

GAO

Report to the Subcommittee on Energy
and Water Development, Committee on
Appropriations, House of
Representatives

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NUCLEAR NONPROLIFERATION

DOE Needs to Address
Uncertainties with and
Strengthen
Independent Safety
Oversight of Its
Plutonium Disposition
Program





Highlights of [GAO-10-378](#), a report to the Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives

Why GAO Did This Study

The end of the Cold War left the United States with a surplus of weapons-grade plutonium, which poses proliferation and safety risks. Much of this material is found in a key nuclear weapon component known as a pit. The Department of Energy (DOE) plans to dispose of at least 34 metric tons of plutonium by fabricating it into mixed oxide (MOX) fuel for domestic nuclear reactors. To do so, DOE's National Nuclear Security Administration (NNSA) is constructing two facilities—a MOX Fuel Fabrication Facility (MFFF) and a Waste Solidification Building (WSB)—at the Savannah River Site in South Carolina. GAO was asked to assess the (1) cost and schedule status of the MFFF and WSB construction projects, (2) status of NNSA's plans for pit disassembly and conversion, (3) status of NNSA's plans to obtain customers for MOX fuel from the MFFF, and (4) actions that the Nuclear Regulatory Commission (NRC) and DOE have taken to provide independent nuclear safety oversight. GAO reviewed NNSA documents and project data, toured DOE facilities, and interviewed officials from DOE, NRC, and nuclear utilities.

What GAO Recommends

GAO recommends, among other things, that NNSA improve its plans for the maturation of critical technologies related to pit disassembly and conduct additional outreach to potential MOX fuel customers. In commenting on a draft of this report, DOE agreed with GAO's recommendations.

View [GAO-10-378](#) or [key components](#). For more information, contact Gene Aloise at (202) 512-3841 or aloise@gao.gov.

NUCLEAR NONPROLIFERATION

DOE Needs to Address Uncertainties with and Strengthen Independent Safety Oversight of Its Plutonium Disposition Program

What GAO Found

The MFFF and WSB projects both appear to be meeting their cost targets for construction, but the MFFF project has experienced schedule delays. Specifically, the MFFF and WSB projects are on track to meet their respective construction cost estimates of \$4.9 billion and \$344 million. However, the MFFF project has experienced some delays over the past 2 years, due in part to the delivery of reinforcing bars that did not meet nuclear quality standards. Project officials said that they expect to recover from these delays by the end of 2010 and plan for the start of MFFF operations on schedule in 2016. The WSB project appears to be on schedule.

NNSA is reconsidering its alternatives for establishing a pit disassembly and conversion capability. However, it seems unlikely that NNSA will be able to establish this capability in time to produce the plutonium feedstock needed to operate the MFFF, due to the amount of time and effort needed to reconsider alternatives and construct a facility as well as the amount of uncertainty associated with NNSA's current plans. NNSA had previously planned to build a stand-alone facility near the MFFF construction site to disassemble pits and convert the plutonium into a form suitable for use by the MFFF. However, NNSA is now considering a plan to combine this capability with another project at an existing facility at the Savannah River Site. NNSA officials could not estimate when the agency will reach a final decision or establish more definitive cost and schedule estimates for the project. However, NNSA's new alternative depends on an aggressive, potentially unrealistic schedule. In addition, NNSA has not sufficiently planned for the maturation of critical technologies to be used in pit disassembly and conversion operations, some of which are being tested at the Los Alamos National Laboratory in New Mexico.

NNSA has one potential customer for most of its MOX fuel, but outreach to other utilities may be insufficient. NNSA is in discussions with the Tennessee Valley Authority to provide MOX fuel for five reactors. NNSA plans to offer several incentives to potential customers, including offering to sell MOX fuel at a discount relative to the price of uranium fuel. In interviews with the nation's nuclear utilities, GAO found that while many of the utilities expressed interest in NNSA's proposed incentives, the majority of utilities also expressed little interest in becoming MOX fuel customers. This suggests that NNSA's outreach to utilities may not be sufficient.

NRC is currently reviewing the MFFF's license application and has identified several issues related to construction. However, oversight of the MFFF and the WSB by DOE's independent nuclear safety entities has been limited. For example, DOE's Office of Health, Safety, and Security has not conducted any oversight activities or participated in any project reviews of the WSB, despite the WSB's status as a high-hazard nuclear facility. In addition, NNSA's Chief of Defense Nuclear Safety has not conducted any nuclear safety oversight activities for the MFFF project and has not conducted all oversight activities for the WSB project that are required by DOE order.

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Abbreviations

ARIES	Advanced Recovery and Integrated Extraction System
CDNS	Chief of Defense Nuclear Safety
DOE	Department of Energy
EVM	earned value management
HSS	Office of Health, Safety, and Security
LANL	Los Alamos National Laboratory
MFFF	Mixed Oxide Fuel Fabrication Facility
MOX	mixed oxide
NNSA	National Nuclear Security Administration
OECM	Office of Engineering and Construction Management
NRC	Nuclear Regulatory Commission
PDCF	Pit Disassembly and Conversion Facility
SRS	Savannah River Site
TRL	technology readiness level
TVA	Tennessee Valley Authority
WSB	Waste Solidification Building

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United States Government Accountability Office
Washington, DC 20548

March 26, 2010

The Honorable Peter J. Visclosky
Chairman
The Honorable Rodney P. Frelinghuysen
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
House of Representatives

The end of the Cold War left a legacy of fissile material that the United States no longer required for national security. This fissile material includes large quantities of weapons-grade plutonium, such as the plutonium used in the pit of a nuclear warhead.¹ Plutonium is a man-made, radioactive element that poses a danger of nuclear weapons proliferation and a risk of environmental, safety, and health consequences. For example, internal exposure in humans to plutonium through inhalation or consumption poses an extremely serious health hazard by exposing organs and tissues to ionizing radiation and increasing the risk of cancer.

In 1997, the Department of Energy (DOE) established a strategy to provide for the disposition of surplus, weapons-grade plutonium.² The National Nuclear Security Administration (NNSA), a separately organized agency within DOE, manages this program, now called the U.S. Plutonium Disposition program. NNSA's goal is to dispose of at least 34 metric tons of surplus, weapons-grade plutonium by (1) combining it with uranium to produce mixed oxide (MOX) fuel and (2) selling the MOX fuel to domestic utilities that own nuclear reactors. Once the MOX fuel is irradiated in a nuclear reactor, it would be rendered useless to potential proliferators. According to NNSA officials, the sale of MOX fuel over a 15-year period could return over \$1 billion to the U.S. Treasury. To achieve this goal, NNSA is currently constructing the following two facilities at the Savannah River Site (SRS) in South Carolina:

¹Weapons-grade plutonium is plutonium with an isotopic ratio of plutonium-240 to plutonium-239 of no more than 0.10. The pit is a key nuclear weapon component that begins the chain reaction leading to a nuclear explosion.

²This program is linked to a larger, international effort with Russia. In 2000, the United States and Russia entered into a Plutonium Management and Disposition Agreement, in which each country pledged to dispose of at least 34 metric tons of surplus weapons-grade plutonium.

-
- MOX Fuel Fabrication Facility (MFFF)—The MFFF is projected to use up to 3.5 metric tons of plutonium a year to fabricate about 1,700 MOX fuel assemblies over a 15-year period. NNSA began construction on the MFFF in August 2007. As we reported in March 2007, NNSA initially estimated that the MFFF would cost about \$1.4 billion and be completed by September 2004.³ NNSA currently projects that the MFFF will cost about \$4.9 billion, be ready for operations by October 2016, and begin producing MOX fuel assemblies in 2018.
 - A Waste Solidification Building (WSB) will process radioactive waste from the MFFF and related facilities. NNSA began construction on the WSB in December 2008, and it is projected to cost \$344 million and to be ready for operations by September 2013.

In addition, because NNSA expects to obtain the majority of the plutonium from nuclear pits, it also plans to build a facility at SRS to disassemble pits and convert the plutonium into a plutonium oxide form suitable for use in MOX fuel.

Several entities oversee nuclear safety for the Plutonium Disposition program. The National Defense Authorization Act of 1999 amended the Energy Reorganization Act of 1974 to require the Nuclear Regulatory Commission (NRC), an independent oversight agency, to regulate and license the operation of the MFFF. DOE is responsible for regulating the nuclear safety of the WSB and the planned Pit Disassembly and Conversion Facility (PDCF), with NNSA taking the primary role. Several other DOE offices and entities have provided independent nuclear safety oversight for all three facilities, including the DOE Office of Health, Safety, and Security (HSS); the NNSA Central Technical Authority; and the NNSA Chief of Defense Nuclear Safety (CDNS).

This report assesses (1) the performance status of the MFFF and WSB construction projects with respect to cost and schedule, (2) the status of NNSA's plans to establish a pit disassembly and conversion capability to supply plutonium to the MFFF, (3) the status of NNSA's plans to obtain customers for MOX fuel from the MFFF, and (4) the actions that NRC and

³GAO, *Department of Energy: Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays*, [GAO-07-336](#) (Washington, D.C.: Mar. 27, 2007).

DOE have taken to provide independent nuclear safety oversight of the MFFF and WSB construction projects.

To assess the performance status of the MFFF and WSB construction projects with respect to cost and schedule, we reviewed earned value management (EVM) data and assessed the reliability of EVM data by evaluating each project's schedule against GAO's scheduling best practices.⁴ We also interviewed key NNSA and contractor officials and reviewed data and key processes used to conduct a risk analysis of the MFFF project's schedule. To assess the status of NNSA's plans to establish a pit disassembly and conversion capability to supply plutonium to the MFFF, we reviewed documentation provided by NNSA and its contractors for the MFFF, WSB, and PDCF projects, including project execution plans, project status reports, EVM data, and independent project reviews. We also reviewed project plans and research and development data related to the Advanced Recovery and Integrated Extraction System (ARIES) project at DOE's Los Alamos National Laboratory (LANL) in New Mexico; toured site facilities at SRS and LANL; and interviewed DOE, NNSA, and contractor officials. To assess the status of NNSA's plans to obtain customers for MOX fuel from the MFFF, we reviewed documentation provided by NNSA and its contractors, including project plans, studies, and MOX fuel production schedules. We also interviewed NNSA and contractor officials. In addition, we analyzed responses to structured interviews we administered to U.S. utilities that own nuclear reactors. We received data from utility officials representing 22 of the 26 utilities, for a response rate of 85 percent. Finally, to assess the actions that NRC and DOE have taken to provide independent nuclear safety oversight of the MFFF and WSB construction projects, we reviewed NRC and DOE regulations related to nuclear safety, NRC inspection reports, and DOE independent review reports. We also spoke with officials in NRC's Office of Nuclear Materials Safety and Safeguards and the Division of Construction Projects; NNSA's program offices responsible for the MFFF and WSB projects; the CDNS; DOE's HSS; and the Defense Nuclear Facilities Safety Board to discuss their oversight roles in relation to the MFFF and the WSB, respectively. Appendix I contains additional information on our scope and methodology.

⁴These practices are found in GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

We conducted this performance audit from January 2009 to March 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

A number of events are important in the history of DOE's U.S. Plutonium Disposition program.

- In 1994, the United States declared 38.2 metric tons of weapons-grade plutonium as surplus to national security needs.
- In 1997, DOE announced a plan to dispose of surplus, weapons-grade plutonium through the following dual approach: (1) conversion into MOX fuel and (2) immobilization in glass or ceramic material. According to DOE, its approach would require the construction of three facilities—a pit disassembly and conversion facility, a MOX fuel fabrication facility, and an immobilization facility.
- In 2000, the United States and Russia entered into a Plutonium Management and Disposition Agreement, in which each country pledged to dispose of at least 34 metric tons of surplus, weapons-grade plutonium, including the disposition of no less than 2 metric tons of plutonium per year.
- In 2000, DOE announced in a record of decision that it would construct a pit disassembly and conversion facility, a MOX fuel fabrication facility, and an immobilization facility at SRS.
- In 2002, NNSA canceled the immobilization portion of its surplus plutonium disposition strategy due to budgetary constraints. In addition, according to NNSA officials, NNSA canceled the immobilization portion because (1) Russia would not dispose of its plutonium if the United States adopted an immobilization-only approach and (2) the technology for MOX fuel fabrication had been in use in Europe for three decades, whereas immobilization of weapons-grade plutonium in glass or ceramic had never before been demonstrated.
- In 2003, NNSA announced that it was pursuing a MOX-only plutonium disposition program to dispose of 34 metric tons of surplus, weapons-grade plutonium.

The majority of the 34 metric tons of surplus, weapons-grade plutonium is in the form of pits, clean metal, and oxides.⁵ The remainder is in nonpit forms, such as contaminated metal, oxides, and residues from the nuclear weapons production process. While NNSA plans to build a pit disassembly and conversion facility to obtain plutonium from pits, it also plans to use the ARIES project—a technology development and demonstration project for pit disassembly and conversion located at LANL—to obtain a small amount of plutonium from pits. In addition, according to NNSA documents, NNSA plans to obtain plutonium from nonpit forms in two ways. First, the K-Area Facility at SRS is storing 4.1 metric tons of plutonium in nonpit form that is already suitable for use by the MFFF.⁶ Second, NNSA plans to prepare and process additional quantities of plutonium (3.7 metric tons) already at the K-Area Facility or planned for storage at the facility.

Prior work by GAO has identified persistent problems with cost overruns and schedule delays on the PDCF project. For example, in our March 2007 report on major DOE construction projects, we found that ineffective DOE project oversight, poor contractor management, and external factors were among the primary reasons for the cost increases and schedule delays associated with the PDCF project.⁷ In addition, according to a May 2005 DOE Inspector General report, NNSA officials attributed schedule delays for the PDCF to the disagreement between the United States and Russia about liability for work performed by U.S. contractor personnel working in Russia and a change in funding priorities.⁸

NNSA project directors are responsible for managing the MFFF, WSB, and PDCF projects and overseeing the contractors that design and construct these facilities. In doing so, project directors follow specific DOE

⁵In addition to the 34 metric tons of weapons-grade plutonium pledged for disposal in 2000, the Secretary of Energy declared 9 metric tons of weapons-grade plutonium as surplus to defense needs in September 2007. According to NNSA documents, NNSA plans to convert this additional material into MOX fuel at the MFFF but has not made an official decision.

⁶The K-Area Facility is SRS's only special nuclear material storage facility designated for storage of significant quantities of plutonium and highly enriched uranium materials. The facility's principal operations building housed K Reactor, which produced nuclear materials to support the United States for nearly four decades. The K Reactor was shut down in 1992.

⁷GAO-07-336.

