



**Memorandum from the Office of the Inspector General**

September 28, 2023

John Dufner

**REQUEST FOR FINAL ACTION – EVALUATION 2022-17384 – TVA NUCLEAR  
PREVENTIVE MAINTENANCE**

Attached is the subject final report for your review and final action. Your written comments, which addressed your management decision and actions planned or taken, have been included in the report. Please notify us when final action is complete. In accordance with the Inspector General Act of 1978, as amended, the Office of the Inspector General is required to report to Congress semiannually regarding evaluations that remain unresolved after 6 months from the date of report issuance.

If you have any questions or wish to discuss our findings, please contact John Anthony H. Jacosalem, Auditor, Evaluations, at (423) 785-4821 or Lindsay J. Denny, Director, Evaluations, at (865) 633-7349. We appreciate the courtesy and cooperation received from your staff during the evaluation.

David P. Wheeler  
Assistant Inspector General  
(Audits and Evaluations)

JAJ:FAJ

Attachment

cc (Attachment):

TVA Board of Directors  
Buddy Eller  
David B. Fountain  
Lucia W. Harvey  
Jeffrey J. Lyash  
Jill M. Matthews  
Matthew M. Rasmussen  
Timothy Rausch  
Ben R. Wagner  
OIG File No. 2022-17384



Office of the Inspector General

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# *Evaluation Report*

To the Vice President,  
Nuclear Engineering

## **TVA NUCLEAR PREVENTIVE MAINTENANCE**

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Evaluation Auditor  
John Anthony H. Jacosalem

Evaluation 2022-17384  
September 28, 2023

## **ABBREVIATIONS**

CR	Condition Report
FY	Fiscal Year
NPG	Nuclear Power Group
NRC	Nuclear Regulatory Commission
PM	Preventive Maintenance
PMCR	Preventive Maintenance Change Request
SPP	Standard Programs and Processes
TVA	Tennessee Valley Authority

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MEMORANDUM DATED SEPTEMBER 26, 2023, FROM JOHN DUFNER TO DAVID P. WHEELER



# Evaluation 2022-17384 – TVA Nuclear Preventive Maintenance

## EXECUTIVE SUMMARY

### Why the OIG Did This Evaluation

The Tennessee Valley Authority (TVA) operates the Browns Ferry, Sequoyah, and Watts Bar nuclear plants, which are capable of generating an average of 8,275 megawatts of electricity each day and providing power to more than 4.5 million homes and businesses, or about one-third of TVA's customers. Preventive Maintenance (PM), which is a key part of the equipment reliability program at TVA's nuclear plants, is defined as predictive, repetitive, and planned maintenance actions taken to maintain a piece of equipment within design-operating conditions and extend its life. Since PM is important to the reliable operation of assets, we performed an evaluation to determine if PM has been performed in accordance with established schedules at nuclear sites.

### What the OIG Found

Based on our review of PM metric data provided by TVA, we determined PMs were generally being performed within established schedules at TVA's nuclear plants; however, some metrics indicated performance could be improved. In addition, we found other areas where improvements are needed, including: (1) some discrepancies between TVA's PM metrics data in Cognos<sup>i</sup> reports and the data submitted to an industry peer organization; (2) PMs needed that were not established, causing declines of equipment condition and a regulatory finding; and (3) recurring issues that prevented or delayed PMs being performed. Additionally, we identified obsolescence-related equipment issues at TVA's nuclear plants. Specifically, obsolescence-related equipment issues were identified in many program, system, and component health reports as having a negative impact.

### What the OIG Recommends

We recommend TVA management (1) take steps to improve performance of certain PM metrics, (2) reconcile discrepancies in PM metrics, and (3) consider mitigation strategies to reduce PMs needed that are not established and recurring issues preventing PMs being completed.

### TVA Management's Comments

Prior to issuing their formal response, TVA management reviewed the draft report and provided informal comments that have been incorporated as appropriate. In response to the draft report, TVA management agreed with

<sup>i</sup> Cognos is the business analytics reporting tool used across TVA to access and analyze company data.



