DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

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MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: D. Eyler

SUBJECT: Maintenance Management at Hanford Tank Farms

This report documents a review of maintenance management at the Hanford Site's Tank Farms. This review was conducted by members of the staff of the Defense Nuclear Facilities Safety Board (Board), D. Eyler, A. Gwal, S. Lewis, E. Rozek, and R. Quirk and W. Linzau (Site Representatives), who visited the site during June 3–5, 2008, and held follow-up teleconferences to clarify certain issues. The review focused on how the overall activity and performance of the maintenance organization are managed and assessed to ensure that the maintenance effort (particularly for safety systems) is planned and executed effectively.

Background. The Hanford Tank Farms are operated and maintained by a contractor for the Department of Energy (DOE)—Office of River Protection (ORP). DOE Order 433.1A, *Maintenance Management Program for DOE Nuclear Facilities*, governs maintenance management at DOE's nuclear facilities to ensure reliable performance of structures, systems, and components (SSCs) that are part of the facility's safety basis. DOE Guide 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*, provides comprehensive guidance on the management of maintenance.

Maintenance Assessments. DOE Order 433.1A requires field office managers to conduct periodic comprehensive assessments of contractors' maintenance management programs. As part of the Order's Contractor Requirements Document, contractors are required to develop a Maintenance Implementation Plan (MIP). DOE Guide 433.1-1 sets forth the elements of a MIP, one of which is a self-assessment program. It also provides guidance with respect to periodic evaluations and assessments of preventive and corrective maintenance programs, and states that each program element should be evaluated at least every other year. Periodic comprehensive assessments of maintenance programs are essential to ensure that the activities associated with maintenance (e.g., prioritization, resource loading, planning, engineering, procurement, and execution) are performed effectively and safely. The Board's staff reviewed the status of ORP's assessments of maintenance, the last two annual assessments of maintenance performed by the contractor, and both ORP's and the contractor's plans for future assessments. The Board's staff noted issues regarding the accomplishment of both the assessments and subsequent corrective actions.

ORP Assessments—ORP's assessments of the contractor's maintenance program during the past 2 years have been limited to evaluation of a few specific functions and individual work activities. ORP has not completed a programmatic assessment in recent years as required by DOE Order 433.1A, and has not scheduled an assessment of the contractor's maintenance management program. This deficiency was not being tracked in ORP's corrective action plan; following discussion with the Board's staff, ORP personnel indicated that a corrective action would be initiated.

Tank Farms Contractor's Assessments—The contractor's MIP identifies the need to conduct self-assessments as part of the maintenance program. However, the MIP does not delineate all of the elements described in DOE Guide 433.1-1 for periodic reviews and assessments of maintenance programs. As a result, the assessments performed in the last 2 years have failed to evaluate several key aspects of maintenance, particularly work practices and training. The assessment being conducted at the time of the visit by the Board's staff did include these elements, and the Board's staff plans to review this assessment once it has been completed. The actions taken in response to the assessments that have been performed in the past 2 years have been limited in scope:

- The assessment performed in August 2006 was accomplished by subcontractor personnel. The assessment was relatively comprehensive, reviewing preventive (including predictive) and corrective maintenance, performance indicators, engineering support, and the contractor's initiatives to improve in several areas. The assessment resulted in numerous sound recommendations; however, only a few actions were taken in response.

- The May 2007 assessment addressed the maintenance backlog, planning, prioritization, and work documents, using interviews of maintenance personnel and limited document reviews. This assessment yielded observations that resulted in some changes in the maintenance routine. However, the assessment was not comprehensive and added limited value to the program.

ORP's Oversight of Maintenance. Responsibility for oversight of maintenance at the Tank Farms is not clearly defined within ORP. According to ORP's Functions, Responsibilities, and Authorities Manual (FRAM), the Tank Farms' Project Office is responsible for implementation of DOE Order 433.1A. However, responsibility for implementing the associated guide, DOE Guide 433.1-1, rests with the Engineering and Nuclear Safety Office. Responsibility for maintenance oversight has not been assigned to any individual within ORP for the past several years; previously, it was the part-time duty of a facility representative. This arrangement is similar to that noted in a letter from the Board to DOE's Office of Environmental Management in June 2002. ORP is taking action to assign responsibility for maintenance oversight to a single individual in the Engineering and Nuclear Safety Office. Such a clear assignment of responsibility will help ensure effective assessment of the contractor's maintenance program.