⁸DOE, Office of Inspector General, *National Nuclear Security Administration's Pit Disassembly and Conversion Facility*, DOE/IG-0688 (Washington, D.C.: May 3, 2005).

directives, policies, and guidance for project management. Among these is DOE Order 413.3A, which establishes protocols for planning and executing a project. The protocols require DOE projects to go through a series of five critical decisions as they enter each new phase of work. These decisions are as follows:

- Critical decision 0, which approves a mission-related need.
- Critical decision 1, which approves the selection of a preferred solution to meet a mission need and a preliminary estimate of project costs—an approval that is based on a review of a project’s conceptual design.
- Critical decision 2, which approves that a project’s cost and schedule estimates are accurate and complete—an approval that is based on a review of the project’s completed preliminary design.
- Critical decision 3, which reaches agreement that a project’s final design is sufficiently complete and that resources can be committed toward procurement and construction.
- Critical decision 4, which approves that a project has met its performance criteria for completion or that the facility is ready to start operations.

To oversee projects and approve these critical decisions, DOE conducts its own reviews, often with the help of independent technical experts. For example, for large projects (with a total project cost of greater than \$100 million), DOE’s Office of Engineering and Construction Management (OECM) validates the accuracy and completeness of the project’s performance baseline as part of the critical decision 2 process.

DOE Order 413.3A also requires projects to use EVM to measure and report the progress of construction projects (with a total project cost of greater than or equal to \$20 million). EVM measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and with the actual cost of work accomplished. Differences in these values are measured in both cost and schedule variances. EVM provides information that is necessary for understanding the health of a program and provides an objective view of program status. As a result, EVM can alert program managers to potential problems sooner than expenditures alone can, thereby reducing the chance and magnitude of cost overruns and schedule delays.

The following DOE offices and entities provide independent nuclear safety oversight:

- HSS is responsible for policy development, independent oversight, enforcement, and assistance in the areas of health, safety, the environment, and security across DOE. Among its functions are periodic appraisals of the environmental, safety, and health programs at DOE sites, including evaluation of a sample of high-hazard nuclear facility at these sites to determine whether the program offices and their contractors are complying with DOE policies.⁹
- The NNSA Central Technical Authority is responsible for maintaining operational awareness of nuclear safety on NNSA projects, especially with respect to complex, high-hazard nuclear operations, and ensuring that DOE's nuclear safety policies and requirements are implemented adequately and properly.
- The CDNS is responsible for evaluating nuclear safety issues and providing expert advice to the Central Technical Authority and other senior NNSA officials. In particular, the CDNS is responsible for (1) validating that efforts to integrate safety into a project's design include the use of a system engineering approach, (2) determining that nuclear facilities have incorporated the concept of defense-in-depth into the facility design process, and (3) validating that federal personnel assigned to an integrated project team as nuclear safety experts are appropriately qualified.

Finally, DOE considers assessments and recommendations from external organizations, most prominently the Defense Nuclear Facilities Safety Board—an independent, external organization that reviews nuclear safety issues at DOE defense facilities and makes nonbinding recommendations to DOE.

⁹DOE regulations (10 CFR pt. 830, app. A to subpt. B § (C)(2)) define three categories of high-hazard nuclear facilities according to their potential to produce significant radiological consequences from an event that could either extend beyond the boundaries of a DOE site, remain within the boundaries of a site, or remain within the immediate vicinity of a nuclear facility.

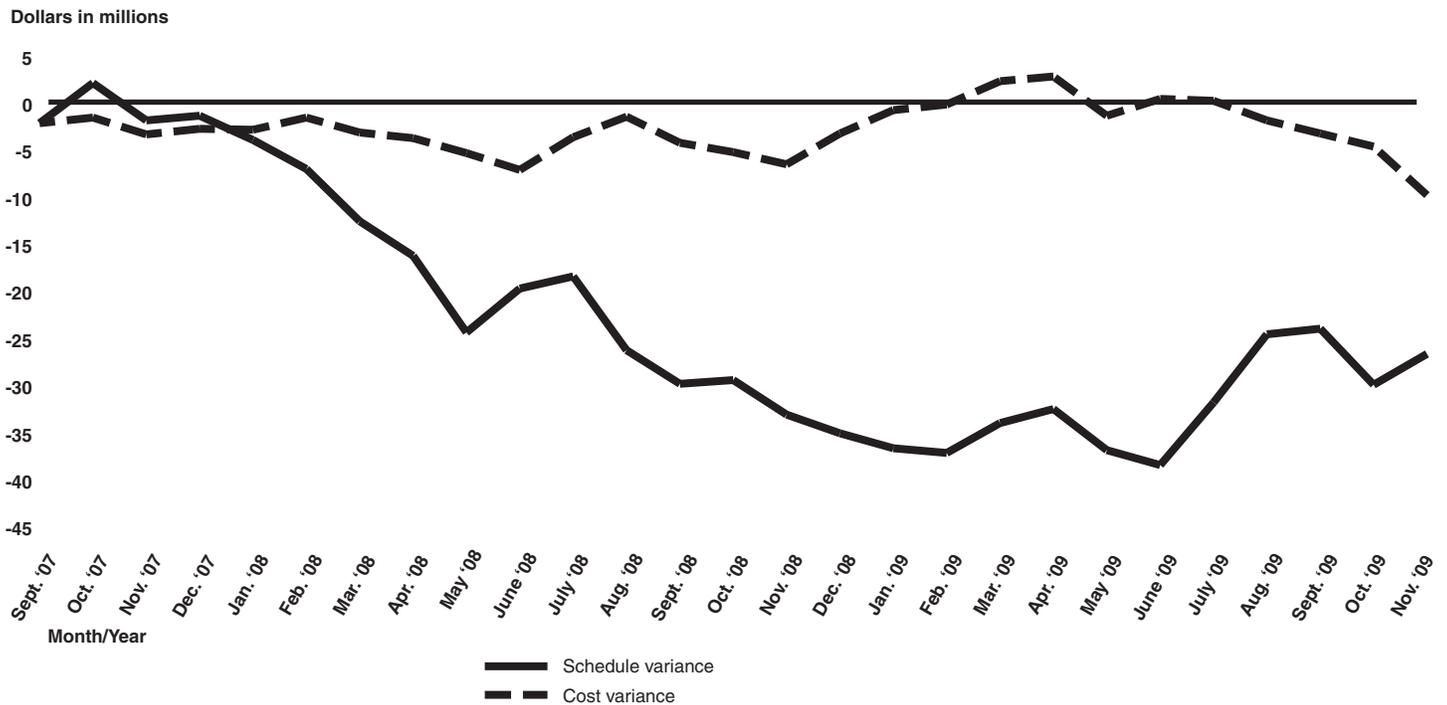
Construction Projects Appear to Be Meeting Cost Targets, but the MFFF Has Had Schedule Delays

The MFFF and WSB construction projects both appear to be meeting their cost targets, but the MFFF project has experienced some delays over the past 2 years. In accordance with DOE project management requirements, both projects are using EVM to measure and report progress against their established cost and schedule estimates (also known as performance baselines) for construction. EVM provides a proven means for measuring such progress and thereby identifying potential cost overruns and schedule delays early, when their impact can be minimized. Differences from the performance baseline are measured in both cost and schedule variances.¹⁰ Positive variances indicate that activities are costing less or are completed ahead of schedule. Negative variances indicate that activities are costing more or are falling behind schedule. These cost and schedule variances can then be used in estimating the cost and time needed to complete the project.

Figure 1 presents information on both cumulative cost and schedule variances for the MFFF project over the 2-year period ending November 2009. With respect to cost, the MFFF project has experienced fluctuating variances during this period. Overall, these cost variances are relatively small compared with the project's average monthly expenditures of over \$20 million. In addition, it is normal for variances to fluctuate during the course of a project.

¹⁰Cost variances compare the earned value of the completed work with the actual cost of the work performed. For example, if a contractor completed \$5 million worth of work (i.e., the earned value of the work) and the work actually cost \$6.7 million, there would be a negative \$1.7 million cost variance. Schedule variances are also measured in dollars, but they compare the earned value of the work completed with the value of work that was expected to be completed. For example, if a contractor completed \$5 million worth of work at the end of the month but was budgeted to complete \$10 million worth of work, there would be a negative \$5 million schedule variance.

Figure 1: Cumulative Cost and Schedule Variances for MFFF over a 2-Year Period (2007-2009)



Source: Shaw AREVA MOX Services, LLC.

However, with respect to the project’s schedule, the MFFF project has experienced consistently negative variances for most of the past 2 years. Specifically, as shown in figure 1, these schedule variances were consistently negative for most of 2008, and, for much of 2009, the project had not completed almost \$40 million in scheduled work. According to the data and project officials, delays during 2008 were due primarily to the delivery of reinforcing bars that did not meet nuclear quality standards. Specifically, in February 2008, NRC inspectors identified numerous pieces of reinforcing bars—steel rods that are used in reinforced concrete—that did not meet industry standards for nuclear facilities. At that point, NNSA’s contractor, Shaw AREVA MOX Services, LLC (MOX Services), had accepted delivery of about 10,000 tons of reinforcing bars on-site and had installed almost 4,000 tons. Although NRC and MOX Services officials determined that the error did not affect the safety of reinforcing bars already installed, this issue had a major effect on the overall schedule for pouring concrete and installing reinforcing bars in the structure during 2008. According to project officials, the project switched to a different

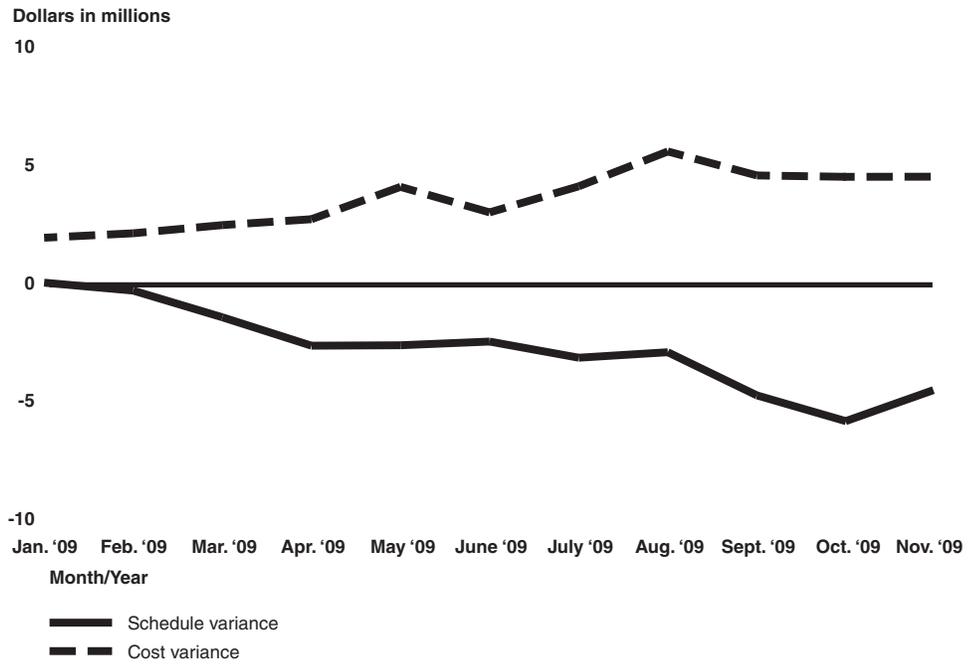
supplier of reinforcing bars in September 2008 and by April 2009 had a sufficient supply of material to support the construction schedule.

Schedule delays in 2009 occurred primarily because project officials decided that they had not allocated sufficient time in the existing schedule to ensure the delivery of materials that would meet the stringent safety and design standards for nuclear facilities. For example, according to project officials, the project extended the amount of time needed to produce concrete for the MFFF to provide additional assurance that the concrete will meet nuclear quality standards. The rate of concrete production will be gradually increased beginning in early 2010, according to project officials. In addition, the project extended the amount of time needed to fabricate and deliver slab tanks, which are used to hold liquid fissile material, to provide additional assurance that these tanks meet stringent safety and design standards.

In recent months, the MFFF project has improved its schedule performance, so that it faced roughly \$25 million in uncompleted work by November 2009, compared with almost \$40 million in uncompleted work earlier in the year. According to project officials, this amount of negative schedule variance is equivalent to about 2 to 3 week's worth of work on the project, and they expect to recover from this variance during 2010. In comparison, these officials stated that the project's schedule includes 16 month's worth of contingency to mitigate any risks from additional delays before the expected start of MFFF operations.

Figure 2 presents information on both cumulative cost and schedule variances for the WSB project over a 11-month period ending in November 2009. With respect to cost, the WSB project has experienced consistently positive cost variances. However, schedule variances have been consistently negative over the same period. By November 2009, the project had not completed over \$4 million worth of scheduled work, compared with average monthly expenditures of roughly \$2 million during fiscal year 2009. According to the NNSA federal project director, the schedule variances are due to a variety of factors, including delays in the procurement of cementation equipment and in the installation of piping due to inclement weather. However, the official said that he expects the project to recover from these delays, and that none of these factors will affect the overall construction schedule for the project.

Figure 2: Cumulative Cost and Schedule Variances for the WSB, January through November, 2009



Source: NNSA.

The reliability of a project’s EVM system depends in large part on the reliability of its underlying schedule. A reliable schedule specifies when the project’s work activities will occur, how long they will take, and how they relate to one another. We have previously identified nine key practices necessary for developing a reliable schedule.¹¹ In a March 2009 testimony before this subcommittee, we identified several instances in which the MFFF project’s schedule did not adhere to these practices.¹² In particular, we found that MFFF project staff had not conducted a risk analysis on their current schedule.

¹¹These practices are (1) capturing all activities, (2) sequencing activities, (3) establishing the duration of activities, (4) assigning resources to activities, (5) integrating activities horizontally and vertically, (6) establishing the critical path for activities, (7) identifying the float time between activities, (8) performing a schedule risk analysis, and (9) monitoring and updating the schedule.

¹²GAO, *Department of Energy: Contract and Project Management Concerns at the National Nuclear Security Administration and Office of Environmental Management*, [GAO-09-406T](#) (Washington, D.C.: Mar. 4, 2009).

However, since our March 2009 testimony, MFFF project officials have taken a number of steps to address our concerns. For example, project officials conducted a risk analysis of the MFFF project schedule in the summer of 2009 and used the results to update their risk management plan. In addition, project officials stated that they have significantly reduced the number of scheduled activities with long durations—that is, activities with start-to-finish durations of over 200 days.¹³ On the basis of these actions, we reevaluated the MFFF project’s schedule against the nine key scheduling practices. We also evaluated the WSB project’s schedule against these same practices. We found that both projects met most of the key practices to a satisfactory degree. For example, one key practice is to plan the schedule so that it can meet critical project dates. To do so, project officials must logically sequence all planned activities in the order that they are to be carried out. In particular, project officials must identify both predecessor activities—which must finish prior to the start of another activity—as well as successor activities—which cannot begin until other activities are completed. We found that the MFFF project had logically sequenced all scheduled activities, while the WSB project had logically sequenced the vast majority of its scheduled activities. For the complete results of our analysis of the projects’ schedules, see appendixes II and III.

