items within the emergent work are addressed so that these don't impact scheduled work?				
	5. Is resource loading done to ensure adequate personnel are available for emergent work?				
	6. Can major equipment reliability vulnerabilities be evaluated and addressed as emergent work?				
	7. Is trending of emergent work done? Is this used for resource scheduling?				

ER State - Reactive

AP-913 Area:	PM Implementation (1)				
Plant:					
Date:					
Name:					
Goal	**Question**	**Response**	**Generally Meets**	**Partially Meets**	**Does not Meet**
Determine if work is managed with a strong priority system	1. Does the work management system use a single priority system for scheduling all work (i.e. PMs, CMs, emergent work)? Is the priority system based on component classification (i.e. critical, non-critical, RTF), problem history, etc? Is the basis clearly defined and available?				
	2. Is the priority system defined and understood by all groups? Do all groups understand their part in determining and maintaining work priority? Does training include priority system understanding?				
	3. Are there daily work schedule meetings to adjust workload as necessary? Is the meeting attended by all groups? Do all have a say in the change of the work schedule? Is emergent work prioritized during this meeting?				

ER State - Reactive

AP-913 Area:	PM Implementation (2)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	**Question**				
Determine if work is managed with a strong priority system (continued)	4. Has management clearly defined their expectations for the completion of PM tasks? Is there a monitoring system in place to keep management informed of PM completion and deferral rates? Do they receive a report on deferred PM's?				
	5. Is there a process for the deferral of PM tasks? Does a deferral require a technical justification? Who is allowed to request the deferral of a PM? Is there a report identifying deferred PMs? Is there a limit on how long PMs can be deferred?				
	6. Is the priority and work schedule effected by deferred PM's?				

ER State - Reactive

AP-913 Area:	PM Implementation (3)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if work is scheduled to ensure manpower is available for important work	1. Is daily work management scheduling done on a 100% basis?				
	2. Is there a priority system for the scheduling of manpower? Is the scheduling done on a daily or routine basis? Is there a process for reviewing scheduling priorities?				
	3. Is manpower scheduling done with "floaters" available for emergent work? If not, how is emergent work handled?				
	4. Has plant management defined priorities and established expectations for completing high priority work? Is on time completion of scheduled work trended and reported to management? Is management part of the process for rescheduling high priority work?				
	5. Do daily work management meetings schedule emergent work or provide assistance to on going work requiring additional support?				

ER State - Reactive

AP-913 Area:	Corrective Action (1)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if systematic troubleshooting is applied and expectations are defined.	1. Is there a process for the identification of equipment problems? Does the process encourage its use? Is the threshold for equipment problem identification clearly defined and appropriate? Do workers identify equipment problems according to these definitions and to management expectations?				
	2. Is the problem-solving process formalized with a procedure containing troubleshooting aids, such as process flowchart, checklists and examples?				
	3. Is there a documented approach to troubleshooting that provides guidance for initial response by operators and maintenance personnel and appropriate involvement of a component/system engineer?				

ER State - Reactive

AP-913 Area:	Corrective Action (2)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if systematic trouble shooting is applied and expectations are defined (continued).	4. Are the roles and responsibilities for support of troubleshooting and field maintenance well established? Are levels of approval and involvement based on the risk and complexity of the proposed troubleshooting actions and the significance of the failure?				
	5. Do root cause evaluations address the symptom or the real problem? Is both internal and external operating experience used in root cause analysis? Does the extent of the resolution include the full extent of the problem?				
	6. Is there a cooperative environment among groups to resolve equipment problems?				

ER State – Reactive

AP-913 Area:	Corrective Action (3)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if repetitive equipment issues are identified and addressed.	1. Is there a plan/process with guidelines that define repetitive equipment failures? Does the definition of repetitive equipment failures include the same or similar components but in different systems?				
	2. Are repeat failures reviewed for inadequate corrective actions?				
	3. Are root cause analyses completed on repetitive equipment issues? Is there more emphasis on repetitive equipment issues - root cause versus apparent cause?				
	4. Is there a mechanism for obtaining management involvement to ensure resolution of repetitive problems? How well is it used?				

ER State – Reactive

AP-913 Area:	Corrective Action (4)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	Question				
Determine if critical equipment failures initiate reviews of PMs, monitoring plans, etc.	1. Is there a definition of what constitutes an equipment failure?				
	2. is there one critical equipment list available to plant staff? Do CMs identify if the equipment addressed is critical, non-critical or RTF?				
	3. Are failures with critical equipment handled differently than non-critical equipment?				
	4. Is there a process to initiate a review of critical equipment failures? Do critical equipment failures initiate a review of PM's, monitoring plans, etc?				
	5. Is emergent work and CMs on critical equipment reviewed for trends and used as input in the PM change process?				
	6. Are critical equipment failures trended?				
	7. Has management cultivated a culture that promotes minimizing equipment deficiencies?				

ER State – Reactive

AP-913 Area:	Performance Monitoring (1)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if monitoring focuses on critical components and attributes	1. Are criteria clearly defined that justify inclusion or exclusion of components and systems in the scope of the component and system monitoring programs? Is the criteria based on functional importance?				
	2. Are components selected for monitoring based upon the importance of the functions performed by the system and whether component failure can defeat the functions?				
	3. Is there a documented technical basis for the selection of monitored parameters, that is based on credible component failure possibilities?				

