

Joyce L. Connery, Chair
Thomas A. Summers, Vice Chair
Patricia L. Lee

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901



October 3, 2024

Ms. Candice Robertson
Senior Advisor
Office of Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Ms. Robertson:

The Defense Nuclear Facilities Safety Board (Board) recently conducted a review of the maintenance program at the Waste Treatment and Immobilization Plant's Low Activity Waste (LAW) Facility at the Hanford Site. The review evaluated the adequacy of the maintenance program against U.S. Department of Energy (DOE) and industry safety standards to ensure reliable performance of structures, systems, and components that are part of the safety basis.

The Board found that the maintenance program for the LAW Facility is implemented in accordance with DOE safety standards. However, the review identified two safety observations associated with weaknesses in (1) meeting expected standards for corrective and preventive maintenance, and (2) failure of the work planning process to consistently produce work instructions that adequately control hazards. The corrective maintenance backlog increased 15 percent between November 2022 and November 2023, and preventive maintenance performance by required date for five of the eight months period surveyed was less than 80 percent, compared to the industry and contractor standard of 90 percent. Workers could not carry out work instructions for nine of twelve work activities observed during the staff team's review interaction without a significant change to the instructions or supporting information. Deficient planning in work packages results in unclear and technically inaccurate work instructions, inconsistency in meeting planning milestones, and lack of incorporation of worker feedback and lessons learned. Resolutions of the underlying causes of these failures and benchmarking against successful maintenance programs would increase maintenance effectiveness and help ensure safe and efficient operation of the facility.

The enclosure contains additional details on the review and provides DOE with information to further improve the safety-related maintenance program practices at the Hanford Site LAW Facility.

Sincerely,



Joyce L. Connery
Chair

Enclosure

- c: The Honorable Jennifer Granholm, Secretary of Energy
- Mr. Brian Vance, Manager, Office of River Protection and Richland Operations Office
- Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

July 26, 2024

Hanford Site Waste Treatment and Immobilization Plant (WTP) Low Activity Waste (LAW) Facility Maintenance Management Program Review

Summary. Members of the Defense Nuclear Facilities Safety Board's (Board) staff conducted a safety review of the WTP LAW Facility maintenance program, with a focus on (1) sufficiency of the maintenance organizational structure, staffing level, and resources; (2) use of appropriate maintenance types and methods; (3) efficiency and timely completion of maintenance work; (4) implementation of an effective work control and execution process; and (5) effectiveness and implementation of the maintenance program approval process.

The staff team identified two safety observations related to the implementation of the maintenance program:

- Weaknesses in achieving expected performance levels hampered timely completion of corrective and preventive maintenance.
- Work planning processes and related reviews did not consistently produce work instructions that adequately control hazards and are workable in the field without modification.

The U.S. Department of Energy (DOE) and Waste Treatment Completion Company (WTCC) management agreed that these issues exist but noted that WTCC's maintenance program and processes are still maturing and will be ready to support hot commissioning. Further, they noted that the LAW Facility was undergoing operational testing, which is expected to result in discovery of problems that increase the need for corrective maintenance. The staff team acknowledges that DOE and WTCC management intend to further improve the maintenance management program.

Current facility operations are not substantially different from future facility operations, and many of the most significant hazards will be introduced before hot commissioning. These circumstances create a need for an effective maintenance program that maintains the functionality of components, equipment, and systems that support the effectiveness, efficiency, and safety of ongoing and future operations. Efforts that WTCC has taken to improve program performance have not substantially improved the efficacy of the processes used to maintain the facility. Based on conditions the staff team observed, resolution of the underlying causes of the safety observations would increase maintenance effectiveness and help accommodate expected or unexpected surges in corrective maintenance and ensure safe operations.