NNSA Is Reconsidering Alternatives for Its Pit Disassembly Mission That Could Delay Production of Material Needed for the MFFF

NNSA recently announced that it is considering a new alternative for its pit disassembly and conversion mission. However, due to the amount of time and effort needed to reconsider alternatives and construct a facility, as well as the amount of uncertainty associated with the agency’s new alternative, it seems unlikely that NNSA will be able to establish this capability in time to produce the plutonium oxide feedstock needed to operate the MFFF. As result of the likely delay in establishing a pit disassembly and conversion capability, NNSA may need to expand the ARIES project at LANL to provide additional interim plutonium feedstock to the MFFF. However, NNSA has not sufficiently planned for such a contingency. In addition, NNSA has not sufficiently planned for the maturation of critical technologies to be used in pit disassembly and conversion operations.

¹³When we conducted our analysis in February 2009, the MFFF project schedule contained 1,064 activities with durations of over 200 days. According to our more recent analysis and interviews with project officials, the MFFF project schedule now has about 30 activities with durations of over 200 days.

**NNSA Recently
Announced a New
Alternative for Pit
Disassembly, but the
Alternative Depends on an
Aggressive, Potentially
Unrealistic Schedule**

In 1997, DOE decided to establish a pit disassembly and conversion capability as part of its strategy for plutonium disposition. Because about two-thirds of the plutonium slated for disposition is contained in nuclear weapon pit form, the ability to disassemble pits is critical to the success of the program. In 2000, DOE decided to construct and operate a PDCF at SRS. Through 2009, NNSA's strategy has been to design and construct the PDCF as a new, stand-alone facility on a site adjacent to the current construction site of the MFFF. While NNSA has never established a definitive cost and schedule estimate for the PDCF project, a 2009 NNSA report estimated that the PDCF would cost \$3.65 billion to construct and be operational by April 2021.¹⁴

However, DOE recently proposed a new alternative for establishing a pit disassembly and conversion capability at SRS. In September 2008, DOE authorized a study to review alternatives to the siting location of the PDCF capability within existing facilities at SRS and, as a result, to potentially improve its approach to disposition of surplus plutonium at SRS. Specifically, the study looked at the feasibility of combining the capabilities of the PDCF project with the Plutonium Preparation project, another project at SRS being managed by DOE's Office of Environmental Management. The purpose of the Plutonium Preparation project, as approved by DOE in June 2008, was to prepare for disposition of up to 13 metric tons of surplus, nonpit, plutonium-bearing materials that are either at the SRS K-Area Facility or planned for storage at the facility. According to DOE's plans, the project would be installed in the K-Area Facility and would prepare the plutonium-bearing materials for disposition via two pathways: (1) converting some of the materials into plutonium oxide feedstock for the MFFF and (2) immobilizing the rest of the materials with high-level waste in glass using the Defense Waste Processing Facility at SRS. According to DOE's 2008 preliminary estimate, this project would be operational in the 2013-2014 time frame at a cost of \$340 million to \$540 million.

¹⁴NNSA, Savannah River Site, *Alternative Study: Pit Disassembly and Conversion at the Savannah River Site* (June 2009), a predecisional draft for official use only.

In November 2008,¹⁵ DOE issued a report stating that it would be feasible to combine the two projects at the K-Area Facility. According to NNSA’s preliminary estimates, the combined project would cost about \$3.65 billion and would be constructed in two phases. The first phase would include the design and installation of equipment in one area of the K-Area Facility to provide the capability (formerly associated with the Plutonium Preparation project) to process 3.7 metric tons of surplus, nonpit plutonium, which would be used as an early source of plutonium oxide feedstock to the MFFF. The second phase would include the modification of a different area within the facility and the design and installation of equipment to provide the pit disassembly and conversion capability.¹⁶ In December 2008, NNSA suspended many of the activities associated with the PDCF project while it performed additional analyses, and DOE suspended activities associated with the Plutonium Preparation project. Finally, in November 2009, DOE approved the “pursuing” of the combined project approach, noting several potential benefits, such as greater funding flexibility, greater flexibility regarding DOE’s secure transportation system, the avoidance of expenditures associated with constructing a new facility, and the avoidance of costs associated with decontaminating and decommissioning two Category 1 nuclear facilities, among others.

However, it appears unlikely that NNSA will be able to establish a pit disassembly and conversion capability in time to produce the plutonium feedstock needed to operate the MFFF beginning in 2021, due to the amount of time and effort needed to reconsider alternatives and construct a facility as well as the amount of uncertainty associated with the agency’s new proposal. First, according to NNSA officials, they do not expect to make a decision in the near future on which approach—either the PDCF as a stand-alone facility or the K-Area Facility combination project—they will ultimately approve. Specifically, officials told us that prior to making any decision, NNSA must first select its preferred alternative as part of the DOE critical decision 1 process. To prepare for critical decision 1, NNSA will need to develop and manage numerous details, including (1) the

¹⁵DOE, Savannah River Site, *Alternative Study: Combining the Pit Disassembly and Conversion Facility (PDCF) and Plutonium Preparation Project (PuP) within the K-Area Complex (KAC)* (November 2008), a predecision draft, unclassified controlled nuclear information.

¹⁶According to NNSA officials, the majority of pit disassembly and conversion processing lines will be installed on the ground level of the facility. However, the project may also install a mezzanine level in several areas to house support equipment and electrical cabinets.

appropriate review and documentation pursuant to the National Environmental Policy Act; (2) a transfer by the Secretary of Energy from the Office of Environmental Management to NNSA of the necessary materials, functions, and facilities to carry out the preferred alternative; and (3) issues related to federal and contractor program management, contract management, project management, and budget/financial management. As a result, NNSA officials said that they are still developing plans and schedules for the combination project and cannot provide any specific project schedule dates at this time. In addition, they stated that once NNSA makes a final decision on its strategy for pit disassembly and conversion as part of the critical decision 1 process, it will take several additional years to develop definitive cost and schedule estimates for its final approach as part of the critical decision 2 process.

Second, a number of issues with NNSA's new proposal raise doubts regarding whether the agency will be able to construct a facility in time to provide the plutonium feedstock necessary to operate the MFFF. For example:

- According to NNSA documents, the K-Area Facility combined project will require an aggressive, near-term acquisition strategy and project development effort to design, construct, and start a pit disassembly and conversion capability under the current time constraints. Phase 1 of the project is scheduled to be operational by 2014 to provide an early source of feedstock (from nonpit plutonium sources) to the MFFF, and phase 2 must be operational by 2021 to provide the bulk of the plutonium oxide feedstock that the MFFF will require to meet its planned production schedule.
- According to NNSA documents, the existing schedule for the K-Area Facility combined project is at an early stage of development and lacks any quantified schedule contingency.
- The project will require construction within an existing, secure, operating facility. Specifically, the project will need to excavate material from existing walls and floors in numerous locations to install piping and utilities, among other things. According to NNSA, during these excavations, the project may encounter conditions that have not been documented in existing design drawings for the K-Area Facility. Construction of a new facility, the original plan for the PDCF project, carries fewer risks of encountering unknown conditions—such as undocumented electrical wiring or other physical interfaces.

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- The project will require substantial coordination between NNSA and the Office of Environmental Management, as well as various contractor organizations, to address competing missions and out-year issues. As a result, according to NNSA, DOE may require additional federal resources and interface agreements between its various offices to ensure the proper integration and execution of the project.

NNSA Has Not Sufficiently Planned for an Expansion of the ARIES Project If Pit Disassembly Operations Are Delayed

NNSA's new alternative assumes that the K-Area Facility combined project will become operational by the 6th year of MFFF operations (2021). However, if the design and construction of the project are delayed, NNSA may have to rely on the ARIES project at LANL to provide additional plutonium oxide feedstock for the MFFF. The ARIES project includes (1) laboratory facility preparation activities, (2) the acquisition of gloveboxes,¹⁷ (3) the design and assembly of a control system to operate the demonstration modules, (4) the preparation of all system documentation requirements, (5) the demonstration of the disassembly and conversion of all types of surplus nuclear weapon pits, (6) material control and accountability, and (7) measurements of personnel radiation exposure from all surplus pit types. LANL conducts activities associated with the ARIES project at its Plutonium Facility 4 building, which was constructed in 1978 as a multiuse plutonium research and development facility. NNSA's current production mission for the ARIES project is to produce about 2 metric tons of plutonium oxide feedstock. Specifically, LANL is to produce 50 kilograms of plutonium oxide by the end of fiscal year 2010, ramp up to a target rate of 300 kilograms per year in fiscal year 2012, and sustain this rate through fiscal year 2017. However, this material—along with additional quantities of plutonium in nonpit form currently stored at the K-Area Facility—will only be enough for the first 5 years of the MFFF production schedule.

NNSA has examined the possibility of expanding the ARIES project at LANL to provide additional plutonium oxide feedstock to the MFFF. Specifically, in May 2008, NNSA published a report that estimated NNSA might need as much as 12 metric tons of plutonium oxide feedstock to bridge a time gap between the startup of operations at the MFFF and the PDCF.¹⁸ The report's authors evaluated several potential scenarios for increasing the amount of equipment and the number of work shifts at

¹⁷A glovebox is a sealed, protectively lined compartment having holes to which are attached gloves for use in handling especially dangerous materials inside the compartment.

¹⁸NNSA, *Report on ARIES Throughput Options* (May 2008), for official use only.

LANL and estimated that ARIES could produce up to 16.7 metric tons of plutonium oxide at a cost of over \$700 million. In conducting its analysis, the report's authors made a number of assumptions, including that space would be available within the Plutonium Facility 4 building to accommodate an expanded ARIES mission, and that LANL would be able to provide the necessary vault space to accommodate an expanded ARIES mission. However, recent GAO work raises questions about the validity of these assumptions. Specifically, in May 2008,¹⁹ we assessed NNSA's plans to expand pit manufacturing operations within the Plutonium Facility 4 building. We found that NNSA would not be able to substantially increase its pit manufacturing capacity in the building for the foreseeable future because of several major constraints, including (1) limited vault space in the Plutonium Facility 4 building for storing pits and associated wastes and (2) competition for available floor space in the building due to the presence of other NNSA and DOE programs. For example, we found that vault space was one of the major limiting factors for pit production in fiscal year 2007, and that the vault was operating at 120 percent of its originally designed capacity.

In a more recent study, NNSA concluded that LANL would not be a viable option to perform the entire pit disassembly and conversion mission. Specifically, in a November 2009 report,²⁰ NNSA stated that the ARIES project would be unable to sustain the annual output of plutonium oxide feedstock necessary to support MFFF operations for a number of reasons. For example, the report stated that because the Plutonium Facility 4 building is a one-of-a-kind, mission-critical facility for national defense, national defense missions in the facility will continue to take precedence over other programs—including the pit disassembly and conversion mission—for the foreseeable future. In addition, the report pointed out several of the same constraints to expanding operations in the Plutonium Facility 4 building that we described in our prior report on pit manufacturing.

NNSA's November 2009 report also concluded that LANL continues to be a viable option to produce some additional plutonium oxide material to fill a

¹⁹GAO, *Nuclear Weapons: NNSA Needs to Establish a Cost and Schedule Baseline for Manufacturing a Critical Nuclear Weapon Component*, GAO-08-593 (Washington, D.C.: May 23, 2008).

²⁰NNSA, *Plutonium Capacity Option Study* (Nov. 19, 2009), unclassified controlled nuclear information.

potential gap if the PDCF project is delayed further. However, the report did not update the prior 2008 report to determine what additional amount of material it would be feasible for the ARIES project to produce. The report also did not provide estimates for how much an expanded ARIES mission would cost or when LANL would be able to produce additional plutonium oxide material. Instead, the report noted that NNSA would need to prepare and validate a detailed, resource-loaded, integrated schedule for an expanded ARIES mission. As a result, it remains uncertain whether ARIES could fill a potential gap if NNSA's main pit disassembly and conversion operations are delayed.

In March 2010, DOE stated that NNSA does not plan on expanding the current mission of the ARIES project until LANL demonstrates that it can sustain a production rate of 300 kilograms of plutonium oxide a year over an extended period of time. In addition, DOE stated that NNSA is evaluating other options to provide plutonium oxide feedstock to the MFFF prior to the start of pit disassembly and conversion operations. These options included (1) the use of 1.4 metric tons of fuel-grade plutonium—material originally not intended for use by the MFFF—already in storage at the K-Area Facility and (2) starting up “limited but sufficient” pit disassembly processes.²¹

NNSA Has Not Sufficiently Planned for the Maturation of Critical Technologies

NNSA's current strategy relies on a number of technologies that are critical to establishing a pit disassembly and conversion capability. These technologies include the following systems and components:

- Pit disassembly—includes a lathe, manipulators, and grippers to cut pits, extract the plutonium, and prepare it for oxidation.
- Hydride dehydride—includes two furnaces to separate plutonium from other pieces of material.
- Direct metal oxidation—includes a furnace to convert plutonium and uranium metal into plutonium and uranium oxide.
- Oxide product handling—includes mill rollers and a blender to size and blend the plutonium oxide product.

²¹Fuel-grade plutonium is plutonium with an isotopic ratio of plutonium-240 to plutonium-239 of greater than 0.10 and less than 0.19.

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- Product canning—includes an automated bagless transfer system to package the final product.
 - Sanitization—includes a microwave furnace to melt components that do not contain plutonium or uranium.

To demonstrate the viability of these technological components, DOE started the ARIES project at LANL in 1998. In addition, four other organizations are conducting testing and development activities in support of some of the critical technologies for pit disassembly and conversion: DOE's Savannah River National Laboratory, DOE's Pacific Northwest National Laboratory, the Clemson Engineering Technologies Laboratory, and a commercial vendor.²²

Assessing technology readiness is crucial at certain points in the life of a project. Within DOE's critical decision framework, such assessments are crucial at critical decision 2—acceptance of the preliminary design and approval of the project's cost and schedule estimates as accurate and complete—and at critical decision 3—acceptance of the final design as sufficiently complete so that resources can be committed toward procurement and construction. Proceeding through these critical decision points without a credible and complete technology readiness assessment can lead to problems later in the project. Specifically, if DOE proceeds with a project when technologies are not yet ready, there is less certainty that the technologies specified in the preliminary or final designs will work as intended. Project managers may then need to modify or replace these technologies to make them work properly, which can result in costly and time-consuming redesign work.

DOE has endorsed the use of the technology readiness level (TRL) process for measuring and communicating technology readiness in cases where technology elements or their applications are new or novel. In March 2008, DOE's Office of Environmental Management published guidance on conducting technology readiness assessments and developing technology maturation plans. According to the guidance, staff should conduct technology readiness assessments using the TRL framework. Specifically, staff are to use a nine-point scale to measure TRLs. This scale ranges from a low of TRL 1 (basic principles observed) to a midlevel of TRL 6

²²The Clemson Engineering Technologies Laboratory is a contract research laboratory operated by Clemson University.

