



June 2022

LOS ALAMOS NATIONAL LABORATORY

Contractor Improving in Safety and Other Areas but Still Faces Challenges

GAO Highlights

Highlights of [GAO-22-105412](#), a report to congressional committees

Why GAO Did This Study

NNSA relies heavily on an M&O contractor to carry out complex and dangerous work related to nuclear weapons production at LANL. Following substantial operational interruptions due to safety lapses, in 2018, NNSA awarded a new contract to manage and operate LANL to Triad. NNSA made changes to the contract with the intent over 10 years to improve safety performance, realize cost savings, and achieve other benefits. NNSA is now seeking to expand plutonium pit production and other missions at LANL and, in turn, increase the laboratory's workforce.

The National Defense Authorization Act for fiscal year 2019 includes a provision for NNSA to report on the costs and benefits of competing any new M&O contract, and for GAO to issue two associated reviews. This is GAO's second review on NNSA's contract with Triad (for GAO's first review, see [GAO-20-292R](#)). In this review, GAO examines (1) steps Triad has taken to improve safety performance at LANL, and how NNSA and other organizations have assessed these steps; and (2) the extent to which anticipated cost savings and other benefits have been realized under the current contract thus far. GAO reviewed NNSA performance evaluations, policies, and regulations, and interviewed DOE and NNSA officials and Triad representatives.

View [GAO-22-105412](#). For more information, contact Allison Bawden at (202) 512-3841 or bawdena@gao.gov.

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What GAO Found

Triad National Security, LLC—the management and operating (M&O) contractor for Los Alamos National Laboratory (LANL) since 2018—has taken steps to improve safety performance and culture at the laboratory. The National Nuclear Security Administration (NNSA) and other federal organizations have assessed these steps positively while acknowledging continued challenges. For example, NNSA found that Triad has made improvements to the documentation and analysis of hazards as well as to policies and practices for reporting safety issues. It has also developed corrective actions to resolve these issues. However, NNSA cited numerous operational incidents, such as injuries and a flood in a nuclear facility, which indicate that lessons learned from errors under the prior contractor have not been fully integrated into laboratory operations. NNSA officials stated they want to see Triad's efforts result in an improved safety culture overall.

NNSA has realized approximately \$35.1 million in anticipated cost savings during the first 3 years of the contract—specifically, lower overall contractor fees paid to Triad versus fees it would have paid the previous LANL contractor. However, in January 2020, GAO found that NNSA did not provide details on the limitations and uncertainties that could affect its cost savings estimate. Such limitations make it difficult to assess how much NNSA can expect to save going forward. For example, NNSA would not realize the total \$76.1 million it anticipated saving if it does not award Triad option years—the last 5 years of the 10 possible years of the contract—which NNSA may award based on contractor performance. NNSA officials stated that Triad has made progress in stabilizing LANL's workforce and has consistently met its annual goal for small business participation. However, Triad is facing challenges attracting new staff and small businesses due to LANL's remote location and the unique nature of LANL's work. NNSA officials said it is too early in the contract's period of performance to determine Triad's overall success in these areas.

Forging of Molten Plutonium at Los Alamos National Laboratory (LANL)



Source: LANL. | [GAO-22-105412](#)

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Abbreviations

DOE	Department of Energy
DOE-EA	Department of Energy Office of Enterprise Assessments
EM	DOE Office of Environmental Management
NNSA	National Nuclear Security Administration
LANL	Los Alamos National Laboratory
M&O	management & operating
NDAA	National Defense Authorization Act
NA-51	NNSA Office of Safety
PF-4	Plutonium Facility-4
SPOMC	safety performance objectives, measures, and commitments
SPP	Strategic Partnership Project
WIPP	Waste Isolation Pilot Plant

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June 14, 2022

Congressional Committees

The National Nuclear Security Administration (NNSA) is responsible for managing a safe, secure, and reliable nuclear stockpile.¹ To carry out this and other missions, NNSA relies on management and operating (M&O) contractors to conduct dangerous and complex work,² such as plutonium research and pit production at NNSA's Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico.³ LANL has historically faced challenges with its safety culture,⁴ which contributed to dangerous safety lapses leading to the suspension of operations at LANL's Plutonium Facility-4 (PF-4) from 2013 to 2017 and the closure of the Department of Energy's (DOE) nearby Waste Isolation Pilot Plant (WIPP) from 2014 to 2017.⁵

Following these incidents, NNSA allowed the contract for LANL to expire 8 years earlier than the maximum period of performance. In June 2018, NNSA awarded a new contract to manage and operate the laboratory in the hopes of achieving improved safety performance, among other

¹NNSA is a separately organized agency within the Department of Energy (DOE) that is responsible for the management and security of DOE's nuclear weapons, nuclear nonproliferation, and naval reactor programs.

²M&O contracts are agreements under which the government contracts for the operation, maintenance, or support, on its behalf, of a government-owned or -controlled research, development, special production, or testing establishment wholly or principally devoted to one or more of the major programs of the contracting agency. Federal Acquisition Regulation, 48 C.F.R. § 17.601.

³Plutonium pits are a key part of U.S. nuclear warheads. Most weapons in the U.S. nuclear stockpile are two-stage nuclear weapons. The first stage consists of a pit typically made of plutonium and other materials that, once detonated along with a second stage, produce the weapon's explosive force.

⁴DOE defines safety culture as the values and behaviors that serve to make safe performance of work the overriding priority.

