UNITED STATES
NUCLEAR REGULATORY COMMISSION
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PDR

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MEMORANDUM FOR: Thomas M. Novak, Director
Division of Safety Programs
Office for Analysis and Evaluation
of Operational Data

FROM: Mark H Williams, Chief
Trends and Patterns Analysis Branch
Office for Anaysis and Evaluation
of Operational Data

SUBJECT: SUMMARY FROM JANUARY 9-10, 1990 MEETING AT OCONEE

On January 9-10, 1990 we met with representatives of Duke Power and NUMARC to pursue the formulation of maintenance performance indicators. The list of attendees is attached. Discussions followed the agenda provided as Attachment 2, and were limited to the Oconee station since Duke staff indicated that no review had been performed for McGuire or Catawba. The Duke staff did invest a significant amount of time in analyzing the indicator for the Oconee case.

Item 2 of the agenda, the discussion of interim indicator results, raised issues on how the indicator would actually be used, and how much of a resource impact any additional indicator, technical merits aside, would have on Duke general office and plant staffs. The concern expressed by Duke staff was that any new indicator would require resources to respond. At a minimum, they would have to periodically review it and understand its implications. This would detract from other inplant reliability analyses already in process, e.g., CFAR, FATS. Their concern about such an impact is proportional to the degree that this indicator would be used based on its face value, e.g., absolute magnitude, without additional analysis and interpretation by knowledgeable individuals.

The NRC staff indicated that the proposed indicator was not intended for use without additional information on maintenance, for example, as found in inspection reports, and that use of any indicator alone as a basis for a regulatory decision or perspective on performance was contrary to NRC policy.

Item 3, root cause analysis of individual component failures, was accomplished by reviewing a selection of failures for ODE equipment. Based on the information in the failure narrative the staff classified these examples as maintenance related, while the utility had not. Of a total of 15 cases reviewed, the Duke staff believed that six could be related to maintenance (as they define it) in whole or in part. With the additional information provided by Duke, the staff concluded that 3 of the 15 cases were not related to maintenance (as the staff defines it based on the Commission

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policy statement). The participants disagreed on the remaining 6 cases, due to the differing definitions of what maintenance encompasses, differing understandings of what the term "maintenance related" means, and the suitability of the NPRDS guidance on what constitutes a degraded failure (which is used in the indicator) and an incipient condition (which is not used in the indicator).

The interpretation of "wearout" is a particular concern. Duke staff contends that wearout is a legitimate cause designation which relates to normal equipment service, and does not necessarily indicate deficient maintenance. On the contrary, Duke staff felt that wearout actually may indicate proactive and desirable maintenance for either the incipient or degraded degrees of failure. The staff does not take issue with this contention per se, but argues only that degraded and immediate failures (where by definition a component cannot adequately perform one or more of its functions) attributed to wearout are relevant to evaluating the effectiveness of maintenance.

In general, the staff indicated that its definitions were consistent with the Commission policy statement on maintenance, with INPO industry guidelines, and current NPRDS reporting guidance on the degree of failure. Duke staff disagreed with the boundaries drawn by the staff in its interpretation of the scope of maintenance. The Duke staff further suggested that the NPRDS guidance on degree of failure, in the context of a proposed maintenance indicator, may be too conservative and result in capturing incipient conditions as degraded failures.

Under Item 5, Duke Power approaches to component failure trending, the Oconee staff provided information on a number of different efforts, either underway or in the formative stages, as described in Attachment 3. One database used for component failure trending purposes is the Failure And Trending module (FAT). This data base contains information for every maintenance work order that indicated a problem. It includes all failures that would be reported to NPRDS, but covers a much greater scope of equipment, and covers problems of a lower severity than those reportable as degraded or immediate failures for NPRDS. When comparing trends under Item 6, Duke staff used the flagging algorithm proposed by the staff in combination with FAT data and generally obtained more flags. No alternative algorithms or thresholds were tried. The Duke staff at Oconee is also making use of CFAR, which is based on NPRDS data and compares a plant against the industry for numerous component groupings and application-coded components using failures per component hour. However, CFAR does not currently provide a trendable indicator.

The Duke staff stated that the proposed indicator provided a measure of component failures, but that as currently calculated it did not line up with the Oconee maintenance organization, and thus would not provide useful feedback to the plant staff. The mechanical maintenance at Oconee is organized by type of component, while the instrumentation and electrical is organized by system. Thus, the system-based calculation underlying the cumulative indicator display, with its mix of different types of components, does not align with the responsibilities of their plant staff. In response, the staff explained that the proposed indicator was programmatic, and not constructed as a detailed feedback tool for taking corrective action. Adverse indicator trends would necessitate a broad review of the maintenance program and its implementation. Nonetheless, the indicator could be made more useful to plant staffs, for example by cutting the data by component type, as suggested earlier by Commonwealth Edison staff. Steps to make the indicator more useful are being pursued by the staff, in addition to eliminating mechanistic problems such as "ghost ticks".

