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YUCCA MOUNTAIN

DOE's Planned Nuclear
Waste Repository Faces
Quality Assurance and
Management Challenges

Statement of Jim Wells, Director
Natural Resources and Environment



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Highlights

Highlights of [GAO-06-550T](#), a testimony before the Subcommittee on the Federal Workforce and Agency Organization, Committee on Government Reform, House of Representatives

Why GAO Did This Study

The Department of Energy (DOE) is working to obtain a license from the Nuclear Regulatory Commission (NRC) to construct a nuclear waste repository at Yucca Mountain in Nevada. The project, which began in the 1980s, has been beset by delays. In 2004, GAO raised concerns that persistent quality assurance problems could further delay the project. Then, in 2005, DOE announced discovery of employee e-mails suggesting quality assurance problems. Quality assurance, which establishes requirements for work to be performed under controlled conditions that ensure quality, is critical to making sure the project meets standards for protecting public health and the environment.

This testimony, which summarizes GAO's March 2006 report (GAO-06-313), provides information on (1) the history of the project's quality assurance problems, (2) DOE's tracking of these problems and efforts to address them since GAO's 2004 report, and (3) challenges facing DOE as it continues to address quality assurance issues within the project.

What GAO Recommends

In its March 2006 report, GAO recommended actions DOE can take to improve the project's management tools and their use in identifying and addressing quality assurance and other problems. In commenting on a draft of the report, DOE agreed with GAO's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-06-550T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

YUCCA MOUNTAIN

DOE's Planned Nuclear Waste Repository Faces Quality Assurance and Management Challenges

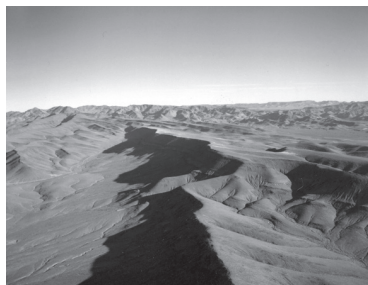
What GAO Found

DOE has had a long history of quality assurance problems at the Yucca Mountain project. In the 1980s and 1990s, DOE had problems assuring NRC that it had developed adequate plans and procedures related to quality assurance. More recently, as it prepares to submit a license application for the repository to NRC, DOE has been relying on costly and time-consuming rework to resolve lingering quality assurance problems uncovered during audits and after-the-fact evaluations.

DOE announced, in 2004, that it was making a commitment to continuous quality assurance improvement and that its efforts would be tracked by performance indicators that would enable it to assess progress and direct management attention as needed. However, GAO found that the project's performance indicators and other key management tools were not effective for this purpose. For example, the management tools did not target existing areas of concern and did not track progress in addressing them. The tools also had weaknesses in detecting and highlighting significant problems for management attention.

DOE continues to face quality assurance and other challenges. First, DOE is engaged in extensive efforts to restore confidence in scientific documents because of the quality assurance problems suggested in the discovered e-mails between project employees, and it has about 14 million more project e-mails to review. Second, DOE faces quality assurance challenges in resolving design control problems associated with its requirements management process—the process for ensuring that high-level plans and regulatory requirements are incorporated into specific engineering details. Problems with the process led to the December 2005 suspension of certain project work. Third, DOE continues to be challenged to manage a complex program and organization. Significant personnel and project changes initiated in October 2005 create the potential for earlier problem areas, such as confusion over roles and responsibilities, to reoccur.

View of Yucca Mountain and the Exploratory Tunnel for the Repository



Source: DOE.

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss our work concerning quality assurance and other management challenges facing the Department of Energy (DOE) as it prepares to construct a deep geological repository at Yucca Mountain in Nevada for the nation's nuclear wastes. My testimony is based on our March 2006 report entitled *Yucca Mountain: Quality Assurance at DOE's Planned Nuclear Waste Repository Needs Increased Management Attention*.¹

DOE is preparing an application for a license from the Nuclear Regulatory Commission (NRC) to construct an underground geological repository at Yucca Mountain for the permanent storage of highly radioactive nuclear waste. Nuclear waste is a by-product of the production of nuclear power, which provides about 20 percent of U.S. electricity. About 50,000 metric tons of nuclear waste are stored at 72 sites around the country, principally at commercial nuclear power plants. These wastes have been accumulating for several decades in surface storage designed to be temporary. The Nuclear Waste Policy Act of 1982 required DOE to construct a repository for permanent storage and to begin accepting these wastes by January 31, 1998. In 2002, after more than 15 years of scientific study, the President recommended and the Congress approved Yucca Mountain as a suitable location for the repository. However, DOE continues to encounter delays, and it is not certain when it will apply for the license to construct the repository.

