Streamlined Reliability-Centered Maintenance (SRCM) Program for Fossil-Fired Power Plants

TR-109795

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REPORT SUMMARY

Following EPRI's philosophy to use and expand existing technology if it makes economic sense, the Institute's Plant Maintenance Optimization Target has adopted a reliability-centered maintenance (RCM) process called Streamlined RCM, or SRCM. SRCM provides a utility a cost-effective process to determine the optimum maintenance strategy for plant systems and equipment based on importance to business objectives. SRCM maintains all the basic steps of traditional RCM.

Background
The evolution into a nonregulated industry has prompted a drive to control operation and maintenance (O&M) programs among electric utilities. For fossil-fired plants, controlling O&M includes the transition from reactive maintenance to a preventive/predictive maintenance strategy. To help its member utilities make the transition and become more competitive, EPRI has initiated Plant Maintenance Optimization development efforts under Target 43 (Turbine, Generator, and Balance of Plant O&M Cost Reduction - 1997) and Target 54 (Plant Maintenance Optimization - 1998). These efforts are intended to help utilities reduce production costs by developing and demonstration cost-effective maintenance methods. This project is part of that program.

Objectives
To develop an integrated program based on RCM methodology that assists a utility in cost-effectively maintaining an optimized maintenance program.

Approach
By using a logical step-by-step approach to determine the maintenance strategy for plant/systems, utilities are able to document the basis for the maintenance program, more effectively manage change to the plant maintenance program, and focus resources on doing the right task at the right time on the right equipment. This report describes how all of the SRCM tools and processes work together. Accompanying this process is software, program management, system and component templates, implementation support, training, and living program development.

Results

Several utilities with varying degrees of plant maintenance programs have used SRCM. Some plants who have had essentially no formal plant maintenance program are using SRCM to create a program for the first time; other plants have used SRCM to optimize their existing plant maintenance program. All utilities anticipate a reduction in unscheduled breakdown maintenance. Other intangible benefits include improved communication between key plant staff concerning system functions, equipment failure causes, and their significance. Additionally, most utilities that have applied SRCM have computed a payback of less than one year.

EPRI Perspective

To date, several utilities have applied SRCM at their various plants. As more utilities participate in EPRI's program, process and product refinements will evolve to enhance SRCM-based tools. EPRI envisions enhancements to the current SRCM program to include a SRCM user's group, implementation support, continued templates data enhancement, and living program support.

TR-109795

Interest Categories

Fossil steam plant performance optimization
Fossil steam plant O&M cost reduction
Combustion turbine/combined cycle plants
Fossil assets management

Keywords

Reliability
Maintenance optimization
Maintenance
Availability
Reliability-centered maintenance

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INTRODUCTION

As the electric power industry evolves into a non-regulated industry, extreme pressures are being placed on plant organizations to reduce costs to meet competition while maintaining or enhancing plant performance. Several utilities have gone through staff reductions as a first line of action for cost reduction. This has prompted a drive to control the operation and maintenance (O&M) programs. For the fossil fired plants in the industry the controlling of the O&M program includes the transition from reactive maintenance as the main stay to a preventive/predictive maintenance strategy. World class facilities know having the proper mix of maintenance is key to cost-effective and enhanced maintenance. The Electric Power Research Institute (EPRI) embarked on a program to assist member utilities in making the transition and becoming more competitive.

This project is part of EPRI's Plant Maintenance Optimization development efforts under Target 43: Turbine, Generator and BOP O&M Cost Reduction (1997) and Target 54: Plant Maintenance Optimization (1998), which are intended to help utilities reduce the cost of production by developing and demonstration cost-effective maintenance methods.

A key element of EPRI's maintenance optimization program is the use of reliability-centered maintenance (RCM) technology to guide a utility in improving and optimizing their maintenance program. Utilizing EPRI's philosophy to use and grow existing technology if it makes economic sense the Plant Maintenance Optimization Target has adopted a RCM process called "Streamlined RCM" or SRCM. SRCM allows a utility to analyze down to the level required to make a maintenance strategy decision while maintaining all of the basic steps of traditional RCM. Accompanying this process is: software, program management, system and component templates, implementation support, training and living program development. All of these integrated products assist a utility in cost-effectively optimizing and maintaining an optimized maintenance program. Figure 1-1 shows how these tools and support provide EPRI members with cost-effective solutions when developing or refining systems and equipment strategies.

Over the past two years, several utilities have embarked on the implementation of SRCM at their various plants. These utilities are at various stages of the program. As more utilities participate in the EPRI program, process and product refinements will evolve to provide enhanced tools to develop and maintain a RCM-based maintenance program.

Each utility and plant needs to decide on objectives and goals when conducting a SRCM program. Usually utilities use SRCM as one means to achieve competitive production costs through maintenance optimization. SRCM will optimize maintenance by utilizing the following principals:

- Concentrate maintenance resources where they will do the most good.

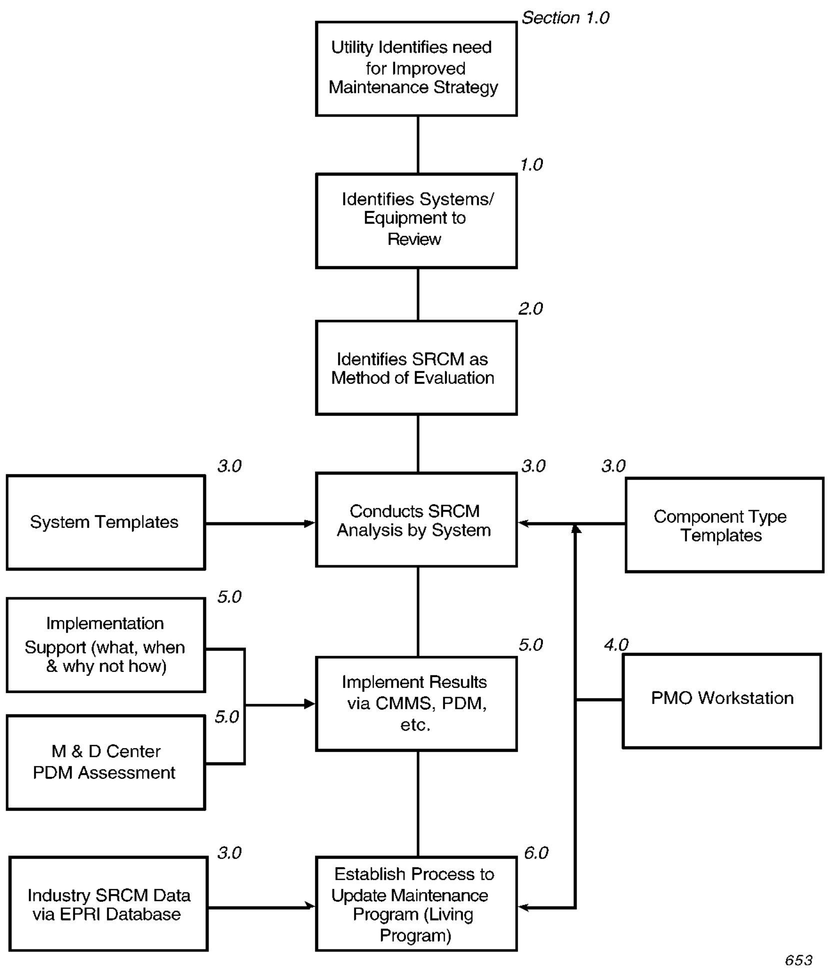

Figure 1-1
EPRI's SRCM Program

- Eliminate unnecessary and ineffective maintenance tasks.
- Devise the simplest and most cost-effective means of maintaining equipment, or testing for degradation focusing on predictive or condition monitoring activities when applicable.
- Develop a documented basis for the maintenance program.
- Utilize plant maintenance and contractor experience when determining PM tasks and frequencies.

In order to achieve the goal of an improved maintenance program at a plant, it is necessary to select systems that will meet the specified goals of the program. The systems typically selected for review are:

1. Main Steam
2. Fuel Handling
3. Circulating Water
4. Ash Handling
5. Sootblowing
6. Boiler Air and Gas
7. Feedwater Heater Drains/Extraction Steam
8. Coal Handling
9. Feedwater
10. Condensate

The criteria for selecting these systems is: overall importance to plant operation, safety, reliability and historical maintenance costs. Cost-effective maintenance is the program objective.

A real, but difficult to document, benefit is that the SRCM process involves and improves communication between the key plant staff functions (operations, maintenance and tech support in traditional organizations, and Production and Support Teams in more recent organizations) concerning system functions, equipment failure causes and their significance. The need for and benefits of, participation by key plant staff in the SRCM process can not be over-emphasized.

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WHY SRCM?

2.1 Classical RCM vs. SRCM

EPRI's experience with RCM methodology began in 1983 in trial applications with nuclear power plant systems. These applications were a direct transfer of existing methodology from the commercial airline industry. Since then, numerous utilities have applied RCM principals to their nuclear plants. In 1991, EPRI responded to utility concern that classical RCM requires too many resources to perform an analysis on an average system. As a result, EPRI embarked upon a major project to investigate possible methods of lowering the cost to perform an RCM analysis while maintaining the technical integrity of the process and results. One approach that resulted from this project was the SRCM process. The SRCM process was validated against classical RCM by applying both methods independently on the same plant system. This comparison found essentially identical PM task recommendations with only minor differences driven by the two analysts different knowledge of the plant and equipment involved. A thorough knowledge of basic RCM methodology is necessary to ensure accurate results when performing SRCM. Figure 2-1 shows a comparison of the two methods.

Given the success of SRCM in the nuclear sector of the power industry, EPRI's fossil group funded several pilot SRCM applications at fossil plant systems. The pilot projects confirmed the cost effective applicability of SRCM to fossil units. Over the past two years, the EPRI-sponsored SRCM process has been applied to 120 systems at nine utilities. Currently an additional 161 systems are being analyzed. These successful SRCM applications together with the high level of utility acceptance has prompted EPRI to develop several additional tools and enhancements of a commercial RCM software tool specifically designed to support the SRCM process. This commercial tool known as the PMO Workstation, developed by ERIN Engineering and Research, Inc., has been used to support the EPRI projects and is now available to members. The software enhancements, funded by EPRI, consist of system and component task selection templates as well as a living program module and will become available in 1998.

2.2 Typical Results From a Fossil SRCM Program

The application of SRCM at several utilities has had widely varying benefits. Some plants who have previously had essentially no formal PM program are using SRCM to create a program for the first time. Other plants have used SRCM to optimize their existing PM program and all utilities anticipate a reduction in the amount of unscheduled breakdown maintenance. The SRCM process includes the review of all equipment in a system thus providing analysis to define the maintenance program for the complete system not just 'critical' equipment in a system. If a system is needed to meet critical plant needs then all critical elements of the system must function properly not just certain components.

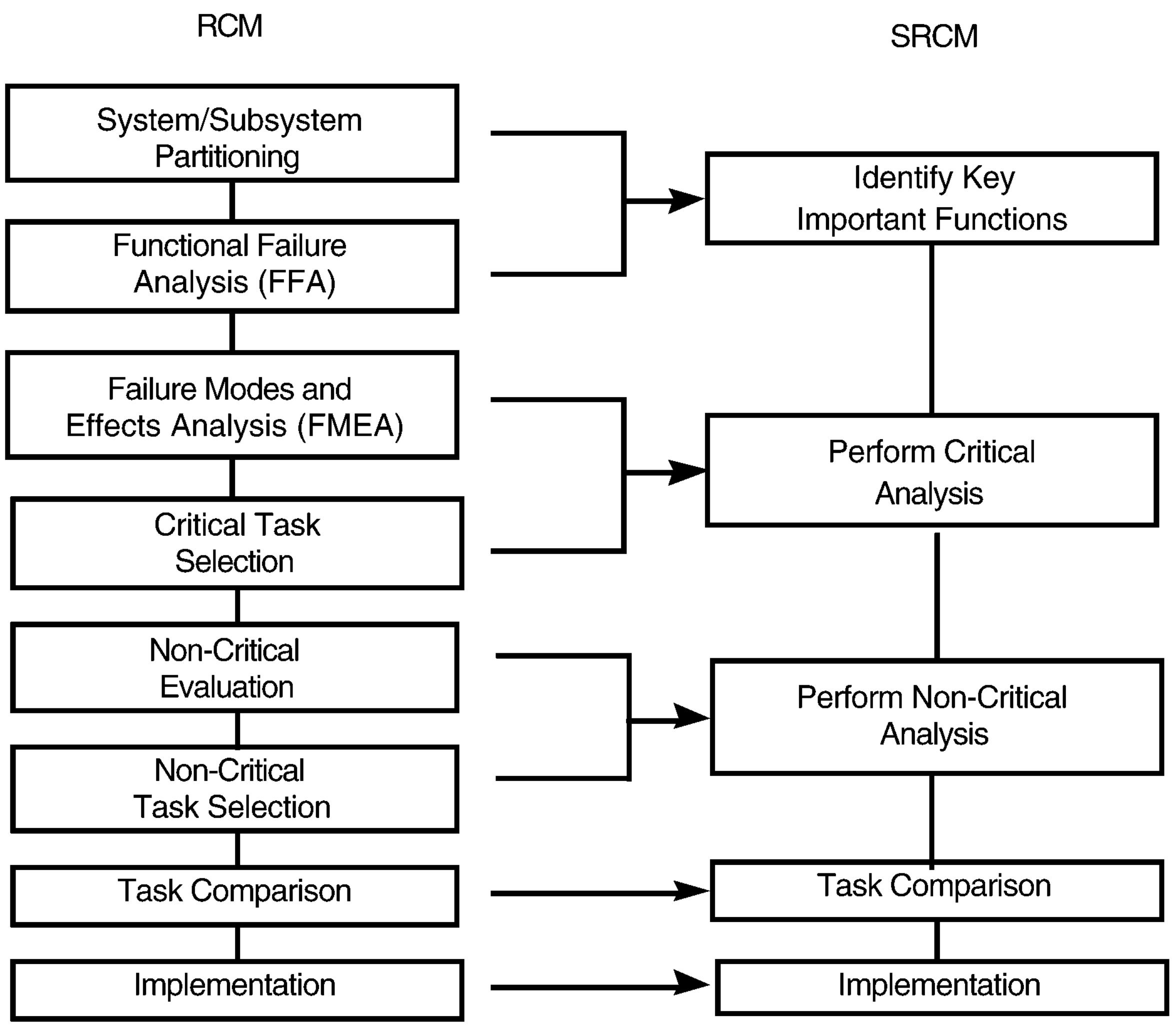

Figure 2-1
RCM/SRCM Comparison

The results to date have noted: adjustment in time-directed PM tasks for both content and frequency, identification of PDM technology applications, functional testing and single point failure potential identification. The maintenance task recommendations have included: a reduction of ineffective maintenance, optimization of all types of PM/PDM tasks, identified design reliability issues and the institution of new performance testing.

The plants using the SRCM process range from new to over 30 years old. Each have an experienced staff with varying degrees of PDM programs in place. SRCM has allowed all the plants to focus their maintenance resources on the right maintenance strategy, integrate the departments for efficiency (e.g. electrical, mechanical, and I&C maintenance, operations, and engineering) and re-prioritize the PM tasks with clear understanding of the ramifications if a task is deferred.