Background. In December 2000, DOE entered into a contract with Bechtel National, Inc., to design, construct, and commission a waste treatment and immobilization plant to remediate the large inventory of mixed radioactive and hazardous liquid waste stored in the Hanford Site tank farms. In March 2017, WTCC, a subcontractor to Bechtel National, Inc., assumed the construction, startup, and commissioning scope of the WTP contract. DOE uses the direct-feed low-activity waste approach to send pretreated tank farm waste from the Tank-Side Cesium Removal system directly to the LAW Facility. The LAW Facility then mixes low activity waste with silica and other glass-forming materials and sends the mixture to high temperature melters to form molten glass. The glass is solidified and eventually sent to the Hanford Site Integrated Disposal Facility.

The objective of the staff team’s safety review was to determine if the WTCC maintenance management program ensures reliable performance of structures, systems, and components (SSC) that are part of the safety basis required by Title 10, Code of Federal Regulations (10 CFR) 830.202, *Safety Basis*, and 10 CFR 830.204, *Documented Safety Analysis*, at hazard category 1, 2, and 3 DOE nuclear facilities. A secondary objective was to determine if the requirements contained in DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*, are effectively implemented [1]. The staff team focused on the hazard category 3 LAW Facility, although the WTP maintenance program also covers the hazard category 3 Effluent Management Facility and other supporting facilities.

The staff team executed the onsite review November 13–16, 2023, performing facility walkdowns and personnel interviews, and attending work management meetings. The staff team also conducted onsite discussions with representatives from the WTCC management team and DOE personnel. The staff team held a meeting with DOE and WTCC personnel on January 24, 2024, to discuss the staff team’s observations.

Discussion. The staff team identified two safety observations.

Maintenance Management Program Does Not Achieve Expected Performance Levels— An effective maintenance management program is necessary for safe and efficient plant operations. It is a generally accepted practice [5, 6] that an effective maintenance management program must include:

- appropriate preventive maintenance tasks with timely completion,
- prompt restoration of malfunctioning equipment, and
- measures that support the evaluation of program performance and continuous improvement.

The WTCC program addresses all these elements. However, as discussed below, the staff team observed that the accomplishment of preventive maintenance prior to required dates (without grace time) was below the industry standard and WTCC management expectations. The corrective maintenance backlog was continuously increasing. Both metrics indicate weaknesses in implementation of the maintenance program.

WTCC management uses key performance indicators (KPI), as shown in the WTCC monthly Governance KPI report [2, 3], to track the performance of the maintenance management program. At the time of the staff team's review, reported KPIs included preventive maintenance performance by required date (without grace period) and delinquent date (required date plus grace period), the cumulative number of delinquent preventive maintenance activities, and the corrective maintenance backlog.

The corrective maintenance backlog increased 15 percent between November 2022 and November 2023, indicating a weakness in processes that support accomplishment of emergent maintenance. The staff team's review of additional information revealed that:

- The corrective maintenance backlog report [2] showed that 339 of 699 work activity items (approximately 48 percent of the backlog) were high priority work activities. WTCC defines high priority work activities [4], such as restoring the design functionality of safety SSCs, based on their operational impacts to a facility.
- The corrective maintenance backlog report showed 123 high priority work activities more than a year old, which may indicate untimely repair of equipment deficiencies and operation of degraded equipment for extended periods.
- The corrective maintenance efficiency (corrective maintenance work packages worked versus corrective maintenance work packages scheduled) during the staff team's visit was 68 percent, similar to previous weeks. The industry target for work schedule compliance is 90 percent or better [6].
- WTCC had not met key performance indicators for the mean-time-to-repair threshold for the 12 months between October 2022 and October 2023.

WTCC is not effectively using prioritization tools and processes to ensure timely maintenance of SSCs, as evidenced by the number of high priority work items listed in the corrective maintenance backlog. The monthly KPI report also showed that timely completion of preventive maintenance by required date was below the industry standard for a mature and fully functioning maintenance program. Specifically, preventive maintenance performance by required date for five of the eight months before the staff team's visit was less than 80 percent. The industry and WTCC standard for preventive maintenance completion by required date is more than 90 percent [2, 5, 6].

