006771.001780

NA702-01 R00

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DESCRIPTION OF CONDITION:

An Area For Improvement (AFI) from the INPO evaluation identified that Equipment problems have complicated plant transients and have contributed to plant events.

☐ Continued

INITIATOR (print)	SIGNATURE	ORGANIZATION	PHONE NO.	MAIL STOP
Dave Eshelman	[signature]	PE	8103	1056

REVIEW, INCLUDING ACTIONS TAKEN / RECOMMENDATIONS:

☐ NCAQ – RECOMMENDED ☒ N/A PLANT OPERATIONS ☐ Continued

SUPERVISOR (print)	SIGNATURE	ORGANIZATION	PHONE NO.	MAIL STOP	DATE
Dave Eshelman	[signature]	PE	8103	1056	11/9/99

REPORTABILITY	OPERABLE
☐ 1 HR ☐ 4 HR ☐ 24 HR ☐ N/A	☐ YES ☐ NO ☐ NON TECH SPEC.

ACTIONS TAKEN / COMMENTS:

☐ Continued

SIGNATURE	DATE	TIME

CATEGORY	OWNER	DUE DATE	CAUSE DETERMINATION
Important	PE	12/10/99	Apparent Cause

☐ SRB ☐ ERB	☐ EXPERIENCE REVIEW ☒ CATPR	☐ EXTENT OF CONDITION ☐ POTENTIAL MRFF	☐ OTHER REVIEWS

NA702_01.DOT 12/98

cc: Initiator
Kowicki
NRM

A-2

[1780]

NA 702-03 R00

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This CR was made important based on management determining this issue warranted apparent cause and CATPR.

MRC Administrator Kristi Nowicki 11/10/99

Continued

NA 702-02 R00

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Problem Statement

Equipment problems have complicated plant transients and have contributed to plant events.

Problem Analysis

Each individual event where equipment problems complicated plant transients/events had its own cause investigation and corrective actions as part of the CR/PCAQR process. In addition to the individual investigations, collective significance reviews were also performed.

PCAQR 1998-1904 performed a collective significance review of the 1998 events, event initiators, and material condition issues. In the area of equipment performance, the need to identify important equipment issues in the backlog and to align organizational priorities was identified. Remedial actions taken included; 1) reviewing the maintenance backlog work to ensure impact on equipment reliability was appropriately considered. (DSO-98-20055) 2) an assessment of equipment health to identify equipment concerns that were prudent to be performed during the remainder of Cycle 12 and during the mid-cycle outage. (NPE-99-00093) 3) a mid-cycle outage to address corrective work to improve plant reliability. 4) strengthening the boric acid control program.

Condition Report 1999-0646 superceded PCAQR 1998-1904. The equipment performance problems were reviewed for causal factors. Of the identified causes: 65% were equipment failure/degradation, 21% of the equipment performance problems were due to design configuration/analysis, and 14% of the problems were caused/contributed to by Maintenance/Testing. Further breakdown showed 28% of the failures were age related component failures, 14% of the failures were related to Preventive Maintenance Program weaknesses, and 25% of the equipment failures were due to human performance issues. The overall conclusion of CR 1999-0646 was that important equipment issues need to be identified and the organizational priorities aligned to address them. The HPES Causal Factor review identified the need to review equipment condition, age, preventive maintenance, and field work practices.

A broader look at the significant equipment problems was performed under Self-Assessment 1999-0076. The self-assessment included a review of all functional failures and Equipment Performance Information Exchange (EPIX) reportable events since January 1st, 1997. The population included 98 EPIX reports involving over 300 key components, sub-components and piece parts. This review was conducted using multiple slices looking for commonality. Data was collected from the INPO Web page on failures and events reported by other sites as well as the industry events data found in Significant Operating Events Reports and other sources to determine any application to failures experienced at Davis-Besse. Additionally data was collected on failures from sources such as the Department of Defense reliability database NPRD95.

☒ Continued

10 CFR PART 21? ☐ YES ☒ NO	SYSTEM CAPABLE OF PERFORMING SPECIFIED FUNCTION? ☐ YES ☐ NO ☒ N/A	
PREPARER (Print) A. C. McAllister	SIGNATURE [signature]	DATE 12/6/99
SUPERVISOR APPROVAL (Print) A. C. McAllister	SIGNATURE [signature]	DATE 12/6/99
MANAGER APPROVAL (Print) ☐ N/A DL Eshelman	SIGNATURE [signature]	DATE 12/8/99
SRB APPROVAL (Print) ☒ N/A	SIGNATURE	DATE
ERB APPROVAL (Print) ☒ N/A	SIGNATURE	DATE

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The review determined that all of the common causes of the equipment problems had been properly addressed in the corrective action program. No new common causes were identified.