The licensing process requires DOE to demonstrate to NRC that its plans for the repository will meet Environmental Protection Agency standards for protecting public health and the environment from harmful exposure to the radioactive waste. To show that it can meet these standards, DOE has been conducting scientific and technical studies at the Yucca Mountain site that will provide supporting documentation for its planned license application. DOE has also established a quality assurance program to meet NRC requirements and ensure that its work and the technical information it produces are accurate and defensible. To accomplish this goal, the program established procedures that require scientific, design, engineering, procurement, records keeping, and other work to be performed under controlled conditions that ensure quality and enable the work to be verified by others. However, persistent problems implementing

¹[GAO-06-313](#) (Washington, D.C.: Mar. 17, 2006).

these procedures and resulting questions about the quality of the work are significantly contributing to delays in DOE's submission of the license application. Resolving these quality assurance issues is essential to proceeding with construction.

In April 2004, we reported that recurring quality assurance problems at the Yucca Mountain project could delay the licensing and operation of the repository. At that time, we also reported that DOE had completed efforts—known as Management Improvement Initiatives (Initiatives)—to better manage quality assurance problems, but could not assess their effectiveness because its performance goals lacked objective measures and time frames for determining success.² Then, in early 2005, DOE reported that it had discovered a series of e-mail messages written in the late 1990s by U.S. Geological Survey (USGS) employees working on the Yucca Mountain project under a contract with DOE that appeared to imply that workers had falsified records for scientific work. Several of these messages appeared to show disdain for the project's quality assurance program and its requirements. In October 2005, DOE began planning an aggressive series of changes—known as the “new path forward”—to the facility design, organization, and management of the Yucca Mountain project. These efforts are intended to address quality assurance and other challenges, including those associated with the USGS e-mails, and advance the license application process. However, in December 2005 and again in February 2006, some project work was stopped due to continuing quality assurance problems.

Our March 2006 report examined (1) the history of the project's quality assurance problems since its start in the 1980s, (2) DOE's tracking of quality problems and progress implementing quality assurance requirements since our April 2004 report, and (3) challenges that DOE faces as it continues to address quality assurance issues with the project. To determine the history of quality assurance problems, we reviewed previous GAO, DOE, and NRC documents, visited the Yucca Mountain site, and interviewed officials from DOE, NRC, and Bechtel/SAIC Company, LLC (BSC), which is DOE's management contractor for the Yucca Mountain project. To assess DOE's tracking of quality-related problems and progress in addressing them, we examined management tools and associated documentation, and interviewed BSC and DOE officials

²GAO, *Yucca Mountain: Persistent Quality Assurance Problems Could Delay Repository Licensing and Operation*, [GAO-04-460](#) (Washington, D.C.: Apr. 30, 2004).

regarding those tools. To identify current quality assurance and other challenges, we attended quarterly NRC management meetings, interviewed the Acting Director and other senior managers of the DOE project, and gathered information on management turnover. The work on our report was conducted from July 2005 through January 2006 in accordance with generally accepted government auditing standards.

In summary, we found the following:

- DOE has had a long history of quality assurance problems at the Yucca Mountain project. In the late 1980s and early 1990s, DOE had problems assuring NRC that it had developed adequate plans and procedures related to quality assurance. As we reported in 1988, NRC had found that DOE's quality assurance procedures were inadequate and its efforts to independently identify and resolve weaknesses in the procedures were ineffective. By the late 1990s, DOE had largely addressed NRC's concerns about its plans and procedures, but its own audits identified quality assurance problems with the data, software, and models used in the scientific work supporting its potential license application. For example, in 1998, a team of project personnel determined that 87 percent of the models used to simulate the site's natural and environmental conditions, and to demonstrate the future repository's performance over time, did not comply with requirements for demonstrating their accuracy in predicting geologic events. More recently, DOE has relied on costly and time-consuming rework to resolve lingering quality assurance concerns. Specifically, in the spring of 2004, DOE implemented a roughly \$20 million, 8-month project called the Regulatory Integration Team to ensure that scientific work was sufficiently documented and explained to support the license application. This effort involved about 150 full-time employees from DOE, USGS, and multiple national laboratories, such as Sandia and Los Alamos, working to inspect technical documents to identify and resolve quality problems.
- DOE cannot be certain that its efforts to improve quality assurance have been effective because the management tools it adopted did not target existing management concerns and did not track progress in addressing significant and recurring problems. DOE announced in 2004 that it was making a commitment to continuous quality assurance improvement and that its efforts would be tracked by performance indicators that would enable it to assess progress and direct management attention as needed; however, its management tools have not been effective for this purpose. Specifically, its one-page summary, or "panel," of selected performance indicators that project managers used in monthly management meetings was not an effective tool for assessing progress because the indicators