The Oconee staff is also becoming used to interpreting the component failure rates provided by CFAR and prefers that similar statistics, i.e., failures normalized by component population, be used to avoid confusion. Given the preference for the CFAR-type approach, Duke staff indicated that they would try to develop a way to turn CFAR results into a trending tool. The Duke staff offered a number of alternatives for staff use in measuring maintenance effectiveness as presented in Attachment 4.

In summary, a number of issues concerning the indicator raised in previous discussions with the AHAC participants were again raised by the Duke staff:

Ascribing the first failure and wearout failures to maintenance,

The potential for counting failures that are discovered by PM and not severe enough to impact the component's primary function (due to some NPRDS failures being coded as "degraded" in accordance with guidance although they are felt to be incipient),

Not highlighting repeat failures or rework,

The presence of "ghost ticks",

The degree of usefulness to the plant staff,

The need for multiple indicators to capture all the nuances of maintenance performance.

The Duke staff views the proposed indicator as an equipment trend indicator, and believes that a component failure oriented indicator is needed as part of a set to monitor maintenance. Duke staff maintained that more than one overall indicator was needed to monitor the maintenance process. The NRC staff agreed and noted that monitoring equipment failures, the focus of the NRC staff activities, was one useful and important measure of maintenance effectiveness that should be used with other utility indicators to assess and improve the maintenance process. The scope of equipment covered by the indicator (ODE) contained as a subset the equipment Duke would be concerned with given the same basis for selection. More than in previous discussions the Duke staff expressed concern about resources needed to deal with the indicator for response and diagnosis. In particular they felt that since they were already committed to periodic use of CFAR, the need for an indicator might be met by some modification of CFAR, thus saving engineering resources.

Mark H Williams, Chief
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Attachments:
As stated

cc: E. Jordan, AEOD
W. Smith, NUMARC
S. Lindsey, Duke Power
L. Wiens, NRR
PDR

Distribution:
TPAB RF
DSP RF
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RDennig
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Attachment 1

Attendance
January 9-10, 1990 Meeting with Duke Power Company
Regarding Maintenance Indicators

Name	Office	Telephone Number
Bob Dennig	NRC/AEOD	301-492-4490
Tom Novak	NRC/AEOD	301-492-4484
Wayne Hallman	DPC/GO	704-373-2345
Walt Smith	NUMARC	202-872-1280
Bill Foster	DPC/ONS/MAINT.	803-885-3152
Mark Williams	NRC/AEOD	301-492-4480
Ronnie Henderson	DPC/ONS/MMSU	803-885-3152
Sam Hamrick	DPC/ONS/MMSU	803-885-3519
Stuart Lindsey	Duke/NUC. MAINT.	704-373-8768
Pierce Skinner	NRC/SRI-Oconee	803-882-6927
Dendy Clardy	DPC/ONS/MAINT.	803-885-3160

Attachment 2

AGENDA

JANUARY 9-10, 1990 MEETING WITH DUKE POWER COMPANY

REGARDING MAINTENANCE INDICATORS

(1) NRC presentation - Performance Indicator Development, Analysis Assumptions and Purpose of Meeting.

(2) Discussion of Interim Indicator Results

(3) NPRDS Reporting of Component Failures Involving Outage-Dominating Equipment.

(4) Root Cause Analysis of Individual Component Failures of Outage-Dominating Equipment.

(5) Discussion of Duke Power's Program's Programs/Approaches for Trending Equipment Failures and Failure Causes as They Relate to Maintenace ("Fats")

(6) Comparison of Maintenance Trend Information

 (a) Trends Calculated with the NRC's Indicator

 (b) Trends Calculated with Duke Power's Indicators(s)

Outline of Trending Approaches at Oconee Nuclear Station

1) Communications from Work Execution Technicians and Planners to Maintenance Engineering of component failure trends and repeat actions recognized while planning and/or performing maintenance. This is an ongoing process and serves as an active feedback mechanism in the Maintenance Triangle concept. Planners now have the capability to retrieve printed information sheets that show a component's corrective maintenance history while planning each work request. This enables the Planner to look for trends during the planning process. The history sheets are attached with the work request so that Work Execution can review as well.

