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September 2019

NUCLEAR WASTE CLEANUP

DOE Faces Project Management and Disposal Challenges with High-Level Waste at Idaho National Laboratory

GAO-19-494

GAO Highlights

Highlights of GAO-19-494, a report to the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

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Why GAO Did This Study

Decades of defense activities at DOE's Idaho National Laboratory produced two forms of waste that EM has managed as HLW: liquid SBW and granular calcine waste. Under an agreement with the state, DOE must treat the waste to prepare it for removal from Idaho by 2035. Construction on the IWTU, EM's facility to treat such waste, was completed in 2012, but initial testing of the SBW treatment process revealed design problems. EM has since been working to reengineer the IWTU. Total project construction and reengineering expenditures have reached nearly $1 billion as of February 2019.

GAO was asked to review EM's efforts to treat and dispose of the SBW and calcine waste. This report examines (1) the extent to which EM's management of the IWTU follows selected project management best practices; (2) challenges EM faces in disposing of the SBW; and (3) challenges EM faces in treating and disposing of the calcine waste.

GAO reviewed agency documents and IWTU project data from March 2017 through February 2018, analyzed EM project management efforts against selected project management best practices for cost and schedule, and interviewed DOE officials.

What GAO Recommends

GAO is making five recommendations, including that DOE develop a strategy for the disposal of the waste. DOE generally agreed with all of these recommendations.

View GAO-19-494. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

The Department of Energy's (DOE) Office of Environmental Management (EM) has not fully followed selected project management best practices in managing the reengineering of the Integrated Waste Treatment Unit (IWTU), shown in the figure, to treat 900,000 gallons of liquid sodium-bearing waste (SBW) that must be solidified for disposal. EM's cost and schedule estimates for IWTU reengineering did not fully meet selected best practices for cost (i.e., did not account for all costs) and schedule estimates (e.g., did not have a valid critical path). For example, EM did not follow best practices for a comprehensive cost estimate because EM did not include both government and contractor costs over the entire project. As of February 2019, EM has experienced approximately $64 million in added costs and a more than 1-year delay in IWTU reengineering. Without fully following best practices for cost and schedule estimates, EM is at risk of future cost overruns and delays in meeting its target disposal milestones.

The Department of Energy's Integrated Waste Treatment Unit at Idaho National Laboratory

Source: Fluor-Idaho, LLC. | GAO-19-494

Based on GAO's review of EM documents, EM faces challenges with its plans for SBW disposal at its preferred disposal site, the Waste Isolation Pilot Plant (WIPP), an underground repository for waste contaminated by nuclear elements, near Carlsbad, New Mexico. These challenges include a statutory prohibition on the disposal of high-level waste (HLW) at WIPP. Further, EM does not have a strategy or timeline to address these challenges or to identify an alternative disposal pathway. Without such a strategy or timeline, EM risks not meeting its commitments with Idaho to prepare the SBW for removal from the state by 2035.

EM faces challenges implementing its selected technology to further treat 1.2 million gallons of granular calcine waste and selecting a potential waste disposal pathway. For example, DOE has identified challenges with retrofitting the IWTU for calcine waste treatment. As a result, EM is deferring further development of its plans to treat the calcine waste. EM officials said that the agency is making progress toward calcine waste disposal by testing options for removing the waste from its storage bins, a precursor to treating or packaging the waste for disposal. However, EM does not have a strategy or timeline for determining its next steps for the treatment and disposal of calcine waste. Such a strategy could help EM in seeking alternatives to its selected treatment technology and provide assurance that it will meet its commitments with Idaho for removing calcine waste from the state by the end of 2035.

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Abbreviations

DOE	Department of Energy
EM	Office of Environmental Management
EPA	Environmental Protection Agency
EVM	earned value management
HLW	high-level waste
INL	Idaho National Laboratory
IWTU	Integrated Waste Treatment Unit
PMRC	Project Management Risk Committee
RCRA	Resource Conservation and Recovery Act, as amended
SBW	sodium-bearing waste
WIPP	Waste Isolation Pilot Plant

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September 9, 2019

The Honorable Deb Fischer
Chairman
The Honorable Martin Heinrich
Ranking Member
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate

During the Cold War era, the U.S. government conducted a wide range of nuclear energy research and defense activities at the Department of Energy's (DOE) Idaho National Laboratory (INL) near Idaho Falls. Since the early 1990s, the state of Idaho has raised concerns about the potential for legacy waste from these activities to contaminate the Eastern Snake River Plain Aquifer,[1] which is situated beneath the INL site.[2] Two types of waste were of principal concern: (1) 900,000 gallons of sodium-bearing waste (SBW), a liquid waste that contains large quantities of sodium and other nitrates, and (2) 1.2 million gallons of calcine waste, a highly radioactive dried waste.[3] In a 1995 court-approved agreement between DOE and the state of Idaho (1995 settlement agreement), DOE agreed to treat the SBW to a solid form by December 31, 2012, and treat the SBW and the calcine waste so that it is ready for disposal outside of the state by a target date of 2035.[4] However, in the decades since DOE signed this and other agreements with the state of Idaho, DOE continues to struggle to meet the 2012 milestone.

[1]Legacy waste includes waste left over from weapons production and energy research.

[2]The aquifer stretches across south central Idaho and supplies irrigation water for roughly 900,000 acres of farmland and drinking water for nearly 200,000 residents.

[3]Calcine waste is the result of liquid waste that has undergone a thermal process that converted the liquid into a solid, granular substance.

[4]In October 1995, the state of Idaho, the U.S. Navy, and DOE reached agreement (most often called the Settlement Agreement), settling a lawsuit filed by the state to prevent shipment of spent nuclear fuel to INL for storage. The settlement agreement required DOE to treat the SBW using a process known as calcination; however, Idaho officials responsible for the oversight of the cleanup told us that the selection of an alternate treatment method for solidifying the waste was permitted after DOE determined that it could not complete the treatment of the SBW using calcination.

The Idaho Department of Environmental Quality monitors DOE's compliance with this and other agreements regarding cleanup milestones at INL. Within DOE, the Office of Environmental Management (EM), as part of its Idaho Cleanup Project, oversees the cleanup of radioactive and hazardous waste at INL, including SBW and calcine waste. EM manages both of these wastes as high-level waste (HLW) that also contains hazardous chemicals, which is referred to as mixed HLW.[5] In 2005, EM contracted for the design and construction of a facility known as the Integrated Waste Treatment Unit (IWTU) to treat the SBW and, following significant facility modifications, to treat the calcine waste for disposal.[6] EM stated in a 2005 Federal Register notice that its preferred disposal site for the solidified SBW is DOE's Waste Isolation Pilot Plant (WIPP), the nation's repository for defense-related transuranic waste located near Carlsbad, New Mexico.[7] EM also stated in a 2002 environmental impact statement that it plans to dispose of the calcine waste in a geologic repository once the waste has been treated to meet standards for land disposal.

[5]HLW is (1) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and (2) other highly radioactive material that the Nuclear Regulatory Commission determines, by rule, consistent with existing law, to require permanent isolation. The term mixed waste means waste that contains both (1) hazardous waste subject to Resource Conservation and Recovery Act and Environmental Protection Agency's implementing regulations or authorized state programs that operate in lieu of the federal program and (2) source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954.

[6]According to EM, the IWTU will treat liquid SBW to a solid form using steam-reforming—a process that EM describes as using superheated steam and other gases to convert the liquid waste to a granular solid in a fluidized bed reactor. Treatment of the SBW was included in EM's contract with C2HM-WG Idaho, LLC for the Idaho Cleanup Project, a 7.5-year contract awarded in 2005. EM later extended this contract for an additional 3 years.

[7]The word transuranic is used for elements that have atomic numbers greater than that of uranium. Transuranic waste is defined in the Waste Isolation Pilot Plant Land Withdrawal Act as waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 C.F.R. pt. 61. Pub. L. No. 102-579, § 2(20), 106 Stat. 4777, 4779 (1992). Transuranic waste typically consists of discarded rags, tools, equipment, soil, or other solid materials that have been contaminated by certain man-made radioactive elements, particularly plutonium. EM identified WIPP as its preferred disposal site for the SBW in a 2005 Record of Decision document; 70 Fed. Reg. 75165 (Dec. 19, 2005).

EM expended $571 million from December 2006 through April 2012 to develop and construct the IWTU to treat the SBW, at which point the agency declared construction complete and transitioned the management of the IWTU from a capital asset project to an operations activity.[8] However, during system testing of the facility in June 2012, the IWTU experienced a malfunction that damaged equipment and revealed problems with the facility's design and inadequate oversight and management systems, according to DOE and contractor reports. As a result, as of June 2019, EM had not started IWTU operations to treat waste as planned. The DOE Office of Inspector General in 2016 found that significant lapses in DOE's project management contributed to problems with the facility.[9]

Since 2012, EM has been attempting to prepare the IWTU to treat the SBW to meet its commitments to the state of Idaho. In 2016, EM awarded its multiyear contract for the Idaho Cleanup Project to Fluor Idaho, LLC.[10] As part of the contract, EM adopted a four-phased approach that Fluor Idaho proposed called the IWTU Resolution of Technical Issues Project (the IWTU reengineering project). The four phases are (1) identifying problems, (2) implementing changes, (3) confirming fixes through testing, and (4) conducting performance testing using a small amount of radioactive waste. Under this approach, the cost and schedule of each phase were to be determined based on the results of the previous phase, according to EM officials with the Idaho Cleanup Project.

[8]EM divides its cleanup work into capital asset projects and cleanup activities. According to DOE's order governing the management of capital asset projects—DOE Order 413.3B—a capital asset project is a project with defined start and end points required in the acquisition of capital assets. Operations activities are reoccurring facility or environmental operations as well as activities that are project-like, with defined start and end dates, according to EM policies.

[9]Department of Energy, Office of Inspector General, *Management of the Startup of the Sodium-Bearing Waste Treatment Facility*, DOE-OIG-16-09 (Washington, D.C.: Mar. 30, 2016).

[10]DOE awarded the Idaho Cleanup Project Core contract to Fluor Idaho in 2016 with a period of performance of 5 years at a value of $1.4 billion (including options). That contract included an option to operate the IWTU; DOE subsequently modified this contract to require Fluor Idaho to make the IWTU fully operational. According to DOE documents and officials, the IWTU was expected to be operational before Fluor Idaho began work under its contract; however, the former contractor was unable to resolve the ongoing technical issues with the IWTU by the time of the contract turnover.

From April 2012 through February 2019, EM expended $416 million toward getting the facility to begin treating waste as planned. As of March 2019, the project was in phase two, and EM officials with the Idaho Cleanup Project estimated that phase three may begin in summer 2019, and phase four in early 2020. Through February 2019, construction and operations expenditures for the IWTU have reached nearly $1 billion. Further, because EM missed a deadline to initiate treatment of the SBW in the IWTU and deadlines in the 1995 settlement agreement, DOE is prohibited from shipping spent nuclear fuel to INL and is required to pay the state of Idaho financial penalties that have reached $6,000 per day.[11] Through June 2019, DOE had accrued financial penalties of $6.2 million,[12] and these penalties will continue to accrue until DOE initiates waste treatment in the IWTU.

We have previously reported that EM faces substantial future cleanup costs and has decades of additional work remaining at contaminated DOE sites, such as at INL. DOE's total environmental liability grew to $494 billion in fiscal year 2018 and represents the largest share of the federal government's environmental liability (86 percent).[13] Because of substantial and increasing estimated cleanup costs like this, we have included the federal government's environmental liability on our list of agencies and program areas that are at high risk of fraud, waste, abuse, and mismanagement or that are most in need of transformation.[14] Further, we have also previously found problems with EM's management

[11]Since DOE missed the December 31, 2012, deadline in the 1995 settlement agreement for treating the liquid SBW to a solid form, all DOE spent nuclear fuel shipments to INL have been suspended. DOE is continuing to accrue daily penalties for failing to initiate treatment of the SBW in the IWTU by the deadline in an amended 1992 Consent Order, which have now reached $2,000 per tank per day, or $6,000 total per day. In addition, DOE also incurred a onetime financial penalty of $648,000 for failing to cease using the tanks storing the SBW by December 31, 2014, as required by the amended 1992 Consent Order DOE entered into with the Idaho Department of Environmental Quality.

[12]According to Idaho Department of Environmental Quality officials, penalties to the state have been paid as a combination of cash and supplemental environmental projects.

[13]According to DOE's fiscal year 2018 financial statement, efforts to treat and dispose of the SBW waste at INL contribute to the department's environmental liability.

[14]GAO, *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas*, GAO-19-157SP (Washington, D.C.: Mar. 6, 2019).

of capital asset projects and operations activities.[15] DOE's management of projects and contracts has been on our high-risk list since 1990 because DOE's record of inadequate project management and oversight of contractors has left the department vulnerable to fraud, waste, abuse, and mismanagement. In our February 2019 high-risk report, we note that while DOE has made some progress toward addressing its challenges with contract and project management, EM needs to take action to understand the root causes of its challenges and incorporate program and project management best practices into its policies.[16]

You asked us to review EM's efforts to treat and dispose of the SBW and calcine waste at INL. This report examines (1) the extent to which EM's management of the IWTU reengineering project follows selected project management best practices; (2) the challenges, if any, EM faces in the disposal of the SBW; and (3) the challenges, if any, EM faces in the treatment and disposal of the calcine waste.

To address all three objectives, we visited INL in December 2017 to obtain documentation and interview officials from EM, which exercises its responsibility for the hazardous waste cleanup at INL through its Idaho Cleanup Project. We also interviewed representatives at INL from Fluor Idaho, LLC, EM's current contractor for the cleanup of both the SBW and calcine waste at the site. Further, we visited Hazen Research, Inc., a subcontractor to Fluor Idaho, to observe pilot testing facilities for the IWTU reengineering project and discuss the status of the project with an EM Idaho Cleanup Project official and representatives from Hazen Research, Inc., and Fluor Idaho.[17]

[15]Other examples of EM capital asset projects that have encountered problems include the Waste Treatment Plant at the Hanford Site and the Salt Waste Processing Facility at the Savannah River Site, facilities that EM is building to process liquid radioactive waste stored in tanks at these sites. See, for example, GAO, *Hanford Waste Treatment Plant: DOE Needs to Take Further Actions to Address Weaknesses in Its Quality Assurance Program*, GAO-18-241 (Washington, D.C.: Apr. 24, 2018), and *Nuclear Waste: Actions Needed to Address Persistent Concerns with Efforts to Close Underground Radioactive Waste Tanks at DOE's Savannah River Site*, GAO-10-816 (Washington, D.C.: Sept. 14, 2010).