ER State – Reactive

AP-913 Area:	Performance Monitoring (2)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	Question				
Determine if indicators of degrading performance or condition are detected and acted upon (continued).	4. Are monitoring requirements selected to provide early identification of degradation? Are monitoring parameters based on or linked to indicators of degradation?				
	5. Do system/component engineers understand contributors to unplanned capability loss factor (UCLF) from their system/components?				
	6. Is there a routine review of the critical component list and what is being monitored for adding/removing components and/or what is being monitored?				

ER State – Reactive

AP-913 Area:	Performance Monitoring (3)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if indicators of degrading performance or condition are detected and acted upon.	1. Are monitoring parameters contained in performance monitoring plans actually monitored on a periodic basis?				
	2. Are plant observations incorporated into performance monitoring? This includes items such as: as found equipment condition from PM's and operator logs and test results.				
	3. If significant adverse trends or individual observations are made does the system/component engineer act upon these?				
	4. Are system health reports used to recommend actions to address degradation of condition or performance? Are the reports used and acted upon?				
	5. Do engineers understand the fundamentals of equipment aging and do they incorporate aging indicators or aging observations into their performance monitoring?				

ER State – Reactive

AP-913 Area:	Continuing Equipment Reliability Improvement (1)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	**Question**				
Determine if component classification is used to prioritize equipment reliability strategy improvements.	1. Are all plant components including those in BOP systems classified?				
	2. Does reliability strategy development and change use component classification to guide the level of attention given to components/systems?				
	3. If all components are not classified, is there a systematic process for addressing those not classified?				
	4. Is component classification a higher priority in the reliability strategy development or change?				
	5. Is there a periodic assessment of component health and vulnerabilities to increase focus on critical systems?				

ER State – Preventive

AP-913 Area:	Continuing Equipment Reliability Improvement (2)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	**Question**				
Determine if basis for PMs established.	1. Does each PM have a documented technical basis?				
	2. Is the basis of PM's for a component based on individual component considerations or by groups of same/similar components with the same criticality, duty, environment, etc?				
	3. Does the basis consider actual operating history?				
	4. Are vendor recommendations and industry best practices considered?				

ER State – Preventive

AP-913 Area:	Continuing Equipment Reliability Improvement (3)	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	Question				
Determine if industry OE is incorporated through changes to PMs.	1. Is there a process for reviewing PM's other than when problems occur?				
	2. Does the process require looking at industry experience?				
	3. Does review of operating experience ensure environment, cycles, etc. are similar prior to making any change?				
	4. Is there a process to continuously review industry events and take the appropriate action?				
	5. Is plant staff involved with industry groups and use of industry information to enhance PMs?				

ER State – Preventive

AP-913 Area:	Continuing Equipment Reliability Improvement (4)				
Plant:					
Date:					
Name:					
Goal	**Question**	**Response**	**Generally Meets**	**Partially Meets**	**Does not Meet**
Determine if PdM is applied to identify degradation trends.	1. Is PdM applied as an integral part of equipment and component reliability strategy development and change?				
	2. Is PdM used to detect equipment degradation, identify emerging problems and proactively schedule maintenance?				
	3. Is PdM used to monitor the condition of key components?				
	4. Do equipment failures require a review of PdM adequacy?				
	5. Are the results of the PdM used to change PM requirements?				
	6. How are the results of PdM activities distributed? Who are the results distributed to?				
	7. Are alarm/alert values established for degradation parameters for critical components?				
	8. Are personnel using PdM trained and technically competent in PdM technologies? Are the PdM techniques and technologies reviewed periodically to ensure they are current with industry practices and experience?				

ER State – Preventive

AP-913 Area:	Performance Monitoring (1)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if trending is performed to predict unacceptable equipment degradation.	1. Does the plant have an established equipment trending program? Who is responsible for the trending?				
	2. Does trending take into account data from all programs, i.e., PMs, PdM, corrective maintenance? Does trending use both industry and plant operating experience?				
	3. Are operator rounds, operator logs, walk downs, test data, etc. trended to predict equipment degradation?				
	4. Are operator workarounds, control room deficiencies and operator burdens tracked and utilized in prediction of equipment degradation?				
	5. Do the results of the trending provide input into the other programs?				
	6. Are trending results used to review and adjust PM tasks/frequencies or initiate improvements?				

ER State – Preventive

AP-913 Area:	Performance Monitoring (2)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if walk downs and operator rounds identify early indicators of degradation.	1. Are walk downs by system engineers completed on a routine basis? Is there a sheet for identification of problems identified?				
	2. Do operator rounds require the identification of component degradation?				
	3. Are degradation types and mechanisms understood by engineers and operators? Are aging indicators understood and identified?				
	4. Are guidelines available providing specific expectation and criteria for walk downs?				
	5. Are long-term aging effects identified such that they are monitored and trended with the appropriate means?				

ER State – Preventive

AP-913 Area:	Performance Monitoring (3)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if cross-system common component trending is used.	1. Does component trending consider similar components in all systems?				
	2. When degradation of a component is observed, does cross system component trending inform others of a potential issue?				
	3. If a change is made associated with a component are similarly operated components in other systems also reviewed?				
	3. If a component functional importance is changed, is there a process to review other similar components or components used in a similar manner?				
	4. Is cross system trending performed by component experts?				
	5. Is industry OE, included in cross system trending?				

ER State – Preventive

AP-913 Area:	PM Implementation	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	Question				
Determine if as-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization.	1, Do all work orders (CM, PM, etc.) require the recording of as found conditions?				
	2. Does guidance exist for what information is important when recording as found condition?				
	3. Is there a mechanism for as found condition information to be reported back to the responsible person or personnel (component engineer, system engineer, PM coordinator)?				
	4. Are as found conditions on components trended?				
	5. Are post maintenance critiques used to identify improvement opportunities?				