Table 2-1 provides some of the overall results from SRCM application at member utilities:

Table 2-1
SRCM Savings

Utility	Payback Period	Annual Savings*
1	1 year	~$300K
2	< 1 year	$270K
3	1 - 2 year(s)	$200K
4	1 year	$600K

*Only includes PM man-hours and parts

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HOW TO PERFORM SRCM

3.1 The SRCM Process

The SRCM produced PM plan must support an individual units mission (base load or load following etc.) to assure the unit performance in compliance with it's intended use or mission. Thus, a units mission provides the basis for determining component critically and subsequent PM task selection.

The following describes the PMO process and Figure 3-1 illustrates the steps of the process.

Data Collection and Plant History Review

The same system data is required to perform this streamlined analysis as is needed for a standard RCM analysis. In order to facilitate this streamlined analysis process and maximize the associated cost benefit, the analyst should perform a detailed review of all the pertinent system information including corrective maintenance and existing PM and surveillance programs prior to starting the main analysis process steps.

Documentation or data required to support this analysis are:

- System Description
- System Drawings (P&ID's, electrical schematics, logic diagrams, etc.)
- Component Listing (electronic)
- Component Corrective Maintenance History (3-5 yrs. if available)
- Existing Preventive Maintenance and Surveillance program (PM and PDM tasks, operator rounds, etc.)
- Commitments/Requirements for existing PM/Surveillance tasks

Information not readily available from the above sources is obtained by interview of knowledgeable plant people.

Identify Functional Failures

The identification of system functional failures is performed in the same manner as in standard RCM. This process varies from standard RCM by focusing the analysis resources on the 'important' functional failures. The analyst identifies all applicable functions for the system and then sorts the functions into two groups with appropriate justification: (1) Important functions and (2) Non-important functions. The criteria for determining whether a function is important can be modified by the organization performing the analysis. Generally, any function that directly affects plant safety, environmental limits or power production is considered important. Non-important functions typically include such items as local indication or secondary system functions. Components that support important functions will be evaluated in the Critical Analysis module. The remaining system components that support non-important functions may still be analyzed in the Non-critical Analysis module.

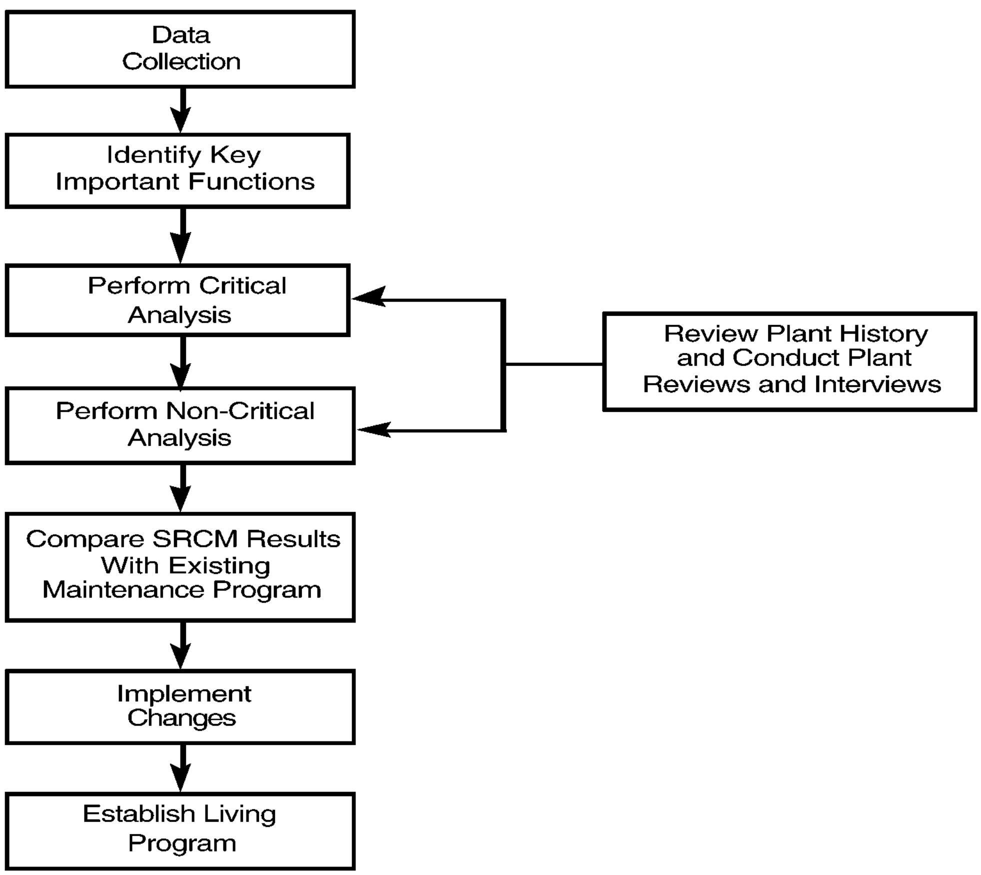


Figure 3-1
SRCM Process

One way to provide additional benefit in analysis effort is to limit identified functions to only those that are important for plant operation and safety. This can be done by first characterizing the functions in fairly general terms and only using resources to identify the functions that are important. This avoids wasting time identifying functions that are not going to be analyzed in the Critical Analysis module, while the remaining system components get analyzed through the Non-Critical Analysis module.

Critical Analysis

Following the standard RCM analysis methodology, the determination that a system component is 'critical' places heavy emphasis on the overall plant effect caused by a specific failure mode of the component. However, in this streamlined process, only the functions that are identified as 'important' are evaluated with a streamlined Failure Modes and Effects Analysis (FMEA) to determine critical equipment. In this streamlined process, the standard FMEA and LTA have been combined into one record. The following discusses the FMEA portion of the component record and the LTA process is described in the PM task recommendation section:

FMEA

In standard RCM analysis, the analyst typically has an individual FMEA record for each dominant failure mode and the resultant local, system, and plant effects. This documentation provides direct linkage of the Functional Failure Analysis (FFA), specific component failure mode, and the local, system, and plant effects for each separate component-failure mode combination to determine component criticality. However, in the SRCM process, the analyst identifies every component that supports the functional failure and lists only the most significant failure modes for each component, along with the most dominant plant effects for the failure modes, all in one component record. The analyst determines the component criticality based on the various failure mode/plant effect combinations and the cumulative significance of the components failure of the specific function.

If a component is determined to be critical, the next step is to identify appropriate causes for the potential failure modes to allow the analyst to identify applicable and effective maintenance tasks for the failure modes and causes that are considered important to identify or eliminate. If a component is determined to be non-critical, it is evaluated further in the non-critical analysis. Task selection for critical components is discussed in detail later.

As with standard RCM, it is important and beneficial to receive engineering and operations review and input into the critical evaluation of the systems components.

Non-Critical Analysis

The non-critical evaluation applies a different set of criteria which places more emphasis on equipment level economic considerations for the components that were determined to be non-critical in the critical analysis or components that support non-important functions. These new criteria will evaluate the benefit of maintaining existing PM tasks or identifying new PM tasks rather than allowing the component to run to failure to help provide a basis for a complete PM program. The criteria used for the non-critical evaluation can be modified to meet plant specific requirements. If the component does not meet any of the non-critical criteria, then the determination is made to allow this component to run-to-failure and perform corrective maintenance when required. If there is a 'yes' response to one of the non-critical evaluation criteria, an appropriate PM task recommendation is made. The identification of appropriate PM task for non-critical equipment will be described in more detail below.

A Maintenance Engineer reviews of the non-critical evaluation are important to ensure a well documented evaluation. This should be performed in conjunction with the review of the critical evaluation to maximize the efficiency of the process. Depending upon the task developed for the non-critical evaluation, it may also be desired to have the responsible Operations personnel available to provide input on some of the maintenance related criteria in the non-critical evaluation.

PM Task Recommendations

Once a component has been determined to be critical, or non-critical but not allowed to run-to-failure, the next step is to recommend applicable and effective preventive maintenance tasks based on the component's importance. Selecting the type of task to be performed and the frequency of the task can be accomplished in several manners.

The approach will utilize preventive maintenance templates as much as possible (see Section 3.4). SRCM projects use generic templates that combine EPRI's current "in-house" templates with capabilities and maintenance philosophies of the plant. Because the maintenance templates do not identify specific component failure modes or links to any specific plant effect, careful consideration must be exercised to ensure that the analyst selects preventive maintenance tasks that will prevent specific dominant failure modes and causes to ensure they are adequately addressed by the preventive maintenance programs. These failure modes and causes can be incorporated from specific facility experience or generic industry experience on similar equipment.

For critical equipment, the analyst selects failure causes associated with the dominant failure modes and effects that are desired to address through the preventive maintenance program. The analyst then identifies the applicable and effective preventive maintenance tasks that are recommended to address the failure mode and cause combinations (failure mechanisms) of concern. A similar step is performed for non-critical equipment that has been identified as requiring a PM task except no failure causes need to be identified.

Another method available to determine the appropriate preventive maintenance tasks for each component is the standard RCM Logic Tree Analysis (LTA). This method can also be used for any component type that does not have a maintenance template.

Task Comparison

After the SRCM PM recommendations have been identified, the final step in the process is to reconcile these recommendations with the existing PM program. The existing PM program should consist of every task performed on a component that has the ability to identify or prevent potential component failures and adverse effects (e.g. Preventive Maintenance tasks, surveillance tasks, lubrication, condition monitoring, etc.). This report becomes the basis for the actions required to implement the final recommendations after approval from the appropriate station personnel. Appendix A contains an example of SRCM work products.

What Does It Take To Conduct SRCM?

Performance of SRCM on any plant system entails a coordinated effort between plant personnel and the analyst. The plant personnel involved include craft, engineering, operations personnel, as well as those directly responsible for the project (Core Team). In order to obtain the most thorough and accurate information about the system under analysis, the analyst must solicit input from these various organizations. For this to happen, the project lead/manager must coordinate schedules such that, for the most favorable impact on the project, the personnel most knowledgeable are available for analysis reviews (Criticality, Task selection and Task Comparison) and Maintenance interviews. This can, at times, be a substantial investment of manpower into the SRCM analysis, therefore, it is vital that the reviews and interviews be conducted efficiently, without sacrificing quality for speed.

Typically, the Core Team make-up consists of personnel from engineering, operations, planning and maintenance (including supervisors, foremen and craft personnel). These personnel are empowered to make decisions and implement changes in the maintenance program (change existing PM tasks, add new tasks, purchase PDM technology/equipment, etc.). The Core Team will also know which personnel are "expert" on a particular system, and will ensure that these experts are available to participate in the analysis. Most often, the analyst will perform the analysis with predetermined steps identified as review points. Usually, these points are the Criticality Analysis, Task Selection and Task Comparison. The reviews are usually conducted by the analyst with the Core Team and any other personnel as appropriate. Quite often, the Criticality Analysis is reviewed by the analyst with only a representative from Operations.

This is acceptable, as Criticality is a functional determination based on the effects of failure on the operation of the plant. However, the criticality review and determination should involve all members of the Core Team, as this will ensure that all members of the group understand the reasoning behind a component's criticality. Task Selection and Task Comparison, however, require full Core Team participation in the reviews.

As part of the Task Selection process, it is necessary for the analyst to conduct interviews with the system experts to identify problems, design deficiencies, ineffective maintenance tasks and practices, as well as suggestions for improvement of the maintenance performed. These experts are usually senior craft personnel or foremen/ supervisors from the mechanical, electrical and instrumentation disciplines, operations and engineering. The interviews are conducted individually or collectively, depending on availability and the goal is to collect information to determine equipment performance and make recommendations as to what maintenance should be performed.

Table 3-1 lists the typical man-hour requirements for performing an SRCM system analysis.

Table 3-1
SRCM Analysis Labor

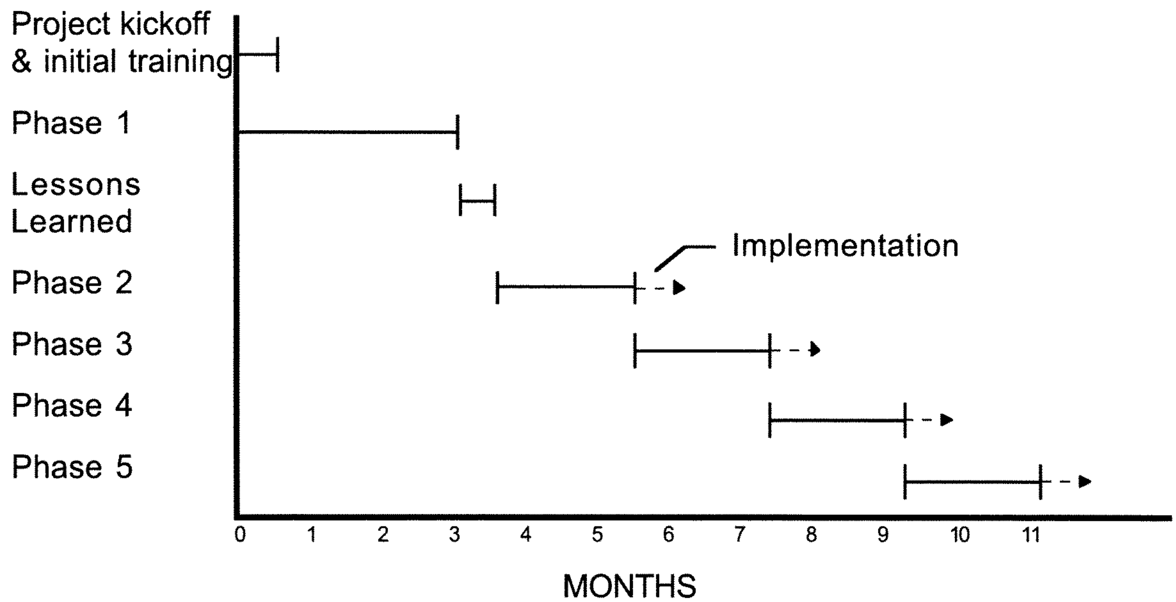
ACTIVITY	HOURS	
	Analyst	Resource/Core Team
Data Collection	24	8
Critical Analysis and Task Selection	80	20
Non-Critical Evaluation and Task Selection	16	8
Analysis Reviews	16	16
Task Comparison and Review	24	12
Implementation	--	20-200 (1)
Totals	152	76-256 (1)

(1) The number of hours required for implementation is utility-specific and driven by a variety of factors, including the scope of changes to the PM program, purchase and installation of new PDM equipment, training in the use, upkeep and interpretation of PDM data, interface between the SRCM software and the utility's maintenance management software, etc. Some systems may require as little as 20 hours.

Schedule

The key to success for multi-system SRCM projects of this nature is to allow a continuous flow of analysis and recommendations that can be reasonably implemented. The timeline below depicts the overall project schedule.

Table 3-2
SRCM Project Schedule



Note: 2 systems/per phase.

The timeline above shows the process used to complete 2 systems per phase. Note that phase 1 is longer due to OJT training. Also note this is a nominal timeline, the actual schedule for a specific phase may be shorter or longer depending on the system sizes, data collection, and availability of plant staff.

During each phase, the EPRI contractor conducts several meetings on-site. Typically, there are 3 one-week long meetings. The first is at the beginning of the phase to finish the task comparison of the previous phase of systems and collect the data for the next phase of systems. The second meeting is to review the FMEA portion of the analysis along with potential task selection. The final meeting is to complete task selection and comparison.

