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# NUCLEAR WASTE

## Further Improvement Needed in the Hanford Tank Farm Maintenance Program



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Resources, Community, and  
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The Honorable John Glenn  
Chairman, Committee on  
Governmental Affairs  
United States Senate

Dear Mr. Chairman:

Over 61 million gallons of high-level radioactive waste are stored in 177 underground storage tanks at the Department of Energy's (DOE) Hanford Site in southeast Washington State. Timely maintenance of these aging tanks and the equipment for monitoring them is critical because of the hazardous nature of the contents and the potential consequences of a significant leak or other accident. However, a 1992 DOE study found problems with the maintenance program. For example, the study found that more than one-third of the gauges for detecting leaks in Hanford's tanks were not working. You asked us to (1) review the progress DOE has made in strengthening the maintenance program and (2) identify opportunities for further improvement.

## Results in Brief

Some progress has been made in strengthening the tank farm maintenance program. In October 1993, Westinghouse Hanford Company (DOE's management and operations contractor for the Hanford Site) started a new approach for coordinating maintenance work on the tank farms. Westinghouse officials believe that this approach has been a factor in reducing the number of uncompleted maintenance projects from 1,969 in January 1994 to 1,517 in October 1994. However, the remaining backlog of projects is still too great to ensure that needed maintenance can be done in a timely manner. Tank farm maintenance personnel estimate that to respond promptly to maintenance needs, the number of projects awaiting completion should not exceed 3 months' work—about 300 projects, or less than one-fifth of the current backlog.

Westinghouse can further improve its maintenance program by reducing the time spent in preparing and closing out maintenance projects. Westinghouse has begun to experiment with procedures that other DOE sites use to reduce such delays, and these experiments show promise. Westinghouse can also improve its program by gathering and analyzing more information about how it processes maintenance projects. Analysis

of such information would help determine how productively maintenance tasks are being carried out and where improvements are needed.

## Background

Between 1943 and 1986, 177 single- and double-shell storage tanks ranging in size from about 55,000 to 1 million gallons were constructed at Hanford to store the highly radioactive, heat-producing, and chemically toxic liquid wastes resulting from the production of nuclear materials. The tanks are arranged in 18 groupings called tank farms. Besides the tanks themselves, tank farms also have equipment such as lines and pumps for transferring waste between tanks, exhausters and compressors for controlling and monitoring heat and chemical reactions going on inside the tanks, instruments to measure temperature and tank levels, and many types of support facilities. Under current plans, Hanford's single-shell tanks will be used for up to 30 more years, and DOE proposes to construct new double-shell tanks that will be used for even longer.

Tank farm maintenance consists of two activities: (1) preventive maintenance, which is designed to keep problems from occurring, and (2) corrective maintenance, which involves correcting problems that occur or modifying facilities to improve their operation. Examples of preventive maintenance include calibrating instruments and servicing pumps, valves, and related equipment. Examples of corrective maintenance include repairing leaking piping, modernizing electrical systems, and repairing defective tank level gauges and other monitoring instruments. Given the potential environmental, health, and safety problems from leaks, spills, or other problems with radioactive or toxic materials, we focused our review on corrective maintenance projects designed to repair tank farm equipment, instruments, and facilities.

Tank farm maintenance, like other maintenance at Hanford, is divided into four classes that are prioritized according to urgency. Priority 1 items include actions to recover from unsafe conditions or to avoid imminent violation of safety requirements, while priority 2 items include regular actions required for facility safety or continuing operations. Nonsafety-related actions are classified as priority 3 or 4, depending on their importance. Of the corrective maintenance projects completed in 1993, about 3 percent were priority 1 and about 88 percent were priority 2, while only 9 percent were priority 3 or 4.