⁵PF-4 is a nuclear facility at LANL that was constructed in the 1970s and that currently supports missions related to plutonium pit manufacturing, pit surveillance, pit disposition, and manufacturing radioisotope power sources for space and defense applications. WIPP is an underground repository for the disposal of certain forms of nuclear waste generated by DOE nuclear weapons activities conducted at sites such as LANL. As discussed further in this report, these facilities were shut down in the 2013 to 2017 time frame due to operational issues related to safety at LANL.

benefits, as we previously reported.⁶ NNSA awarded the new contract in the midst of increased concerns around safety at LANL as it undertakes an expansion of its nuclear weapons missions, including increased plutonium pit production.⁷

This is the second of two reviews we have conducted in response to provisions included in the John S. McCain National Defense Authorization Act (NDAA) for fiscal year 2019. The NDAA directs NNSA to report on the costs and benefits of competing any new M&O contract, among other things, and it includes provisions for GAO to conduct two associated reviews.⁸ In our first review, issued in January 2020, we reported on the costs of competing NNSA's contract for LANL.⁹ We also reported on benefits NNSA anticipated over the life of the new contract, including improved safety performance, an estimated \$76.1 million in cost savings, and increased workforce stability and small business participation.¹⁰

In this review, we examined (1) what steps the new contractor has taken to improve safety performance at LANL, and how NNSA and other federal organizations have assessed these steps to date; and (2) the extent to which anticipated cost savings and other benefits on which we reported in 2020 have been realized to date under the current contract.

To address the first objective, we reviewed documents and interviewed officials about past and present safety performance issues at LANL. Specifically, we reviewed DOE regulations and other documentation related to safety performance requirements and expectations, such as NNSA's 2018 contract with Triad National Security, LLC to manage and operate LANL. We also reviewed documents describing Triad's actions related to safety, such as Triad documentation of its safety improvement initiatives. We also interviewed officials from NNSA's Los Alamos Field

⁶GAO, *National Nuclear Security Administration Contracting: Review of the NNSA Report on the Los Alamos National Laboratory Contract Competition*, [GAO-20-292R](#) (Washington, D.C.: Jan. 30, 2020).

⁷We have a separate and ongoing review examining NNSA's plutonium modernization plans, schedule, and cost—including for pit production at LANL—in response to several House and Senate committee reports.

⁸Pub. L. No. 115-232, § 3131, 132 Stat. 1636, 2298 (2018).

⁹As we discuss further in this report, NNSA has had multiple contracts to manage and operate LANL throughout its history. Throughout this report, we attempt to clarify the specific contract to which we are referring in any given instance.

¹⁰[GAO-20-292R](#).

Office, which is responsible for oversight of laboratory operations, to understand their perspectives on Triad's safety-related efforts. We reviewed NNSA's documented assessments of these actions, including its year-end performance evaluation reports. For reporting purposes, we grouped the issues discussed in these sources into four thematic categories, including (1) safety issues management, (2) safety control documentation, (3) conduct of operations, and (4) safety culture.

To address the second objective, we reviewed NNSA documents on contractor fees and cost savings, including NNSA's contract with Triad, NNSA's cost savings calculations, and award fee determination letters. We also interviewed NNSA officials to better understand NNSA's cost savings estimation methodology, including any assumptions associated with NNSA's calculations. To determine the extent to which NNSA has achieved its anticipated cost savings to date, we calculated savings from fiscal years 2019 through 2021 based on NNSA documentation of actual fees paid to Triad during this time period. We also identified examples of limitations that NNSA did not identify as part of its cost savings estimate.

To assess workforce stability and small business participation, we reviewed NNSA's contract with Triad and interviewed NNSA officials to identify any workforce or small business participation goals. We also reviewed Triad data on LANL's workforce and funds Triad has obligated to small business subcontracts. We determined these data to be reliable for the purposes of reporting on Triad's progress in these areas. We made this determination based on interviews with NNSA officials and Triad representatives who manage the data, reviews of related documentation, and a comparison of the data to source documents. We also reviewed NNSA's annual performance evaluation reports to determine how NNSA has assessed Triad's workforce and small business performance. We interviewed officials from NNSA's Los Alamos Field Office to understand their perspectives on Triad's efforts in these areas to date. Appendix I provides more information on our scope and methodology.

We conducted this performance audit from September 2021 to June 2022 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.