Management of Material Problems. The Board's staff reviewed the status of the resolution of several significant material problems noted in recent System Health Reports (SHRs) and observed the conduct of a daily management meeting at which the status of safety systems and issues related to their maintenance were discussed. The staff also conducted walkdowns of the AY/AZ and AP Tank Farms, a hose-in-hose transfer line storage area, and a measuring and test equipment storage area. The contractor has adequate procedures and methods in place to recognize, track, and respond to material problems. In general, the maintenance backlog for safety systems is at a manageable level, and corrective actions for material deficiencies are pursued to completion. However, the Board's staff noted problems with the engineering organization's determination of maintenance requirements for safety-significant waste transfer isolation valves and its planning of some maintenance activities. Additionally, the Board's staff observed problems with the interfaces among the contractor's operations, engineering, and maintenance organizations. These items are discussed in detail in Attachment 1.

Maintenance Management Reports. The Board's staff reviewed key reports and planning documents used to record trends, identify significant problems, and determine proper allocation of resources for maintenance activities. While these reports are generally useful, the Board's staff believes they could be improved to provide better input to maintenance planning. These observations are provided in Attachment 2.

Conclusion. The review by the Board's staff revealed that the overall management of maintenance by the contractor is generally adequate to ensure that corrective action is taken for material deficiencies. The corrective maintenance backlog for safety systems appears to be manageable. Additionally, the contractor has taken action to improve the condition of SSCs at the Tank Farms in recent years.

Given the scope of activity required to ensure effective and adequate maintenance of safety systems, it is essential that maintenance programs be comprehensively assessed as required by DOE Order 433.1A. Such assessments are not being performed by ORP, and are being performed with limited effectiveness by the contractor. Without periodic comprehensive assessments and completion of corrective actions, the effectiveness and adequacy of the maintenance program cannot be assured.

The contractor's engineering organization has not adequately determined maintenance requirements for waste transfer isolation valves. Additionally, the Board's staff noted problems with the engineering organization's planning of some maintenance activities. Finally, the interfaces among the contractor's operations, engineering, and maintenance organizations need to be improved.

Attachment 1
Management of Material Problems

During its review of the following items, the Defense Nuclear Facilities Safety Board (Board) staff noted some problems with the engineering organization's determination of maintenance requirements and planning of maintenance activities. There were also several instances of problems with the interfaces among the operations, engineering, and maintenance organizations.

Seat Leakage Testing of Waste Transfer System Isolation Valves. According to the Documented Safety Analysis (DSA), isolation valves in the waste transfer system perform a safety-significant function by preventing (or limiting to an inconsequential volume) the misrouting (i.e., leakage) of waste into physically disconnected piping during transfers. The DSA notes that to perform this function, the valves may be two-way ball valves in the "closed" position or three-way ball valves in the "block flow" position. The DSA requires seat leakage testing of the isolation valves of the waste transfer system after jumper fabrication or valve installation. Some exceptions include valves such as those installed in the valve pit of the 241-AP Tank Farm. The design, installation, and in-service performance of these valves have been evaluated by the contractor to provide confidence in satisfactory performance during waste transfers. Compensatory measures (e.g., radiological monitoring) are taken for waste transfers performed using these particular valves for isolation. The approach used by the contractor to ensure that the valve seats will perform satisfactorily over the life of the facility is not clear. The contractor committed to providing a rationale for its expectation that the seat integrity of the waste transfer isolation valves will meet the requirements of the safety basis through their intended life.

Standard Selection—The contractor uses guidance from American National Standards Institute (ANSI)/Fluid Control Institute, Inc. (FCI) 70-2-2006, *Control Valve Seat Leakage*, for determining seat leakage for valves after jumper fabrication. This standard is referenced in the DSA (although a provision is made that allows the use of equivalent methods). However, this standard explicitly states that it is intended for proportional control valves, and that if line isolation is the normal expectation for the valve application, another standard, such as American Petroleum Institute (API) Standard 598, *Valve Inspection and Testing*, should be used. Contractor personnel stated that they selected this test method because they decided it would provide assurance of good seat leakage performance, and that testing to other standards (e.g., API Standard 598) is conducted by the manufacturer. The contractor needs to document why use of ANSI/FCI 70-2-2006 is appropriate for the valve designs installed in the valve pits.