3.3 System Templates

The task for system templates involves the development and automation of SRCM analysis templates by system (e.g. boiler feedwater, circulating water, etc.) using previously performed system studies for the bases. These system templates will be arranged by various types (e.g. circulating water - Type A is no redundant pumps, Type B - redundant pumps) allowing the user to select the type that most closely reflects the users' system. The generic system templates will be electronically available through the PMO workstation and once selected, electronic guidance via analysis checklists/ questionnaires, etc. will be used to guide the user in the conversion of the generic study to plant specific. Currently there are generic system templates for 10 systems analyzed with automated guidance. Additionally, as more systems are analyzed via EPRI's SRCM program, the use and expansion of available system templates can occur.

The ten systems are listed below:

1. Fuel Handling
2. Sootblowing
3. Feedwater
4. Boiler Gas and Air
5. Boiler Steam and Water
6. Circulating Water
7. Condensate
8. Ash Waste
9. Fuel Delivery
10. Turbine

Each system type consists of variations in system configuration. The types are by system and allow the user to select a system type closest to his to begin his own analysis. Once a type has been selected, the Workstation generates the appropriate copy of the data to allow change for specific aspects of analysis. The workstation prompts the user to review the template for appropriate changes of minor configuration differences, operational and maintenance use/strategies, specific history differences, and equipment identification. Once the analyst has completed his review, a specific system study is ready for implementation.

Under the cross license agreement between EPRI and ERIN for the use of the PMO Workstation, ERIN has incorporated the system and component type templates into the PMO Workstation in conjunction with the living program module funded by EPRI R&H business unit. Appendix B provides example screens of the Workstation.

3.4 Component Type Templates

The second kind of template developed is the component type maintenance templates. These templates consist of maintenance strategies for various component types. This is similar to the work ERIN conducted for EPRI Nuclear during the PECO Limerick project. These templates will be based on system studies previously analyzed via the SRCM program. The templates will be expanded as more information becomes available, particularly by make and model or new component types. The templates are specific to fossil unit experience and include component types unique to fossil such as pulverizers, fuel handling, scrubbers, etc. The templates are automated and provide user customization of templates based on user criteria such as technology capabilities and level of conservatism desired in their maintenance program.

The workstation accommodates an unlimited number of component templates allowing expansion. The templates support the task selection activity for critical and non-critical equipment. The templates look similar to Table 3-3.

For each of the templates listed above a basis screen is included to provide further justification information for PM tasks and frequencies. Also, an ability to review a general instruction on how to perform each task (e.g. PDM, time-directed or testing) in the template is included. Each component basis information consists of a histogram or other pertinent data that reflects how many plants perform the task at various frequencies, and failure history that includes failure causes and corrective tasks.

Table 3-3
Example of a Generic Maintenance Template

Component type: **PUMPS (CENTRIFUGAL)**										
Component Classification Category:										
Critical YES	✓	✓	✓	✓						
NO					✓	✓	✓	✓		
Environment Harsh	✓	✓			✓	✓				
Non-Harsh			✓	✓			✓	✓		
Usage Frequently	✓		✓		✓		✓			
Seldom		✓		✓		✓		✓		
	Frequency								Failure Cause	**COMMENTS**
Condition Monitoring Tasks:										***Tasks identified for Non-Critical should ONLY be performed on expensive/large pumps. Otherwise, choose from the Time-Directed listing.***
Perform full spectrum vibration monitoring. Establish baseline and action levels. Trend results.	3M	6M	3M	6M	6M	12M	6M	12M	BS; GW; LC; SC	
Perform lube oil analysis. Establish action levels. Trend results.	3M	6M	3M	6M	12M	12M	12M	12M	BS; SC; SL; DL	*Sampling and analysis of lube oil to include water, sediment, viscosity. A qualitative and quantitative analysis of metal and impurity content to be performed for diagnostics only.*
Perform component performance test over full range of operation. Establish baseline and action levels. Trend results.	18M	18M	18M	18M	NN	NN	NN	NN	IW; SC	*This test should include pressures, temperatures, flows, leaf-offs, etc.*
Time Directed Tasks:										
Perform detailed clean and inspect. Include inspection for erosion/corrosion.	CD /54M	CD /54M	CD /54M	CD /54M	CD /90M note 2	CD /90M note 2	CD /90M note 2	CD /90M note 2	BS; DL; IW; LC; PL; SC; SL; UD	*Use these frequencies only if NOT implementing ALL the Condition-Monitoring and Surveillance Tasks, otherwise, condition direct this task.*
Perform overhaul of component	CD /60M	CD /90M	CD /60M	CD /90M	NN	NN	NN	NN	BS; DL; IW; SC; UD; GW; AG; PL	*Use these frequencies only if NOT implementing ALL the Condition-Monitoring and Surveillance Tasks, otherwise, condition direct this task.*
Perform visual/pump seal inspection	OR	OR	OR	OR	OR	Note 1	OR	Note 1	DL; LC; PL; SL; UD	*The qualitative observation of a component's condition or performance.*
Perform check of lubricant, add or change oil when needed	OR	OR	OR	OR	OR	Note 1	OR	Note 1	BS; DL; SC; SL	*Use lube oil analysis to condition direct the oil change when possible.*
Lubricate (Greased bearings and coupling)	18M	18M	18M	18M	24M	24M	24M	24M	BS; DL; SC; SL	
Perform changeout of lubricant	CD /18M	CD /18M	CD /18M	CD /18M	CD /24M	CD /24M	CD /36M	CD /36M	BS; DL; SC; SL	Use these frequencies if not performing lube oil sampling.
Surveillance Tasks:										
Monitor vibration and temperatures, and performance.	1D	1D	1D	1D	1W	1W	1W	1W	BS, LC, SC	*Data log and trend either daily or weekly.*
Economic Considerations:										
Run until corrective maintenance is required	NA	NA	NA	NA	✓	✓	✓	✓		

3.5 Training and Analysis Support

A Typical 10 system project provides detailed SRCM training at multiple levels. The Core Team members receive extensive training. Others will have training commensurate with their level of participation. Training for Core Team members is provided at the plant and is performed in a workshop environment in which utility personnel would obtain actual experience performing SRCM analyses on a simplified system. The workshop includes:

- System function and functional failure determination
- Equipment failure mode and effects analysis (FMEA) and criticality determination
- Component task selection
- Implementation
- Living program development
- Effect based analysis (criticality checklist)

This training is conducted over one (1) day and provides employees a firm understanding of RCM/SRCM concepts.

The primary training method used is on-the-job (OJT) training. Training is held during site visits for reviews and interviews of the system studies. This OJT will provide Core Team members required knowledge for implementing results and supporting the remaining phases of system studies.

To complement the training of core team members, it is important for plant staff to have an understanding of the SRCM process. While at the plant site, EPRI provides a 1-2 hour training session to as many plant staff members as desired. The presentation material are left with the utility to continue training by core team members for future needs.

The following minimal support options are available and are not intended as equivalent to full service support. Even though the PMO Workstation is free of charge to target 43(97) and T54(98) members, EPRI requires a member to at least have the minimal training.

1. Software provided without enhancements for immediate use (PMO Workstation, Version 3.1) with one week of training consisting of 1½ days on SRCM process, plus ½ day on workstation, plus 1 day of facilitation, and 1 day of off-site paper review of final product. Note: if personnel to do system study received SRCM training via

EPRI SRCM workshop, then the option changes to 2 days of facilitation support instead of 1 day. It is intended that the plant actually perform an SRCM analysis (as time permits) on a unit system during the week of training.

2. Facilitation support consisting of 3 one-week hands-on training on-site at one plant.

3. Pilot project where utility personnel conduct 1 to 2 systems analysis in parallel with an ERIN analyst performing analysis on 1 to 2 different systems.

4. Pilot project where ERIN conducts 3-5 system studies with utility training.

5. Total unit project where ERIN conducts 10 system studies.

6. All plants/units analysis conducted by ERIN - cost subject to number of units/plants and similarity of units.

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PMO WORKSTATION

The SRCM program at EPRI includes the use of ERIN's PMO Workstation. Through a cross license, EPRI has obtained a no-cost to member license for the installation and use of the PMO Workstation and EPRI's enhancements to this software at a Target 54 member's plants.

PMO Workstation Description

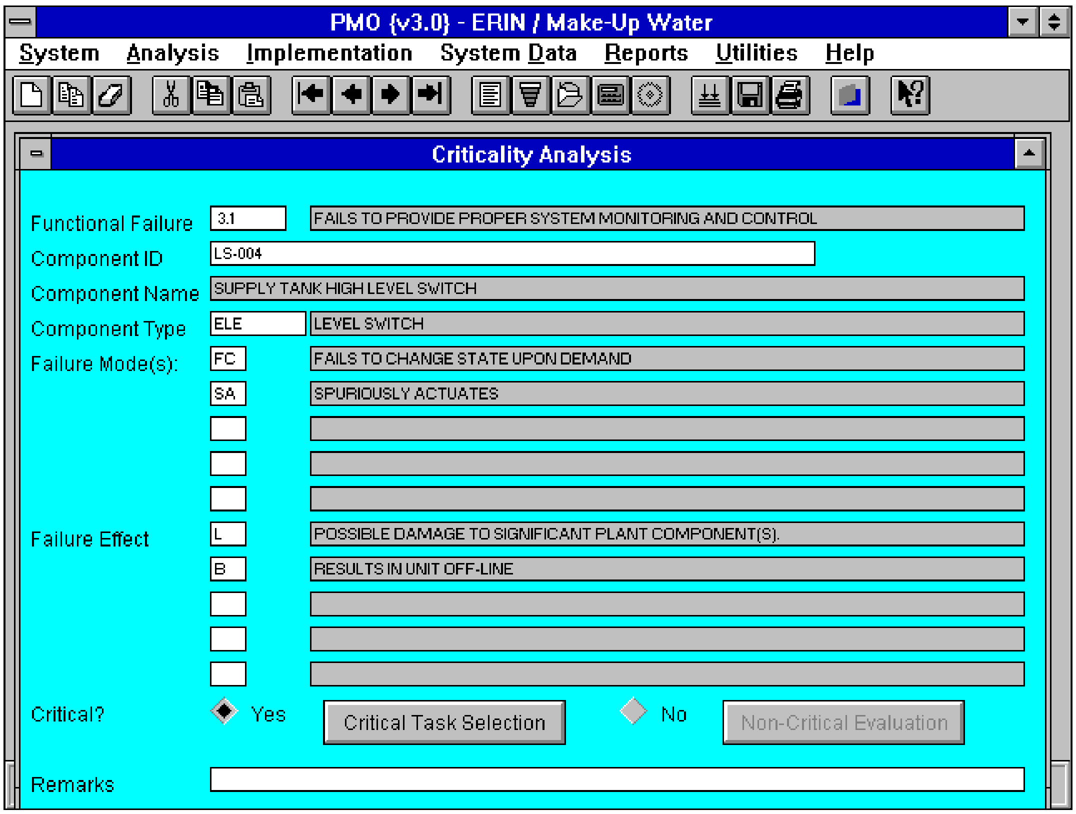
The Plant Maintenance Optimizer (PMO) Workstation Version 3.1 is an MS-Windows 3.1 relational database management software package for the PC that uses dBase 3plus file structures. The PMO Workstation provides an on-line data entry, storage, retrieval, and report generating capability. Separate databases are used for each of the principle PMO tools: Functional Failure Analysis (FFA), Criticality Analysis, Non-Critical Evaluation, Critical and Non-Critical Task Selection, PM Task Comparison, and Implementation Tracking. Lookup files are used to store common information such as component descriptions, failure modes, failure causes and effects, and the current maintenance program for the system(s) being analyzed.

The PMO Workstation is designed to be used efficiently with simple manipulations of a mouse, thus minimizing keystrokes. PMO has extensive built-in reports which may be modified by the user through a separate report generation software package. Reports are printed using standard MS-Windows fonts and may be viewed in their entirety prior to printing through the PMO View Report window. In addition, reports may be filtered to isolate any portion of the database.

The PMO Workstation is completely self-contained and requires no additional database software. To assist with setting up new system analyses, certain data files may be imported by the user by using "flat files" in ASCII comma-delimited format. This data includes System Component Lists, Current Maintenance Program data, and Corrective Maintenance History data, if desired. Additionally, many of the lookup files are pre-loaded with standard data. These files consist of codes and corresponding descriptions that are used to simplify the data entry in many PMO modules. The lookup databases including Component Types, Failure Effects, Failure Causes, Task Bases, Recommended PM Tasks, and PMO Recommendation Justifications were developed by ERIN Engineering to provide a set of commonly used choices for these fields and to provide a foundation for developing plant-specific lookup databases for PMO Workstation users. The component types and failure modes were obtained from a review of industry sources including the IREP Generic Database and IEEE-500.

NOTE: As with PMO Workstation databases in general, the contents of any lookup files may be customized by the user at any time.

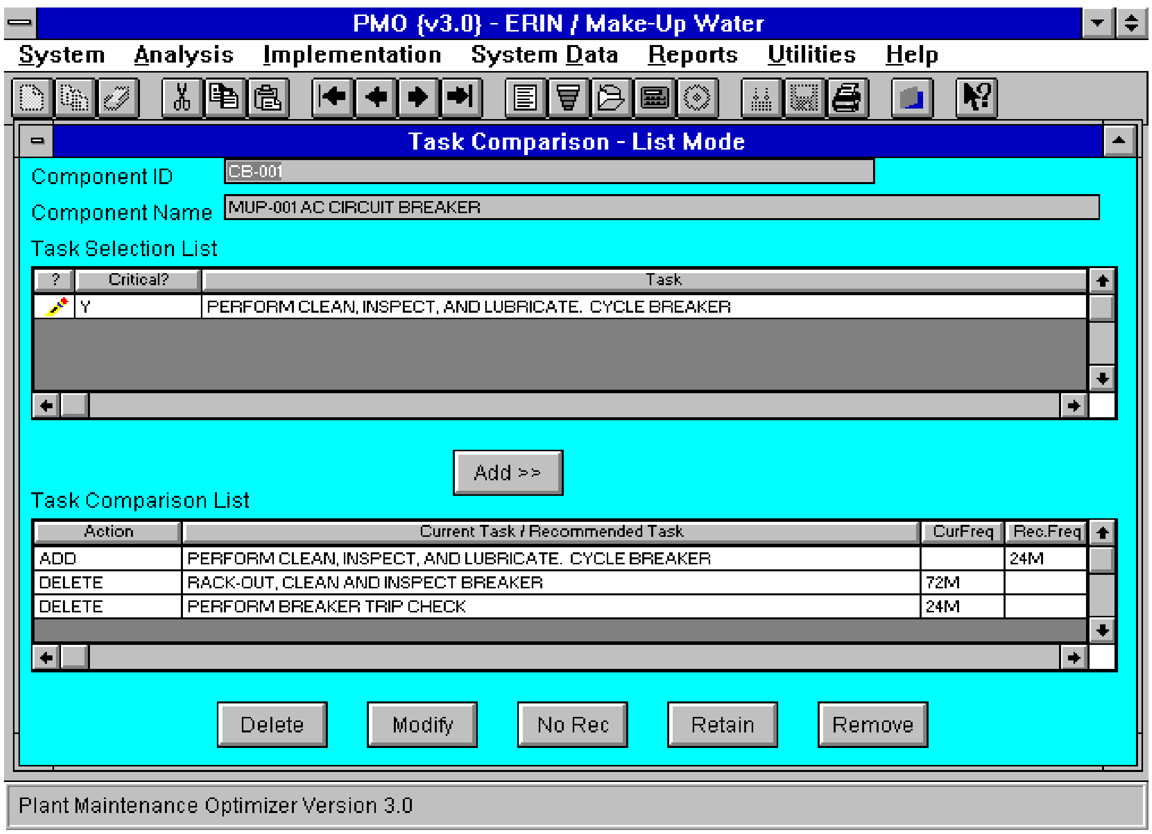
A sample Criticality Analysis data entry screen is shown below, as well as a brief description of several major features that are included with the PMO Workstation.