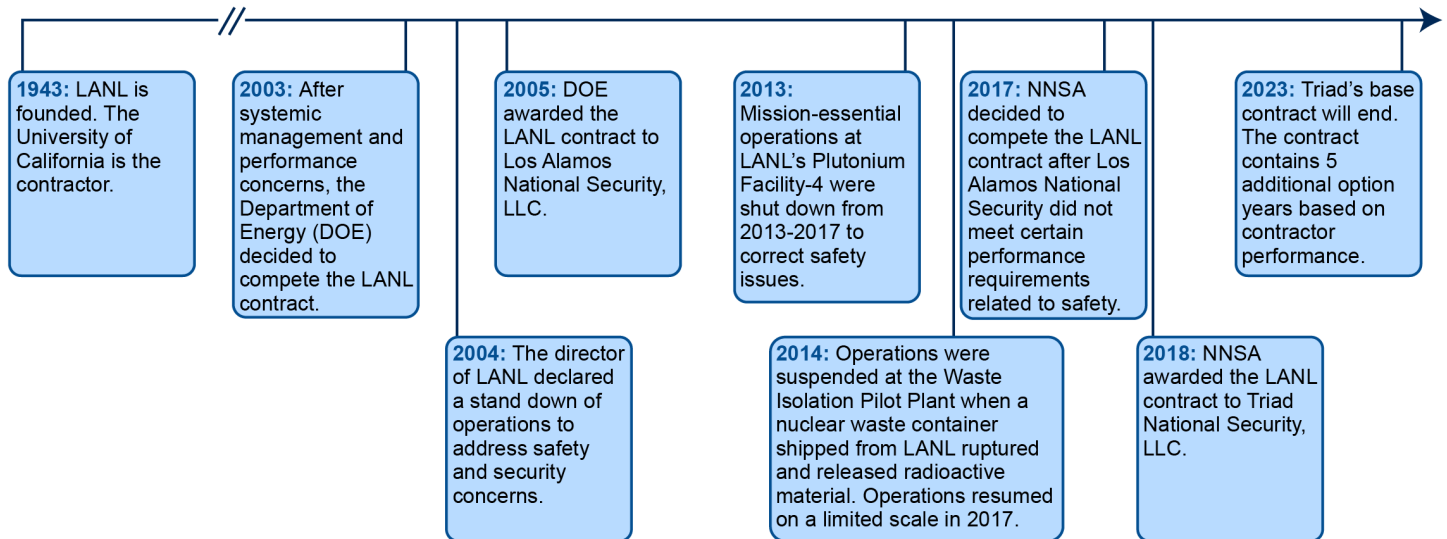
Background

History of Contractor Safety Performance at LANL

According to NNSA, LANL’s primary mission is national security. This includes the design, qualification, certification, and assessment of nuclear weapons. Several of LANL’s operations involve working with high-hazard materials. Over the past 2 decades, we have documented safety and security weaknesses at LANL that have twice contributed to NNSA’s decision to seek a new M&O contractor for the laboratory. Figure 1 presents a timeline of contractor changes and significant safety issues.

Figure 1: Time Line of Contractor Changes and Related Safety Issues at Los Alamos National Laboratory (LANL), 1943–2023

The National Nuclear Security Administration’s (NNSA) decisions to seek new management and operating contractors for LANL have been preceded by significant safety issues.



Source: Prior GAO reports on LANL. | GAO-22-105412

1943 to 2006. The University of California managed and operated LANL. Our November 2005 report on the stand-down of laboratory operations in 2004 cited numerous safety and security issues that led to the event, including the partial blinding of a student in a laser accident and the mishandling of classified information.¹¹ In January 2008, we reported on

¹¹GAO, *Stand-Down of Los Alamos National Laboratory: Total Costs Uncertain; Almost All Mission-Critical Programs Were Affected but Have Recovered*, [GAO-06-83](#) (Washington, D.C.: Nov. 18, 2005).

long-standing safety concerns at LANL,¹² including criticality concerns and noncompliant safety documentation under the University of California's management.¹³ We reported at that time that, from fiscal year 2003 through fiscal year 2005, LANL experienced 16 reported safety accidents serious enough to warrant investigation, including radiological exposure incidents. Due to systemic management concerns under the University of California, DOE decided to compete its contract for LANL management and operations, and it awarded a new contract in 2005.

2006 to 2018. Los Alamos National Security, LLC managed and operated LANL.¹⁴ As we previously reported, NNSA allowed this contract to expire because Los Alamos National Security did not meet certain levels of performance, including safety performance, according to NNSA officials.¹⁵ As previously discussed, several significant safety incidents under the contractor contributed to NNSA's decision to compete the contract, which could have been extended until 2026. In one incident, operations were suspended at PF-4 following a series of violations of nuclear safety

¹²GAO, *Los Alamos National Laboratory: Information on Security of Classified Data, Nuclear Material Controls, Nuclear and Worker Safety, and Project Management Weaknesses*, [GAO-08-173R](#) (Washington, D.C.: Jan. 10, 2008).

¹³Criticality involves an inadvertent nuclear chain reaction. To prevent such an occurrence from happening, DOE regulations and directives require contractors to evaluate potential accident conditions and put in place appropriate controls and safety measures.

¹⁴Los Alamos National Security, LLC, was a limited liability company made up of the Regents of the University of California, Bechtel National, BWXT Government Group, Inc., and URS, an AECOM company.

¹⁵The contract contained an award term provision, which allowed the contractor to earn additional years of contract performance between fiscal years 2013 and 2026, based on achieving certain levels of performance. In May 2019, we reported that NNSA decided to recompile the contract and revoke all award terms it had awarded Los Alamos National Security after the contractor failed to earn its award term for the fourth year in a row. NNSA officials whom we interviewed for our May 2019 report stated that the agency needed to extend the end of the contract for 1 year from fiscal years 2017 to 2018 in order to have sufficient time to complete the acquisition for the new contract. See GAO, *Performance Evaluations Could Better Assess Management and Operating Contractor Costs*, [GAO-19-5](#) (Washington, D.C.: Feb. 26, 2019).

controls and other breakdowns in work discipline.¹⁶ Additionally, operations at WIPP were suspended after workers at LANL used incompatible absorbent in a nuclear waste container that caused the container to later explode underground, releasing a small amount of radiation into the environment above ground.

2018 to present. Triad is the current M&O contractor at LANL.¹⁷ The value of the 5-year base period of the contract is approximately \$11.4 billion, which includes management and operating costs, fixed contractor fees, and contractor award fees of up to approximately \$130 million that Triad can earn for positive performance. The contract also includes 5 additional option years, with an approximate value of \$11.7 billion, according to NNSA estimates—including additional fixed and award fees—to be exercised at NNSA’s discretion.¹⁸ NNSA’s decision of whether to exercise the option years, as well as the amount of fees to be awarded to Triad, is based on annual evaluations of the contractor’s performance in meeting objectives and goals to which NNSA and Triad agree for each period of performance, according to the contract.