[16]GAO-19-157SP.

[17]Hazen Research, Inc., is an industrial research and development firm located in Golden, Colorado.

To assess the extent to which EM's management of the IWTU reengineering project follows selected project management best practices, we selected project management best practices related to developing project cost and schedule estimates and project monitoring, such as through the use of an earned value management (EVM) system and independent reviews.[18] We selected these best practices because they have been identified as being central to DOE's management of projects from our previous work as well as included in the Project Management Institute's *A Guide to the Project Management Body of Knowledge—Sixth Edition*.[19] To assess the IWTU reengineering project's cost estimate, we compared EM's estimates for phases one and two of the reengineering project to best practices from GAO's Cost Estimating and Assessment Guide (cost guide), focusing on the comprehensiveness characteristic.[20] To assess the IWTU reengineering project's schedule estimate, we compared EM's March 2018 integrated master schedule for the project to best practices from GAO's *Schedule Assessment Guide* (schedule guide), focusing on the well-constructed and comprehensive characteristics.[21] To assess EM's monitoring of the project, we used our

[18]EVM is an industry standard and is considered a best practice for conducting cost and schedule performance analysis for projects. It measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for the period and with the actual cost of the work accomplished.

[19]The Project Management Institute is a not-for-profit association that provides global standards for, among other things, project and program management. These standards are used worldwide and provide guidance on how to manage various aspects of projects, programs, and portfolios. *PMBOK* is a trademark of the Project Management Institute. Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide),* Sixth Edition, 2017.

[20]Of the four characteristics discussed in our cost guide, we focused on the characteristic for the comprehensiveness of the cost estimate because, according to our cost guide, if a cost estimate is not comprehensive—that is, not complete—then it cannot fully meet the other best practice characteristics. GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009). Further, we reviewed estimates that EM provided for phases one and two of the reengineering project as they were the only estimates available for the project at the time. EM also provided a cost estimate for the treatment of SBW in the IWTU; however, EM officials told us that this aspect of the contract was likely to be renegotiated.

[21]We selected best practices related to the well-constructed characteristic because, according to GAO's schedule guide, if the schedule is not well-constructed, it will not allow sufficient understanding of the program as a whole. We also assess the comprehensive characteristic as it is needed to evaluate an EVM system. GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: December 2015). According to our schedule guide, an integrated master schedule incorporates all activities—those of the contractor and government—necessary to complete a program.

cost guide to assess data from EM's EVM system for the IWTU reengineering project from March 2017 through February 2018, which included phases one and two of the project.[22] Lastly, to assess the extent to which DOE has conducted independent reviews of the IWTU reengineering project, we reviewed DOE's policy related to reviews of projects with commissioning or start-up risks and documentation that EM's Idaho Cleanup Project prepared for these reviews.[23]

To examine challenges EM faces in the disposal of the SBW, we reviewed federal laws, regulations, and DOE's order and manual for radioactive waste management.[24] We also reviewed documentation related to EM's plans for the disposal of the SBW, such as environmental impact statements. We interviewed DOE officials from its Office of the General Counsel, EM's Office of Regulatory Compliance, EM's Office of Nuclear Materials, EM's Office of Waste and Materials Management, and EM's Idaho Cleanup Project. We also conducted interviews with officials from Idaho's Department of Environmental Quality and New Mexico's Environment Department, as well as representatives from two environmental advocacy groups, to obtain their perspectives on the challenges facing EM's SBW disposal efforts.

To examine challenges EM faces in the treatment and disposal of the calcine waste, we reviewed laws, regulations, and DOE documents, including a 2016 analysis of alternatives report on calcine waste treatment and disposal.[25] We also interviewed officials from EM's Idaho Cleanup Project and Office of Nuclear Materials, contractor representatives from Fluor Idaho, and officials from the Environmental

[22]For our assessment of selected best practices related to EM's cost and schedule estimates, and best practices for an EVM system, we applied the following scoring system: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

[23]Department of Energy, Deputy Secretary of Energy, *Memorandum: "Operational Release" Milestone for DOE Projects* (Washington, D.C.: Aug. 11, 2016).

[24]Department of Energy, *Radioactive Waste Management*, DOE Order 435.1 (Washington, D.C.: January 2007). Department of Energy, *Radioactive Waste Management Manual*, DOE Manual 435.1-1 (Washington, D.C.: June 2011).

[25]Department of Energy, *Independent Analysis of Alternatives for Disposition of the Idaho Calcined High-Level Waste Inventory* (Washington, D.C.: April 2016).

Protection Agency (EPA) responsible for implementing the Resource Conservation and Recovery Act, as amended (RCRA).[26] Additional details on our objectives, scope, and methodology can be found in appendix I.

We conducted this performance audit from September 2017 to September 2019 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

This section provides an overview of (1) the legal framework governing mixed HLW, (2) the status of EM's IWTU reengineering project, (3) EM's requirements for capital asset projects and operations activities, (4) DOE's policy for the review of projects with start-up risks, and (5) our best practices for assessing cost and schedule estimates.

Legal Framework Governing Mixed HLW

The treatment and disposal of mixed HLW at INL is governed by a number of federal laws that define the roles of federal agencies and states in managing mixed HLW, as well as cleanup agreements among DOE, the state of Idaho, and other parties. DOE primarily regulates radioactive components of HLW under the Atomic Energy Act of 1954, as amended,[27] and the Nuclear Waste Policy Act of 1982, as amended.[28] These acts define HLW as (1) the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and (2) other highly radioactive material that the Nuclear Regulatory Commission determines by rule, consistent with existing law, requires permanent isolation. DOE considers calcine waste HLW

[26]RCRA was enacted in 1976 to establish a framework for managing hazardous waste from its generation to final disposal.

[27]Pub. L. No. 83-703, 68 Stat. 919 (1954) (*codified as amended at generally* 42 U.S.C. §§ 2011 to 2297g-4).

[28]Pub. L. No. 97-425, 96 Stat. 2201 (1983) (*codified as amended at generally* 42 U.S.C. §§ 10101-10270).

because it is solidified liquid waste produced during the reprocessing of spent nuclear fuel. EM manages the SBW as mixed HLW because, according to reports from DOE and National Academies, [29] (1) the SBW was produced in the later stages of spent nuclear fuel reprocessing,[30] (2) the tanks in which the SBW is stored previously held HLW, (3) the SBW is stored in a location at INL where waste is managed as HLW, and (4) the waste contains hazardous chemicals subject to RCRA and EPA's implementing regulations or authorized state programs that operate in lieu of the federal program. HLW must be disposed of in a geologic repository unless the Nuclear Regulatory Commission approves an alternative disposal site.

DOE Order 435.1 and Manual 435.1-1 describe the department's policy and requirements for managing DOE's radioactive waste, including HLW, to ensure that it is managed in a manner that is protective of worker and public health and safety and the environment. Manual 435.1-1 also established processes to determine whether waste resulting from reprocessing spent nuclear fuel can be managed as transuranic waste or low-level waste if certain criteria are met, which is referred to as a determination that the waste is incidental to reprocessing.[31] According to the manual, HLW is waste incidental to reprocessing if, among other things, the waste has been processed, or will be processed, to remove key radionuclides to the maximum extent technically and economically practicable.

Hazardous components of mixed HLW are regulated by EPA or authorized states under RCRA. EPA's regulations require hazardous waste to meet certain treatment standards before land disposal of the

[29]National Research Council, *Alternative High-Level Waste Treatments at the Idaho National Engineering and Environmental Laboratory* (Washington, D.C.: 1999). The National Research Council is part of the National Academies of Sciences, Engineering, and Medicine.

[30]According to a Nuclear Regulatory Commission document, the reprocessing of spent nuclear fuel at INL involved several stages. Spent nuclear fuel was first dissolved, producing an acidic water-based solution, which was then processed through a first-cycle extraction system to separate uranium (or first-cycle extraction waste) from the bulk of the fission products. Finally, the separated uranium was processed through second- and third-cycle extraction systems to remove residual radioactive materials.

[31]Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material. DOE Manual 435.1-1.

waste unless a variance is granted.[32] The regulations specify that the treatment standard (i.e., the required method for treatment) for Idaho's mixed HLW is vitrification—the immobilization of waste in glass.[33] Where EPA has authorized states to implement hazardous waste management programs, those state programs operate instead of the federal program. EPA, under RCRA, has authorized the state of Idaho to administer its own hazardous waste management program. EPA has also authorized New Mexico to administer its own hazardous waste management program. Pursuant to such authorization, New Mexico's Environment Department issues the permit for hazardous waste storage and disposal at WIPP under the New Mexico Hazardous Waste Act.

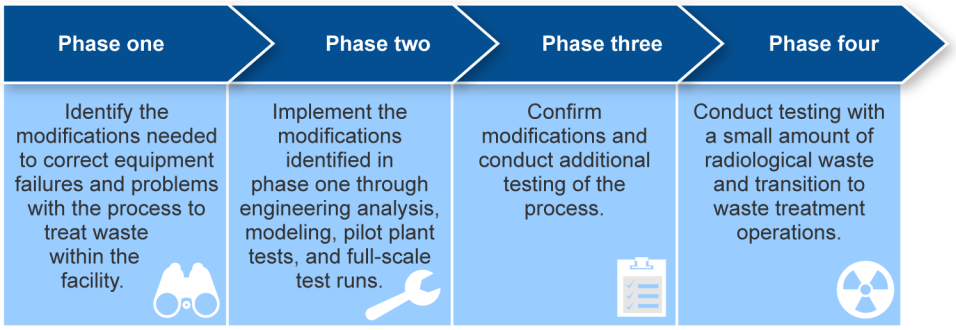
Status of IWTU Reengineering Project

As of March 2019, EM's IWTU reengineering project was in phase two of the four-phased approach to get the facility operational, according to EM Idaho Cleanup Project officials. According to project reports, phase one focused on identifying fixes to resolve problems with the facility's equipment and waste treatment process, for example, by performing engineering analyses and chemistry studies. Phase two has focused on implementing these fixes, for example, by modifying a piece of equipment that separates solidified waste before it is moved to storage canisters, according to the contractor's project plan. Figure 1 summarizes the four-phased approach for the IWTU reengineering project.

[32]The RCRA treatment standards do not apply to transuranic mixed waste designated and accepted for disposal at WIPP. Waste Isolation Pilot Land Withdrawal Amendment Act, Pub. L. No. 104-201, tit. XXXI, subtit. F, § 3188(a), 110 Stat. 2422, 2853 (1996). The act does not affect the applicability of other RCRA requirements to transuranic mixed waste. Treatment standards are expressed as either numerical standards or required methods of treatment. For the purpose of this report, we use the term variance to include national capacity and site-specific variances, treatability variances, determinations of equivalent treatment, and no migration petitions.

[33]Specifically, radioactive high level wastes generated during the reprocessing of fuel rods and displaying certain hazardous characteristics is subject to the vitrification treatment standard. 40 C.F.R. § 268.40, "Treatment Standards for Hazardous Wastes" Table.

Figure 1: Phased Approach for the Department of Energy's (DOE) Integrated Waste Treatment Unit Reengineering Project



Source: GAO analysis of DOE documents. | GAO-19-494

According to EM documents, as of February 2019 total expenditures on phases one and two were approximately $150 million, about $64 million more than original costs estimated for those two phases combined, and the project was over 1 year behind schedule. Phase two has taken longer and cost more than initially estimated because of additional problems and required modifications to the facility as the work has progressed, according to EM Idaho Cleanup Project officials.[34] Appendix II provides information on the actual costs of phases one and two compared to estimated costs. As previously noted, EM officials with the Idaho Cleanup Project estimated in March 2019 that phase three may begin in summer 2019. Further, these officials stated that phase three will involve a 6-month outage to continue implementing changes to the facility prior to the start of a 60-day performance test using a simulated waste form. EM Idaho Cleanup Project officials stated that phase four could begin in early 2020 and that EM and Fluor Idaho had yet to determine whether an outage would need to occur before starting testing with a small amount of the SBW.

EM's Requirements for Capital Asset Projects and Operations Activities

EM divides its cleanup work into capital asset projects and operations activities, two types of activities governed by different applicable project management policies:

- **Capital asset projects.** DOE Order 413.3B governs EM's program and project management activities for the acquisition of capital assets,

[34]These modifications included the development and construction of a manway portal into the main process vessel.

with the stated goal of delivering fully capable projects within the planned cost, schedule, and performance baseline.[35] The order establishes five critical decision points of project development that each end with a major approval milestone that cover the life of a project. The order specifies requirements that must be met, including developing and managing project cost and schedule estimates to move a project past each critical decision milestone. EM capital asset projects include construction projects and cleanup projects, such as soil and water remediation and facility decommissioning and demolition.

- **Operations activities.** Operations activities are recurring facility or environmental operations, as well as activities that are project-like, with defined start and end dates, according to EM policy.[36] EM operations activities include operating waste processing facilities and the stabilization, packaging, transportation, and disposition of nuclear waste. EM manages operations activities based on requirements listed in a cleanup policy that it issued in July 2017.[37] In February 2019, we found that EM cleanup site managers have discretion in how to classify cleanup work because DOE and EM have not established requirements on what work should be managed as an operations activity under EM's cleanup policy or as a capital asset project under DOE Order 413.3B.[38] Further, we found that operations activities have less stringent management requirements than capital asset projects. We recommended that EM establish requirements for classifying work as an operations activity and revise its cleanup policy to follow program and project management leading practices. DOE generally agreed with our recommendations.

[35]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010).

[36]Department of Energy, Office of Environmental Management, *Policy and Protocol for Office of Environmental Management Operations Activities* (Washington, D.C.: Feb. 28, 2012).

[37]Department of Energy, Office of Environment Management, *Requirements for Management of the Office of Environmental Management's Cleanup Program* (Washington, D.C.: July 20, 2017). EM also uses additional guidance listed in standard operating policies and procedures that provide more detail on how EM should implement the requirements outlined in the 2017 cleanup policy.