poorly represented the major management concerns and were changed frequently. For example, the panel did not include an indicator to represent the management concern about unclear roles and responsibilities—a problem that could undermine accountability within the project. Use of the indicator panel was discontinued in late 2005, and DOE is deciding on a tool to replace it. Moreover, a second management tool—trend evaluation reports—also did not track relevant concerns. The reports generally had technical weaknesses for identifying recurrent and significant problems and inconsistently tracked progress toward resolving the problems. For example, lacking reliable data and an appropriate performance benchmark for determining the significance of human errors as a cause of quality problems, DOE's trend reports offered no clear basis for tracking progress on such problems. In addition, under the trend reports' rating categories, the rating assigned to convey the significance of a problem was overly influenced by a judgment in the report that there were already ongoing management actions to address the problem, rather than solely assessing the problem's significance. For example, the trend report's rating of one particular problem at the lowest level of significance did not accurately describe the problem or sufficiently draw management's attention to it.

- DOE's aggressive "new path forward" effort faces substantial quality assurance and other challenges, as it prepares to submit the license application to construct the repository at Yucca Mountain. First, the March 2005 announcement of the discovery of USGS e-mails suggesting the possible falsification of quality assurance records has resulted in extensive efforts to restore confidence in scientific documents, and DOE is conducting a wide-ranging review of approximately 14 million e-mails to determine whether they raise additional quality assurance issues. Such a review creates a challenge not just because of the sheer volume of e-mails to be reviewed, but also because DOE will have to decipher their meaning and determine their significance, sometimes without clarification from authors who have left the project. Furthermore, if any of the e-mails raise quality assurance concerns, further review, inspection, or additional work may need to be performed. Second, DOE faces quality assurance challenges associated with an inadequate requirements management process—the process responsible for ensuring that broad plans and regulatory requirements affecting the project are tracked and incorporated into specific engineering details. In December 2005, DOE issued a stop-work order on some design and engineering work until it can determine whether the requirements management process has been improved. Third, DOE continues to be challenged by managing a changing and complex program and organization. The significant project changes initiated under the new path forward create the potential for confusion over

accountability as roles and responsibilities change—a situation DOE found to contribute to quality assurance problems during an earlier transition period. For example, one proposed reorganization—establishing a lead laboratory to assist the project—would not only have to be effectively managed, but also would introduce a new player whose accountability DOE would have to ensure. DOE has also experienced turnover in 9 of 17 key management positions since 2001—including positions related to quality assurance—that has created management continuity challenges. For example, three individuals have directed the project since 1999, and the position is currently occupied by an acting director. Since DOE is still formulating its plans, it is too early to determine whether its new path forward effort will resolve these challenges.

In our report, we recommend that DOE strengthen its management tools by (1) improving the tools’ coverage of the Initiatives’ areas of concern, (2) basing the tools on projectwide analysis of problems, (3) establishing quality guidelines, (4) making indicators and analyses more consistent over time, and (5) focusing rating categories on problem significance rather than a judgment on the need for management action. In commenting on the report, DOE agreed with our recommendations.

Background

The Congress enacted the Nuclear Waste Policy Act of 1982 to establish a comprehensive policy and program for the safe, permanent disposal of commercial spent nuclear fuel and other highly radioactive wastes in one or more mined geologic repositories. The act charged DOE with (1) establishing criteria for recommending sites for repositories; (2) “characterizing” (investigating) three sites to determine each site’s suitability for a repository (1987 amendments to the act directed DOE to investigate only the Yucca Mountain site); (3) recommending one suitable site to the President, who would submit a recommendation of such site to the Congress if he considered the site qualified for a license application; and (4) upon approval of a recommended site, seeking a license from NRC to construct and operate a repository at the site. The Yucca Mountain project is currently focused on preparing an application for a license from NRC to construct a repository. DOE is compiling information and writing sections of the license application, conducting technical exchanges with NRC staff, and addressing key technical issues identified by NRC to ensure that sufficient supporting information is provided.

In February 2005, DOE announced that it does not expect the repository to open until 2012 at the earliest, which is more than 14 years later than the

1998 goal specified by the Nuclear Waste Policy Act of 1982. More recently, the conference report for DOE's fiscal year 2006 appropriations observed that additional significant delays to submitting a license application are likely. In October 2005, the project's Acting Director issued a memorandum calling for the development of wide-ranging plans for the "new path forward" to submitting the license application. The plans address the need to review and replace USGS work products, establish a lead national laboratory to assist the project, and develop a new simplified design for the waste canisters and repository facilities, among other things. In addition, DOE announced, in April 2006, that it was proposing legislation intended to accelerate licensing and operations. For example, the legislation provides that if NRC authorizes the repository, subsequent licensing actions would be conducted using expedited, simplified procedures.