2) Maintenance Engineers are accountable for defining and driving Technical Support Programs for components and systems. The TSP's include component trending activities. The Maintenance Engineers are expected to define and perform programmed maintenance in an "ownership" manner, and they monitor the performance and failures of their components on a regular basis. The Maintenance Engineers supply regular feedback and conduct meetings to inform appropriate Planning, Work Execution, Radiation Protection, Operations and Maintenance Management of actions that are needed for problem components discovered thru trending or components that will be monitored closely for trends while operating. Maintenance Engineers maintain trend data in a variety of places ranging from personal files to computer data sets.

3) Some examples of Technical Support Programs where trending is ongoing are:

a. The Predictive Maintenance and Monitoring Program (PM2). This program includes the acquisition and trending of vibration and oil analysis data for rotating equipment. The responsible Maintenance Engineer monitors the data for adverse trends and prescribes corrective and preventive maintenance when trends indicate actions are necessary.

b. The Pipe Erosion/Corrosion Control Program. This program includes the acquisition of pipe and fitting wall thicknesses that are maintained in a computer file. The responsible Maintenance Engineer monitors the data for trends that show wall thicknesses that are decreasing at an adverse rate. When trends are discovered, the Maintenance Engineer prescribes the appropriate actions.

c. Instrument procedures provide data sheets for I&E Technicians to identify components where malfunctions or exceeded calibration tolerances are discovered. These data sheets are named Component Malfunction/

Maximum Tolerance Limit Exceeded sheets. The data sheets are forwarded to the responsible Maintenance Engineers for evaluation, and the sheets are kept in I&E Maintenance Engineering files for trending data. The I&E Maintenance Engineers review the filed data for trends.

d. The I&E Maintenance Engineer responsible for the RPS system monitors the Reactor Coolant flow for deviations greater than one-half percent and trends that show increasing deviations. As increasing deviations are discovered, the Maintenance prescribes the necessary actions to prevent excessive deviations.

e. The I&E Maintenance Engineer responsible for the Control Rod Drive breakers monitors the trip times obtained during monthly Preventive Maintenance testing and trends the data for trip times that show increases towards a limit established by the engineer. The engineer prescribes necessary actions when adverse increases are apparent.

f. The Performance group trends leak rate data, valve stroke times, pump performance etc. and notifies Maintenance when adverse trends are discovered.

g. Limitorque valve operator MOVATS and lubrication analysis data is trended by the responsible Maintenance Engineers for predictive maintenance purposes.

4) The following failure reports are provided to Maintenance Engineers for their use in trending components.

a. The "Valve Report Card" is supplied to the Maintenance Valve Engineer after each Refueling Outage. This failure report identifies any corrective maintenance work requests written within the thirty day window following the the Refueling Outage. The engineer analyzes the identified valve failures for failure trends as well as work execution effectiveness.

b. The "Multiple Work Request Report" is supplied to both Mechanical and I&E Maintenance Engineering groups. This report identifies components that encounter multiple failures (not necessarily related) in a selected time period.

c. The "Average Failure Frequency Report" is supplied to both Mechanical and I&E Maintenance Engineering groups. This report develops failure rates or frequencies considering component populations, number of corrective maintenance work request written within a selected time period for respective components and the amount of work hours expended.

d. The "Component Failure Analysis Report" (CFAR) is now being supplied to the Maintenance Engineering groups quarterly. CFAR identifies Oconee's NPRDS components that are experiencing higher failure rates than similar component applications throughout the industry. NPRDS reports that are submitted are now being supplied to the corresponding Maintenance Engineers on a monthly basis with a summary sheet being sent to the Maintenance Engineering Manager.

e. Special failure reports are supplied to Maintenance Engineers as they request them and as the MMSU group discovers failures that indicate a need for further investigation. These reports are built from maintenance history data and failure data contained in the Equipment Database (EQDB), Nuclear Maintenance Database (NMDB) and the Failure and Trending module (FAT).

f. Future capabilities being considered are reports that identify rework, repeat failures, and corrective maintenance required following PM's.

5) Examples of other maintenance indicators trended at Oconee:

a. Oconee's Management Information System report (MIS report) is a monthly report that supplies a detailed accounting of work hours expended by types of work, the ratio of Preventive Maintenance to Corrective Maintenance work hours, the number of high priority work requests written and closed out during the month, the work request backlog greater than 90 days, the status of each open work request and the responsible Planner. Each monthly issue is reviewed and trended by Maintenance Management.

b. Weekly audits of work requests by Planning Coordinators and Planning Manager for completeness and accuracy. One purpose of the audits is to trend the quality of information documented on work requests.

c. Housekeeping reports are used to trend Materiel Condition.

d. The Operations group identifies Control Room Annunciators and Instruments out of service monthly to the Planning group for corrective action. Planning and Operations trend the monthly reports.

e. Others.

