Jan. 26, 2017

Efficiency Bulletin: 17-03a
Value-Based Maintenance

Changing the industry’s culture of “reliability at any cost” and “more is better” to one where maintenance is treated as a highly valued and limited resource is key to advancing safety and reliability in a cost-effective manner. This is the principal efficiency bulletin in a series that more effectively integrates cost considerations into equipment reliability processes.

Addressees: Chief nuclear officers, NEI APCs and INPO APCs

Issue: PMP-003, Value-Based Maintenance

Summary of Efficiency Opportunity

- Desired end-state—Stations fully implement value-based maintenance and the associated culture change to appropriately optimize safety and reliability through the most efficient utilization of maintenance. Maintenance strategies will achieve the required levels of reliability for the least life cycle cost. Cost-benefit analysis will be a routine element of the preventive maintenance (PM) change process.

- Value proposition (vision of excellence)—Through the implementation of value-based maintenance tools, each unit is projected to begin to see significantly reduced annualized maintenance costs by Dec. 31, 2018. The station maintenance budget required to maintain high levels of equipment reliability is expected to be reduced by at least 25 percent by Dec. 31, 2020.
Why is it important?—The shift to value-based maintenance complements the earlier change to the critical component definition (Efficiency Bulletin 16-25) to provide the process and tools that can be effectively and consistently implemented in the nuclear industry. The change establishes more cost-effective maintenance strategies for those components whose failures do not result in unacceptable consequences.

Industry benchmark value(s)—Equipment reliability index (ERI) continues to meet industry standards and improve.

Measure of effectiveness—Industry metrics will be established to capture and track cost savings from this initiative.

Maximum benefit is obtained when this efficiency opportunity is implemented in conjunction with Efficiency Bulletin 17-03b, “Embracing Cultural Shifts for Value-Based Maintenance.”

Background

This bulletin is principal in a series that integrates cost-effectiveness into equipment reliability processes. Efficiency Bulletin 16-25, “Critical Component Reduction,” previously established a zero failure tolerance policy for components whose failures result in “unacceptable” consequences and differentiated them from components whose failures do not result in those consequences. This efficiency bulletin expands this guidance and provides the following:

- A definition for a new, value-based maintenance strategy: one that optimizes safety and reliability while carefully weighing the cost of component maintenance. This includes identifying possible adverse costs caused by a resulting increase in failure rates associated with a change in a maintenance strategy for a component. Simply reducing preventive maintenance will likely not reduce costs if it results in increased corrective maintenance, reduced safety or reliability, or increased regulatory scrutiny. The total costs and impact to the station are required to be considered when establishing components as noncritical and analyzing value-based maintenance strategies for noncritical components. This is shown in Attachment 1.

- A value-based approach for assessing total costs and impact of a maintenance strategy is replacing the current industry discrete listing of attributes for noncritical components that drives them to be considered for PMs.

- A graded approach to plan, assess and perform maintenance on lower criticality components.

Relevant Standards

Performance Objectives and Criteria (INPO):

- ER.1, Engineers establish high standards for equipment performance and promote intolerance for failures of critical equipment.
- ER.2, Engineering and maintenance strategies focus on components and systems that are critical to safe, reliable plant operation. Components are classified as critical based on the relative importance for maintaining system function.
- ER.2, A thorough process is used to review and document the technical bases of deferrals, changes, additions and deletions of preventive maintenance tasks.
MA.1, Maintenance personnel ensure high-quality preventive maintenance is performed to support equipment reliability and that feedback is provided that accurately reflects equipment performance.

OE.1, Internal and industry operating experience is shared and used to prevent events and improve equipment, worker and station performance.

EN.1, Engineers engage operations and maintenance personnel to fully understand equipment condition and performance issues, the operational impact of those issues, and preventive maintenance effectiveness.

EN.1, Engineers identify equipment management strategies, including preventive and predictive maintenance, to improve equipment performance and ensure long-term reliability.