As we reported in January 2020, NNSA officials stated that improving contractor safety performance was a key driver in competing the contract, and that NNSA sought to address these issues by including a performance clause focused on improving safety culture at LANL.¹⁹

¹⁶Triad representatives whom we interviewed and who worked at LANL under the previous contractor cited some specific incidents that precipitated NNSA’s decision to shut down PF-4, including workers co-mingling plutonium rods dangerously close together in violation of nuclear safety controls to prevent a criticality accident. According to a 2014 NNSA report following the shutdown, there were several other incidents indicating a fundamental breakdown in work control and conduct of operations. See National Nuclear Security Administration, *Final Report for Criticality Safety Program Weaknesses Resulting in an Operational Pause at the Plutonium Facility (PF-4): A Root Cause Analysis of Federal Oversight* (Washington, D.C.: April 2014).

¹⁷Triad National Security, LLC, is a limited liability company composed of Battelle Memorial Institute, the Regents of the University of California, and the Texas A&M University System.

¹⁸While the values of some of the base years in its contract with Triad include Strategic Partnership Project (SPP) costs and fees, to date, NNSA has yet to determine the value of these costs and fees during the option years. Therefore, SPP costs and fees are not included the \$11.7 billion estimated value of the option years in the contract. SPPs are a mechanism by which the contractor may perform work for non-DOE entities or allow non-DOE entities to use DOE facilities for work that is not directly funded by DOE appropriations.

¹⁹[GAO-20-292R](#).

According to NNSA's 2019 cost-benefit report on the competition, NNSA also anticipated several other benefits from competing the contract. These benefits included \$76.1 million in estimated cost savings over the potential 10-year life of the contract,²⁰ workforce stability at LANL for 5 to 10 years, and an increase in small business participation by 15.7 percent over the 5-year base period of the contract.²¹

NNSA awarded Triad the new LANL contract in the midst of an expansion of the laboratory's nuclear weapons missions that has increased concerns around safety and workforce stability. NNSA is required by law to produce plutonium pits—a critical nuclear weapon component—at a minimum threshold that increases over several years, including at least 30 at LANL in 2026, in order to maintain the viability of the nuclear weapons stockpile.²² The U.S. is limited currently to production of pits for research and development purposes; it has not manufactured a new pit for use in a weapon since 2012, and it has not had the capability to produce more than 10 pits per year for over 2 decades.²³

To achieve a 30 pit per year capability, LANL is currently undertaking several large-scale infrastructure investments to build new facilities and configure existing facilities with new equipment, while also increasing its workforce and operations in areas like waste management, pit disassembly and oxide conversion, and high-performance computing systems.²⁴ The challenges with such an expansion are compounded by the need to undertake construction and installation efforts alongside ongoing dangerous plutonium and other nuclear operations, according to NNSA officials. Because of its expanding mission, officials stated that

²⁰The \$76.1 million in potential cost savings was based on the maximum fee that Triad could earn under the contract compared to the maximum fee that could have been earned under the prior contract to manage and operate LANL, according to NNSA's cost-benefit report and NNSA officials.

²¹National Nuclear Security Administration, *Cost-Benefit Analysis for Competition of Management and Operating Contracts* (Washington, D.C.: April 2019).

²²50 U.S.C. § 2538a. NNSA is required by law to produce plutonium pits at a minimum threshold that increases over several years, including at least 30 in 2026. Separately from this review, we are reviewing NNSA's integrated master schedule for producing plutonium pits.

²³LANL plans to produce their first weapons-ready (or "war reserve") pit by 2023.

²⁴As stated above, we have ongoing work examining NNSA's plutonium modernization plans, schedule, and cost—including for pit production at LANL.

LANL's budget has also increased substantially in recent years. Specifically, DOE's fiscal year 2023 budget request of approximately \$4.6 billion for LANL represents a 130 percent increase from its fiscal year 2018 budget request for LANL of approximately \$2 billion.

NNSA Contractor Safety Requirements

NNSA contractors that manage and operate NNSA facilities must adhere to several safety-related federal regulations and additional DOE and NNSA safety requirements—many of which NNSA incorporated by reference in its contract with Triad. For example, according to the contract, Triad is required to comply with DOE's Facility Safety Order, which establishes contractor requirements for criticality safety, fire protection, mitigation of natural hazards, and the design of safety structures, systems, and components.²⁵ Additional safety requirements include the following:

Safety issues management. DOE requires M&O contractors to maintain contractor assurance systems.²⁶ Such systems include an issues management process that enables the contractor to report and assess the severity of potential issues, including safety issues, and to develop corrective actions as needed to prevent recurrence.²⁷

Safety control documentation. DOE requires contractors to analyze and document potential hazards, as well as any mitigating controls that can help ensure safe operations of nuclear facilities. For example, DOE regulations require contractors to maintain a safety basis for each nuclear facility at a site.²⁸ Safety bases document hazards and the resulting set of controls that provide reasonable assurance that a nuclear facility can be operated safely. Safety bases provide progressively more stringent levels

²⁵DOE Order 420.1C.

²⁶Contractor assurance systems are self-monitoring systems designed and used by M&O contractors to oversee their own performance and to self-identify and correct potential problems. We previously reported on NNSA's use of information from contractor assurance systems to conduct oversight of M&O contractors. See *National Nuclear Security Administration: Actions Needed to Clarify Use of Contractor Assurance Systems for Oversight and Performance Evaluation*, [GAO-15-216](#) (Washington, D.C.: May 22, 2015).