(system/subsystem model or prototype demonstration in relevant environment) to a high of TRL 9 (total system used successfully in project operations). According to the guidance, for any critical technologies that did not receive a TRL of 6 or higher during such an assessment, staff should develop a technology maturation plan, which is supposed to describe planned technology development and engineering activities required to bring immature technologies up to the desired TRL of 6 or higher. This plan should include preliminary schedule and cost estimates to allow decision makers to determine the future course of technology development. In addition, the guidance stated that once a project reached the critical decision 2 stage, all critical technologies should have reached a TRL of 6.

NNSA has undertaken a number of assessments of technological maturity and readiness for pit disassembly and conversion over the past decade as part of the ARIES project. For example, the PDCF project team carried out an evaluation of the maturity of ARIES equipment in 2003. According to project officials, the TRL framework was first used to assess the maturity of pit disassembly and conversion technologies in November 2008, in accordance with the Office of Environmental Management’s 2008 guidance.²³ In addition, as part of an independent review of the PDCF project, NNSA issued a report in January 2009 that included a technology readiness assessment of the ARIES equipment and other critical technologies.²⁴ The results of this assessment, as well as the earlier assessment conducted in 2008, are shown in table 1.

Table 1: Technology Assessments of Critical Pit Disassembly and Conversion Technologies Conducted in 2008 and 2009

Technology system/component	TRL	
	As assessed by the PDCF project in 2008	As assessed by NNSA’s independent review in 2009
Pit disassembly	6-7	5
Hydride dehydride	3-4	4

²³Washington Group International, Inc., *Unclassified Summary for Technical Readiness of PDCF Processes (U)* (Denver, Co: Nov. 10, 2008).

²⁴NNSA, *Final Report: Technical Independent Project Review for the Pit Disassembly and Conversion Facility (PDCF) at the Savannah River Site* (Jan. 13, 2009), for official use only.

Technology system/component	TRL	
	As assessed by the PDCF project in 2008	As assessed by NNSA's independent review in 2009
Direct metal oxidation	7-8	5
Oxide product handling	4-5	4
Product canning	7-8	6
Sanitization	4-6	4-6

Sources: Washington Group International, Inc.; NNSA.

As table 1 shows, there are a number of key technologies for pit disassembly and conversion that had not attained a TRL of 6. In accordance with the guidance on TRLs, NNSA should have a technology maturation plan in place to describe the planned technology development and engineering activities required to bring immature technologies up to the desired TRL of 6 or higher. According to NNSA officials, LANL had developed such a plan.²⁵ However, we found that LANL's plan lacked several key attributes of a technology maturation plan as described by DOE's guidance. Specifically, we found the following problems with LANL's plan:

- A technology maturation plan is supposed to be developed to bring all immature critical technologies up to an appropriate TRL. However, LANL's plan only addressed the technologies under development at LANL as part of the ARIES project. The plan did not address technologies, such as the oxide product handling equipment, being tested by the four other organizations.
- For each technology assessed at less than TRL 6, a technology maturation plan should include preliminary schedule and cost estimates to allow decision makers to determine the future course of technology development. However, LANL's plan did not include preliminary estimates of cost and schedule.
- LANL's plan is dated November 2007. However, NNSA has conducted or sponsored two technology readiness assessments of the PDCF critical technologies since that date. As a result, LANL's plan is out of date and

²⁵LANL, *Pit Disassembly and Conversion Integrated Design Support and Test Plan* (November 2007).

does not take into account the current state of maturity of its critical technologies.

NNSA officials told us that while they recognize some of the problems with the project's existing technology maturation plan, they have already prepared budget and schedule estimates for technology development activities in a number of separate documents (including the overall PDCF project schedule). However, they still have not updated the current technology maturation plan in accordance with DOE guidance. Until such an update is completed, it is uncertain whether these technologies will be sufficiently mature in time to meet the current, aggressive schedule for establishing a PDCF capability.

NNSA Has One Potential Customer for Most of Its MOX Fuel, but Outreach to Others May Be Insufficient

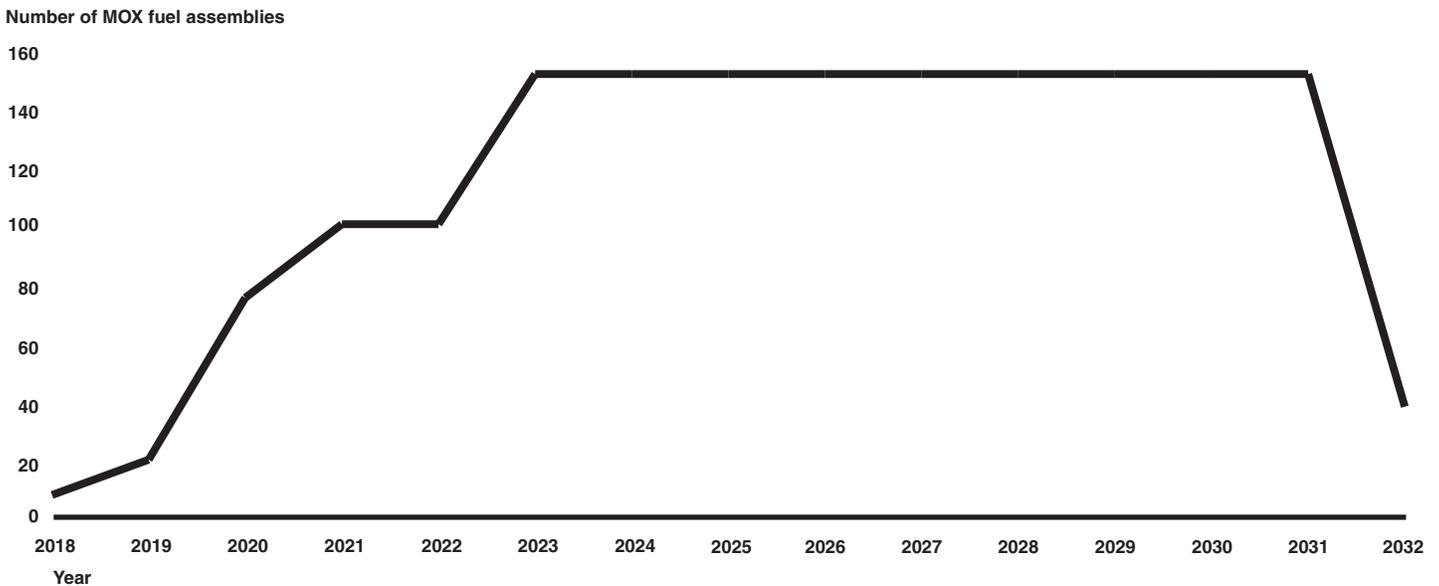
NNSA has offered several incentives to attract customers for its MOX fuel and is working toward a formal agreement for the Tennessee Valley Authority (TVA) to purchase most of this fuel. However, NNSA's outreach to other utilities may not yet be sufficient to inform potential customers of incentives to use MOX fuel.

NNSA Has Taken Steps to Attract Customers and Is in Negotiations with TVA

NNSA and its contractor for the MFFF project, MOX Services, have established a production schedule for the fabrication of MOX fuel assemblies from surplus, weapons-grade plutonium. According to the current production schedule, the MFFF is to produce 8 MOX fuel assemblies in 2018, the initial year of production. The MFFF's production rate is then to increase over the next 5 years up to a maximum rate of 151 fuel assemblies per year (see fig. 3). The MFFF is expected to produce 1,700 fuel assemblies during its production run. In addition, according to NNSA's plans, these fuel assemblies will be designed for use in pressurized water nuclear reactors, which are the most common type of nuclear reactor in use in the United States.²⁶

²⁶A pressurized water reactor uses pressurized water to transfer heat from the reactor core to the steam generator, which then produces steam to turn the turbine generator.

Figure 3: The MFFF Planned Production Schedule for MOX Fuel Assemblies



Source: Shaw AREVA MOX Services, LLC.

In June 2000, Duke Power (now Duke Energy Carolinas, LLC, or Duke), a power utility that operates seven pressurized water reactors in North Carolina and South Carolina, signed a subcontract with NNSA’s contractor for the MFFF project, MOX Services. According to NNSA officials, this subcontract gave the utility the option to purchase up to three-fourths of the MOX fuel produced by the MFFF at a discount relative to the price of normal reactor fuel, which uses low enriched uranium. According to the officials, the subcontract also obligated MOX Services to compensate Duke if the MOX fuel was not delivered by December 2007. However, as project delays continued to push back the start of construction, Duke, MOX Services, and NNSA began discussions in 2005 to renegotiate the subcontract. After nearly 3 years of discussions, Duke and MOX Services were unable to reach agreement by the negotiation deadline, and the subcontract automatically terminated on December 1, 2008.

As negotiations with Duke came to an end, MOX Services, at NNSA’s direction, issued a request to nuclear utilities in October 2008 to express their interest in the MOX fuel program. The request outlined a number of possible incentives to mitigate the risks to utilities in using MOX fuel—risks that include the need to modify reactors and obtain an operating license amendment from NRC to use MOX fuel. For example, the request discussed the possibility of (1) selling MOX fuel at a discount relative to

the price of uranium fuel²⁷ and (2) paying for costs associated with modifying a reactor and obtaining an operating license amendment from NRC. Furthermore, in January 2009, DOE reserved 12.1 metric tons of highly enriched uranium from its stockpile and hired a contractor to downblend this amount into 155 to 170 metric tons of low enriched uranium to serve as a backup supply of fuel if MOX fuel deliveries to customers are delayed.²⁸ As of December 2009, NNSA and MOX Services were still working on an agreement on liability if fuel is not delivered on time.

According to NNSA officials, three utilities have responded to MOX Services' request and have expressed interest in the MOX fuel program. Notably, in February 2010, NNSA and TVA executed an interagency agreement to fund TVA studies on the use of MOX fuel in five of TVA's reactors. Under the agreement, TVA will perform work on core design, licensing, modifications, and other related activities to evaluate the use of MOX fuel in its reactors. According to an NNSA official, using MOX fuel in five of TVA's reactors could account for up to 85 percent of the MFFF's output. The official also stated that an agreement with TVA to become a customer could be signed by the fall of 2010. TVA officials stated that they believed that familiarity gained by working with DOE during the Blended Low Enriched Uranium would help them work with DOE during the MOX program and cited this factor in their decision to begin discussions about becoming a customer for MOX fuel. Aside from TVA, NNSA officials characterized their contact with two other utilities as in the preliminary stages, and they could not estimate when or if they would secure them as customers for MOX fuel.

Because utilities typically contract with fuel suppliers at least 5 years in advance, NNSA and MOX Services will need to secure customers several years before they deliver MOX fuel to them. NNSA officials said that their goal is to obtain at least one customer by the end of fiscal year 2010, in part because the 5-year period during which the MFFF will increase its

²⁷According to NNSA officials, the sale of MOX fuel over the course of the program would return approximately \$1.1 billion to the U.S. Treasury, even with a discount relative to the price of uranium fuel. This figure assumes that the price of uranium fuel will remain at least at March 2009 levels; increases and decreases in uranium fuel price would affect the amount of revenue from MOX fuel sales.

²⁸NNSA officials told us that current plans are for the backup fuel to be stored at the contractor's facility in the form of canisters. If the backup fuel is needed, the canisters can be delivered to a utility's fuel fabricator to be converted into reactor fuel assemblies.

production capacity will allow them additional time to secure more customers. Furthermore, if TVA agrees to be a customer and uses MOX fuel in five of its reactors, these officials said that NNSA may only need one additional utility to account for the remainder of the MFFF's planned production of MOX fuel assemblies.

However, NNSA faces two main obstacles in obtaining TVA as its primary customer. First, some of TVA's reactors that would be candidates for using MOX fuel may not be permitted to use the fuel due to their status as backup reactors in DOE's tritium production program. According to NNSA officials, the 2000 U.S.-Russian plutonium disposition agreement could be interpreted as precluding reactors involved in weapons production from being used to dispose of MOX fuel. TVA officials told us that they are working with DOE to transfer tritium production responsibilities to another TVA reactor that is not presently a candidate for the MOX program. Second, although NNSA currently plans to produce MOX fuel assemblies for use in pressurized water reactors, three of TVA's reactors that are candidates for burning MOX fuel are boiling water reactors.²⁹ NNSA officials told us that they are studying how the MFFF can be reconfigured to produce fuel assemblies for boiling water reactors. In particular, they stated that the MFFF's design is based on a French MOX Facility, which can switch production between fuel assemblies for pressurized water reactors and for boiling water reactors in about 10 to 20 days. However, the officials also stated that they might need to conduct additional tests on using MOX fuel assemblies in boiling water reactors before producing the fuel assemblies in large quantities, and that it was unclear whether such tests would delay the MOX production schedule.

In March 2010, DOE stated that NNSA is evaluating several options for providing alternative sources of plutonium oxide material to the MFFF prior to the start of pit disassembly and conversion operations. One option under consideration is to adjust the "quantity and timing in providing initial fuel deliveries" to potential customers.

²⁹In a boiling water reactor, water moves through the reactor core and becomes a water-steam mixture, after which the water is removed and the steam is used to move the turbine generator.

NNSA’s Proposed Incentives Might Attract Customers, but Current Outreach May Be Insufficient

We interviewed fuel procurement officials at 22 of the nation’s 26 nuclear utilities to determine the extent to which nuclear utilities are interested in participating in DOE’s MOX fuel program and to evaluate what factors may influence their interest.³⁰ The factors we asked about were based on input we received from industry experts, DOE officials, and former utility officials. (For a list of the structured interview questions that we asked utilities, see app. IV.) As shown in table 2, utility officials most often identified the following factors as very or extremely important when assessing their level of interest in participating in the MOX fuel program:

- consistent congressional funding of the program,
- DOE’s ability to ensure timely delivery of MOX fuel,
- DOE’s ability to ensure the timely delivery of a backup supply of uranium fuel,
- the cost of MOX fuel relative to the cost of reactor fuel, and
- the opportunity to test MOX fuel in their reactors prior to full-scale use.

Table 2: Factors Affecting a Utility’s Interest in the MOX Fuel Program

Factor	Number of utilities characterizing factor as “very important” or “extremely important”
Congressional funding of the program throughout its expected duration	20
DOE’s ability to ensure timely delivery of MOX fuel	20
DOE’s ability to ensure timely delivery of backup uranium fuel	19
Cost of MOX fuel relative to reactor fuel	19
Opportunity to test MOX fuel prior to full-scale use	19
Cost of modifying the reactor for MOX fuel use	17
Costs associated with obtaining NRC licensing to use MOX fuel	15

³⁰To quantify utilities’ responses, we administered a structured interview to utilities, in which we asked them identical questions and requested that they select their answers from a series of set responses.