## Evaluation 2022-17384 – TVA Nuclear Preventive Maintenance

### EXECUTIVE SUMMARY

our recommendations and stated actions were taken to address the recommendations. In addition, TVA management stated that there are currently processes in place that address the third recommendation. See the Appendix for management's complete response.

#### Auditor's Response

We agree with TVA management's actions planned or taken to address our recommendations.

## **BACKGROUND**

The Tennessee Valley Authority (TVA) operates the Browns Ferry, Sequoyah, and Watts Bar nuclear plants, which are capable of generating an average of 8,275 megawatts of electricity each day. These nuclear plants generate enough energy to power more than 4.5 million homes and businesses, or about one-third of TVA's customers. According to TVA, nuclear power is the best option for generating large amounts of electricity that is safe, clean, reliable and cost-effective, which allows TVA to have competitive rates and high reliability.

Preventive Maintenance (PM), which is a key part of the equipment reliability program at TVA's nuclear plants, is defined as predictive, repetitive, and planned maintenance actions taken to maintain a piece of equipment within design-operating conditions and extend its life. PMs are classified as Critical and Non-Critical. Critical PMs involve components in which failure will directly result in an unacceptable consequence such as a reactor trip, power reduction greater than 20 percent, or loss of critical safety functions. Non-Critical PMs involve components that do not meet the critical classification, where consequences of failure include loss of redundant features that increases generation risk, refueling equipment failure, or power reduction less than 20 percent.

Nuclear Power Group (NPG) Standard Programs and Processes (SPP) 06.2, *Preventive Maintenance*, describes the process and related requirements for controlling PM activities at each nuclear site and applies to all groups involved in establishing, executing, revising, and monitoring the effectiveness of the nuclear plant PM program. The goal of TVA's PM program is to increase assurance that:

- Equipment is maintained such that preventable failures are avoided.
- Equipment functions are within design parameters.
- Degradation will be identified and corrected before malfunction occurs for critical components and exceeding acceptable failure rates for non-critical components.
- Equipment life is optimized.
- A cost-effective maintenance program is realized.

Each site tracks and reports the following four PM metrics to monitor performance:<sup>1</sup>

- **Delinquent (Late) PMs** – PMs that have exceeded the grace period<sup>2</sup> without an approved deferral.

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<sup>1</sup> NPG-SPP-06.2, *Preventive Maintenance*, listed a fifth PM metric, PM Revision Backlog; however, TVA notified us they no longer track and report this metric. TVA revised the procedure during our evaluation and removed the metric.

<sup>2</sup> The grace period is the time allotted after the PM's scheduled due date in which the activity may be completed without being considered late, which is typically 25 percent beyond the due date.

- **PM Deferrals** – PMs for which there has been an approved technical justification to extend beyond the late date.
- **PM Backlog** – PMs that are in the last 50 percent of the grace period.
- **Preventive Maintenance Change Request (PMCR)<sup>3</sup> Backlog Age** – PMs for which the PMCR has not been approved within 60 days.

According to TVA, the PM procedure provides for a “Living PM Program” that utilizes PM efforts in conjunction with maintenance history to continuously optimize the performance frequency and scope for each periodic PM task. PM coordinators at each site use Cognos<sup>4</sup> to generate reports from the source data for each PM metric on a monthly basis. The Cognos reports provide a list of the PMs as well their current status and additional details. However, this is a snapshot of the PM data at the time the report is generated, and PM coordinators were not aware of any methods for obtaining the historical PM data. PM metrics for Late PMs, PM Backlog, and PM Deferrals are provided to an industry peer organization.

NPG-SPP-09.16.1, *System, Component, and Program Health*, provides guidance on performing system, component, and program health reports. This procedure describes the method for improving and maintaining the performance of equipment at nuclear plants by identifying: (1) shortfalls in equipment performance or in programs that are important to maintain equipment performance that result in actions for improvement and (2) issues that will affect future performance of equipment such as aging, wearout, obsolescence, which require actions to address in a proactive manner. Health reports can also be used by each nuclear plant’s senior leadership team to assist in business and risk-based decisions.