Several factors are likely contributors to the weak performance of the program:

- WTCC does not have a mature reliability centered maintenance (RCM) program. The DOE Federal Energy Management Program, *Operations & Maintenance Best Practices* [5], states that "RCM is a systematic approach to evaluate a facility's equipment and resources to best mate the two and result in a high degree of facility reliability... RCM is highly reliant on predictive maintenance but also recognizes that maintenance activities on equipment that is inexpensive and unimportant to facility reliability may best be left to a reactive maintenance approach." An ongoing

systematic evaluation of high value, difficult to replace, or mission essential equipment could preempt unplanned failures and help ensure safe and efficient mission accomplishment.

- WTCC is in the early stages of implementing the LAW facility's predictive maintenance program. For instance, WTCC has not consistently implemented predictive maintenance tools such as ultrasonic devices for safety SSCs. Additionally, WTCC has not established key performance indicators for monitoring the RCM program, such as "percent equipment covered by condition monitoring." In some cases, WTCC's RCM strategy primarily relied on spare critical parts as a mitigation strategy (to shorten out-of-service time by having a spare) with some preventive and predictive maintenance activities as a support. The RCM strategy should emphasize preventing failure of important equipment.
- The preventive maintenance program is primarily based on vendor recommendations without regard to how WTP uses the equipment and under what conditions. This type of implementation can result in an excessive number of preventive maintenance tasks. WTCC engineering is evaluating preventive maintenance tasks with a goal of optimizing the tasks and task frequency. This action could make the preventive maintenance workload more manageable and potentially free up resources to apply to corrective or predictive maintenance. Early completion of this task could yield significant benefits.
- WTCC management has a mandate to schedule 100 percent of available resources. This condition results in optimization issues, such as reduced flexibility in resource allocation, that increase the risk of schedule instability. The staff team acknowledges the reality of the scheduling mandate. However, WTCC's management's existing planning and scheduling practices exacerbate conditions by not ensuring contingency work is available and ready. Any unexpected issues or delays in work activities can cause inefficient use of maintenance staff and a need for work reprioritization, resulting in schedule churn. This in turn can cascade into additional downstream schedule delays.
- Limited personnel participation is impacting the effectiveness of maintenance work preparation meetings. WTP maintenance procedure 24590-WTP-GPP-RAMN-WC-0003, *Scheduling, Work Authorization and Work Release* [7], which provides a process for work preparation meeting attendance, does not require a quorum. The procedure also identifies that the attendance of specific personnel at work planning meetings is either recommended or optional. In some cases, needed stakeholders do not consistently attend planning meetings.

WTCC personnel did take some actions to address corrective maintenance backlog issues [8]. But at the time of the staff team's onsite visit, these actions had not resulted in expected improvements. WTCC management had also not comprehensively reviewed its processes to identify the deficient conditions that prevent them from achieving the desired performance level for corrective and preventive maintenance activities. Additionally, WTCC management has not

performed any formal benchmarking of its maintenance processes and compared results against known effective maintenance programs, or performed a causal analysis to identify the fundamental issues that lead to program performance levels that fail to meet management expectations.

Following the team's visit, WTCC management conducted an accelerated response team analysis of corrective maintenance processes. The analysis resulted in several process modifications, including screening open corrective maintenance work orders to determine if they were still necessary, and the use of repetitive work packages. These actions resulted in an initial decline in the corrective maintenance backlog. While this is encouraging, the most recent backlog report [3] shows an increase in the corrective maintenance backlog even though the planning backlog has decreased. Additionally, the staff team's inspection of the backlog data during the period of decreasing backlog determined that much of the decline resulted from work package cancellations rather than improved work performance. WTCC management could benefit from performing detailed analyses to determine the cause and take actions to prevent the rise of the corrective maintenance backlog.

Finally, WTCC can further improve how it measures maintenance program performance. For example, WTCC management could reconsider use of the KPI for preventive maintenance by delinquent date, as factoring in grace periods when measuring performance can lead to a false sense of security about the ability of the program to consistently get work done. WTCC maintenance management program KPIs are also inconsistent with the Federal Energy Management Program's *Operations & Maintenance (O&M) Best Practices Guide*, Table 3.1.3, [5]. For instance, WTCC's KPIs do not include metrics commonly used to manage emergent maintenance. Emergent maintenance disrupts the maintenance planning and scheduling process, which reduces overall program efficiency. A more complete set of metrics would provide WTCC management additional insight into actions they might use to effectively manage emergent maintenance and reduce the corrective maintenance backlog.