Factor	Number of utilities characterizing factor as “very important” or “extremely important”
Public opinion regarding MOX fuel use	14
Storage of MOX fuel on site prior to use	7

Source: GAO analysis of structured interviews of 22 utilities.

We then asked utilities about possible incentives—some of which have already been proposed by NNSA and DOE—that may affect their interest in becoming program participants.³¹ We also asked about scenarios in which DOE offered a discount of 15 percent and 25 percent for MOX fuel relative to the price of regular reactor fuel. As shown in table 3, DOE’s payment for costs associated with reactor modifications and NRC licensing to use MOX fuel—two incentives DOE has actually proposed to utilities—resulted in the largest number of utilities expressing increased interest in participating in the MOX fuel program.

Table 3: Number of Utilities Indicating Increased Interest in the MOX Fuel Program Due to Possible Incentives

Incentive	Number of utilities expressing increased interest
DOE payment for reactor modifications for MOX fuel use ^a	15
DOE payment of costs associated with obtaining NRC licensing to use MOX fuel ^a	14
DOE offering a 25 percent discount for MOX fuel in relation to regular reactor fuel	13
DOE funding for MOX fuel testing prior to full-scale use	12
DOE offering a 15 percent discount for MOX fuel in relation to regular reactor fuel	8

Source: GAO structured interview of 22 utilities.

^aIndicates proposed DOE incentive.

However, despite the incentives offered, as of October 2009 the majority of the utilities that we interviewed expressed little or no interest in becoming MOX fuel customers. Specifically, 12 utilities reported they were either not interested or not very interested in becoming MOX fuel customers, 8

³¹During our interviews, we only identified DOE as the party offering potential incentives to simplify our questions.

utilities were somewhat interested, and only 2 utilities indicated that they were currently very interested or extremely interested in the program. Three utilities indicated that they were currently interested enough to consider contacting DOE about becoming MOX fuel customers. When asked to consider the proposed incentives, however, 8 utilities expressed such interest.³² NNSA officials stated that they have communicated their willingness to provide incentives to potential customers. However, neither NNSA nor MOX Services has provided additional outreach or information to utilities in general since the October 2008 request for expression of interest.³³ Furthermore, 11 utilities responded in our interviews that they had heard or read very little about the MOX fuel program, while 5 responded that they had received no information. In our view, the fact that so few utilities expressed sufficient interest in even contacting NNSA and MOX Services suggests that NNSA's outreach may not be sufficient.

NRC Has Been Providing Oversight for the MFFF, but DOE's Independent Oversight of the MFFF and the WSB Has Been Limited

NRC has primary regulatory responsibility for nuclear safety at the MFFF, and NRC's activities to date have included authorizing construction, identifying safety-related issues with construction, and reviewing the license application for the operation of the facility. DOE has primary regulatory responsibility for nuclear safety at the WSB and has looked at some aspects of nuclear safety for both the MFFF and the WSB as part of its management reviews. However, oversight by DOE's independent nuclear safety entities has been limited.

³²Specifically, we asked utility officials to estimate what their interest in participating in the program would have to be to submit an expression of interest to DOE.

³³An NNSA official told us that, as of February 2010, MOX Services is in discussions with a nuclear services company to market and sell a portion of the MFFF's output. Under this agreement, the nuclear services company would purchase a portion of the output of the MFFF and then would be responsible for selling the fuel assemblies to nuclear utilities. The NNSA official told us that he could not specify when a contract between MOX Services and the company will be presented to NNSA for approval, although it could occur at some point in 2010. MOX Services is also holding exploratory discussions about potential roles in marketing MOX fuel to U.S. utilities with the two other commercial nuclear fuel fabrication and services companies that operate in the United States.

NRC Has Been Reviewing the MFFF’s License Application and Has Identified Issues with Construction Practices

NRC is responsible for licensing the MFFF to produce fuel for commercial nuclear reactors. To do so, NRC is using a two-stage review and approval process: the first stage is construction authorization, and the second stage is license application approval. The construction authorization stage began in February 2001, when the MFFF contractor submitted an application to begin construction. As part of the construction authorization review, NRC reviewed key documents, including the project’s preliminary safety designs, environmental impact statement, and quality assurance plan. NRC approved the facility’s construction authorization request in March 2005.

NRC began its review of the MFFF project’s application for a license to possess and use radioactive materials in December 2006. NRC has divided the license review into 16 areas, including criticality/safety, chemical processing, and fire protection. NRC has issued requests for additional information for each of the 16 review areas. According to NRC officials, once NRC staff obtain all of the necessary information in a given area, they prepare a draft section for that area to be included in the draft Safety Evaluation Report for the facility. As shown in table 4, NRC had drafted sections for 6 of the 16 review areas as of January 2010. Once all of the draft sections are complete, NRC staff will prepare a draft safety evaluation report and, after concurrence from NRC management, will submit them to NRC’s Advisory Committee on Reactor Safeguards—a committee of experts that is independent of the staff and that reports directly to NRC’s commissioners—for review and comment. NRC staff are then to incorporate, at their discretion, the committee’s comments into the license approval document and issue a final safety evaluation report for the facility, which NRC expects to occur in December 2010. Once NRC completes the licensing review and verifies that MOX Services has completed construction of the primary structures, systems, and components of the MFFF, it may issue the license. NRC officials stated that they could issue the license by 2014 or 2015, depending on the construction status of the facility.

Table 4: Status of NRC’s Review of the MFFF’s Operating License as of January 2010

Review area	Safety section drafted
Chemical processing	No
Civil/Structural	Yes
Classified matter handling	Yes
Criticality safety	Yes
Confinement	No

Review area	Safety section drafted
Emergency planning	Yes
Environmental protection	Yes
Fire protection	No
Human factors	No
Instrumentation and control	No
Integrated safety analysis	No
Management measures	No
Material control and accounting	No
Physical protection	No
Plant systems	No
Radiation protection	Yes

Source: NRC.

One issue that NRC raised during its review of the MFFF project is the design of safety controls to prevent a chemical reaction known as a “red oil excursion.”³⁴ Specifically, in January 2004, during the construction authorization stage, a senior NRC chemical safety reviewer stated that the MFFF’s planned safety controls to prevent a red oil excursion differed from those recommended by DOE and the Defense Nuclear Facilities Safety Board. In response, NRC convened a panel in March 2005 to evaluate the reviewer’s concerns. The panel issued a report in February 2007 concluding that although NRC’s construction authorization of the MFFF did not need to be revisited, there was wide agreement among NRC staff and the Advisory Committee on Reactor Safeguards that significant technical questions remained unanswered about the MFFF’s planned safety controls. To address these technical questions, NRC has taken a number of actions, including the following:

- NRC engaged the assistance of the Brookhaven National Laboratory to provide two independent assessments of the risk of a red oil excursion at the facility. Brookhaven National Laboratory issued an initial report in March 2007 and a follow-up report in August 2009 in which it examined

³⁴A red oil excursion is an explosive, runaway reaction that can occur when organic solvents containing tributylphosphates come into contact with nitric acid. While this reaction could occur during the manufacture of MOX fuel, it is not specific to the MOX process.

updated safety information provided by MOX Services.³⁵ The second of the two reports concluded that the risk of a red oil excursion at the facility is highly unlikely.

- During the current licensing application stage, NRC officials have requested and received additional information from MOX Services related to planned safety controls to prevent a red oil excursion. However, as of our review, NRC staff had not completed their draft safety evaluation report for this area.

NRC's oversight responsibilities also include inspecting the construction of the MFFF as well as the project's own quality assurance plan. NRC's Division of Construction Projects, based in NRC's Region II headquarters in Atlanta, conducts periodic inspections of the MFFF that assess the design and installation of the facility's principal structures, systems, and components and verify that the project's quality assurance program is adequately implemented. These inspections involve document reviews and site inspections over several weeks and can include specialty reviews in welding, concrete, and other construction subject areas. NRC evaluates the MFFF's construction against standards set by the American Concrete Institute and the American Society of Mechanical Engineers, among others. In addition to the Region II inspections, NRC maintains one resident inspector at the construction site who conducts day-to-day inspection activities, such as walk-throughs. NRC also plans to hire an additional full-time resident inspector for the MFFF in fiscal year 2010.

As part of its ongoing inspection of the construction of the MFFF, NRC has issued 16 notices of violation against MOX Services since the start of construction in August 2007 related to various subjects, including quality assurance and control over design changes. (See app. V for a complete list and description of NRC notices of violation.) Although NRC has classified all of the violations to date as severity level IV, the lowest safety-

³⁵Brookhaven National Laboratory, *Risk Assessment of Red Oil Excursions in the MOX Facility* (Upton, N.Y.: March 2007), for official use only; Brookhaven National Laboratory, *Risk Assessment of Red Oil Excursions in the MOX Facility* (Upton, N.Y.: August 2009), for official use only.

significant designation in its four-category scale, the violations have had an effect on the project's schedule.³⁶

In addition to its regular construction reviews, NRC issues periodic assessments of the contractor's performance. In its latest assessment, released in November 2009, NRC concluded that MOX Services had conducted its overall construction activities at the MFFF in an acceptable manner. However, NRC also determined that MOX Services must improve its control over changes to the MFFF's design and increase its attention to its quality assurance oversight of vendors. NRC identified several examples of deficiencies associated with performing, verifying, and documenting design changes and noted failures on the part of MOX Services to adequately translate requirements into design and construction documents. In addition, NRC concluded that its finding of a violation related to MOX Services' vendor oversight indicates "a challenge to [MOX Services'] quality assurance staff to provide effective oversight of vendors that perform work on, fabricate, or supply components and equipment for use at the MFFF." In its assessment, NRC stated that it will conduct additional inspections to assess the effectiveness of MOX Services' corrective actions. In response to NRC's assessment, MOX Services stated that it is taking steps to strengthen its design control process, such as increasing training for quality control supervisors; introducing quality control checklists into its subcontractor and construction procedures; and conducting oversight visits to vendors.

DOE Included Nuclear Safety in Management Reviews of the Projects, but Oversight by DOE's Independent Nuclear Safety Entities Has Been Limited

Although DOE has incorporated elements of nuclear safety in management reviews of the MFFF and the WSB projects that were conducted as part of its critical decision review process, DOE's independent nuclear safety entities were minimally involved. As part of the critical decisions 2 and 3 review process for the MFFF project, OECM conducted a review of the MFFF project during April and May, 2006, which included nuclear safety as one of several review areas. A review team comprising independent consultants and former DOE officials evaluated, among other things, the integration of nuclear safety into the project's environmental, safety, and health programs, as well the contractor's process for addressing issues found by NRC. The review identified one finding related to safety, noting

³⁶As we have previously described, one of these violations was NRC's February 2008 findings and notice of violation related to nonconforming reinforcing bars, which resulted in delays in the schedule for the pouring of concrete during 2008.

that the ongoing revision of the project contract could introduce conflicts with NRC regulations. NNSA accepted the review's recommendation to develop a memorandum of understanding with NRC to resolve this issue.

Regarding the WSB project, OECM conducted a review during September 2008—as part of the critical decision 2 process—that included nuclear safety as one of several review areas. The review team examined key WSB documents related to nuclear safety, including the facility's safety evaluation report, preliminary documented safety analysis, and the design hazard analysis report. The review team recommended that an additional hazard analysis for one system be performed but determined that overall, the hazard analyses and safety assessments for the WSB were comprehensive and complete. In addition, NNSA's Office of Project Management and Systems Support conducted another review of the WSB project during September 2008 as part of the critical decision 3 process. Because it was almost simultaneous with OECM's review, NNSA's review was less comprehensive and focused specifically on the WSB's ability to protect against a red oil excursion. This review resulted in a single recommendation, that is, for additional justification for the inclusion of certain equipment in the facility's design. In response to the recommendation, the WSB project team submitted a revised safety evaluation report justifying the equipment.

Oversight by HSS Has Been Limited

HSS is responsible for policy development, enforcement, and independent oversight in the areas of health, safety, the environment, and security across DOE. To accomplish this responsibility, this office performs appraisals to verify, among other things, that the department's employees, contractors, the public, and the environment are protected from hazardous operations and materials. However, these appraisals are designed to complement, not duplicate, program office oversight and self-assessments. In particular, HSS conducts visits to DOE sites and reviews a sample of facilities at those sites, including construction activities for new facilities. In addition, according to HSS officials, the office assists DOE's program offices by conducting reviews of documents supporting the safety basis—which is a technical analysis that helps ensure the safe design and operation of DOE's nuclear facilities—of a sample of high hazard nuclear facilities at a DOE site. For example, in response to our October 2008 report, which found that HSS was not conducting reviews of the safety basis of new, high-hazard nuclear facilities, HSS issued a new appraisal process guide in July 2009 that emphasized increased focus on the safety

basis at such facilities.³⁷ Finally, HSS has other oversight and advisory responsibilities related to nuclear safety during critical decision reviews for major DOE facilities. These responsibilities are spelled out in DOE's Order 413.3A, which provides direction on program and project management for the acquisition of capital assets, and include the following actions:

- participating on the Energy Systems Acquisition Advisory Board—a body comprising senior DOE officials who advise DOE's Secretarial Acquisition Executive in critical decisions regarding major projects and facilities;
- advising the DOE Secretarial Acquisition Executive on environmental, safety, and security matters related to all critical decision approvals;
- serving on independent project reviews as a team member at the request of the Secretarial Acquisition Executive or program officials; and
- participating on external independent reviews as an observer at OECM's request.

Regarding the MFFF project, HSS has provided limited oversight. According to HSS officials, a more limited amount of oversight is appropriate for the MFFF because of the National Defense Authorization Act of 1999, which gave NRC responsibility for regulating nuclear safety at the MFFF. HSS has conducted some inspection activities at the MFFF, including reviewing reinforced concrete and structural steel at the facility during site visits to SRS in August and September, 2009. However, HSS officials said that these activities did not include a review of documents supporting the MFFF's safety basis. In addition, while HSS officials stated that personnel from HSS's predecessor office participated in the critical decisions 2 and 3 reviews for the MFFF project during 2006, HSS was unable to provide any documentation to substantiate this statement.³⁸ According to department officials, HSS had limited resources for conducting reviews and needed to focus its resources on facilities that were not subject to external regulation.

³⁷GAO, *Nuclear Safety: Department of Energy Needs to Strengthen Its Independent Oversight of Nuclear Facilities and Operations*, [GAO-09-61](#) (Washington, D.C.: Oct. 23, 2008); and DOE, Office of Health, Safety, and Security, *Office of Environment, Safety, and Health Evaluations Appraisal Process Guide* (Washington, D.C.: July 2009).

³⁸DOE established HSS in October 2006.