²⁷See Department of Energy, *DOE Order 226.1B, Implementation of Department Of Energy Oversight Policy* (Washington, D.C.: Apr. 25, 2011); and National Nuclear Security Administration, *NNSA Supplemental Directive 226.1C, NNSA Site Governance* (Washington, D.C.: Oct. 1, 2019).

²⁸10 C.F.R. §§ 830.3, 830.201-830.207.

of hazard control based on whether the hazard affects a single worker only, the facility more broadly, or the public and environment around the facility.

Within specified nuclear facilities, contractors must also develop and document a criticality safety program that addresses operations dealing with fissionable material with the potential for criticality, and which ensures that such material—such as plutonium being machined or manipulated—remains subcritical.²⁹ As part of such a program, DOE requires contractors to develop criticality safety evaluations, which analyze the criticality hazard associated with a fissionable material process or system and develop limits and controls to prevent a criticality accident.³⁰

Disciplined conduct of operations. DOE requires contractors to establish a conduct of operations program that ensures workers are held accountable for safe operations, report issues promptly, inspect equipment, and exhibit behavioral discipline.³¹

Safety culture. DOE defines safety culture as an organization's values and behaviors, modeled by its leaders, which serve to make the safe performance of work the overriding priority to protect the workers, the public, and the environment. DOE's Integrated Safety Management System Guide breaks down safety culture into three focus areas—leadership, worker engagement, and organizational learning.³² The guide provides associated metrics that sites can use to assess an organization's safety culture.

²⁹10 C.F.R. § 830.204.

³⁰Department of Energy, *DOE Order 420.1C, Facility Safety* (Washington, D.C.: Nov. 14, 2019); and *DOE-STD-3007-2017, Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities* (Washington, D.C.: Dec. 20, 2017).

³¹Department of Energy, *DOE Order 422.1, "Conduct of Operations"* (Washington, D.C.: Feb. 3, 2022).

³²According to senior DOE officials, integrated safety management is DOE's overarching framework for safely planning, executing, and monitoring work at nuclear facilities. DOE's Integrated Safety Management System Guide (DOE Guide 450.4-1C) provides supplemental information to help organizations implement DOE's requirements for integrated safety management.

As we reported in 2020, NNSA awarded the new contract to manage and operate LANL in the hopes of achieving improved safety performance.³³ NNSA officials whom we interviewed at that time told us they sought to address LANL's safety performance challenges by including a performance clause focused on improving the safety culture at LANL in the new contract. This clause states that the contractor is to improve the organizational and safety culture by allocating resources and leadership focus to ensure mission deliverables and desired outcomes are achieved and that the laboratory is operated efficiently, safely, and securely. This clause cites DOE's safety culture focus areas of leadership, worker engagement, and organizational learning as areas for specific attention.

NNSA's Approach to Safety Performance Assessment

NNSA's annual performance evaluation process is intended to assess the contractor's entire performance for the year, including compliance with the DOE, NNSA, and regulatory requirements described above. NNSA's Los Alamos Field Office has the primary responsibility to evaluate contractor performance in accordance with NNSA's Corporate Performance Evaluation Process policy.³⁴ According to this policy, NNSA develops an annual performance evaluation and measurement plan that establishes high-level goals and objectives against which NNSA evaluates contractor performance on an ongoing basis. The plan also includes more specific key outcomes against which NNSA will evaluate contractor performance at the end of each fiscal year.

Annual performance evaluation reports summarize NNSA's year-end assessment of the contractor's performance in meeting the goals, objectives, and key outcomes established in NNSA's performance evaluation and measurement plans.³⁵ The reports provide a final rating that NNSA uses to determine the amount of fee to award the contractor for that year. As discussed above, NNSA's contract with Triad states that

³³[GAO-20-292R](#).

³⁴National Nuclear Security Administration, *NAP-540.3: Corporate Performance Evaluation Process for Management and Operating Contractors* (Washington D.C.: Dec. 22, 2016). NNSA's corporate performance evaluation policy was previously called NAP 4-C. NNSA renumbered the policy as NAP 540.3 in 2019.

³⁵While NNSA's Los Alamos Field Office has the primary responsibility to conduct day-to-day oversight of contractor activities and evaluate Triad's contract performance, other federal organizations, such as DOE's Office of Enterprise Assessments, also conduct routine reviews of LANL operations. NNSA may consider these organizations' findings when assessing performance, but NNSA retains sole responsibility to evaluate contract performance.

NNSA may also award up to a maximum of 5 additional option years beyond the 5-year base period of the contract, depending on performance.³⁶

NNSA's performance evaluation policy does not require that NNSA's performance evaluation and measurement plans contain explicit safety performance objectives or key outcomes; however, NNSA's 2021 implementing guidance includes sections discussing the use of safety performance information for the purpose of performance assessment.³⁷ Officials at NNSA's Los Alamos Field Office stated that NNSA has, to date, defined NNSA's safety performance expectations in general terms in order to encourage Triad to address safety holistically rather than focus on specific areas to the exclusion of others. For example, in its fiscal year 2022 performance evaluation and measurement plan, NNSA called on Triad to "[cultivate] a performance excellence culture that encompasses all aspects of operations and continues to emphasize safety and security, improving the responsiveness of Triad's leadership team to issues and opportunities for continuous improvement." Officials at NNSA's Los Alamos Field Office stated that their oversight activities in a given year may nonetheless focus on the contractor's compliance with specific safety-related laws and requirements, as appropriate.³⁸

³⁶NNSA has moved towards using option years instead of award terms to incentivize M&O contractor performance. In 2019, we reported that DOE commonly used an award term incentive—where the contractor can earn an additional year of performance, following the base years, for each year the contractor exceeded certain thresholds in annual performance evaluations (see [GAO-19-5](#)). According to NNSA officials whom we interviewed for this report, the award-term arrangement obligated NNSA to provide additional years of performance well in advance, which put NNSA in a difficult position if, in the interim, contractor performance began to decline. Under an option year arrangement, NNSA may wait until up to 60 days before an option year would begin before awarding it. NNSA thus decided to incorporate option years under the Triad contract instead of the award term incentive, in case contractor performance decreased towards the end of the contract. To date, NNSA has not yet awarded any option years to Triad.