ER State – Preventive

AP-913 Area:	Corrective Action	Response	Generally Meets	Partially Meets	Does not Meet
Plant:					
Date:					
Name:					
Goal	Question				
Determine if a site-wide management list of key equipment issues is used to prioritize equipment improvements and planning.	1. Does the site maintain a single top 10 (or similar) list of equipment issues?				
	2. Does the list represent a consensus of senior site management (maintenance, operations, engineering, etc.)?				
	3. How often is the list updated? What input is used to develop/revise the list? Is there a process for the addition of components to this list?				
	4. Are there regularly scheduled meetings with senior management to review the list and action items?				
	5. Is the top ten list readily available and its purpose understood by plant staff?				

ER State – Proactive

AP-913 Area:	Continuing Equipment Reliability Improvement (2)				
Plant:					
Date:					
Name:					
Goal	**Question**	**Response**	**Generally Meets**	**Partially Meets**	**Does not Meet**
Determine if equipment reliability strategies are effected to address: (a) equipment related plant vulnerabilities (b) significant equipment related issues not improved by PM actions (continued).	5. Is there a multi-discipline review used to evaluate strategies developed to address vulnerabilities and equipment issues not resolved by PM changes?				
	6. Are industry and plant OE reviewed and analyzed periodically for identifying previously unidentified or unconsidered vulnerabilities?				
	7. Are repeat failures reviewed for inadequate corrective actions? Is this information used to update PM's, PdM, etc?				

ER State – Proactive

AP-913 Area:	Long-Term Planning, LCM (1)				
Plant:					
Date:					
Name:					
Goal	Question	Response	Generally Meets	Partially Meets	Does not Meet
Determine if long term plans (stand alone or in health reports) address equipment issues, including aging and obsolescence.	1. Is there a long range plan (i.e. multi-year or multi-cycle) for major systems, major components and component types?				
	2. Is the long range plan integrated with plant processes (like in the system health reports) or are they stand-alone? If they are stand-alone do they receive input from the organizations cognizant of equipment issues?				
	3. Does the long term plan use the results of the equipment reliability analysis?				
	4. Does the long term plan include addressing mitigation of aging stressors?				
	5. Does station management encourage forward looking points of view on performance to preclude unanticipated failures?				
	6. Do long term plans address potential vulnerabilities for major or long lead equipment, equipment obsolescence and vendor obsolescence?				

ER State – Proactive

AP-913 Area:	Long-Term Planning, LCM (2)				
Plant:					
Date:					
Name:					
Goal	**Question**	**Response**	**Generally Meets**	**Partially Meets**	**Does not Meet**
Determine if long term equipment plans are reconciled with the plant's budget and schedule.	1. Are equipment reliability improvements requiring budget (capital or increased O&M) identified for budget planning considerations?				
	2. Are equipment reliability improvements requiring significant outage effort identified for scheduling considerations?				
	3. Does plant management view that plant budgeting and scheduling decisions are important factors in improving equipment reliability?				
	4. Is there a correlation between equipment design changes and long term schedule and budget?				
	5. Does the work management system include future (long range) equipment overhauls, change outs, etc. driven by PMs and provide this input into the long range plan?				
	6. Does the long term plan include feedback on changes to the budget and schedule that could effect planned equipment strategies?				

ER State – Proactive

F
Opportunity Templates

AP-913 Area:	**Scoping and Identification of Critical Components**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if components are classified by functional importance (critical, non-critical, run-to-failure or similar) and the basis is documented.	1. Does the plant have a single accepted definition of functional importance?	
	2. Is the definition of functional importance based on industry standard documents? Does the definition of functional importance include critical, non-critical, run-to-failure or similar definitions?	
	3. Are components classified in accordance with the definitions of functional importance?	
	4. Does the classification include a documented basis for the classification? Is all information available in a single location?	
	5. Is there a process for reviewing functional importance and classification? Is it clear how to make changes?	
	6. Do plant changes initiate reviews of functional importance and changes in classification if needed?	

ER State – Reactive

AP-913 Area:	Other	Opportunities
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if scheduled work is protected from emergent work through supplemental activities such as FIN (Fix-It-Now) teams.	1. Is there a separate work team/group to address emergent work?	
	2. Are there teams which are able to complete emergent work? Do the teams include all necessary skills and organizational authorizations?	
	3. Are there daily reviews of emergent work and new issues to ensure proper prioritization? Do these involve all effected departments?	
	4. Is daily emergent work prioritized and scheduled such that critical items within the emergent work are addressed so that these don't impact scheduled work?	
	5. Is resource loading done to ensure adequate personnel are available for emergent work?	
	6. Can major equipment reliability vulnerabilities be evaluated and addressed as emergent work?	
	7. Is trending of emergent work done? Is this used for resource scheduling?	

ER State – Reactive

AP-913 Area:	PM Implementation (1)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if work is managed with a strong priority system	1. Does the work management system use a single priority system for scheduling all work (i.e. PMs, CMs, emergent work)? Is the priority system based on component classification (i.e. critical, non-critical, RTF), problem history, etc? Is the basis clearly defined and available?	
	2. Is the priority system defined and understood by all groups? Do all groups understand their part in determining and maintaining work priority? Does training include priority system understanding?	
	3. Are there daily work schedule meetings to adjust workload as necessary? Is the meeting attended by all groups? Do all have a say in the change of the work schedule? Is emergent work prioritized during this meeting?	