Since PM is important to the reliable operation of assets, we performed an evaluation of PM performed at TVA nuclear sites.

## **OBJECTIVE, SCOPE, AND METHODOLOGY**

The objective of this evaluation was to determine if preventive maintenance has been performed in accordance with established schedules at nuclear sites. The scope of the evaluation included fiscal years (FY) 2021–2022. To achieve our objective, we:

- Interviewed TVA personnel and reviewed the following to gain a better understanding of PM requirements:
  - NPG-SPP-06.2, *Preventive Maintenance*
  - NPG-SPP-9.18.2, *Equipment Reliability Classification and Maintenance Strategy Development*

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<sup>3</sup> A PMCR is the process by which any new PMs and existing PM revisions, deferrals, rescheduling, or cancellations must obtain approval.

<sup>4</sup> Cognos is the business analytics reporting tool used across TVA to access and analyze company data.



- Reviewed FYs 2021–2022 PM metrics from the Cognos reports<sup>5</sup> to determine if PMs were being performed in accordance with the established schedules.
- Compared FYs 2021–2022 monthly PM metrics from the Cognos reports to PM metric data provided to an industry peer organization for consistency.
- Obtained and reviewed FYs 2021–2022 program, system, and component health reports to determine if issues identified were the result of PMs not being performed as required. There were 92 program, 436 system, and 48 component health reports required for the 2-year time period.<sup>6</sup>
- Reviewed condition reports (CR)<sup>7</sup> from FYs 2021–2022 to identify issues related to PM. We identified 88 CRs that mentioned PM-related issues.

This evaluation was conducted in accordance with the Council of the Inspectors General on Integrity and Efficiency's *Quality Standards for Inspection and Evaluation*.

## **FINDINGS**

Based on our review of PM metric data provided by TVA, we determined PMs were generally being performed within established schedules at TVA's nuclear plants; however, some metrics indicated performance could be improved. In addition, we found other areas for improvement, including: (1) some discrepancies with PM data; (2) PMs that were needed but had not been established, resulting in declines of equipment condition and a regulatory finding; and (3) recurring issues such as lack of materials, labor resources, or clearances, which prevented or delayed PMs being completed.

Additionally, we identified obsolescence-related equipment issues at TVA's nuclear plants. Specifically, obsolescence-related equipment issues were identified in many program, system, and component health reports as having a negative impact.

### **PMs WERE GENERALLY PERFORMED WITHIN ESTABLISHED SCHEDULES**

We found PMs were generally performed in accordance with established schedules at Browns Ferry, Sequoyah, and Watts Bar nuclear plants based on our review of the FYs 2021–2022 Cognos report data. TVA uses the Late PM metric to track if PMs are being performed in accordance with established schedules. During FY 2021–2022, each plant had zero Late PMs. However, as discussed below, we noted PM performance related to the (1) Non-Critical PM Deferrals and (2) PM Backlog metrics could be improved.

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<sup>5</sup> Due to the limitations obtaining historical PM data noted in the background section above, we were unable to verify the accuracy of the Cognos reports.