³⁷National Nuclear Security Administration, *Fiscal Year 2021 Corporate Performance Evaluation Process Annual Implementation Guidance* (Washington, D.C.: Mar. 17, 2021).

³⁸According to officials, NNSA takes a risk-based approach to oversight, and focuses its oversight activities on areas in which contractor performance has been lagging, contractors' self-monitoring capabilities are less mature, or hazards are high. At LANL, NNSA's Los Alamos Field Office develops annual assessment plans that outline specific safety-related assessments for the fiscal year. These assessments may focus on any number of safety-related functional areas, such as electrical safety, radiation protection, and criticality safety, according to officials.

NNSA and Other Assessments Note Contractor's Safety Improvements, but Challenges Remain

In the first 3 out of 10 possible years of contract performance under Triad, NNSA officials as well as documented assessments completed by NNSA and other organizations have noted demonstrable improvements. Also noted were ongoing challenges in key safety areas that contributed to NNSA's decision to compete the LANL contract in 2018. These safety areas include safety issues management, safety control documentation, disciplined conduct of operations, and safety culture.³⁹ (Appendix II includes a summary of NNSA's assessments of safety performance at LANL for fiscal years 2019 through 2021.)

Safety issues management. Previous DOE assessments found that safety issues management under the prior LANL contractor had numerous problems, including (1) personnel misclassifying the severity associated with some issues, (2) rarely analyzing the effectiveness of corrective actions to address such issues, and (3) not following procedures when such analyses were conducted.⁴⁰ According to DOE officials, these problems allowed issues to go unresolved for years and problematic behaviors associated with these issues to persist.

According to Triad representatives and NNSA officials and documents, Triad has taken several steps to improve safety issues management. For example, Triad launched an issues management improvement initiative in 2020 that included updating LANL's issues management policy to streamline the processes associated with each safety issue's risk level. According to Triad representatives with whom we spoke, Triad determined that LANL's issues management policy contained procedural

³⁹We interviewed officials at NNSA's Los Alamos Field Office for their perspectives on safety areas of concern that contributed to NNSA's decision to re compete its contract for LANL in 2018 and that have informed NNSA's safety performance assessment approach with Triad to date. We identified key safety issues that emerged in these and other interviews we conducted with officials from NNSA's Office of Safety (NA-51), DOE's Office of Enterprise Assessments (DOE-EA), and other federal offices. We also identified safety issues raised in NNSA performance evaluation reports, DOE-EA reports, and other assessments. For reporting purposes, we grouped the issues discussed in these sources into four thematic categories: (1) safety issues management, (2) safety control documentation, (3) conduct of operations, and (4) safety culture. See appendix I for further details about our methodology.

⁴⁰Department of Energy Inspector General, *Issues Management at the Los Alamos National Laboratory*, DOE-OIG-16-07 (February 2016); and Department of Energy Office of Enterprise Assessments, *Assessment of the Management of Nuclear Safety Issues at the Los Alamos National Laboratory* (Washington, D.C.: April 2019). According to DOE's 2019 report, such weaknesses can allow layers of defense for nuclear safety to degrade to the extent they did leading to the pause in July 2013 of key fissile material operations in Plutonium Facility-4 (PF-4) at LANL for over 4 years.

steps for medium- and high-risk safety issues that exceeded DOE requirements and were sometimes unnecessary, which motivated staff to rarely use medium- and high-risk designations. Triad revised its policy in 2020 by removing some of these requirements and granting more discretion to responsible line managers for determining the right steps to address issues, among other changes. Representatives also told us that Triad established teams to periodically review the effectiveness of a random sample of corrective actions.

NNSA officials noted several Triad efforts have appeared to encourage LANL staff to proactively identify and report safety issues. For example, managers have self-reported incidents in which they themselves were chiefly involved. Triad also employs “learning teams” to review and report on lessons learned from positive and negative operational experiences. NNSA officials stated that such efforts appear to be resulting in more issues being identified in advance rather than uncovered by an external evaluation or as the result of adverse events.

However, in its fiscal year 2020 performance evaluation report, NNSA noted that Triad’s issues management process still lacked an effective means to evaluate risk and identify trends across the laboratory. NNSA cited security and maintenance issues that indicated Triad’s efforts to improve corrective actions were not as effective as they could be. In its fiscal year 2021 performance evaluation report, NNSA found that there had been minimal improvement in establishing a consistent approach to categorizing and reporting events. Some groups at LANL took an inclusive approach to reporting issues, while others reported issues only once they triggered certain thresholds. According to NNSA’s report, Triad’s inconsistent approach to managing and reporting issues increases the risk for repeat events, compliance violations, and hazardous material releases.