Given the delays, the Congress has considered other options for managing existing and future nuclear wastes, such as centralized interim storage at one or more DOE sites. In addition, the conference report for DOE's fiscal year 2006 appropriations directed DOE to develop a spent nuclear fuel recycling plan to reuse the spent fuel. However, according to the Nuclear Energy Institute, which represents the nuclear energy industry, none of technological options being considered will eliminate the need to ultimately dispose of nuclear waste in a geologic repository.

DOE Has a Long History of Quality Assurance Problems at Yucca Mountain

DOE has had a long history of quality assurance problems at the Yucca Mountain project. In the project's early stages, DOE had problems assuring NRC that it had developed adequate quality assurance plans and procedures. By the late 1990s, DOE had largely addressed NRC's concerns about its plans and procedures, but its own audits identified quality assurance problems with the data, software, and models used in the scientific work supporting its potential license application. While recently resolving these quality problems, DOE is now relying on costly and time-consuming rework to ensure the traceability and transparency of several technical work products that are key components of the license application.

As we reported in 1988, NRC reviewed DOE's quality assurance program for the Yucca Mountain project and concluded that it did not meet NRC

requirements³ and that DOE's quality assurance audits were ineffective. In 1989, NRC concluded that DOE and its key contractors had yet to develop and implement an acceptable quality assurance program. However, by March 1992, NRC determined that DOE had made significant progress in improving its quality assurance program, noting among other things, that all of the contractor organizations had developed and were in the process of implementing quality assurance programs that met NRC requirements, and that DOE had demonstrated its ability to evaluate and correct deficiencies in the overall quality assurance program.

By the late 1990s, however, the DOE quality assurance program began detecting new quality problems in three areas critical to demonstrating the repository's successful performance over time: data management, software management, and scientific models.

- *Data management.* In 1998, DOE identified quality assurance problems with the quality and traceability of data, specifically that some data had not been properly collected or tested to ensure its accuracy and that data used to support scientific analysis could not be properly traced back to its source. DOE found similar problems in April and September 2003.
- *Software management.* DOE quality assurance procedures require that software used to support analysis and conclusions about the performance and safety of the repository be tested or created in such a way to ensure that it is reliable. From 1998 to 2003, multiple DOE audits found recurring quality assurance problems that could affect confidence in the adequacy of software.
- *Model validation.* In 1998, a team of project personnel evaluated the mathematical models used to simulate natural and environmental conditions and determined that 87 percent of them did not comply with validation requirements to ensure they accurately predict geologic events. In 2001, and again in 2003, DOE audits found that project personnel were not properly following procedures, specifically in the areas of model documentation, model validation, and checking and review. Further, the 2003 audit concluded that previous corrective actions designed to improve validation and reduce errors in model reports were not fully implemented.

³GAO, *Nuclear Waste: Repository Work Should Not Proceed Until Quality Assurance Is Adequate*, [GAO/RCED-88-159](#) (Washington, D.C.: Sept. 29, 1988).

After many years of working to address these quality assurance problems with data, software, and models, DOE had mostly resolved these problems by February 2005.

As DOE prepares to submit the Yucca Mountain project license application to NRC, it is relying on costly and time-consuming rework to ensure that the documents supporting its license application are accurate and complete. Although the department had known for years about quality assurance problems with the traceability and transparency of technical work products called Analysis and Model Reports (AMR)—a key component of the license application—DOE did not initiate a major effort to address these problems until 2004. AMRs contain the scientific analysis and modeling data that demonstrate the safety and performance of the planned repository and, among other quality requirements, must be traceable to their original source material and data and be transparent in justifying and explaining their underlying assumptions, calculations, and conclusions. In 2003, based in part on these problems, as well as DOE's long-standing problems with data, software, and modeling, NRC conducted an independent evaluation of three AMRs to determine if they met NRC requirements for being traceable, transparent, and technically appropriate for their use in the license application. In all three AMRs, NRC found significant problems with both traceability and transparency.⁴ NRC concluded that these findings suggested that other AMRs may have similar problems and that such problems could delay NRC's review of the license application, as it would need to conduct special inspections to resolve any problems it found with the quality of technical information.