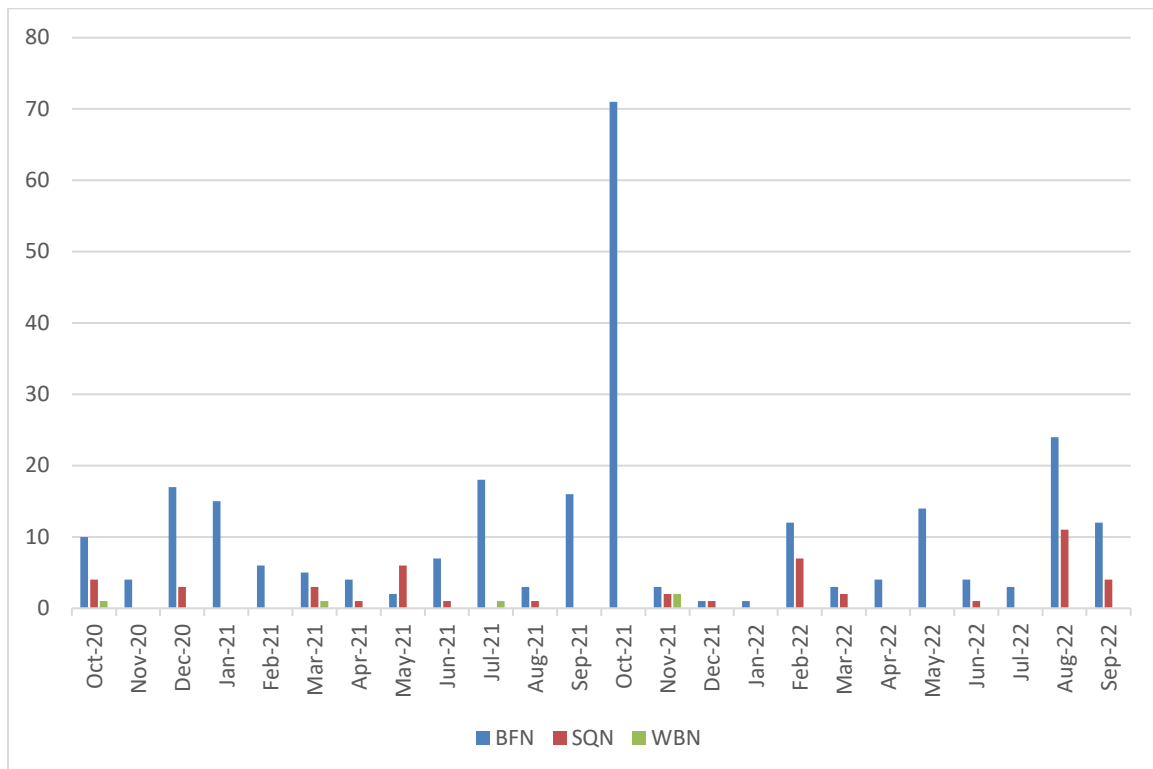
<sup>6</sup> TVA was not able to provide 4 program, 2 system, and 1 component health reports for the period.

<sup>7</sup> CRs are used at TVA's nuclear plants to document the condition, evaluation, and resolution of identified issues.

## PM Deferrals

The PM Deferrals metric tracks the number of PMs that were deferred beyond the scheduled late date. During FYs 2021–2022, there were 3 Critical PM Deferrals; 1 each in October 2021 and September 2022 at Browns Ferry, and 1 in November 2021 at Watts Bar. Although there were minimal Critical PM Deferrals during the period, the performance of deferred Non-Critical PMs could be improved at Browns Ferry and Sequoyah. During FYs 2021–2022, Browns Ferry averaged 11, Sequoyah averaged 2, and Watts Bar averaged less than 1 Non-Critical PM Deferral each month. See Figure 1 below for each plant’s monthly Non-Critical PMs deferrals during FYs 2021–2022.