Seat Leakage Acceptability—Seat leakage checks of these valves are not possible after installation because of the system configuration. In recognition of this limitation, the contractor conducted seat leakage checks of similar design valves after 500 cycles to establish confidence that the valve seats will maintain their integrity throughout their intended life. However, the testing did not appear to include all valve designs in use. Additionally, the testing included no compensation for the changes in valve seat wear due to aging or potential abrasiveness of the waste. A specific issue exists for seats made of Kynar® material. Results of testing of valves with Kynar® seats indicate these valves will probably develop unacceptable leakage well before reaching 500 cycles. Finally, the testing was not done in accordance with ANSI/FCI 70-2-2006; no evaluation of the equivalency of the test method was performed as required by the DSA. During discussions with the contractor to explore this issue, it was determined that the seat leakage performance required of the waste transfer isolation valves throughout their expected life to support the safety basis had not been clearly specified.

Position Indicators for Waste Transfer System Isolation Valves. The indicator that is normally used to verify the position of a waste transfer system isolation valve is located on a reach rod that extends above the valve pit. However, it was discovered in June 2007 that, following upgrades to about 90 valve assemblies for the double-shell tanks, the associated reach rods (which are articulated) were not connected to some valve stems, thereby invalidating the valve position indication shown on the reach rod indicator. Subsequent investigation revealed other problems with these valve assemblies, including broken actuators and connecting pins, that could result in incorrect valve position indication. Until the valve actuators are replaced (a long-term effort), the contractor is using video cameras in the valve pits to determine valve position when it is necessary to use one of the affected valves for isolation. However, the three-way ball valves do not have a stop pin that clearly indicates valve position within the required tolerance. For these valves, the video camera image is overlaid with an image developed by computer software that shows the valve's appearance when the valve is in the desired position to verify that valve alignment is within tolerance. Fortunately, the valve bodies are a cubic shape, facilitating this method. The problem and potential resolutions were well documented by the contractor, and a plan to improve the design and the installation procedures for the reach rods is being developed. However, the problems were largely preventable, and compensating guidance for operations personnel has not yet been provided.

Causes of the Problems—The root cause of the lack of engagement of the reach rods was poor evaluation of the mock-up of the valve installation procedure. Additionally, the broken components were due to a failure to recognize the need to adjust the design of the valve actuator and connecting pin to reflect the higher operating torques for the new valves, particularly those with seats made of Kynar® material. Of note, the testing done to verify seat leakage performance after 500 valve cycles identified the problem of high operating torques for valves with seats made of Kynar® material. Unfortunately, this finding was not factored into the decision to install valves with this seat material.

Need to Provide Compensatory Operational Guidance—An existing Technical Safety Requirement (TSR) administrative control requires independent verification of valve position when a valve is used to provide isolation. The contractor has not, however, promulgated procedures describing how independent verification is to be accomplished using video camera methods. Contractor personnel have acknowledged the need to promulgate procedures describing the attributes for independent verification using video camera methods.

Failure of a Primary Ventilation System Exhaust Fan and Associated Alarm at SY Tank Farm. The contractor holds a daily management meeting to review ongoing and emergent issues and work; part of the discussion addresses safety-related equipment that is out of service.

This daily meeting was instituted as a corrective action for a significant observation reported in a formal assessment by the Department of Energy's Environmental Management Office of Operations Oversight (EM-62). According to the corrective action plan, the meeting's purpose is to discuss "safety and emergent issues, equipment status, and critical path work." The Board's staff observed the conduct of one such daily meeting. During the course of the meeting, the failure of a primary ventilation system exhaust fan in the SY Tank Farm several days previously was reviewed. The explanation provided for the loss of the fan was a power outage. Management personnel did not pursue the matter further. Subsequent questioning by the Board's staff revealed some issues associated with this problem.

Poor Communication and Coordination—The fan stopped running because of a brief power outage. The loss of the fan was not detected until operations personnel discovered the problem during periodic inspection of the equipment. No alarm sounded because the tank pressure alarms were automatically disabled following the loss of power. This situation was attributed to the software associated with the programmable logic controllers (PLCs) for the SY Tank Farm's alarm system. Manual reset of the alarm circuitry is required to restore alarm function following a loss of power.