Regarding nuclear safety oversight of the WSB project, which is solely regulated by DOE, we found that HSS had not conducted any oversight activities or participated in any critical decision reviews. Specifically, HSS officials told us that they have not reviewed any documents supporting the WSB's safety basis, nor have they conducted any inspection activities at the WSB construction site. Despite the issuance of HSS's new appraisal process guide, which contains inspection protocols for new and unfinished high-hazard nuclear facilities, an HSS official told us that the office has yet to determine when they will inspect the WSB. An HSS official told us that he was uncertain whether a WSB inspection would occur in 2010 because an ongoing internal DOE review has delayed the development of the office's 2010 inspection schedule. However, if HSS's initial visit occurs later than 2010, NNSA will have already completed at least half of the WSB's construction, according to the project's schedule.

Additionally, HSS did not participate in any of the critical decision reviews for the WSB project because of existing DOE guidelines. Specifically, although the WSB is considered a category 2 (high-hazard) nuclear facility, it is categorized as a nonmajor project.³⁹ According to DOE's order, HSS is not required to participate on the review board for a nonmajor project. In addition, neither OECM nor NNSA requested HSS to participate on the project reviews conducted for critical decisions 2 and 3.

Oversight by CDNS Has Been Limited

DOE's Order 413.3A calls for the NNSA Central Technical Authority to maintain operational awareness regarding complex, high-hazard nuclear operations, and to ensure that DOE's nuclear safety policies and requirements are implemented adequately and properly. The order also directs the CDNS to support the Central Technical Authority in this effort by

- participating as part of the Energy Systems Acquisition Advisory Board for major facilities, or similar advisory boards for minor facilities;
- providing support to both the Central Technical Authority and the Acquisition Executive regarding the effectiveness of efforts to integrate safety into design at each of the critical decisions, and as requested during other project reviews;

³⁹DOE Order 413.3A defines a nonmajor project (other than an environmental management project) as one with a total project cost of less than \$750 million.

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- determining that nuclear facilities have incorporated the concept of defense-in-depth into the facility design process;
 - validating that the integration of design and safety basis activities includes the use of a system engineering approach tailored to the specific needs and requirements of the project; and
 - validating that federal personnel assigned to projects as nuclear safety experts are appropriately qualified.

The CDNS's manual for implementing DOE Order 413.3A provides additional guidance, such as establishing the responsibilities of CDNS staff for evaluating safety activities at nuclear facilities. The manual also directs the head of the CDNS to participate in relevant staff meetings for NNSA projects that are requesting a decision from the Energy Systems Acquisition Advisory Board, an activity that may not be delegated for major projects.⁴⁰

However, according to the head of the CDNS, his office has not participated in any safety review activities at the MFFF because NRC is regulating nuclear safety at the facility. The head of the CDNS acknowledged that his office's approach to overseeing nuclear safety for the MFFF project does not follow the guidance set out in DOE orders and related manuals and has not been formally adopted by NNSA. He stated this approach is necessary to make more efficient use of CDNS resources by focusing oversight activities on facilities regulated entirely by DOE. According to NNSA officials, DOE Order 413.3A does not explicitly exempt the CDNS from overseeing facilities regulated by NRC. Agency officials stated that NNSA is working with the Department to have that exemption inserted into the order during an upcoming revision of the order. NNSA officials stated that, historically, there was never an intention that the CDNS would have responsibilities for facilities regulated by NRC, and that this needs to be clarified in the order.

The CDNS has provided some oversight of the WSB project, but according to the head of the CDNS, this oversight has been limited, due in part to difficulty in applying DOE's guidance to the WSB and staffing issues. The CDNS participated as an observer on the advisory board for the WSB

⁴⁰DOE, "Implementation of CDNS Responsibilities Regarding Safety in Design and Construction of Nuclear Facilities" (CDNS M 413.3A).

project during the project's critical decisions 2 and 3 processes. However, the head of the CDNS said that he had no record of whether his office participated in or evaluated the results of OECM's review during the critical decision 2 process, which included several lines of inquiry related to nuclear safety. During the critical decision 3 process for the WSB project, CDNS staff reviewed key project safety documents to determine how the facility would protect against a red oil excursion and determine the qualifications of the federal staff person assigned to the project as a nuclear safety expert.

Despite these efforts, the head of the CDNS told us that during the critical decision 3 review, his office experienced some difficulty in implementing the guidance established in DOE orders for the WSB project. The office's current policy is to review a project's safety documentation early in the design process and determine whether it conforms to DOE's relevant safety standard for integrating safety into design and incorporating defense-in-depth.⁴¹ The WSB project had completed its design work before DOE issued its current standard, and before the CDNS implemented a systematic approach to fulfilling its functions. Consequently, the CDNS did not perform a systematic review of WSB safety documentation. The CDNS head characterized the WSB review as being an ad hoc, qualitative assessment of some of the project's safety documentation. Additionally, the CDNS has not evaluated the qualifications of the nuclear safety expert that replaced the one evaluated as part of the critical decision 3 review. However, according to the head of the CDNS, his office only plans to evaluate the qualifications of new staff during technical reviews of the project, not after every change to the project team's composition.

The head of the CDNS told us that his office has begun developing a more systematic approach to evaluating the design safety of DOE facilities. In addition, he stated that he would like to conduct additional safety reviews of facilities currently in design and construction. However, he said that these efforts have been hampered, in part due to staffing shortages. For example, the CDNS had a staff of 13 people in 2007. As of December 2009, however, only 4 people remained on the CDNS staff due to attrition and NNSA's decision to transfer some of the personnel into other program offices. The head of the CDNS stated that current staffing levels have led the CDNS to focus its attention on projects that are still in the design

⁴¹DOE, "DOE Standard: Integration of Safety into the Design Process," DOE-STD-1189-2008 (Washington, D.C.: March 2008).

phase. He said that it was doubtful that the CDNS would return to the WSB to ensure that safety basis controls are fully integrated during its construction. Concerns over CDNS staffing issues also were raised by the Defense Nuclear Facilities Safety Board. Specifically, in its March 2009 letter to the Secretary of Energy, the safety board noted that reduced staff levels and the transfer of CDNS personnel into NNSA's program offices have reduced the effectiveness of the office.

Conclusions

NNSA is already over 2 years into its construction schedule for the MFFF and expects the facility to become operational by 2016. It has also established a production schedule for fabricating up to 151 MOX fuel assemblies per year at full production. However, the agency faces uncertainty as to (1) its ability to supply the MFFF with sufficient quantities of plutonium oxide feedstock to meet its planned production schedule of MOX fuel and (2) the demand for MOX fuel assemblies from potential customers.

Regarding the supply of plutonium oxide feedstock, NNSA only has a limited quantity of feedstock on hand to supply the MFFF prior to the start of pit disassembly operations. However, NNSA has not established a definitive strategy for pit disassembly operations, nor does it expect to do so in the near future. As a result, it appears unrealistic that NNSA will be able to meet its current production schedule for MOX fuel without obtaining additional sources of plutonium oxide. NNSA has stated that while it does not plan on expanding the current mission of the ARIES project until LANL demonstrates a sustained production rate over an extended period of time, it is evaluating other options to address this potential shortfall of plutonium oxide. These options include (1) the use of 1.4 metric tons of fuel-grade plutonium already in storage at the K-Area Facility, (2) starting up "limited but sufficient" pit disassembly processes, and (3) adjusting the "quantity and timing" in delivering MOX fuel to potential customers. We have concerns with these options, including:

- NNSA's use of a "wait-and-see" approach to the ARIES project, and the implications this may have on the ability of the ARIES project to meet its current and future production goals;
- the implications of the use of fuel-grade plutonium on the design and safety of the MFFF, and the extent to which DOE has adequately determined how much additional material throughout the DOE complex may be suitable and available for use by the MFFF;

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- how DOE plans to establish limited pit disassembly processes given the current lack of a definitive strategy for pit disassembly operations; and
 - how DOE plans to adjust the MOX fuel production schedule, and the implications this may have on the cost and schedule for operating the MFFF and DOE's ability to attract potential MOX fuel customers.

In addition to these concerns, while NNSA's strategy relies on critical technologies currently under development at LANL and other sites for pit disassembly and conversion operations, its current technology maturation plan does not meet DOE's current guidance because the plan is outdated and incomplete. Without a plan that provides more details on the options DOE has mentioned to increase the supply of plutonium oxide, or a comprehensive technology maturation plan, it is uncertain whether NNSA will be able to meet the MFFF's planned production schedule.

Regarding obtaining customers for MOX fuel assemblies, our survey of utilities indicated that some utilities might be interested in becoming customers but appear unaware of the incentives NNSA and DOE are offering. Without additional outreach, NNSA may not be able to obtain sufficient customers for the MOX fuel it plans to produce, which would leave the agency with nuclear material it cannot dispose of and the U.S. Treasury with a forgone opportunity for revenue.

Although DOE incorporated some aspects of nuclear safety oversight in its management reviews of the MFFF and WSB projects, oversight by HSS and the CDNS has been limited. Specifically, HSS has conducted limited oversight activities at the MFFF but has played no role in the WSB project because of its designation as a nonmajor project. Conversely, the CDNS has played no role in the MFFF project and has provided some elements of nuclear safety oversight for the WSB project. However, it has not fully met the responsibilities laid out for it by DOE order, in part due to a lack of a formal, standardized approach for reviewing project safety documents. We believe that HSS's exclusion from the WSB project reviews, as well as the limited involvement of the CDNS in the WSB project reviews, creates a gap in oversight of the WSB and similar facilities.

Recommendations for Executive Action

We are making the following five recommendations.

To address uncertainties associated with NNSA's plans to establish a pit disassembly and conversion capability, we recommend that the

Administrator of the National Nuclear Security Administration take the following three actions:

- Develop a plan to mitigate the likely shortfall in plutonium oxide feedstock for the MFFF prior to the start of pit disassembly operations. This plan should include, at a minimum, the following five items: (1) the actions needed to ensure that the ARIES project will meet its existing production goals, and the cost and schedule associated with any needed expansion of the project; (2) an assessment of how much additional plutonium material, including fuel-grade plutonium, is available within the DOE complex for use as feedstock for the MFFF; (3) an assessment of the effect on the design and safety of the MFFF from the use of fuel-grade plutonium as feedstock; (4) an assessment of potential changes to the MOX fuel production schedule and the effect of these changes on the cost and schedule for operating the MFFF; and (5) an assessment of the cost and schedule associated with obtaining a limited but sufficient pit disassembly process to produce feedstock for the MFFF.
- Develop a technology maturation plan for the pit disassembly and conversion mission that (1) includes all critical technologies to be used in pit disassembly and conversion operations and (2) provides details (including preliminary cost and schedule estimates) on planned testing and development activities to bring each critical technology up to a sufficient level of maturity.
- Conduct additional outreach activities to better inform utilities about the MOX fuel program and related incentives.

To ensure that the WSB and similar projects receive consistent nuclear safety oversight that is independent from the DOE program offices, we make the following two recommendations:

- The Secretary of Energy should revise DOE Order 413.3A to provide that HSS participate in key project reviews for the WSB and similar high-hazard facilities prior to the beginning of construction activities regardless of their status as nonmajor projects.
- The Administrator of NNSA should ensure that the CDNS conducts oversight activities to the extent called for by DOE Order 413.3A and establishes a formal, standardized approach to reviewing safety documentation.

Agency Comments and Our Evaluation

We provided the Department of Energy, the National Nuclear Security Administration, and the Nuclear Regulatory Commission with a draft of this report for their review and comment. In commenting on the draft report, the NNSA Associate Administrator for Management and Administration said that DOE agreed with the report and its recommendations.

However, we have concerns about DOE's response to one of our recommendations. Specifically, in commenting on our recommendation in a draft report that NNSA should develop a plan for expanding the ARIES project to produce additional quantities of plutonium oxide feedstock for the MFFF, DOE stated that NNSA is also evaluating other options for producing additional feedstock material for the MFFF, including (1) the use of 1.4 metric tons of fuel-grade plutonium already in storage at the K-Area Facility, (2) starting up "limited but sufficient" pit disassembly processes, and (3) adjusting the "quantity and timing" in delivering MOX fuel to potential customers. This information was not disclosed to us during our review, and we have a number of concerns about these options. For example, regarding the option to process fuel-grade plutonium, the MFFF was designed to process weapons-grade plutonium, not fuel-grade plutonium. As a result, we are concerned about the implications of this option on the design and safety of the MFFF. We are also concerned about the extent to which DOE has adequately determined how much additional material might be available throughout the DOE complex for use as an alternative source of feedstock for the MFFF. To address these concerns, we revised our conclusions and expanded our original recommendation to ensure that NNSA establishes a plan to more clearly explain its strategy for mitigating the likely shortfall in plutonium oxide feedstock for the MFFF prior to the start of pit disassembly operations.

DOE's written comments are reprinted in appendix VI, and NRC's written comments are reprinted in appendix VII. In addition, DOE and NRC provided detailed technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, the Administrator of NNSA, and other interested parties. We will also make copies available at no charge on GAO's Web site at <http://www.gao.gov>.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of

Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix VIII.

A handwritten signature in black ink that reads "Gene Aloise". The signature is written in a cursive style with a large, looped initial "G".

Gene Aloise
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

To assess the performance status of the MOX Fuel Fabrication Facility (MFFF) and the Waste Solidification Building (WSB) construction projects regarding cost and schedule, we requested and analyzed earned value management (EVM) data contained in the projects' monthly reports and variance reports, as well as EVM data for the MFFF project contained in Excel spreadsheets. We assessed the adequacy of the MFFF project's use of EVM reporting by using a set of analysis tasks developed by GAO. In addition, we assessed the reliability of the EVM data by evaluating each project's schedule against GAO's scheduling best practices.¹ We have previously identified nine key practices necessary for developing a reliable schedule. These practices are (1) capturing all activities, (2) sequencing activities, (3) establishing the duration of activities, (4) assigning resources to activities, (5) integrating activities horizontally and vertically, (6) establishing the critical path for activities, (7) identifying the float time between activities, (8) performing a schedule risk analysis, and (9) monitoring and updating the schedule. To assist us in these efforts, we contracted with Technomics, Inc., to perform an in-depth analysis of data used in the MFFF's integrated master schedule and the WSB's current schedule. For the MFFF project, we also conducted a review of the project's schedule risk analysis, which was performed during the summer of 2009. We also interviewed officials from the Department of Energy's (DOE) National Nuclear Security Administration (NNSA) and MOX Services regarding their use of EVM data, scheduling practices, and schedule risk analyses for the two projects. Finally, we conducted tours of the MFFF construction project at DOE's Savannah River Site (SRS), and met officials from the MFFF's contractor, MOX Services, Inc.; and DOE's NNSA and Office of Engineering and Construction Management (OECM).

To assess the status of NNSA's plan to establish a pit disassembly and conversion capability to supply plutonium to the MFFF, we reviewed documentation provided by NNSA and its contractors for the Pit Disassembly and Conversion Facility (PDCF), Plutonium Preparation Project, K-Area Complex, and MFFF projects, including project execution plans, project status reports, EVM data, and independent project reviews. We also requested information from NNSA on risks associated with the development of technology used in pit disassembly and conversion. We analyzed these risks using DOE guidance on assessing technology

¹GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

readiness.² We also reviewed project plans, testing and development data, and feasibility studies related to the Advanced Recovery and Integrated Extraction System (ARIES) project. We also toured the ARIES facility at DOE's Los Alamos National Laboratory (LANL) in New Mexico and interviewed officials involved in the project.