**FYs 2021–2022 Non-Critical PM Deferrals by Plant**



**Figure 1**

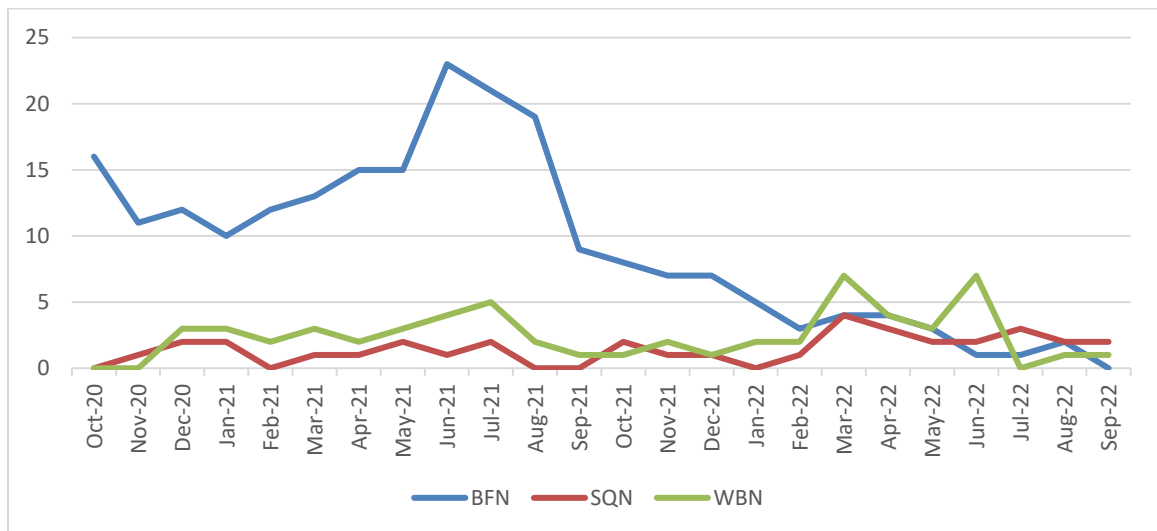
We reviewed PM-related CRs and found 2 that identified negative trends in the Non-Critical PM deferral metric, 1 at Browns Ferry and 1 at Sequoyah. The CR for Browns Ferry was initiated in January 2021 and identified a continued trending decline for this PM metric since October 2020. No actions were taken in response to the CR and it was closed in May 2021 based on improvement in the metric. The CR for Sequoyah was initiated in September 2021 and stated that the plant was performing below comparable industry peers for this specific PM metric. According to one of the CR originators, there are too many PMs causing an unnecessary burden on resources. Additionally, NPG-SPP-06.2, *Preventive Maintenance*, states that “. . . more PMs are not better . . .” and “PMs that do not directly mitigate the risks associated with an important failure mechanism are a waste of resources and can reduce reliability.” To address the issue at Sequoyah, a single point-of-contact was assigned for driving a reduction plan of

Non-Critical PMs. The CR action was marked complete in October 2021. However, after the CRs were closed, both plants continued to generally perform below comparable industry peers for this PM metric through December 2022, according to the industry peer organization.

**PM Backlog**

NPG-SPP-06.2, *Preventive Maintenance*, allows for a grace period before PMs are considered late. The grace period is the time allotted after the PM’s scheduled due date in which the activity may be completed without being considered late, which is typically 25 percent of the frequency the PM is performed. The PM Backlog metric includes PMs that are in the last 50 percent of their grace period. TVA tracks this measure for both Critical and Non-Critical PMs. See Figure 2 below and Figure 3 on the following page for each plant’s monthly Critical and Non-Critical PM Backlog, respectively, during FYs 2021-2022.