This self-assessment identified weaknesses in the current plant preventive maintenance program. Aging failure mechanisms were identified that the plant does not currently have any effective preventive or predictive activities to address. Condition Report 1999-1463 documented that the elastomers in diaphragm valves located in high radiation fields may fail earlier than normally expected. Condition Report 1999-1512 documented that additional monitoring capability is required to prevent the failure of large AC motors prior to the end of plant life. Project 1999-1016 was submitted to obtain budgetary funding to begin addressing equipment aging issues.

During the course of the aging review, investigators identified that we appear to have a knowledge deficiency with respect to component and material aging. An example to illustrate the lack of knowledge is the electrolytic capacitor aging problem. When the problem of electrolytic capacitors was first identified, an effort was made to identify all potential effected equipment. Personnel conducting the review of mechanical equipment often did not have sufficient technical knowledge to identify the potential problem and as a result, the electrical power and related control circuits associated with the mechanical equipment such as power supplies for components in mechanical systems were often overlooked. Additionally, some end of life failure mechanisms appear to have never been considered.

Typical Life spans of selected equipment were researched. It was identified that there is frequently a large variance in mean time between failures for most components. Review of Nonelectronic Parts Reliability Data 1995 (NPRD95) which is an U.S. Military database supports this conclusion as well as failure information from the petro chemical industry. A significant factor contributing to the difficulty in predicting the meantime between failures of components is the relatively small number of similar components both on site and within the nuclear power industry. Where a typical refinery might have 3000 similar pumps, we may have only four similar pumps on site, and within the industry only a few other sites use the same pump. Small numbers such as these make it difficult to obtain statistically significant results. When using data from other industries, caution must be exercised because many factors are involved in the rate of equipment aging. A number of these aging factors are operating environment, radiation exposure, energized state, run hours, number of demands, and the design and quality of initial construction, as well as quality of preventive maintenance. However, several valid observations on the equipment aging issue were made and are given below:

1) Mechanical components do not frequently fail catastrophically but rather exhibit some degradation before failure. The expected life of most mechanical equipment is relatively long. Most important pieces of mechanical equipment that have a life span less than 40 years have predictive activities that monitor the performance of the equipment. Few big "surprises" are expected for mechanical components. Examples of this include the turbines, large pumps, safety grade pumps, and a large number of motor operated or air operated valves.

2) Packing has an identified life of less than forty years and there were no identified activities to replace packing. As a result of this assessment, a plan has been developed to periodically repack valves in certain applications such as high-energy primary and secondary valves in containment, which can impact unidentified RCS leakage and or containment sump leakage. Reviews are still in progress to identify valves in steam and feedwater systems in containment that should be periodically repacked

3) Many components have elastomers as sub components. The EQ program has identified many safety-related components with elastomer sub-components and PMs are in place to replace these before their identified end of life. It was recently identified that HP Feedwater Heater 1-4 and 2-4 Normal Drain Valve Positioners contain elastomers that are not intended to be used at the actual operating temperatures. Condition Report 1999-1731 was generated to track the resolution of this problem. Additionally it was identified that the elastomer in diaphragm valves located in high radiation fields may fail earlier than normally expected. Condition Report 1999-1463 was generated to ensure these diaphragm valves are evaluated and preventive maintenance activities are generated to resolve this potential problem.

☒ Continued

4) Electrical and electronic components often fail with little to no warning. Most of these components have life spans of less than forty years. It was also identified that many instrumentation vendors assume their equipment lifetime is in the 15 to 20 year range. Many Davis-Besse electronic systems have no programmatic refurbishment or replacement program such as the one instituted for the Integrated Control System (ICS). Resolution of this issue will be pursued under project 1999-1018.