Notice the menu items presented along the top of the window. These menus provide quick access to each PMO module. For example, while editing the Criticality Analysis data above, you may decide to add a new component to your component list. You would simply select the System Data menu item, select the Component List submenu, and proceed to add a new component on-the-fly, without the need to exit the Criticality Analysis module. To include this new component in the Criticality Analysis, return to the Criticality Analysis screen (by closing the Component List screen), and double click in the Component ID field. You will be presented with the entire Component List. Locate the component you just added and double click on it. It will then be automatically placed in the Component ID field on the screen.

NOTE: All “code” fields in PMO may utilize this “expert assistance” by placing the cursor in the desired field and double-clicking the mouse. A selection list will be presented from which you may select an item by, once again, double clicking on the desired item.

You will also notice the PMO toolbar across the top of the window. Each PMO data entry screen is provided with its own toolbar, which gives users the ability to navigate quickly through the data, add or copy records, filter the database, print a report, etc. If you would like to view the Criticality Analysis Report on the screen, merely click the Printer icon in the toolbar (e.g. the third icon from the right). Once the report is presented on-screen, you will have the option to view the report, print the report, or The PMO Workstation also greatly simplifies the Task Comparison process by allowing users to view all Recommended Tasks and all Current Maintenance tasks on the same screen, as shown below:



Utilizing this module, analysts can quickly perform the Task Comparison on-screen. A comparison of current maintenance tasks and recommended tasks (shown in the Task Selection List above) may be made by highlighting the desired line item from each list, and then clicking the appropriate button shown on the bottom of the screen. The final result of this step in the analysis is presented in the lower list box titled “Task

Comparison List". This box contains all of the final task recommendations that will individually need to be implemented.

As you can see, the PMO Workstation greatly simplifies the PMO analysis by reducing the data entry required. Throughout each analysis, expert assistance selection lists are provided to further simplify these tasks. Finally, although the software is extremely user-friendly, a comprehensive User Manual is included with the product that describes, in detail, each module in the Workstation.

The following describes the hardware and software requirements for the Plant Maintenance Optimizer (PMO) Workstation Version 3.1.

Hardware

- IBM Personal Compatible (or compatible) with a 80386 processor or better;

  Note: a 80486-based or Pentium processor is highly recommended due to increased speed while operating in the Microsoft Windows environment.

- At least 20 Megabytes of hard disk storage, either local or network based (greater storage may be required if extensive PMO analyses are performed;

- VGA graphics capability;

- 1 Meg of RAM for Microsoft Windows 3.1 or Windows for Workgroups 3.11, 4 Meg of RAM for Windows 95, 8 Meg of RAM for Windows NT;

- Keyboard and Microsoft-compatible mouse;

- HP Laserjet printer, or compatible, with at least 1 MB of memory;

Software

- Microsoft Windows 3.1 or Windows for Workgroups 3.11, Windows 95, or Windows NT;

- Expanded memory manager such as QEMM, 386MAX, or EMM386 while operating in the Microsoft Windows 3.1 or Windows for Workgroups 3.11 environments;

In addition to the PMO Workstation to manage the data developed by the SRCM analysis, EPRI has funded enhancements to the PMO Workstation to: automate the component PM task selection, provide system templates and automation of the living program. These features are designed to make more efficient the generation of SRCM results while providing sound technical and consistent results. The living program enhancement is to facilitate all aspects of maintenance program updating. The living program tool guides the reviewer on how to make changes, document the decisions, and maintain a historical file. It is also designed to link directly to the computerized maintenance management system (CMMS) to obtain historical work order records and to import new changes to the maintenance program. The workstation enhancements will be available in 1998.

An EPRI user group will be funded to allow for direct inputs from users on enhancements, modifications, and other aspects of the workstation. Periodic meetings and newsletters will be the major means of interface.

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IMPLEMENTING SRCM RESULTS

The results from an SRCM analysis include the addition of new PM tasks or the deletion, modification, or retention of existing tasks. For the tasks to be retained, no effort is required for implementation other than ensuring the tasks are packaged and planned appropriately. For new tasks, determining whether it is for a critical component or not and the type of PM task (e.g., condition monitoring, operator rounds, PDM, time-directed, or testing task) is necessary to understand the importance and effort required for implementation. In fact, these recommendations tend to be the most time consuming, particularly when the recommendation is for a new PDM activity. For modification or deletion of current tasks, the activity is merely updating the task frequency or deleting the task from the CMMS. Task information contained in the CMMS may include specific direction to the maintenance crafts-man on what maintenance actions are required as well as what maintenance history information is needed. Emphasis is placed on what actions are required not on how to perform the actions.

Full implementation is achieved when an executable PM program is contained within the CMMS using the SRCM analyses as its bases. This will in-turn require updating the SRCM analyses when changes of the maintenance program are required. The living program is designed to manage the change to the SRCM analyses.

The on-going work under EPRI W03889-01 provides recommendations for continued maintenance program improvements. One such improvement opportunity has been identified which allows a utility to ensure adequate and optimum implementation of the SRCM analysis. The contractor identifies successes and difficulties in transferring analysis results to implementable tasks by reviewing the plants implementation product.

This effort will compare an actual component SRCM PM task CMMS implementation with the original intent of the analysis recommendation. Will the proper execution of the developed task (job list, checklists, etc.) within the CMMS system address the failure mechanisms to be prevented. All SRCM analysis recommendations are reviewed.

The utility provides the contractor electronic or hard copy detail of each task implementation by system. The contractor compares the implemented task information against the analysis. Marked-up tasks are provided to the utility for their use.

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LIVING PROGRAM

The objectives of the Living Program are to: 1) ensure that design, unit mission and operation changes are reflected in PM program 2) ensure that new maintenance technologies are optimally used in the PM program 3) track maintenance experience to confirm that the bases for the recommendations remain valid and that they are still effective and 4) keep current the SRCM decision basis.

A Living Program procedure defining responsibility for the program, detailing the program elements, and specifying the schedule for reviews and updates is one of the EPRI SRCM program deliverables.

The Living Program must have a complete listing of the system analyses, PM recommendations, and PM task implementation status.

Elements of the Living Program include:

1. Tracking and close-out of open items from the SRCM analyses implementation.

2. Completing timely PM change requests reviews for components with SRCM evaluations.

3. Reviewing plant modifications

4. Reviewing SRCM and PM program effectiveness by monitoring and trending maintenance history

5. Periodically reviewing new predictive maintenance capabilities, and assisting maintenance personnel with optimizing application of new technologies.

The approach described above provides a cost effective method for developing a reliability-based "Living" PM program. The approach uses a thorough, proven methodology for comprehensive analyses of plant components and systems. It utilizes an approach based on RCM principles that are the most cost effective while maintaining proper technical rigor.

The resulting PM program enhances plant safety and reliability while focusing maintenance resources on components that are important to key system functions. The program is structured to prevent dominant and recurring failure modes. This program application approach identifies proper tasks with frequencies that are applicable and cost-effective in preventing important components. It provides a thorough, documented basis for doing or not doing PM tasks while substituting unnecessary tasks such as scheduled overhauls with predictive maintenance tasks when appropriate.

EPRI is funding continued software development to reduce the cost of Living Program implementation by linking the PMO Workstation with the plant computer maintenance management system (CMMS). The PMO Workstation Living Program software enhancement will reduce the time required to periodically updating the SRCM analysis and subsequent equipment task selection by using actual operating and maintenance experience history stored in the CMMS.

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FUTURE PLANS

Since SRCM integrates, interfaces and affects many plant programs, there are several activities envisioned to help EPRI members continue reducing production costs.

The development of enhancements to the current SRCM program is envisioned to include the following:

1. SRCM User's group
2. Implementation support
3. Continued templates data enhancement
4. Living program support

Areas that seem to be a natural maintenance optimization technology or processes extension include:

1. Reliability Modeling
2. Spare Parts inventory
3. Reliability centered design and operation

Further concept refinement is required before action in these potential interest areas can begin. Appendix C describes reliability modeling initial concepts.

A

PMO WORK PRODUCTS - SAMPLE SYSTEM STUDY

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Date: 5/29/199

Functional Failure Analysis - Functions

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3

System: FUEL HANDLING

ID	Function
01.	PROVIDE ADEQUATE CAPABILITY TO ACCEPT COAL AND TRANSFER THE COAL TO STOCKPILES. (DH)
02.	TRANSPORT THE COAL FROM THE STOCKPILES TO THE COAL PREPARATION AND SILO FILL SYSTEM. (DI)
03.	PREPARE THE COAL AND DELIVER IT TO THE POWERHOUSE COAL BUNKERS. (DJ)
04.	OBTAIN ACCURATE WEIGHT TOTALS OF THE COAL AND PROVIDE REPRESENTATIVE COAL SAMPLES FOR ANALYSIS. (DK)
05.	MINIMIZE COAL DUST ESCAPE TO THE ENVIRONMENT. (DL)

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Functional Failure Analysis - Functional Failures

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

ID	Functional Failure	Analyzed?	Remarks
01.01	FAILS TO PROVIDE ADEQUATE CAPABILITY TO ACCEPT COAL AND TRANSFER THE COAL TO STOCKPILES.	Yes	Dumper, Conveyors 1, 2 & 7
02.01	FAILS TO TRANSPORT THE COAL FROM THE STOCKPILES TO THE COAL PREPARATION AND SILO FILL SYSTEM.	Yes	Stacker/Reclaimer, Reclaim feeders, Emergency Reclaim
03.01	FAILS TO PREPARE THE COAL AND DELIVER IT TO THE POWERHOUSE COAL BUNKERS.	Yes	Conveyors 3, 4A/B, 5A/B, 6A/B, 10, Crushers, Magnetic Separators, Silos, Cascade Conveyors
04.01	FAILS TO OBTAIN ACCURATE WEIGHT TOTALS OF THE COAL AND PROVIDE REPRESENTATIVE COAL SAMPLES FOR ANALYSIS.	Yes	Belt Scales, "As Received" and "As Fired" Sampling
05.01	FAILS TO MINIMIZE COAL DUST ESCAPE TO THE ENVIRONMENT.	Yes	Dust Collectors, Exhaust Fans, Filters

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

01.01 --> FAILS TO PROVIDE ADEQUATE CAPABILITY TO ACCEPT COAL AND TRANSFER THE COAL TO STOCKPILES.

Functional Failure / Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
06DHBRK 1B1 ---> DUMPER MOTOR BRAKE (WEST)	BRAKE --> FAILS TO DISENGAGE; FAILS TO ENGAGE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ; OPERATOR ACTION REQUIRED;	No	POSS DAMAGE TO DUMPER MOTOR IF BRAKE FAILS TO OPERATE PROPERLY
06DHBRK 1B2 ---> DUMPER MOTOR BRAKE (EAST).	BRAKE --> FAILS TO DISENGAGE; FAILS TO ENGAGE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ; OPERATOR ACTION REQUIRED;	No	POSS DAMAGE TO DUMPER MOTOR IF BRAKE FAILS TO OPERATE PROPERLY
06DHBRK 1C2 ---> POSITIONER HAULAGE BRAKE.	BRAKE --> FAILS TO ENGAGE; FAILS TO DISENGAGE;	OPERATOR ACTION REQUIRED;	No	IF BRAKE FAILS, IT COULD RESULT IN IMPROPER POSITIONING OF RAIL CAR
06DHBRK 1C3 ---> POSITIONER ARM MOTOR BRAKE.	BRAKE --> FAILS TO ENGAGE; FAILS TO DISENGAGE;	OPERATOR ACTION REQUIRED;	No	IF BRAKE FAILS, IT COULD RESULT IN IMPROPER POSITIONING OF RAIL CAR
06DHFAN 301 ---> POSITIONER HAULAGE MOTOR COOLING FAN	FAN --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ;	No	POSSIBLE DAMAGE TO HAULAGE MOTOR IF FAN FAILS
06DHFDR 1A1 ---> TRACK HOPPER FEEDER 'A'	FEEDER --> FAILS TO OPERATE PROPERLY;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER AND ONLY TWO ARE REQUIRED FOR NORMAL OPERATION
06DHFDR 1B1 ---> TRACK HOPPER FEEDER 'B'	FEEDER --> FAILS TO OPERATE PROPERLY;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER AND ONLY TWO ARE REQUIRED FOR NORMAL OPERATION
06DHFDR 1C1 ---> TRACK HOPPER FEEDER 'C'	FEEDER --> FAILS TO OPERATE PROPERLY;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER AND ONLY TWO ARE REQUIRED FOR NORMAL OPERATION