To assess the status NNSA's plans to obtain customers for mixed-oxide (MOX) fuel from the MFFF, we reviewed project documents, including interest requests communicated to utilities, descriptions of possible incentives for participating in the MOX program, and analyses on the expected return to the government from the sale of MOX fuel. We also interviewed officials from NNSA and the Tennessee Valley Authority (TVA) on current efforts to secure TVA as a customer for MOX fuel, as well as officials from Duke on factors that caused the utility to end its agreement with NNSA's contractor to purchase MOX fuel. To further identify factors affecting utilities' interest in the MOX fuel program, we conducted structured telephone interviews of U.S. nuclear utilities. We chose to interview fuel procurement officers because they would be the most knowledgeable respondents about factors affecting fuel purchasing decisions, including considerations for MOX fuel. We asked fuel procurement officers to provide information on their current interest in MOX fuel, important factors in the consideration of using MOX fuel, and possible incentives for the adoption of MOX fuel. To develop the structured interview questionnaire, GAO social science survey specialists and GAO staff developed a draft of the questionnaire on the basis of survey design principles and information obtained in interviews with DOE and nuclear utility officials. The draft questionnaire underwent a blind review by an additional social science survey specialist and was edited to ensure consistency among questions and clearly defined terms. The revised draft questionnaire was then pretested on three respondents, all of whom were familiar with the nuclear fuel procurement process. During the pretests, respondents were asked about their understanding of the questions, how they would approach constructing their answers, and any editorial concerns. The draft questionnaire underwent a final revision before being used to conduct the structured telephone interviews.

Structured interviews were completed by fuel procurement officials from 22 of the 26 nuclear utilities in the United States, for an overall response

²DOE, Office of Environmental Management, *Technology Readiness Assessment (TRA)/Technology Maturation Plan (TMP) Process Guide* (Washington, D.C.): March 2008.

rate of 85 percent. All of the interviews were conducted during September and October, 2009. Respondents were contacted in advance to schedule a time to complete the interview. One of the 22 responding utilities elected not to answer three of the interview questions, but the other 21 completed the entire questionnaire. Data from the interviews were recorded and entered by the interviewer. A social science analyst performed a 100 percent check of that data entry by comparing them with their corresponding questionnaires, to ensure that there were no errors.

To examine the actions that NRC and DOE have taken to provide independent nuclear safety oversight of the MFFF and WSB construction projects, we reviewed oversight documentation and reports and interviewed oversight officials from both agencies. In relation to NRC's oversight activities, we examined documents related to NRC's approval of the MFFF's construction authorization request; information requests submitted by NRC to MOX Services in support of NRC's ongoing review of the facility's operating license application; and technical analyses conducted by Brookhaven National Laboratory on behalf of NRC examining the likelihood of a red oil excursion at the facility. We also reviewed documents related to NRC's construction inspection program, including inspection guidance and procedures, inspection reports, periodic assessments of MOX Services' performance, and MOX Services' responses to inspection findings. We also interviewed officials from the Nuclear Regulatory Commission's Office of Nuclear Materials Safety and Safeguards and the Region II Division of Construction Projects. In relation to DOE's inspection activities, we reviewed DOE project management and nuclear safety oversight guidance, protocols for conducting facility inspections, inspection reports, and records of decision related to reviews conducted by DOE's Office of Health, Safety, and Security (HSS) and the Chief of Defense Nuclear Safety. We also reviewed reports by the Defense Nuclear Facilities Safety Board on DOE oversight and interviewed Safety Board officials. We interviewed officials from NNSA's Office of Fissile Materials Disposition, HSS's Office of Independent Oversight, and the Chief of Defense Nuclear Safety.

We conducted this performance audit from January 2009 to March 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Extent to Which the MFFF Project's Schedule Used Key Practices

Practice	Explanation	Rating	GAO analysis
Capturing all activities	The schedule should reflect all activities as defined in the program's work breakdown structure, including activities to be performed by both the government and its contractors.	Fully	The project has provided evidence that the schedule reflects both government and contractor activities, such as the building and testing of software components, as well as key milestones for measuring progress.
Sequencing activities	The schedule should be planned so that it can meet critical program dates. To meet this objective, activities need to be logically sequenced in the order that they are to be carried out. In particular, activities that must finish prior to the start of other activities (i.e., predecessor activities), as well as activities that cannot begin until other activities are completed (i.e., successor activities), should be identified. By doing so, interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. The schedule should avoid logic overrides and artificial constraint dates that are chosen to create a certain result.	Fully	Of the approximately 22,000 normal activities, all are logically sequenced—that is, the schedule identifies interdependencies among work activities that form the basis for guiding work and measuring progress.
Establishing the duration of activities	The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. In particular, durations of longer than 200 days should be minimized.	Mostly	Of the 22,000 normal activities, only 569 have durations of over 200 days. In addition, the schedule includes 38 activities with a remaining duration over 500 days and 10 activities with remaining duration over 1,000 days (3.9 years).
Assigning resources to activities	The schedule should reflect what resources (e.g., labor, material, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist.	Mostly	Of the 22,000 normal activities, resources are placed on 3,124 of these, and 13,988 of these have no resources. However, the program does have all resources captured in an alternate software package. According to DOE, the current baseline reflects \$2.2 billion.
Integrating activities horizontally and vertically	The schedule should be horizontally integrated, meaning that it should link the products and outcomes associated with other sequenced activities. These links are commonly referred to as "handoffs" and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that traceability exists among varying levels of activities and supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule.	Mostly	Due to concerns about total float values discussed below in "identifying float between activities," the schedule has not fully integrated key activities horizontally. The schedule has sufficiently integrated key activities vertically.

**Appendix II: Extent to Which the MFFF
Project's Schedule Used Key Practices**

Practice	Explanation	Rating	GAO analysis
Establishing the critical path for activities	Using scheduling software, the critical path—the longest duration path through the sequenced list of key activities—should be identified. The establishment of a program's critical path is necessary for examining the effects of any activity slipping along this path. Potential problems that might occur along or near the critical path should also be identified and reflected in the scheduling of the time for high-risk activities.	Fully	The project has established a number of critical paths by using the scheduling software to identify activities with low or zero float, as well as by identifying high-risk activities. Project officials said that they conduct weekly meetings to keep track of critical path activities.
Identifying the "float time" between activities	The schedule should identify float time—the time that a predecessor activity can slip before the delay affects successor activities—so that schedule flexibility can be determined. As a general rule, activities along the critical path typically have the least amount of float time. Total float time is the amount of time flexibility an activity has that will not delay the project's completion (if everything else goes according to plan). Total float that exceeds a year is unrealistic and should be minimized.	Partially	The schedule contains 8,600 activities with total float exceeding 400 days (1.5 years) and 669 activities with total float exceeding 1,000 days (3.9 years). Many of the activities with large total float values are tied to completion milestones, rather than to an intermediate successor.
Performing a schedule risk analysis	A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a program's completion date. This analysis focuses not only on critical path activities but also on activities near the critical path, since they can potentially affect program status.	Fully	Project officials conducted a schedule risk analysis during the summer of 2009. This analysis was performed using statistical techniques and focused on critical path and near-the-critical-path activities. Officials said that this analysis has provided important overall project risk information to management.
Monitoring and updating the schedule	The schedule should be continually monitored to determine when forecasted completion dates differ from the planned dates, which can be used to determine whether schedule variances will affect downstream work. Individuals trained in critical path method scheduling should be responsible for ensuring that the schedule is properly updated. Maintaining the integrity of the schedule logic is not only necessary to reflect true status, but is also required before conducting a schedule risk analysis.	Fully	Project officials said that they update the schedule on a weekly basis. In particular, project controls staff are associated with each engineering group and provide a status update on a weekly basis.

Sources: Shaw AREVA MOX Services, LLC (data); GAO (analysis).

Note: The ratings we used in this analysis are as follows: Based on the documentation provided, "fully" means that the project fully satisfied the criterion; "mostly" means that the project satisfied the criterion to a large extent; "partially" means that the project satisfied the criterion in part; "minimally" means that the project satisfied the criterion to a minimal extent; and "not" means that the project did not satisfy the criterion.

Appendix III: Extent to Which the WSB Project's Schedule Used Key Practices

Practice	Explanation	Rating	GAO analysis
Capturing all activities	The schedule should reflect all activities as defined in the program's work breakdown structure, including activities to be performed by both the government and its contractors.	Fully	The project's schedule reflects both government and contractor activities, such as the building and testing of cementation equipment, as well as key milestones for measuring progress.
Sequencing activities	The schedule should be planned so that it can meet critical program dates. To meet this objective, activities need to be logically sequenced in the order that they are to be carried out. In particular, activities that must finish prior to the start of other activities (i.e., predecessor activities), as well as activities that cannot begin until other activities are completed (i.e., successor activities), should be identified. By doing so, interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. The schedule should avoid logic overrides and artificial constraint dates that are chosen to create a certain result.	Mostly	Of 2,066 activities that are currently in progress or have not yet started, 80 are not logically sequenced—that is, the schedule does not identify interdependencies among work activities that form the basis for guiding work and measuring progress.
Establishing the duration of activities	The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. In particular, durations of longer than 200 days should be minimized.	Mostly	Ninety-eight of the 2,066 activities that are currently in progress or have not yet started have durations of 100 days or more. While durations should be as short as possible and have specific start and end dates to objectively measure progress, project officials provided a valid rationale for the duration of these activities.
Assigning resources to activities	The schedule should reflect what resources (e.g., labor, material, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist.	Fully	The schedule reflects \$336 million in resource costs. The project's cost baseline is \$344 million. According to project officials, they are aware of this discrepancy. They stated that while all of the project resources are reflected in the schedule, a software problem has caused some of these resources to not show up. Project officials are working to correct this software problem.

**Appendix III: Extent to Which the WSB
Project's Schedule Used Key Practices**

Practice	Explanation	Rating	GAO analysis
Integrating activities horizontally and vertically	The schedule should be horizontally integrated, meaning that it should link the products and outcomes associated with other sequenced activities. These links are commonly referred to as "handoffs" and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that traceability exists among varying levels of activities and supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule.	Fully	Project officials provided evidence that the schedule is sufficiently integrated.
Establishing the critical path for activities	Using scheduling software, the critical path—the longest duration path through the sequenced list of key activities—should be identified. The establishment of a program's critical path is necessary for examining the effects of any activity slipping along this path. Potential problems that might occur along or near the critical path should also be identified and reflected in the scheduling of the time for high-risk activities.	Fully	A critical path has been established. The critical path dates are driven by the logic of the schedule.
Identifying the "float time" between activities	The schedule should identify float time—the time that a predecessor activity can slip before the delay affects successor activities—so that schedule flexibility can be determined. As a general rule, activities along the critical path typically have the least amount of float time. Total float time is the amount of time flexibility an activity has that will not delay the project's completion (if everything else goes according to plan). Total float that exceeds a year is unrealistic and should be minimized.	Mostly	The schedule contains 1,482 activities that have a float time of over 100 days. However, project officials provided a valid rationale for having activities with large float times.
Performing a schedule risk analysis	A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a program's completion date. This analysis focuses not only on critical path activities but also on activities near the critical path, since they can potentially affect program status.	Fully	Project officials stated that they conducted a schedule risk analysis using statistical techniques in July 2008 on the baseline schedule.
Monitoring and updating the schedule	The schedule should be continually monitored to determine when forecasted completion dates differ from the planned dates, which can be used to determine whether schedule variances will affect downstream work. Individuals trained in critical path method scheduling should be responsible for ensuring that the schedule is properly updated. Maintaining the integrity of the schedule logic is not only necessary to reflect true status, but is also required before conducting a schedule risk analysis.	Fully	Project officials conduct weekly meetings to review and update the project schedule.

Sources: NNSA (data); GAO (analysis).

Note: The ratings we used in this analysis are as follows: Based on the documentation provided, "fully" means that the project fully satisfied the criterion; "mostly" means that the project satisfied the criterion to a large extent; "partially" means that the project satisfied the criterion in part; "minimally" means that the project satisfied the criterion to a minimal extent; and "not" means that the project did not satisfy the criterion.

Appendix IV: Summary Results of Interviews with 22 Utilities

1. How much information have you heard or read about DOE's MOX fuel program?

Response	Frequency
A great deal of information	1
Some information	5
Very little information	11
No information	5

2. Does your utility own any reactors that are compatible with AREVA fuel designs?

Response	Frequency
No	2
Yes	19

Note: The numbers in the table do not total to 22 because one utility elected not to respond to this question.

3. Taking into account your current reactor fleet, what is your utility's current level of interest in participating in the MOX fuel program? (Choose One)

Response	Frequency
Not at all interested	2
Not very Interested	10
Somewhat interested	8
Very interested	1
Extremely interested	1

4. What kinds of reactors owned by your utility do you think would be the most likely candidates for MOX fuel if your utility decided to participate in the MOX fuel program? Please choose only one answer.

Response	Frequency
BWR only	2
PWR only	13
Both	7

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

5. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Somewhat important	3
Very important	9
Extremely important	10

6. If DOE would sell MOX fuel to your utility at a 15% discounted price relative to the market price for uranium fuel, what do you think your utility's level of interest in participating in the MOX program would be?

Response	Frequency
Not at all interested	2
Not very Interested	7
Somewhat interested	8
Very interested	5

7. If DOE would sell MOX fuel to your utility at a 25% discounted price relative to the market price for uranium fuel, what do you think your utility's level of interest in participating in the MOX program would be?

Response	Frequency
Not at all interested	2
Not very Interested	4
Somewhat interested	8
Very interested	4
Extremely interested	4

8. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Somewhat important	5
Very important	5
Extremely important	12

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

9. If DOE would cover the costs associated with reactor modifications for compatibility with MOX fuel, what do you think your utility's level of interest in participating in the MOX program would be?

Response	Frequency
Not very interested	2
Somewhat interested	11
Very interested	6
Extremely interested	3

10. How important are the costs associated with NRC licensing requirements, in terms of monetary outlays and staff time, to your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not very important	2
Somewhat important	5
Very important	7
Extremely important	8

11. If DOE would cover the costs associated with obtaining NRC licenses, what do you think your utility's level of interest in participating in the MOX program would be?

Response	Frequency
Not at all interested	1
Not very interested	2
Somewhat interested	9
Very interested	8
Extremely interested	2

12. Another factor that may affect your level of interest is the ability to test the quality and safety of MOX fuel at your reactor. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not very important	1
Somewhat important	2
Very important	4
Extremely important	15

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

13. If DOE offered to fund a demonstration program of MOX fuel at your reactor, what do you think your utility's level of interest in participating in the MOX program would be?