Westinghouse Waste Tank Operations Group, the organization responsible for tank farm operations, has two units that together are responsible for

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maintenance activities. The first unit, production control, consists mainly of planners, schedulers, engineers, clerks, and related staff and is responsible for preparing, scheduling, and closing out the work. The second unit, maintenance, consists of craft workers who do the actual maintenance work (electricians, instrument technicians, pipefitters, and others) and their supervisors. The fiscal year 1994 budget of \$32 million for these two organizations supports a staff of 146 managers and other professionals, 22 administrative staff, and 93 craft employees.

Westinghouse manages most tank farm maintenance through a process called the job control system.<sup>1</sup> This process or system can be grouped into six general phases—identification and validation, planning, approval, scheduling, work and retesting, and closure. The initial phase of the system involves identifying and agreeing on the projects to be done, after which the item is assigned to a planner, who prepares the work “package”—a detailed plan and related documents covering the work to be done. Once prepared, the work package is reviewed and approved by a number of officials, such as health and safety personnel and facility managers. When all necessary approvals have been obtained, the job can be scheduled for work. When the work is completed and the equipment retested, the package is reviewed to ensure that (1) the work was done correctly, (2) needed changes to operating or maintenance procedures were made, and (3) the package was completed. The package is then sent to storage.

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## Backlog of Corrective Maintenance Exceeds Desired Levels

Between February 1991 and October 1994, Hanford’s inventory of uncompleted corrective maintenance projects ranged from a high of 1,992 projects to a low of 1,517. To ensure that maintenance needs are responded to in a timely manner, the inventory should be 90 days of work or about 300 projects, according to managers in Westinghouse’s production control unit. If the number is substantially higher than 300, as has been the case over the past 3 years, many projects could remain unaddressed for long periods.

The hazardous nature of the waste in the tank farms makes timely maintenance critical. This requires not only that actual problems be corrected but also that monitoring equipment be maintained so that it can detect problems as they occur. As the following examples show, projects in Hanford’s corrective maintenance backlog have required both types of attention.

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<sup>1</sup>Some routine maintenance tasks are managed through a simpler process.

- In 1991, a worker found that an asbestos gasket on a ventilation system in one tank farm had been leaking a small amount of radioactive contaminant on the ground. As of October 1994—more than 1,175 days later—the corrective maintenance had not been completed. A Westinghouse official said that the leak had been sealed with tape pending final repair. A facility representative said that the work had not been given more emphasis because such leaks were common in the tank farms.
- In June 1992, a special study team from DOE's Office of Environmental Restoration and Waste Management found that more than one-third of the liquid level gauges had failed, including those in 10 tanks that posed safety concerns, such as a risk of explosion. The July 1994 tank farm monthly report—the most recent report available—shows that automated instruments used for detecting and reporting leaks in 18 tanks were not working at the end of June 1994—including 6 that had been out of service for more than a year.<sup>2</sup>

To help understand what contributes to the backlog, we analyzed how long it took Westinghouse to process a corrective maintenance project. Our analysis focused on 660 projects closed in calendar year 1993, for which phase-by-phase data were available within the job control system.<sup>3</sup> On average, these 660 projects took 325 days from start to finish. The distribution of the 325 days was as follows:

- The largest portion of calendar time—162 days, or 50 percent—was spent preparing to start work on the project. This portion encompasses the planning, approval, and scheduling phases. These three phases averaged 67, 36, and 59 days, respectively.
- By far the smallest portion of calendar time was spent actually doing the maintenance work and retesting the equipment. On average, this phase took 21 days, or about 7 percent of the total time. Data from the job control system show that the actual time to make the repairs averaged about 30 hours.<sup>4</sup>
- The final phase of the process—closure—took an average of 142 days, or about 44 percent of the time. The purpose of this phase is to ensure that the work was done correctly and completely.

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<sup>2</sup>Because automated instruments in these tanks were out of service, manual readings were taken.

<sup>3</sup>When we requested information on corrective maintenance projects closed in 1993, the job control system contained information on 725 projects completed during the year. We were unable to include 65 older projects in our analysis because complete phase-by-phase information on them was not available.

<sup>4</sup>The job control system does not have similar data on the number of hours spent in other phases of the work.