[38]GAO, *Nuclear Waste Cleanup: DOE Could Improve Program and Project Management by Better Classifying Work and Following Leading Practices*, GAO-19-223 (Washington, D.C.: Feb. 19, 2019)

Beginning in January 2005, EM managed the development and construction of the IWTU facility as a capital asset project. Once EM determined that construction on the facility was complete in April 2012, the project exited the capital asset oversight process established in DOE Order 413.3B and has since been managed as an operations activity, according to EM Idaho Cleanup Project officials. DOE officials also told us that the IWTU reengineering project has been managed as an operations activity because the facility has been constructed and is now in a period of maintenance and repair.[39] Figure 2 shows a picture of the exterior of the IWTU facility.

Figure 2: Exterior of the Department of Energy's (DOE) Integrated Waste Treatment Unit at Idaho National Laboratory

Source: Fluor-Idaho, LLC. | GAO-19-494

DOE's Policy for the Monitoring of Projects with Start-up Risks

In August 2016, DOE's Deputy Secretary of Energy issued a memorandum[40] establishing a new oversight requirement for selected projects for which an extended period of transition to operations is likely—the phase after construction is complete but before full operational

[39]According to Office of Management and Budget Circular No. A-11, capital assets include not only the assets as initially acquired but also additions, improvements, modifications, replacements, rearrangements and reinstallations, and major improvements. Ordinary repairs and maintenance are not considered capital asset projects.

[40]Department of Energy, Deputy Secretary of Energy, *Memorandum: "Operational Release" Milestone for DOE Projects*.

capability is attained—called the operational release milestone.[41] According to the memorandum, DOE created the operational release milestone in the department's project life cycle to provide additional oversight after the completion of the project under DOE's Order 413.3B.[42] DOE officials from the Office of Project Management stated that the operational release milestone was largely created in response to EM's experience with the IWTU facility not operating as expected. Under these new requirements, program offices are to provide DOE's Project Management Risk Committee (PMRC) with regular updates on selected projects until full operational capability of each facility is attained.[43] Specifically, program offices are required to (1) develop and execute a plan that describes how the program will reach operational capability, which is referred to as an operational release plan, and (2) provide progress updates to the PMRC on the project, as described below.

- **Operational release plan.** Officials from DOE's Office of Project Management—which serves as the secretariat for the PMRC—stated that the purpose of the operational release plan is for the program office to describe what steps are required for the project to reach its operational capability. According to EM's guidance, the operational release plan should present the key processes, activities, interrelationships, risks, management and oversight, decision milestones and approvals, and overall schedule to achieve operational release.

[41]Officials from DOE's Office of Project Management told us that program offices are responsible for identifying projects to be included for review in the operational release milestone. In addition to the IWTU, EM has determined that this new project management milestone would apply to the Salt Waste Processing Facility at the Savannah River Site in South Carolina and certain components of the Waste Treatment and Immobilization Plant at the Hanford Site in Washington.

[42]As of the update to DOE Order 413.3B in April 2018, the department had yet to incorporate this milestone into the project management life cycle defined under the order. DOE officials from the Office of Project Management told us in October 2018 that the department plans to incorporate the requirements for the operational release memorandum in the order in its next revision.

[43]DOE's PMRC was established in 2014 to review and provide advice on capital asset projects with a total project cost of $100 million or more, according to DOE documents. Its purpose is to reduce the risks associated with projects across DOE and advise senior leaders on project management, including on project cost, schedule, and technical issues. The committee includes nine senior DOE officials from across the department, including top project management officials from the National Nuclear Security Administration, the Office of Science, and EM. The PMRC is supported by DOE's Office of Project Management, which serves as the executive secretariat for the committee.

- **Progress updates.** According to the memorandum and the PMRC's standard operating procedures, program offices are to provide the PMRC with quarterly progress updates on selected projects, including lessons learned, until full operational capability is attained.

GAO's Best Practices for Developing Cost and Schedule Estimates

The GAO's cost guide and schedule guide compiled best practices corresponding to the characteristics of high-quality and reliable cost and schedule estimates.[44] According to the cost guide, a high-quality, reliable cost estimate has four characteristics: comprehensive, well-documented, accurate, and credible. A comprehensive cost estimate has enough detail to ensure that cost elements are neither omitted nor double-counted. If a cost estimate is not comprehensive (that is, complete), then it cannot fully meet the other characteristics (i.e., well-documented, accurate, or credible). In addition, according to the schedule guide, a high-quality, reliable schedule has four characteristics: comprehensive, well-constructed, controlled, and credible. A comprehensive schedule captures all government and contractor activities necessary to accomplish a project's objectives, and a well-constructed schedule sequences all activities using the most straightforward logic possible. If a schedule is not comprehensive, with all activities accounted for, it is uncertain whether all activities are scheduled in the correct order, resources are properly allocated, missing activities will appear on the critical path, or a schedule risk analysis can account for all risk. If a schedule is not well-constructed, it will not be able to properly calculate dates and predict changes in the future, among other things.

[44]GAO-09-3SP and GAO-16-89G.

EM Has Not Fully Followed Selected Best Practices for Cost and Schedule Estimates, and Unreliable Data May Limit EM's Ability to Measure Performance

EM has not fully followed selected project management best practices for cost and schedule estimates for the IWTU reengineering project. EM generally followed best practices for a reliable EVM system to measure the performance of the reengineering project. However, in analyzing IWTU reengineering project data from March 2017 through February 2018, we found that the system is producing unreliable data, which may limit EM's ability to measure the project's performance. Further, EM has taken some steps toward meeting requirements under DOE's process for monitoring projects with start-up risks.

EM Has Not Fully Followed Selected Best Practices for Cost and Schedule Estimates for the IWTU Reengineering Project

EM has not fully followed (i.e., has partially met) selected best practices in developing the cost and schedule estimates we reviewed for phases one and two of the IWTU reengineering project and future planned IWTU operations.[45] We made the following observations based on our analysis of these cost estimating documents and a March 2018 project schedule:

- **Comprehensive cost estimate (partially met):** EM partially met best practices for a comprehensive cost estimate. According to our cost guide, a comprehensive cost estimate should reflect the project's technical requirements and current schedule and account for all possible costs.[46] While the cost estimate was based on documented technical information, it was not based on a standardized work breakdown structure.[47] Without a standard, product-oriented work

[45]The ratings we used in these analyses are as follows: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

[46]GAO-09-3SP.

[47]A work breakdown structure deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. According to our cost guide, establishing a product-oriented work breakdown structure is a best practice because it allows a program to track cost and schedule by defined deliverables, such as a hardware or software component. This allows a program manager to more precisely identify which components are causing cost or schedule overruns and more effectively mitigate root causes.

breakdown structure to facilitate the tracking of resource allocations and expenditures, EM may not be able to reliably estimate the cost of future similar programs. While assumptions are listed in EM's documents describing the cost estimates, no document discusses whether the assumptions came from inputs from technical subject matter experts or whether the assumptions are associated with specific risks. Since assumptions are best guesses, best practices state that the risk associated with any of these assumptions changing need to be identified and assessed.

Further, the IWTU reengineering project's cost estimate was not complete because it did not account for all possible costs. According to our cost guide, a life cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. The project's cost estimate did not reflect all life cycle costs, in part because estimates for phases three and four of the project had not been developed at the time of our review. Best practices state that all costs be included in an estimate, even in early stages, such as at a rough order of magnitude.[48] EM officials from the Idaho Cleanup Project said that a cost estimate was not developed for the total cost of the IWTU reengineering project because of the approach for negotiating the cost and schedule baseline prior to the start of each phase. Without developing a cost estimate for the IWTU reengineering project that is comprehensive (e.g., accounts for all possible costs), EM will not have reasonable assurance that it can successfully plan program resource requirements.

- **Well-constructed schedule estimate (partially met):** EM partially met best practices for a well-constructed schedule. According to our schedule guide, a well-constructed schedule includes activities that are logically sequenced; a valid critical path; and a reasonable amount of total float, meaning an accurate reflection of the schedule's

[48]According to our cost guide, a rough order of magnitude estimate—a quick, high-level cost estimate—may be developed when a quick cost estimate is needed and few details are available. Usually based on historical ratio information, a rough order of magnitude estimate can be developed for a particular phase or portion of an estimate to the entire cost estimate, depending on available data. GAO-09-3SP.

flexibility.[49] EM's March 2018 schedule had minimal sequencing issues and a continuous critical path, with the exception of an external dependency, and the critical path was free of lags and constraints.[50] However, there were long duration activities on the critical path that should be reevaluated to determine if they can be broken into more manageable pieces. Without a valid critical path, management cannot focus on activities that will detrimentally affect the key program milestones and deliveries if they slip. Additionally, the schedule estimate included unreasonably large values of positive and negative float. According to best practices, a schedule should identify reasonable values of float so that the schedule's flexibility can be determined to help accommodate for delays. EM officials from the Idaho Cleanup Project explained that the amount of total float was a result of the methods they used to structure the logic of the schedule estimate, which according to our best practices may have caused the schedule to be overly optimistic. According to scheduling best practices, without accurate values of total float, the schedule cannot be used to identify activities that could be permitted to slip and thus release and reallocate resources to activities that require more resources to be completed on time. Inaccurate values of total float also falsely depict true program status, which could lead to decisions that may jeopardize the program. In addition, the March 2018 schedule contained 14 activities with large amounts of negative float, meaning that these activities were behind schedule. Without fully developing a well-constructed schedule estimate for the IWTU reengineering project, EM will not have reasonable assurance that it

[49]Float represents the level of flexibility in a schedule. According to our schedule guide, float may be positive, negative, or zero. Positive float indicates the amount of time that an activity can be delayed without delaying a project's finish date. Negative float indicates the time that must be recovered so as not to delay the project's finish date beyond the constrained date. Zero float means that any amount of activity delay will delay the program's finish date by an equal amount. Without accurate values of float, management cannot use the schedule to identify activities that could be permitted to slip and thus release and reallocate resources to activities that require more support to be completed on time. GAO-16-89G.

[50]Lags are used in a schedule to denote the passing of time between two activities. According to our schedule guide, lags cannot be assigned resources and should not represent work. Lags simply delay the successor activity, and no effort or resources are associated with them. Constraints are generally used to demonstrate an external event's effect on a schedule. However, according to our schedule guide, because they prevent activities from responding dynamically to network logic, including actual progress and availability of resources, lags can affect float calculations and the identification or continuity of the critical path and can mask progress or delays in the schedule.

can successfully achieve its plans to reengineer the IWTU and begin treatment of the SBW without further delays.

- **Comprehensive schedule estimate (substantially met):** EM substantially met best practices for a comprehensive schedule. According to our schedule guide, a comprehensive schedule includes all activities for both the government and its contractors to accomplish their objective, assigns resources (e.g., labor and materials) to all activities, and establishes how long each activity will take. EM's March 2018 schedule substantially captured all activities, but it may not have been planned to the level of detail for the work necessary to accomplish a program's objectives as defined in the program's work breakdown structure. For example, the schedule had activities that were described as level of effort but were not assigned the level of effort activity type. Level of effort activities represent effort that has no measurable output and, according to best practices, should be clearly marked so they do not interfere with the critical path. Further, the schedule substantially met the best practice of assigning resources to all activities. For example, the schedule assigned resources to specific materials and equipment as well as to travel, training, and labor.

Appendix II contains the full results of our analysis of selected best practices for the cost and schedule of the IWTU reengineering project.

As previously noted, EM is managing the IWTU reengineering project as an operations activity. We reported in February 2019 that EM manages operations activities using less stringent requirements than those used for capital asset projects, posing cost and schedule risks.[51] For example, under EM's 2017 cleanup policy, there is no requirement for operations activities to follow best practices for cost estimates developed during contract execution. We recommended that EM review and revise its 2017 cleanup policy to include project management leading practices related to scope, cost, schedule performance, and independent reviews. DOE concurred with our recommendation and stated that EM was already in the process of reviewing its policy for necessary updates, revisions, and modifications, and that EM would consider our recommendation, as appropriate, during this process.

[51]GAO-19-223.

EM officials with the Idaho Cleanup Project acknowledged that they do not have an estimate for the total cost or a completion date for the IWTU reengineering project or a schedule for when waste treatment operations will begin and be completed. An EM Idaho Cleanup Project official told us that Fluor Idaho submitted cost and schedule estimates for phases three and four of the reengineering project in January 2019 and that EM requested an independent cost estimate for this work from the Defense Contract Audit Agency, with contract negotiations between EM and Fluor Idaho for these phases estimated to begin in spring 2019.[52] In addition, EM officials from the Idaho Cleanup Project acknowledged that a schedule for waste treatment operations at the project has not been developed. Further, these officials noted that design modifications to the IWTU are expected to reduce its operating capability, lengthening the time needed to treat the SBW. As a result, EM and Fluor Idaho plan to renegotiate the cost of their contract related to the treatment of the waste in the project, according to EM Idaho Cleanup Project officials. Specifically, because of the modifications to the project, the rate at which the SBW is treated will be slower than initially estimated, according to EM officials from the Idaho Cleanup Project. Treatment of all 900,000 gallons of the SBW was originally estimated to be completed in 10 months, but agency officials now estimate that treatment may take from 3 to 7 years—as much as eight times longer than originally planned. As previously noted, EM has already experienced approximately $64 million in added costs and, as of February 2019, a delay of over 1 year. Without fully following best practices for a comprehensive cost estimate and well-constructed schedule estimate for SBW waste treatment operations, EM cannot be assured that it has reliable cost and schedule estimates for decision-making, placing it at risk of continued cost overruns and delays in achieving its plans to reengineer the IWTU and begin treatment of the SBW.[53]

[52]These new estimates were not finalized in time to be considered for this report.

[53]According to our cost guide, without reliable cost estimates, agencies are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls. GAO-09-3SP.