To address problems of traceability and transparency, DOE initiated an effort in the spring of 2004 called the Regulatory Integration Team (RIT) to perform a comprehensive inspection and rework of the AMRs and ensure they met NRC requirements and expectations.⁵ According to DOE officials, the RIT involved roughly 150 full-time personnel from DOE, USGS, and multiple national laboratories such as Sandia, Los Alamos, and Lawrence Livermore. The RIT decided that 89 of the approximately 110 AMRs needed rework. According to DOE officials, the RIT addressed or

⁴U.S. Nuclear Regulatory Commission, *U.S. Nuclear Regulatory Commission Staff Evaluation of U.S. Department of Energy Analysis Model Reports, Process Controls, and Corrective Actions* (Washington, D.C., Apr. 7, 2004).

⁵In addition, the RIT edited the AMRs to assure consistency and ease of technical and regulatory reviews.

corrected over 3,700 problems, and was completed approximately 8 months later at a cost of about \$20 million. In a February 2005 letter to DOE, the site contractor stated that the RIT effort had successfully improved the AMRs' traceability and transparency.

Subsequently, however, DOE identified additional problems with traceability and transparency that required further inspections and rework. DOE initiated a review of additional AMRs that were not included in the scope of the 2004 RIT review after a March 2005 discovery of e-mails from USGS employees written between May 1998 and March 2000 implying that employees had falsified documentation of their work to avoid quality assurance standards. These additional AMRs contained scientific work performed by the USGS employees and had been assumed by the RIT to meet NRC requirements for traceability and transparency. However, according to DOE officials, DOE's review determined that these AMRs did not meet NRC's standards, and rework was required. DOE identified similar problems as the focus of the project shifted to the design and engineering work required for the license application. In February 2005, the site contractor determined that, in addition to problems with AMRs, similar traceability and transparency problems existed in the design and engineering documents that constitute the Safety Analysis Report—the report necessary to demonstrate to NRC that the repository site will meet the project's health, safety, and environmental goals and objectives. In an analysis of this problem, the site contractor noted that additional resources were needed to inspect and rework the documents to correct the problems.

DOE Cannot Be Certain Its Efforts to Improve Quality Assurance Have Been Effective Because of Weaknesses in Tracking Progress and Identifying Problems

DOE's management tools for the Yucca Mountain project have not enabled it to effectively identify and track progress in addressing significant and recurring quality assurance problems. Specifically, its panel or one-page summary of selected performance indicators did not highlight the areas of management concern covered by its Management Improvement Initiatives (Initiatives) and had weaknesses in assessing progress because the indicators kept changing. Its trend reports also did not focus on tracking these management concerns, had technical weaknesses for identifying significant and recurrent problems, and has inconsistently tracked progress with problems. Furthermore, the trend reports have sometimes been misleading as to the significance of the problems being presented because their significance ratings tend to be lower if corrective actions were already being taken, without considering the effectiveness of the actions or the problem's importance to the project.

In April 2004, DOE told us it expected that the progress achieved with its Initiatives for improving quality assurance would continue and that its performance indicators would enable it to assess further progress and direct management attention as needed. By that time, the actions called for by the Initiatives had been completed and project management had already developed a “panel” of indicators to use at monthly management meetings to monitor project performance. The panel was a single page composed of colored blocks representing selected performance indicators and their rating or level of performance. For example, a red block indicated degraded or adverse performance warranting significant management attention, a yellow block indicated performance warranting increased management attention or acceptable performance that could change for the worse, and a green block indicated good performance. The panel represented a hierarchy of indicators where the highest-level indicators were visible, but many lower-level indicators that determined the ratings of the visible indicators were not shown. Our review analyzed a subset of these indicators that DOE designated as the best predictors in areas affecting quality.

We found that the panel was not effective for assessing continued progress because its indicators poorly represented the management concerns identified by the Initiatives. The Initiatives had raised concerns about five key areas of management weakness as adversely affecting the implementation of quality assurance requirements, and had designated effectiveness indicators for these areas. (These areas of concern are described in app. I.) However, two of the Initiatives’ five key areas of concern—roles and responsibilities as well as work procedures—were not represented in the panel’s visible or underlying indicators. In other cases, the Initiatives’ effectiveness indicators were represented in underlying lower-level indicators that had very little impact on the rating of the visible indicator. For example, the Initiatives’ indicator for timely completion of employee concerns was represented by two lower-level indicators that together contributed 3 percent of the rating for an indicator visible in the panel.

Another shortcoming of the panel was that frequent changes to the indicators hindered the ability to identify problems for management attention and track progress in resolving them. The indicators could change in many ways, such as how they were defined or calculated. Such changes made it difficult to measure progress because changes in indicator ratings could reflect only the changes in the indicators rather than actual performance changes. Some of the indicators tracking quality issues changed from one to five times during the 8-month period from

April 2004 through November 2004. Even after a major revision of the panel in early 2005, most of the performance indicators tracking quality issues continued to change over the next 6 months—that is, from March 2005 through August 2005. Only one of these five indicators did not change during this period. One indicator was changed four times during the 6-month period, resulting in it being different in more months than it remained the same. Moreover, the panel was not always available to track problems. It was not created for December 2004 through February 2005, and it has not been created since August 2005. In both cases, the panel was undergoing major revisions. In December 2005, a senior DOE official told us that the project would begin to measure key activities, but without use of the panel.

