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Integrated Operations and Maintenance of Fossil Plant Systems: System Health Reporting

Published Health Report Matrix

Setup | Print

Standard System	Plant A U1	Plant A U2	Plant A U3	Plant A U4	Plant B U1	Plant C U1	Plant C U2
0 - All Systems Or None Specified							
1A - Boiler - Economizer to Drum, Burners	W ~ : 03/03/09	M ~ : 03/09/09	U v : 03/09/09	U ~ : 03/09/09	U v : 03/16/09		
1B - Main & Auxlary Steam (Turbine,Pipe & Valves)	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	U v : 07/15/09	U v : 07/15/09
2 - Condensate	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	U v : 02/06/09	U v : 02/06/09
3 - Feedwater	U ~ : 04/30/09	U ~ : 05/06/09	U ~ : 05/06/09	U ~ : 05/06/09	U ~ : 05/06/09	Multiple Reports	M ^ : 05/12/09
5 - Extraction Steam	M ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	M ~ : 10/03/08	W ~ : 07/22/09	W ~ : 07/22/09
6 - Heater Drains & Vents	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09		
8 - Fire Equipment							
11 - Startup System					W ~ : 04/27/09	M ^ : 02/23/09	M ^ : 02/23/09
12 - Auxiliary System							
13 - Fire Detection System							
14A - Ash Sluice & Handling -Precipitator/Baghouse	W ^ : 03/17/09	W ~ : 03/17/09	W v : 03/17/09	W ~ : 03/17/09		U v : 07/22/09	U v : 07/22/09
14B - Ash Sluice And Handling - Mechanical	W ~ : 11/15/08	W ~ : 11/20/08	W ~ : 11/20/08	W ~ : 11/20/08	M v : 11/20/08	U v : 03/19/09	U v : 03/19/09
16 - Soot Blowing-Air & Steam	U ~ : 09/26/08						
18 - Fuel Oil System							
19 - Lighting-Off Oil & Air System	U ~ : 10/20/08	A ^ : 10/20/08	M ~ : 10/20/08	U ~ : 10/20/08			
24 - Raw Cooling Water						W v : 05/30/07	W v : 10/24/08
26 - High-Pressure Fire-Protection							
27 - Condenser Circulating Water	M ^ : 12/11/08	U ~ : 12/12/08	U ~ : 12/12/08	U ~ : 12/12/08	W ~ : 12/12/08	U v : 02/17/09	U v : 02/17/09
28 - Water Treatment System							
30 - Ventilation System	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09		
32 - Control Air System							
33 - Station Service Air System							
35 - Generator Cooling System	U ~ : 10/02/08	W ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	A ~ : 10/03/08		
36 - Feedwater Secondary Treatment							
39 - CO2 Fire Protection & Purging							
40 - Station Drainage System							
43 - Sampling & Water Quality							
44 - Building Heat System							
45 - Steam Seal System	W ~ : 03/12/09	W ~ : 03/12/09	W ~ : 03/12/09	W ~ : 03/12/09	W ? : 03/12/09	W v : 01/15/09	W v : 01/15/09
47 - Turbo-Generator Controls & Oil System						W ^ : 04/22/09	W ^ : 04/22/09
48 - Combustion & Boiler Analog Control							
49A - Combustion Fuel Air & Gas -Fans,Ductwork,APH	W ~ : 04/20/09	W ? : 04/19/09	M v : 04/19/09	W ~ : 04/20/09	Multiple Reports	Multiple Reports	U ^ : 05/08/09
49B - Combustion Fuel Air & Gas -Bunkers,Pulverizers	U ^ : 07/13/09	U ^ : 07/13/09	U v : 07/13/09	U ^ : 07/13/09	U ^ : 07/13/09		U v : 07/03/08
55 - Annunciator & Seq Events Recording						U v : 02/14/07	U v : 09/15/08
57 - Generator Excitation	W ~ : 07/09/08						
58 - Generator Bus Duct Cooling							
59 - Generator Seal Oil System	A ~ : 05/06/09	W ^ : 05/06/09	W ~ : 05/06/09	W ~ : 05/06/09	A ~ : 05/06/09		
81 - Absorber Circulation						U v : 04/01/09	U v : 04/01/09

Integrated Operations and Maintenance of Fossil Plant Systems: System Health Reporting

1017528

Final Report, December 2009

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PRODUCT DESCRIPTION

As budget margins for operations and maintenance programs become tighter, the need for fully integrated, streamlined programs becomes more essential. Organizations are being required to function more efficiently and effectively despite having their budget and personnel resources significantly reduced. Newly developed technology, especially information technology, has played a key role in assisting power-producing organizations as they strive to develop strategic management plans for their existing assets.

In 2008, the Electric Power Research Institute's (EPRI's) Program 69, Maintenance Management and Technology, initiated a project to investigate advanced practices in streamlining operations and maintenance programs. One of the key assertions made by this investigation has been that standardization and commonality are major factors in establishing a streamlined organization. The presence of commonality and standards allows organizations to leverage information across a wide range of domains that would otherwise be isolated.

The Program 69 projected initiated in 2008 was intended to push the boundaries of integration and highlight areas in which greater leveraging of information could yield even greater benefits to the asset owner. Of primary interest was the integration of advanced maintenance management practices with the technological advancements that were being developed surrounding the major systems and components at fossil-fired power plants. EPRI released a 2008 technical report (product 1015717) that proposed a standard technical strategy for maintaining plant equipment, regardless of function or location. At the conclusion of that report, some recommendations were offered that could enhance an organization's ability to apply this technical approach to all equipment in a generating fleet, gaining a framework for making informed, objective decisions on how and where to allocate budget resources. One of the recommendations involved the development of system health reporting programs, which are the subject of the present report.

Results and Findings

This report documents a generic approach to developing a system health reporting program. This approach was modeled after practices that have been implemented and currently exist in the fossil-based electric power generation industry. The report provides an overview of what a system health reporting program looks like, including key elements, roles, and responsibilities, and gives examples of applications to various asset types.

Challenges and Objectives

The objective of the report is to provide fossil plant management with the vision and means to develop a fully integrated, comprehensive process that allows organizations to gather and coordinate available information into a format supporting objective asset management principles. The report is intended to serve all personnel who have responsibilities tied to monitoring and assessing asset conditions, making budget-related decisions, and developing strategic asset management plans.

Applications, Value, and Use

As fossil-based power-producing organizations face greater challenges in terms of assessing and maintaining their current generating assets, the need to be more efficient with equipment information management is becoming paramount. System health reporting programs and similar initiatives will become essential for organizations seeking to develop optimal asset management strategies. These programs will provide the means to prioritize budget allocations and ensure that the proper resources are being directed to the appropriate areas of the organization.

EPRI Perspective

As fossil-based power-producing organizations continue to evolve, two key elements become ever more prevalent. First, the amount of information-producing technology relating to equipment and equipment condition continues to expand. This creates a situation in which management and personnel can quickly become overwhelmed with information if the proper processes are not in place to help manage this information. Second, as organizations continue to lose key technical knowledge due to retirements and downsizing, the need to efficiently collect and organize asset information in order to assist new plant staff becomes even greater.

As a novel approach to asset management, system health reporting is primed to make a significant impact on the fossil-based power industry. It provides the vision and structure to information management that will give organizations the ability to better manage their current assets and develop strategic operations and maintenance plans.

Approach

A team of EPRI staff and industry experts experienced in the field of system health reporting was assembled to document current practices deployed in the fossil-based power generation industry. These practices were assembled into generalized descriptions and functions of a system health reporting program. The generalized processes were documented to provide an overview of a system health reporting program as well as to provide examples of how these practices are currently applied in the industry.

Keywords

System health
System management
Maintenance management
Condition-based maintenance
Budgeting
Asset management

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CONTENTS

1 INTRODUCTION 1-1
Background 1-1
Objectives 1-3
Issues and Challenges 1-3
Scope 1-3
Approach 1-4
Reference 1-4

2 SYSTEM HEALTH REPORTING OVERVIEW 2-1
Elements of a System Health Reporting Program 2-2
Standardized Issues, Performance Indicators, and Metrics 2-3
Prioritized System Issues 2-5
The Operations Perspective 2-6
The Maintenance Perspective 2-6
The Engineering Perspective 2-7
Management Review 2-8
Roles and Responsibilities 2-8
The System Owner/Engineer/Manager 2-8
The Plant Review Committee 2-9
The Corporate Review Committee 2-9
Peer Review Teams 2-9
Engineering Assessment Teams 2-10
Technology Examination Teams 2-11
Operations Department 2-11
Maintenance Department 2-11
Reporting Format and Integration of Information 2-12
The System Health Status Display 2-12
The System Health Report Case 2-13

Standardized Issues/Indicators and Metrics 2-17
Condition Assessment Programs 2-18
System Health Reporting Summary 2-19

3 SYSTEM HEALTH CASE STUDY: BOILER FEEDWATER SYSTEM 3-1
System Definition and Boundaries 3-1
Equipment Descriptions 3-2
Condition Assessment Programs 3-2
Data/Information Sources 3-3
System Health Report Scenario 3-3

4 SYSTEM HEALTH CASE STUDY: BOILER SYSTEM 4-1
System Definition and Boundaries 4-1
Equipment Descriptions 4-1
Condition Assessment Programs 4-2
Data/Information Sources 4-3
System Health Report Scenario 4-3

5 CONCLUSIONS AND RECOMMENDATIONS 5-1

A SYSTEM HEALTH REPORTING PROGRAM EXAMPLE: REPORT PRODUCT A-1

B SYSTEM HEALTH REPORTING PROGRAM EXAMPLE: STANDARDIZED ISSUES AND PERFORMANCE INDICATORS B-1

LIST OF FIGURES

Figure 2-1 System Health Reporting Overview 2-1
Figure 2-2 System Health Reporting Program Overview 2-2
Figure 2-3 Example of System Health Reporting Program Standard Issues 2-4
Figure 2-4 System Health Reporting Program Standardized Metrics (Partial List) 2-5
Figure 2-5 Prioritized System Issues 2-5
Figure 2-6 System Health Reporting Program—System Health Status Report 2-12
Figure 2-7 System Health Report Case—System and Report Definitions 2-14
Figure 2-8 System Health Report Case—Status Description and Documentation 2-15
Figure 2-9 System Health Report Case—Top Issues and Department Perspectives 2-16
Figure 2-10 System Health Report Case—Information Sources 2-16
Figure 2-11 System Health Report Case—Standardized Issues/Indicators and Metrics 2-17
Figure 2-12 System Health Report Case—Predictive Maintenance Program Results 2-18
Figure 2-13 System Health Report Case—Engineering Assessment Program Results 2-19
Figure 3-1 Fleetwide System Health Report—Feedwater System 3-3
Figure 3-2 Partial Listing of System Health Reporting Issues/Indicators 3-4
Figure 3-3 Predictive Maintenance Technology Assessments Summary 3-5
Figure 3-4 Predictive Maintenance Technology Assessment Report 3-6
Figure 3-5 Predictive Maintenance Technology Detailed Report 3-7
Figure 3-6 Component Assessments Summary Report 3-8
Figure 3-7 Component Assessment Detailed Report 3-9
Figure 3-8 System Health Report Case Summary—Feedwater System 3-10
Figure 4-1 Fleetwide System Health Report—Boiler System 4-3
Figure 4-2 Partial Listing of System Health Reporting Issues/Indicators 4-4
Figure 4-3 Component Assessments Summary Report 4-5
Figure 4-4 Detailed Assessment Report 4-6
Figure 4-5 Detailed Assessment Report (continued) 4-7
Figure 4-6 Detailed Component Condition Evaluation Test 4-8
Figure 4-7 Risk Assessment Summary 4-8
Figure 4-8 Risk Assessment Issue Report 4-9
Figure 4-9 System Health Report Case Summary—Boiler System 4-10

1
INTRODUCTION

Background

As the electric power industry continues to evolve with respect to the mix of energy sources, fossil-fired generating assets remain an essential aspect of the energy portfolio. Coal-, oil-, and natural gas-based generating units continue to provide the majority of the world's electric power, and will be expected to do so for the foreseeable future until alternative energy sources can achieve the economic and technical standards necessary to replace these traditional fossil resources. From a business perspective, this impending and uncertain transition presents a difficult predicament. As these assets continue to age, operational and maintenance resource requirements represent a significant investment for the asset owners. The uncertainty surrounding how long these assets will be required to run—or how long the assets will remain profitable to run—makes decisions regarding investment in these assets difficult. Fossil power organizations are more than ever before faced with difficult decisions about where and how to budget equipment upgrades, modifications, and repairs, or about whether any actions should be taken at all.

To address such a complex situation, utilities and other power-producing organizations have placed an even greater emphasis on streamlining operations and maintenance programs in order to achieve the greatest level of reliability while optimizing the allocation of valuable resources. The central focus of these streamlined programs is to implement the most efficient and effective combination of processes and technologies that allow personnel to do the following:

- Collect the most important information regarding asset conditions
- Assess various assets and compare them to one another based upon asset condition
- Make decisions on which actions should be taken to ensure that generating units operate reliably, efficiently, and cost-effectively

In 2008, EPRI's Program 69, Maintenance Management & Technology, initiated a project to investigate advanced practices in streamlining operations and maintenance programs. One of the key assertions made by this investigation has been that standardization and commonality are major factors in establishing a streamlined organization. The presence of commonality and standards allows organizations to leverage information across a wide range of domains that would otherwise be isolated. For example, a standardized predictive maintenance (PdM) program outlines which technologies are applied to which specific pieces of equipment. Procedures are established that allow personnel to capture the information necessary to accurately depict the individual condition of all equipment covered under the PdM program.

A common information management system is then utilized to organize the information for all equipment types and used as the basis for making comparisons between separate individual assets.

The Program 69 project initiated in 2008 intended to push the boundaries of integration and highlight areas in which greater leveraging of information could yield even greater benefits to the asset owner. Of primary interest was the integration of advanced maintenance management practices with the technological advancements that were being developed surrounding the major systems and components at fossil-fired power plants—namely, the boiler, turbine, and generator. EPRI released a technical report in 2008 that proposed a standard technical strategy for maintaining plant equipment, regardless of function or location [1]. At the conclusion of that 2008 report, recommendations were given that could enhance an organization's ability to apply this technical approach to all equipment in a generating fleet. This standardized strategy would then provide the framework for which organizations could make informed, objective decisions on how and where to allocate budget resources.

One of the recommendations provided in the 2008 EPRI report involved the development of system health reporting programs. The following is an excerpt from the recommendation:

> While organizations that practice CBM [condition-based maintenance] have set the foundation for a maintenance program that is highly focused on unit reliability, they still face difficult challenges. One such challenge involves taking all information generated during the Condition Assessment phase of the technical maintenance process and effectively utilizing this information as input to a systematic maintenance decision-making process. As illustrated earlier in this report, condition assessment programs have the capability to generate significant amounts of information regarding systems, components, and equipment. Examples include routine inspections made by operators, detailed inspections made by maintenance personnel, engineering assessments, results from predictive maintenance technology exams, plant process data, and online performance monitoring data. In addition to this influx of information, histories and trends involving this data are often used as part of the assessment process. Without a systematic approach to acquire and organize this information into a meaningful, consistent input for a maintenance decision-making process, much of the potential effectiveness of these condition assessment processes is lost and the maintenance process is compromised.
>
> To address this issue, a common approach to information integration should be structured that has applications to all plant systems, components, and equipment. This practice would provide maintenance organizations with the ability to accumulate all outputs resulting from various condition-monitoring/assessment activities and assemble them into comprehensive "living" health reports at all system, component, and equipment levels. These health reports represent complete condition status updates that reflect current conditions as well as trends in past conditions. This approach is already in practice at some organizations; however, these practices still remain underdeveloped and lack consistency for all plant systems, components, and equipment.
>
> The primary benefit provided by use of a common process for accumulating and integrating condition assessment information is that it provides a consistent set of outputs that can be used as inputs for maintenance decision-making processes. For example, the

health of turbine intercept valves can be viewed in the same database as the health of induced draft fans, condenser tubes can be viewed along with platen superheaters, and feedwater heaters can be assessed alongside coal conveyors. Approaches for facilitating this information integration process are currently in practice throughout the industry; however, shortcomings often exist in regards to consistency, tools and technology to support these processes, and—most importantly—the ability to use past and present equipment condition as a basis for prognostics. Advancements in any of these areas that focus on a common, consistent basis relating to all plant systems, components, and equipment would provide significant reliability improvement opportunities.

Objectives

The purpose of this report is to describe the processes and steps necessary to develop a functional system health reporting program. This report will serve as a guideline that describes what constitutes a system health reporting program and what steps are necessary to implement such a program. This report will focus on establishing processes, but will reference software and supporting technologies where applicable for illustrative purposes.

Issues and Challenges

A successful system health reporting program offers the potential for significant benefit to an organization, based upon the ability to integrate and coordinate large amounts of information from a wide array of sources. With this potential benefit also come potential challenges. One of the primary challenges involves developing the framework for information to become integrated. Multiple sources of information are intended to be utilized including human inputs, sensor outputs, technical evaluations, and a variety of other sources. All of this information must be collected and organized into a useful and systematic structure that is standardized.