EM Generally Followed Best Practices for Measuring Project Performance and Has Taken Some Steps toward Meeting Requirements for Monitoring the IWTU Reengineering Project

EM's EVM System for the IWTU Reengineering Project Generally Followed Best Practices, but Unreliable Data May Limit EM's Ability to Measure Performance

We analyzed IWTU reengineering project data for March 2017 through February 2018 from EM's EVM system and found that while EM has followed (i.e., fully met or substantially met) some best practices for a reliable EVM system, the system is producing unreliable data.[54] These unreliable data may limit EM's ability to measure the project's performance. EVM is a management tool used to measure the value of work accomplished in a given period and compare it with the planned value of work scheduled for the same period and with the actual cost of the work accomplished. EVM data can alert project managers to potential problems sooner than expenditures alone can, and EVM's use as a management tool is considered a best practice for conducting cost and schedule performance analysis for projects, according to our cost guide.[55] EM requires the use of an EVM system under its contract with Fluor Idaho for the Idaho Cleanup Project.[56]

Overall, we found that EM followed best practices to ensure that its EVM data for the IWTU reengineering project were (1) comprehensive and (2) used by leadership for decision-making. However, EM did not follow (i.e., partially met) best practices to ensure that the data resulting from the EVM system are reliable. Specifically:

[54]The ratings we used in this analysis are as follows: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

[55]GAO-09-3SP.

[56]Our analysis of EM's EVM data was specific to data for the IWTU reengineering project from March 2017 to February 2018 and did not include a review of the EVM system for the entire Idaho Cleanup Project, which EM's contractor, Fluor Idaho, manages.

- EM **substantially met** best practices for a comprehensive EVM system by, for example, requiring the contractor's EVM system to comply with the guidelines established by the Earned Value Management Systems EIA-748-D Intent Guide;[57] EM conducted a compliance review of Fluor Idaho's EVM system in March 2017 and found some areas in need of improvement.[58] In addition, EM has an EVM surveillance system in place under its contract with Fluor Idaho, and EM officials from the Idaho Cleanup Project stated that they review data from the EVM system each month.
- EM **substantially met** best practices ensuring that leadership uses the EVM data for decision-making. For example, Fluor Idaho updated data in its EVM system monthly during the period we reviewed, and EM reported issues in a monthly review briefing between EM and the contractor, according to EM Idaho Cleanup Project officials. Agency management also tracked the causes of cost and schedule variances in the data. However, the monthly reports did not contain all the information that best practices recommended. Specifically, the performance measurement baseline was not included in the contractor performance reports provided, so we could not determine how the performance measurement baseline changed as the project evolved.[59]
- EM **partially met** best practices ensuring that the EVM system provides reliable data because, for instance, the system contained numerous anomalies, leading the system to produce unreliable data. Specifically, we found one or more anomalies present in all months of data reviewed, such as missing or negative values. While EM was able to explain the causes for most of these anomalies, negative

[57]The Earned Value Management Systems EIA-748-D Intent Guide was created by the National Defense Industrial Association, Integrated Program Management Division in August 2018 for organizations to be able to evaluate the quality of an EVM system to determine the extent to which cost, schedule, and technical performance data can be relied on for program management purposes. These guidelines are best practices that provided a scalable approach to using EVM for any contract type, contract size, and duration. They consist of 32 guidelines in five categories: (1) organization; (2) planning, scheduling, and budgeting; (3) accounting considerations; (4) analysis and management reports; and (5) revisions and data maintenance.

[58]DOE Order 413.3B assigns to the Office of Project Management the responsibility to certify contractor earned value management systems. The Office of Project Management did not certify Fluor Idaho's system.

[59]According to our cost guide, a performance measurement baseline is used in EVM to detect deviations from the plan and give insight into problems and potential impacts. GAO-09-3SP.

values should occur rarely, if ever, in EVM reporting because they imply the undoing of previously scheduled or performed work.[60] According to best practices, all anomalies should also be identified and the reason for each should be fully explained in EM's monthly EVM reports. However, EM did not document the reasons for these anomalies in its monthly reports. EM officials from the Idaho Cleanup Project said that most of the anomalies in the data were due to the phase two estimate including authorized unpriced work—that is, additional work that EM agreed to let the contractor perform without first negotiating or independently verifying the costs.[61] If errors in EVM reports are not detected, then EVM data will be skewed, resulting in bad decision-making and limiting EM's ability to use the EVM system to measure project performance.

Appendix III provides detailed information on EM's performance on each EVM best practice. An EVM system that produces unreliable data may contribute to EM's challenges in measuring the performance of its operations activities. Our findings in this regard are consistent with our prior reports examining EM's use of EVM systems in other contracts. For example, in February 2019 we reviewed the use of EVM systems in the 21 contracts EM uses to execute its operations activities, including Fluor Idaho's contract for the cleanup at INL, and found that EM has not followed best practices to ensure that these systems (1) are comprehensive, (2) provide reliable data, and (3) are used by EM leadership for decision-making.[62] We recommended that EM update its cleanup policy to require that EVM systems be maintained and used in a way that follows EVM best practices, such as ensuring the reliability of the data in the system. Without following best practices for ensuring EVM data reliability for the IWTU reengineering project's EVM system, EM leadership may not have access to reliable performance data with which to make informed decisions as it manages billions of dollars' worth of cleanup work and provides information to Congress and other stakeholders on the cleanup work every year.

[60]While a negative value may occasionally occur as a result of retroactive accounting adjustments, this practice should not be the norm.

[61]According to EM officials, the authorized unpriced work was put into the baseline in December of 2016. However, this estimate was $20 million above the negotiated costs, which caused the negative values in the EVM system once the work was definitized—or negotiated between EM and the contractor—in May 2017.

[62]GAO-19-223.

EM Has Taken Some Steps toward Meeting Requirements for Monitoring the IWTU Reengineering Project under DOE's Process for Projects with Start-up Risks

In 2016, DOE instituted independent review requirements to monitor facilities with commissioning or start-up risks, and EM has taken some steps toward meeting those requirements for the IWTU reengineering project.[63] As previously noted, DOE's policy requires program offices to (1) develop and execute an operational release plan and (2) provide progress updates to the PMRC on the project each quarter. We made the following observations on EM's actions to meet these requirements for the reengineering of the IWTU project:

- EM developed an operational release plan for the IWTU project in December 2016, which preceded EM's developing guidance for these plans. We found that the operational release plan included the majority of elements that EM's guidance later required.
- EM has provided five progress update briefings to the PMRC on the IWTU reengineering project, according to DOE documents, but these briefings have not occurred each quarter as required by DOE's policy. Officials from DOE's Office of Project Management told us that briefings generally occur when progress has been made on a project. EM's guidance for operational release plans also states, with regard to progress update briefings, that an alternate reporting schedule may be proposed for PMRC approval. The PMRC made recommendations in three of these five briefings. For example, the PMRC recommended that EM revisit and review documents to ensure that the delegated authority is clear, current, and appropriate prior to facility start-up and the introduction of radioactive materials. According to documentation prepared following EM's most recent briefing to the PMRC in February 2019, the PMRC recommended an update on the project in July 2019.

[63]Department of Energy, Deputy Secretary of Energy, *Memorandum: "Operational Release" Milestone for DOE Projects*.

EM Faces Three Main Challenges to Its Plans for SBW Disposal but Does Not Have a Strategy or a Timeline to Manage Those Challenges

Based on our review of EM documentation and plans, the agency does not have a strategy or timeline to address its three main challenges for disposing of the SBW or for identifying an alternative disposal pathway. EM identified WIPP as its preferred disposal site for the SBW in a 2005 Record of Decision document,[64] but in March 2019 EM officials told us that a final decision on the disposal path for the SBW had not been made. The three main challenges EM faces in its plan to dispose of the SBW at its preferred disposal site are: (1) the permit for WIPP prohibits the SBW from being disposed of at WIPP, (2) federal law prohibits HLW from being disposed of at WIPP, and (3) there are existing capacity limitations to disposal at the WIPP facility. EM has taken some steps to address these challenges, as discussed further below.

WIPP permit's prohibition of the disposal of certain tank waste. New Mexico amended its permit for WIPP in 2004 to prohibit waste that has ever been managed as HLW, including the SBW at INL, from being disposed at WIPP unless the disposal of such waste is specifically approved through a permit modification.[65] In 2013, DOE and its contractor responsible for operating and managing the facility filed a request with the state of New Mexico to modify the WIPP permit to remove this prohibition, which could allow the SBW to be disposed of at WIPP if EM determined that the SBW is waste incidental to reprocessing. However, the process was put on hold following the suspension of operations at WIPP in 2014, according to officials from DOE's Carlsbad Field Office and New Mexico's Environment Department.[66] In April 2019, officials from New Mexico's Environment Department said that they anticipated holding discussions with DOE and its contractor for the facility regarding the prohibition after the renewal of the WIPP permit in July 2020. However, a representative from a New Mexico environmental organization said that this proposed modification would likely face strong public opposition. This representative noted that previous DOE attempts to expand the types of waste that could be disposed of at WIPP caused significant public

[64]70 Fed. Reg. 75165 (Dec. 19, 2005).

[65]The 2004 permit modification that New Mexico's Environment Department issued prohibited the disposal of transuranic mixed waste that has ever been managed as HLW and waste from 243 specific tanks at EM's Hanford, Savannah River, and INL sites, including the tanks containing the SBW.

[66]In February 2014, waste operations at WIPP were suspended following a truck fire and an unrelated radiological release. Waste operations resumed in January 2017 with the emplacement of waste from above-ground storage at WIPP, and off-site waste receipts resumed in April 2017, according to EM officials.

concern in New Mexico. Further, New Mexico Environment Department officials told us that processing permit modifications of this nature would likely require public hearings and opportunities for input and may take as long as 2 years or more to complete.

Federal statutory prohibition on HLW disposal at WIPP. The Waste Isolation Pilot Plant Land Withdrawal Act prohibits disposal of HLW at WIPP.[67] Therefore, to enable EM to dispose of the SBW at WIPP, the SBW would need to be classified as non-HLW, or the act would need to be amended to remove the prohibition. DOE has a process for determining that certain waste resulting from reprocessing spent nuclear fuel, such as the SBW and calcine waste, could be managed as either transuranic waste or low-level waste, which are not HLW. Under DOE Order 435.1 and Manual 435.1-1, DOE may determine that waste is incidental to reprocessing and therefore manage the waste as transuranic waste or low-level waste if it meets certain criteria.[68] EM began developing documentation supporting a waste incidental to reprocessing determination for the SBW in 2001. For example, in September 2001, EM requested consultation from the Nuclear Regulatory Commission, which oversees the nuclear power industry, on a draft waste incidental to reprocessing determination so that the SBW could be managed as transuranic waste and disposed of at WIPP rather than in an HLW repository.

[67]Pub. L. No. 102-579, § 12, 106 Stat. 4777, 4791 (1992).

[68]For waste incidental to reprocessing to be managed as transuranic waste, it must meet the following criteria: (1) it has been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; (2) it will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and (3) it is managed pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, in accordance with the provisions of chapter III of DOE Manual 435.1-1, as appropriate. For waste incidental to reprocessing to be managed as low-level waste, it must meet the following criteria: (1) it has been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; (2) it will be managed to meet safety requirements comparable to the performance objectives established in Nuclear Regulatory Commission regulations; and (3) it is managed pursuant to DOE's authority under the Atomic Energy Act of 1954, as amended, in accordance with the provisions of chapter IV of DOE Manual 435.1-1, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as established in 10 C.F.R. § 61.55, or it will meet alternative requirements for waste classification and characterization as DOE may authorize.

DOE's Authority to Determine That Certain Waste Is Not HLW

In 2002, while litigation over the Department of Energy's (DOE) authority to use DOE Order 435.1 and Manual 435.1-1 was pending, DOE sought enactment of legislation clarifying its authority to manage portions of tank waste that have low levels of radioactivity as low-level waste. In response, Congress enacted section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 in October 2004. Under section 3116, radioactive waste resulting from the reprocessing of spent nuclear fuel is not high-level waste (HLW) if the Secretary of Energy, in consultation with the Nuclear Regulatory Commission, determines that it meets specified conditions. These conditions include that the waste does not require disposal in a deep geologic repository and has had highly radioactive radionuclides removed to the maximum extent practical. However, section 3116 only applies to waste stored at DOE sites in Idaho and South Carolina that is not transported from those states. Therefore, DOE cannot use section 3116 to classify the sodium-bearing waste (SBW) as transuranic waste for disposal as DOE's agreements with Idaho require the SBW to be removed from the state.

Source: GAO analysis of DOE information and Pub. L. No. 108-375, div. C, tit. XXXI, § 3116, 118 Stat. 1811, 2162-64 (2004). | GAO-19-494

However, DOE's authority to use Order 435.1 and Manual 435.1-1 to classify the SBW and other waste from reprocessing as non-HLW was challenged in a federal lawsuit in 2001, resulting in EM suspending its development of the waste incidental to reprocessing determination. Following the dismissal of the lawsuit on procedural grounds, EM restarted the internal process for developing the waste incidental to reprocessing determination for the SBW, according to EM officials and documents.[69] For example, EM identified the waste incidental to reprocessing determination for the SBW as a priority item for executive decision-making in a 2017 EM study on mission operations.[70] Internal discussions about this determination continued between EM and DOE into 2018, but the waste incidental to reprocessing determination was not finalized, according to EM officials.[71]

In October 2018, EM published a notice in the *Federal Register* seeking public comment on its proposed interpretation of the statutory definition of HLW, which EM officials said could help the agency make a decision about the classification of the SBW. EM also published a supplemental notice in June 2019 to modify the interpretation and provide additional information to the public, such as on the role of the Nuclear Regulatory Commission and states.[72] Table 1 presents the statutory definition, the proposed interpretation from the October 2018 *Federal Register* notice, and the modified interpretation from the June 2019 *Federal Register*

[69]The federal district court held that the relevant provisions of the order and manual were inconsistent with the Nuclear Waste Policy Act, but a federal appeals court reversed that decision on procedural grounds in November 2004 and ordered dismissal of the suit without ruling on the underlying claim.

[70]In August 2017, EM embarked on a 45-day review of its program to identify opportunities to improve mission operations, placing emphasis on the need for and timeliness of executive decisions, according to draft documentation.

[71]DOE has successfully used the waste incidental to reprocessing process under Order 435.1 and Manual 435.1-1 to determine that certain wastes associated with West Valley Demonstration Project in New York can be managed as low-level waste.