The software problem was identified in October 2007, following the installation of the PLCs as part of an upgrade. Operations personnel compensated for the problem by making an entry in the shift management turnover sheet regarding the need to reset the alarms following a loss of power, in anticipation of the problem being corrected within a few weeks. However, engineering personnel decided to include correction of the problem in another project, which resulted in an extended delay in the corrective action. Moreover, this plan was not communicated to operations personnel. Consequently, the requirement to reset the alarm was not added to formal operating procedures used for a loss of power, and when the problem occurred, operations personnel did not understand why the alarm failed to actuate.

Determination of Testing Requirements—System response following a loss of power was not fully tested after the PLCs were installed. The testing focused on the effect of a loss of power on the hardware and did not evaluate the performance of the software. Consequently, the fact that the default settings for the software were not adequate was not identified during post-installation testing.

Locked-in Alarms at AP Tank Farm. During the walkdown of AP Tank Farm, the Board's staff noted that two alarms used to detect tank leakage into the soil were in an alarm condition. The operating log indicated that the alarms have been alarming since January 2008; "snow melt/rainwater" was listed as the cause. No action to correct the problem had been taken; the contractor's responsible facility manager had not been made aware of the problem.

Attachment 2
Maintenance Management Reports

The following observations were made by the Defense Nuclear Facilities Safety Board (Board) staff during its review of several key reports and planning tools used by the contractor to manage maintenance activities. While these reports and tools are generally useful, improvements could be made to the effectiveness of maintenance planning.

Performance indicators for maintenance are included as part of a monthly report to management, focusing on the backlog of preventive and corrective maintenance. System Health Reports (SHRs) are issued quarterly, and include information regarding system operability, availability, and reliability; backlog of preventive and corrective maintenance; component failures; outstanding Problem Evaluation Reports (PERs); modifications in progress or completed; and significant issues. Contractor management uses these reports to address problems with the reliability of safety systems. The content and format of the reports could be improved to allow for better identification of problems and management of resources.

Performance Indicators. The performance indicators reported to senior management regarding maintenance are limited to the numbers of overdue preventive maintenance tasks and outstanding corrective maintenance items, along with graphs that show the trend for the past year and the length of time for which tasks have been outstanding. The performance indicator report contains no discussion or graphic that documents the resource requirements for alleviating the backlog, describes the impact of these items, or provides details on the actions being taken to address items that are long overdue.

System Health Reports. System engineers report significant problems relatively thoroughly in the SHRs, and this is beneficial to management. However, some problems are described repeatedly in reports with no change in status. Moreover, a substantial portion of the information provided in the SHRs is redundant and is not presented in a useful manner. For example, the reports contain calculations of operability, availability, and reliability. For safety systems, there are separate calculations based on a "function" availability definition and a separate definition of availability provided by the Office of River Protection. These multiple measurements of similar indicators do not appear to add value. Trends are reported, but no quantitative indicators are graphed to evaluate the trends as described in the Department of Energy (DOE) Guide 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1.* Overdue preventive maintenance and corrective maintenance backlogs are reported. However, corrective maintenance is not reported as part of the backlog unless it has been outstanding for more than 180 days.

Resource Prioritization. The contractor issues a monthly listing of priorities for Tank Farm operations. Technical Safety Requirements, safety, and environmental compliance are consistently at the top of the list. This prioritization is echoed in the contractor's instruction on work control. Labor resources are allocated during weekly and daily meetings in accordance with the priority listing. However, the contractor does not use the priority listing to determine resource allocation in any systematic way over the long term. The contractor aperiodically estimates future labor resource requirements, but the methodology used for deriving these estimates is unclear. For example, the contractor estimated required labor resources for anticipated activities (including upgrades, maintenance, and operations) at the beginning of 2008; hiring of additional personnel was based on that estimate. For corrective maintenance, a flat rate for labor was used in the estimate; job-specific estimates for the maintenance backlog were not included. For all other activities, estimates were obtained from supervisors, and it is unclear to what degree historical data were used (as discussed in DOE Guide 433.1-1) to derive these estimates. The efficacy of the 2008 resource estimate is questionable in that most of the items it covers (which include upgrades to safety systems) are substantially behind schedule in the execution of critical-path activities. Of note, the contractor's 2006 maintenance assessment resulted in a recommendation that performance indicators reflect task hours for maintenance. Even though the evaluation performed by the contractor in response to this assessment revealed significant inaccuracies in estimates of personnel resources for both preventive and corrective maintenance, the performance indicators were not changed to reflect this recommendation.