Weaknesses in Work Planning and Prework Reviews—The staff team observed that work planning processes and related reviews do not identify deficient planning prior to execution of work. Processes for coordinating and tracking essential activities prior to work execution were also not effective. Weaknesses in planning and prework review processes have resulted in an increased reliance on workers to identify errors in work instructions and hazard controls during execution of work activities. This overreliance on workers to intervene at the last minute can result in undetected errors in the work package and work execution process, leading to undesirable outcomes such as damage to safety equipment and unsafe work conditions.

The staff team observed that workers had an appropriate questioning attitude toward identifying discrepancies in work packages and noted multiple instances of a positive safety culture that empowers a “stopping when unsure” work environment. The staff team observed good use of human performance tools in the field and consistent execution of rigorous pre-job briefs, which were compliant with applicable procedures and used the required checklists. In each case, assigned workers were actively engaged and demonstrated a questioning attitude, which detected work planning deficiencies (i.e., incorrect work instructions or procedures, missing or incorrect personnel assignments, inadequate safety requirements, lockout/tagout

(LOTO) errors, and missing personnel qualifications). However, workers made these identifications late in the process or at the last minute before execution. In some cases, workers did not identify work planning issues, and the work proceeded to execution.

Deficient planning in work packages results in unclear and technically inaccurate work instructions, inconsistency in meeting planning milestones, and lack of incorporation of worker feedback and lessons learned (see Appendix A for examples of deficient work packages). Workers could not carry out work instructions for nine of twelve work activities observed during the staff team's review interaction without a significant change to the instructions or supporting information. Several work packages contained incomplete or inaccurate information. In some cases, the staff team noted deficiencies during pre-job briefings; in others, it noted the deficiencies during execution of the work. In two instances, the work resulted in undesirable outcomes (the automatic start of a fire pump and over-greasing of equipment bearings).

Several factors may contribute to poor quality work packages and inability to execute work packages in the field:

- The process for coordinating and tracking essential activities, such as job hazard analyses and prerequisite action reviews, both before and during work execution, needs improvement. Planners do not identify prerequisite and support activities early in the planning process to ensure effective execution of the main work activity. Additionally, field work supervisors are not consistently performing workability reviews, which are the last opportunities to catch errors and prevent issues before conduct of the work. This has resulted in work being allowed to proceed without ensuring adequate review of the work instructions and participation of appropriate personnel. Scheduling of workability reviews and more rigorous performance of the existing workability review process, along with an expansion of the supporting checklist to address potential work performance roadblocks, could improve the consistency and adequacy of pre-work preparations. Thorough pre-work preparation would help ensure readiness to support scheduled work or allow timely adjustments to the work schedule resulting in more efficient and effective work accomplishment.
- WTCC's ability to meet planning milestones in accordance with work planning processes is inconsistent. For example, during the week of the review interaction 16 jobs were still in planning or pre-planning status for execution the following week. Some jobs did not have required parts. Nine jobs did not have required LOTOs completed. On one job, the job hazard analysis walkdown was only completed the day before the meeting finalizing the next week's activities and was being held in the schedule at risk. Numerous jobs were still in other review stages. Failure to meet planning milestones has a direct impact on work package quality and can result in work planning team members facing schedule pressure to simultaneously complete multiple tasks.
- LAW Facility personnel indicated that lessons learned and feedback to improve work instructions were not incorporated during subsequent reperformance of the same job. The staff team observed that, in five cases, work instructions for preventive

maintenance tasks that had been performed multiple times could not be performed without modification, indicating either a previous failure to note the conditions or a failure to correct previously noted conditions. Failure to incorporate worker feedback can increase errors and rework, create poor quality work, and increase risks of accidents and injuries.