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Functional Failure	Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
	06DHGATE1A1 ---> TRACK HOPPER FEEDER GATE A	GATE --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS
	06DHGATE1B1 ---> TRACK HOPPER FEEDER GATE B	GATE --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS
	06DHGATE1C1 ---> TRACK HOPPER FEEDER GATE C	GATE --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS
	06DHHTR 1A ---> CONVEYOR 1 GEAR REDUCER HEATER 1A	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ; OPERATOR ACTION REQUIRED; LOSS OF REDUNDANCY;	No	TWO HEATERS FOR CONVEYOR 1 GEAR REDUCER (REDUNDANT??); IF HEATER FAILS COULD RESULT IN LOSS OF LUBRICATION
	06DHHTR 1B ---> CONVEYOR 1 GEAR REDUCER HEATER 1B	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S).; OPERATOR ACTION REQUIRED; LOSS OF REDUNDANCY;	No	TWO HEATERS FOR CONVEYOR 1 GEAR REDUCER (REDUNDANT??); IF HEATER FAILS COULD RESULT IN LOSS OF LUBRICATION
	06DHHTR 1C2 ---> DUMPER POSITIONER HAULAGE GEAR RDR HTR	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ;	No	POSSIBLE DAMAGE TO GEAR REDUCER IN COLD WEATHER (LOSS OF LUBRICATION)
	06DHHTR 1C3 ---> DUMPER POSITIONER ARM GEAR RDR HTR	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	POSSIBLE DAMAGE TO SIGNIFICANT PLANT COMPONENT(S) ;	No	POSSIBLE DAMAGE TO GEAR REDUCER IN COLD WEATHER (LOSS OF LUBRICATION)
	06DHHTR 305A ---> DUMPER CAR CLAMP HYD UNIT HEATER 1	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Functional Failure	Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
	06DHHTR 305B ---> DUMPER CAR CLAMP HYD UNIT HEATER 2	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHTR 305C ---> DUMPER CAR CLAMP HYD UNIT HEATER 3	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHTR 305D ---> DUMPER CAR CLAMP HYD UNIT HEATER 4	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHTR 321A ---> DUMPER TRUCK LOCK HYD UNIT HEATER 321A	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHTR 321B ---> DUMPER TRUCK LOCK HYD UNIT HEATER 321B	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHTR 3922 ---> DUMPER TRACK HOPPER GATE HYD UNIT HEATER	HEATER --> FAILS TO ENERGIZE/REMAIN ENERGIZED; FAULTS TO LINE;	OPERATOR ACTION REQUIRED;	No	FAILURE OF HEATER MAY RESULT IN LOSS OF HYDRAULICS IN COLD WEATHER
	06DHHX 3901 ---> DUMPER TRUCK LOCK HYD UNIT OIL COOLER	COOLER --> HAS LOSS OF FUNCTION/LOSS OF HEAT TRANSFER;	OPERATOR ACTION REQUIRED;	No	FAILURE OF COOLER MAY RESULT IN LOSS OF HYDRAULICS DUE TO OVERHEATING
	06DHHYCL1A1 ---> DUMPER TRACK HOPPER GATE A HYD CYL A	HYDRAULIC VALVE OPERATOR --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Functional Failure	Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
	06DHHYCL1B1 ---> DUMPER TRACK HOPPER GATE A HYD CYL B	HYDRAULIC VALVE OPERATOR --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS
	06DHHYCL1C1 ---> DUMPER TRACK HOPPER GATE A HYD CYL C	HYDRAULIC VALVE OPERATOR --> FAILS TO OPEN; FAILS TO CLOSE;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDER GATES FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPS
	06DHMO 1 ---> CONVEYOR 1 MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	IF CONVEYOR 1 FAILS TO OPERATE, EMERGENCY RECLAIM AVAILABLE UNTIL REPAIRED
	06DHMO 1A1 ---> TRACK HOPPER FEEDER "A" MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPERATION
	06DHMO 1B1 ---> TRACK HOPPER FEEDER "B" MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPERATION
	06DHMO 1C1 ---> TRACK HOPPER FEEDER "C" MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	LOSS OF REDUNDANCY; OPERATOR ACTION REQUIRED;	No	THERE ARE THREE FEEDERS FROM THE TRACK HOPPER; TWO FEEDERS REQUIRED FOR NORMAL OPERATION
	06DHMO 1C2 ---> COAL CAR POSITIONER HAULAGE MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	IF MOTOR FAILS, IT MAY CAUSE IMPROPER POSITIONING OF RAIL CAR
	06DHMO 1C3 ---> DUMPER POSITIONER ARM MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	IF MOTOR FAILS, IT COULD RESULT IN IMPROPER POSITIONING OF RAIL CAR

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Functional Failure	Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
	06DHMO 305A ---> DUMPER CAR CLAMP HYD UNIT 1 MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHMO 305B ---> DUMPER CAR CLAMP HYD UNIT 2 MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHMO 305C ---> DUMPER CAR CLAMP HYD UNIT 3 MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHMO 305D ---> DUMPER CAR CLAMP HYD UNIT 4 MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHMO 321A/B ---> DUMPER TRUCK LOCK HYD PUMP MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER TRUCK LOCK
	06DHMO B1 ---> CAR ROTARY DUMPER WEST MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	WITHOUT MOTOR, DUMPER INOPERABLE
	06DHMO B2 ---> CAR ROTARY DUMPER EAST MOTOR	MOTOR --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	WITHOUT MOTOR, DUMPER INOPERABLE
	06DHP 305A ---> DUMPER CAR CLAMP HYD UNIT 1 PUMP	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START;	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP

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Criticality Analysis

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Functional Failure	Component ID	Failure Mode(s)	Failure Effect(s)	Critical?	Remarks
		EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);			
	06DHP 305B ---> DUMPER CAR CLAMP HYD UNIT 2 PUMP	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START; EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHP 305C ---> DUMPER CAR CLAMP HYD UNIT 3 PUMP	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START; EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHP 305D ---> DUMPER CAR CLAMP HYD UNIT 4 PUMP	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START; EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER CLAMP
	06DHP 321A ---> DUMPER TRUCK LOCK HYD PUMP 321A	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START; EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER TRUCK LOCK
	06DHP 321B ---> DUMPER TRUCK LOCK HYD PUMP 321B	MOTOR DRIVEN PUMP --> FAILS TO RUN (INCLUDES DEGRADED OPERATION); FAILS TO START; EXTERNALLY LEAKS (APPLIES TO WORKING FLUID ONLY);	OPERATOR ACTION REQUIRED;	No	LOSS OF HYDRAULICS TO DUMPER TRUCK LOCK
	06DHPEL 301 ---> POSITIONER PHOTOELECTRIC LIGHT	ELEMENT --> HAS NO OUTPUT;	OPERATOR ACTION REQUIRED;	No	LOSS OF LIGHT COULD RESULT IN

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Critical Task Selection Summary Report
(Critical Tasks only)

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
03DJBSC 302 --> CASCADE CONV 302 BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR) ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 303 --> CASCADE CONV 303 BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 304 --> CASCADE CONV 304 BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				

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Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	

03DJBSC 306 --> CASCADE CONV 306 BACKSTOP CLUTCH

MCU --> CLUTCH

Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE;
Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;

Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	

03DJBSC 307 --> CASCADE CONV 307 BACKSTOP CLUTCH

MCU --> CLUTCH

Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE;
Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;

Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS	6M	ELEC	

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Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	FOR THE ASSOCIATED CONVEYOR.			
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR) ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 5A --> CONVEYOR 5A BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR) ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 5B --> CONVEYOR 5B BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 6A --> CONVEYOR 6A BACKSTOP CLUTCH				

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Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJBSC 6B --> CONVEYOR 6B BACKSTOP CLUTCH				
MCU --> CLUTCH				
Failure Mode(s) --> FAILS TO ENGAGE; FAILS TO DISENGAGE; Failure Cause(s) --> BROKEN/BOUND SPRING; DISC/SEAT WEAR; LINKAGE BINDING; LOOSE PARTS/DEFECTIVE CONNECTIONS; SUBCOMPONENT FAILURE;				
	DEVELOP A SAMPLING PROGRAM TO DISASSEMBLE AND INSPECT THE BACKSTOP CLUTCHES FOR THE COAL HANDLING CONVEYORS BASED ON REVIEW OF FAILURE HISTORY AND FREQUENCY OF USE. IT SHOULD BE SUCH THAT EACH CLUTCH IS INSPECTED WITHIN A 5 YR TIME FRAME.	ONCE	ENGR	TASK DESCRIPTION TO BE DEVELOPED
	VERIFY PROPER OPERATION OF CLUTCH DURING FUNCTIONAL TEST OF EMERGENCY PULL CORDS FOR THE ASSOCIATED CONVEYOR.	6M	ELEC	
	VISUALLY CHECK OIL (SIGHTGLASS LEVEL, SEDIMENT, COLOR). ADD/REPLACE AS REQUIRED.	1M	COAL HAND	
03DJCNVR10 --> CONVEYOR 10				
MCO --> CONVEYOR				
Failure Mode(s) --> FAILS TO OPERATE PROPERLY; Failure Cause(s) --> BEARING SEIZURE; DEGRADED/LOSS OF LUBRICATION; GEAR WEAR; LOOSE PARTS/DEFECTIVE CONNECTIONS; UNCOUPLING FROM DRIVER;				
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND	

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Component ID Type	Recommended Task	Frequency	Resp.Disclpl	Recommended Bases
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND	
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR	
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.

03DJCNVR301 --> CASCADE CONVEYOR 301

MCO --> CONVEYOR

Failure Mode(s) --> FAILS TO OPERATE PROPERLY;
Failure Cause(s) --> BEARING SEIZURE; DEGRADED/LOSS OF LUBRICATION; GEAR WEAR; LOOSE PARTS/DEFECTIVE CONNECTIONS; UNCOUPLING FROM DRIVER;

Component ID Type	Recommended Task	Frequency	Resp.Disclpl	Recommended Bases
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND	
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND	
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR	
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.

03DJCNVR302 --> CASCADE CONVEYOR 302

MCO --> CONVEYOR

Failure Mode(s) --> FAILS TO OPERATE PROPERLY;
Failure Cause(s) --> BEARING SEIZURE; DEGRADED/LOSS OF LUBRICATION; GEAR WEAR; LOOSE PARTS/DEFECTIVE CONNECTIONS; UNCOUPLING FROM DRIVER;

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Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND	
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND	
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR	
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.

03DJCNVR303 --> CASCADE CONVEYOR 303

MCO --> CONVEYOR

Failure Mode(s) --> FAILS TO OPERATE PROPERLY;
Failure Cause(s) --> BEARING SEIZURE; DEGRADED/LOSS OF LUBRICATION; GEAR WEAR; LOOSE PARTS/DEFECTIVE CONNECTIONS; UNCOUPLING FROM DRIVER;

Component ID Type	Recommended Task	Frequency	Resp.Discipl	Recommended Bases
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND	
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND	
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR	
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.

03DJCNVR304 --> CASCADE CONVEYOR 304

MCO --> CONVEYOR

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Component	Component Type	Failure Modes	Non-Critical Evaluation Criteria	Critical?
03DJBS 301 --> CONVEYOR 10 BELT SCALE	MSC --> SCALE	FAILS TO PROVIDE PROPER OUTPUT;	High repair/replacement cost or excessive corrective maintenance? ;Component important to support maintenance or operations activities (e.g. important indication)? ;	No
03DJBS 302 --> CASCADE CONV 307 BELT SCALE	MSC --> SCALE	FAILS TO PROVIDE PROPER OUTPUT;	High repair/replacement cost or excessive corrective maintenance? ;Component important to support maintenance or operations activities (e.g. important indication)? ;	No
03DJCNVR5A --> CONVEYOR 5A	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJCNVR5B --> CONVEYOR 5B	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJCNVR6A --> CONVEYOR 6A	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJCNVR6B --> CONVEYOR 6B	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJCRSH1A --> COAL CRUSHER 1A	MRU --> CRUSHER	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJCRSH1B --> COAL CRUSHER 1B	MRU --> CRUSHER	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJDCV 6A1 --> DRIBBLE CONVEYOR 6A	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;		No
03DJDCV 6B1 --> DRIBBLE CONVEYOR 6B	MCO --> CONVEYOR	FAILS TO OPERATE PROPERLY;		No
03DJFDR 1A2 --> COAL CRUSHER FEEDER 1A	MFD --> FEEDER	FAILS TO OPERATE PROPERLY;	Simple maintenance to maintain instrinsic reliability? ;	No
03DJFDR 1B2 --> COAL CRUSHER FEEDER 1B	MFD --> FEEDER	FAILS TO OPERATE PROPERLY;	Simple maintenance to maintain instrinsic reliability? ;	No
03DJGATE1A2 --> CRUSHER HOPPER GATE 1A	MGA --> GATE	FAILS TO OPEN;FAILS TO CLOSE;	Simple maintenance to maintain instrinsic reliability? ;	No
03DJGATE1A3 --> CRUSHER BYPASS GATE 1A	MGA --> GATE	FAILS TO OPEN;FAILS TO CLOSE;	Simple maintenance to maintain instrinsic reliability? ;	No
03DJGATE1B2 --> CRUSHER HOPPER GATE 1B	MGA --> GATE	FAILS TO OPEN;FAILS TO CLOSE;	Simple maintenance to maintain instrinsic reliability? ;	No

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03DJGATE1B3 --> CRUSHER BYPASS GATE 1B	MGA --> GATE	FAILS TO OPEN;FAILS TO CLOSE;	Simple maintenance to maintain instrinsic reliability? ;	No
03DJGATE301 --> TRNSF HOPPER FEEDER GATE 301	MGA --> GATE	FAILS TO CLOSE;		No
03DJGATE302 --> TRNSF HOPPER FEEDER GATE 302	MGA --> GATE	FAILS TO CLOSE;		No
03DJHCP 5A --> CONVEYOR 5A HYDRAULIC COUPLING	MCP --> PUMP COUPLING	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJHCP 5B --> CONVEYOR 5B HYDRAULIC COUPLING	MCP --> PUMP COUPLING	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJHCP 6A --> CONVEYOR 6A HYDRAULIC COUPLING	MCP --> PUMP COUPLING	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJHCP 6B --> CONVEYOR 6B HYDRAULIC COUPLING	MCP --> PUMP COUPLING	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJHPR 1C --> CRUSHER SURGE HOPPER	MHP --> HOPPER	EXTERNALLY LEAKS;PLUGS;		No
03DJHPR 301 --> TRNSF HOPPER 301	MHP --> HOPPER	EXTERNALLY LEAKS;PLUGS;		No
03DJHTR 3901 --> CONVEYOR 5A GEAR REDUCER HEATER	EHR --> HEATER	FAILS TO ENERGIZE/REMAIN ENERGIZED;FAULTS TO LINE;		No
03DJHTR 3902 --> CONVEYOR 5B GEAR REDUCER HEATER	EHR --> HEATER	FAILS TO ENERGIZE/REMAIN ENERGIZED;FAULTS TO LINE;		No
03DJHTR 3903 --> CONVEYOR 6A GEAR REDUCER HEATER	EHR --> HEATER	FAILS TO ENERGIZE/REMAIN ENERGIZED;FAULTS TO LINE;		No
03DJHTR 3904 --> CONVEYOR 6B GEAR REDUCER HEATER	EHR --> HEATER	FAILS TO ENERGIZE/REMAIN ENERGIZED;FAULTS TO LINE;		No
03DJMO 1A --> COAL CRUSHER 1A MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 1A2 --> COAL CRUSHER FEEDER 1A MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No

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03DJMO 1B --> COAL CRUSHER 1B MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 1B2 --> COAL CRUSHER FEEDER 1B MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 5A --> CONVEYOR 5A MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 5B --> CONVEYOR 5B MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 6A --> CONVEYOR 6A MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJMO 6B --> CONVEYOR 6B MOTOR	EMO --> MOTOR	FAILS TO RUN (INCLUDES DEGRADED OPERATION);FAILS TO START;	High repair/replacement cost or excessive corrective maintenance? ;	No
03DJRGR 5A --> CONVEYOR 5A GEAR REDUCER	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;Causes failure of another significant component? ;	No
03DJRGR 5B --> CONVEYOR 5B GEAR REDUCER	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;Causes failure of another significant component? ;	No
03DJRGR 6A --> CONVEYOR 6A GEAR REDUCER	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;Causes failure of another significant component? ;	No
03DJRGR 6A1 --> DRIBBLE CONVEYOR 6A GEAR REDUCER 6A1	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;		No
03DJRGR 6A1A --> DRIBBLE CONVEYOR 6A GEAR REDUCER 6A1A	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;		No
03DJRGR 6B --> CONVEYOR 6B GEAR REDUCER	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;	High repair/replacement cost or excessive corrective maintenance? ;Causes failure of another significant component? ;	No
03DJRGR 6B1 --> DRIBBLE CONVEYOR 6B GEAR REDUCER 6B1	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;		No