Personnel must also be dedicated to this program and its supporting technologies. In the fossil power generation industry, no two organizations are identical. With that being the case, different personnel in different organizations will be required to carry out essential functions and responsibilities within the program that will be unique to their organization. Individuals will be responsible for different roles and technology involvement depending on the structure of their organization. In cases where technology gaps exist, modifications and/or adjustments must be accounted for in the processes to ensure that the key features of the program are functional.

Scope

The scope of this report encompasses the following elements:

- An overview of a system health reporting program
- Roles and responsibilities that are necessary to facilitate a functional system health reporting program

- A general process description for integrating condition assessment programs with system health reporting programs
- An industry case study of how system health reports are assembled, from an example dynamic component (pump/motor) to a system-level report (boiler feedwater system)
- An industry case study of how system health reports are assembled, from an example passive component (boiler circuit) to a system-level report (boiler system)
- Conclusions and recommendations for how a system health reporting program can support future initiatives involving advancements in operations and maintenance

Approach

A team of EPRI staff and industry experts experienced in the field of system health reporting was assembled to document current practices deployed in the fossil-based power generation industry. These practices were assembled into generalized descriptions and functions of a system health reporting program. The generalized processes were documented to provide an overview of a system health reporting program, as well as to provide examples of how these practices are currently applied in the industry.

Reference

1. *An Integrated Approach to Improved Plant Reliability: Assessment of a Common Process Framework for Maintaining Critical Equipment*. EPRI, Palo Alto, CA: 2008. 1015717.

2
SYSTEM HEALTH REPORTING OVERVIEW

As maintenance organizations are forced to operate under restricted budgets and limited resources, the need to integrate and organize as much information as possible becomes an essential aspect of a successful maintenance program. Effectively integrated equipment information provides management with the ability to efficiently monitor and assess a wide range of assets. With these advanced management capabilities, organizations can develop objective, strategic maintenance plans. A system health reporting program is designed to provide management with these capabilities. Essentially, it is a program that produces a reporting structure allowing management to quickly identify the status of assets across a fleet, system, plant, or equipment type and make uniform comparisons from asset to asset (Figure 2-1).

Published Health Report Matrix

Setup Print

Standard System	Plant A U1	Plant A U2	Plant A U3	Plant A U4	Plant B U1	Plant C U1	Plant C U2
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27 - Condenser Circulating Water	M ^ : 12/11/08	U ~ : 12/12/08	U ~ : 12/12/08	U ~ : 12/12/08	W ~ : 12/12/08	U v : 02/17/09	U v : 02/17/09
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57 - Generator Excitation	W ~ : 07/09/08						
58 - Generator Bus Duct Cooling							
59 - Generator Seal Oil System	A ~ : 05/06/09	W ^ : 05/06/09	W ~ : 05/06/09	W ~ : 05/06/09	A ~ : 05/06/09		
81 - Absorber Circulation						U v : 04/01/09	U v : 04/01/09

Figure 2-1
System Health Reporting Overview

This formatted knowledge base provides organizations with the ability to objectively assess numerous types of assets, communicate various equipment-related issues, and quickly drill down through the asset hierarchy in order to bring to light more detailed information regarding these issues.

Elements of a System Health Reporting Program

A system health reporting program is a process framework in which information from numerous data sources over a wide range of assets is channeled together into a single, common reporting format (Figure 2-2). This format assembles information into an organized, hierarchical structure that provides a consistent basis for comparison.

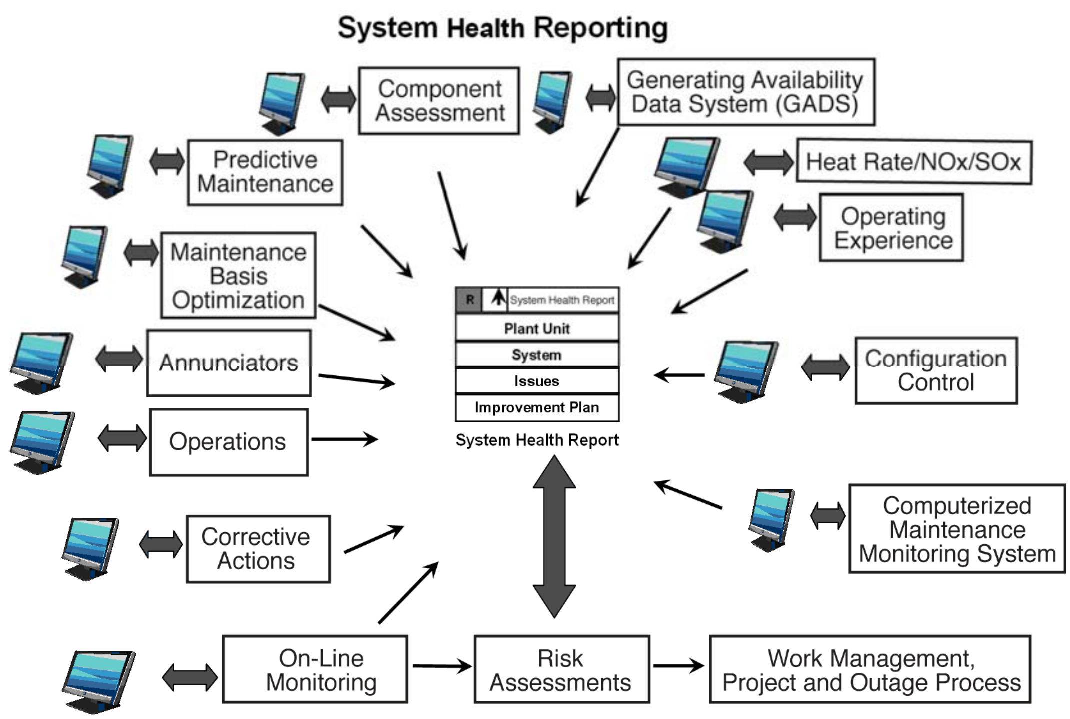


Figure 2-2
System Health Reporting Program Overview

The multiple sources of data are intended to cover all relevant programs associated with equipment/system functionality and condition assessment, including operations, maintenance, engineering, instrumentation and control, performance, and management.

The primary function of a system health reporting program is to generate a report format that allows management the ability to efficiently and objectively evaluate a wide range of assets. In order to do this effectively, certain key elements are necessary to ensure creation of a report structure that contains the information needed to make these evaluations. These key elements include the following:

- Standardized issues, performance indicators, and metrics
- Prioritized system issues
- The operations perspective
- The maintenance perspective
- The engineering perspective
- Management review

Standardized Issues, Performance Indicators, and Metrics

The foundation of a system health reporting program is the ability to assess and compare a variety of different asset types based on numerous condition assessment data sources. In almost all cases, making a one-to-one comparison of different equipment condition assessments would be virtually impossible. For example, a vibration reading on a motor shaft is very difficult to directly compare to a wall thickness analysis on a heat exchanger tube. A structured system health reporting program provides the basis for making comparisons by introducing a set of standardized equipment issues and performance indicators. These issues relate to physical condition of assets, work control processes, technical evaluations, system configuration, maintenance, performance, and so on (Figure 2-3).

System Health Reports	
System Health Performance Indicator	**Source**
1) Operator Work-Arounds	Operations
2) Disabled Annunciators	Operations
3) AUO Rounds Deficiencies	Operations
4) Longstanding Clearances Age	Operations
5) Operator Critical Limits Out of Spec Age	Operations
6) Safety Deficiencies	System Engineering
7) Environmental Deficiencies	System Engineering
8) CM Work Orders – Non-Outage	Maintenance
9) CM Work Orders – Outage	Maintenance
10) PMs – Outage	Maintenance
11) PMs – Deferred/Late on Critical Equipment	Maintenance
12) PdM – Red/Yellow Assessments	PlantView
13) PdM – Deferred/Late Past 7 Days	PlantView
14) Preventable Failures on Critical Equipment	System Engineering
15) PERs with Late Action Items	Problem Evaluation Report
16) Component Assessment Rating – Outage	PlantView
17) Component Assessment Rating – Non-Outage	PlantView
18) Unavailable Spares on Major Components	System Engineering
19) Major Modifications/Projects Deferred	System Engineering

Figure 2-3
Example of System Health Reporting Program Standard Issues

Most system health reporting programs utilize 30–40 standardized issues and indicators. These issues are designed to be generic and objective enough to cover all plant equipment types, but refined enough to provide significant insight into the condition of the assets. In some cases, there will be indicators that are not relevant to specific types of equipment. For example, some equipment is not covered by a predictive maintenance (PdM) program. These issues would still be included in the overall system health report for consistency purposes, but because there is no PdM function, there would never be a PdM-based issue relating to that piece of equipment.

In conjunction with each of the standardized issues and indicators that are used in the system health report, standardized metrics are also employed to quantify the status of each issue/indicator. These metrics provide the criteria for rating the issue/indicator in a quantitative, comparable format. This is typically a tiered-point system in which an issue/indicator is ranked into one of the tiers based on defined criteria. These points and tiers remain consistent for all system/equipment evaluations for all assets in the system health reporting program. Scores are tabulated for each asset based upon these metrics and aggregated to produce an asset status that is available at multiple levels throughout the equipment hierarchy (Figure 2-4). An example of standardized issues/indicators and corresponding metrics is found in Appendix B of this report.

System Health Performance Indicator		Source	Green Criteria (0 points)	Blue Criteria (1 points)	Yellow Criteria (3 points)	Red Criteria (6 points)
1.	Operator Work Arounds – lagging indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
2.	Disabled Annunciator / Nuisance Alarms – leading indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
3.	AUO Rounds Deficiencies – non outage leading indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
4.	Long Standing Clearances age – Lagging indicator (optional)	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
5.	Operator Critical Limits Out of Spec duration - leading indicator	**OPS**	None > 1 day	any > 1 day and < 2 days	Any ≥ 3 days	Any ≥ 3 days
6.	Safety deficiencies (including WO)	**SE**	None > 7 day	any ≥ 7-14 days	Any 14-30 days	Any 30 days
7.	Environmental deficiencies (design, maintenance including WOs).	**SE**	None > 7 day	any ≥ 7-14 days	Any 14-30 days	Any 30 days
8.	CM WOs – non-outage; excluding PMs, major component outages, and critical spare rebuilds – leading indicators	**Maint.**	All < 6 Months	Any ≥ 6 months and 9 months	Any ≥ 9 months and < 12 months	Any ≥ 12 months

Figure 2-4
System Health Reporting Program Standardized Metrics (Partial List)

Prioritized System Issues

The ranking system based on standardized issues/indicators and metrics is intended to provide a uniform quantification process for assessing various assets. This serves as a guideline enabling system owners to produce a prioritized list of system issues based on the severity of these issues. These prioritized issues are evaluated by the system owner, and action plans are developed for the highest-priority issues within each system—typically, the top three to five issues (Figure 2-5).

System Health Reports
Combustion Air and Gas **Top 5 System Issues**
1) Replace expansion joints per capital project
2) Upgrade pulverizers per capital projects
3) Replace auxiliary air dampers and drives
4) Troubleshoot and repair 1044 and 1053 air dampers
5) Develop operating procedure and action levels for dP across APH

Figure 2-5
Prioritized System Issues

These issues and action plans are presented to management during planning and review meetings as formal bases for developing asset strategies, creating budgets, and distributing resources.

The Operations Perspective

System health reporting programs are designed to provide comprehensive feedback to management and asset owners that is representative of each of the major disciplines involved in a power plant. Although each of the disciplines—operations, maintenance, and engineering—is equally critical, the feedback relating to operations is perhaps the most relevant in terms of imminent system functionality. Operators are dependent upon plant equipment functioning properly and typically have a good understanding of the operating condition of the equipment. Because of this, it is imperative that the operational effects of system issues are documented and addressed in a system health reporting program.

Specific types of information that is documented in the operations perspective include the following:

- **Operator work-arounds:** Inoperable equipment that requires operators to deviate from standard operating practices and utilize bypass systems and procedures; these conditions should be brought to the attention of system owners and accounted for in the system health reporting process.
- **Critical operating parameters:** Operating limits and ranges that operators maintain to ensure safe and efficient control of the operating unit; deviations from intended design parameters and limits should be brought to the attention of system owners and accounted for in the system health reporting process.
- **Annunciators:** Alarms that are put in place to alert operators when control limits and thresholds have been exceeded; any annunciators that can be classified as legitimate repeat alarms need to be brought to the attention of system owners and accounted for in the system health reporting process; any annunciators classified as "nuisance alarms" should also be brought to the attention of the system owner so steps to remove or reset these alarms can be taken.
- **Operator procedures:** Guidelines that are put in place to provide assistance in equipment operations; any procedures that have deviated from original design specifications should be brought to the attention of system owners and accounted for in the system health reporting process.

The Maintenance Perspective

In addition to any input provided by the operations organization, it is also necessary to gather feedback from maintenance personnel regarding any maintenance-related issues that prohibit optimal system performance and/or reliability. In most situations, maintenance personnel have the first-hand knowledge of equipment condition based upon previous repair or replace activities that have taken place on an asset. This information can be invaluable because it can provide insight as to whether or not equipment was returned to design specifications, whether any repairs made were simply intended to be temporary fixes, and how effective a maintenance activity will be in terms of ensuring equipment performance and/or reliability.

Specific types of information that is documented in the maintenance perspective include the following:

- **Preventive maintenance (PM) program compliance.** PM programs are established to address equipment-related issues on critical components prior to equipment failures; the compliance of thoroughly completing scheduled PM activities is crucial to the success of a PM program; any significant deviations in compliance with this program should be brought to the attention of system owners and accounted for in the system health reporting process.
- **PM-related backlog.** PM backlogs represent the amount of planned equipment maintenance work that is deferred due to a number of possible causes; both outage-related and non-outage-related PM backlogs should be monitored and trended to assess whether or not maintenance programs are efficiently able to meet the maintenance needs of the plant; any significant accumulation, or significant increase, in PM-related backlog should be brought to the attention of system owners and accounted for in the system health reporting process.
- **Corrective maintenance (CM)-related backlog.** CM backlogs represent the amount of unplanned equipment maintenance work that is deferred due to a number of possible causes; both outage-related and non-outage-related CM backlogs should be monitored and trended to assess whether or not maintenance programs are efficiently able to meet the maintenance needs of the plant; any significant accumulation, or significant increase, in CM-related backlog should be brought to the attention of system owners and accounted for in the system health reporting process.
- **Safety-related work orders.** Safety is an essential aspect of any organization; maintenance work orders that are generated for safety-related reasons should be closely monitored and trended to ensure that operating environments surrounding plant equipment are safe and reliable; any safety-related work orders that are developed should be brought to the attention of system owners and accounted for in the system health reporting process.
- **Work closure feedback.** One of the most crucial aspects of maintenance relates to the competency of the maintenance craft and their ability to thoroughly complete repair/replace activities; it is essential to have feedback documented that illustrates how effective a maintenance activity was in restoring equipment back to design conditions; any deviations with respect to this should be brought to the attention of system owners and accounted for in the system health reporting process.

The Engineering Perspective

Although the role of a system owner is typically filled by someone from or related to the engineering discipline, it is still necessary to capture the perspective of the engineering organization itself. System owners should consult with engineering assessment teams to document key findings and results of any engineering-related equipment examination. System owners should also consult with project management teams to discuss any design/modification projects that are intended for the respective system. Final consultation should be made with a site's engineering management team to ensure that all information included in the system health reporting process is representative of the engineering program for the system.

Management Review

Upon completion of a system health report, periodic reviews are scheduled in order to evaluate and validate reports at both a plant level and a fleetwide level. Management is presented with the information contained in the system health report by the respective system owner, or a suitable representative. Top issues relating to that system are reviewed and discussed, as are the action plans that have been developed to address those issues. Management feedback is then documented by either the engineering manager or the system owner and recorded in the Management Review section of the system health report.

Roles and Responsibilities

There are numerous roles that are essential to a system health reporting program. The following is a generalized list of important roles and a brief description of the responsibilities and functions related to each particular role. As stated previously, no two fossil organizations are structured identically; therefore, the emphasis of these descriptions should be placed upon the **functionality** of the position. In some cases, more than one person will be needed to facilitate the position. In other cases, one person may be able to address the functionality of multiple roles.

The System Owner/Engineer/Manager

The system owner/engineer/manager (for brevity, *system owner*) is the most critical job function in a system health reporting program. The system owner is the central figure of the overall process, and the only job function that is required is to interact with almost all parties involved with the program.

System owners are system experts who can come from any of the major disciplines (operations, maintenance, or engineering), provided they have the experience and knowledge to understand and evaluate system function, design, performance, and reliability. It is preferable that a system owner be a part of the established on-site personnel, as opposed to corporate-based (or multi-site) personnel. This allows the system owner the ability to interact with the system/equipment on a daily basis and allows for a more intimate knowledge of the system; however, system owners do **not** have to be dedicated to a single system.

The responsibility of each system owner is, ultimately, to ensure that system health reports are created and maintained for each of their systems. These reports are typically generated on a quarterly, semi-annual, or annual basis. Preparation of these reports involves activities such as meeting with engineering assessment teams to discuss test results, working with technology examination teams to trend examination results, developing a prioritized list of system issues, generating a strategic action plan for the system, and meeting with the plant review committee to verify and validate the system health report.