- The week after work is executed, a meeting informally tracks items that resulted in delays to performing work. However, these meetings do not capture work package quality issues that are corrected to allow work to continue. This can result in known issues persisting and propagating into future work activities.
- Key stakeholders do not always attend pre-job briefs. The staff team observed several pre-job briefs in which operations, additional craft, and industrial hygiene personnel required to perform actions as part of the job were not present. Failure to have all required participants and stakeholders at the pre-job brief, combined with potentially deficient work packages, increases the probability that personnel may not properly perform the work, resulting in adverse conditions that affect equipment and personnel safety.
- Supervisors frequently re-task and substitute planners in the middle of planning work packages due to emergent tasks or changing priorities. This task shuffling results in the new planner needing to become familiar with all aspects of the job, duplicating the effort of the original planner. These disruptions increase the likelihood of errors in work packages and affect the planning process, reducing overall efficiency.

WTCC management documented work package quality issues in two condition reports [9, 10]. Although they did not perform a causal analysis for either condition, they did identify corrective actions. The actions were focused on the planning walkdown process and work schedule performance, and included:

- briefing planners on walkdown expectations,
- monitoring walkdown participation,
- management of walkdown resources, and
- development of KPIs to track and trend work schedule performance.

However, based on the staff team's observations, WTCC management actions have not effectively resolved the work package quality issues, indicating that a cause analysis is warranted. Identification of the root causes of poor work package quality would allow WTCC management to identify effective corrective actions. Additionally, WTCC management could benefit from periodically evaluating the effectiveness of their corrective action implementation so they can adjust their approach, if necessary, to resolve this condition.

The staff team also observed significant schedule instability due to ineffective implementation of the work activity scheduling process, which causes major downstream work execution challenges (of the 12 jobs chosen by the staff team for observation, only 3 were worked during the onsite interaction week). Work activities are not confirmed and assigned to

the crafts until after the 5 a.m. work release meeting held every workday. As the result, the field work supervisor and workers cannot adequately prepare for assigned jobs (e.g., request a LOTO, review the job hazard analysis, review work package and supporting procedures). The inadequate time allowed for task preparation combined with work package quality issues noted above have affected scheduling and created an environment where errors are common. Additionally, WTCC has not implemented important KPIs (e.g., schedule or scope stability) to measure, track, and trend adverse scheduling issues.

WTCC personnel stated they are actively working on process changes to improve schedule stability. These include rewriting the work prioritization procedure, optimizing preventive maintenance work activities, implementing a zone coverage strategy, and reducing corrective maintenance backlogs. Zone coverage strategy is a maintenance strategy that allows management to divide up personnel into different zones or areas, allowing personnel to focus only on their own assigned zone. Implementation of the zone coverage concept is expected to result in benefits that include enhanced expertise in equipment and processes, clearer assignment of roles and responsibilities, improved information sharing, optimized resource allocation, minimized downtime, and improved efficiency in the planning process.

Conclusion. The staff team identified two safety observations associated with the performance levels of the maintenance program and weaknesses in work planning and prework review processes. Improvements in work planning preparation, schedule stability, incorporating lessons learned, and benchmarking against successful external maintenance programs could lead to safety improvements.

WTCC personnel have taken actions on some of the staff team's concerns [8, 9, 10]. However, actions taken by WTCC personnel have not improved the maintenance program performance levels or the work planning and prework review process issues. Since the staff team's review, WTCC has created an accelerated response team to improve work planning. However, it is too early to evaluate the impact of that action.