ER State – Reactive

AP-913 Area:	PM Implementation (2)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if work is managed with a strong priority system (continued)	4. Has management clearly defined their expectations for the completion of PM tasks? Is there a monitoring system in place to keep management informed of PM completion and deferral rates? Do they receive a report on deferred PM's?	
	5. Is there a process for the deferral of PM tasks? Does a deferral require a technical justification? Who is allowed to request the deferral of a PM? Is there a report identifying deferred PMs? Is there a limit on how long PMs can be deferred?	
	6. Is the priority and work schedule effected by deferred PM's?	

ER State – Reactive

AP-913 Area:	PM Implementation (3)	Opportunities
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if work is scheduled to ensure manpower is available for important work.	1. Is daily work management scheduling done on a 100% basis?	
	2. Is there a priority system for the scheduling of manpower? Is the scheduling done on a daily or routine basis? Is there a process for reviewing scheduling priorities?	
	3. Is manpower scheduling done with "floaters" available for emergent work? If not, how is emergent work handled?	
	4. Has plant management defined priorities and established expectations for completing high priority work? Is on time completion of scheduled work trended and reported to management? Is management part of the process for rescheduling high priority work?	
	5. Do daily work management meetings schedule emergent work or provide assistance to on going work requiring additional support?	

ER State – Reactive

AP-913 Area:	Corrective Action (1)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if systematic troubleshooting is applied and expectations are defined.	1. Is there a process for the identification of equipment problems? Does the process encourage its use? Is the threshold for equipment problem identification clearly defined and appropriate? Do workers identify equipment problems according to these definitions and to management expectations?	
	2. Is the problem-solving process formalized with a procedure containing troubleshooting aids, such as process flowchart, checklists and examples?	
	3. Is there a documented approach to troubleshooting that provides guidance for initial response by operators and maintenance personnel and appropriate involvement of a component/system engineer?	

ER State – Reactive

AP-913 Area:	Corrective Action (2)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if systematic trouble shooting is applied and expectations are defined (continued).	4. Are the roles and responsibilities for support of troubleshooting and field maintenance well established? Are levels of approval and involvement based on the risk and complexity of the proposed troubleshooting actions and the significance of the failure?	
	5. Do root cause evaluations address the symptom or the real problem? Is both internal and external operating experience used in root cause analysis? Does the extent of the resolution include the full extent of the problem?	
	6. Is there a cooperative environment among groups to resolve equipment problems?	

ER State – Reactive

AP-913 Area:	Corrective Action (3)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if repetitive equipment issues are identified and addressed.	1. Is there a plan/process with guidelines that define repetitive equipment failures? Does the definition of repetitive equipment failures include the same or similar components but in different systems?	
	2. Are repeat failures reviewed for inadequate corrective actions?	
	3. Are root cause analyses completed on repetitive equipment issues? Is there more emphasis on repetitive equipment issues - root cause versus apparent cause?	
	4. Is there a mechanism for obtaining management involvement to ensure resolution of repetitive problems? How well is it used?	

ER State – Reactive

AP-913 Area:	Corrective Action (4)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if critical equipment failures initiate reviews of PMs, monitoring plans, etc.	1. Is there a definition of what constitutes an equipment failure?	
	2. is there one critical equipment list available to plant staff? Do CMs identify if the equipment addressed is critical, non-critical or RTF?	
	3. Are failures with critical equipment handled differently than non-critical equipment?	
	4. Is there a process to initiate a review of critical equipment failures? Do critical equipment failures initiate a review of PM's, monitoring plans, etc?	
	5. Is emergent work and CMs on critical equipment reviewed for trends and used as input in the PM change process?	
	6. Are critical equipment failures trended?	
	7. Has management cultivated a culture that promotes minimizing equipment deficiencies?	

ER State – Reactive

AP-913 Area:	Performance Monitoring (1)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if monitoring focuses on critical components and attributes	1. Are criteria clearly defined that justify inclusion or exclusion of components and systems in the scope of the component and system monitoring programs? Is the criteria based on functional importance?	
	2. Are components selected for monitoring based upon the importance of the functions performed by the system and whether component failure can defeat the functions?	
	3. Is there a documented technical basis for the selection of monitored parameters, that is based on credible component failure possibilities?	

ER State – Reactive

AP-913 Area:	Performance Monitoring (2)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if indicators of degrading performance or condition are detected and acted upon (continued).	4. Are monitoring requirements selected to provide early identification of degradation? Are monitoring parameters based on or linked to indicators of degradation?	
	5. Do system/component engineers understand contributors to unplanned capability loss factor (UCLF) from their system/components?	
	6. Is there a routine review of the critical component list and what is being monitored for adding/removing components and/or what is being monitored?	

ER State – Reactive

AP-913 Area:	Performance Monitoring (3)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if indicators of degrading performance or condition are detected and acted upon.	1. Are monitoring parameters contained in performance monitoring plans actually monitored on a periodic basis?	
	2. Are plant observations incorporated into performance monitoring? This includes items such as: as found equipment condition from PM's and operator logs and test results.	
	3. If significant adverse trends or individual observations are made does the system/component engineer act upon these?	
	4. Are system health reports used to recommend actions to address degradation of condition or performance? Are the reports used and acted upon?	
	5. Do engineers understand the fundamentals of equipment aging and do they incorporate aging indicators or aging observations into their performance monitoring?	