[72]The October 2018 Federal Register notice contains little discussion of the role that the Nuclear Regulatory Commission and states would play in implementing DOE's new interpretation. The June 2019 Federal Register notice states that DOE intends to maintain its strong relationship with the Nuclear Regulatory Commission and engage with the commission on the best way to continue that relationship when and as it applies the HLW interpretation in the future. The June 2019 notice also states that DOE will work closely with state officials and regulators on a site-by-site basis to ensure compliance with applicable programmatic requirements and regulatory agreements before classifying any reprocessing waste as non-HLW under this interpretation or in consequent disposal decisions.

notice.[73] EM officials told us that under the new interpretation, waste would be disposed of in accordance with its characteristics (which determines risk) instead of solely based on the source of the waste (which does not determine risk).

Table 1: Statutory Definition of High-Level Waste (HLW) and the Department of Energy's (DOE) Interpretation

Statutory definition of HLW	DOE's proposed interpretation of HLW definition	DOE's interpretation of HLW definition, June 2019
High-level waste means • highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and • other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.	Reprocessing waste is non- HLW if the waste • does not exceed concentration limits for Class C low-level radioactive waste[a] as set out in 10 C.F.R. § 61.55 or • does not require disposal in a deep geologic repository and meets the performance objectives of a disposal facility as demonstrated through a performance assessment conducted in accordance with applicable regulatory requirements.[b]	Reprocessing waste may be determined to be non- HLW if the waste • does not exceed concentration limits for Class C low-level radioactive waste as set out in 10 C.F.R. § 61.55, and meets the performance objectives of a disposal facility, or • does not require disposal in a deep geologic repository and meets the performance objectives of a disposal facility as demonstrated through a performance assessment conducted in accordance with applicable requirements.

Sources: 42 U.S.C. § 10101(12), 83 Fed. Reg. 50909 (Oct. 10, 2018), and 84 Fed. Reg. 26835 (June 10, 2019) | GAO-19-494

Note: The October 2018 *Federal Register* notice contains little discussion of the role that the Nuclear Regulatory Commission and states would play in the implementation of DOE's new interpretation. The June 2019 *Federal Register* notice states that DOE intends to maintain its strong relationship with the Nuclear Regulatory Commission and engage with the commission on the best way to continue that relationship when and as it applies the HLW interpretation in the future. The June 2019 notice also states that DOE will work closely with state officials and regulators on a site-by-site basis to ensure compliance with applicable programmatic requirements and regulatory agreements before classifying any reprocessing waste as non-HLW under this interpretation or in consequent disposal decisions.

[a]The Nuclear Regulatory Commission has divided low-level waste into categories of increasing levels of hazard exposure, beginning with Class A, followed by Classes B and C, as defined in 10 C.F.R. § 61.55.

[b]Performance objectives require land disposal facilities to be sited, designed, operated, and controlled after closure so that reasonable assurance exists to protect the public, workers, and the environment from releases of radioactivity.

[73]83 Fed. Reg. 50909 (Oct. 10, 2018); 84 Fed. Reg. 26835 (June 10, 2019). The statutory definition of HLW is (1) highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and (2) other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation. 42 U.S.C. § 10101(12).

Stakeholders, including members of the public, state and local governments, tribes, and the Nuclear Regulatory Commission, expressed a range of perspectives about EM's proposed interpretation in public comments. For example, some stakeholders submitted comments expressing concern about the Nuclear Regulatory Commission being excluded from the determination of what is HLW under the interpretation. These comments also stated that the interpretation is contrary to federal law and that the interpretation will elicit legal challenges. Other stakeholders expressed support for the interpretation in comments submitted to EM stating, for example, that the proposed interpretation could accelerate the cleanup of tank waste at DOE sites and result in cost savings.

According to an EM document, potential benefits of the interpretation, if implemented, include a more risk-based approach to waste classification, which could provide a more cost-effective and timely approach to DOE's cleanup mission. However, EM officials stated that it was premature to discuss the administrative actions, such as revising orders or regulations that would be required to implement the new interpretation. The June 2019 Federal Register notice states that DOE will consider what actions may be needed and appropriate to update applicable DOE directives, such as Order 435.1 and Manual 435.1-1, in light of this interpretation and address any revisions in future actions. EM officials also told us that they did not have a timeline for implementing the new interpretation.[74] Further, EM officials stated that if the HLW interpretation is implemented, alternative disposal options could also be considered for the SBW, but they declined to specify what those options could be.[75]

Limitations on disposal at WIPP. Further, existing limitations in the disposal space at WIPP could affect the disposal of the SBW at the facility. We reported in September 2017 that DOE does not currently have sufficient disposal space at WIPP for the waste identified in its 2016

[74]According to the June 2019 *Federal Register* notice, a statutorily required report, which is currently undergoing interagency review, will provide more information and details on implementation actions. Section 3139 of the National Defense Authorization Act for Fiscal Year 2018 required the report and required that it be submitted to relevant congressional committees by February 1, 2018. Pub. L. No. 115-91, § 3139, 131 Stat. 1283, 1903-1904 (2017).

[75]The June 2019 *Federal Register* notice states that the new interpretation incorporates the requirement for reprocessing waste to meet the performance objectives of a low-level waste disposal facility to be determined as non-HLW.

annual inventory report—a document that tracks waste intended to be disposed of at the facility.[76] Specifically, DOE will need to expand the repository to accommodate this waste as well as other potential waste, such as the SBW, for which DOE has yet to determine if it meets all of WIPP's waste acceptance criteria.[77] In March 2019, DOE officials stated that WIPP could be expanded within the current Waste Isolation Pilot Plant Land Withdrawal Act boundary for the site to accommodate the current planned waste and additional waste inventories.[78] Specifically, DOE officials said that mining for a new disposal panel and design work for additional disposal panels was under way, and mining of the additional panel was scheduled to commence in 2021. Further, in September 2017 we also reported that additional potential waste beyond what is captured in the inventory could exceed WIPP's statutory capacity. However, in December 2018, New Mexico's Environment Department approved a modification to the WIPP permit—which was requested by DOE and its contractor that operates and manages WIPP—that will change the way waste volume is calculated to exclude empty space inside waste packing. According to DOE officials, this means that additional waste can be disposed of at WIPP under the existing statutory limit. Further, DOE officials stated that the revised counting methodology will reduce an overstatement in the volume of record for emplaced waste by about 30 percent. However, in January 2019 three environmental organizations filed lawsuits challenging the modification, which the court consolidated and, in May 2019, stayed pending mediation.[79]

[76]GAO, *Plutonium Disposition: Proposed Dilute and Dispose Approach Highlights Need for More Work at the Waste Isolation Pilot Plant*, GAO-17-390 (Washington, D.C.: Sept. 5, 2017).

[77]DOE's annual transuranic waste inventory report tracks the transuranic waste intended to be disposed of at WIPP and estimates the volumes of transuranic waste planned for disposal at WIPP until the facility's closure. The report distinguishes between WIPP-bound and potential waste. While DOE sites may designate waste streams as potential for many different reasons, it is usually because of regulatory or data constraints, such as the lack of waste characterization data.

[78]The Waste Isolation Pilot Plant Land Withdrawal Act limits the volume of transuranic waste that can be disposed of at WIPP and establishes boundaries for the site. The act caps the facility's volume of transuranic waste at 6.2 million cubic feet. DOE officials stated that WIPP has used less than 1 square mile of the 16 square miles, the area within the site boundary.

[79]Concerned Citizens for Nuclear Safety v. New Mexico Env't Dep't, Case No. A-1-CA-37894.

EM officials said that if the office is not able to dispose of the SBW at WIPP, its plan is to dispose of the SBW—once it is treated to a solid form in the IWTU—with the calcine waste in an HLW geologic repository. However, there is still no HLW disposal site in the United States. In 2008, DOE submitted a license application to the Nuclear Regulatory Commission for an HLW repository at Yucca Mountain, Nevada, about 100 miles northwest of Las Vegas. In 2010, however, DOE terminated its efforts to obtain a license for the Yucca Mountain repository.

Under the 1995 settlement agreement with the state of Idaho, DOE is required to treat the SBW so that it is ready for disposal outside of the state by a target date of 2035. An EM official responsible for the disposition of the SBW at INL told us that EM has not developed a strategy, including a timeline, for addressing challenges, including the WIPP permit prohibition, the federal law prohibition, and existing capacity limitations, that could affect EM's ability to meet this target date. According to standards for internal control, federal agency management should identify, analyze, and respond to risks related to achieving a defined objective.[80] Until it develops such a strategy, including a timeline, to implement the actions required to achieve its preferred disposal pathway, or an alternative, for the SBW, EM will not have reasonable assurance that it can achieve its preferred plan for disposal or begin identifying an alternative. Moreover, if EM implements its new interpretation of HLW and uses this definition to classify the SBW as non-HLW, there is significant risk for extended litigation, which may delay to EM's plans to dispose of the SBW at its preferred disposal site.

[80]GAO, *Standards for Internal Control in the Federal* Government, GAO-14-704G (Washington, D.C.: September 2014).

Because of Technological and Disposal Path Challenges, EM Has Suspended Its Plans to Treat Calcine Waste but Has Not Formally Identified an Alternative Approach

EM faces challenges implementing its selected treatment technology for calcine waste and faces uncertainties with a waste disposal pathway. As a result, the agency is suspending further development of its plan to treat calcine waste for land disposal, according to EM documents and officials. EM Idaho Cleanup Project officials told us that the agency is continuing to make progress toward its milestones for calcine waste disposal by considering alternatives for processing the waste for land disposal and conducting a pilot project to remove it from the oldest storage vessel. However, EM does not have a strategy or timeline for determining its next steps for the ultimate treatment and disposal of calcine waste.

EM Is Suspending Development of Its Selected Treatment Technology for Calcine Waste Because of Technological and Disposal Path Challenges

Because of challenges with implementing its chosen treatment technology as well as selecting a potential waste disposal pathway, EM is suspending further development of its plan to treat calcine waste for land disposal, according to EM documents and officials. In December 2009 EM identified hot isostatic pressing as its preferred treatment technology for preparing the calcine waste for land disposal outside of Idaho.[81] Hot isostatic pressing is a manufacturing process that applies elevated temperatures and pressurized gas to materials in a containment vessel, resulting in a ceramic waste form.[82] EM officials from the Idaho Cleanup Project told us that while hot isostatic pressing is a technology used in other industries, such as in industrial manufacturing, it has not been used before to treat HLW.[83] Further, hot isostatic pressing would require a variance or an EPA regulation establishing a new treatment standard

[81]75 Fed. Reg. 137 (Jan. 4, 2010); 75 Fed. Reg. 1615 (Jan. 12, 2010).

[82]To treat the calcine waste, DOE planned to first retrieve the granular waste from the bin sets, pneumatically transferring it to surge storage in the treatment facility. The waste would then be mixed with additives that help to form the ceramic material and filled in cans, which are then treated at elevated temperatures and pressure to create the ceramic waste form.

[83]The Australian Nuclear Science and Technology Organization and the United Kingdom's National Nuclear Laboratory have also initiated studies of using hot isostatic pressing to treat nuclear materials and waste, according to DOE officials.

prior to land disposal.[84] According to EM Idaho Cleanup Project officials and agency documents, EM selected hot isostatic pressing as the treatment technology because EM's analyses assumed it would result in significant cost savings for disposal at Yucca Mountain compared to other methods.

In February 2011, an independent DOE review team issued a preliminary technology readiness assessment for using hot isostatic pressing for calcine waste treatment as part of DOE's process for managing capital asset projects.[85] The review team identified several concerns, such as whether components of the technology would be mature enough to meet EM's planned milestones and challenges with EM's decision to retrofit and reuse the IWTU for the calcine waste treatment mission. EM officials from the Idaho Cleanup Project said that the decision to retrofit and reuse the IWTU for the calcine waste after treating the SBW resulted from reluctance within DOE to build another "first-of-a-kind" treatment facility. However, the review team's report stated that the decision to retrofit the facility may result in logistical and physical maintenance challenges because of space limitations and height requirements.[86]

Based on the results of an independent analysis of alternatives for calcine waste disposition, published in April 2016, EM decided to suspend developing the hot isostatic pressing technology, according to EM officials from the Idaho Cleanup Project.[87] DOE initiated this analysis of alternatives in response to a new requirement from the Secretary of

[84]Under RCRA regulations, the treatment standard (i.e., a required method of treatment) for Idaho's mixed HLW is vitrification, unless a variance from the regulation is obtained prior to land disposal. According to EPA officials, there are two options available for using a treatment other than the treatment specified in the regulations: (1) EM could seek a determination that hot isostatic pressing is equivalent to the treatment standard of vitrification or (2) EM could request that EPA establish a new national treatment standard. In either case, according to EPA officials, EM would have to demonstrate that the alternative treatment method can achieve a measure of performance equivalent to vitrification. EPA regulations also require the alternative treatment method to comply with federal, state, and local requirements and protect human health and the environment.

[85]A technology readiness assessment is a systematic, evidence-based process that evaluates the maturity of hardware and software technologies critical to a larger system's performance or fulfilling the key objectives of an acquisition program.

[86]Department of Energy, *Preliminary Technology Readiness Assessment of the Calcine Disposition Project, Volume One* (Washington, D.C.: February 2011).

[87]Department of Energy, *Independent Analysis of Alternatives for Disposition of the Idaho Calcined High-Level Waste Inventory* (April 2016).

Energy and because hot isostatic pressing is not a mature technology for HLW, according to EM's summary report for the analysis.[88] The report identified uncertainties and challenges with the use of hot isostatic pressing when compared to other potential treatment options given, including that

- hot isostatic pressing is significantly different than vitrification and would require the development and acceptance of testing protocols to validate that it produces a robust waste form,
- hot isostatic pressing had the second greatest estimated cost (more than $2 billion) of the options assessed in the analysis of alternatives,
- hot isostatic pressing represented the highest operational safety risk of all of the options assessed given its use of high pressures and temperatures, and
- other treatment options may perform better for managing the waste because of significant advances in technology since the selection of hot isostatic pressing in 2009.