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Component	Component Type	Failure Modes	Non-Critical Evaluation Criteria	Critical?
03DJRGR 6B1A --> DRIBBLE CONVEYOR 6B GEAR REDUCER 6B1A	MGB --> GEAR BOX	FAILS TO OPERATE PROPERLY;		No
03DJVBR 3901 --> CRUSHER SURGE HOPPER VIBRATOR 3901	MMD --> MECHANICAL DEVICE	FAILS TO OPERATE AS REQUIRED;		No
03DJVBR 3902 --> CRUSHER SURGE HOPPER VIBRATOR 3902	MMD --> MECHANICAL DEVICE	FAILS TO OPERATE AS REQUIRED;		No
03DJVBR 3932 --> TRNSF HOPPER 302 VIBRATOR	MMD --> MECHANICAL DEVICE	FAILS TO OPERATE AS REQUIRED;		No
03DJVBR 3933 --> TRNSF HOPPER 301 VIBRATOR	MMD --> MECHANICAL DEVICE	FAILS TO OPERATE AS REQUIRED;		No
03DKBS 4 --> CONVEYOR 5A BELT SCALE	MSC --> SCALE	FAILS TO PROVIDE PROPER OUTPUT;		No
03DKBS 5 --> CONVEYOR 5B BELT SCALE	MSC --> SCALE	FAILS TO PROVIDE PROPER OUTPUT;		No
03ECBKR 308B21 --> MCC BKR, CASCADE DIVERSION GATE 302A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B22 --> MCC BKR, CASCADE DIVERSION GATE 302B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B23 --> MCC BKR, CASCADE DIVERSION GATE 303A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B24 --> MCC BKR, CASCADE DIVERSION GATE 303B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B31 --> MCC BKR, CASCADE DIVERSION GATE 304A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B32 --> MCC BKR, CASCADE DIVERSION GATE 304B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B33 --> MCC BKR, TRANSFER HOPPER GATE 301	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B41 --> MCC BKR, BELT BRUSH - CASCADE CONV 301	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B42 --> MCC BKR, BELT	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No

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Component	Component Type	Failure Modes	Non-Critical Evaluation Criteria	Critical?
BRUSH - CASCADE CONV 302				
03ECBKR 308B43 --> MCC BKR, BELT BRUSH - CASCADE CONV 303	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B44 --> MCC BKR, BELT BRUSH - CASCADE CONV 304	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B45 --> MCC BKR, BELT BRUSH - CONVEYOR 10	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B46 --> MCC BKR, DRIBBLE CONVEYOR 6A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308B51 --> MCC BKR, BELT BRUSH - CONVEYOR 6A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C16 --> MCC BKR, CASCADE DIVERSION GATE 306A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C17 --> MCC BKR, CASCADE DIVERSION GATE 306B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C21 --> MCC BKR, CASCADE DIVERSION GATE 307A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C22 --> MCC BKR, CASCADE DIVERSION GATE 307B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C33 --> MCC BKR, BELT BRUSH - CASCADE CONV 305	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C34 --> MCC BKR, BELT BRUSH - CASCADE CONV 306	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C35 --> MCC BKR, BELT BRUSH - CASCADE CONV 307	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C36 --> MCC BKR, BELT BRUSH - CONVEYOR 6B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR 308C42 --> MCC BKR, TRANSFER HOPPER GATE 302	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No

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Non-Critical Component Evaluation Report

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component	Component Type	Failure Modes	Non-Critical Evaluation Criteria	Critical?
03ECBKR 308C43 --> MCC BKR, DRIBBLE CONVEYOR 6B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS11 --> MCC BKR, AFSS MAIN BREAKER	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS12 --> MCC BKR, AFSS CONTROL PANEL	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS13 --> MCC BKR, AFSS SAMPLE COLLECTOR CONT PNL	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS14 --> MCC BKR, AFSS SAMPLE CRUSHER	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS21 --> MCC BKR, AFSS SECONDARY BELT FEEDER	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR AFSS22 --> MCC BKR, AFSS PRIMARY BELT FEEDER	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR ARSS11 --> MCC BKR, ARSS MAIN BREAKER	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR C231 --> SUS BKR, CONVEYOR 5A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR C232 --> SUS BKR, CONVEYOR 5B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR CH2A25 --> MCC BKR, COAL CRUSHER HOPPER GATE 1A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR CH2A31 --> MCC BKR, COAL CRUSHER FEEDER 1A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR CH2A33 --> MCC BKR, BELT BRUSH - CONVEYOR 5A	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR CH2B24 --> MCC BKR, COAL CRUSHER HOPPER GATE 1B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No
03ECBKR CH2B26 --> MCC BKR, COAL CRUSHER FEEDER 1B	EMC --> MOTOR CONTROLLER	FAILS TO OPERATE PROPERLY;	Causes failure of another significant component? ;	No

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Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
03DJBS 301 --> CONVEYOR 10 BELT SCALE					
MSC --> SCALE					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?; Component important to support maintenance or operations activities (e.g. important indication)?;					
	PERFORM AN ENGINEERING STUDY TO MODIFY THE BELT SCALE CONTROLS SO THAT WATER FROM WASHDOWNS DOES NOT AFFECT THE ELECTRONICS.	ONCE	ENGR		No
	PERFORM CALIBRATION CHECK. LOOP CHECK TO FEEDER CONTROLS.	36M	E&I		No
03DJBS 302 --> CASCADE CONV 307 BELT SCALE					
MSC --> SCALE					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?; Component important to support maintenance or operations activities (e.g. important indication)?;					
	PERFORM AN ENGINEERING STUDY TO MODIFY THE BELT SCALE CONTROLS SO THAT WATER FROM WASHDOWNS DOES NOT AFFECT THE ELECTRONICS.	ONCE	ENGR		No
	PERFORM CALIBRATION CHECK. LOOP CHECK TO FEEDER CONTROLS.	36M	E&I		No
03DJCNVR5A --> CONVEYOR 5A					
MCO --> CONVEYOR					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;					
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND		No
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND		No
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR		No

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Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.	No

03DJCNVR5B --> CONVEYOR 5B

MCO --> CONVEYOR

Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;

Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND		No
CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND		No
PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR		No
PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.	No

03DJCNVR6A --> CONVEYOR 6A

MCO --> CONVEYOR

Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;

Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND		No
CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND		No
PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH	ONCE	ENGR		No

Plant Maintenance Optimizer Version 3.1
Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

Date: 5/29/1997

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
	GREASELESS BEARINGS.				
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.	No
03DJCNVR6B --> CONVEYOR 6B					
MCO --> CONVEYOR					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;					
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF PULLEYS. ADD/REPLACE AS REQUIRED.	3M	COAL HAND		No
	CHECK QUANTITY AND QUALITY OF LUBRICANT OF ROLLERS AND IDLERS. ADD/REPLACE AS REQUIRED.	6M	COAL HAND		No
	PERFORM COST BENEFIT STUDY OF REPLACING ALL CONVEYOR BEARINGS WITH GREASELESS BEARINGS.	ONCE	ENGR		No
	PERFORM VISUAL INSPECTION. CHECK CONDITION AND OPERATION OF BELT, COUPLING, ROLLERS, SCRAPERS, BELT BRUSHES, SIDE RUBBERS AND DEFLECTOR SHIELDS. REPAIR/REPLACE AS REQUIRED.	1M	COAL HAND	FAILURE OF THESE COMPONENTS LEADS TO COAL BUILDUP ON BELT, SAFETY HAZARD OF SPILLAGE, TIME CONSUMING CLEANUP, ETC.	No
03DJCRSH1A --> COAL CRUSHER 1A					
MRU --> CRUSHER					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;					
	PERFORM LUBE OIL SAMPLE ANALYSIS (FERROGRAPHY, SEDIMENT, WATER, ETC...). ESTABLISH ACTION LEVELS AND TREND RESULTS.	SEASONAL	LAB	TASK DESCRIPTION TO BE DEVELOPED. TASK PERFORMED 1M PER SEASON.	No
	PERFORM VIBRATION MONITORING. ESTABLISH BASELINE, SET ACTION LEVELS AND TREND.	SEASONAL	ENGR	TASK DESCRIPTION TO BE DEVELOPED. TASK PERFORMED 1M PER SEASON.	No

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Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
03DJCRSH1B --> COAL CRUSHER 1B					
MRU --> CRUSHER					
Evaluation Criteria --> High repair/replacement cost or excessive corrective maintenance?;					
	PERFORM LUBE OIL SAMPLE ANALYSIS (FERROGRAPHY, SEDIMENT, WATER, ETC...). ESTABLISH ACTION LEVELS AND TREND RESULTS.	SEASONAL	LAB	TASK DESCRIPTION TO BE DEVELOPED. TASK PERFORMED 1M PER SEASON.	No
	PERFORM VIBRATION MONITORING. ESTABLISH BASELINE, SET ACTION LEVELS AND TREND.	SEASONAL	ENGR	TASK DESCRIPTION TO BE DEVELOPED. TASK PERFORMED 1M PER SEASON.	No
03DJDCV 6A1 --> DRIBBLE CONVEYOR 6A					
MCO --> CONVEYOR					
Evaluation Criteria -->					
	PMO has determined that this non-critical component should be RUN TO FAILURE and corrective maintenance performed.				No
03DJDCV 6B1 --> DRIBBLE CONVEYOR 6B					
MCO --> CONVEYOR					
Evaluation Criteria -->					
	PMO has determined that this non-critical component should be RUN TO FAILURE and corrective maintenance performed.				No
03DJFDR 1A2 --> COAL CRUSHER FEEDER 1A					
MFD --> FEEDER					
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					

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Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

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Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
	INSPECT FEEDER COUPLING, SPRINGS, CABLES AND DAMPENERS FOR EXCESSIVE WEAR AND DEGRADATION.	12M	MECH		No
03DJFDR 1B2 --> COAL CRUSHER FEEDER 1B					
MFD --> FEEDER					
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					
	INSPECT FEEDER COUPLING, SPRINGS, CABLES AND DAMPENERS FOR EXCESSIVE WEAR AND DEGRADATION.	12M	MECH		No
03DJGATE1A2 --> CRUSHER HOPPER GATE 1A					
MGA --> GATE					
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					
	CYCLE GATE TO CHECK FULL TRAVEL. SAMPLE ACTUATOR GREASE, ADD/REPLACE AS NECESSARY. VERIFY PROPER TORQUE/LIMIT SWITCH SETTINGS.	12M	E&I		No
	PERFORM VISUAL INSPECTION FOR WEAR, CORROSION AND EROSION.	24M	MECH		No
03DJGATE1A3 --> CRUSHER BYPASS GATE 1A					
MGA --> GATE					
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					
	CYCLE GATE TO CHECK FULL TRAVEL.	12M	MECH		No
	PERFORM VISUAL INSPECTION FOR WEAR, CORROSION AND EROSION.	24M	MECH		No
03DJGATE1B2 --> CRUSHER HOPPER GATE 1B					
MGA --> GATE					

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Non-Critical Task Selection Summary Report
(Non-Critical Tasks only)

Date: 5/29/1997

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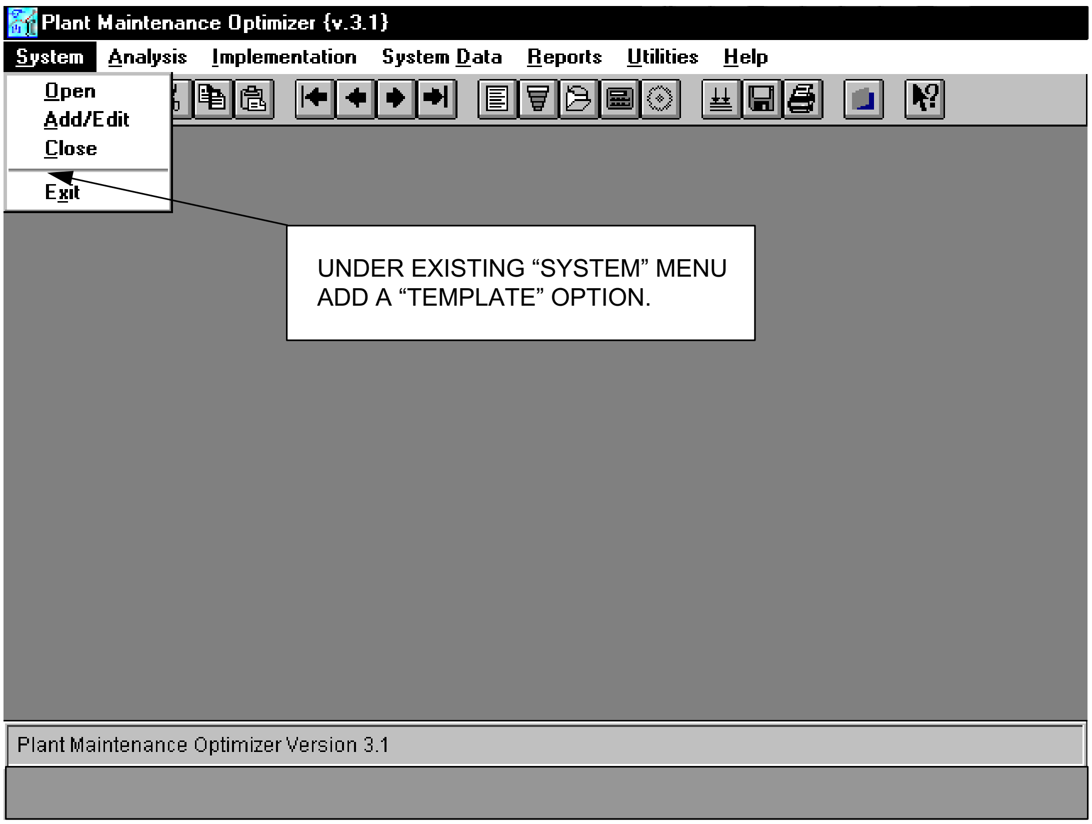
Plant: COUNCIL BLUFFS ENERGY CENTER UNIT 3
System: FUEL HANDLING