5) Motors have an expected life which can vary from months to forty years, and as such it is unreasonable to expect all the important motors to last the life of the plant. A review of failure data from other plants via the Equipment Performance Information Exchange (EPIX) has 27 motor failures at various plants due to winding age problems in the last two years. Davis-Besse's recent winding failures have not been due to equipment age, but due to over-greasing or power cable problems. The Reactor Coolant Pump motors, Circ Water Pump Motors, and the Main Generator, as well as the EDGs had some activities to evaluate and /or refurbish these large electrical machines. A failure of one of these machines will have a significant negative economic consequence. A number of other motors on site which are important to plant reliability are not included in a refurbishment or predictive maintenance program. Examples of these motors include Condensate Pump motors, Turbine Plant Cooling Water Pump motors, Stator Cooling Water Pump motors, Component Cooling Water Pump motors, Makeup Pump motors, etc. Again a loss of one of these 4160 VAC motors could result in a significant economic loss. Resolution of this issue will be pursued under project 1999-1016 and Modification 99-61.

6) There are common misconceptions on site related to the plant's 40 year design life. During plant design, relatively few components were formally evaluated to determine their expected life. Only Class I systems received a fatigue analysis to verify the adequacy of components to operate for a forty year plant life. Some components such as the turbines, received some limited analysis, but this was only to identify the maximum time between inspections and was not intended to assess equipment lifetimes. Certain design specifications did specify a design life of 40 years in addition to typically referenced codes and standards. Some Specifications also identified some specific environmental conditions (ambient temperature and pressure and even cumulative radiation dose to the component over 40 years). Because the specifications do not normally identify all the conditions that could be correlated to service life, there was no mechanism to evaluate or certify this condition (other than the OEM's judgment). Additionally, vendors assume certain maintenance activities will be performed on the component during its life that we might take exception to such as repacking greased bearings every quarter.

Of the 98 EPIX reports and functional failures 18% of the time the root cause or the action to prevent reoccurrence was a preventive maintenance activity. The 4160 VAC breakers and the Auxiliary Boiler are typical examples of the preventive maintenance root cause or action to prevent reoccurrence. The inadequate preventive maintenance includes the lack of a PM, PM instructions not detailed enough, or PM frequency is not high enough. These specific causes were evenly distributed and a trend does not appear. It should be noted that there were two cases in which a plant power reduction was the result of inadequate preventive maintenance. In one case the cause was lack of details in the PM which resulted in improper reassembly. The second case was an oversight on the need for a preventive maintenance activity to clean control system fluid filters. Additionally there was one plant trip (Manual trip during SFRCS testing due to SP7B solenoid in October 1998) where a preventive maintenance activity to periodically replace the solenoids may have prevented the plant trip. These failures were addressed as common cause mechanisms and the corrective action is complete. It is impossible for any PM program to prevent all failures. Based upon a review of industry data submitted to EPIX, Davis-Besse percentage of failures due to inadequate preventive maintenance is within industry norms.

The self-assessment investigated the use of the INPO databases for assistance in failure investigation. This area of the assessment was investigated by the use of a questionnaire for the plant engineers. The various industry data bases were searched 68 times by those who responded. Reviews identified that some engineers conduct query the data bases more frequently than others with a range from 13 per year to as little as once per year. Additionally it was identified that the INPO EPIX failure database was queried only a few times. The survey also identified that the data base reviews have not identified any meaningful information. Meaningful data has been obtained in the past by others and the fact that no meaningful information was obtained by personnel performing the reviews is an indicator that reviews are not extracting information that is available. Improving the knowledge and capabilities of plant engineers to search the INPO EPIX failure database is being tracked as a follow-up item under SA 1999-0076.

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Industry Experience

INPO AP-913, Equipment Reliability Process Description, describes an integrated set of processes for maintaining equipment reliability. The document reflects the integration of experience gained from equipment performance assist visits to operating plants and benchmark trips to European and domestic utilities. The equipment reliability process was designed with the direct participation of several utilities actively involved in improvement and reengineering of their own processes.

In an effort to uncover the fundamental causes of our equipment reliability problems, the INPO equipment reliability process was compared to our existing process. Following are the significant differences. (Numbering reflects the INPO AP-913 step numbering.)

1.1 Establish Performance Criteria & Monitoring Parameters

Monitored parameters and acceptable levels of performance should be related to measurable indications of component degradation.

Component performance criteria include specific threshold values for condition-monitoring data.

1.3 Monitor/Trend Component Performance – Perform cross-system component failure and problem trending using maintenance history, condition report data, and industry operating experience such as EPIX.

Establish component engineering expertise to resolve emergent equipment and maintenance problems. This allows system engineers to perform longer term equipment reliability activities.