### Relevant Regulatory Requirement

- 10 CFR 50.65, Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants
- Regulatory Guide 1.160, Monitoring the Effectiveness of Maintenance at Nuclear Power Plants

### Guidance

- This efficiency bulletin provides the change management and recommends software tools to implement a new approach for the development of cost-effective equipment maintenance strategies to support a reduction in the total cost of maintenance. Specifically, the following are being implemented:
  - Value-based maintenance processes for noncritical components will utilize cost data in conjunction with performance data when determining the acceptability of equipment performance, as well as monitor the effectiveness of strategy changes. The process changes should include, but are not limited to, the following:
    - Implement PM change processes that ensure maintenance strategies are designed to achieve required levels of reliability for optimized costs, including labor, materials and associated administrative costs.
    - Institutionalize cost monitoring and analysis of performance at the component and system levels. This includes expected levels of work order productivity.
    - Integrate cost-benefit analysis into station work order and PM change processes. Ensure that the PM change processes provide guidance to support development of maintenance strategies that maintain the required equipment reliability for least cost.
    - Document cost justifications into the PM basis documents. This includes documenting any expected failures based on the maintenance strategy, including anticipated failure rates and failure mechanisms. This documentation will support minimizing administrative costs associated with failure cause analysis.
    - Require expected cost documentation for any PM changes requesting new PMs or changes requiring additional resource or material costs. Stations should set a threshold at which a cost-benefit analysis is required to implement a PM change.
    - Ensure that any process changes continue to protect the reliability of AP-913 critical components.
  - An industry maintenance database has been established that will allow for the evaluation of the total cost of maintenance strategies and identification of the most cost effective maintenance strategies.
  - An industry “data visualization tool” has been obtained that provides the capability to evaluate maintenance cost data at the component level to determine opportunities for industry savings and ability to perform station, fleet or industry comparison of maintenance costs to identify best practices. Results will be shared throughout the industry.
Tools that allow the development of more cost-effective maintenance strategies are being obtained. The tools also determine increases in failure rates that may result from performing less preventive maintenance. Data derived from these tools will be utilized by industry groups to evaluate improvement of maintenance strategies that still support reliable operations based on business needs. A list of recommended tools and approaches will be provided directly to utilities.

- At a minimum, the following targeted component maintenance strategies will be evaluated for implementation at each site by Dec. 31, 2018:
  - circuit breakers
  - air-operated valves
  - relays.

**Note:** Further background information on value-based maintenance can be found in the Equipment Reliability Working Group white paper “Management of Maintenance Costs,” Rev. 0, June 2015. (This document can be obtained from the INPO member website.)

**Recommended Industry Actions**

- Revise applicable fleet/station processes and procedures to incorporate value-based maintenance approach. Examples of revised process documents will be provided to the industry.
- Task the industry working groups for circuit breakers, air-operated valves and relays to review the recommended changes to the industry value-based maintenance strategies for their equipment and implement site-specific strategies as appropriate to realize cost savings.
- Continue to develop common value-based maintenance tools.
- Share best practices for communications methods to facilitate the culture change to value-based maintenance throughout the utility organization.
- Coordinate implementation of value-based maintenance with the other complimentary efficiency bulletins (shown below):

  - **EB 16-16 for High-Cost, Noncritical PM Reduction**: Utilities identify known opportunities for High-Cost, Noncritical PMs Reductions. Early implementation of VBM
  - **EB 16-25 Critical Component Reduction**: Implement Classification Change
  - **EB 17-03a, Value-Based Maintenance (VBM)**: Implement Value-Based Maintenance/Targeted PM Changes/Savings
  - **EB 17-03b, Embracing Cultural Shifts for Value-Based Maintenance**: Broadly communicate the reasons and need for changing the approach to maintaining equipment
Change Management Considerations

Industry Activities

- Industry communications are being developed to facilitate the understanding of the changes to the approach of developing optimized maintenance strategies and the needed change in station culture to take full advantage of value-based maintenance:
  - Site leadership communicates the importance of embracing value-based reliability to the station staff in a high-visibility manner, using presentations, video, articles, etc. The acceptability of run-to-maintenance for select components is clearly communicated. (Efficiency Bulletin 17-03b, “Embracing Cultural Shifts for Value-Based Maintenance.”)
- Industry webinar to provide background for initiative and provide an open forum to ask questions. Webinar information can be found at https://web.inpo.org/Pages/Nuclear-Promise-Issues.aspx.
- Industry presentation to be provided to all nuclear site key stakeholders to communicate the change.
- Discuss change and change management at Equipment Reliability Working Group (ERWG) and other routine industry meetings.
- As value-based maintenance is implemented through the industry and lessons learned are incorporated, the Equipment Reliability Working Group and INPO will consider further refinements to AP-913.