Safety control documentation. According to NNSA officials and Triad representatives who served under the prior LANL contractor, the prior contractor’s safety control documentation was characterized by incomplete analyses, including safety basis and criticality safety analyses. For example, during the 2013-2017 period when operations at LANL’s Plutonium Facility-4 (PF-4) were suspended, external assessments found that of over 400 criticality safety evaluations for the facility, about 300 were noncompliant. This was because the evaluations did not account for certain hazards, including earthquakes or other large-scale events that could compromise systems meant to keep plutonium from going critical.

Triad inherited a large backlog of work to bring these evaluations into full compliance, according to NNSA officials.

NNSA officials and assessments have cited several positive efforts to improve safety control documentation at LANL under Triad. For example, officials stated that Triad has been more transparent and communicative with NNSA's field office when updating and validating safety basis documentation compared to the prior contractor. They also cited two recent cases where Triad staff identified possible gaps related to fire hazards in safety basis documentation for two facilities. Triad also recently updated its unreviewed safety question process, which NNSA performance documentation stated should help increase efficiency and improve LANL's process for addressing potential inadequacies in safety basis documentation.⁴¹ Triad representatives with whom we spoke also stated that the backlog of noncompliant criticality safety evaluations it inherited from the prior contractor has been nearly addressed. They also stated that Triad anticipates bringing the last of PF-4's evaluations into full compliance by the end of fiscal year 2022.

NNSA and DOE assessments and officials have nonetheless noted some ongoing challenges in LANL's safety control documentation. NNSA officials and performance evaluation reports noted some recent omissions in safety basis documentation that indicate that Triad has not fully applied the lessons learned from safety basis problems under the prior contractor. For example, in its fiscal year 2021 performance evaluation report, NNSA cited a recent Defense Nuclear Facilities Safety Board evaluation that found Triad's safety bases for PF-4 and related facilities failed to consider the complete spectrum of possible chemical reactions present in some nuclear waste streams.⁴² The Safety Board's report stated that such an omission contributed to the radiological release at the Waste Isolation Pilot Plant (WIPP) in 2014.

⁴¹10 C.F.R. § 830.3(a) defines the unreviewed safety question process as the mechanism for keeping a safety basis current by reviewing potential unreviewed safety questions, reporting unreviewed safety questions to DOE, and obtaining approval from DOE prior to taking any action that involves an unreviewed safety question.

⁴²The Defense Nuclear Facilities Safety Board is an independent organization within the executive branch of the U.S. government, chartered with the responsibility of providing recommendations and advice to the President and the Secretary of Energy regarding public health and safety issues at DOE's defense nuclear facilities. It was established by statute in 1988. National Defense Authorization Act, Fiscal Year 1989, Pub. L. No. 100-456, div. A, tit. XIV, § 1441, 102 Stat. 1918, 2076-2085 (1988) (codified as amended at 42 U.S.C. §§ 2286-2286l).

Officials at NNSA's Los Alamos Field Office also cited a comparable incident from February 2021, in which the minor combustion of oxygen and titanium welding shards in a waste drum at PF-4 revealed that Triad had not considered certain chemical reactions in its safety basis for the facility. NNSA's fiscal year 2021 report noted additional safety basis problems, such as inconsistencies and incomplete information in Triad's evaluation of a significant water spill incident that revealed potential gaps in PF-4's safety basis.

With regard to criticality safety evaluations, DOE reported in May 2021 that most of the criticality safety evaluations it reviewed at PF-4 were compliant and that all derived criticality safety controls that DOE reviewed were robust.⁴³ However, in its fiscal year 2021 performance evaluation, NNSA noted that Triad's criticality safety limits at PF-4 had become overly restrictive, which could reduce operational flexibility needed for LANL's expanding missions. According to NNSA officials, such a conservative approach to safety controls, though perhaps well intended, can encourage staff to circumvent safety procedures in frustration. It can also lead to missed opportunities to safely consolidate materials and free up space to aid in the expansion of plutonium operations.

Disciplined conduct of operations. According to NNSA officials and assessments, poor conduct of operations under the previous contractor—such as the use of an incompatible absorbent in a nuclear waste container that caused the radiological release at WIPP—was a key factor contributing to the decision to shut down operations at WIPP and PF-4 in the 2013 to 2017 time frame.⁴⁴

Triad documents and Triad representatives with whom we spoke described efforts to improve conduct of operations at LANL. For example,

⁴³Department of Energy Office of Enterprise Assessments, *Assessment of the Triad National Security, LLC Nuclear Criticality Safety Program at the Los Alamos National Laboratory* (May 2021).

⁴⁴From 1988 to 2015, NNSA was responsible for the acquisition and management of legacy nuclear waste cleanup work at LANL, though such activities were funded by DOE's Office of Environmental Management (EM). The radiological release at WIPP occurred during this period. In September 2015, NNSA and EM signed a memorandum of understanding (MOU) that transferred the acquisition and management of legacy waste at LANL to EM, and maintained responsibility for newly generated waste with NNSA. According to officials at NNSA's Los Alamos Field Office, while NNSA's portfolio of waste-related effort has been reduced as a result of the 2015 MOU, the issues surrounding the 2014 WIPP accident remain relevant for Triad, which is responsible for newly generated waste in buildings such as PF-4. Generation of new waste will increase as plutonium pit production work expands.

Triad established worker-led environment, safety, and security teams for each of the laboratory's directorates. As of January 2021, about 465 workers had participated in such teams, which assist in developing LANL's internal safety and security goals, convene learning teams to investigate safety issues, and lead various behavioral and cultural improvement initiatives around safety. Triad also implemented a safe conduct of operations "campaign" based on eight core principles that Triad has integrated into employee orientation materials and safety culture trainings for senior staff, according to Triad documentation. As of January 2022, nearly 1,000 senior staff have taken safety trainings based on these principles, according to Triad.