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To provide some basis of comparison for assessing the timeliness of the process at Hanford, we asked maintenance managers at DOE's Savannah River Site and Idaho National Engineering Laboratory (INEL) to provide us with information about how long it took to complete corrective maintenance at their tank farms. Savannah River reported that corrective maintenance projects completed in 1993 averaged 143 days from start to finish; at INEL the figure was 138 days. The three sites have similar types of tanks, tank wastes, and maintenance activities associated with their tank farms. However, because each site has its own system for structuring the work and maintaining data on the process, it was not possible to make phase-by-phase comparisons between locations.

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## New Approach to Organizing Work Has Helped Reduce the Backlog of Corrective Maintenance Projects

While the backlog is still too great to ensure timely response to all corrective maintenance needs, it has decreased in recent months. Between January and October 1994, the inventory of uncompleted projects dropped from 1,969 to 1,517. One factor contributing to the decrease, according to Westinghouse personnel, was the implementation of a new approach to make the maintenance process more productive.<sup>5</sup>

During the past 2 years, Westinghouse undertook three major initiatives to improve the productivity of its tank farm maintenance. Two of the initiatives have basically been abandoned in favor of the third initiative. The first initiative, called the Team Concept, involved assigning a cross-sectional group to handle maintenance at specific facilities. The concept encountered difficulties in implementation and was gradually abandoned. Westinghouse's production control manager said that the major problems encountered were weak scheduling systems and a lack of management discipline to keep team members working in the facilities to which they had been assigned. The second initiative, called SD-028, allowed streamlined planning for replacing parts. After an audit of a sample of work packages found that staff failed to comply with the requirements of the procedure, SD-028 was also canceled.

The new approach, called the "zone concept," was implemented in October 1993. This approach was adapted from DOE's Waste Isolation Pilot Plant in New Mexico, where the maintenance manager credited it with substantially reducing the maintenance backlog. The new approach centers on a different method for getting work done. The approach

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<sup>5</sup>Another factor was that Westinghouse reviewed the list of uncompleted projects and eliminated ones that duplicated others or that were judged to be no longer needed.

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attempts to break down the separation between various Westinghouse units having maintenance, safety, and related responsibilities. While retaining separate production control and maintenance units, the new approach divides maintenance work into 10 zones and assembles an interdisciplinary group to coordinate the work in each zone.<sup>6</sup> Under this concept, for example, fixing an electrical zone problem would be planned, coordinated, and scheduled by a group with representatives from production control and maintenance and from other Westinghouse units responsible for tank farm operations, safety, and health physics.

Early indications are that the zone concept has played a role in reducing the backlog of projects. Westinghouse officials believe that the zone concept has increased efficiency and had other benefits, such as better communication between craft workers and managers and more timely completion of maintenance. Previously, according to the officials, maintenance was often interrupted because, for example, craft workers or support staff were not available or safety requirements were not being met. The incidence of such delays dropped from an average of 114 per month in fiscal year 1993 to an average of about 33 per month in fiscal year 1994.

More time is needed to assess how much the zone concept will increase productivity and deal effectively with maintenance problems because its structure and staffing are still evolving. For example, since the concept was initially implemented, some zones have been added, while others have been combined.

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## Other Ways to Improve Efficiency Remain Only Partly Addressed

Several other opportunities remain available for reducing the time needed to complete maintenance projects. These include reducing the time spent in preparing and closing out maintenance projects, developing benchmarks for measuring performance, and gathering and analyzing information about how much time and money are spent on individual work projects. As currently implemented, the zone concept does not address these issues.

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<sup>6</sup>The 10 zones are electrical, mechanical, and instrumentation zones in each of Hanford's two tank farm areas; a zone for the evaporator and some related facilities; a painting and insulation zone; a compliance and sampling zone; and a zone for safety projects and major maintenance work done by a subcontractor.