6) Indicators such as Availability Factor, Safety System Actuations, Forced Outage Rate, Corrective Maintenance Backlog, High Priority Work Requests, Ratio of PM to Total Maintenance, PM's Overdue, Thermal Performance, Capacity Factor and Number of Continuous Days of Operation have shown favorable trends during the past years and indicate that Oconee's Maintenance Programs are effective in managing component failures.

***** PROPOSED OPTIONS *****

for

MAINTENANCE EFFECTIVENESS INDICATOR

OPTION 1: Utilize LER and Forced Outage Rate Data

Reasons: * Both LER and Forced Outage Rate is now reported to the NRC under familiar reporting guidelines. This data is relatively pure and accessible for the NRC use.

* Maintenance related LER data would provide indications of those maintenance challenges to safety systems or design operating bases for a plant. Forced Outage rate data captures the challenges to the major outage causing equipment. Together they provide a good basic picture of a plant's maintenance without constructing another indicator.

Cost/Benefit: * Cost to the NRC and industry would be minimal. This data is well understood and will not require redundant analysis/review which would be necessitated by the new indicator.

Needs: * Better Maintenance cause codes need to be defined for the LER reporting. In addition, the current LER data would need to be reviewed and reclassified for a prior baseline period (eg. 3 years backfit would probably give a good track record for trending). Based on a review of Oconee LER data for 3 years, this took about 45 minutes for all 3 units.

Option 2: Utilize some of the important "Maintenance Indicators"

Reasons: * A defined core of these maintenance indicators when reviewed collectively, do provide a more accurate picture of Maintenance Program Effectiveness then any one indicator could. These are what most utilities use to measure their program effectiveness; therefore, the data is again well defined.

Cost/Benefit: * Cost to the NRC and industry would be minimal. This data is well understood and will not require redundant analysis / defense which would be necessitated by the new indicator.

Needs: * Both the industry and the NRC need to come to a more definitive agreement as to what "Maintenance" means. This will require definition of a core set of indicators that when looked at cumulatively provide indication of Maintenance Program health. Possibly a reliability/availability indicator needs to be added to the "Set" of accepted indicators.

Option 3: **Utilize CFAR type report(s) or Reconstructed Indicator(s) based on Failure Data Grouped on Component Types**

Reasons: * Failure data grouped by system appears to be ineffective in correlating with other program indicators; therfore, any reliability type indicator(s) need to be grouped based on component groups similarly to CFAR. This would provide some feedback on repeat failures. In effect trending CFAR "hits" or failure rates would provide the same type of information and alleviate the extra cost to the industry of trending a duplicate indicator.

Cost/Benefit: * Cost to the NRC and industry would be high if a new indicator is utilized. This higher cost would be the result of trending 2 similar indicators, since the industry is now by and large using CFAR to monitor NPRDS reportable equipment reliability.

* The cost for the NRC to use CFAR would not be as high but CFAR in its present form is still judged inadequate to represent Maintenance Program effectiveness. Thus even if CFAR is provided to the Commission, it will require some additional cost to reconstruct CFAR for the type of analysis desired. However, CFAR data is well understood and will not require redundant analysis/review which would be necessitated by the new indicator.

Needs: * If a new reliability indicator is generated then several major changes need to incorporated to make it useful:

1. Grouping should be made by major critical component groups mutually agreed upon by the industry and the Commission.

2. Wearout should be allowed as a legitimate separate cause code not strictly maintenance related. Additional definition of legitimate wearout will be needed to satisfy both industry and Commission.

3. Failure trending should account for population size of the group (ie. % failures of a given population would provide some benefit for efficiency of maintenance).

4. Failure trending should be strictly plotted as total # of failures, or failure rate, or % failures for given population per quarter. If trigger levels are desired then Alert and Alarm levels should be established based on statistical confidence limits of population functional ability (ie. something like a 90% confidence of 90% of the population being functionally operable during a given time period). An algorithm which averages failures should be not used.

5. A reliability indicator should not be used unilaterally to measure maintenance program effectiveness, but should be only one of several indicators evaluated. Also the PM program should be accounted for in any maintenance indicator.

6. Impact of the failure needs to be evaluated and incorporated (eg. Was the failure significant to system operability and safety)