ER State – Reactive

AP-913 Area:	**Continuing Equipment Reliability Improvement (1)**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if component classification is used to prioritize equipment reliability strategy improvements.	1. Are all plant components including those in BOP systems classified?	
	2. Does reliability strategy development and change use component classification to guide the level of attention given to components/systems?	
	3. If all components are not classified, is there a systematic process for addressing those not classified?	
	4. Is component classification a higher priority in the reliability strategy development or change?	
	5. Is there a periodic assessment of component health and vulnerabilities to increase focus on critical systems?	

ER State – Preventive

AP-913 Area:	**Continuing Equipment Reliability Improvement (2)**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if basis for PMs established.	1. Does each PM have a documented technical basis?	
	2. Is the basis of PM's for a component based on individual component considerations or by groups of same/similar components with the same criticality, duty, environment, etc?	
	3. Does the basis consider actual operating history?	
	4. Are vendor recommendations and industry best practices considered?	

ER State – Preventive

AP-913 Area:	**Continuing Equipment Reliability Improvement (3)**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if industry OE is incorporated through changes to PMs.	1. Is there a process for reviewing PM's other than when problems occur?	
	2. Does the process require looking at industry experience?	
	3. Does review of operating experience ensure environment, cycles, etc. are similar prior to making any change?	
	4. Is there a process to continuously review industry events and take the appropriate action?	
	5. Is plant staff involved with industry groups and use of industry information to enhance PMs?	

ER State – Preventive

AP-913 Area:	Continuing Equipment Reliability Improvement (4)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if PdM is applied to identify degradation trends.	1. Is PdM applied as an integral part of equipment and component reliability strategy development and change?	
	2. Is PdM used to detect equipment degradation, identify emerging problems and proactively schedule maintenance?	
	3. Is PdM used to monitor the condition of key components?	
	4. Do equipment failures require a review of PdM adequacy?	
	5. Are the results of the PdM used to change PM requirements?	
	6. How are the results of PdM activities distributed? Who are the results distributed to?	
	7. Are alarm/alert values established for degradation parameters for critical components?	
	8. Are personnel using PdM trained and technically competent in PdM technologies? Are the PdM techniques and technologies reviewed periodically to ensure they are current with industry practices and experience?	

ER State – Preventive

AP-913 Area:	Performance Monitoring (1)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if trending is performed to predict unacceptable equipment degradation.	1. Does the plant have an established equipment trending program? Who is responsible for the trending?	
	2. Does trending take into account data from all programs, i.e., PMs, PdM, corrective maintenance? Does trending use both industry and plant operating experience?	
	3. Are operator rounds, operator logs, walk downs, test data, etc. trended to predict equipment degradation?	
	4. Are operator workarounds, control room deficiencies and operator burdens tracked and utilized in prediction of equipment degradation?	
	5. Do the results of the trending provide input into the other programs?	
	6. Are trending results used to review and adjust PM tasks/frequencies or initiate improvements?	

ER State – Preventive

AP-913 Area:	Performance Monitoring (2)	Opportunities
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if walk downs and operator rounds identify early indicators of degradation.	1. Are walk downs by system engineers completed on a routine basis? Is there a sheet for identification of problems identified?	
	2. Do operator rounds require the identification of component degradation?	
	3. Are degradation types and mechanisms understood by engineers and operators? Are aging indicators understood and identified?	
	4. Are guidelines available providing specific expectation and criteria for walk downs?	
	5. Are long-term aging effects identified such that they are monitored and trended with the appropriate means?	

ER State – Preventive

AP-913 Area:	Performance Monitoring (3)	
Plant:		
Date:		
Goal	Question	Opportunities
Determine if cross-system common component trending is used.	1. Does component trending consider similar components in all systems?	
	2. When degradation of a component is observed, does cross system component trending inform others of a potential issue?	
	3. If a change is made associated with a component are similarly operated components in other systems also reviewed?	
	3. If a component functional importance is changed, is there a process to review other similar components or components used in a similar manner?	
	4. Is cross system trending performed by component experts?	
	5. Is industry OE, included in cross system trending?	

ER State – Preventive

AP-913 Area:	PM Implementation	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if as-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization.	1, Do all work orders (CM, PM, etc.) require the recording of as found conditions?	
	2. Does guidance exist for what information is important when recording as found condition?	
	3. Is there a mechanism for as found condition information to be reported back to the responsible person or personnel (component engineer, system engineer, PM coordinator)?	
	4. Are as found conditions on components trended?	
	5. Are post maintenance critiques used to identify improvement opportunities?	

ER State – Preventive

AP-913 Area:	Corrective Action	Opportunities
Plant:		
Date:		
Goal	**Question**	
Determine if a site-wide management list of key equipment issues is used to prioritize equipment improvements and planning.	1. Does the site maintain a single top 10 (or similar) list of equipment issues?	
	2. Does the list represent a consensus of senior site management (maintenance, operations, engineering, etc.)?	
	3. How often is the list updated? What input is used to develop/revise the list? Is there a process for the addition of components to this list?	
	4. Are there regularly scheduled meetings with senior management to review the list and action items?	
	5. Is the top ten list readily available and its purpose understood by plant staff?	

ER State – Proactive

AP-913 Area:	**Continuing Equipment Reliability Improvement (2)**	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if equipment reliability strategies are effected to address: (a) equipment related plant vulnerabilities (b) significant equipment related issues not improved by PM actions (continued).	5. Is there a multi-discipline review used to evaluate strategies developed to address vulnerabilities and equipment issues not resolved by PM changes?	
	6. Are industry and plant OE reviewed and analyzed periodically for identifying previously unidentified or unconsidered vulnerabilities?	
	7. Are repeat failures reviewed for inadequate corrective actions? Is this information used to update PM's, PdM, etc?	