The independent team performing this analysis also concluded that uncertainties regarding plans for an HLW geologic repository also affect EM's ability to move forward with selecting a treatment technology. According to EM officials from the Idaho Cleanup Project and documents, EM's selection of hot isostatic pressing was based on assumptions developed based on sending the waste to the Yucca Mountain disposal facility. Specifically, an important factor in the selection of hot isostatic pressing as the treatment technology was its ability to provide the lowest volume of final waste, while producing a robust waste form, which would reduce disposal costs at Yucca Mountain. As previously noted, the licensing for developing the Yucca Mountain facility was terminated in 2010. The team performing the analysis of alternatives concluded that because selecting an appropriate treatment technology greatly depends on the calcine waste's disposal path and associated waste form performance requirements, EM should defer making a final decision on the treatment technology until the performance objectives of the disposal path are better defined.

[88]In December 2014, the Secretary of Energy issued a memorandum requiring each project exceeding $50 million in total cost to conduct an analysis of alternatives, independent of its contractor, prior to approval of an approach and its cost range.

EM Is Focusing on Interim Activities for Calcine Waste Treatment and Disposal but Does Not Have a Strategy, Including a Timeline, for Addressing Challenges

While further decisions regarding a treatment technology for the calcine waste are suspended, EM officials from the Idaho Cleanup Project said that they are taking steps to demonstrate to regulators from Idaho's Department of Environmental Quality that they are making progress to prepare the calcine waste for disposal outside the state. Under DOE's 1995 settlement agreement with Idaho, treatment of all calcine waste is to be completed by a target date of December 31, 2035. Further, DOE is required to meet interim milestones for the cleanup of the waste under a site treatment plan that DOE developed for the Idaho Department of Environmental Quality.[89] EM officials from the Idaho Cleanup Project told us that they planned to work with the Idaho Department of Environmental Quality to make changes to milestones specific to calcine waste in the site treatment plan, and Idaho Department of Environmental Quality officials stated in December 2018 that preliminary discussions on this topic occurred in September 2018. Further, EM Idaho Cleanup Project officials identified actions that EM is taking at the site to study alternatives to treatment and aspects of the disposal process.

- EM officials from the Idaho Cleanup Project stated that with the suspension of developing hot isostatic pressing, they are studying the potential packaging of the calcine waste for disposal without additional treatment, or "direct disposal." The analysis of alternatives report identified direct disposal as having significant cost savings over other technologies. However, the team performing the analysis of alternatives also found that this method has a high degree of regulatory uncertainty and it is not clear whether it would be accepted by stakeholders, such as state regulators and the public.[90] EPA officials told us that if EM wanted to proceed with plans for the direct disposal of the calcine waste in a geologic repository, EM would need, among other things, to seek a no-migration variance from EPA. A petition for a no-migration variance must demonstrate, to a reasonable degree of certainty, that the hazardous components would not leak or escape once the HLW is buried underground for as long as the waste remains hazardous. EPA officials added that there is a very high bar for such variances; only one such request has been

[89]According to DOE's 2018 site treatment plan for INL, milestones for the calcine waste include DOE procuring contracts for the construction of a calcine waste treatment facility by September 30, 2019; initiating construction by September 30, 2020; conducting system testing by March 31, 2023; and commencing operation of the facility by March 31, 2024.

[90]Department of Energy, *Independent Analysis of Alternatives for Disposition of the Idaho Calcined High-Level Waste Inventory*.

approved since 1984, and it was later rescinded. In February 2019, an EM Idaho Cleanup Project official told us that EM has met with officials from the Idaho Department of Environmental Quality and EPA to receive their preliminary input on this approach.

- EM Idaho Cleanup Project officials said that they are focusing in the near term on developing and testing a system to retrieve the calcine waste from its storage vessels, called bin sets. According to EM documents, retrieval of the calcine waste from the bin sets is a precursor to treating or packaging the waste for disposal, and there are several challenges to address in developing an effective retrieval system.[91] As a result, EM directed its contractor to conduct a project to retrieve calcine waste from the oldest bin set and move it to a partially empty bin set under EM's contract for hazardous waste cleanup at INL. The project serves to both test different forms of technologies and also to cease use of the older bin set, which does not have the same structural integrity as the other bin set because of its design, according to EM officials from the Idaho Cleanup Project and documents. The project is estimated to cost $50 million over 5 years, according to these officials. Fluor Idaho's plan for the calcine waste retrieval project involves developing a full-scale mock-up of the retrieval process for testing in fiscal years 2019 and 2020, with the commissioning and start-up of the full-scale system and transfer of the waste to occur in fiscal year 2021. In February 2019, an EM official told us that $6 million was obligated to the pilot project in fiscal year 2019 in part because of increased costs for the IWTU reengineering project and cleanup of transuranic waste at INL.

Despite these efforts, EM officials from the Idaho Cleanup Project acknowledged that the agency has no plan to issue a new Record of Decision or amend the 2010 Record of Decision selecting the treatment option for calcine waste. Although EM identified challenges with using hot isostatic pressing for the treatment of the calcine waste in its technical readiness assessment in 2011 and analysis of alternatives in 2016, an EM official told us that the agency does not have a strategy for determining its next steps in treating this waste for land disposal. According to standards for internal control, federal agency management should identify, analyze, and respond to risks related to achieving a defined objective.[92] Without developing a strategy, including a timeline, to

[91]For example, according to an EM document, the design and configuration of each bin set is different, which may require custom approaches to retrieval.

[92]GAO-14-704G.

identify and develop a treatment approach for the calcine waste, EM does not have reasonable assurance that it will meet milestones for the completion of treatment of all calcine by a target date of December 31, 2035.

Conclusions

EM has been working since 2005 to construct and operate the IWTU to treat the SBW and calcine waste at INL. Despite declaring construction complete in 2012 at a cost of $571 million, EM is still working to repair and reengineer the IWTU following the discovery of facility problems during testing, with expenditures surpassing $416 million. EM has made progress in identifying the engineering problems plaguing the facility and implementing technical changes and expects to complete the second of the four phases of the reengineering project in mid-2019, with its next series of system testing to begin in early 2020. However, EM has experienced significant cost increases and schedule delays in phase two of the IWTU project, and additional engineering and testing remains to be completed before beginning a multiyear effort to treat the SBW. EM's ability to achieve the project's estimated cost and schedule in phase two may have been hampered because EM has not fully followed best practices for ensuring that the cost estimate is complete and the schedule estimate is well-constructed. By ensuring that the cost estimate for future phases of the IWTU reengineering project and the SBW treatment operations is comprehensive (e.g., account for all possible costs), EM will have greater assurance that it can successfully plan program resource requirements. Moreover, by developing a well-constructed schedule estimate for the IWTU reengineering project and the SBW treatment operations, EM will have greater assurance that it can successfully achieve its plans to reengineer the IWTU and begin treatment of the SBW without further delays. Further, while EM is using an EVM system to measure the performance of the project and generally followed best practices for EVM systems, the system produces unreliable data. By following best practices for ensuring EVM data reliability for the IWTU reengineering project's EVM system, EM leadership will have better access to reliable performance data as it manages billions of dollars' worth of cleanup work and provides information to Congress and other stakeholders on the cleanup work every year.

EM faces long-standing challenges to implementing its preferred alternative for disposing of the treated SBW at WIPP. Key among these challenges are provisions in federal law and the WIPP permit that prevent EM from disposing of the SBW at WIPP. EM has taken some steps toward addressing these challenges, such as seeking public comment on

its new interpretation of the statutory definition of HLW that according to EM could allow the waste to be disposed of at WIPP or an alternative to an HLW geologic repository. However, EM has no strategy or timeline for making any changes to DOE policies and regulations that may be required to implement its new interpretation or for making decisions regarding disposing of the SBW. Until it develops such a strategy, including a timeline, to implement the actions required to achieve its preferred disposal pathway, or an alternative, for the SBW, EM will not have reasonable assurance that it can achieve its preferred plan for disposal or begin the process of identifying an alternative. Further, if EM implements its new interpretation of HLW and uses this definition to classify the SBW as non-HLW, there is significant risk for extended litigation, which may delay EM's plans to dispose of the SBW at its preferred disposal site.

Moreover, EM faces challenges in completing treatment of the calcine waste by a target date of December 31, 2035, in light of its decision to suspend development of the selected treatment technology, hot isostatic pressing, and the absence of an HLW geologic repository. Even though EM is studying alternatives to using hot isostatic pressing to prepare the calcine waste for disposal, it has not developed a strategy or a timeline for determining its plans for treating this waste for disposal. Without developing such a strategy, including a timeline, for the treatment and disposal of the calcine waste to ensure that EM meets the milestone for completing the treatment of the waste by December 31, 2035, EM does not have reasonable assurance that it can meet its milestones.

Recommendations for Executive Action

We are making five recommendations to DOE:

- The Secretary of Energy should direct the Assistant Secretary of EM to develop cost estimates for the IWTU reengineering project and the SBW treatment operations that meet best practices for being comprehensive (e.g., account for all costs). (Recommendation 1)
- The Secretary of Energy should direct the Assistant Secretary of EM to develop schedule estimates for the IWTU reengineering project and the SBW treatment operations that meet best practices for being well-constructed. (Recommendation 2)
- The Secretary of Energy should direct the Assistant Secretary of EM to follow best practices for ensuring the reliability for the IWTU reengineering project's EVM system. (Recommendation 3)

- The Secretary of Energy should direct the Assistant Secretary of EM to develop a strategy, including a timeline, for implementing the actions required to achieve its preferred disposal pathway, or an alternative, for the SBW. (Recommendation 4)
- The Secretary of Energy should direct the Assistant Secretary of EM to develop a strategy, including a timeline, to identify and develop a treatment approach for the disposal of the calcine waste to ensure that EM meets the milestone for completing the treatment of this waste by the target date of December 31, 2035. (Recommendation 5)

Agency Comments and Our Evaluation

We provided a draft of this report for review and comment to the Secretary of Energy and the Administrator of the EPA. DOE provided written comments on the draft report, which are presented in appendix IV. EPA did not provide written comments. DOE and EPA both provided technical comments that we incorporated in the report as appropriate.

DOE agreed with our recommendations related to the management of the IWTU reengineering project, including developing cost and schedule estimates that meet best practices and ensuring the reliability of the EVM system for the project. Regarding the cost estimate, DOE committed to developing cost estimates that meet best practices and stated that cost estimates for phases three and four of the IWTU reengineering project have been developed and reviewed by the Defense Contract Audit Agency. For the schedule estimate, DOE stated that the schedules for phases three and four have been developed and that the inclusion of these phases in the schedule is in accordance with best practices for the well-constructed characteristic. With regard to the EVM system, DOE stated that cost and performance data will be included in the EVM system in accordance with EVM best practices once contract negotiations are completed, which the agency estimated would conclude by December 31, 2019.

DOE also agreed with our recommendations to develop a strategy, including a timeline, for the disposal of the SBW and calcine waste. DOE further stated that EM is in the process of developing a site options analysis for INL and other EM sites to identify opportunities to complete cleanup work through more efficient and innovative approaches over the next decade. This analysis is expected to be completed in fiscal year 2020, according to DOE. DOE stated that EM's HLW interpretation issued in June 2019 could potentially open new disposal pathways for some reprocessing waste, such as SBW and calcine, while noting that

decisions about whether and how this interpretation will apply to existing wastes have yet to be made.

In its written comments, DOE disagreed with our recommendation to seek clarification from Congress on DOE's authority to classify the SBW as other than HLW if such clarification is necessary to avoid extended litigation. DOE stated the agency does not require additional clarification from Congress to classify reprocessing waste as other than HLW. We are deleting our recommendation but continue to believe that there is significant risk for extended litigation if EM implements its new interpretation of HLW and uses this definition to classify the SBW as non-HLW. Extended litigation may delay EM's plans to dispose of the SBW at its preferred disposal site.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, the Administrator of the Environmental Protection Agency, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or trimbled@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made significant contributions to this report are listed in appendix V.

David C. Trimble
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

Our report examines (1) the extent to which the Department of Energy's (DOE) Office of Environmental Management's (EM) management of the Integrated Waste Treatment Unit (IWTU) reengineering project follows selected project management best practices; (2) challenges EM faces in the disposal of the sodium-bearing waste (SBW); and (3) challenges EM faces in the treatment and disposal of the calcine waste. To address these three objectives, we conducted a site visit to DOE's Idaho National Laboratory (INL) in December 2017. During the site visit, we obtained documentation and interviewed officials from EM, which is responsible for hazardous waste cleanup at INL through its Idaho Cleanup Project. We also interviewed representatives from Fluor Idaho, LLC, which is the private contractor that manages hazardous waste cleanup at INL for EM, including the cleanup of the SBW and calcine waste. In addition, we conducted a site visit to Hazen Research, Inc., a subcontractor to Fluor Idaho, to observe pilot testing facilities for the IWTU reengineering project and discuss the status of the project with an EM official from the Idaho Cleanup Project and representatives from Hazen Research, Inc., and Fluor Idaho.[1]

To assess the extent to which EM's management of the IWTU reengineering project meets selected project management best practices, we first identified areas deemed to be important to project management based on our previous work on DOE projects and leading practices from the Project Management Institute, which are generally recognized as leading practices for project management.[2] Specifically, we reviewed the project management leading practices identified in the Project Management Institute's *A Guide to the Project Management Body of Knowledge—Sixth Edition*.[3] From this review, we selected project management practices related to developing cost and schedule estimates and conducting project monitoring through the use of earned value management (EVM) and independent reviews. We then conducted assessments of these best practices, as discussed below.

[1]Hazen Research, Inc., is an industrial research and development firm located in Golden, Colorado.

[2]The Project Management Institute is a not-for-profit organization that provides global standards for project and program management. These standards are used worldwide and provide guidance on how to manage various aspects of projects, programs, and portfolios.

[3]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition, 2017. *PMBOK* is a trademark of the Project Management Institute, Inc.

Cost. To determine the extent to which the cost estimate for the IWTU reengineering project is reliable, we conducted an abridged analysis of the IWTU reengineering project's cost estimate, focusing on its comprehensiveness. Typically, in analyzing a cost estimate against best practices in GAO's *Cost Estimating and Assessment Guide* (cost guide),[4] we examine four characteristics, each defined by multiple criteria:

- comprehensive,
- accurate,
- well-documented, and
- credible.