Response	Frequency
Not at all interested	2
Not very interested	5
Somewhat interested	5
Very interested	6
Extremely interested	3

Note: The numbers in the table do not total to 22 because one utility elected not to respond to this question.

14. Another factor that may affect your level of interest is DOE's ability to ensure the timely delivery of MOX fuel (i.e. – Delivery occurs at an interval that meets a reactor's needed timeline to prepare prior to a refueling outage). How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not very important	1
Somewhat important	1
Very important	3
Extremely important	17

15. Another factor that may affect your level of interest is DOE's ability to provide a compatible backup supply of uranium fuel as assurance in case of delays in the delivery of MOX fuel. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not very important	1
Somewhat important	2
Very important	8
Extremely important	11

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

16. Another factor that may affect your level of interest is the storage of MOX fuel at your reactor site for longer than the interval that meets a reactor's needed timeline prior to a refueling outage. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not at all important	2
Not very important	3
Somewhat important	10
Very important	4
Extremely important	3

17. Another factor that may affect your level of interest is public opinion regarding the use of MOX fuel. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Not at all important	1
Not very important	1
Somewhat important	6
Very important	9
Extremely important	5

18. DOE's MOX fuel program relies on annual Congressional appropriations. Another factor that may affect your level of interest is the consistency of funding for the program through 2033. How important is this factor in your assessment of your utility's current level of interest in participating in the MOX fuel program?

Response	Frequency
Somewhat important	2
Very important	8
Extremely important	12

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

19. In addition to the factors described above, are there any other factors or issues that we have not discussed that affected your assessment of your utility's current interest in participating in the MOX fuel program?

Open ended responses are not presented in this appendix.

20. How interested in participating do you think your utility would have to be to actually submit such an expression of interest?

Response	Frequency
Somewhat interested	5
Very interested	10
Extremely interested	6

Note: The numbers in the table do not total to 22 because one utility elected not to respond to this question.

21. The MOX Fuel Fabrication Facility is expected to begin delivery of MOX fuel in 2018 and continue supplying fuel through 2032. How confident are you in DOE's ability to deliver MOX fuel on time throughout this period?

Response	Frequency
Not at all confident	3
Not very confident	11
Somewhat confident	8

22. How confident are you in DOE's ability to ensure that a compatible backup supply of uranium fuel is delivered on time in the case of MOX fuel delays?

Response	Frequency
Not very confident	4
Somewhat confident	15
Very confident	2
Extremely confident	1

**Appendix IV: Summary Results of Interviews
with 22 Utilities**

23. How satisfied are you with the amount of outreach that MOX Services and DOE have used to obtain interest in the MOX fuel program?

Response	Frequency
Very dissatisfied	1
Somewhat dissatisfied	3
Neither satisfied nor dissatisfied	14
Somewhat satisfied	3
Very satisfied	1

Appendix V: Nuclear Regulatory Commission's Notices of Violation for the MFFF

NRC report date	Description of violation	Outcome
October 30, 2009	MOX Services failed to ensure that design considerations were considered during installation of structures.	To be determined.
October 30, 2009	MOX Services' design control procedures did not require that the method of design verification, or the results, be adequately documented when design verifications were performed.	To be determined.
October 30, 2009	MOX Services failed to provide a technical justification for an engineering change request.	To be determined.
October 30, 2009	MOX Services failed to include a sequential description of work to be performed in implementing documents.	To be determined.
September 11, 2009	MOX Services failed to promptly identify, evaluate, correct, and document conditions adverse to quality, including incorrect placement of a floor and failure to document a rebar deficiency in the corrective action program.	MOX Services conducted a root cause analysis for the conditions that led to each of the findings in NRC's September 11, 2009, inspection report and instituted actions, including improving communications between engineering, construction, and quality control personnel; adopting checklists for changes; and adding additional training for engineering personnel. NRC stated that the actions appeared adequate, and that it will verify implementation during later inspections.
September 11, 2009	MOX Services failed to perform quality-affecting activities in accordance with approved drawings and specifications.	MOX Services conducted a root cause analysis for the conditions that led to each of the findings in NRC's September 11, 2009, inspection report and instituted actions, including improving communications between engineering, construction, and quality control personnel; adopting checklists for changes; and adding additional training for engineering personnel. NRC stated that the actions appeared adequate, and that it will verify implementation during later inspections.
September 11, 2009	MOX Services failed to provide and adequate documented justification for changes to final designs.	MOX Services conducted a root cause analysis for the conditions that led to each of the findings in NRC's September 11, 2009, inspection report and instituted actions, including improving communications between engineering, construction, and quality control personnel; adopting checklists for changes; and adding additional training for engineering personnel. NRC stated that the actions appeared adequate, and that it will verify implementation during later inspections.
July 30, 2009	MOX Services failed to correctly translate applicable requirements into design documents.	MOX Services initiated corrective actions to address these issues.

**Appendix V: Nuclear Regulatory Commission's
Notices of Violation for the MFFF**

NRC report date	Description of violation	Outcome
May 11, 2009	Suppliers were found to fail to meet a basic NQA-1 requirement, indicating that MOX Services failed to ensure that services were controlled to ensure conformance with specified technical and QA requirements.	NRC determined that MOX Services' oversight of its contractors was acceptable, despite numerous examples of failures to meet the QA requirements.
January 30, 2009	Testing documentation for two separate tests did not include the required information.	MOX Services revised documentation procedure to include the necessary information.
January 30, 2009	On two separate occasions, the contractor failed to incorporate an approved design change in project documents, and later did not verify a field drawing, which resulted in failure to identify that the drawing did not implement design requirements.	MOX Services took steps to ensure that documentation was appropriately revised, and added the design change into the corrective action plan to initiate correction before concrete placement.
October 30, 2008	NRC found that some design reviews did not ensure that design inputs were correctly incorporated into field drawings.	MOX Services revised the design drawings to match the as-built drawings after completing an analysis of the structure.
July 29, 2008	Contractor failed to identify certain conditions adverse to quality assurance plan requirements, including those related to incorrectly poured concrete.	MOX Services placed the matter into its corrective action program and took steps to ensure adequate pouring of concrete.
April 30, 2008	Contractor failed to take corrective action for conditions adverse to quality, including providing adequate resolution to justify the use of reinforcing steel splices that did not meet industry standards.	NRC reviewers concluded that MOX Services implemented appropriate actions to control purchase of items from the reinforcing bar vendor.
April 30, 2008	Contractor failed to ensure that numerous pieces of reinforcing bar met industry standards for bend radius.	NRC reviewers concluded that MOX Services implemented appropriate actions to control purchase of items from the reinforcing bar vendor.
October 30, 2007	NRC found that MOX Services had not followed quality insurance procedures, including, for example, ensuring that a vendor provided clear instructions for operating a concrete batch plant, which resulted in improperly mixed concrete.	MOX Services took over concrete testing and took corrective actions, including revising procedures and bringing in independent experts to make recommendations for improvement.

Source: NRC.

Appendix VI: Comments from the Department of Energy



Department of Energy
National Nuclear Security Administration
Washington, DC 20585



March 19, 2010

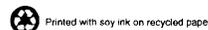
Mr. Gene Aloise
Director, Natural Resources
and Environment
U.S. Government Accountability Office
Washington, D.C. 20458

Dear Mr. Aloise:

The Department of Energy (Department) appreciates the opportunity to review and provide comments to the Government Accountability Office's (GAO) report, *NUCLEAR NONPROLIFERATION: DOE Needs to Address Uncertainties with and Strengthen Independence Safety Oversight of Its Plutonium Disposition Program*, GAO-10-378. In response to a Congressional Mandate, we understand that GAO performed this review to assess the (1) status of the MOX Fuel Fabrication Facility (MFFF) and Waste Solidification Building (WSB) construction projects with respect to cost and schedule, (2) status of NNSA's plans to establish a pit disassembly and conversion capability, (3) status of NNSA's plans to obtain customers for mixed oxide (MOX) fuel from the MFFF, and (4) actions that the Nuclear Regulatory Commission (NRC) and DOE have taken to provide independent nuclear safety oversight of the two projects.

The Department agrees with the report and the recommendations. One conclusion GAO reached as a result of its nuclear utility survey was that utility interest in MOX fuel is enhanced by the offering of certain incentives: DOE compensation for utility reactor modifications, license amendments and fuel testing, and price discounts for MOX fuel relative to low enriched uranium fuel. NNSA notes that all of these incentives have previously been offered to utilities in two separate MOX Services Requests for Expressions of Interest and discussed in numerous other interactions with nuclear utilities.

Since the issuance of your report, NNSA and the Tennessee Valley Authority have signed an interagency agreement to evaluate the use of MOX fuel made from U.S. surplus weapons plutonium in TVA's Sequoyah and Browns Ferry nuclear power reactors, a total of five large units. Under the interagency agreement, TVA will perform work on nuclear core design, safety analyses, environmental and reactor modification assessments, and other related activities. NNSA is optimistic that these studies will yield favorable results, and that other institutional issues noted in GAO's report will be manageable. The five TVA reactors could potentially use between 85 and 100 percent of the output of the MFFF. The signing of the interagency agreement indicates the Department's commitment to and success in working with the utilities on the MOX projects.



We also note that some aspects of the results section do not recognize actions that HSS has taken to strengthen its oversight of nuclear facilities undergoing construction, major modification, or major changes in mission and operations. We believe the GAO report should more clearly distinguish between the level of Office of the Health, Safety and Security (HSS) oversight and that of the Nuclear Regulatory Commission.

Our responses to the recommendations below are:

1. Develop a plan for expanding the ARIES project at Los Alamos National Laboratory (LANL)....

Expanding ARIES production is one of several options NNSA is evaluating to provide feedstock to the MFFF prior to the start of pit disassembly and conversion operations. Other options include: (1) process additional material suitable for MFFF feedstock currently under the jurisdiction of the Office of Environmental Management (EM) at the Savannah River Site (SRS), (2) work with utilities interested in irradiating MOX fuel as to the quantity and timing in providing initial fuel deliveries, and (3) start up limited but sufficient processes in the Pit Disassembly and Conversion project to produce feedstock for MFFF.

NNSA's current production schedule calls for LANL to produce 50 kilograms of certified oxide by end of fiscal year (FY) 2010. Subsequently, LANL must ramp up to a target rate of 300 kilograms per year in FY 2012 and sustain this rate through FY 2017 in order to meet the two metric ton mission. As a prudent measure, NNSA undertook a study in May 2008 of various options for expanding the production of plutonium oxide at the Los Alamos National Laboratory (ARIES). However, until LANL demonstrates that they can produce 300 kilograms per year and sustain this rate over an extended period of time, NNSA considers further expansion of this potential risk mitigation alternative to be premature.

2. Develop a technology maturation plan for the pit disassembly and conversion mission....

NNSA agrees with the recommendation, but notes that in a previous report issued by GAO in March 2007, *Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays*, GAO stated that:

“Specifically, the DOE project director for the Pit Disassembly and Conversion Facility systematically measured and assessed readiness levels for each component of the overall project.”

While we were encouraged by this finding, we realize the need to continue updating the technology maturation plan for the Pit Disassembly and Conversion project as the development and testing efforts progress. With this in mind, as the project prepares for Critical Decision 1, Approve Alternative Selection and Cost Range, a

technology readiness assessment will be conducted and a new integrated technology plan will be developed to assess all critical technologies to be used in pit disassembly and conversion operations. This work will be closely integrated with the project's cost and schedule performance baseline and the risk management plan. All technology development activities will be managed and controlled as part of the integrated project schedule.

3. Conduct additional outreach activities

NNSA agrees with this recommendation and is actively considering changes in the contracting approach for the marketing and sales of MOX fuel that would better align these efforts with customary nuclear fuel market practices. In particular, NNSA is exploring marketing and sales of MOX fuel to utilities through established nuclear fuel fabrication vendors with substantial sales organizations and established relationships with U.S. utilities. In addition, NNSA is creating a backup inventory of low-enriched uranium (derived from down-blended surplus highly enriched uranium) to serve as fuel supply assurance to participating utilities in the event of delays in production of MOX fuel.

4. The Secretary of Energy revise DOE Order 413.3A.....

HSS agrees with the recommendation. The current version of DOE Order 413.3A provides for HSS participation, if so requested by the line organizations. However, HSS has considerable expertise and experience with best practices and common pitfalls in safety programs at the Department sites, including construction activities. As GAO recommends, it would be prudent for the Department to better use the HSS expertise on project reviews and to modify DOE Order 413.3A to include more definitive language about HSS participation on project reviews for higher hazard nuclear facilities.

5. The Administrator of NNSA ensure that CDNS conducts oversight activities....

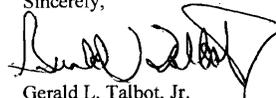
NNSA agrees with this recommendation. Just recently, CDNS has been able to obtain the necessary staffing to provide oversight to the extent called for by the DOE order. However, there is no clear exclusion of CDNS in the DOE Order 413.3A from oversight of facilities regulated by the Nuclear Regulatory Commission (NRC). However, we are working with the Department to have that exception inserted into the Order during the upcoming revision of the Order. Historically there was never an intention that CDNS would have responsibilities for facilities for which the NRC is the regulator. That needs to be clarified in the Order.

For your consideration, enclosed are other general/technical corrections and minor suggestions to the report.

**Appendix VI: Comments from the Department
of Energy**

If you have any questions concerning this response, please contact JoAnne Parker,
Acting Director, Policy and Internal Controls Management at 202-586-1913.

Sincerely,



Gerald L. Talbot, Jr.
Acting Associate Administrator
for Management and Administration

cc: Deputy Administrator for Defense Nuclear Nonproliferation
Senior Procurement Executive
Acting Director, Office of Independent Oversight, HSS
Office of Environmental Management

Enclosure

Appendix VII: Comments from the Nuclear Regulatory Commission



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 18, 2010

Mr. Eugene E. Aloise, Director
Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Aloise:

In response to your request on February 19, 2010, the U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the draft report entitled "Nuclear Nonproliferation: DOE Needs to Address Uncertainties with and Strengthen Independent Safety Oversight of Its Plutonium Disposition Program" (GAO-10-378), and provides the enclosed comments. The NRC appreciates the opportunity to review and comment on the draft report and looks forward to discussing any of the comments at your request. Please feel free to contact our staff regarding the draft report.

Sincerely,

A handwritten signature in black ink, appearing to read "R. W. Borchardt".

R. W. Borchardt
Executive Director
for Operations

Enclosure: As stated

Appendix VIII: GAO Contact and Staff Acknowledgments

GAO Contact

Gene Aloise, (202) 512-3841 or aloisee@gao.gov

Staff Acknowledgments

In addition to the individual named above, Daniel Feehan, Assistant Director; Steve Carter; Antoinette Capaccio; Tisha Derricotte; Jennifer Echard; Jason Holliday; and Ben Shouse made key contributions to this report.

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