The Plant Review Committee

The *plant review committee* is a team of plant management representatives that is responsible for reviewing the system health reporting program results on a periodic basis. Typically, these reviews are conducted on a quarterly, semi-annual, or annual schedule. System owners from each of the plant systems are given the opportunity to meet with the plant review committee during these reviews to discuss the major issues and intended action plans regarding their plant systems. The plant review committee is responsible for verifying and validating the information presented in the system health reporting program results. This information is to be used to facilitate the plant's budget planning process.

The Corporate Review Committee

The *corporate review committee* is a team of corporate management representatives that is responsible for reviewing the system health reporting program results on a periodic basis. Typically, these reviews are conducted on a semi-annual or annual schedule. Representatives from each plant's management team are given the opportunity to meet with the corporate review committee during these reviews to discuss the major issues and intended action plans regarding their plants. The corporate review committee is responsible for verifying and validating the information presented in the system health reporting program results. This information is to be used to facilitate the fleet's budget planning process.

Peer Review Teams

Peer review teams are groups of peers within an organization that represent the various elements of the system health reporting program: system owners, operations management, maintenance management, and engineering management. Peer review teams are responsible for reviewing and discussing the results of their respective elements concerning the system health reporting program. Typically, these meetings are conducted on a monthly or quarterly schedule. The meetings are intended to provide a forum in which plant element specialists (that is, system owners, operations management, maintenance management, and engineering management) can meet with their peers within the organization to discuss potential issues, share experiences, validate information, and develop action plans. The results of these meetings are used in the system health reporting program during the plant review committee meetings and, eventually, the corporate review committee meetings.

Engineering Assessment Teams

Engineering assessment teams are part of the plant's equipment condition assessment programs. These teams are typically responsible for carrying out engineering-based examination techniques, including nondestructive examination (NDE) testing and other similar assessments. Examples of the types of assessments conducted by these teams are the following:

- Magnetic particle examination (MT)
- Liquid penetrant examination (PT)
- Eddy current examination (ET)
- AC potential drop
- Ultrasonic examination (UT)
- Radiography (RT)
- Electromagnetic acoustic transducers (EMAT)
- Low-frequency electromagnetic technique (LFET)
- Pulsed eddy current (PEC)
- Infrared thermography
- Transient infrared thermography
- Alloy identification
- Replication
- Portable hardness testing
- Miniature sampling
- UT-oxide

The primary responsibility of these teams within the system health reporting program is to collect the information/data produced by these examinations and organize the results into a format that allows objective comparisons to be made from one asset to another. Typically, an organization will identify a number of standard issues/indicators that are directly related to these engineering assessments. Engineering assessment teams must determine whether or not examination results are acceptable or unacceptable based on the defined criteria; the results must then be linked to the metrics established for the standard issues/indicators.

Engineering assessment teams are responsible for meeting with system owners and engineering management teams on a regular basis to discuss issues and concerns regarding system performance and reliability. It is also their responsibility to work with system owners and engineering management teams to discuss necessary action plans to address any concerns with the respective systems.

Technology Examination Teams

Technology examination teams are also part of the plant's equipment condition assessment programs. These teams are typically responsible for executing and managing the plant's predictive maintenance (PdM) program, which is responsible for carrying out technology exams such as the following:

- Vibration analysis
- Acoustic analysis
- Oil/lubrication analysis
- Infrared thermography
- UT-oxide

The primary responsibility of these teams within the system health reporting program is to collect the information/data produced by these evaluations and organize the results into a format that allows objective comparisons to be made from one asset to another. Typically, an organization will identify a number of standard issues/indicators that are directly related to technology examination results. Technology examination teams must determine whether or not test results that are acceptable or unacceptable, based on the defined criteria; the results must then be linked to the metrics established for the standard issues/indicators.

Operations Department

As stated previously, feedback from operations is an essential aspect of any asset performance/reliability improvement initiative. With respect to the system health reporting program, it is the responsibility of the *operations team* to document and track issues that are prohibitive to the safe and intended operation of the equipment, systems, and unit. Organizations typically develop standard issues/indicators in the system health reporting program that represent the functional status of plant equipment from an operations perspective. It is the responsibility of the operations team to collect information from operator logbooks; operator rounds; alarms; clearances and tag-outs; and other sources of operational information and link this information to the standardized issues and performance indicators. Validation of this data should be made by the operations manager and the respective system owner.

Maintenance Department

Maintenance programs are structured to ensure that the systems and equipment within a generating asset remain within design and operating specifications. In the event that a system or equipment fails and no longer fulfills its intended functions, it is the responsibility of the maintenance craft to repair or replace the system and equipment in order to ensure the safe and reliable operation of the asset. It is also the responsibility of the maintenance program to ensure that periodic maintenance is executed that prohibits systems and equipment from degrading into failed conditions. Because maintenance personnel have direct access to these systems and equipment under these circumstances, their feedback concerning the quality or thoroughness of maintenance activities is invaluable. Maintenance personnel have the ability to determine whether systems and equipment have been repaired sufficiently to last until the next scheduled outage, as well as whether systems and equipment are degrading faster than originally expected. With respect to the system health reporting program, it is the responsibility of the maintenance organization to document this type of information regarding system/equipment condition. These documented conditions should be formatted to link to the standardized issues/indicators that were developed by the organization to characterize the status of plant maintenance. Maintenance managers should be expected to coordinate with system owners to ensure that the necessary information regarding maintenance is appropriately captured and validated.

Reporting Format and Integration of Information

The System Health Status Display

One of the primary benefits of a system health reporting program is the integrated *system health status display* that is generated with all of the data/information collected throughout the process (see Figure 2-6, a duplication of Figure 2-1 that has been reproduced here for proximity of reference).

Published Health Report Matrix

Setup Print

Standard System	Plant A U1	Plant A U2	Plant A U3	Plant A U4	Plant B U1	Plant C U1	Plant C U2
0 - All Systems Or None Specified							
1A - Boiler - Economizer to Drum, Burners	W ~ : 03/03/09	M ~ : 03/09/09	U v : 03/09/09	U ~ : 03/09/09	U v : 03/16/09		
1B - Main & Auxilary Steam (Turbine,Pipe & Valves)	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	U v : 07/15/09	U v : 07/15/09
2 - Condensate	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	Multiple Reports	U v : 02/06/09	U v : 02/06/09
3 - Feedwater	U ~ : 04/30/09	U ~ : 05/06/09	U ~ : 05/06/09	U ~ : 05/06/09	U ~ : 05/06/09	Multiple Reports	M ^ : 05/12/09
5 - Extraction Steam	M ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	M ~ : 10/03/08	W ~ : 07/22/09	W ~ : 07/22/09
6 - Heater Drains & Vents	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09	A ~ : 02/09/09		
8 - Fire Equipment							
11 - Startup System					W ~ : 04/27/09	M ^ : 02/23/09	M ^ : 02/23/09
12 - Auxiliary System							
13 - Fire Detection System							
14A - Ash Sluice & Handling -Precipitator/Baghouse	W ^ : 03/17/09	W ~ : 03/17/09	W v : 03/17/09	W ~ : 03/17/09		U v : 07/22/09	U v : 07/22/09
14B - Ash Sluice And Handling - Mechanical	W ~ : 11/15/08	W ~ : 11/20/08	W ~ : 11/20/08	W ~ : 11/20/08	M v : 11/20/08	U v : 03/19/09	U v : 03/19/09
16 - Soot Blowing-Air & Steam	U ~ : 09/26/08						
18 - Fuel Oil System							
19 - Lighting-Off Oil & Air System	U ~ : 10/20/08	A ^ : 10/20/08	M ~ : 10/20/08	U ~ : 10/20/08			
24 - Raw Cooling Water						W v : 05/30/07	W v : 10/24/08
26 - High-Pressure Fire-Protection							
27 - Condenser Circulating Water	M ^ : 12/11/08	U ~ : 12/12/08	U ~ : 12/12/08	U ~ : 12/12/08	W ~ : 12/12/08	U v : 02/17/09	U v : 02/17/09
28 - Water Treatment System							
30 - Ventilation System	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09	U ~ : 08/03/09		
32 - Control Air System							
33 - Station Service Air System							
35 - Generator Cooling System	U ~ : 10/02/08	W ~ : 10/03/08	W ~ : 10/03/08	W ~ : 10/03/08	A ~ : 10/03/08		
36 - Feedwater Secondary Treatment							
39 - CO2 Fire Protection & Purging							
40 - Station Drainage System							
43 - Sampling & Water Quality							
44 - Building Heat System							
45 - Steam Seal System	W ~ : 03/12/09	W ~ : 03/12/09	W ~ : 03/12/09	W ~ : 03/12/09	W ? : 03/12/09	W v : 01/15/09	W v : 01/15/09
47 - Turbo-Generator Controls & Oil System						W ^ : 04/22/09	W ^ : 04/22/09
48 - Combustion & Boiler Analog Control							
49A - Combustion Fuel Air & Gas -Fans,Ductwork,APH	W ~ : 04/20/09	W ? : 04/19/09	M v : 04/19/09	W ~ : 04/20/09	Multiple Reports	Multiple Reports	U ^ : 05/08/09
49B - Combustion Fuel Air & Gas -Bunkers,Pulverizers	U ^ : 07/13/09	U ^ : 07/13/09	U v : 07/13/09	U ^ : 07/13/09	U ^ : 07/13/09		U v : 07/03/08
55 - Annunciator & Seq Events Recording						U v : 02/14/07	U v : 09/15/08
57 - Generator Excitation	W ~ : 07/09/08						
58 - Generator Bus Duct Cooling							
59 - Generator Seal Oil System	A ~ : 05/06/09	W ^ : 05/06/09	W ~ : 05/06/09	W ~ : 05/06/09	A ~ : 05/06/09		
81 - Absorber Circulation						U v : 04/01/09	U v : 04/01/09

Figure 2-6
System Health Reporting Program—System Health Status Report

This particular type of output is an effective reporting format that provides management with the capability to quickly and efficiently monitor, trend, and assess plant systems and equipment. It also provides the capability to objectively compare and contrast the performance and reliability of dissimilar systems and equipment that are subjected to a wide variety of issues.

There are several key elements to the report format identified in Figure 2-6. First, a list of standard systems—defined by the organization as a fleetwide standard with each item having a common, clear definition—is placed on one axis of the matrix display. Second, a list of all operating units within the fleet (or specific section of the fleet—that is, coal-fired, fossil-fired, peaking assets, and so on) is depicted along the opposite axis. Last, within each of the matrix cells, a status is depicted corresponding to the specific system for the specific unit. In each cell are three vital pieces of information: the current status of the system, the trend in system status, and the date of the most recent system health report. The current system status is depicted by some tiered classification defined by the organization. In the example illustrated by Figure 2-6, the organization uses a five-tier system relating to “Acceptable” (Green and “A”), “Watch List” (Blue/Cyan and “W”), “Marginal” (Yellow and “M”), “Unacceptable” (Red and “U”), and “Nonapplicable” (Blank). Each status corresponds to the output of standard issues/indicators and metrics that has been defined by the organization. The trend for each specific system for each unit is also depicted on this report. This is also a tiered system that illustrates whether the status of the system is improving, maintaining, or deteriorating. Definitions for when and how these trends are applied are also up to each individual organization, but should be kept consistent across the fleet. Finally, the date of the last completed system health report is shown in the cell. This provides a reference to address the timeframe and relevance relating to each system status.

The System Health Report Case

Corresponding to each of the matrix cells in the system health status display, an underlying *system health report case* exists that is the source of information defining the system status. An example of a complete report case is presented in Appendix A of this report. There are several key components that make up a system health report case, some of which have already been described in preceding sections of this report.

Figure 2-7 illustrates an example of information that is necessary for a system health report case. (Blank spaces in this figure and in some others that follow are the result of redaction of confidential details.) This information includes the following:

- The name of the system
- An identifier to depict the specific report
- A summary of the system including the system definition and boundaries
- A current status of the report case (new report, incomplete, completed, and so on)
- Reporting dates (initiation, completion, upcoming reports, and so on)
- System owner name
- Reviewing manager name

Report Instance Definition

- Main & Auxilary Steam #10074
- Main & Auxilary Steam / Reports Library (all sites)

Update Delete

Report Title	- Main & Auxilary Steam #10074
Brief Summary	System 1 consists of the boiler and High Energy Piping (HEP), which includes all components from Economizer Inlet header to the HP turbine, the Low Temperature RH piping back to boiler, through the Reheater, and to the IP turbine. The steam generator is a tangentially fired, twin furnace, combined circulation boiler built by . Each furnace is divided into inboard and outboard cells, each with elevations of coal nozzles. . The design Main Steam and Reheat Outlet temperatures are . Main Steam Outlet pressure is psig and flow is with no additional design margin for load peaks. The Reheat Outlet pressure is . Boiler design pressure is psig and the Reheat Inlet temperature is . The Reheat design pressure is psig. Each furnace is made up of fusion welded panels with identical Economizers, Superheat, and Reheat surfaces. Each furnace is wide by deep by ft high with total heating surface of ft2 with total furnace volume of ft3. The Superheater is comprised of stage, horizontal, partition panel, platen and pendants with ft2 of heating surface. The Reheater is horizontal, inlet and outlet pendant with ft2 of heating surface. The Economizer contains ft2 of heating surface and has a design pressure of .
Recommendation	Plans exist for the Outage to address all unacceptable component assessments and high risk assessments with the exception of four issues: (1) Penthouse asbestos (2) Reheat Outlet leg tubes at end of life (3) Deteriorated Superheater Attemperators with the project currently below the line (4) Boiler in need of chemical cleaning. For issue 1, was requested to provide a cost estimate. For issue 2, Plant Engineering will develop a plan to address after some further investigation. Issue 3 has a good chance of getting funded. Issue 4 will be pushed out to a subsequent Outage because, although the boiler does need to be chemically cleaned, there are other components that are higher priority.

Status	Published	Report Date	07/18/2009 20:19
Reported By		Date Published	07/19/2009 22:29
Reviewed By		Next Report Date	07/18/2010 20:19

Figure 2-7
System Health Report Case—System and Report Definitions

Along with information regarding the report title and summary, more information is necessary regarding the current status rating of the system. The tiered-rating structure used for the system health status display must have a source and a justification (Figure 2-8). A section of the system health report case should provide the system owner with the ability to select which status tier the system is currently categorized in. It should also offer the ability to select a status trend and the ability to provide a written justification for why the current status has been selected.

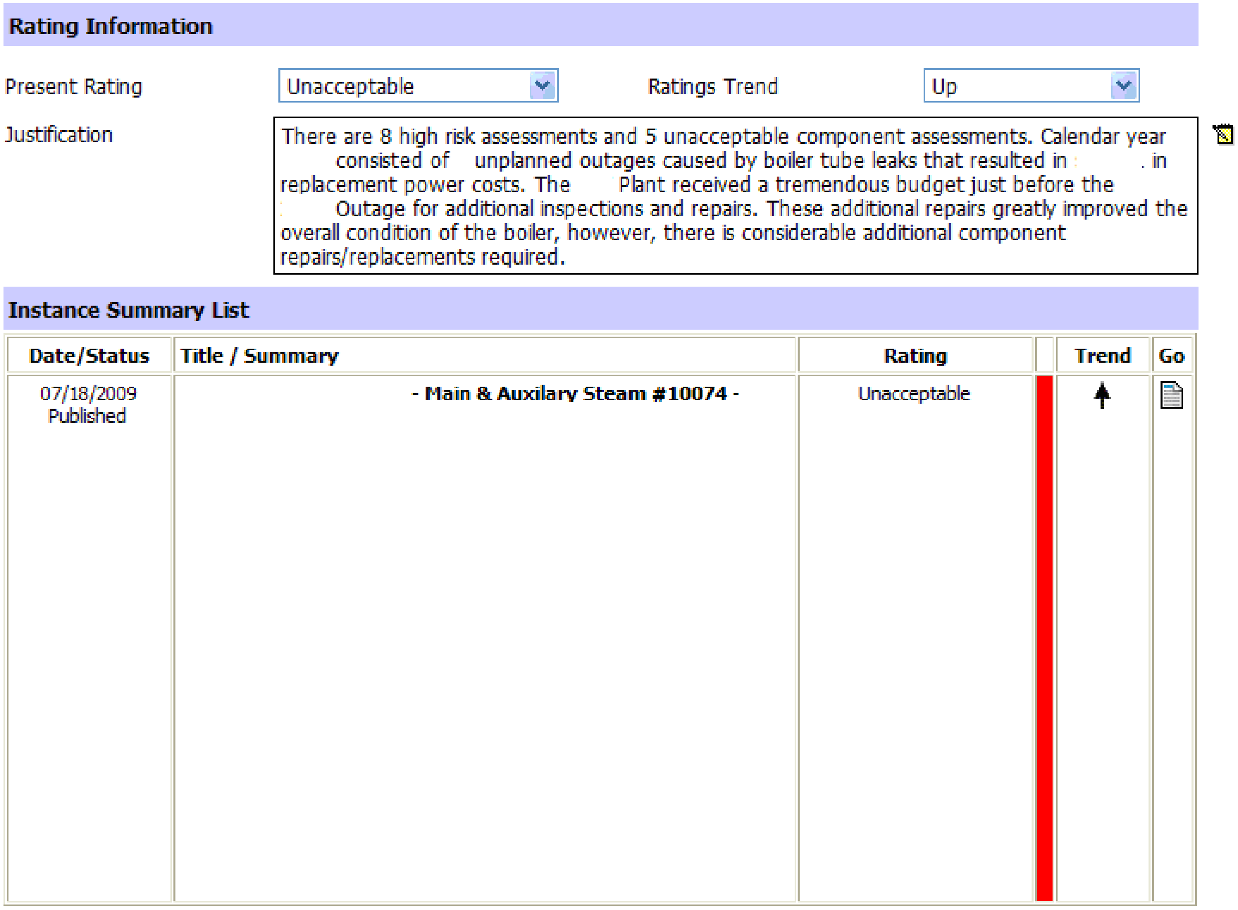


Figure 2-8
System Health Report Case—Status Description and Documentation

As mentioned previously in this report, a system health reporting program is dependent upon the perspective of several disciplines and teams within the organization. A system health report case should have a section that allows each of these disciplines/teams to supply a summary of their perspectives (Figure 2-9). This allows review committees to review the top concerns as they apply to each facet of the organization. This process also allows the committees an opportunity to provide feedback to the site management and system owner regarding validation of the system issues and action plans.