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## Reducing the Time Required to Prepare and Close Out Maintenance Projects

We identified steps that Savannah River and INEL are taking to reduce the time spent in preparing and closing out maintenance projects.

Westinghouse managers have recently experimented with these same approaches, with promising results. However, the managers have not established any plans for taking these approaches beyond the experimental stage.

- At INEL, officials adopted a collaborative process for approving corrective maintenance plans, trimming this phase of the process to a few minutes each for most projects. By comparison, the fiscal year 1993 projects we analyzed at Hanford took an average of 36 days to approve. In July 1994, Westinghouse experimented with this approach at Hanford. By drawing together all staff responsible for approving a group of about a dozen similar packages, Westinghouse was able to approve those projects in a single meeting. The manager responsible for the initiative, who is applying this approach on a limited basis, estimated that the cost savings from reductions in staff time would amount to about \$10,000 a month. He plans to continue this process with this group of packages and would like to expand it further.
- INEL and Savannah River have assigned staff as coordinators to close out a project once the work has been done and tested. Under their systems, work packages are in the closure phase for an average of 9 days at INEL and 38 days at Savannah River. It is during this phase that the work package is reviewed to ensure that (1) the work was done correctly, (2) needed changes to operating or maintenance procedures were made, and (3) the package was completed. At Hanford, production control staff do not consider closure a high priority, and no staff are exclusively assigned to this phase. As a consequence, the average package spent 142 days in this phase—almost as much time as is spent in planning, approving, and scheduling the work. Earlier in 1994, Westinghouse's production control manager said that he had made a limited effort to reduce the closure time by directing his staff to close out packages when they had time available. Westinghouse succeeded in reducing closure time to about 70 days, and Westinghouse officials believe the time can be reduced to about 30 days. However, because no staff have been directly assigned to this task, there is no assurance that the closure phase will continue to receive needed attention.

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## Developing Benchmarks for Measuring Maintenance Performance

Hanford's corrective maintenance projects showed wide variations in the time they took in the various phases of the process. In the planning phase, for example, half of the fiscal year 1993 projects we reviewed were



completed in 17 days or less, but some took as long as 763 days. Likewise, approval was completed for half of the projects in 13 days or less, but some took as long as 712 days. Similar variation was present in other phases as well.

The wide variation points to a basic problem in Hanford's maintenance program: The program lacks clear expectations about how long the work should take. Without such expectations, important projects can languish as the following examples show:

- A 1-day job to prevent water lines from leaking and shutting down a system that helps prevent accidental releases of radioactivity spent a year in the scheduling phase.
- Another project involved replacing a \$3 filter on a \$300 vacuum pump used for monitoring leakage of radioactive material. A staff member with whom we discussed this project said that if the filter were to fail, the entire vacuum pump would have to be replaced. He said that although he kept putting the project on the schedule, other staff bumped it in favor of other projects. In all, 329 days elapsed between the time the work package was initiated and the time the filter was replaced.

Recent studies have pointed out the advisability of adopting benchmarks (called "engineered performance standards") for how long work should take to ensure efficient use of resources and workable schedules.<sup>7</sup> In May 1993, a consultant's report recommended that Westinghouse adopt these standards. A similar recommendation was made for Savannah River's tank farms in January 1994, where work is now under way to put performance standards in place.

Some Hanford officials are implementing engineered performance standards but not those who oversee tank farm maintenance. A manager in the landlord maintenance program<sup>8</sup> at Hanford said that he is beginning to implement the standards in his program. He said that while it is too soon to identify improvements in productivity, the performance standards have already improved the accuracy of work scheduling. In October 1994, the tank farm production control manager told us that Westinghouse is struggling with budget and staffing issues and has no plans to implement

<sup>7</sup>Audit of Staffing Requirements at the Westinghouse Savannah River Company, U.S. Department of Energy, DOE/IG-0340, Jan. 1994. Value Management Evaluation for the Measurement and Improvement of Productivity, a report prepared for Westinghouse Hanford Company, Richland, Washington, H.B. Maynard and Company, Inc., May 1993.