**FYs 2021–2022 Critical PM Backlog by Plant**



**Figure 2**

### FYs 2021–2022 Non-Critical PM Backlog by Plant

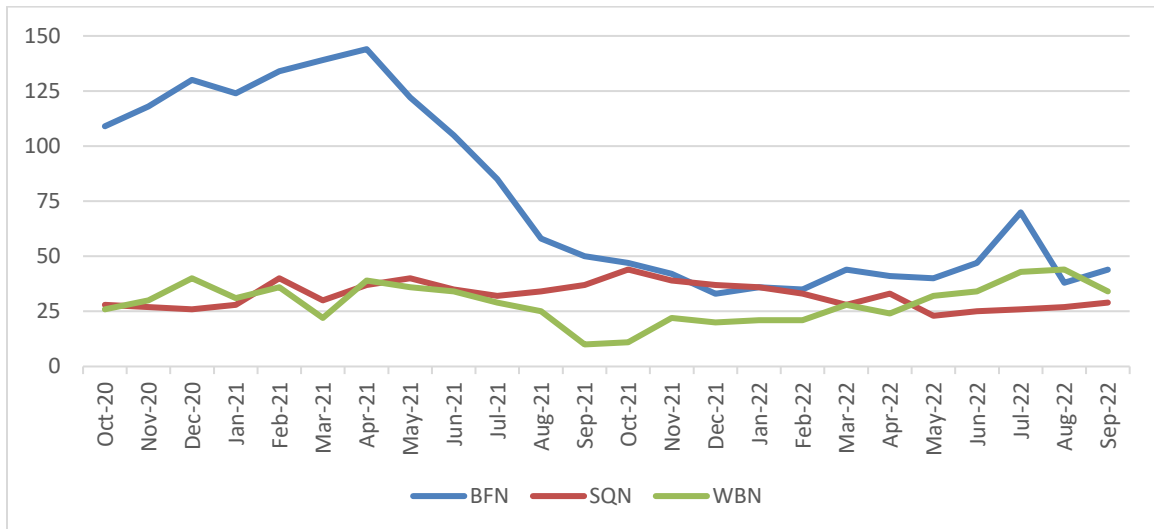


Figure 3

The median industry performance for the PM Backlog metric was less than 3 Critical PMs and less than 20 Non-Critical PMs during FYs 2021–2022, indicating performance could be improved for Critical PMs at Browns Ferry and Watts Bar, and Non-Critical PMs at all three nuclear plants. While Browns Ferry showed elevated Critical and Non-Critical PM levels for this metric in FY 2021, there was improvement in both categories during FY 2022.

## AREAS FOR IMPROVEMENT

We found areas for improvement related to PMs at nuclear plants, including: (1) some discrepancies between TVA's PM metrics data in Cognos reports and the data submitted to an industry peer organization; (2) PMs needed that were not established, causing declines of equipment condition and a regulatory finding; and (3) recurring issues that prevented or delayed PMs being performed.

### Data Discrepancies

During our performance of data reliability procedures, we compared Cognos reports to data submitted to an industry peer organization by TVA and found discrepancies for the PM Deferrals and PM Backlog metrics. See Figure 4 on the following page for a breakdown of the discrepancies for the PM Deferrals and PM Backlog metrics for FYs 2021–2022.

### PM Metric Discrepancies Between Cognos Data and Data Reported to the Industry Peer Organization for FYs 2021–2022

Plant	Number of Months with Discrepancies	Range of Discrepancies
<b>PM Deferrals (Critical)</b>		
Browns Ferry	1	1
Watts Bar	1	1
<b>PM Deferrals (Non-Critical)</b>		
Browns Ferry	5	1–3
Sequoyah	2	1–2
Watts Bar	3	1
<b>PM Backlog (Critical)</b>		
Browns Ferry	5	1–5
Sequoyah	1	1
Watts Bar	16	1–7
<b>PM Backlog (Non-Critical)</b>		
Browns Ferry	8	1–3
Sequoyah	24	10–23
Watts Bar	19	1–6

Figure 4

According to NPG-SPP-06.2, *Preventive Maintenance*, judgment can be applied to exclude certain PMs from being counted against the PM metric due to situations that may prevent the PM from being completed beyond the control of the plant. Examples of these types of situations include a Conservative Operations Alert,<sup>8</sup> unplanned equipment failure preventing removal from service, or equipment out of service. However, there is no log documenting the justification or the quantitative effect of such judgments. While this could explain some discrepancies, PM coordinators indicated that clerical/human error may also account for some of the discrepancies.

#### PMs Needed That Were Not Established

We found 2 CRs initiated during FYs 2021–2022 that identified declines of equipment condition and reduced reliability attributable to PMs needed that had not been established. Specifically, the issues identified included:

- No PMs were implemented for a temporary modification made to plant equipment. The temporary modification was kept in place longer than originally intended and the equipment failed. To address this issue, the PM for this equipment was put in place, and other temporary modifications were reviewed for potential PMs.
- A lack of PMs was degrading operability and reducing the reliability of a system. The CR states that there was inadequate PMs (if any at all) for a system integral to plant operations. Specifically, in the process of replacing older system equipment, the associated PMs were deactivated. However, the PMs were not transferred to the new equipment, and not performing PM

<sup>8</sup> A Conservative Operations Alert is an internal alert declared when power system conditions require proactive measures to preserve the reliability of the TVA power system, such as rescheduling work that has a risk of impacting generation.

eventually caused a performance decline. TVA addressed the issue by implementing the PMs for the new equipment.