For this review, we assessed the cost estimate for the IWTU reengineering project against the comprehensive characteristic, in part because EM officials told us that they had yet to develop a cost estimate for the program beyond phases one and two at the time of our review. Specifically, we reviewed the cost estimate for the operation of the IWTU and the IWTU reengineering project, which, at the time of our review, was only developed for phases one and two of the project. If a cost estimate is not comprehensive (that is, complete), then it cannot fully meet the well-documented, accurate, or credible best practice characteristics. For instance, if the cost estimate is missing some cost elements, then the documentation will be incomplete, the estimate will be inaccurate, and the result will not be credible because of the potential underestimating of costs and the absence of a full risk and uncertainty analysis. See appendix II for a summary assessment of the IWTU reengineering project's cost estimate compared to selected best practices.

Schedule. To assess EM's schedule for the IWTU reengineering project, we conducted an abridged analysis of the IWTU reengineering project's schedule, focusing on comprehensiveness and the degree to which it is well-constructed. Typically, in analyzing a schedule estimate against best practices in GAO's Schedule Assessment Guide (schedule guide),[5] we examine four characteristics, each defined by multiple criteria:

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

[5]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: December 2015).

- comprehensive,
- well-constructed,
- credible, and
- controlled.

For this review, we assessed the IWTU reengineering project schedule that EM provided in March 2018 against the well-constructed characteristic, in part because EM officials told us that they had yet to develop a schedule estimate for the totality of the reengineering project because of Fluor Idaho's phased approach. If a schedule estimate is not well-constructed, it will not be able to properly calculate dates and predict changes in the future. When activities are missing logic links, the schedule will not be able to automatically transmit these delays to future activities that depend on them. When this happens, the schedule will not allow a sufficient understanding of the program as a whole, and users of the schedule will not have confidence in the dates and the critical path. In addition, we evaluated the comprehensive characteristic because it contributed to our analysis of EM's EVM system, as described below. See appendix II for a summary assessment of the IWTU reengineering project's schedule estimate compared to selected best practices.

EVM. In addition, we analyzed EM's use of EVM as a way to assess its monitoring of the IWTU reengineering project's cost and schedule. EVM measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for the period and with the actual cost of the work accomplished. It is an industry standard and is considered a best practice for conducting cost and schedule performance analysis for projects. Our EVM analysis focused on Fluor Idaho's EVM data for the IWTU reengineering project contained in cost performance reports from March 2017 to February 2018 and the project schedule that EM provided in March 2018. Specifically, we compared this project documentation with EVM best practices as identified in our cost guide.[6] Our research has identified a number of best practices that are the basis of effective EVM and should result in reliable and valid data that can be used for making informed decisions. These best practices have been collapsed into three high-level characteristics of a reliable EVM system, which are

- establish a comprehensive EVM system,

[6]GAO-09-3SP.

- ensure that the data resulting from the EVM system are reliable, and
- ensure that the program management team is using EVM data for decision-making purposes.

See appendix III for our summary assessment of the IWTU reengineering project's EVM data compared to best practices. EVM data are considered reliable if the overall assessment ratings for each of the three characteristics are substantially or fully met. If any of the characteristics are not met, minimally met, or partially met, then the EVM data cannot be considered reliable.

Independent reviews. To assess the extent to which DOE has conducted independent reviews of the IWTU reengineering project, we examined DOE and EM policies to identify requirements for conducting reviews of operations activities. Specifically, we reviewed a 2016 DOE memorandum that established that DOE's Project Management Risk Committee (PMRC) would provide independent review of selected projects in the operational release phase, the PMRC's standard operating procedures, and EM's guidance for projects in the operational release milestone. We examined documentation from the PMRC's reviews of the IWTU reengineering project, including documentation that EM officials from the Idaho Cleanup Project prepared for these reviews and recommendations that the PMRC made to EM for the project. In addition, we spoke with officials from DOE's Office of Project Management, which serves as the secretariat of the PMRC; EM's Office of Acquisition & Project Management; and EM's Idaho Cleanup Project about independent reviews of projects in the operational release phase.

To examine challenges EM faces in the disposal of the SBW, we reviewed federal laws, regulations, and DOE policies on radioactive waste management, including those described in DOE Order 435.1 on radioactive waste management and its implementation manual. In addition, we examined EM's October 2018 and June 2019 *Federal Register* notices, which provide DOE's new interpretation of the statutory definition of high-level radioactive waste (HLW).[7] We also reviewed documentation related to EM's plans for disposing of the SBW at DOE's Waste Isolation Pilot Plant (WIPP) in New Mexico, such as Record of Decision documents for proposed actions that require development of environmental impact statements, and the hazardous waste facility permit

[7]83 Fed. Reg. 50909 (Oct. 10, 2018); 84 Fed. Reg. 26835 (June 10, 2019).

for WIPP that the New Mexico Environment Department issued. We interviewed DOE officials from the Office of the General Counsel; officials from EM's Idaho Cleanup Project and Carlsbad Field Office, which is responsible for DOE's oversight of WIPP; and officials from EM's Office of Regulatory Compliance, Office of Nuclear Materials, and Office of Waste and Materials Management. We also interviewed officials from Idaho's Department of Environmental Quality and New Mexico's Environment Department, as well as representatives from two environmental advocacy groups in Idaho and New Mexico, to obtain their perspectives on the challenges facing EM's SBW disposal efforts.

To examine challenges EM faces in the treatment and disposal of the calcine waste, we reviewed federal laws, regulations, and documents that DOE and EM's contractors for the Idaho Cleanup Project prepared related to the calcine waste cleanup mission. For example, we reviewed documents assessing treatment and disposal alternatives for calcine waste, including a 2016 analysis of alternatives report that EM prepared and a 2015 contractor-prepared report assessing the feasibility of the direct disposal of calcine waste. We interviewed officials from EM's Idaho Cleanup Project and Office of Nuclear Materials; EM's Chief Engineer; and representatives from EM's contractor, Fluor Idaho, about plans for treating and disposing of the calcine waste and the retrieval pilot project. In addition, we reviewed Environmental Protection Agency (EPA) Resource Conservation and Recovery Act, as amended (RCRA) regulations, guidance, and documents concerning land disposal requirements. We also interviewed officials from EPA's Office of Land and Emergency Management and Region 10 about EPA's responsibilities for implementing RCRA. Lastly, we interviewed officials from the Idaho Department of Environmental Quality about how EM's calcine waste treatment and disposal efforts address milestones in the Idaho Settlement Agreement.

We conducted this performance audit from September 2017 to September 2019 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: Cost and Schedule Estimates Compared to Actual Costs and Schedule for the Integrated Waste Treatment Unit Reengineering Project

Table 2 describes the initial cost and schedule estimates for the four phases of the Integrated Waste Treatment Unit reengineering project compared to actual expenditures and schedule as of February 2019.

Table 2: Cost and Schedule Estimates for the Department of Energy's (DOE) Office of Environmental Management's (EM) Integrated Waste Treatment Unit Reengineering Project Compared to Actual Costs and Schedule, as of February 2019

Phase	Status	Estimated costs (dollars in millions)	Actual costs as of February 2019 (dollars in millions)	Difference between estimated and actual costs (dollars in millions)	Estimated schedule (months)	Actual schedule as of February 2019 (months)	Difference between estimate and actual schedule (months)
Phase one	Complete	19	12	7	5	5	—
Phase two	Ongoing	67	138	(71)	14	28	(14)
Phase three	Not yet started[a]	TBD	—	—	TBD	—	—
Phase four	Not yet started[a]	TBD	—	—	TBD	—	—

Legend:

() = negative value

TBD = to be determined

— = not applicable

Source: GAO analysis of EM documents. | GAO-19-494

Note: Cost figures are direct costs, excluding fee, general and administrative expenses, overhead, and pension costs.

[a]As of March 2019, EM had not yet defined cost and schedule estimates for phases three and four because, according to DOE officials, these estimates will depend to a significant extent on the results of phase two. In addition, since phases three and four have not yet begun, actual figures are not available. Appendix II: Assessment of EM's Cost and Schedule Estimates for the IWTU Reengineering Project Compared with Selected Best Practices

Table 3 details our assessment of the Office of Environmental Management's (EM) cost estimate for phases one and two of the Integrated Waste Treatment Unit (IWTU) reengineering project compared to selected best practices for cost estimating published in GAO's *Cost Estimating and Assessment Guide* (cost guide).[1] For this review, we assessed the cost estimate for the IWTU reengineering project against the comprehensive characteristic, in part because EM officials told us that they had yet to develop a cost estimate for the program beyond phases one and two, at the time of our review of these documents. We assessed the comprehensive characteristic for the IWTU reengineering cost estimate because if a cost estimate is not comprehensive—that is,

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

complete—then it cannot fully meet the other best practice characteristics.[2] According to our analysis, EM's cost estimate for the IWTU reengineering project partially met best practices for a comprehensive cost estimate.

Table 3: Assessment of the Department of Energy's Office of Environmental Management's (EM) Cost Estimate for Phases One and Two of the Integrated Waste Treatment Unit (IWTU) Reengineering Project Compared with Selected Best Practices

Characteristic *(overall assessment)*	Best practice	GAO assessment[a]
Comprehensive: *(Partially met)*	The cost estimate includes all life cycle costs	**Partially met.** Program officials stated that the estimate did not reflect all life cycle costs because costs for phases three and four of the repair project had yet to be determined at the time of our review. Officials told us that the cost for these phases would be negotiated with the contractor when phase two was close to completion. Furthermore, the cost estimate does not contain any costs for government activities, only contractor costs. Without fully accounting for life cycle costs, management will have difficulty successfully planning program resource requirements and making wise decisions.
	The cost estimate completely defines the program, reflects the current schedule, and is technically reasonable	**Substantially met.** There are several documents that contain most of the technical baseline information. However, the documentation provided does not indicate management approval of the technical baseline or show any evidence of updating.
	The cost estimate work breakdown structure is product-oriented, traceable to the statement of work/objective, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted	**Partially met.** The work breakdown structure provided shows three levels of indenture with dictionaries. However, the cost estimate is not broken down by this same structure. Instead, we found that the cost estimate provided shows costs segmented at a high level for labor, material, and overhead. Without a product-oriented work breakdown structure to facilitate the tracking of resource allocations and expenditures, EM may not have the proper insight to reliably estimate the cost of future similar programs.
	The estimate documents all cost-influencing ground rules and assumptions	**Partially met.** There are assumptions listed in the various documents. However, there is no documentation that indicates whether these assumptions came from inputs from the technical community or had risk distributions identified to capture the effects of them varying. The risks are also not tied to specific work breakdown structure elements. Unless ground rules and assumptions are clearly documented, the cost estimate will not have a basis for areas of potential risk to be resolved. Furthermore, the estimate will not be able to be reconstructed when the original estimators are no longer available.

Source: GAO analysis of EM documents. | GAO-19-494

Note: We assessed the comprehensive characteristic for the IWTU reengineering cost estimate because if a cost estimate is not comprehensive—that is, complete—then it cannot fully meet the other best practice characteristics. The other three characteristics of a cost estimate are well-documented, accurate, and credible.

[2]The other three characteristics of a cost estimate, according to our cost guide, are well-documented, accurate, and credible.

[a]The ratings we used in this analysis are as follows: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

Table 4 details our assessment of EM's schedule for the IWTU reengineering project compared to selected best practices for project schedules published in GAO's Schedule Assessment Guide (schedule guide).[3] For this review, we assessed the schedule against the well-constructed characteristic, in part because EM officials told us that they had yet to develop a schedule for the totality of the reengineering project because of the contractor's phased approach. We assessed the well-constructed characteristic because, among other reasons, if a schedule is not well-constructed, it will not be able to properly calculate dates and predict changes in the future. In addition, we evaluated the comprehensive characteristic as it is needed to evaluate an earned value management system.[4] According to our assessment, EM's schedule for the reengineering project partially met best practices related to the well-constructed characteristic and substantially met best practices related to the comprehensive characteristic.

[3]GAO, *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G (Washington, D.C.: December 2015).

[4]The other characteristics of a schedule, according to our schedule guide, are controlled and credible.

Table 4: Assessment of the Department of Energy's Office of Environmental Management's (EM) Schedule for Phases One and Two of the Integrated Waste Treatment Unit (IWTU) Reengineering Project Compared with Selected Best Practices

Characteristic (overall assessment)	Best practice	GAO assessment[a]
Well-constructed *(Partially met)*	Sequencing all activities	**Substantially met.** EM's schedule for the IWTU reengineering project did not include a substantive amount of logical anomalies.
	Confirming that the critical path is valid	**Partially met.** The critical path is continuous, with the exception of a dependency that falls outside of the IWTU reengineering project, and free of lags and constraints. However, there are long duration activities on the critical path that should be reevaluated to determine if they can be broken down into more manageable pieces. Without a valid critical path, management cannot focus on activities that will detrimentally affect the key program milestones and deliveries if they slip. Unless the schedule can produce a true critical path, the program office will not be able to provide reliable timeline estimates or identify when problems or changes may occur and their effects on downstream work.
	Ensuring reasonable total float	**Minimally met.** The schedule includes large amounts of total float that do not appear to be an accurate reflection of the schedule's true flexibility. Our analysis also found that the schedule includes negative float, meaning that activities are behind schedule. Negative float indicates that not enough time has been scheduled for the activity and is usually caused by activities taking longer or starting later than planned, making target dates infeasible. EM may have to take some corrective action or the negative float may act as a threat to the project end dates.
Comprehensive *(Substantially met)*	Capturing all activities	**Substantially met.** EM's schedule for the IWTU reengineering project substantially captures all activities. For example, there is sufficient detail to define how deliverables will be produced, the schedule appears to contain both government and contractor activities, and the schedule benefits from an extensive use of user-defined fields and codes. However, it may not be planned to a level of detail to accomplish the program's objectives as defined in the program's work breakdown structure. Further, the schedule lacks a milestone for completing contract line item number 6 IWTU work, and the schedule contains mislabeled activities that can interfere with the critical path. Additionally, while some remaining activities have a cost and schedule risk code assigned, the schedule does not include risk mitigation activities.
	Assigning resources to all activities	**Substantially met.** There are specific material and equipment resources, as well as travel, training, and various labor resources, assigned in the schedule. However, EM did not provide evidence that analyses were performed to ensure that resources are sufficient and available or that there is a plan in place for resolving resource deficiencies.