ER State – Proactive

AP-913 Area:	Long-Term Planning, LCM (1)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if long term plans (stand alone or in health reports) address equipment issues, including aging and obsolescence.	1. Is there a long range plan (i.e. multi-year or multi-cycle) for major systems, major components and component types?	
	2. Is the long range plan integrated with plant processes (like in the system health reports) or are they stand-alone? If they are stand-alone do they receive input from the organizations cognizant of equipment issues?	
	3. Does the long term plan use the results of the equipment reliability analysis?	
	4. Does the long term plan include addressing mitigation of aging stressors?	
	5. Does station management encourage forward looking points of view on performance to preclude unanticipated failures?	
	6. Do long term plans address potential vulnerabilities for major or long lead equipment, equipment obsolescence and vendor obsolescence?	

ER State – Proactive

AP-913 Area:	Long-Term Planning, LCM (2)	
Plant:		
Date:		
Goal	**Question**	**Opportunities**
Determine if long term equipment plans are reconciled with the plant's budget and schedule.	1. Are equipment reliability improvements requiring budget (capital or increased O&M) identified for budget planning considerations?	
	2. Are equipment reliability improvements requiring significant outage effort identified for scheduling considerations?	
	3. Does plant management view that plant budgeting and scheduling decisions are important factors in improving equipment reliability?	
	4. Is there a correlation between equipment design changes and long term schedule and budget?	
	5. Does the work management system include future (long range) equipment overhauls, change outs, etc. driven by PMs and provide this input into the long range plan?	
	6. Does the long term plan include feedback on changes to the budget and schedule that could effect planned equipment strategies?	

ER State – Proactive

G
Gap Solutions Table

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A REACTIVE	**Scoping and Identification of Critical Components**	Components are classified by functional importance (critical, non-critical, run-to-failure or similar) and the basis is documented	Critical Component Identification Process, EPRI: 2003. 1007935 System Monitoring by System Engineers, EPRI: 1997. TR-107668 Survey on the Use of Configuration Risk & Safety Management Tools at Nuclear Power Plants, EPRI: 1998. TR-102975
	Other	Scheduled work is protected from emergent work through supplemental activities such as FIN teams	
	PM Implementation	Work is managed with a strong priority system	Web-Based Maintenance Assessment Tool Plant to Plant Benchmarking Module, EPRI: 2003. 1003500 Reliability & PM Balancing Risk and Reliability, EPRI: 2003. 1002936 Reliability and Risk Significance, EPRI: 2003. 1007079
		Work is scheduled to ensure manpower is available for important work	Web-Based Maintenance Assessment Tool, Plant to Plant Benchmarking Module, EPRI: 2003. 1003500 Reliability & PM Balancing Risk and Reliability, EPRI: 2003. 1002936
	Corrective Action	Systematic troubleshooting is applied and expectations are defined	System & Equipment Troubleshooting Guideline, EPRI: 2002. 1003093 Random Wound Motor Failure Investigation, EPRI: 2000. 1000898

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A REACTIVE	**Corrective Action** (Continued)	Systematic troubleshooting is applied and expectations are defined (Continued)	Troubleshooting of Electric Motors, EPRI: 2000. 1000968 Boric Acid Corrosion Guideline, Rev 1, EPRI: 2001. 1000975 Pump Troubleshooting Guide, Vol. 1, EPRI: 2000. TR-114612-V1 Pump Troubleshooting Guide, Vol. 2, EPRI: 2000. 1000919
		Repetitive equipment issues are identified and addressed	Collected Field Data on Electric Part Failures and Aging in Nuclear Power Plant Instrumentation and Control (I&C) Systems, EPRI: 2002. 1003568 Instrumentation and Control Experience Reference, EPRI: 1993. TR-100856 Strategies for Optimizing Engineering Effectiveness in Corrective Action, EPRI: 1999. TR-109626
		Critical equipment failures initiate reviews of PMs, monitoring plans, etc.	Strategies for Optimizing Engineering Effectiveness in Corrective Action Programs, EPRI: 1999. TR-109626
	Performance Monitoring	Monitoring focuses on critical components and attributes	Web Based PM Basis Database, EPRI: 2003. 1002930 Thermal Fatigue Monitoring Guidelines, EPRI: 2001. 1001016

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A R E A C T I V E	**Performance Monitoring** (Continued)	Monitoring focuses on critical components and attributes (Continued)	Service Water Systems Corrosion & Deposition Source Book, EPRI: 1993. TR-103403 Zebra Mussel Monitoring & Control Guide, EPRI: 1992. TR-101782 Steam Turbine Disk Brittle Failure: Influencing Parameters & Probabilistic Analysis Demonstration, EPRI: 2002. 1003264 Thermal Performance Engineer Handbook Vol. 1&2, EPRI: 1998. TR-107422-V1 and TR-1074022-V2 System Monitoring by System Engineers, EPRI: 1997. TR-107668 Equipment Condition Monitoring Tem-plates: Addendum to the Preventative Maintenance Basis, EPRI: 2000. TR-106857 (Volumes 1-38) 1000621