<sup>8</sup>This group is responsible for the general maintenance of roads and buildings not maintained under other programs and for other needed site maintenance.

the standards at this time. However, he said that the standards, tailored to the Hanford tank farm maintenance operation, would be useful.

### Developing and Analyzing Information on Maintenance Times and Costs

Even though DOE policy requires facilities to be maintained in a cost-effective manner, Westinghouse lacks information on project costs and the number of hours used to complete maintenance projects. We identified two main ways in which Westinghouse could improve this information:

- For craft workers, such as pipefitters and electricians, Westinghouse could examine INEL's and Savannah River's approaches for obtaining more specific data than Hanford currently keeps. At Hanford, at the end of a project, craft workers summarize the time they spent on the task and record the information in the maintenance package. Parts supplied are also listed in the package. However, the cost of the various types of staff performing the work and the cost of the material used are not developed. By contrast, INEL and Savannah River develop additional information on maintenance performance by recording craft hours and associated costs and adding the cost of materials used. At INEL, the cost reports are sent to facility managers to use to prepare facility budgets and to help decide if equipment should be replaced. At Savannah River, cost information is also used in decisions to repair or replace equipment.
- For other workers, such as planners, engineers, or safety personnel, Westinghouse could examine ways to collect similar project-by-project information. Currently, these workers charge their time to broad budget categories, such as corrective maintenance or preventive maintenance, and do not record how much time they spend working on individual maintenance projects. Collecting more specific information is important to identify how much time workers actually spend preparing the packages during the considerable periods of calendar time the projects spend in planning, approval, and scheduling.

Because Hanford's information about hours and costs is limited, managers cannot tell how productively maintenance tasks are being carried out and where improvements are needed. Better information could lead to greater accuracy in predicting the actual time required for work and more effective schedules. During our review, we identified specific benefits, such as the following:

- Better information could help management use staff more efficiently. We examined this potential in a random selection of 16 maintenance projects

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for which we tracked workers' use of time during the work and retest phase when repairs were actually being done. We found that about 38 percent of the time was used in performing the work; 34 percent was spent in related activities, such as donning protective clothing and conducting pre-job meetings; and 28 percent was spent on nonproductive activities, such as waiting for assistance needed to perform the work. For example, on one maintenance job we observed, staff who were working overtime waited for at least 6 hours for the results of air sampling and for approval to use a three-eighth-inch pressure valve on a three-quarter-inch pipe.

- More accurate information about the number of hours needed to complete certain tasks could help managers improve work scheduling. Currently, the planner estimates the time and crafts required to do the work when the package is planned. The craft workers report the time they spent at the conclusion of the job. However, no analysis of any differences is conducted to help in planning future projects. For about one-third of the 1993 jobs with sufficient information to make such an analysis, the difference between the planned and reported time spent on the project was more than 50 percent.
- Better information could direct management attention to whether projects were languishing because of inattention. For example, we examined one maintenance project to repair a leak detection alarm that was in the planning phase for 20 months. None of the three planners involved in the job whom we interviewed had any records to show how much time they had spent working on the package. If this information were available, Westinghouse managers would be better able to determine whether the number of hours spent was reasonable for an effort that took 20 months to complete. The Westinghouse tank farm production control manager said that information on the actual time spent working on packages would be helpful. He said that a number of approaches are available to obtain this information but none has been implemented.

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## Conclusions

Successful resolution of problems facing the tank farm maintenance program requires a wider range of actions than Westinghouse now has under way. The zone concept shows promise in improving communication between work units and making the maintenance process more productive, but reducing the backlog of maintenance projects to an acceptable level requires that Westinghouse make full use of additional procedures that have proven successful at other DOE tank farms. Westinghouse's experiments with these procedures have demonstrated their usefulness. What is needed now is to apply these lessons

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systematically. Westinghouse also needs to gather more data about its maintenance operations in order to better understand how the projects proceed and to identify opportunities for further improvement.