Major Considerations

Executive Summary

Calendar year consisted of unplanned outages caused by boiler tube leaks that resulted in in replacement power costs. The Plant received a tremendous budget just before the Outage for additional inspections and repairs. These additional repairs greatly improved the overall condition of the boiler, however, there is considerable additional component repairs/replacements required. Most of the problems experienced in are a result of fuel switches, year round SCR operation, sootblower problems, and Auxiliary Air Dampers (all parts of other systems). There have been tube leaks in of concern: 'A' left Upper Waterwall OOS corrosion and 'A' RH Outlet leg tube. There are significant other risks present, which have been captured in Component Assessments, Risk Assessments, and Projects and can achieve a significant run in the near future. Currently, the main issues without mitigation plans are; penthouse asbestos, RH Outlet leg tubes, Chemical Clean the boiler, and prioritization of thousands of feet of longitudinal seam welded piping. This is a tremendous threat to generation, safety, and powerhouse cleanliness, as a failure from any one of these seam-welded components may result in asbestos contamination throughout the plant. All High Energy Piping welds have an inspection history with the exception of the few that have not been located. All SH mixing header welds have a 14 year inspection interval and all others have a 20 year inspection interval.

System Engineers Top 5 - the System Engineers list their top issues with their system including a mitigation plan, barriers to resolution, and what help they need from management.

(1) Lower WW replacement (2) Replace the two inboard RH Outlet link reducers (3) Develop and implement a solution for the RH Outlet leg tubes (4) M121 and 122 Weld replacements (5) Prioritization of longitudinal seam-welded components.

Operations Summary

Maintenance Summary - insert here a summary of the maintenance parameters

Engineering Manager Review Comments - The engineering manager should review and insert here their comments, approvals, etc. Add the EM responsibilities from the 9.25 procedure

(1) Lower Water Wall cracking. (1) Risk of unit EFOR from tube leaks - Tube Leaks have occurred in . Projected leaks are through . Projected O&M repair costs are for repair/inspection and approximately start-up fuel cost for an approximate total of each event. Improved System EFOR and EAL . Duration typical Outage is . Each time leak occurs, scaffold entire furnace bottom, sandblast tubes, perform LPA UT inspection to locate add'l cracks. Grind out cracks/reweld. Short Term cost . Implement Capital Project ; Replace Lower Water Wall Panels for . (2) Risk of unit EFOR from tube leaks/hot air leaks - Tube Leaks have occurred in . Projected leaks through . Projected O&M repair costs for repair/inspection and approximately start-up fuel cost for approximate total each event. Improved System EFOR and EAL Duration typical Outage is . Each planned outage until replacement: remove lagging/insulation and powerbrush exposed tubes at seal air box welds. Perform MT inspection to locate cracks. Grind out cracks/reweld. Short Term cost . Implement Capital Project Windbox; Replace Windbox and Burner Panels .

MRC Review Comments - The MRC shall review and provide agreement with the results and action plan....add the stuff from the procedure

(3) Risk of unit EFOR from tube leaks - Tube Leaks have occurred. Projected leaks through . Projected O&M repair costs for repair/inspection and approximately start-up fuel cost for approximate total l for each event. Avoided System EFOR and EAL . Duration typical Outage is . Continue inspection of damaged/degraded attemperators. Each planned outage, remove bolt(s) gain access for borescope inspection of all attemperators. Compare condition of liner/nozzles to results. If liners begin to deteriorate/break up, inspection MUST be extended to cut SH platen inlet header stub tubes to look for debris in header and remove if present. Also x-ray lower bends of each SH platen element to look for debris. Estimated replacement of attemperators each Outage based on inspection results of During inspection/partial replacement sequence, a continued exposure to potential tube leaks is present as latent risk until attemperators replaced. Short Term cost Implement Capital Project SH ATTEMP; Replace Superheat Attemperators . (4) ID eroded header caps on S-14 and S-19 safeties. (4) EFOR from header cap failure. Improved System EFOR and EAL . Duration typical Outage . Disassemble safety valves/perform remote visual (borescope) inspection of header cap ID during planned outages until project execution. Short Term cost . Implement Capital Project Replace Header Caps on S-13, S-14, and S-16 Safeties. .

Action Items

Figure 2-9
System Health Report Case—Top Issues and Department Perspectives

Finally, one of the other primary benefits of a system health reporting program is that it provides the capability to integrate information from numerous sources, programs, and processes (Figure 2-10). This is accomplished by utilizing the results produced by processes, programs, and initiatives from all aspects of the organization and linking them to a common analysis framework. These results and processes should be readily accessible through the system health report case, as should the results corresponding to the standardized issues/indicators and metrics used to generate the system health report status.

Related Displays

Display Name	Description of Display	Go
Issue Summary		
Metrics Summary		
PdM Assessments		
Risk Assessments		
Component Assessments		
Instance Summary List		
Report Definition		

Figure 2-10
System Health Report Case—Information Sources

Standardized Issues/Indicators and Metrics

The standardized list of issues and performance indicators, as well as the metrics used to characterize these issues/indicators, should be readily accessible through the system health report case. It should contain a listing of all the issues/indicators agreed upon by the organization, as well as a definition for how the indicator is tracked and what constitutes various ratings associated with the metrics (Figure 2-11). System owners should have the ability to modify these ratings and provide justification for how and why certain ratings were given.

Metrics Summary

- Feedwater #5514
Report Date: April 13, 2009

Update

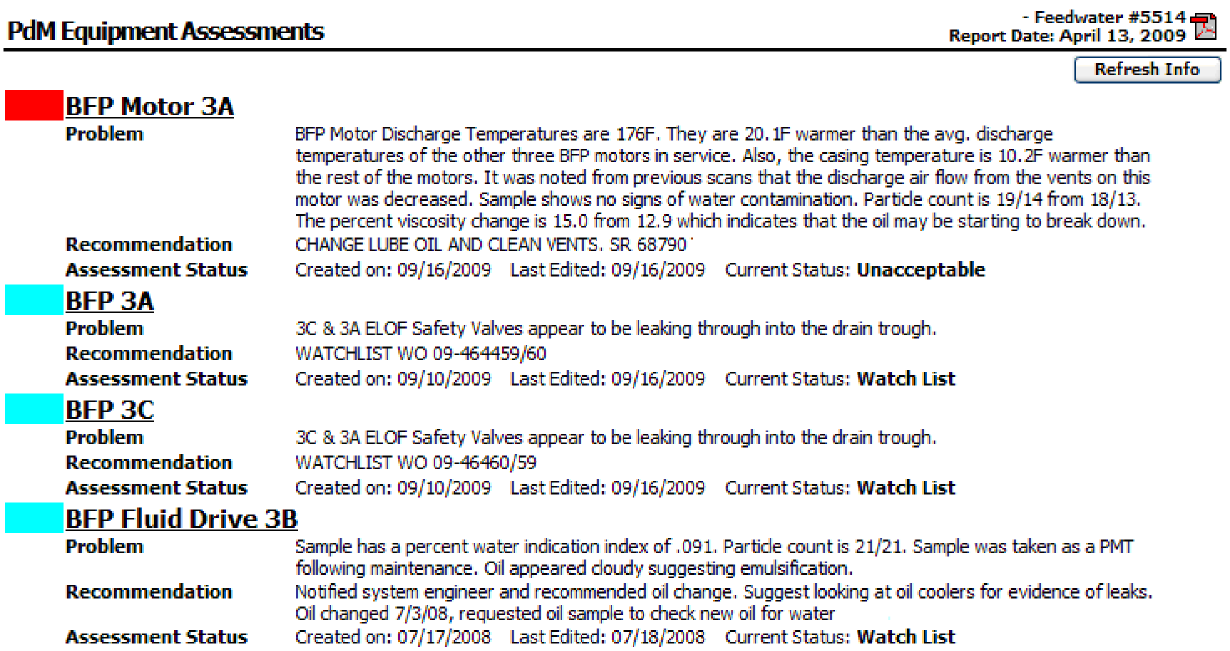
Report Metrics

Description		Value	Condition	Comments & Notes	Go	Go
Operator Work Arounds. List number of OWAs [each]		0	Acceptable			
CR Deficiencies, Disabled Alarms and Nuisance Alarms including DCS Alarms [each]		0	Acceptable			
Operator Rounds Deficiencies - non outage leading indicator [each]		0	Acceptable			
Long Standing clearances age - lagging indicator [each]		0	Acceptable			
Critical System Operating Limits Out of Spec - duration [each]		2	Marginal	#3 HPH condition and 3B BFP vibration		
Safety Deficiencies including WO's [each]		0	Acceptable			
Environmental Deficiencies including WO's [each]		0	Acceptable			
CM WO's - non-outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		15	Watch List			
CM WO's - outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		1	Watch List			
CM Cost $/Month [$/month]		0	Acceptable			
PM's -Outage scheduled - not completed [each]		1	Marginal			
PM's on Critical Components that are deferred or late [each]		2	Marginal			
PdM Predictive Maintenance - Red/Yellow Equipment Assessments- leading indicator [each]		1	Unacceptable	3B BFP vibration / Moderate Risk Assessment		

Figure 2-11
System Health Report Case—Standardized Issues/Indicators and Metrics

Condition Assessment Programs

One of the key aspects of a successful system health reporting program is the ability to link condition assessment information directly to the system health reporting process via the standardized issues/indicators. This can only be accomplished if an integrated system is established that allows results from condition assessment programs to be synchronized with the system health reporting program. These sources can include such information as PdM technology examination results for individual pieces of equipment (Figure 2-12), details regarding engineering assessments that have been conducted on equipment and systems (Figure 2-13), information derived from on-line monitoring sources (thermal performance monitoring programs, PI systems, and so on), and/or information derived from manual input resulting from inspections or observational rounds (maintenance inspections, operator rounds, and so on).



PdM Equipment Assessments

- Feedwater #5514
Report Date: April 13, 2009

Refresh Info

BFP Motor 3A

Problem BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased. Sample shows no signs of water contamination. Particle count is 19/14 from 18/13. The percent viscosity change is 15.0 from 12.9 which indicates that the oil may be starting to break down.

Recommendation CHANGE LUBE OIL AND CLEAN VENTS. SR 68790

Assessment Status Created on: 09/16/2009 Last Edited: 09/16/2009 Current Status: **Unacceptable**

BFP 3A

Problem 3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.

Recommendation WATCHLIST WO 09-464459/60

Assessment Status Created on: 09/10/2009 Last Edited: 09/16/2009 Current Status: **Watch List**

BFP 3C

Problem 3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.

Recommendation WATCHLIST WO 09-46460/59

Assessment Status Created on: 09/10/2009 Last Edited: 09/16/2009 Current Status: **Watch List**

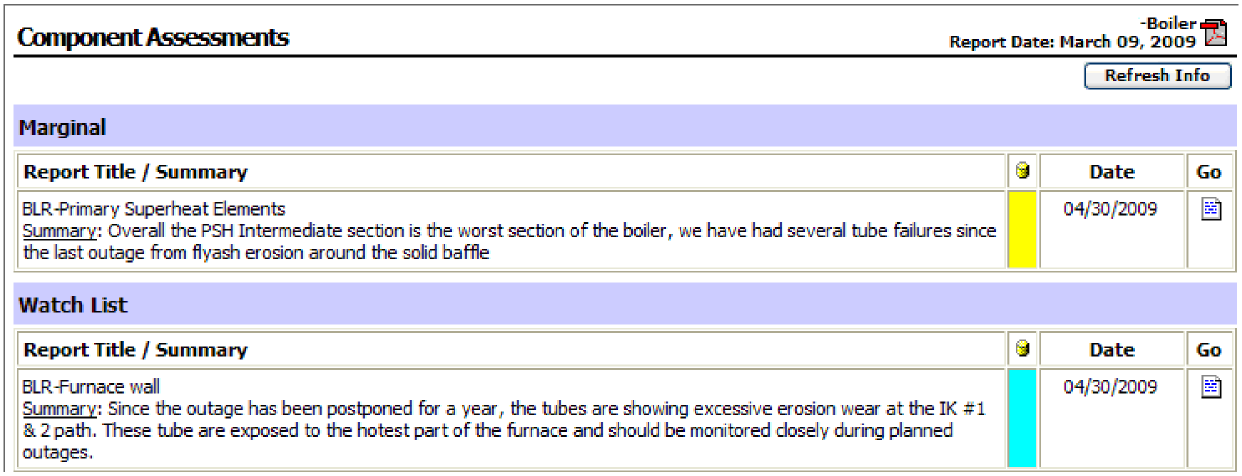
BFP Fluid Drive 3B

Problem Sample has a percent water indication index of .091. Particle count is 21/21. Sample was taken as a PMT following maintenance. Oil appeared cloudy suggesting emulsification.

Recommendation Notified system engineer and recommended oil change. Suggest looking at oil coolers for evidence of leaks. Oil changed 7/3/08, requested oil sample to check new oil for water

Assessment Status Created on: 07/17/2008 Last Edited: 07/18/2008 Current Status: **Watch List**

Figure 2-12
System Health Report Case—Predictive Maintenance Program Results



Component Assessments -Boiler
Report Date: March 09, 2009
Refresh Info

Marginal

Report Title / Summary		Date	Go
BLR-Primary Superheat Elements Summary: Overall the PSH Intermediate section is the worst section of the boiler, we have had several tube failures since the last outage from flyash erosion around the solid baffle		04/30/2009	

Watch List

Report Title / Summary		Date	Go
BLR-Furnace wall Summary: Since the outage has been postponed for a year, the tubes are showing excessive erosion wear at the IK #1 & 2 path. These tube are exposed to the hotest part of the furnace and should be monitored closely during planned outages.		04/30/2009	

Figure 2-13
System Health Report Case—Engineering Assessment Program Results

System Health Reporting Summary

The key to a successful system health reporting program is the ability to integrate the information outlined in the preceding sections into a common, organized structure. The most important aspects of implementing such a program are the following:

- Establishing the organization and structure of the processes necessary to support the condition assessment programs that feed the system health reporting program
- Instilling the reporting formats that enable the objective assessment and comparison of dissimilar assets, the primary focus being the establishment of the set of standardized issues/indicators and corresponding metrics and the process for translating raw condition assessment results into these defined issues/indicators
- Developing and/or implementing an information management system that allows data/information from each of these varying sources to be easily integrated into a single source
- Establishing clearly defined roles and responsibilities as discussed in preceding sections of this report

3
SYSTEM HEALTH CASE STUDY: BOILER FEEDWATER SYSTEM

This section presents a case study for a system health reporting program that has been implemented and put into practice by an organization. This particular example involves a boiler feedwater system and is intended to illustrate how various elements of the process are derived and organized into a single, cohesive structure. The purpose of this section is to depict the role of a dynamic, mechanical/electrical asset (pump/motor) and demonstrate how the various condition assessment programs and activities associated with this asset—in particular, on-line predictive maintenance technologies and other assessment methods—contribute to the system health reporting process.

The case study outlines the following aspects of the system health reporting program:

- System definition and boundaries
- Equipment descriptions
- Condition assessment programs
- Data/information sources
- System health report scenario

System Definition and Boundaries

The boiler feedwater system is defined by all of the equipment and piping required to take output from the condensate system and produce high-pressure, high-temperature feedwater to the boiler. The boundaries of this system begin with the deaerator storage tanks and conclude with the economizer inlet valve.