Suggested component engineering expertise: motors, pumps, valves(manual, check, relief, etc.), MOV, AOV, EQ, breakers, power supplies, recorders, controllers, transmitters, heat exchangers, with a focus beyond regulatory compliance for both short term and long term health.

Expand equipment failure trending for components used across several systems.

Trending of as-found equipment condition codes may provide early indication of potential failures or need to adjust PM task or frequency.

Consult non-nuclear sources of component failure information and trending parameters/strategies.

2.1 Perform Corrective Maintenance – Perform corrective maintenance in accordance with the station work management process. Ensure the as-found condition is documented for component type failure trending.

2.4 Key equipment Problems prioritization by Management – Establish a site-wide prioritization of equipment problems based on plant safety, operational impact, and station availability. This is a cross-discipline activity that should be performed by the key station leadership team. Equipment reliability improvement is the result of a common station focus to completely resolve key equipment problems.

Demonstrate a low tolerance for equipment problems.

Focus on the long term equipment reliability solutions, not just emergent failures.

Integrate this process with the site work management and corrective action processes.

Provide management support for the equipment reliability process with resources and budget.

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3.9 Does an Applicable PM Template Exist? – The PM template is a documented maintenance strategy for a particular component type that lists significant failure modes, possible indications of degradation, and recommended condition-based or time based PMs.

4.2 Develop System/Component Long Range Maintenance Strategy – Establish the optimal maintenance methods for each potential failure and define the long-term frequency for condition-based maintenance, planned refurbishment, and replacement. Long term strategy for component types such as MOVs and breakers should be included in each applicable system strategy for consistency.

Summary of weaknesses based on industry comparison

Lack of component engineers and associated component programs.

Lack of a method to record and trend as-found equipment condition.

Lack of an effective prioritization system.

Lack of dedicated equipment reliability resources.

Lack of PM templates.

Lack of system/component long-range maintenance strategies.

Lack of PM program focus.

Remedial Actions

Remedial actions for the specific events were covered under the individual PCAQRs/CRs.

1. Perform system health review to identify equipment problems and resolutions / schedule. Eshelman Complete
2. Review, reprioritize and reschedule equipment maintenance activities. Eshelman Complete
3. Review OEs, industry experience for components to identify vulnerabilities, and submit work items to preclude problems. Eshelman Complete
4. Revise Boric Acid Corrosion Control program based on benchmarking to schieve industry best practice. Eshelman Complete ←
5. Identify current equipment problems or concerns. Eshelman Complete
6. Compare 1998 problems and initiatives to current problems and initiatives to identify areas not covered. Eshelman 1/27/00
7. Address / prioritize the equipment / areas not covered. Eshelman 2/10/00
8. Identify any programmatic and/or organizational changes required to more aggressively deal with equipment issues. Eshelman / Rogers / Coakley 3/1/00
9. Develop and obtain agreement from site management on the goal of the PM program (i.e. prevent all equipment failures, or prevent equipment failures which result in plant shutdowns, forced outages, etc.) Eshelman 3/1/00

☒ Continued

Apparent Causes

1. Lack of component engineers and associated component programs which effectively apply industry experience. Much of the component expertise that existed on site 10 years ago was down sized and has not been replaced.

2. Lack of a method to record, retrieve, and trend as-found equipment condition.

3. Lack of an effective site prioritization system.

4. Lack of dedicated equipment reliability resources.

5 Lack of standard PM templates to identify typical activities and frequencies for different groupings of equipment.

6. Lack of clear PM program goals.

6. Lack of system/component long-range maintenance strategies.

Corrective Action to Prevent Recurrence

1. Assignment and development of component engineers and the ability to trend components across system boundaries is being tracked under CR 1999-1948.

2. Work with PETP to update ED6665C, Personnel/Equipment History sheet to record as found condition. Shreiner Due Date 1/31/00

3. Creation of a site-wide prioritization system is being tracked under CR 1999-0646.

4. Provide at least one additional billet for equipment reliability. S. Moffit Due Date 12/25/99

5. Creation of component PM templates is being tracked under CR 1999-1948.

6. Develop long range maintenance strategies and goals. D. Eshelman Due Date 10/1/00

7. Implement any needed re-organizational changes to allow effective use of resources on long-term equipment issues and life-cycle engineering. D. Eshelman Due Date 7/30/00

☐ Continued

END OF RECORD