We also found 1 system health report that stated PMs for the hardened containment vent system were not performed as required by regulation. According to TVA personnel, the PMs were not put in place before the required date, which led to a finding from the Nuclear Regulatory Commission (NRC). The NRC inspectors determined that the deficiency was more than minor because it adversely affected an NRC cornerstone objective to provide reasonable assurance that physical design barriers protect the public from radionuclide releases caused by accidents or events.

### **Recurring Issues**

During our review of health reports and CRs, we identified recurring issues that prevented or delayed PMs being completed. The recurring issues included a lack of materials, labor resources or clearances, scope growth, equipment malfunction, and technical specifications limitations. We also found 3 CRs that specifically stated TVA Nuclear had self-identified a trend of being unable to perform PMs due to unavailability of materials. At least 2 of the 3 CRs stated that lack of materials was causing delays in multiple Critical PMs being performed.

Health reports also indicated there were recurring issues that prevented or delayed PMs being performed. For example, some health reports indicated PMs could not be performed during a refueling outage due to technical specifications limitations. Some health reports also indicated PM deferrals were caused by a lack of materials. For example:

- Several health reports stated that no maintenance has been performed for multiple years on obsolete critical breakers. The health reports further state PMs are being deferred because there are no spare parts available to replace any breakers that fail during testing, and there is no existing replacement strategy.
- One health report stated that 4 PMs were deferred without engineering justification due to materials not being ordered in time.
- One health report stated a significant threat to the system was the lack of replacements of components (although they are available from the vendor) necessary to implement a PM. The health report further states that the system has been operated beyond the recommended service life and the longer this PM is delayed, the higher the risk of an age-related component failure.

### **ADDITIONAL INFORMATION**

We identified 180 system, 9 component, and 8 program health reports where obsolescence-related equipment issues negatively impacted program, system, or component health. Some of the health reports indicated the issues were related

to obtaining funding, lack of spare parts, obsolete parts being difficult to obtain, and supply chain issues (e.g., the component is/will no longer be supported by or available from the supplier). Additionally, some of the CRs discussed above, that stated PMs were not able to be performed due to a lack of materials, were obsolescence-related.

During our evaluation, we interviewed 11 TVA Nuclear personnel that provided program, system, and component health reports, and 4 PM coordinators. When asked if obsolescence-related equipment issues were negatively affecting programs, systems, or component health or performance, all responded affirmatively. Furthermore, some of these personnel indicated that the obsolescence-related equipment issues increase risk to plant operations and/or generation, such as risk of potential forced outages. Based on the concerns above, we plan to initiate a separate evaluation of obsolescence-related equipment issues within TVA Nuclear.

## **RECOMMENDATIONS**

We recommend the Vice President, Nuclear Engineering:

- Take steps to improve Non-Critical PM Deferrals, Critical PM Backlog and Non-Critical PM Backlog performance.

**TVA Management's Comments** – TVA agreed with the recommendation and stated actions have been taken to improve performance for the Non-Critical PM Deferrals and Critical PM Backlog metrics. TVA also stated the Non-Critical PM Backlog metric has been removed from the Work Management (WM) Index. See the Appendix for TVA management's complete response.

**Auditor's Response** – We agree with TVA's actions taken.

- Reconcile discrepancies in PM metrics and document judgments made to exclude PMs from the metrics.

**TVA Management's Comments** – TVA agreed with the recommendation and stated exclusions were reviewed with no issues identified. In addition, a new software tool will be used to process exclusions to improve documentation. See the Appendix for TVA management's complete response.

**Auditor's Response** – We agree with TVA's planned actions.

- Consider mitigation strategies to reduce PMs needed that are not established and recurring issues preventing or delaying PMs being performed.