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## Recommendations

We recommend that the Secretary of Energy direct the Manager of the Richland Field Office to take the following actions:

- Streamline the processes for (1) approving corrective maintenance plans and (2) closing out completed maintenance work by adopting procedures used at other DOE sites and already tested in experiments at Hanford.
- Develop (1) benchmarks and, where appropriate, engineered performance standards for tank farm maintenance and (2) more complete data on the time required for, and the cost of, conducting each maintenance project. DOE should then use this information to adjust the benchmarks and standards and to identify additional opportunities to improve tank farm maintenance.

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Appendix I discusses the scope and methodology we used in conducting our work. As agreed with your office, we did not obtain written agency comments on a draft of this report. However, we discussed our findings with the director of the tank farm operations office and with the tank farm operations manager at Westinghouse. The officials said that the findings were generally consistent with their own assessment of the tank farm maintenance activities. However, they provided additional information on recent actions taken to improve tank farm maintenance. As a result, we conducted additional work and revised the draft to reflect recent changes in the program.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Secretary of Energy; and the Director, Office of Management and Budget. We will make copies available to others upon request.

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Please call me at (202) 512-3841 if you or your staff have any questions.  
Major contributors to this report are listed in appendix II.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Victor S. Rezendes". The signature is fluid and cursive, with the first name being the most prominent.

Victor S. Rezendes  
Director, Energy and  
Science Issues



# Scope and Methodology

To address the Senate Committee on Governmental Affairs' concerns about the Department of Energy's (DOE) tank farm maintenance program, we used a number of different approaches. At DOE's Hanford Site, we reviewed various reports on the tank farm maintenance program; reviewed key DOE orders and Westinghouse manuals; discussed maintenance activities with DOE staff, Westinghouse managers and workers, and state and federal regulators; reviewed maintenance work packages; observed work in process; and obtained and analyzed data on maintenance work from Westinghouse's job control system. To help us assess the Hanford program, we visited the Idaho National Engineering Laboratory's (INEL) tank farm and tank farms at DOE's Savannah River Site. At our request, managers at those facilities developed information related to their maintenance workload.

## Data Base Analysis

To determine how long it takes to complete maintenance work at the Hanford tank farms, we analyzed work package data. Westinghouse maintains data on each work package in a computerized job control system data base. The system, implemented in February 1991, stores information such as who originated the work package, location and description of the work, when work began or ended, names of staff who reviewed the package, and other relevant information. This data base is updated to track the package through the process. We validated the accuracy of these data by selecting a small sample of work packages and comparing the information shown in the actual package with data in the computerized system. We generally found only minor discrepancies.

We obtained from Westinghouse copies of the data base for all open and closed corrective maintenance packages as of January 15, 1994. We used a data base program and a statistical analysis program to analyze the data. We singled out those work packages that were completed in 1993—725 out of a total of 4,673 work packages. We used data from our analysis to compute the range of time packages spent in various stages of the process, how many steps they incurred, and average and median time spent in each phase. We also analyzed other related factors such as whether preapproved procedures were used and priority of the work. We discussed our methodology with Westinghouse staff, who agreed that our approach would accurately portray the time spent performing corrective maintenance work at Hanford.

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## Work Observation

To determine how efficient Westinghouse was in performing the repairs called for in the work packages, we reviewed several studies that had reported problems in performing the work. Also, on 10 different days between November 1993 and January 1994, we attended the early morning meeting at which maintenance jobs were released. We selected 16 jobs that were released for work at these meetings.<sup>1</sup> We then observed the workers assigned to the jobs from their pre-job meetings through the completion or suspension of that days' work on those jobs. The 16 jobs included both preventative and corrective maintenance at the evaporator and several tank farms. We monitored the activities of all staff assigned to the work location. We summarized the activities of the assigned maintenance craft workers into the following categories: performing the work, related activities, and other.

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<sup>1</sup>One job was selected on two different days.



# Major Contributors to This Report

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## Energy and Science Issues

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