Company Actions

- Site/fleet preventative maintenance process owners revise governing processes and procedures.
- Obtain access to software tools, and develop the change management considerations required to effectively implement value-based maintenance. Integrate cost-benefit analysis into the station PM change processes.
- Designate personnel to become proficient with the value-based maintenance tools.
- Industry experience has shown that stations are more successful when they establish proficiency with the software tools prior to moving onto higher consequential components.
- Corporate and sitewide communication and promotion of the initiative.
- Reinforce expectations for a healthy technical conscience, specifically that individuals thoroughly challenge analyses and recommendations to ensure the full range of potential consequences is clearly defined, understood and communicated as part of the final decision-making.
- Using the industry data visualization software, monitor cost at the component and system levels to minimize total maintenance costs while maintaining required reliability.

Guiderails

- Full implementation of this bulletin will result in a reduction in preventive maintenance to important components. Importantly, many of these components may be safety-related, impact control room operations, affect reactivity management indicators or contribute to risk in the station PRA analyses. Consequently, stations should ensure that the following guiderails are in place:
  - The consequence of failure must be clearly understood during the value-based maintenance evaluation so that nuclear safety and plant reliability is not compromised while adjusting maintenance strategies. Consequences may include more-expensive and unplanned corrective maintenance as well as intangibles such as staffing the outage control center or loss of regulatory margin. If the cost to recover from a failure exceeds the cost savings realized through reducing a component’s PM, neither financial performance nor station reliability will be improved. Importantly, this is true for noncritical equipment as well as critical components.
  - The process controls for the scope, frequency and scheduling of preventative maintenance tasks (PM change request and deferral processes) must continue to require the appropriate technical authority to review maintenance strategy changes to identify potential impacts to the reliability of critical, Maintenance Rule high-risk-significant and risk-significant components.
Appropriate maintenance strategies must be maintained commensurate with component importance. Specifically, the station’s administrative controls should ensure that regulatory and industry commitments (NRC, NERC, NEIL, etc.) are appropriately evaluated prior to any change in maintenance strategy.

The impact of change to maintenance strategies on the critical spare parts and long-range planning processes should be evaluated during PM changes to ensure the changes do not result in an inappropriate business impact.

The projected increase in failure rates as well as the cost of failures should be considered when changing maintenance strategies.

When changes are made to PM tasks that extend frequency beyond the normal service life recommended by the vendor, a healthy technical conscience requires that the basis of these changes be retained so this information is readily retrievable.

At a minimum, the set of performance indicators (Attachment 2) should be monitored to determine if unintended, adverse consequences begin to occur so that action can be taken to arrest the adverse trend.

Report Your Site’s Results

Please report your company’s implementation of this improvement opportunity, including the date of completion. Send this information along with your company point of contact to EfficiencyBulletin@NEI.org.

Industry Contacts

- Industry champion for this issue: Andy Winter, 610-765-5940, andrew.winter@exeloncorp.com
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Industry Approval:

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Value-Based Maintenance

There are Points of Maximum Reliability as well as Minimum Total Maintenance Cost
Attachment 2
Performance Indicators

Full implementation of this bulletin will result in a reduction in preventive maintenance to important components. **Many of these components may be safety-related, impact control room operations, affect reactivity management indicators or contribute to risk in the station PRA analyses.** The following indicators should be monitored, as a minimum, to determine if unintended adverse consequences begin to occur so that corrective action can be taken to arrest the adverse trend.

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Functional failure of a high-safety-significant or risk-significant system/function</td>
<td>• Maintenance Rule functional failures</td>
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<td></td>
<td>• Regulatory oversight process</td>
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<td>Unplanned engineered safety features system actuation</td>
<td>• Licensee event reports</td>
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<td>Unplanned shutdown LCO actions statement less than or equal to 72 hours</td>
<td>• Short-term unplanned LCO entries</td>
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<td></td>
<td>• Online Reliability Loss Factor</td>
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<td></td>
<td>• Unit Capability Factor</td>
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<td></td>
<td>• Equipment Reliability Index (ERI)</td>
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<tr>
<td>Unplanned power reductions of 20 percent or less</td>
<td>• Online Reliability Loss Factor</td>
</tr>
<tr>
<td></td>
<td>• Unit Capability Factor</td>
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<tr>
<td></td>
<td>• Unplanned Power Reductions per 7000 Hours Critical (NRC Indicator)</td>
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<tr>
<td></td>
<td>• Consequential Failure Events (ERI sub-indicator)</td>
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<tr>
<td></td>
<td>• Reactivity Management Performance Indices</td>
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<tr>
<td>Maintenance cost metric</td>
<td>• ERWG/PMWG will develop industry cost metric (within the cost visualization tool) to be maintained at INPO</td>
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