**TVA Management's Comments** – TVA agreed with the recommendation and stated there are currently processes in place that address the recommendation. Temporary modifications are typically installed for less than 18 months where PM should not be required, and if maintenance is required, it should be identified by the temporary modification process. All new plant

equipment integral to plant operations is installed in accordance with *Plant Modifications and Engineering Change Control*.

Due to COVID and supply chain constraints, sites have moved the review for identification of long-lead parts from 26 weeks to 52 weeks. Improved PM backlog metrics indicate this mitigation has been effective. See the Appendix for TVA management's complete response.

**Auditor's Response** – We agree with TVA's actions taken.



September 26, 2023

David P. Wheeler

**MEMORANDUM**

**SUBJECT: RESPONSE- DRAFT EVALUATION 2022-17384-TVA NUCLEAR PREVENTATIVE MAINTENANCE**

Tennessee Valley Authority (TVA) Nuclear Power appreciates the TVA Office of Inspector General's (OIG) review of the Nuclear Preventive Maintenance (PM) Program. The Preventive Maintenance Program is a key part of the plant reliability program at TVA's nuclear sites. We value the OIG team's insights as it provides us with an opportunity to further strengthen and improve our site's plant reliability.

TVA management has reviewed the OIG Evaluation Report Dated August 25, 2023. The response to your recommendations is as follows:

**Recommendation 1:**

Take steps to improve Non-Critical PM Deferrals, Critical PM Backlog and Non-Critical PM Backlog performance.

**Response:**

TVA Nuclear agrees with this recommendation and has taken action to improve Non-critical PM deferral, Critical PM Backlog, and non-Critical PM Backlog performance. Since the data in the report was collected, we have reduced Non-Critical PMs Deferred across the fleet from .81 to .33. Critical PM Backlog (deep in grace) from .43 to .29. Non-Critical PM Backlog (deep in grace) remains stable and below industry target. However, it should be noted that the Industry Working group has aligned to remove this indicator from the WM Index as it is not indicative of WM health. Therefore, no further action is needed.

**Recommendation 2:**

Reconcile discrepancies in PM metrics and document judgments made to exclude PMs from the metrics.

**Response:**

TVA Nuclear agrees with this recommendation. The exclusions reviewed (difference between data in COGNOS and PIC) revealed no issues. But, we agree the documentation of the exclusions should be strengthened. We have a new software tool in the CASSIE update that we are using to process exclusions going forward to improve documentation. Therefore, no further action is needed.

**Recommendation 3:**

Consider mitigation strategies to reduce PMs need that are not established and recurring issues preventing or delaying PMs being performed.

Response:

TVA Nuclear agrees with this recommendation. TVA Nuclear currently has processes in place that address the recommendation. Of the examples that were provided for a lack of PMs one was associated with a Temporary Modification. A temporary modification is typically installed for less than 18 months where PM should not be required. If maintenance is required, this maintenance should be identified by the existing temporary modification process as required by NPG-SPP-09.3. The second item documents equipment that was replaced and new PMs were not created. All new plant equipment that is integral to plant operations is installed in accordance with NPG-SPP-09.3 (Plant Modifications and Engineering Change Control). This process requires as part of the impact review process that any required PMs be established. The last example was associated with a PM that was not performed prior to its due date. The preventative maintenance (PM) program (NPG-SPP-06.2) address first time PMs and address how to establish the first performance date.

For the part of the recommendation associated with reoccurring issues that delay PM performances. Our current guidance (NPG-SPP-07.1) for identification of long lead parts has those parts identified at T-26. Due to supply chain constraints driven by COVID and other Supply chain constraints, Sites have moved this review out to T-52 to mitigate the extended lead times encountered. Improved PM backlog metric indicate this mitigation has been effective.

If you have any questions or need additional information, please contact me at (423)-751-8049 or by email [jdufner@tva.gov](mailto:jdufner@tva.gov).

Sincerely,



John Dufner  
Vice President, Nuclear Engineering  
Tennessee Valley Authority  
LP 4A-C

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OIG File No. 2022-17384