According to DOE, a second management tool, the project's quarterly trend evaluation reports, captured some aspects of the Initiatives' areas of concern and their associated effectiveness indicators that were not represented in the performance indicators. However, the trend reports are designed more to identify emerging and unanticipated problems than to monitor progress with already identified problems, such as those addressed by the Initiatives. In developing these reports, trend analysts seek to identify patterns and trends in condition reports, which document problematic conditions through the project's Corrective Action Program. For example, analysis might reveal that most occurrences of a particular type of problem are associated with a certain organization.

In practice, DOE missed opportunities to use trend reports to assess progress in the Initiatives' areas of concern. For example, DOE missed an opportunity to use trend reports to discuss the Initiatives' goal that the project's work organizations become more accountable for self-identifying significant problems. The August 2005 trend report briefly cited an evaluation of a condition report highlighting the low rate of self-identification of significant problems during the previous quarter and reported the evaluation's conclusion that it was not a problem warranting management attention. However, the trend report did not mention that about 35 percent of significant problems were self-identified during the previous quarter, while the Initiatives' goal was that 80 percent of significant problems would be self-identified.

Beyond whether they effectively track the Initiatives' areas of concern, trend reports generally face serious obstacles to adequately identifying recurrent and significant problems. For example, trend analysis tends to focus on the number of condition reports issued, but the number of reports does not necessarily reflect the significance of a problem. For

example, the number of condition reports involving requirements management decreased by over half from the first quarter to the second quarter of fiscal year 2005. However, this decrease was not a clear sign of progress. Not only did the number rise again in the third quarter, but the May 2005 trend report also noted that the number of all condition reports had dropped during the second quarter. According to the report, the volume of condition reports had been high in the first quarter because of reviews of various areas, including requirements management.

Due, in part, to these obstacles, trend reports have not consistently determined the significance of problems or performed well in tracking progress in resolving them. For example, trend reports have questionably identified human performance as a significant problem for resolution and ineffectively tracked progress in resolving it because there was (1) no clearly appropriate or precise benchmark for performance, (2) a changing focus on the problem, and (3) unreliable data on cause codes. The February 2004 trend report identified a human performance problem based on Yucca Mountain project data showing the project's proportion of skill-based errors to all human performance errors was two times higher than benchmark data from the Institute of Nuclear Power Operations (INPO).⁶ Interestingly, the report cautioned that other comparisons with these INPO data may not be appropriate because of differences in the nature, complexity, and scope of work performed, but did not explain why this caution did not apply to the report's own comparison. While this comparison has not appeared in trend reports since May 2004, a November 2004 trend report changed the focus of the problem to the predominance of human performance errors in general, rather than the skill-based component of these errors. (Later reports reinterpreted this predominance as not a problem.) The report cited an adverse trend based on the fact that the human performance cause category accounted for over half of the total number of causes for condition reports prepared during the quarter. Nevertheless, by February 2005, trend reports began interpreting this predominance as generally appropriate, given the type of work done by the project. That is, the project's work involves mainly human efforts and little equipment, while work at nuclear power plants involves more opportunities for errors caused by equipment. In our view, this interpretation that a predominance of human performance errors would

⁶Skill-based errors are defined in trend reports as unintentional errors resulting from people not paying attention to the task at hand.

be expected implies an imprecise benchmark for appropriate performance.

Further, although trend reports continued to draw conclusions about human performance problems, the February 2005 report indicated that any conclusions were hard to justify because of data reliability problems with cause coding. For example, the majority of problems attributed to human performance causes are minor problems, such as not completing a form, that receive less-rigorous cause analysis. This less-rigorous analysis tends to reveal only individual human errors—that is, human performance problems—whereas more-rigorous analysis tends to reveal less-obvious problems with management and procedures.

Another shortcoming of the trend reports was that their rating categories made it difficult to adequately determine the significance of some problems. Specifically, trend reports sometimes assigned a problem a lower significance than justified because corrective actions were already being taken. The rating categories for a problem's significance also involve an assessment of the need for management action. In their current formulation, DOE's rating categories cannot accurately represent both these assessments, and the designated rating category can distort one or the other assessment. For instance, a November 2005 trend report rated certain requirements management issues as a "monitoring trend"—defined as a small perturbation in numbers that does not warrant action but needs to be monitored closely. However, this rating did not accurately capture the report's simultaneous recognition that significant process problems spanned both BSC and DOE and the fact that the numbers and types of problems were consistently identified over the previous three quarters. A more understandable explanation for why the problem received a low rating is that designating the problem at any higher level of significance would have triggered guidelines involving the issuance of a condition report, which, according to the judgment expressed in the report, was not needed. Specifically, the report indicated that existing condition reports have already identified and were evaluating and resolving the problem, thereby eliminating the need to issue a new condition report.