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A REACTIVE	**Performance Monitoring** (Continued)	Monitoring focuses on critical components and attributes (Continued)	Thermal Fatigue Monitoring Guidelines, EPRI:2001. 1001016 Aging Effects for Electrical Components, EPRI: 2001. 1003057 Surveillance, Monitoring, & Diagnostic Techniques to Improve Diesel Generator Reliability, EPRI: 1988. NP-5924 Heat Exchanger Performance Monitoring Guidelines, EPRI: 1991. NP-7552 An Assessment of Safety-Relief Valve Performance & Testing Issues in the Nuclear Industry, EPRI: 1999. TE-112830 Condition Monitoring Program for 4kV Environmentally Qualified Motors, EPRI: 1997. TR-107524 Balance-of-Plant Heat Exchanger Condition Assessment & Inspection Guide, EPRI: 1999. TR-108009 Considerations of Reactor Coolant Pump Vibration for Condition Monitoring & Diagnostics, EPRI: 1997. TR-108480

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A REACTIVE	**Performance Monitoring** (Continued)	Monitoring focuses on critical components and attributes (Continued)	Battery Performance Monitoring by Internal Ohm Measurements, Application Guidelines for Stationary Batteries, EPRI: 1997. TR-108826 Air-Operated Valve Evaluation Guide, EPRI: 1999. TR-111412 Investigations into Preferential Attack of Welds in Carbon Steel Piping & Vessels EPRI: 2003. 1007772 Supplemental Guidance for Testing & Monitoring Service Water Heat Ex-changers, EPRI: 2003. 1003320
		Indicators of degrading performance or condition are detected & acted upon	SysMon 2.0 Users' Manual, EPRI: 2001. 1000260 Infrared Thermography Guide, EPRI: 1994. 1006534 Thermal Fatigue Monitoring Guidelines, EPRI: 2001. 1001016 System Monitoring & Reporting Tool (SMART) Study: Generic Application Evaluation, EPRI: 2001. 1002964 Site Requirement Survey Information Collection Document, System Monitoring & Reporting Tool (SMART), EPRI: 2002. 1003477

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A REACTIVE	**Performance Monitoring** (Continued)	Indicators of degrading performance or condition are detected & acted upon (Continued)	Capacitor Performance Monitoring Project, EPRI: 2000. 1001257 HVAC Testing, Adjusting & Balancing Guidelines, EPRI: 2001. 1003082 Surveillance, Monitoring & Diagnostic Techniques to Improve Diesel Generator Reliability, EPRI NP-5924 CARS, Control Anomaly Recognition System: System Concept, Requirements, & Specifications, EPRI: 2002. 1003563 Improved Temperature Monitoring of Water Cooled Generators with Flow Restrictions in Stator Windings, EPRI: 2002. 1007118 Infrared Thermography Field Application Guide, EPRI: 1999. TR-107142 Battery Performance Monitoring by Internal Ohmic Measurements:Emergency Lighting Unit Batteries, EPRI: 1996. TR-106862 How to Conduct Material Condition Inspections, EPRI: 1994. TR-104514 Emergency Diesel Generator Bearing Monitoring Using HFED Techniques, EPRI: 1996. TR-107251

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
A R E A C T I V E	**Performance Monitoring** (Continued)	Indicators of degrading performance or condition are detected & acted upon (Continued)	Application Guide for Evaluation of Actual Output Capability for AOVs, EPRI: 1997. TR-107321 System Monitoring by System Engineering, 37 System Monitoring Plans, EPRI: 1998. TR-107434 Supplemental Guidance for Testing and Monitoring Service Water Heat Exchangers, EPRI: 2003. 1003320 Turbine Valve Diagnostics, EPRI: 2003. 1004558 Testing of Stator Windings for Thermal Aging: Primer, EPRI: 2003. 1009252 Assessment and Validation of Non-Intrusive MOV Diagnostic Technologies, EPRI: 2003. 1003561

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
B PREVENTIVE	**Continuing Equipment Reliability Improvement**	Component classification is used to prioritize equipment reliability strategy improvements	Preventative Maintenance Basis Overview and Volumes 1-38, EPRI: 1997. TR-106857-RI Vols. 1-38 1000621
		Basis for PMs is established	Web Based PM Basis Database, EPRI: 1002930 Guidelines for Application of the EPRI Preventive Maintenance Basis, EPRI: 1999. TR-112500 PMBD 5.0, Preventive Maintenance Basis Database on CD-ROM for Win 95/98/NT/ 2000/RP, EPRI: 2003. 1009275
		Industry OE is incorporated through changes to PMs	The Maintenance Engineer Fundamentals Handbook, EPRI: 1996. TR-106853 Guidelines on Improving Maintenance Effectiveness-Preventative and Predictive Maintenance, EPRI: 1998. TR-107042 Guideline on Assessing Maintenance Effectiveness, EPRI: 1996. TR-107759
		PdM is applied to identify degradation trends	Performance Metrics for Condition-Based Maintenance Technology Application Programs, EPRI: 2003. 1003682 PdM Technology Identification,Development, and Implemetation for 2003, EPRI: 2003. 1003755 Predictive Maintenance Primer, EPRI: 2003. 1007350