Equipment Descriptions

The equipment included in this system is as follows:

- Deaerator storage tanks
- Boiler feedwater pumps
- Boiler feedwater pump motors
- Boiler feedwater pump hydraulic coupling fluid drive
- High-pressure feedwater heaters

Condition Assessment Programs

The assessment programs in practice at the site are intended to provide the capabilities of collecting, monitoring, and evaluating equipment condition parameters. The condition assessment programs in place are:

- Operator rounds
- System engineer walkdowns
- Corrective action program
- Engineering examinations
  - Nondestructive examination
  - Flow-accelerated corrosion testing
  - Metallurgical analysis
- Predictive maintenance
  - Vibration analysis
  - Infrared thermography
  - Oil analysis
  - Acoustic monitoring
  - Motor breaker analysis
  - Chemical analysis
  - Cycle isolation monitoring

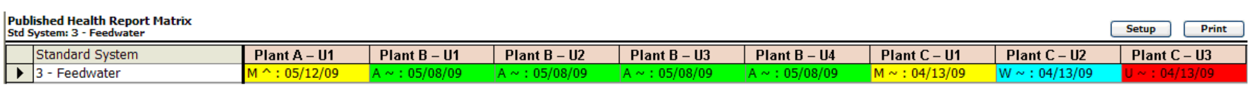
Data/Information Sources

The information utilized by the system health reporting program comes from a wide variety of sources. Primarily, this data/information is stored in the following sources and integrated with the system health reporting program:

- Enterprise asset management system (EAMS)—Maximo
- Computerized maintenance monitoring system (CMMS)
- PlantView equipment management modules
  - Predictive maintenance
  - Maintenance basis optimization (MBO)
  - Risk assessment
  - Component assessment
  - Plant operations
- North American Electric Reliability Corporation (NERC) Generating Availability Data System (GADS) reporting software
- Plant instrumentation system

System Health Report Scenario

The result of a system health reporting program identified the condition of a number of boiler feedwater systems within a particular fleet (Figure 3-1).


Published Health Report Matrix
Std System: 3 - Feedwater

Setup Print

Standard System	Plant A – U1	Plant B – U1	Plant B – U2	Plant B – U3	Plant B – U4	Plant C – U1	Plant C – U2	Plant C – U3
3 - Feedwater	M ^ : 05/12/09	A ~ : 05/08/09	A ~ : 05/08/09	A ~ : 05/08/09	A ~ : 05/08/09	M ~ : 04/13/09	W ~ : 04/13/09	U ~ : 04/13/09

Figure 3-1
Fleetwide System Health Report—Feedwater System

Most units demonstrated “Acceptable” (Green) condition and performance criteria relating to these systems; however, one unit did exhibit characteristics that led to a system health rating of “Unacceptable” (Red). The criteria that were used to create these system assessments were a standardized set of 44 system issues/indicators, corresponding to 44 standardized metrics. As mentioned previously in this report, these issues/indicators and metrics provide a common basis for comparison that has been established by the organization (Figure 3-2).

Metrics Summary - Feedwater #5514
Report Date: April 13, 2009

Update

Report Metrics

Description		Value	Condition	Comments & Notes	Go	Go
Operator Work Arounds. List number of OWAs [each]		0	Acceptable			
CR Deficiencies, Disabled Alarms and Nuisance Alarms including DCS Alarms [each]		0	Acceptable			
Operator Rounds Deficiencies - non outage leading indicator [each]		0	Acceptable			
Long Standing clearances age - lagging indicator [each]		0	Acceptable			
Critical System Operating Limits Out of Spec - duration [each]		2	Marginal	#3 HPH condition and 3B BFP vibration		
Safety Deficiencies including WO's [each]		0	Acceptable			
Environmental Deficiencies including WO's [each]		0	Acceptable			
CM WO's - non-outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		15	Watch List			
CM WO's - outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		1	Watch List			
CM Cost $/Month [$/month]		0	Acceptable			
PM's -Outage scheduled - not completed [each]		1	Marginal			
PM's on Critical Components that are deferred or late [each]		2	Marginal			
PdM Predictive Maintenance - Red/Yellow Equipment Assessments- leading indicator [each]		1	Unacceptable	3B BFP vibration / Moderate Risk Assessment		

Figure 3-2
Partial Listing of System Health Reporting Issues/Indicators

Figure 3-2 depicts a partial listing of the system health reporting issues/indicators for the unit that registered an “Unacceptable” rating. The primary concern for this system was related to a few selected areas—specifically surrounding PdM examination results and equipment operating outside of design limits. These PdM examination results are a product of various technology assessment practices that have been implemented and monitored at the site. Specific cases in which examination results have been documented as outside of specification, or “Unacceptable,” can be viewed within the system health report by drilling down into the PdM examination results (Figure 3-3).

PdM Equipment Assessments

- Feedwater #5514
Report Date: April 13, 2009

Refresh Info

BFP Motor 3A

Problem	BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased. Sample shows no signs of water contamination. Particle count is 19/14 from 18/13. The percent viscosity change is 15.0 from 12.9 which indicates that the oil may be starting to break down.
Recommendation	CHANGE LUBE OIL AND CLEAN VENTS. SR 68790
Assessment Status	Created on: 09/16/2009 Last Edited: 09/16/2009 Current Status: **Unacceptable**

BFP 3A

Problem	3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.
Recommendation	WATCHLIST WO 09-464459/60
Assessment Status	Created on: 09/10/2009 Last Edited: 09/16/2009 Current Status: **Watch List**

BFP 3C

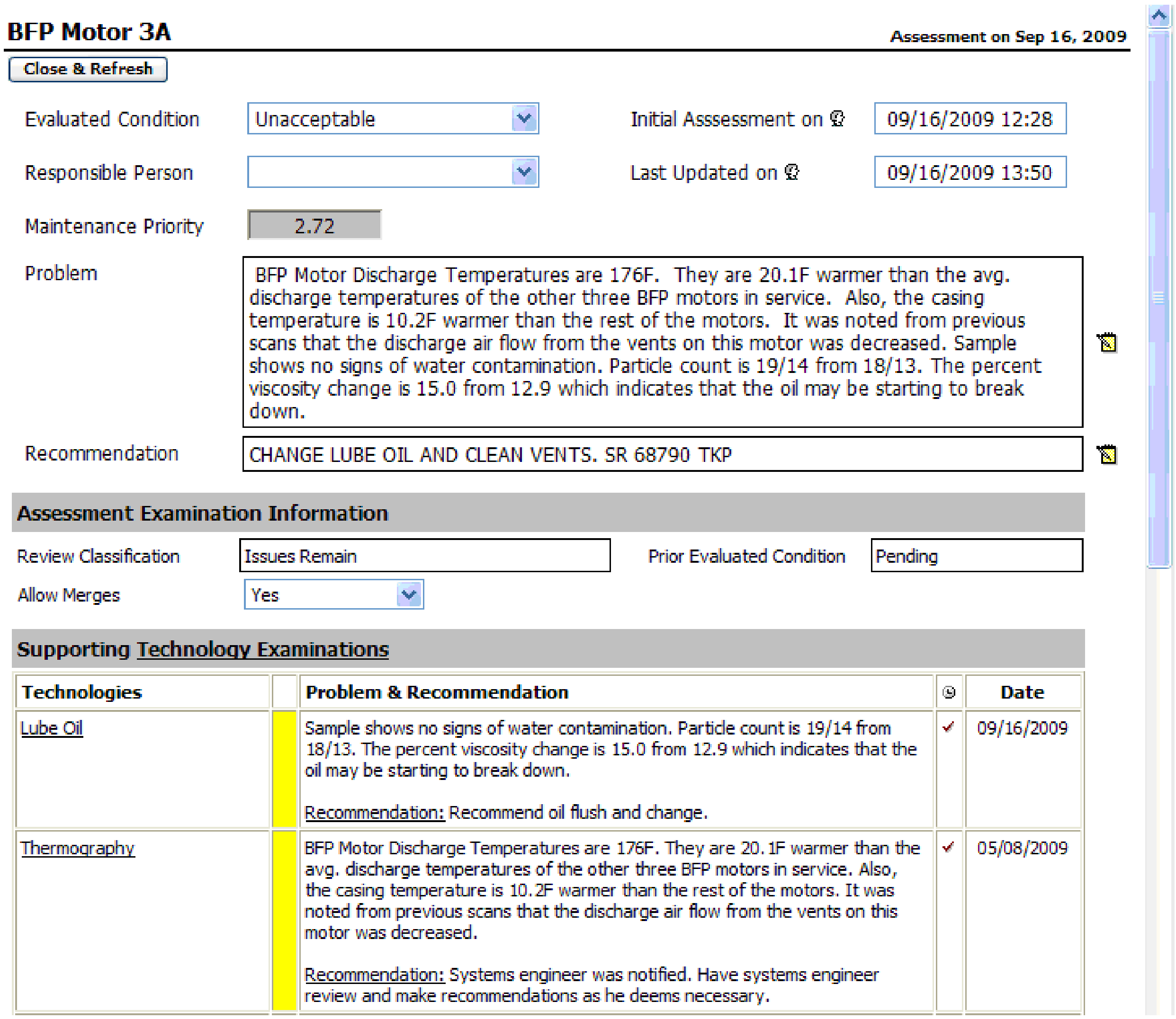
Problem	3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.
Recommendation	WATCHLIST WO 09-46460/59
Assessment Status	Created on: 09/10/2009 Last Edited: 09/16/2009 Current Status: **Watch List**

BFP Fluid Drive 3B

Problem	Sample has a percent water indication index of .091. Particle count is 21/21. Sample was taken as a PMT following maintenance. Oil appeared cloudy suggesting emulsification.
Recommendation	Notified system engineer and recommended oil change. Suggest looking at oil coolers for evidence of leaks. Oil changed 7/3/08, requested oil sample to check new oil for water
Assessment Status	Created on: 07/17/2008 Last Edited: 07/18/2008 Current Status: **Watch List**

Figure 3-3
Predictive Maintenance Technology Assessments Summary

The summary of PdM technology assessments in Figure 3-3 illustrates a number of instances in which examination results identified problematic situations relating to this unit's feedwater system. Of specific concern was a PdM case that identified an issue involving one of the boiler feedwater pump motors. Further examination indicated that there were two PdM technology examinations in the recent past that triggered "Marginal" (Yellow) results (Figure 3-4).



BFP Motor 3A — Assessment on Sep 16, 2009

Close & Refresh

Evaluated Condition: Unacceptable
Initial Asssessment on: 09/16/2009 12:28
Responsible Person:
Last Updated on: 09/16/2009 13:50
Maintenance Priority: 2.72

Problem: BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased. Sample shows no signs of water contamination. Particle count is 19/14 from 18/13. The percent viscosity change is 15.0 from 12.9 which indicates that the oil may be starting to break down.

Recommendation: CHANGE LUBE OIL AND CLEAN VENTS. SR 68790 TKP

Assessment Examination Information

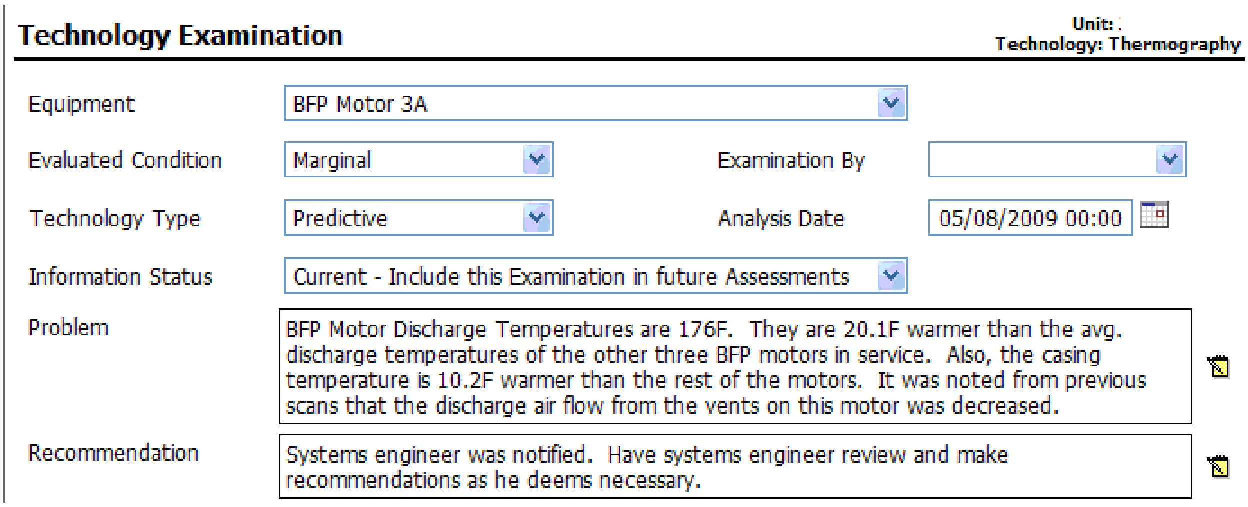
Review Classification: Issues Remain
Prior Evaluated Condition: Pending
Allow Merges: Yes

Supporting Technology Examinations

Technologies		Problem & Recommendation		Date
Lube Oil		Sample shows no signs of water contamination. Particle count is 19/14 from 18/13. The percent viscosity change is 15.0 from 12.9 which indicates that the oil may be starting to break down. Recommendation: Recommend oil flush and change.	✓	09/16/2009
Thermography		BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased. Recommendation: Systems engineer was notified. Have systems engineer review and make recommendations as he deems necessary.	✓	05/08/2009

Figure 3-4
Predictive Maintenance Technology Assessment Report

The two PdM technology examinations in question were a lubrication oil (lube oil) analysis that was conducted on September 16, 2009, and an infrared thermography (IRT) assessment that was completed on May 8, 2009. The lube oil analysis showed signs of lubrication breakdown. Although there was no water contamination of the oil, particle counts and viscosity readings both indicated degraded oil conditions. The IRT assessment also showed signs of equipment degradation. Discharge temperatures from the motor assembly were running 20°F (11.1°C) warmer than normal, and the casing was 10°F (5.5°C) above average. It was noted that previous assessments of the motor assembly had indicated that discharge air flow had decreased, indicating degraded conditions (Figure 3-5).


Technology Examination

Unit: .
Technology: Thermography

Equipment	BFP Motor 3A		
Evaluated Condition	Marginal	Examination By	
Technology Type	Predictive	Analysis Date	05/08/2009 00:00
Information Status	Current - Include this Examination in future Assessments		
Problem	BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased.		
Recommendation	Systems engineer was notified. Have systems engineer review and make recommendations as he deems necessary.		

Figure 3-5
Predictive Maintenance Technology Detailed Report

This type of information provided by the PdM technology examination program for all equipment within the feedwater system corresponded to the "Unacceptable" (Red) rating on the standardized issues/indicators list. Because there were issues detected by the PdM program surrounding both the alpha (3A) and bravo (3B) feedwater pumps, one PdM metric displayed "Unacceptable" performance and two other PdM-related metrics displayed "Marginal" performance.

In addition to the information that was identified by the PdM technology assessments, further concerns with the feedwater system were discovered through detailed engineering examinations (component assessments) of plant equipment. These issues similarly corresponded to a number of the 44 standardized issues/indicators in much the same way as the PdM issues. The primary issues uncovered by component assessment activities related to the high-pressure feedwater heaters (HPHs). Specific issues were identified relating to the #1 and #3 HPHs, especially HPH #3 (Figures 3-6 and 3-7).

Component Assessments

- Feedwater #5514
Report Date: April 13, 2009

Refresh Info

Marginal

Report Title / Summary		Date	Go
U3 HPH #3 Summary: RETUBED 03/86.		04/22/2009	

Watch List

Report Title / Summary		Date	Go
U3 HPH #1 Summary: RETUBED 04/86.		04/22/2009	
U3 DA TANK / HEATER Summary: INSPECTION OF . U3 DA TANK AND HEATER 11/2004		08/06/2009	

Acceptable

Report Title / Summary		Date	Go
U3 HPH #2 Summary: RETUBED 06/84		04/22/2009	

Figure 3-6
Component Assessments Summary Report

Assessment Report Detail

Library: Component Assessments (all sites)
Report: Feedwater Heaters

Close & Refresh

Detail Name/Title	U3 HPH #3
Summary	RETUBED 03/86.
Assessment	93 PLUGGED TUBES. 11.6%
Recommendation	ECT NEXT PO
Evaluated Condition	Marginal
Date of Report	04/22/2009
Report By	
Last Updated on	04/22/2009

Assessment Report Details

Name		Component	Summary	Date	Go	Go
Channel Head and Divider Plate		Channel Head and Divider Plate	The divider plate was modified to a more reliable design LIKE ON ALL HPH HEATERS; HOWEVER, U3 #3 HPH DIVIDER PLATE HAS SO MUCH WELD MATERIAL ON IT THAT TUBE LEAKS MIGRATE EVERYWHERE.	04/22/2009		
Heat Exchanger Shell		Heat Exchanger Shell	Shell was modified to be welded, removing the flanged joint. Shell leaks at previous weld repairs occur approxmately annually.	04/22/2009		
Tubes / Tube Ends		Tubes/Tube Ends	11.6% of the tubes in this heater are plugged.	04/22/2009		
Tubesheets		Tubesheets	Tube plugging excessive welding	04/22/2009		
Pressure Boundary Fasteners		Pressure Boundary Fasteners		04/22/2009		
Support Assembly		Support Assembly		04/22/2009		

Figure 3-7
Component Assessment Detailed Report

An engineering evaluation of HPH #3 identified a number of plugged tubes (93, 11.6%) corresponding to an "Unacceptable" (Red) rating. In conjunction with plugged tubes, the heat exchanger has also been experiencing tube leaks that resulted in a number of "Unacceptable" parameters for the examination. These "Unacceptable" component assessments resulted in "Unacceptable" ratings on component assessment-related standard issues/indicators. This combination of poor predictive maintenance and component assessment issues/indicators are what led to an "Unacceptable" system rating on the system health report.