However, by rating the problem at the lowest level of significance, the trend report did not sufficiently draw management's attention to the problem. At about the same time the trend report judged no new condition reports were necessary, a separate DOE investigation of requirements management resulted in 14 new condition reports—3 at the highest level of significance and 8 at the second-highest level of significance. These condition reports requested, for instance, an analysis of the collective

significance of the numerous existing condition reports and an assessment of whether the quality assurance requirement for complete and prompt remedial action had been met. As a result of the investigation and a concurrent DOE root cause analysis,⁷ DOE stated during the December 2005 quarterly management meeting with NRC that strong actions were required to address the problems with its requirements management system and any resulting uncertainty about the adequacy of its design products.

I would now like to update you on the project's February 2006 stop-work order, which occurred too late to be included in our report. We believe this incident is an example of how the project's management tools have not been effective in bringing quality assurance problems to top management's attention. After observing a DOE quality assurance audit at the Lawrence Livermore National Laboratory in August 2005, NRC expressed concern that humidity gauges used in scientific experiments at the project were not properly calibrated—an apparent violation of quality assurance requirements. According to an NRC official, NRC communicated these findings to BSC and DOE project officials on six occasions between August and December 2005, and issued a formal report and letter to DOE on January 9, 2006. However, despite these communications and the potentially serious quality assurance problems involved, the project's acting director did not become aware of the issue until January 2006, after reading about it in a news article. Due to concerns that quality assurance requirements had not been followed and the length of time it took top management to become aware of the issue, BSC issued a February 7, 2006, stop-work order affecting this scientific work. Project officials have begun a review of the issue.

⁷A root cause analysis seeks to determine the root cause of a problem, which is the underlying cause that must change in order to prevent the problem from reoccurring.

DOE's New Path Forward to Submitting a License Application Faces Substantial Quality Assurance and Other Challenges

In pursuing its new path forward, DOE faces significant quality assurance and other challenges, including (1) determining the extent of problems and restoring confidence in the documents supporting the license application after the discovery of e-mails raising the potential of falsified records, (2) settling the design issues and the associated problems with requirements management, and (3) replacing key personnel and managing the transition of new managers and other organizational challenges.

The early 2005 discovery of USGS e-mails suggesting possible noncompliance with the project's quality assurance requirements has left lingering concerns about the adequacy of USGS's scientific work related to the infiltration or flow of water into the repository and whether other work on the project has similar quality assurance problems. As part of its new path forward, DOE has taken steps to address these concerns. It is reworking technical documents created by USGS personnel to ensure that the science underlying the conclusions on water infiltration is correct and supportable. In addition, DOE is conducting an extensive review of approximately 14 million e-mails to determine whether they raise additional quality assurance concerns. According to NRC on-site representatives, screening these millions of e-mails to ensure that records were not falsified will be challenging. Further, many of the e-mails were written by employees who no longer work at the project or may be deceased, making it difficult to learn their true meaning and context. Moreover, if additional e-mails raise quality assurance concerns, DOE may have to initiate further review, inspections, or rework.

DOE officials have stated that it will need to resolve long-standing quality assurance problems involving requirements management before it can perform the design and engineering work needed to support the revised project plans called for by its new path forward. According to a 2005 DOE root cause analysis report, low-level documents were appropriately updated and revised to reflect high-level design changes through fiscal year 1995. However, from 1995 through 2002, many of these design documents were not adequately maintained and updated to reflect current designs and requirements. Further, a document that is a major component of the project's requirements management process was revised in July 2002, but has never been finalized or approved. Instead, the project envisioned a transition to a new requirements management system after the submission of the license application, which at that time was planned for December 2004. However, for various reasons, the license application was not submitted, and the transition to a new requirements management system was never implemented. The DOE report described this situation as "completely dysfunctional" and identified the root cause of these

conditions as DOE's failure to fund, maintain, and rigidly apply a requirements management system. According to an NRC on-site representative, repetitive and uncorrected issues associated with the requirements management process could have direct implications for the quality of DOE's license application.