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
B PREVENTIVE	**Continuing Equipment Reliability Improvement** (Continued)	Component classification is used to prioritize equipment reliability strategy improvements (Continued)	Advanced Electric Motor Predictive Maintenance Project, EPRI: 2003. 1008377
	Performance Monitoring	Trending is performed to predict unacceptable equipment degradation	System Monitoring & Reporting Tool (SMART) Study: Generic Application Evaluation, EPRI: 2001. 1002964 Improved Temperature Monitoring of Water-Cooled Generators with Flow Restrictions in Stator Windings, EPRI: 2002. 1007118 Thermal Performance Engineer's Handbook, Vol. 1, Introduction to Thermal Performance, EPRI: 1998. TR-107422-V1 Thermal Performance Engineer's Handbook, Vol. 2, Advanced Concepts in Thermal Performance, EPRI: 1998. TR-107422-V2 Service Water Systems Corrosion and Deposition Sourcebook, EPRI: 1993. TR-103403 Thermal Fatigue Monitoring Guidelines, EPRI: 2001. 1001016 Surveillance, Monitoring, and Diagnostic Techniques to Improve Diesel Generator Reliability, EPRI: 1988. NP-5924 Heat Exchanger Performance Monitoring Guidelines, EPRI: 1991. NP-7552

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
B P R E V E N T I V E	**Performance Monitoring** (Continued)	Trending is performed to predict unacceptable equipment degradation (Continued)	EPRI LeakTrac Software, EPRI:2001 1009010 EPRI LeakTrac Database, Version 1.1 on CD-ROM for Win 95/98/NT/2000/XP EPRI: 2003. 1009010
		Walk downs and operator rounds identify early indicators of degradation	How to Conduct Material Condition Inspections, EPRI: 1994. TR-104514 Identification & Defection of Aging Issues, EPRI: 2003. 1007932 Aging Assessment Field Guide, EPRI: 2003. 1007933
		Cross-system common component trending is used	Equipment Condition Monitoring Templates: Addendum to the Preventative Maintenance Basis, EPRI: 2000. TR-106857 (Volumes 1-38) 1000621
	PM Implemetation	As-found equipment condition is documented and provided as feedback to performance monitoring and PM optimization	Guideline for As-Found Reporting, EPRI: 2003. 1002935

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
C PROACTIVE	**Corrective Action**	A site-wide management list of key equipment issues is used to prioritize equipment improvements and planning	EPRIlite-An Equipment Reliability and Obsolescence Evaluation Tool, EPRI: 2001. 1003103
	Continuing Equipment Reliability Improvement	Equipment reliability strategies are effected to address: - Equipment related plant vulnerabilities - Significant equipment reliability issues not improved by PM actions	EPRIlite-An Equipment Reliability and Obsolescence Evaluation Tool, EPRI: 2001. 1003103 Guidelines on Improving Maintenance Effectiveness-Preventative and Predictive Maintenance, EPRI: 1998. TR-107042 Condition Based Maintenance at Duke Power: Lessons Learned, EPRI: 1996. TR-105855 Predictive Maintenance (PdM) Cost Benefit Process --Nuclear Power, EPRI: 2000. TE-114847 Investigations into Preferential Attack of Welds in Carbon Steel Piping & Vessels, EPRI: 2003. 1007772 Preventive Replacement Database 1.0 web application, EPRI: 2003. 1003511 Preventive Replacement: Case Studies, Draft Screening/Evaluation Process, EPRI: 2003. 1003743
	Long-Term Planning, LCM	Long term plans (stand alone or in health reports) address equipment issues, including aging and obsolescence	Demonstration of Life Cycle Managaement Planning for SSCs, EPRI: 2001. 1000806

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
C P R O A C T I V E	**Long-Term Planning, LCM** (Continued)	Long term plans (stand alone or in health reports) address equipment issues, including aging and obsolescence (Continued)	Identfication and Detection of Aging Issues, EPRI: 2003. 1007932 Aging Assessment Field Guide, EPRI: 2003. 1007933 PSE Cable Aging Training, EPRI: 2003. 1003318 Aging Effects for Structures & Structural Components (Structural Tools) Revision 1, EPRI: 2003. 1002950 EPRI lite-An Equipment Reliability and Obsolescence Evaluation Tool, EPRI: 2001. 1003103
		Long term equipment plans are reconciled with the plant's budget and schedule	Application of a Cost-Benefit Analysis Methodology to Nuclear I&C System Upgrades, EPRI: 1992. TR-101984 Nuclear Plant Life Cycle Management Economics, EPRI: 1995. TR-104326 Valuation and Management of Nuclear Assets: Options Model and Case Studies, EPRI: 1996. TR-106842 Life Cycle Management Plan for Main Generator and Exciter at Wolf Creek Generating Station, EPRI: 2003. 1007019

State	Primary AP-913 Area	Goal of the Focused Gap Evaluation To determine if -	EPRI Technical Information
C P R O A C T I V E	**Long-Term Planning, LCM** (Continued)	Long term equipment plans are reconciled with the plant's budget and schedule (Continued)	Life Cycle Management Plan for Main Generator and Exciter at Callaway Plant, EPRI: 2003. 1007020 Life Cycle Management Plan for Main Generator and Exciter at Palo Verde Nuclear Generating Station, EPRI: 2003. 1007021 Life Cycle Management Plan for Main Generator and Exciters at Diablo Canyon Power Plant, EPRI: 2003. 1007024 Life Cycle Management Plan for Main Generator and Exciter at Comanche Peak Steam Electric Station, EPRI: 2003. 1007025 Life Cycle Management Planning Sourcebooks: Volume 5: Main Generator, EPRI: 2003. 1007423 Main Generator and Exciter Life Cycle Management Plans at STARS Nuclear Plants, EPRI: 2003. 1007960 Feedwater Heater LCM Sourcebook, EPRI: 2003. 1009073 Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance Overhauls and Inspections, EPRI: 2003. 1004950

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