This system condition information and status was used to develop the case report summary (Figure 3-8).

Major Considerations

Executive Summary

This is the first Feedwater SHR

System Engineers Top 5 - the System Engineers list their top issues with their system including a mitigation plan, barriers to resolution, and what help they need from management.

#3 HPH shell has been repeatively weld repaired. Steam inlet nozzle has been repeatively weld repaired. Tube sheet tube leak repair method has resulted in tube sheet degradation beyond repair. #3 HPH has a tube leak
3B BFP has high than normal vibration - . 3B BFP also has sound like flow through it with pump oos - . 3A and 3C BFP emergency leakoff regulators are leaking thru - .

Operations Summary

Zero OWAs

Maintenance Summary - insert here a summary of the maintenance parameters

On 04/23/2009 there are 16 CM WOs open and 7 PM WOs open. BCWPs and Injection water system under Boiler System

Engineering Manager Review Comments - The engineering manager should review and insert here their comments, approvals, etc. Add the EM responsibilities from the 9.25 procedure

1) For next report, please add TIB recommendations to add safeties to the feedwater side of the HP heaters. 2) Pls. prepare a CPJ for replacement of Unit 3 #3 HP heater.

MRC Review Comments - The MRC shall review and provide agreement with the results and action plan....add the stuff from the procedure

Figure 3-8
System Health Report Case Summary—Feedwater System

This system health report case identified the top issues as determined by the system owner through the system health reporting process. Perspectives were added by operations, maintenance, and engineering.

4
SYSTEM HEALTH CASE STUDY: BOILER SYSTEM

This section presents another case study for a system health reporting program that has been implemented and put into practice by an organization. This particular example involves a boiler system and is intended to illustrate how various elements of the process are derived and organized into a single, cohesive structure. The purpose of this section is to depict the role of a passive asset (boiler tubing) and demonstrate how the various condition assessment programs and activities—particularly nondestructive examination (NDE) technologies and other assessment methods—contribute to the system health reporting process.

The case study outlines the following aspects of the system health reporting program:

- System definition and boundaries
- Equipment descriptions
- Condition assessment programs
- Data/information sources
- System health report scenario

System Definition and Boundaries

The boiler system is defined by all of the piping and equipment required to take outputs from the boiler feedwater system and produce high-temperature, high-pressure steam for the main steam system, which eventually feeds the turbine-generator system. The boundaries of the boiler system begin with the boiler drum inlet header and conclude at the steam drum exit to the high-energy piping.

Equipment Descriptions

The equipment that is classified under this system includes:

- Steam drum
- Boiler waterwalls
- Boiler penthouse
- Primary superheater
- Secondary superheater

- Cold reheat piping
- Hot reheat piping
- Convection pass
- Attemperators
- Windbox
- Burners

Condition Assessment Programs

The assessment programs in practice at the site are intended to provide the capabilities of collecting, monitoring, and evaluating equipment condition parameters. The condition assessment programs and technologies in place are as follows:

- Visual inspections
- Tube diameter inspections
- Welding X rays
- Boroscopic inspections
- Shear wave wall inspections
- Metallurgical testing
- Infrared thermography
  - Drains
  - Hot spot surveying
- Service/maintenance requests open

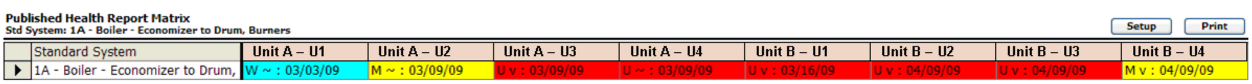
Data/Information Sources

The information utilized by the system health reporting program comes from a wide variety of sources. Primarily, this data/information is stored in the following sources and integrated with the system health reporting program:

- Enterprise asset management system (EAMS)—Maximo
- Computerized maintenance monitoring system (CMMS)
- PlantView equipment management modules
  - Predictive maintenance
  - Maintenance basis optimization
  - Risk assessment
  - Component assessment
  - Plant operations
- ATI Aware
- Internal heat rate system

System Health Report Scenario

The overall result of a system health reporting program identified the condition of a number of boiler systems within a particular fleet (Figure 4-1).

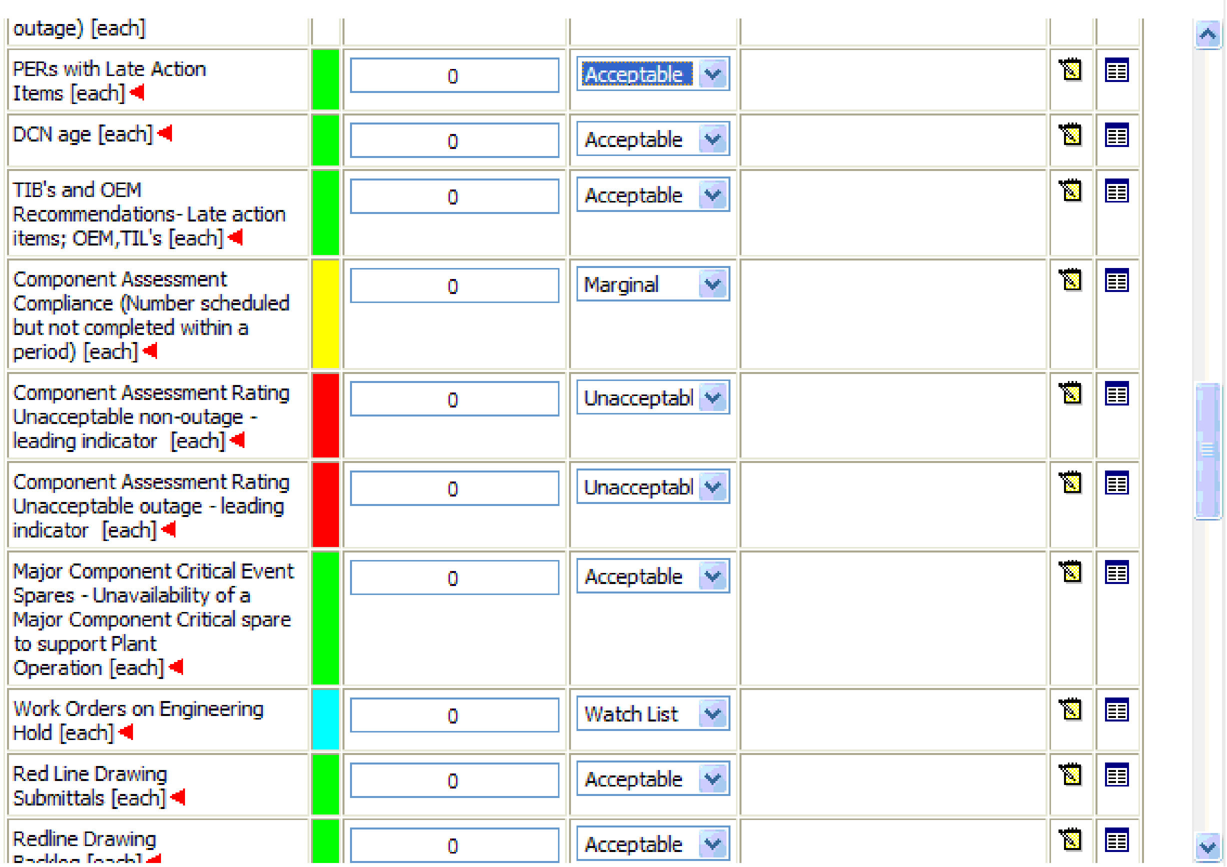

Published Health Report Matrix
Std System: 1A - Boiler - Economizer to Drum, Burners

Setup Print

Standard System	Unit A – U1	Unit A – U2	Unit A – U3	Unit A – U4	Unit B – U1	Unit B – U2	Unit B – U3	Unit B – U4
1A - Boiler - Economizer to Drum,	W ~ : 03/03/09	M ~ : 03/09/09	U v : 03/09/09	U ~ : 03/09/09	U v : 03/16/09	U v : 04/09/09	U v : 04/09/09	M v : 04/09/09

Figure 4-1
Fleetwide System Health Report—Boiler System

Specific information relating to Unit 3 at a generating station resulted in an “Unacceptable” rating for that boiler. This rating was determined by evaluating the system based upon the 44 standardized issues/indicators and metrics designated by the organization for the system health reporting program. Out of the 44 issues/indicators, a number of issues/indicators fell within the “Watch-List” (Blue), “Marginal” (Yellow), or “Unacceptable” (Red) status ranges (Figure 4-2).



outage) [each]		
PERs with Late Action Items [each]	0	Acceptable
DCN age [each]	0	Acceptable
TIB's and OEM Recommendations- Late action items; OEM,TIL's [each]	0	Acceptable
Component Assessment Compliance (Number scheduled but not completed within a period) [each]	0	Marginal
Component Assessment Rating Unacceptable non-outage - leading indicator [each]	0	Unacceptabl
Component Assessment Rating Unacceptable outage - leading indicator [each]	0	Unacceptabl
Major Component Critical Event Spares - Unavailability of a Major Component Critical spare to support Plant Operation [each]	0	Acceptable
Work Orders on Engineering Hold [each]	0	Watch List
Red Line Drawing Submittals [each]	0	Acceptable
Redline Drawing Backlog [each]	0	Acceptable

Figure 4-2
Partial Listing of System Health Reporting Issues/Indicators

Although the majority of the issues/indicators fell within satisfactory—or “Acceptable” (Green)—limits, some of the primary unsatisfactory metrics were a result of engineering evaluations that were conducted during boiler inspections. These “Unacceptable” and “Marginal” ratings in Figure 4-2 link directly to information contained within the organization’s component assessment, or engineering inspection, program (Figure 4-3).

Component Assessments

-Boiler
Report Date: March 09, 2009

Refresh Info

Marginal

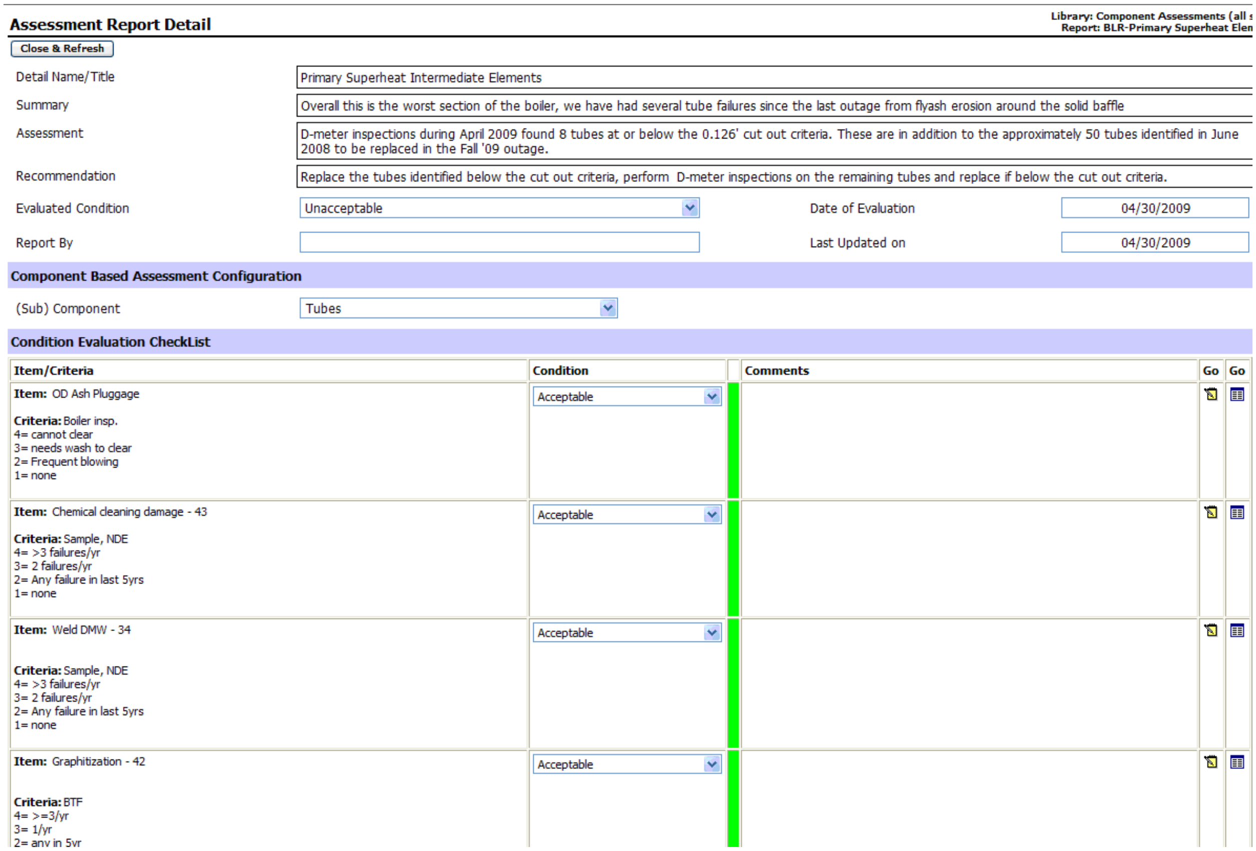
Report Title / Summary		Date	Go
BLR-Primary Superheat Elements Summary: Overall the PSH Intermediate section is the worst section of the boiler, we have had several tube failures since the last outage from flyash erosion around the solid baffle		04/30/2009	

Watch List

Report Title / Summary		Date	Go
BLR-Furnace wall Summary: Since the outage has been postponed for a year, the tubes are showing excessive erosion wear at the IK #1 & 2 path. These tube are exposed to the hotest part of the furnace and should be monitored closely during planned outages.		04/30/2009	

Figure 4-3
Component Assessments Summary Report

From the summary report, it can be seen that as of April 2009, two separate issues were prevalent within the boiler system: one involving the primary superheat (PSH) circuit of the boiler and the other involving the sidewalls of the furnace. The component assessment report for the PSH circuit is a detailed analysis that evaluates the equipment based upon a number of predetermined condition indicators and criteria (Figures 4-4 and 4-5).



Assessment Report Detail

Library: Component Assessments (all s
Report: BLR-Primary Superheat Elen

Close & Refresh

Detail Name/Title	Primary Superheat Intermediate Elements
Summary	Overall this is the worst section of the boiler, we have had several tube failures since the last outage from flyash erosion around the solid baffle
Assessment	D-meter inspections during April 2009 found 8 tubes at or below the 0.126' cut out criteria. These are in addition to the approximately 50 tubes identified in June 2008 to be replaced in the Fall '09 outage.
Recommendation	Replace the tubes identified below the cut out criteria, perform D-meter inspections on the remaining tubes and replace if below the cut out criteria.
Evaluated Condition	Unacceptable
Date of Evaluation	04/30/2009
Report By	
Last Updated on	04/30/2009

Component Based Assessment Configuration

(Sub) Component: Tubes

Condition Evaluation CheckList

Item/Criteria	Condition	Comments	Go	Go
Item: OD Ash Pluggage **Criteria:** Boiler insp. 4= cannot clear 3= needs wash to clear 2= Frequent blowing 1= none	Acceptable			
Item: Chemical cleaning damage - 43 **Criteria:** Sample, NDE 4= >3 failures/yr 3= 2 failures/yr 2= Any failure in last 5yrs 1= none	Acceptable			
Item: Weld DMW - 34 **Criteria:** Sample, NDE 4= >3 failures/yr 3= 2 failures/yr 2= Any failure in last 5yrs 1= none	Acceptable			
Item: Graphitization - 42 **Criteria:** BTF 4= >=3/yr 3= 1/yr 2= any in 5yr	Acceptable			

Figure 4-4
Detailed Assessment Report

Criteria: Boiler insp. NDE MT, PT 4= >25% cracked 3= 10% to 25% cracked 2= up to 10% 1= none	Acceptable	
Item: Supports Fatigue, Thermal & Mechanical -39 **Criteria:** Maint records / interv. 4= >10% repaired 3= 10% repaired 2= any 1= none	Acceptable	
Item: OD Fire Side Corrosion -33 **Criteria:** Boiler insp. NDE UT 4= > 20% of tubes with 20% wall loss OR any one tube with >35% wall loss 3= up to 20% of tubes with 20% wall loss 2= 'alligator' surface 1= none	Acceptable	
Item: OD Flyash Erosion -14 **Criteria:** Boiler insp. NDE UT 4= > 20% of tubes with 20% wall loss OR any one tube with >35% wall loss 3= up to 20% of tubes with 20% wall loss 2= polishing 1= none	Unacceptable	
Item: Tube Long Term Overheat -32 **Criteria:** HT Tube RLA 4= Pred >=3/yr 3= Pred = 1/yr 2= Predict any in 5yr 1= None predicted	Watch List	
Item: Low Temperature Creep -24 **Criteria:** Sample, NDE 4= >3 failures/yr 3= 2 failures/yr 2= Any failure in last 5yrs 1= none	Acceptable	
Item: OD Maintenance Damage -44 **Criteria:** Sample, NDE 4= >3 failures/yr 3= 2 failures/yr	Acceptable	

Figure 4-5
Detailed Assessment Report (continued)

Figures 4-4 and 4-5 provide a partial listing of the tests and criteria that are used by the organization to evaluate the condition of a PSH circuit. Each test has a tiered ranking system based upon predetermined criteria. The results of each test correspond to a status rating that is indicative of the equipment condition. As illustrated by Figures 4-4 and 4-5, the majority of the engineering evaluations resulted in acceptable status ratings; however, there were two that posed significant problems, specifically outer diameter (OD) flyash erosion that received an "Unacceptable" (Red) rating.