In December 2005, DOE issued a stop-work order on design and engineering for the project's surface facility and certain other technical work. DOE stated that a root cause analysis and an investigation into employee concerns had revealed that the project had not maintained or properly implemented its requirements management system, resulting in inadequacies in the design control process. The stop-work order will be in effect until, among other things, the lead contractor improves the requirements management system, validates that processes exist and are being followed, and requirements are appropriately traced to implementing mechanisms and products. Further, DOE will establish a team to take other actions necessary to prevent inadequacies in requirements management and other management systems from recurring.

Finally, DOE continues to be challenged to effectively manage a changing and complex program and organization. The significant project changes initiated under the new path forward create the potential for confusion over accountability as roles and responsibilities change—a situation DOE found to contribute to quality assurance problems during an earlier transition period. An important part of this challenge is ensuring that accountability for quality and results are effectively managed during the transition to the new path forward. For example, DOE's plan to establish a lead laboratory to assist the project would not only have to be effectively managed, but also would introduce a new player whose accountability DOE would have to ensure. According to one DOE manager, transitioning project work to a lead laboratory under a direct contract with DOE could pose a significant challenge for quality assurance because the various laboratories assisting with the project are currently working under BSC quality assurance procedures and will now have to develop their own procedures.

In addition, the project faces management challenges related to ensuring management continuity at the project. DOE has experienced turnover in 9 of 17 key management positions since 2001. For example, in the past year, the project has lost key managers through the departures of the Director of Project Management and Engineering, the Director of the License Application and Strategy, the Director of Quality Assurance, and the contractor's General Manager. To ensure the right managers move the

project forward to licensing, the project has a recruitment effort for replacing key departing managers. Further, the director position for the project has been occupied by three individuals since 1999 and is currently filled by an acting director. The current Acting Director took his position in summer 2005, and initiated the new path forward in October 2005. DOE is currently awaiting congressional confirmation of a nominee to take the director position. However, the current Acting Director told us he expects that the new path forward will be sustained after the new director assumes the position because it has been endorsed by the Secretary of Energy.

Conclusions

DOE has a long history of trying to resolve quality assurance problems at its Yucca Mountain project. Now, after more than 20 years of work, DOE once again faces serious quality assurance and other challenges while seeking a new path forward to a fully defensible license application. Even as DOE faces new quality assurance challenges, it cannot be certain that it has resolved past problems. It is clear that DOE has not been well served by management tools that have not effectively identified and tracked progress on significant and recurring problems. As a result, DOE has not had a strong basis to assess progress in addressing management weaknesses or to direct management attention to significant and recurrent problems as needed. Unless these quality assurance problems are addressed, further delays on the project are likely.

Mr. Chairman, this concludes my prepared statement, I would be happy to respond to any questions that you or other Members of the Subcommittee may have at this time.

GAO Contact and Staff Acknowledgments

For further information about this testimony, please contact Jim Wells at (202) 512-3841 or wellsj@gao.gov. Casey Brown, John Delicath, Terry Hanford, and Raymond Smith also made key contributions to this statement.

Appendix I: The Management Improvement Initiatives' Key Areas of Concern

The Department of Energy's Management Improvement Initiatives (Initiatives) perceived five key areas of management weakness as adversely affecting the implementation of quality assurance requirements at the Yucca Mountain project:

1. Roles and responsibilities were becoming confused as the project transitioned from scientific studies to activities supporting licensing. The confusion over roles and responsibilities was undermining managers' accountability for results. The Initiatives' objective was to realign DOE's project organization to give a single point of responsibility for project functions, such as quality assurance and the Corrective Action Program, and hold the project contractor more accountable for performing the necessary work in accordance with quality, schedule, and cost requirements.
2. Product quality was sometimes being achieved through inspections by the project's Office of Quality Assurance rather than being routinely implemented by the project's work organizations. As a result, the Initiatives sought to increase work organizations' responsibility for being the principle means for achieving quality.
3. Work procedures were typically too burdensome and inefficient, which impeded work. The Initiatives sought to provide new user-friendly and effective procedures, when necessary, to allow routine compliance with safety and quality requirements.
4. Multiple corrective action programs existed, processes were burdensome and did not yield useful management reports, and corrective actions were not completed in a timely manner. The Initiatives sought to implement a single program to ensure that problems were identified, prioritized, and documented and that timely and effective corrective actions were taken to preclude recurrence of problems.
5. The importance of a safety-conscious work environment that fosters open communication about concerns was not understood by all managers and staff, and they had not been held accountable when inappropriately overemphasizing the work schedule, inadequately attending to work quality, and acting inconsistently in practicing the desired openness about concerns. Through issuing a work environment policy, providing training on the policy, and improving the Employee Concerns Program, the Initiatives sought to create an environment in which employees felt free to raise concerns without

fear of reprisal and with confidence that issues would be addressed promptly and appropriately.

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