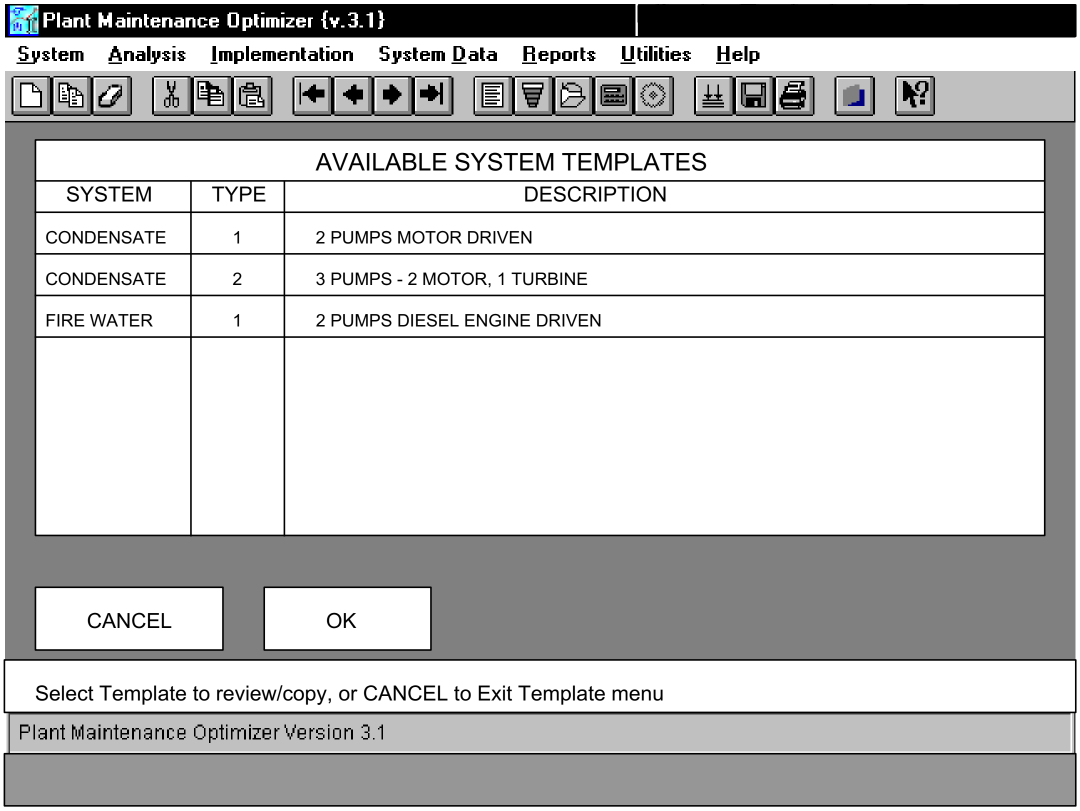
Component ID Type	Recommended Task	Frequency	Resp. Discipline	Recommended Bases	Critical?
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					
	CYCLE GATE TO CHECK FULL TRAVEL. SAMPLE ACTUATOR GREASE, ADD/REPLACE AS NECESSARY. VERIFY PROPER TORQUE/LIMIT SWITCH SETTINGS.	12M	E&I		No
	PERFORM VISUAL INSPECTION FOR WEAR, CORROSION AND EROSION.	24M	MECH		No
03DJGATE1B3 --> CRUSHER BYPASS GATE 1B					
MGA --> GATE					
Evaluation Criteria --> Simple maintenance to maintain instrinsic reliability?;					
	CYCLE GATE TO CHECK FULL TRAVEL.	12M	MECH		No
	PERFORM VISUAL INSPECTION FOR WEAR, CORROSION AND EROSION.	24M	MECH		No
03DJGATE301 --> TRNSF HOPPER FEEDER GATE 301					
MGA --> GATE					
Evaluation Criteria -->					
	PMO has determined that this non-critical component should be RUN TO FAILURE and corrective maintenance performed.				No
03DJGATE302 --> TRNSF HOPPER FEEDER GATE 302					
MGA --> GATE					
Evaluation Criteria -->					
	PMO has determined that this non-critical component should be RUN TO FAILURE and corrective maintenance performed.				No