Figure 4-6 provides the detailed information of the ultrasonic testing (UT) that generated the "Unacceptable" status rating. It was determined on April 30, 2009, that over 20% of the PSH tube walls were greater than 20% eroded.

Assessment History - CheckList Summary **Sub-Component: Tubes**

Primary Superheat Intermediate Elements (-BLR -1 -M)

Summary	Overall this is the worst section of the boiler, we have had several tube failures since the last outage from flyash erosion around the solid baffle
Assessment	D-meter inspections during April 2009 found 8 tubes at or below the 0.126' cut out criteria. These are in addition to the approximately 50 tubes identified in June 2008 to be replaced in the Fall '09 outage.
Recommendation	Replace the tubes identified below the cut out criteria, perform D-meter inspections on the remaining tubes and replace if below the cut out criteria.
Assessment Status	Date of Report: 04/30/2009 Last Edited: 04/30/2009 Current Status: **Unacceptable**

Condition Evaluation CheckList

Item/Criteria	Condition		Comments
Item: OD Flyash Erosion -14 **Criteria:** Boiler insp. NDE UT 4= > 20% of tubes with 20% wall loss OR any one tube with >35% wall loss 3= up to 20% of tubes with 20% wall loss 2= polishing 1= none	Unacceptable		

Figure 4-6
Detailed Component Condition Evaluation Test

In addition to the component assessment activities, the organization also utilized a risk assessment program to analyze and document equipment with high levels of risk. Through this risk assessment program, several issues relating to the boiler system were identified (Figure 4-7).

Risk Assessments -Boiler
Report Date: March 09, 2009

Refresh Info

Moderate

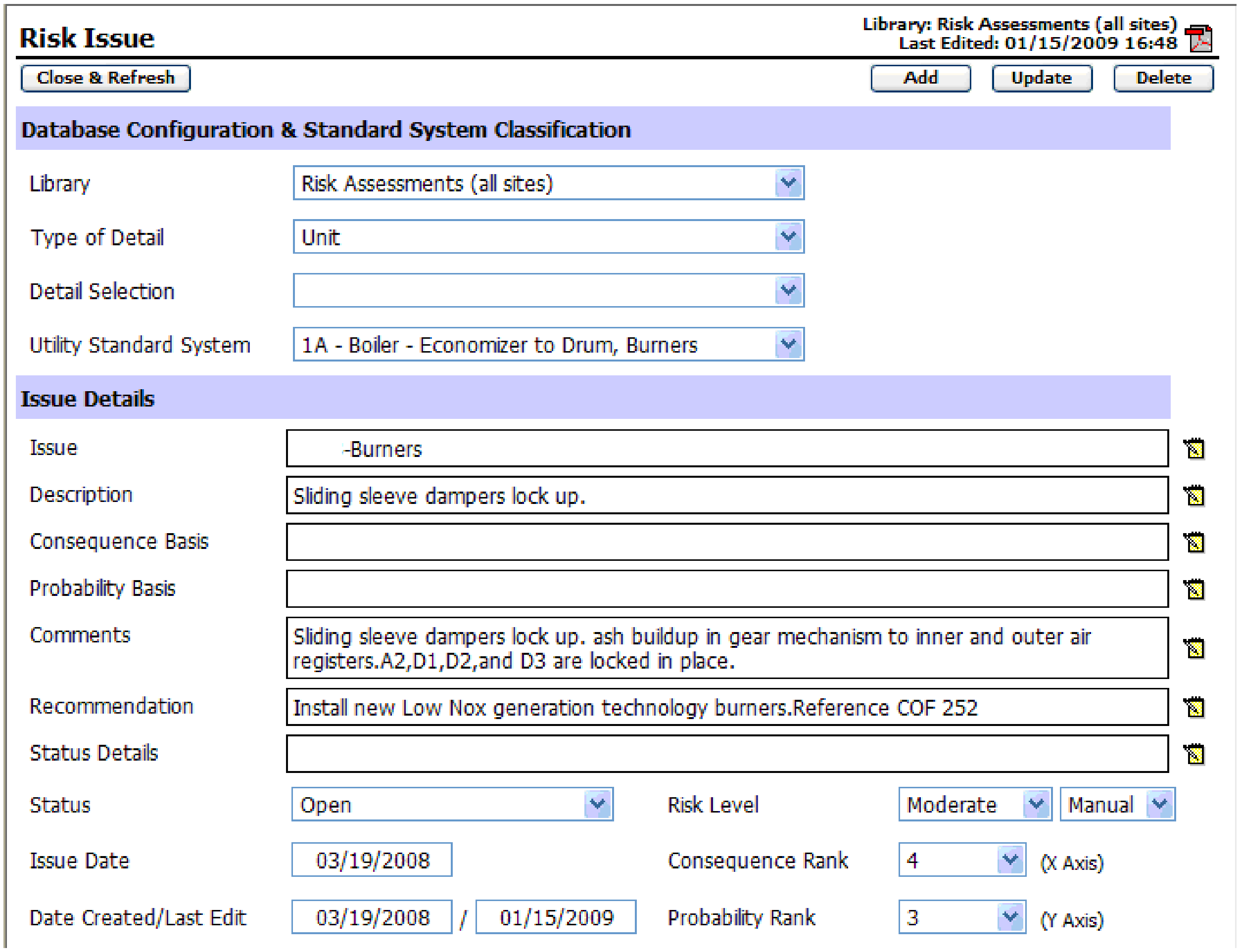
Issue / Comments	Status	CR	PR	Go
COF3-Boiler - Lower Rear Slope **Comments:** rear lower slope refractory and insulation missing, enclosure dilapidated	Open	3	3	
COF3-Burners **Comments:** Sliding sleeve dampers lock up. ash buildup in gear mechanism to inner and outer air registers.A2,D1,D2,and D3 are locked in place.	Open	4	3	
COF3-Boiler-Upper deflection Arch **Comments:** Refractory has deteriorated and seals on the side walls and division wall penetrations allowing ash to build up in DAZ. Also, the seal skirt has detached and hanging in places.	Open	3	4	
COF3-Boiler - Bottom Ash Hoppers **Comments:** Refractory breaking up, missing, bricks missing. Holes developing in casing	Open	3	3	

Low

Issue / Comments	Status	CR	PR	Go
COF3 Boiler - SSH Inlet elements & header. **Comments:** Tubes are original.	Open	3	2	

Figure 4-7
Risk Assessment Summary

Although no risk issues were identified that were rated as severe, or "High," several were identified in the "Moderate" range. Of significance here was a risk issue corresponding to the burners. This risk issue was designated as having a high criticality ranking (corresponding to a 4 out of 5 consequence rank) and a moderate probability ranking (corresponding to a 3 out of 5 probability rank). These concerns and the recommended risk mitigation plans were documented in a risk assessment issue report (Figure 4-8).


Risk Issue
Library: Risk Assessments (all sites)
Last Edited: 01/15/2009 16:48
Close & Refresh
Add
Update
Delete

Database Configuration & Standard System Classification

Library	Risk Assessments (all sites)
Type of Detail	Unit
Detail Selection	
Utility Standard System	1A - Boiler - Economizer to Drum, Burners

Issue Details

Issue	-Burners
Description	Sliding sleeve dampers lock up.
Consequence Basis	
Probability Basis	
Comments	Sliding sleeve dampers lock up. ash buildup in gear mechanism to inner and outer air registers.A2,D1,D2,and D3 are locked in place.
Recommendation	Install new Low Nox generation technology burners.Reference COF 252
Status Details	

Status	Open	Risk Level	Moderate / Manual
Issue Date	03/19/2008	Consequence Rank	4 (X Axis)
Date Created/Last Edit	03/19/2008 / 01/15/2009	Probability Rank	3 (Y Axis)

Figure 4-8
Risk Assessment Issue Report

This combination of "Unacceptable" component assessment and risk assessment ratings within the 44 standardized issues/indicators was the underlying cause of the "Unacceptable" (Red) rating on the system health reporting display. This rating was justified and reviewed by the system owner. Action plans were outlined and documented, as well as the perspectives of each of the major disciplines (operations, maintenance, and engineering). This information was documented within the system health report case (Figure 4-9).

Major Considerations

Executive Summary

During this period the boiler has had three events all related to flyash erosion.

System Engineers Top 5 - the System Engineers list their top issues with their system including a mitigation plan, barriers to resolution, and what help they need from management.

1)PSH Outlet & Intermediate tube leaks from Flyash Erosion--Need to purchase & install new upgrade IK's 15 & 16 per COF 370. Also install Tubes with CONFORMACLAD coating. 2)STOH in SSH Inlet from attemperator backing plates blocking flow--- Replace attemperator per CP COF 329. Inspect header via X-ray.3) Water Wall & Supply tube leaks from corrosion fatigue failures--Perform inspection in high stress areas at buckstays and improve water chemistry monitoring thru new automated chemical feed system. 4) High Boiler Air infiltration--Replace high crown seals and refractory in the upper nose arch and lower slope areas. 5) Drum safeties are obsolute, no parts available and leak thru-- Replace with new upgrade safety valve. 6) Burners sleeve dampers and register are frozen and hard to maintain.--Replace burners per COF 252. 7) SSH Inlet element tube leaks from LTOH,--Replace original elements, hdr and install gas temp probes .

Operations Summary

Operations biggest contraint is dealing with burner sleeve dampers.

Maintenance Summary - insert here a summary of the maintenance parameters

Work Orders continue to build up which are associated with FOMO or Plannned Outages. Budgets constraints are a major concern during FOMO hindering the work off activities.

Engineering Manager Review Comments - The engineering manager should review and insert here their comments, approvals, etc. Add the EM responsibilities from the 9.25 procedure

MRC Review Comments - The MRC shall review and provide agreement with the results and action plan....add the stuff from the procedure

Figure 4-9
System Health Report Case Summary—Boiler System

5 CONCLUSIONS AND RECOMMENDATIONS

This report presents the vision and approach for establishing an integrated system health reporting program. Such programs, and similar initiatives, will continue to become essential elements of streamlined operations and maintenance programs within the fossil-based power generation industry. Organizations will need to maximize their ability to generate useful, actionable equipment condition information, organize that information into a consistent analysis format, and systematically evaluate the status of their assets in order to properly allocate the limited and valuable resources that are at their disposal.

As stated previously in this report, one of the primary objectives of organizations is to find processes (and supporting technologies) that allow them to optimally integrate information, data, knowledge, and results that are spread across various assets, programs, initiatives, departments, technologies, and numerous other sources. A key advantage of deploying system health assessments in an integrated system is the ability to quickly drill down from higher-level reports that show a system health issue into the supporting reports that detail the basis for the health assessment. This creates an “openness” to the process that forces a rationale for assessments and pinpoints the specific actions needed to restore acceptable health. This need for improved system health assessments was the driving factor for the EPRI project that commenced in 2008 and led eventually to the production of this report. The intention was to identify the processes (and supporting technologies) that promote an integrated approach to operations and maintenance, regardless of asset classification. One of the key ingredients of this process is to identify a method that gives organizations the capability to objectively analyze and compare systems, components, and equipment. This would require a process structure that enables disparate information from numerous sources to be brought together in a systematic approach and compared with a generic severity ranking. The severity ranking, in turn, is established *a priori* for each system based on considerations unique to that system. System health reporting programs provide the structure to facilitate this process and the means to integrate data/information from a wide array of sources.

As further research and development is conducted in this field, it is recommended that the concept of system health reporting programs be incorporated. A 2008 EPRI report (1015717) focused on establishing a common technical baseline for organizing a maintenance program focused on condition assessment activities. The present report identifies an approach to organizing the products of those condition assessment programs into a systematic structure to assess and compare various assets to one another. New research and development should look to expand upon this methodology by focusing on future-oriented activities such as prognostics and long-term planning and prioritization. A system health reporting program provides the means to integrate condition assessment information and determine the current status of an asset, but it fails to completely predict expected future conditions of that asset. Further research and development in this area would provide useful resources for organizations by supporting more efficient long-term planning and budgeting capabilities.

A

SYSTEM HEALTH REPORTING PROGRAM EXAMPLE: REPORT PRODUCT

This appendix presents an example of output from a system health reporting program. (Some details have been redacted to maintain confidentiality.) Included are illustrations of the main case report page, outlining the top five system issues, a listing of the standardized issues/indicators, a listing of the metrics associated with those issues/indicators, and the condition assessment results primarily used to generate those metric ratings.

[redacted]- Feedwater #5514

Health Report
Monday, April 13, 2009

Report Instance Information

Report Title	[redacted]- Feedwater #5514		
Brief Summary	Initial U3 Feedwater System Health Report		
Recommendation	Replace #3 HPH		
Status	Published	**Report Date**	04/13/2009 14:13
Reported By	[redacted]	**Date Published**	04/29/2009 09:31
Reviewed By	MRC	**Next Report Date**	04/13/2010 14:13

Rating Information

Present Rating	Unacceptable	**Ratings Trend**	Neutral
Justification	U3 #3 HPH is at risk in impacting unit generation. Neutral rating based on it being first PV SHR		

Instance Summary List

Date/Time	Title/Summary	Rating		Trend
04/13/2009 14:13	[redacted]- **Feedwater #5514** - Initial U3 Feedwater System Health Report	**Unacceptable**	R	↔

Major Considerations

Executive Summary

This is the first PV U3 Feedwater SHR

System Engineers Top 5 - the System Engineers list their top issues with their system including a mitigation plan, barriers to resolution, and what help they need from management.

#3 HPH shell has been repeatively weld repaired. Steam inlet nozzle has been repeatively weld repaired. Tube sheet tube leak repair method has resulted in tube sheet degradation beyond repair. #3 HPH has a tube leak[redacted]BFP has high than normal vibration -[redacted] 3B BFP also has sound like flow through it with pump oos -[redacted] 3A and 3C BFP emergency leakoff regulators are leaking thru -[redacted]

Operations Summary

Zero OWAs

Maintenance Summary - insert here a summary of the maintenance parameters

On 04/23/2009 there are 16 CM WOs open and 7 PM WOs open. BCWPs and Injection water system under Boiler System

Engineering Manager Review Comments - The engineering manager should review and insert here their comments, approvals, etc. Add the EM responsibilities from the 9.25 procedure

1) For next report, please add TIB recommendations to add safeties to the feedwater side of the HP heaters. 2) Pls. prepare a CPJ for replacement of Unit 3 #3 HP heater.

MRC Review Comments - The MRC shall review and provide agreement with the results and action plan....add the stuff from the procedure

OWA - Operator Work Arounds

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Operator Work Arounds. List number of OWAs [each]		0	

Control Room Deficiencies, Nuisance Alarms, Disabled Annunciators

There are no Issues in this category defined for this Report.

1

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Metric Description		Value	Comments & Notes
CR Deficiencies, Disabled Alarms and Nuisance Alarms including DCS Alarms [each]		0	

Operator Rounds Deficiencies-non-outage- leading indicator from eSOMS database

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Operator Rounds Deficiencies - non outage leading indicator [each]		0	

Long Standing Clearances age - lagging indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Long Standing clearances age - lagging indicator [each]		0	

Critical System Operating Limits Out of Spec - duration

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Critical System Operating Limits Out of Spec - duration [each]		2	#3 HPH condition and 3B BFP vibration

Safety Deficiencies including WO's

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Safety Deficiencies including WO's [each]		0	

Environmental Deficiencies including WO's

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Environmental Deficiencies including WO's [each]		0	

CM WO's - non-outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
CM WO's - non-outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		15	

CM WO's - outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
CM WO's - outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		1	

CM Cost $/Month

There are no Issues in this category defined for this Report.