Appendix A: Staff Observed Deficient Work Packages

The staff team observed the following work package deficiencies and identified conditions that resulted in the deficiencies:

- **ICPCWPS01, *Replace Differential Pressure Switch Inside T1 Cabinet of MVE-PSUP-2001.*** Workers at a pre-job briefing noted that a procedural step had the potential to cause a loss of power and trip, resulting in a loss of joule heating to the melter. However, the procedure did not identify a critical action step for the potential loss of power and trip of the system. Additionally, the procedure did not have any requirement to contact operations prior to performing this step, although operators would need to perform recovery actions. Waste Treatment Completion Company (WTCC) personnel identified this issue during performance of the work and addressed it by briefing control room operators and getting approval to proceed after identifying required operator actions needed to recover from a potential trip.
- **COWP-WC-23-03023, LAW, SAL, *PVM Biannual Check for PCW Valve Operation Per (WI#) 24590-LAW-JV-PCW-YV-2111.*** An operator who was present at the pre-job brief notified the work team that a step in the procedure was not identified as a critical step to prevent an auto-start of a fire pump. The operator identified an upstream manual valve that needed to be closed to prevent a manual action. Although WTCC revised the procedure and performed another pre-job brief, opening valve YV-2111 remotely from the control room still sent an auto-start signal to the fire pump. In addition, WTCC personnel later communicated to the staff team that this was the first time they were performing this activity, but the work team was not aware of that.
- **24590-WTP-COWP-WC-21-03597, *Annual LAW C2V Supply Air Handler Fan/Motor Lubrication.*** The staff team observed this activity until the work team paused it to get clarification on an unexpected part found in the bearing housing. The work team later completed the task, which resulted in “over-greasing” two bearings. Event Evaluation 23-087-01 identified the preliminary cause for over-greasing the bearings as “Work steps in the work package did not provide clear direction to the workers, resulting in over greasing the equipment bearings.”
- **24590-WTP-COWP-WC-23-04941, *CIV-ACU-00032 5 Year Greasing of ACU Blower Motor.*** The pre-job brief noted that the procedure identified an incorrect grease gun and provided guidance for the number of strokes required to apply a specific quantity of grease. A technical change to the procedure was prepared and implemented to remove the wrong grease gun and add the correct grease gun.
- **COWP-WC-23-06945, *Monthly Inspection and Maintenance of LAW LPH Pour Cave Hoists 24590-LAW-MJ-LPHHST-00002/00004.*** On the morning of work execution, WTCC personnel found that job hazard analysis safety requirements did not cover all aspects of the job or capture changed conditions at the jobsite. They

paused the job due to the unresolved issues with the job hazard analysis, and the staff team was not able to observe completion of the job.

- **24590-WTP-COWP-WC-23-06960, *Weekly vibration PCW-PMP-000005 A/B/C and PCW-MTR-00005 A/B/C.*** The work procedure required that certain actions be taken if workers noted “adverse” vibrations, but it did not define what constituted “adverse” vibrations. Workers questioned these issues while recording vibration data. The staff team noted that workers perform these actions weekly and had performed them many times previously without identifying the issue.

References

- [1] Department of Energy, *Maintenance Management Program for DOE Nuclear Facilities*, DOE Order 433.1B, Chg. 1, March 12, 2013.
- [2] Waste Treatment Completion Company, *Governance KPI Meeting*, September 23, 2023.
- [3] Waste Treatment Completion Company, *Governance KPI Meeting*, April 15, 2024.
- [4] Waste Treatment Completion Company, *Work Control Program Description*, 24590-WTP-PD-RAMN-WC-0001, January 3, 2023.
- [5] Federal Energy Management Program, *Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency*, August 2010.
- [6] National Aeronautics and Space Administration, *Reliability-Centered Maintenance Guide*, September 2008.
- [7] Waste Treatment Completion Company, *Scheduling, Work Authorization and Work Release*, 24590-WTP-GPP-RAMN-WC-0003, November 16, 2022.
- [8] Waste Treatment Completion Company, *Maintenance CM backlog negative trend*, 24590-WTP-GCA-MGT-23-00879, October 3, 2023.
- [9] Waste Treatment Completion Company, *Walkdowns not addressing procedural requirements*, 24590-WTP-GCA-MGT-23-00121, February 9, 2023.
- [10] Waste Treatment Completion Company, *Leadership actions to correct deficiencies not resulting in acceptable schedule performance*, 24590-WTP-GCA-MGT-23-00128, February 9, 2023.