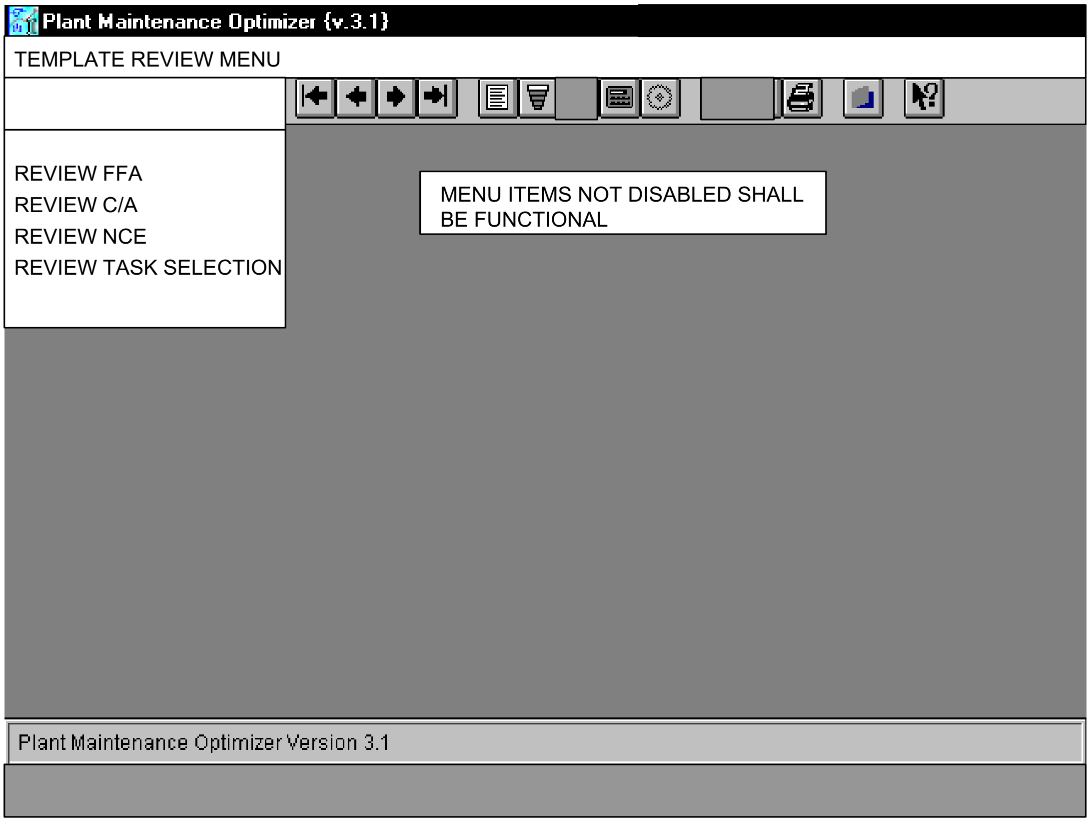
B

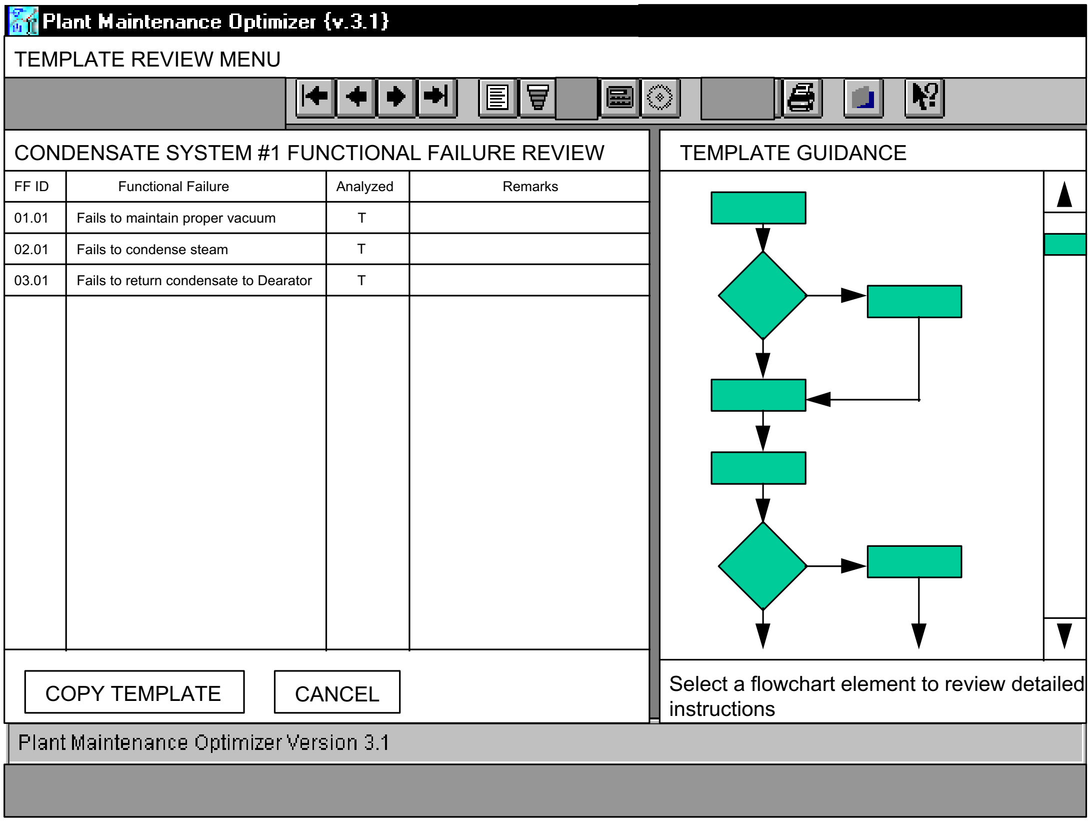
SYSTEM TEMPLATE SCREENS

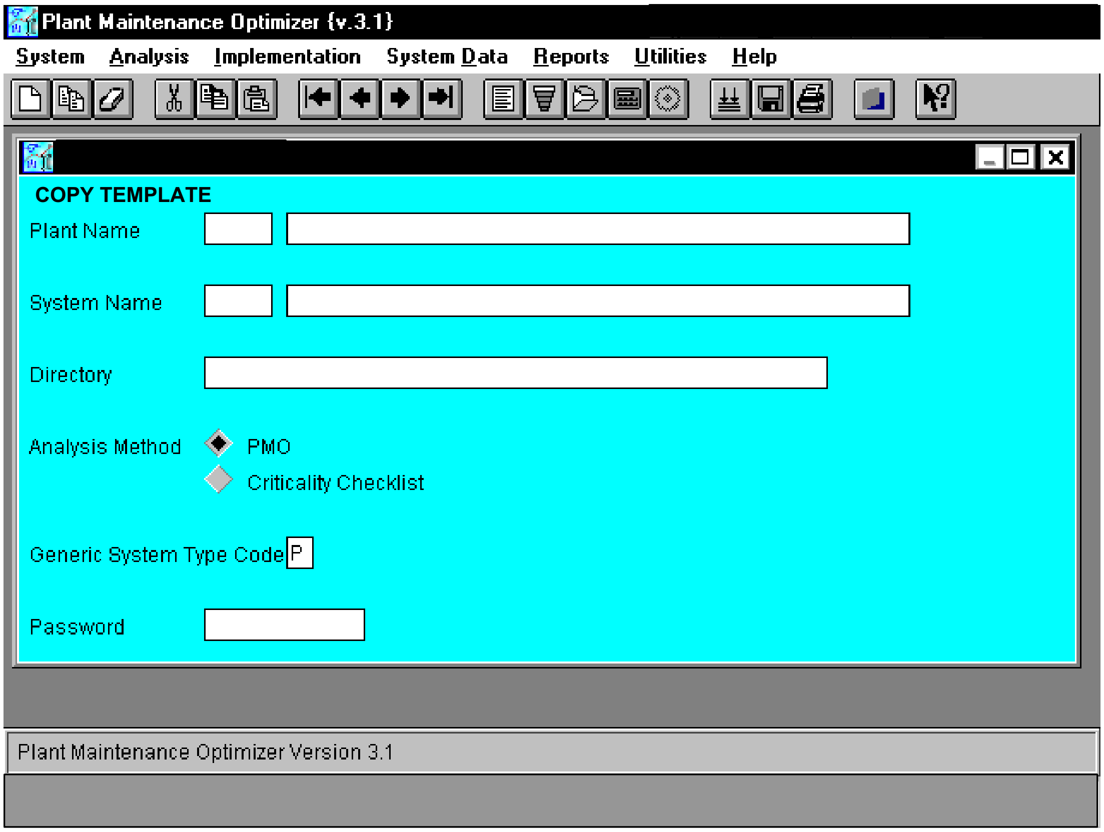


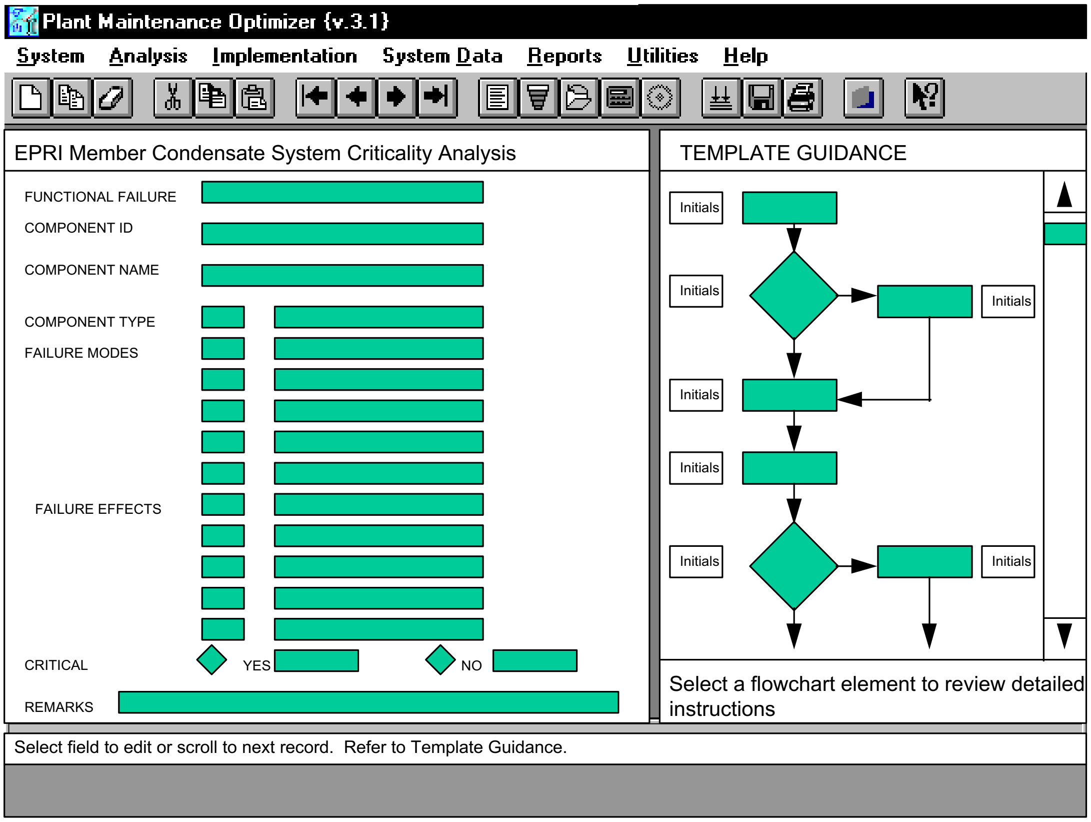
System Template Screens

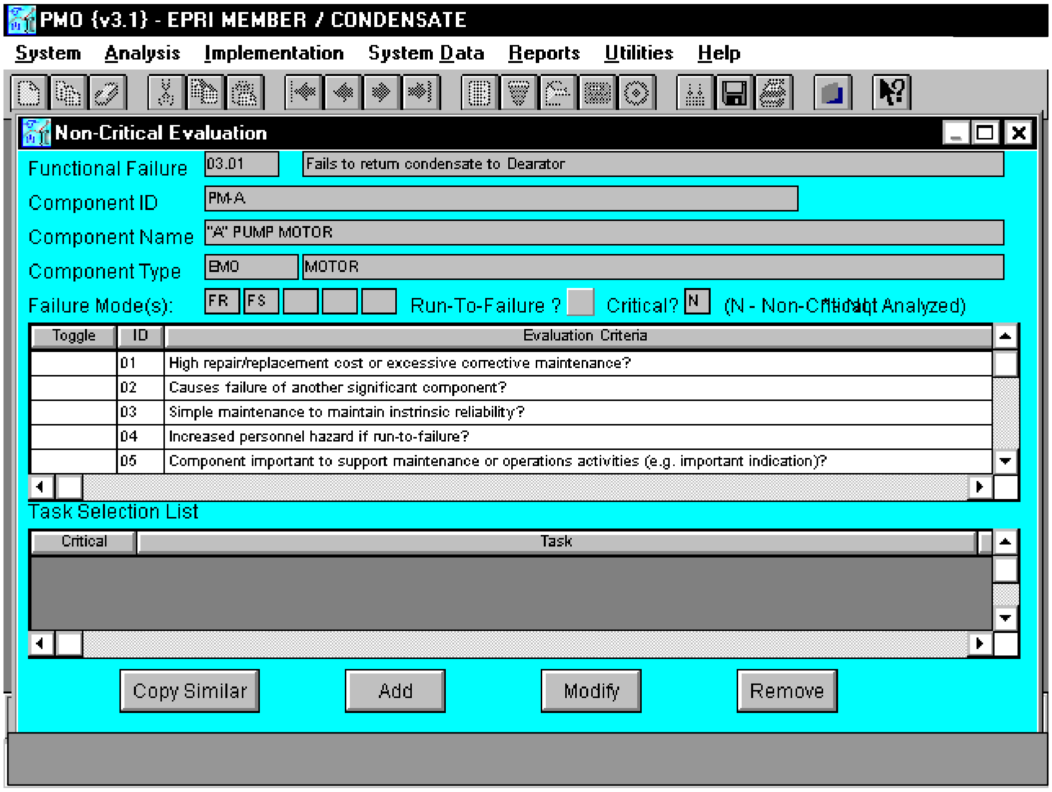


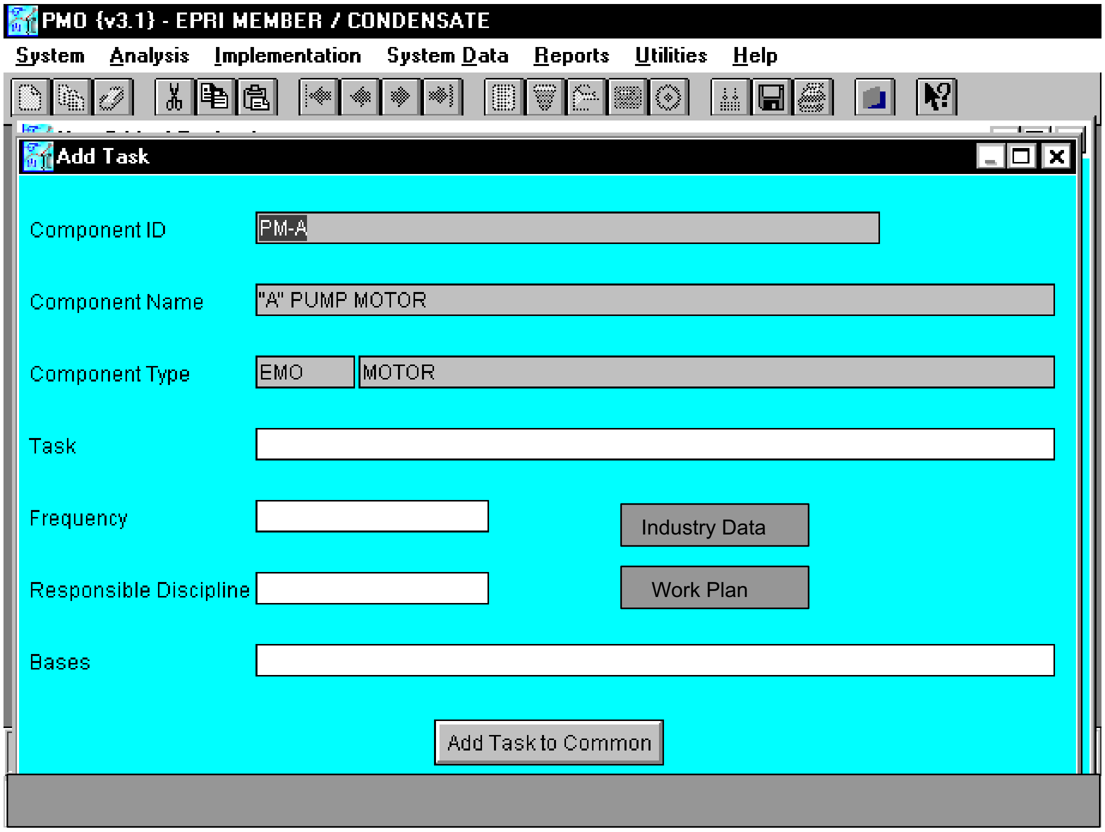

Plant Maintenance Optimizer {v.3.1}
TEMPLATE REVIEW MENU
REVIEW FFA
REVIEW C/A
REVIEW NCE
REVIEW TASK SELECTION
MENU ITEMS NOT DISABLED SHALL BE FUNCTIONAL
Plant Maintenance Optimizer Version 3.1


Plant Maintenance Optimizer {v.3.1}
TEMPLATE REVIEW MENU
CONDENSATE SYSTEM #1 FUNCTIONAL FAILURE REVIEW
FF ID
Functional Failure
Analyzed
Remarks
01.01
Fails to maintain proper vacuum
T
02.01
Fails to condense steam
T
03.01
Fails to return condensate to Dearator
T
COPY TEMPLATE
CANCEL
TEMPLATE GUIDANCE
Select a flowchart element to review detailed instructions
Plant Maintenance Optimizer Version 3.1


Plant Maintenance Optimizer {v.3.1}
System Analysis Implementation System Data Reports Utilities Help
COPY TEMPLATE
Plant Name
System Name
Directory
Analysis Method
PMO
Criticality Checklist
Generic System Type Code
P
Password
Plant Maintenance Optimizer Version 3.1


Plant Maintenance Optimizer {v.3.1}
System Analysis Implementation System Data Reports Utilities Help
EPRI Member Condensate System Criticality Analysis
FUNCTIONAL FAILURE
COMPONENT ID
COMPONENT NAME
COMPONENT TYPE
FAILURE MODES
FAILURE EFFECTS
CRITICAL
YES
NO
REMARKS
TEMPLATE GUIDANCE
Initials
Select a flowchart element to review detailed instructions
Select field to edit or scroll to next record. Refer to Template Guidance.


PMO {v3.1} - EPRI MEMBER / CONDENSATE
System Analysis Implementation System Data Reports Utilities Help
Non-Critical Evaluation
Functional Failure
03.01
Fails to return condensate to Dearator
Component ID
PM-A
Component Name
"A" PUMP MOTOR
Component Type
EMO
MOTOR
Failure Mode(s):
FR
FS
Run-To-Failure ?
Critical?
N
Toggle
ID
Evaluation Criteria
01
High repair/replacement cost or excessive corrective maintenance?
02
Causes failure of another significant component?
03
Simple maintenance to maintain instrinsic reliability?
04
Increased personnel hazard if run-to-failure?
05
Component important to support maintenance or operations activities (e.g. important indication)?
Task Selection List
Critical
Task
Copy Similar
Add
Modify
Remove


PMO {v3.1} - EPRI MEMBER / CONDENSATE
System
Analysis
Implementation
System Data
Reports
Utilities
Help
Add Task
Component ID
PM-A
Component Name
"A" PUMP MOTOR
Component Type
EMO
MOTOR
Task
Frequency
Industry Data
Responsible Discipline
Work Plan
Bases
Add Task to Common

C

APPLICATION OF PLANT RELIABILITY ASSESSMENT TECHNOLOGY TO ENHANCE POWER PLANT PERFORMANCE

Problem Statement

The deregulation of the electric power industry has put added pressures on utilities and power producers to exhaust all cost effective avenues to get better performance out of existing power plants. The vast majority of existing fossil fueled and nuclear powered thermal power plants were designed in an era when operating and maintenance costs were passed on to the consumer in highly regulated environment. As deregulation unfolds, the pressure to reduce operating and maintenance costs has been fierce. It is widely recognized that plant reliability performance and heat rate reduction offer the greatest potential for reducing operating and maintenance costs.

In recent years there has been great progress in improving plant reliability performance by such straightforward approaches as operating experience feedback, forced outage root cause analysis and heat rate improvement programs. However, there is a limit on the degree of plant performance enhancement that can be accomplished by addressing the causes of yesterday's performance problems. To be able to take the reliability performance to the next level and to approach the level of performance that can be supported by today's technologies, and to determine where future efforts should be focused, there is an important role for predictive reliability modeling of current operating plants. When coupled with reliability centered maintenance programs, predictive reliability modeling (PRM) can provide an invaluable tool to guide the important decisions that must be made to bring power generation reliability performance to its maximum achievable level.

What is Predictive Reliability Modeling (PRM) ?

Simply said, PRM is the application of reliability engineering technology to develop models and databases that can be use to predict the future reliability performance of a complex system, such as an electric power generation facility. Reliability modeling tools such as reliability block diagrams, fault trees and simulation techniques are used to predict such reliability performance measures as plant availability factor, capacity factor, forced outage rate, and expected annual costs of replacement power. These tools express the plant and system success criteria in terms of quantifiable data parameters such as component failure rates, duration of plant outages and the extent of energy production lost from any scenario involving a need for power reduction, trip or forced outage. While key results are obtained in terms of plant reliability performance indicators such as those listed above, modern state-of-the-art methods of reliability assessment can also be used to:

- Determine the importance of individual components and operator actions contributing to plant unavailability and capacity factor reductions. Use these importance indicators to set priorities for actions to improve performance.
- Identify and evaluate new design and operational features that improve plant performance.
- Predict the impacts of changes or trends in component performance to plant performance.
- Evaluate new strategies for testing and maintaining equipment and reallocate maintenance resources in a manner that will optimize performance.
- Monitor changes of plant configuration to evaluate risk of plant shutdown and how to control it.
- Evaluate maintenance issues such as impacts of planned maintenance schedules and spare parts inventory on plant performance.
- Determine the optimum schedules for shipping and storing fuel supplies to minimize disruptions in plant performance.

Is PRM an Established Technology ?

Yes, PRM has been around since the 1950's and is a product of the technology of reliability engineering and risk assessment. The Electric Power Research Institute has sponsored a computer software program known as UNIRAM which has been used extensively for this purpose. More recently, ERIN Engineering and Research, Inc. has developed a new and more powerful approach known as ***PLANTFORMA***® which expands on the capabilities of UNIRAM and offers great promise with respect to the ease and cost of its application to real problems. ***PLANTFORMA***® incorporates a more powerful solution scheme that was inspired in the field of probabilistic risk assessment (PRA). PRA is an offshoot of reliability engineering technology that emphasizes quantitative aspects of reliability prediction. Instead of modeling plant reliability factors in terms of component reliability factors as practiced in UNIRAM and alternative softwares developed for this purpose, ***PLANTFORMA®*** uses a scenario based framework that is more successful in modeling outages and losses in production the way they would actually occur in real life. As a result, it is easier to process data to support the associated models, and the reliability performance prediction are easily obtained and free of usually made simplifying assumptions.

How do I Implement *PLANTFORMA®* ?

The tasks of setting up the initial models, maintaining them and using them to support critical decisions to effect performance enhancements are facilitate through a very simple step by step process.

1. Definition of Plant and Systems Success Criteria
2. Fault Tree Construction
3. Minimal Cutset Determination
4. Definition of Scenarios for Each Cutset
5. Modeling and Quantification of Scenario Frequencies
6. Characterization of Scenario Impacts
7. Integrated Quantification of Reliability, Availability, and Capacity Factor
8. Analysis of Reliability Importance Measures
9. Sensitivity and Uncertainty Analysis

These steps are implemented interactively and seamlessly with ***PLANTFORMA®*** by the user who needs to be knowledgeable about all system engineering and operational characteristics of his system that could influence reliability, but does not need to have expertise in the specialized field of systems reliability assessment.

Proposed Demonstration Project

To demonstrate the application of ***PLANTFORMA®*** technology , which was originally developed and applied at the South Texas Project Electric Generating Station and is now available for widescale application in the electric power industry, the following pilot project is proposed. In this project we shall select an existing coal-fired thermal power plant whose plant reliability performance needs enhancement or whose costs of maintaining high performance need to be reduced. The concept of this project is to demonstrate the technology by focusing on some selected systems that will be modeled in detail in the context of a high level model of the entire plant. It expected that the insights developed from this pilot study will have a value to the participating utility that far exceeds the project costs as there will be sufficient detail in the treatment of selected systems to uncover ways to improve performance and reduce the cost of maintaining it. On the other hand, the project is structured to get some immediate return on the investment without first requiring a full detailed model of the entire plant which would be more costly to develop.

The key tasks of the demonstration are briefly discussed below

Task 1 Plant Familiarization

In this task the ERIN project team will collect information, make a visit to the site and gain an overall familiarization with the plant, its key systems and operational characteristics. The goal of this task is to support the development of a high level model of the plant, its key systems and their success criteria to support different operating states such as full power operation and operation at reduced power operation. The capabilities to maintain key equipment with the plant on-line at full or reduced power operation will be determined. A secondary goal is to select two major systems for detailed evaluation in this pilot study.

Task 2 Plant Operating Experience Review

Information will be collected from available sources on the plant operating experience with respect to reliability performance indicators. This will be supplemented by information from similar plants that will be collected from generic industry sources such as EPRI reports and NERC GADS. This will help support selection and detailed modeling of selected systems in subsequent tasks.

Task 3 Systems Model Development

Two major systems such as the feedwater and condensate, circulating water, main steam, turbine-generator, coal storage, fuel feed, boiler air and fluegas, and plant auxiliary systems will be selected for detailed analysis in this pilot study by mutual agreement with the utility. For these systems, detailed reliability models will be developed to investigate opportunities for performance enhancement and operating cost reduction. These detailed models will be incorporated into a high level model of the entire plant with the remaining systems modeled in a coarse level of detail. This will facilitate the modeling of the impacts of components in the selected systems on overall plant performance.

Task 4 Plant Reliability Data Base Development

A reliability data base will be developed in this task primarily from generic sources as well as any available information from plant operating history. This data base includes component failure rates, repair times, and the frequency and duration of key planned and unplanned maintenance tasks. Information on the time required to return the plant to full power operation from an outage will also be developed, as needed to support reliability model quantification.

Task 5 Integrated Plant Availability and Capacity Factor Assessment

PLANTFORMA® will be used to facilitate an integrated analysis of plant reliability, availability and capacity factor performance. Typical output from this assessment is attached to this proposal. The reliability performance indicators to be developed include:

- Plant Trip Frequency
- Plant Availability Factor
- Plant Capacity Factor
- Forced Outage Rate
- Unplanned Capability Loss Factor
- Risk of plant down time (expected hours per year offline)
- Risk of production loss (expected Mwe-hours per year of lost production)
- Risk of replacement power cost (expected cost per year for replacement power)

Task 6 Reliability Performance Importance Analysis

In this task the ***PLANTFORMA***® tool will be used to determine the major contributors to losses in production due to performance issues in terms of individual scenarios, components, maintenance activities, and other key contributors for the two systems selected. This will facilitate the setting priorities for consideration for performance enhancement and operating cost reduction.

Task 7 Final Report

A technical report will be prepared to document the key assumptions and provide a convenient reference for future use and expansion of the project models and analyses.

Task 9 Technology Transfer

ERIN will provide the participating utility with the training needed to use the models developed in this project in the user friendly environment of ***PLANTFORMA***® . The utility can perform its own updates and expand the pilot study models to full scope detailed analyses of all systems as needs for these analyses present themselves in the future.

Deliverables

The deliverables provided in this project include a high level model of the entire plant, detailed models of two major plant systems and ***PLANTFORMA***® software that can be used to study and evaluate ways to reduce cost and enhance performance. A final report will be provided that will recommend specific measures to improve performance and reduce costs associated with operating and maintaining plant equipment.