[redacted]- Feedwater #5514

Health Report
Monday, April 13, 2009

Metric Description		Value	Comments & Notes
CM Cost $/Month [$/month]		0	

PM's - Outage scheduled - not completed

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PM's -Outage scheduled - not completed [each]		1	

PM's on Critical Components that are deferred or late

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PM's on Critical Components that are deferred or late [each]		2	

PdM Predictive Maintenance - Red/Yellow Equipment Assessments- leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PdM Predictive Maintenance - Red/Yellow Equipment Assessments- leading indicator [each]		1	3B BFP vibration / Moderate Risk Assessment

PdM Compliance- Number of equipment Assessments not completed within 7 days after Technology Exams

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PdM Compliance- Number of equipment Assessments not completed within 7 days after Technology Exams [each]		0	

PdM's on Critical Equipment that are deferred or late

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PdM's on Critical Equipment that are deferred or late		0	

TAP's- outage number of TAP's coded as outage that exist after a Planned Outage (PO)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
TAP's- outage number of TAP's coded as outage that exist after a Planned Outage (PO) [each]		0	

TAP's- non-outage lagging indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
TAP's- non-outage lagging indicator [each]		0	

C Level Equipment PER's originated during report period AND C Level Equipment PER's remaining open at the end of the period

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
C Level Equipment PER's originated during report period AND C Level Equipment PER's remaining open at the end of the period [each]		0	

3

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Critical Component Preventable Failures with open action - lagging indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Critical Component Preventable Failures with open action - lagging indicator [each]		0	

PER's Level A or B in this period (item forced an outage)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PER's Level A or B in this period (item forced an outage) [each]		0	

PERs with LATE Action Items

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
PERs with Late Action Items [each]		0	

DCN age

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
DCN age [each]		0	

TIB's and OEM Recommendations- Late action items; OEM,TIL's

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
TIB's and OEM Recommendations- Late action items; OEM,TIL's [each]		1	Install FWH tube side RVs per insurance audit

Component Assessment Compliance (Number scheduled but not completed within a period)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Component Assessment Compliance (Number scheduled but not completed within a period) [each]		0	

Component Assessment Rating Unacceptable non-outage - leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Component Assessment Rating Unacceptable non-outage - leading indicator [each]		0	

Component Assessment Rating Unacceptable outage - leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Component Assessment Rating Unacceptable outage - leading indicator [each]		0	

Major Component Critical Event Spares - Unavailability of a Major Component Critical spare to support Plant Operation

There are no Issues in this category defined for this Report.

[redacted]- Feedwater #5514

Health Report
Monday, April 13, 2009

Metric Description		Value	Comments & Notes
Major Component Critical Event Spares - Unavailability of a Major Component Critical spare to support Plant Operation [each]		0	

Work Orders on Engineering Hold

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Work Orders on Engineering Hold [each]		0	

Red Lined Drawings Submittals

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Red Line Drawing Submittals [each]		0	

Redline Drawing Backlog

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Redline Drawing Backlog [each]		0	

GADS- events with > XMWHL

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
GADS- events with > XMWHL [each]		0	

Major Modifications/ Projects Deferred during reporting period

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Major Modifications / Projects Deferred during report period [each]		0	

Maintenance Basis Failure in Reporting Period (MBO)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Maintenance Basis Failure in Reporting Period (MBO) [each]		0	

Maintenance Basis Failures w/o Mitigation Plan

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Maintenance Basis Failures w/o Mitigation Plan [each]		0	

Obsolete Critical Equipment without Mitigation Plan

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Obsolete Critical Equipment without Mitigation Plan [each]		0	

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Risk Assessment Ratio (B&G) / (R&Y)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Risk Assessment Ratio (B&G) / (R&Y) [ratio]		0	

Risk Assessment without mitigation plan

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Risk Assessment without mitigation plan [each]		0	

Risk Assessments HIGH not associated with an Outage

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Risk Assessment - High - not associated with and Outage [each]		0	

Risk Assessments - HIGH- associated with a planned Outage

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Risk assessments -HIGH- associated with planned outage PO [each]		0	

Risks not identfied which results in a PER

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Risks not identfied which results in a PER [each]		0	

Inadequate or missing OPS procedure (outdated Design Basis, System Operating Limits information, etc.)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
OPS procedures w/o Design Basis or System Operating Limits information [each]		0	

Inadequate or missing Maintenance Procedures or Packages (outdated Vendor, TIB, Experience Review lessons learned Information)

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Work Orders or Maintenance Procedures w/o updated Vendor, TIB, or Experience Review lessons learned Information [each]		0	

Top Equipment Issues identified with untimely or inadequate plan to prevent, detect, or correct condition - leading indicator

There are no Issues in this category defined for this Report.

Metric Description		Value	Comments & Notes
Top Equipment Issues identified with untimely or inadequate plan to prevent, detect, or correct condition - leading indicator [each]		0	

OPS, Maintenance, and System Engineer Required Training conducted

There are no Issues in this category defined for this Report.

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Metric Description		Value	Comments & Notes
OPS, Maintenance, and System Engineer Training conducted [each]		0	

7

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Metrics

Metric Description		Value	Comments & Notes
Operator Work Arounds. List number of OWAs [each]		0	
CR Deficiencies, Disabled Alarms and Nuisance Alarms including DCS Alarms [each]		0	
Operator Rounds Deficiencies - non outage leading indicator [each]		0	
Long Standing clearances age - lagging indicator [each]		0	
Critical System Operating Limits Out of Spec - duration [each]		2	#3 HPH condition and 3B BFP vibration
Safety Deficiencies including WO's [each]		0	
Environmental Deficiencies including WO's [each]		0	
CM WO's - non-outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		15	
CM WO's - outage; excluding PM's, major component outages, and critical spare rebuilds- leading indicator [each]		1	
CM Cost $/Month [$/month]		0	
PM's -Outage scheduled - not completed [each]		1	
PM's on Critical Components that are deferred or late [each]		2	
PdM Predictive Maintenance - Red/Yellow Equipment Assessments- leading indicator [each]		1	3B BFP vibration / Moderate Risk Assessment
This item deleted - omit [each]		0	
PdM Compliance- Number of equipment Assessments not completed within 7 days after Technology Exams [each]		0	
PdM's on Critical Equipment that are deferred or late		0	
TAP's- outage number of TAP's coded as outage that exist after a Planned Outage (PO) [each]		0	
TAP's- non-outage lagging indicator [each]		0	
C Level Equipment PER's originated during report period AND C Level Equipment PER's remaining open at the end of the period [each]		0	
Critical Component Preventable Failures with open action - lagging indicator [each]		0	
PER's Level A or B in this period (item forced an outage) [each]		0	
PERs with Late Action Items [each]		0	
DCN age [each]		0	
TIB's and OEM Recommendations- Late action items; OEM,TIL's [each]		1	Install FWH tube side RVs per insurance audit
Component Assessment Compliance (Number scheduled but not completed within a period) [each]		0	
Component Assessment Rating Unacceptable non-outage - leading indicator [each]		0	

8

[redacted] - Feedwater #5514

Health Report
Monday, April 13, 2009

Metrics

Component Assessment Rating Unacceptable outage - leading indicator [each]		0	
Major Component Critical Event Spares - Unavailability of a Major Component Critical spare to support Plant Operation [each]		0	
Work Orders on Engineering Hold [each]		0	
Red Line Drawing Submittals [each]		0	
Redline Drawing Backlog [each]		0	
GADS- events with > XMWHL [each]		0	
Major Modifications / Projects Deferred during report period [each]		0	
Maintenance Basis Failure in Reporting Period (MBO) [each]		0	
Maintenance Basis Failures w/o Mitigation Plan [each]		0	
Obsolete Critical Equipment without Mitigation Plan [each]		0	
Risk Assessment Ratio (B&G) / (R&Y) [ratio]		0	
Risk Assessment without mitigation plan [each]		0	
Risk Assessment - High - not associated with and Outage [each]		0	
Risk assessments -HIGH- associated with planned outage PO [each]		0	
Risks not identfied which results in a PER [each]		0	
OPS procedures w/o Design Basis or System Operating Limits information [each]		0	
Work Orders or Maintenance Procedures w/o updated Vendor, TIB, or Experience Review lessons learned Information [each]		0	
Top Equipment Issues identified with untimely or inadequate plan to prevent, detect, or correct condition - leading indicator [each]		0	
OPS, Maintenance, and System Engineer Training conducted [each]		0	

9

Health Report
Monday, April 13, 2009

[redacted] - Feedwater #5514

Non-Acceptable / PdM Equipment Assessments

Equipment / Problem		Status	Date
BFP Motor 3A **Problem:** BFP Motor Discharge Temperatures are 176F. They are 20.1F warmer than the avg. discharge temperatures of the other three BFP motors in service. Also, the casing temperature is 10.2F warmer than the rest of the motors. It was noted from previous scans that the discharge air flow from the vents on this motor was decreased. Sample shows no signs of water contamination. Particle count is 19/14 from 18/13. The percent viscosity change is 15.0 from 12.9 which indicates that the oil may be starting to break down.	R	Unacceptable	09/16/2009
BFP 3A **Problem:** 3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.	C	Watch List	09/16/2009
BFP 3C **Problem:** 3C & 3A ELOF Safety Valves appear to be leaking through into the drain trough.	C	Watch List	09/16/2009
BFP Fluid Drive 3B **Problem:** Sample has a percent water indication index of .091. Particle count is 21/21. Sample was taken as a PMT following maintenance. Oil appeared cloudy suggesting emulsification.	C	Watch List	07/18/2008

Component Assessments

Report Title / Summary		Date
Marginal		
U3 HPH #3 **Summary:** RETUBED 03/86.	Y	04/22/2009
Watch List		
U3 HPH #1 **Summary:** RETUBED 04/86.	C	04/22/2009
[redacted] U3 DA TANK / HEATER **Summary:** INSPECTION OF JSF U3 DA TANK AND HEATER 11/2004	C	08/06/2009
Acceptable		
U3 HPH #2 **Summary:** RETUBED 06/84	G	04/22/2009

B

SYSTEM HEALTH REPORTING PROGRAM EXAMPLE: STANDARDIZED ISSUES AND PERFORMANCE INDICATORS

This appendix presents an example of standardized issues/indicators and their corresponding metrics. Also included is an example of the tiered ranking system that is used to rate and classify each of the metrics.

System Health Performance Indicator		Source	Green Criteria (0 points)	Blue Criteria (1 points)	Yellow Criteria (3 points)	Red Criteria (6 points)
1.	Operator Work Arounds – lagging indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
2.	Disabled Annunciator / Nuisance Alarms – leading indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
3.	AUO Rounds Deficiencies – non outage leading indicator	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
4.	Long Standing Clearances age – Lagging indicator (optional)	**OPS**	None > 4m	Any ≥ 4 months and ≤ 6 months	Any ≥ 12 months	Any ≥ 12 months
5.	Operator Critical Limits Out of Spec duration - leading indicator	**OPS**	None > 1 day	any > 1 day and < 2 days	Any ≥ 3 days	Any ≥ 3 days
6.	Safety deficiencies (including WO)	**SE**	None > 7 day	any ≥ 7-14 days	Any 14-30 days	Any 30 days
7.	Environmental deficiencies (design, maintenance including WOs).	**SE**	None > 7 day	any ≥ 7-14 days	Any 14-30 days	Any 30 days
8.	CM WOs – non-outage; excluding PMs, major component outages, and critical spare rebuilds – leading indicators	**Maint.**	All < 6 Months	Any ≥ 6 months and 9 months	Any ≥ 9 months and < 12 months	Any ≥ 12 months
9.	CM WOs – outage; excluding PMs, major components outages, and critical spare rebuilds – leading indicators	**Maint**	None after Planned Outage (PO)	1 after - PO	2 after - PO	3 after PO
10.	CM Cost $ / Month (This item deferred till later) (optional)	**Later**	Trend down	Trend flat	Trend up <5%/ month	Trend up> 5%/month
11.	PMs – Outage – leading indicator (Number of PMs not completed during a planned outage) (optional)	**Maint**	None after Planned Outage (PO)	1 after PO	2 after PO	3 after PO
12.	PMs on Critical Component that are deferred or late – leading indicator	**Maint**	≤ 1 deferred/ period	≥ 2 and ≤ 3 deferred/period	≥ 4 and ≤ 5 deferred/period	> 5 deferred/ period
13.	PdM Predictive Maintenance – Red/Yellow Equipment Assessments – leading indicator	**PV**	None > 4 months	any ≥ 4 months and < 6 months	any ≥ 6 months and < 12 months	any ≥ 12 months
14.	PdM Equipment Assessments – Number of not completed within 7 days period of Tech Exams (optional)	**PV**	None	≥ 1 and < 5	any ≥ 5 months and <12 months	Any ≥12 months
15.	PdMs on Critical Equipment that are deferred or late	**PV**	≤ 1 deferred/ period	≥ 2 and ≤ 3 deferred/period	≥ 4 and ≤ 5 deferred/period	> 5 deferred/ period
16.	TAPs – outage Number of TAP coded outage existing after a Planned Outage (PO)	**SE**	None	1 after (PO)	2 after (PO)	≥ 3 after (PO)

System Health Performance Indicator		Source	Green Criteria (0 points)	Blue Criteria (1 points)	Yellow Criteria (3 points)	Red Criteria (6 points)
17.	TAPs – non outage. Lagging indicator	**SE**	All < 3 months	Any ≥ 3 months and < 6 months	Any ≥ 6 months and < 12	Any ≥ 12
18.	PERs Level C (Equipment) originated during report period, plus Level C Equipment PERs remaining Open at the end of the report period	**PER**	None	1	2	≥ 3
19.	Critical component preventable failures with open late Actions – lagging indicator (optional)	**SE**	None	Any over 3 months old	Any over 6 months old	Any over 9 months old
20.	PERs Level A or B in this period	**PER**	None	N / A	N / A	≥ 1
21.	PERs with late Action Items (optional)	**PER**	None	1	2	3
22.	DCN Age open DCN, that are non – outage – leading indicator	**SE**	All < 16 weeks	any ≥ 16 weeks and < 26 weeks	Any ≥ 26 weeks	Any > 52 weeks
23.	TIB, OEM, recommendations, etc. **–** Open action items (optional)	**SE**	None	1	2	≥ 3
24.	Component Assessment Compliance (Number scheduled but not completed in period)	**SE**	None	1	2	≥ 3
25.	Component Assessment Rating unacceptable non – outage – Leading indicator	**PV**	None > 4 month	Any ≥ 4 months and < 6 months	Any ≥ 6 months and < 12 months	Any ≥ 12 months
26.	Component Assessment Rating unacceptable – outage – Leading Indicator (excluding those found during outage)	**PV**	None after Planned Outage (PO)	1 after - PO	2 after - PO	3 after PO
27.	Major Component Critical Spares – Unavailability of a Major Component Critical Spare to support plant operations. (Actual Event)	**SE**	none	> 1 critical spare is unavailable for plant operations	none	none
28.	Work Orders in Engr Hold	**CMMS**	None > 4 months	Any ≥ 4 months < 6 months	Any ≥ 6 months and < 12 months	Any ≥ 12 months
29.	Red Line Drawings Submitted	**SE**	Any	≥ 1	N/A	N/A
30.	Red Line Drawings Backlog (optional)	**SE**	None > 4 months	Any ≥ 4 months < 6 months	Any ≥ 6 months and < 12 months	Any ≥ 12 months
31.	GADs – Event with > X MWHL (exclude Boiler events)	**GADS**	None	Any X < 100 MWHL	Total X ≥ 100 MWHL	Any one event X > 100 MWHL
32.	Major Modification/Projects deferred during report period. (optional)	**SE**	None	1	2	3
33.	Maintenance Basis Failures in reporting period (optional)	**SE**	None	1 or 2	3 or 4	≥ 5

System Health Performance Indicator		Source	Green Criteria (0 points)	Blue Criteria (1 points)	Yellow Criteria (3 points)	Red Criteria (6 points)
34.	Maintenance Basis Failures without mitigation plan. (optional)	**SE**	None	1 or 2	3 or 4	≥ 5
35.	Obsolete Critical Equipment without mitigation plan (optional)	**SE**	None	1	2	≥ 3
36.	Risk Assessment Ratio (B&G) / (R&Y) (optional)	**PV**	≥ 2	≥ 1.5 and < 2	≥ 1.0 and < 1.5	< 1.0
37.	Risk Assessment without Mitigation plan (optional)	**PV**	None	Any Blue or Green Rsik	Any Yellow Risk	Any Red Risk
38.	Risk Assessment – HIGH Risk (RED) not associated with an outage.	**PV**	None > 1 months	Any ≥ 1 months and < 3 months	Any ≥ 3 months and < 6 months	Any > 6 months
39.	Risk Assessments High Risk (RED) associated with planned outage PO	**PV**	None After PO	1 After PO	2 After PO or any after 2 PO	≥ 3 After PO or any after 3 PO
40.	Risk not Identified which results in a PER (optional)	**PV**	None	Any One Level C	≥ 2 Level Cs	Any Level A or B or ≥ 3 Level C
41.	Inadequate or missing OPS procedures (optional)	**OPS**	0	1	2	3
42.	Inadequate or missing Maintenance Procedures / Packages (optional)	**Maint.**	0	1	2	3
43.	Top Equipment Issues identified with untimely or inadequate plan to prevent, detect or correct condition – leading indicator (optional)	**SE**	None	≥ 1 issue with failure likely within the next 30 months	≥ 1 issue with failure of a critical component likely before next PO	> 1 issue with failure of a critical component likely before next SHR due
44.	OPS, Maintenance, and System Engineer training conducted. (optional)	**SE**	All < 16 weeks	Any > 16 weeks	Any ≥ 26 weeks	Any ≥ 52 weeks

* Non-outage excludes major component outage work activities, contingency activities, outage PM, and Outage CMs.

* Criteria are on a per unit basis assuming one SHR per system, per unit. Adjust if multiple units.

** Available is considered to be within the or other industry shared stock system.

*** Do not “double count” line items. If an item counts against more than one line or column it should be counted against the item that will charge the most points. If the point values for multiple line items are equal, count the item against just one item, which it best fits, in the judgment of the System Engineer. However the report card item descriptions and color be shown for all items even if duplicated.

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