Characteristic (overall assessment)	Best practice	GAO assessment[a]
	Establishing the durations of all activities	**Partially met.** All activities in the schedule have consistent time units and are assigned a calendar. However, our analysis found that the remaining activity durations are questionable and may not be short enough to be consistent with the needs of effective planning and program execution. If activities are too long, the schedule may not have enough detail for effective progress measurement and reporting. If it is not practical to divide the work into smaller activities or insert intermediate milestones, justification for long durations should be given in the schedule basis document. Greater activity detail might be necessary if it helps management understand and address the implications of risk and uncertainty.

Source: GAO analysis of EM data. | GAO-19-494

Note: We assessed the schedule for the IWTU reengineering project against the well-constructed characteristic because if a schedule is not well-constructed, it will not be able to properly calculate dates and predict changes in the future, among other things. We also evaluated the comprehensive characteristic because it contributed to our analysis of the Department of Energy's earned value management system.

[a]The ratings we used in this analysis are as follows: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

Appendix III: Assessment of EM's EVM Data for the IWTU Reengineering Project Compared with Best Practices

Table 5 details our assessment of March 2017 to February 2018 data from the Department of Energy's (DOE) Office of Environmental Management's (EM) earned value management (EVM) system for the Integrated Waste Treatment Unit (IWTU) reengineering project.[1] 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. By using the metrics derived from these values to understand performance status and to estimate cost and time to complete, EVM can alert program managers to potential problems sooner than expenditures alone can. Our research has identified a number of best practices that are the basis of effective EVM and should result in reliable and valid EVM data that can be used for making informed decisions.[2] Specifically, EM followed (i.e., substantially met) best practices to ensure that its EVM system is (1) comprehensive and (2) used by leadership for decision-making, but did not follow (i.e., partially met) best practices to ensure that the data resulting from the EVM system are reliable.

Table 5: Assessment of the Department of Energy's Office of Environmental Management's (EM) Earned Value Management (EVM) Data for the Integrated Waste Treatment Unit Reengineering Project Compared with GAO Best Practices

Characteristic ***(overall assessment)***	**Best practice**	**GAO assessment**[a]
Establish a comprehensive EVM system *(Substantially met)*	The program has a certified EVM system	**Substantially met.** The contractor is required to meet EVM system guidelines, and EM conducted a compliance review in March 2017. The compliance review found some areas that needed improvement, including a potential non-compliance issue with how cost and schedule variances are calculated.
	An integrated baseline review was conducted to ensure that the performance measurement baseline captures all of the work	**Minimally met.** An integrated baseline review was not conducted. Instead, the contractor's reviewed proposal became the initial baseline. Without conducting an integrated baseline review, management cannot have the confidence that the performance measurement baseline provides reliable cost and schedule data for managing the project and that it projects accurate estimated costs at completion.

[1]Our analysis of DOE's EVM data was specific to data for the IWTU reengineering project from March 2017 to February 2018 and did not include a review of the EVM system for the entire Idaho Cleanup Project, which DOE's contractor, Fluor Idaho, manages.

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

Characteristic *(overall assessment)*	Best practice	GAO assessment[a]
	The schedule reflects the work breakdown structure, the logical sequencing of activities, and the necessary resources	**Substantially met.** The project schedule substantially meets guidelines for implementing EVM. For example, the schedule sequences all activities and assigns specific material and equipment resources. However, the schedule may not be planned to a level of detail to accomplish the project's objectives as defined in the work breakdown structure. For example, the schedule has activities that are defined as level of effort but are not assigned the level of effort activity type.
	EVM surveillance is being performed	**Fully met.** The contract has a requirement for EVM system surveillance that covers many best practices for EVM surveillance. EM officials also stated that the EVM data are reviewed each month.
Ensure that the data resulting from the EVM system are reliable *(Partially met)*	EVM data do not contain any anomalies	**Partially met.** The EVM data we reviewed contained numerous anomalies, such as negative or missing values. Specifically, the monthly contractor EVM reports that we reviewed showed one or more anomalies in each of the months. EM officials explained that most of the anomalies found are due to the phase two estimate including authorized unpriced work. This authorized unpriced work was put into the baseline in December 2016. However, this estimate was $20 million above the negotiated costs, which caused negative adjustments to be made in May 2017 when the effort was definitized. EVM data should be valid and have minimal anomalies because anomalies can limit management's ability to identify potential cost and schedule shortfalls. Moreover, all anomalies should be identified, and the reason for each should be fully explained in the monthly EVM reports. To do less limits the completeness and accuracy of these values and thus makes the resulting variance determinations unreliable.
	EVM data are consistent among various reporting formats	**Partially met.** GAO only had reports in one format available to review, so we were unable to compare across formats.[b] EM officials told us that the performance measurement baseline is formally reported in several EVM formats; however, we were not able to independently verify this assertion. It is important to ensure that cost performance reports are consistent across formats and do not contain anomalies that would make them invalid. If errors are not detected, then the data will be skewed, resulting in bad decision-making.
	Estimate at completion is realistic	**Partially met.** We compared the contractor's estimate at completion against our own independent calculation to determine the feasibility of the contractor's estimate. The contractor's estimate at completion fell within the range of our calculated estimate at completion. However, when we adjusted the data to remove months with large negative variances, the resulting estimate at completion was significantly higher than our pessimistic forecast, which is not reasonable. A credible estimate at completion is critical for better program planning and avoiding a situation in which work must be stopped because funds have been exhausted. Further, early warning of impending funding issues enables management to take corrective action to avoid any surprises.

Characteristic *(overall assessment)*	Best practice	GAO assessment[a]
Ensure that the program management team is using EVM data for decision-making purposes *(Substantially met)*	EVM data, including cost and schedule variances, are reviewed on a regular basis	**Substantially met.** Monthly variance reports, which track the monthly performance indices and why variances occur, are created. Only some of the variance data are provided as a graph. The monthly variance reports are missing other expected graphs such as budget at completion. EVM data should be analyzed graphically because performance trends provide valuable information about how a project is doing and are important for accurately predicting costs at completion.
	Management uses EVM data to develop corrective action plans	**Fully met.** The EVM data are updated monthly. A tracking system identifies and reports issues monthly; these issues are then reported in a monthly review briefing.
	The performance measurement baseline is updated to reflect changes	**Partially met.** The program has a change control process. However, the performance measurement baseline was not included on the contractor performance reports provided, so we could not determine how the performance measurement baseline has changed as the project has evolved. Since the performance measurement baseline should always reflect the most current plan for accomplishing the authorized work and incorporating changes accurately and in a timely manner, it is vital that the performance measurement baseline be updated regularly in order to maintain the effectiveness of the EVM system. It is also important to note that a detailed record of any performance measurement baseline changes should be established and always maintained. Doing so makes it easy to trace all changes to the program and lessens the burden on program personnel for compiling this information during updates to the project cost estimate.

Source: GAO analysis of EM documents. | GAO-19-494

[a]The ratings we used in this analysis are as follows: "Fully met" means EM provided complete evidence that satisfies the entire best practice. "Substantially met" means EM provided evidence that satisfies a large portion of the best practice. "Partially met" means EM provided evidence that satisfies about half of the best practice. "Minimally met" means EM provided evidence that satisfies a small portion of the best practice. "Not met" means EM provided no evidence that satisfies the best practice.

[b]EVM data are typically provided to the Department of Energy in a standard report called the contract performance report. This report is the primary source of cost and schedule status information and provides the information needed for effective program control. The contract performance report provides cost and schedule variances, based on actual performance against the plan, which can be further examined to understand the causes of any differences.

Appendix IV: Comments from the Department of Energy

Department of Energy
Washington, DC 20585

August 9, 2019

David C. Trimble
Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Trimble:

Thank you for providing a draft copy of the Government Accountability Office (GAO) report, Nuclear Waste Cleanup: *DOE Faces Project Management and Disposal Challenges with High-Level Waste at Idaho National Laboratory*, GAO-19-494. The Department of Energy has reviewed the draft report and provides comments in the enclosure.

The Office of Environmental Management (EM) commits to developing cost and schedule estimates that meet best practices for the Integrated Waste Treatment Unit reengineering project, and ensuring the reliability of the earned value management system for the project. In addition, EM will continue to review and update, as appropriate, plans for calcine and sodium bearing waste disposition. Several actions cited in Recommendations 1, 2, and 3 are already developed and/or are ongoing. EM will consider GAO's draft report recommendations during these processes.

If you have any questions, please contact me or Jeff C. Griffin Ph.D., Associate Principal Deputy Assistant Secretary for Field Operations, at (202) 287-5502.

Sincerely,

William I. White
Senior Advisor for Environmental Management
to the Under Secretary for Science

Enclosures:
1. EM Response to Report Recommendations
2. EM Technical Comments
3. Office of Project Management Oversight and Assessments Technical Comments

Enclosure

Response to Report Recommendations

Recommendation 1: The Secretary of Energy should direct the Assistant Secretary of the Office of Environmental Management (EM) to develop cost estimates for the Integrated Waste Treatment Unit (IWTU) reengineering project and Sodium Bearing Waste (SBW) treatment operations that meet best practices for being compressive (e.g., account for all costs).

Management Response: Concur

Cost estimates for Phases 3 and 4 have been developed and reviewed by the Defense Contract Audit Agency (DCAA). This covers the work through the confirmatory testing and preparations to start up the facility. As the project progresses, estimates will be revisited as needed.

Estimated Completion Date: Award of contract modifications incorporating these cost estimates for the balance of the workscope are estimated to complete by December 31, 2019.

Recommendation 2: The Secretary of Energy should direct the Assistant Secretary of EM to develop schedule estimates for the IWTU reengineering project and SBW treatment operations that meet best practices for being well-constructed.

Management Response: Concur

The schedule for Phases 3 and 4 has been developed and will be maintained by the contractor once the contract negotiations for these phases are complete. The inclusion of all phases in the schedule is in accordance with the best practice of being well constructed.

Estimated Completion Date: Award of contract modifications incorporating the schedule are estimated to complete by December 31, 2019.

Recommendation 3: The Secretary of Energy should direct the Assistant Secretary of EM to follow best practices for ensuring the reliability for the IWTU reengineering project's Earned Value Management System (EVMS).

Management Response: Concur

Cost and performance data for Phases 3 and 4 will be included in the EVMS in accordance with EVMS reliability best practices once the contract negotiations have been completed.

Estimated Completion Date: Award of contract modifications incorporating cost and schedule estimates are estimated to complete by December 31, 2019.

Recommendation 4: The Secretary of Energy should direct the Assistant Secretary of EM to develop a strategy, including timeline, to implement the required actions to achieve its preferred disposal pathway, or an alternative, for the SBW.

1

Enclosure

Management Response: Concur

EM is in the process of developing a site options analysis for the Idaho Site and other EM sites to identify opportunities to complete cleanup work through more efficient and innovative approaches over the next decade. We expect to complete the site options analysis in fiscal year (FY) 2020. EM also issued its supplemental high level waste (HLW) interpretation on June 10, 2019, as a first step in a process of potentially opening new disposal pathways for some reprocessing waste. Decisions about whether and how this interpretation of HLW will apply to existing wastes will be the subject of subsequent actions.

Estimated Completion Date: Estimated completion of the Idaho Site options analysis is December 31, 2019.

Recommendation 5: The Secretary of Energy should direct the Assistant Secretary for EM to seek clarification from Congress on DOE authority to classify the SBW as other than HLW if EM determines such clarification is necessary to avoid extended litigation.

Management Response: Non-Concur

Please consider eliminating this recommendation as DOE has determined that such clarification is not necessary.

DOE does not require additional clarification from Congress to classify reprocessing waste as other than HLW. As discussed in the DOE, *Supplemental Notice Concerning U.S. Department of Energy Interpretation of High-Level Radioactive Waste* (84 FR 26835), by not further defining the terms "highly radioactive" and "sufficient concentrations," within the statutory definition of HLW, Congress left it to DOE to determine when reprocessing waste meets these standards. Consistent with its long-standing authority under the Atomic Energy Act of 1954, as amended, (AEA, 42 U.S.C. 2011 et seq.) to ensure that radioactive waste from the United States' defense program is managed and disposed of in a safe manner, DOE has the legal authority to interpret the term HLW in the AEA and the Nuclear Waste Policy Act of 1982, as amended, (NWPA, 42 U.S.C. 10101 et seq.) to determine that certain of its reprocessing wastes are not HLW based on their radiological characteristics. DOE HLW interpretation is consistent with the AEA, the NWPA, and Section 3116 of the 2005 Ronald Reagan National Defense Authorization Act (Section 3116, Pub. L. 108–375). Decisions about whether and how DOE interpretation of HLW will apply to existing wastes, and whether such wastes may be managed as non-HLW, will be the subject of subsequent actions.

Recommendation 6: The Secretary of Energy should direct the Assistant Secretary for EM to develop a strategy, including timeline, to identify and develop a treatment approach for the disposal of the calcine waste to ensure that EM meets the milestone for completing the treatment of calcine waste by the target date of December 31, 2035.

2

Enclosure

Management Response: Concur

DOE will continue to review and update its disposition alternatives for calcine as part of the annual updates to the Idaho National Laboratory Site Treatment Plan. In addition, EM is in the process of developing a site options analysis for the Idaho Site and other EM sites to identify opportunities to complete cleanup work through more efficient and innovative approaches over the next decade. We expect to complete the site options analysis in FY 2020. EM also issued its supplemental HLW interpretation on June 10, 2019, as a first step in a process of potentially opening new disposal pathways for some reprocessing waste. Decisions about whether and how this interpretation of HLW will apply to existing wastes will be the subject of subsequent actions.

Estimated Completion Date: Estimated completion of the Idaho Site options analysis is December 31, 2019.

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Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

David C. Trimble, (202) 512-3841 or trimbled@gao.gov

Staff Acknowledgments

In addition to the contact named above, Casey L. Brown (Assistant Director), Emily Ryan (Analyst in Charge), Juaná Collymore, Jennifer Echard, Richard P. Johnson, Jason Lee, Eli Lewine, Katrina Pekar-Carpenter, Karen Richey, Jeanette Soares, Sheryl Stein, Farrah M. Stone, Paul Sturm, and Sara Sullivan made key contributions to this report.