NNSA officials cited additional efforts by Triad that they stated demonstrate the potential to improve conduct of operations. These efforts include increased rigor and frequency of management observations and verifications in floor operations. They also include an incentive program that provides lump-sum rewards to leaders and staff who achieve significant performance goals and exhibit desired behaviors.

Recent NNSA assessments have nonetheless highlighted several incidents that indicate improving conduct of operations at LANL remains a challenge. In its fiscal year 2021 performance evaluation report and related documentation, NNSA cited events related to conduct of operations that affected LANL's mission during the fiscal year, including

- nonadherence to safety procedures that led to a water overflow in a PF-4 vault,
- nonadherence to required glovebox procedures,⁴⁵
- unauthorized work taking place during construction activities, and
- a series of injuries and lower-level issues at PF-4.

NNSA officials stated that efforts such as Triad's incentive program and its renewed focus on management observations and verifications in floor operations are positive steps toward affecting behavioral change, but reduction in incidents remains an important long-term goal. NNSA recently made this expectation more explicit by including a new

⁴⁵In a nuclear laboratory, a glovebox is a sealed container equipped with two flexible gloves that allow the user to manipulate nuclear materials without being exposed to radioactivity.

performance objective related to minimizing operational upsets in its fiscal year 2022 performance evaluation and measurement plan for Triad.⁴⁶

Safety culture. NNSA officials cited the aforementioned problems with safety issues management, safety control documentation, and conduct of operations, among other problems, as indications that LANL's safety culture under the prior contractor needed systemic improvement.

In addition to Triad's efforts to address specific safety processes or practices, NNSA officials cited additional strategic efforts Triad has taken to address safety culture—which influences all of the specific safety areas previously discussed. For example, Triad participated in an NNSA Office of Safety working group stood up in 2021. The working group aimed to improve contractors' and NNSA's use of safety performance information from contractor assurance systems—specifically, contractors' annual safety performance objectives, measures, and commitments⁴⁷—for evaluating contractor safety performance and culture. Triad subsequently collaborated with NNSA to establish annual safety performance objectives, measures, and commitments for fiscal year 2022 that are aligned with DOE's three safety culture focus areas (leadership, organizational learning, and employee engagement). Triad also stood up a senior-level working group to develop a strategy to improve LANL's culture along the three focus areas. Triad has also participated in a DOE Safety Culture Improvement Panel, a high-level organization devoted to promoting and monitoring safety culture across DOE, and it contracted

⁴⁶NNSA's new objective states that contractors are to "demonstrate leadership in driving enhanced and sustainable formality and rigor of operations through proactive implementation of effective and efficient measures to minimize operational upsets that have potential to impact mission." A senior NNSA official that helped develop the objective stated that NNSA worked with Triad to develop the objective following a 2021 study by NNSA's Office of Safety, which found that corrective actions had been ineffective at reducing the average number of work stoppages related to conduct of operations at NNSA sites for the last decade.

⁴⁷Under the clauses that DOE regulations require to be included in M&O contracts, contractors must establish annual "safety performance objectives, measures, and commitments" (commonly referred to as SPOMCs) (see 48 C.F.R. § 970.5223-1). SPOMCs are used for self-assessment as part of contractor assurance systems, and are thus distinct from the "goals, objectives, and key outcomes" that NNSA establishes in its annual performance evaluation and measurement plans to evaluate contractor performance. However, recent NNSA policies have incorporated and expanded upon the use of contractors' SPOMCs as part of NNSA's annual performance evaluation process [see National Nuclear Security Administration, *Functions, Responsibilities, and Authorities (FRA) For Safety Management*, Supplemental directive 450.2B (Washington, D.C.: Apr. 23, 2021); and *Fiscal Year 2021 Corporate Performance Evaluation Process Annual Implementation Guidance*]. NNSA's effort to clarify the use of SPOMCs is ongoing.

with an external consultant to help LANL improve its methodology to conduct internal safety culture surveys.

NNSA officials nonetheless stated that safety culture at LANL still needs improvement, as evidenced by, for example, the incidents cited in NNSA's fiscal year 2021 performance evaluation report (as discussed above). NNSA officials stated that they see some of the biggest challenges to improving safety culture at PF-4, where significant construction is occurring alongside active plutonium pit production, disassembly operations, and pit surveillance. According to officials involved in a recent NNSA Office of Safety study of conduct of operations, a culture where efficiency is prioritized above safety still prevailed in some operations at PF-4. The officials also noted that expanding missions at LANL—to include numerous high hazard activities in PF-4—may further exacerbate these cultural issues and challenge efforts to improve safety culture at the laboratory. Officials from NNSA's Los Alamos Field Office stated that, overall, Triad has improved safety performance in some specific areas, but NNSA wants to see these improvements result in improved operational discipline and safety culture overall.

NNSA Is Saving Money in Contractor Fees, and Reports Show Progress in Achieving Other Benefits

NNSA Is Saving Money in Contractor Fees, But Limitations in Its Cost Savings Estimate Make It Difficult to Assess Future Cost Savings

NNSA has begun realizing some of the cost savings that it anticipated achieving by competing the M&O contract for LANL—specifically, reduced contractor fees in comparison to fees allowed under its prior contract. However, as we previously reported, NNSA did not include full details on the limitations and uncertainties that could affect its cost savings estimate. Such limitations and uncertainties make it difficult to assess the actual amount NNSA can expect to save over the life of the contract.⁴⁸

⁴⁸[GAO-20-292R](#).

NNSA's 2019 report on the agency's cost-benefit analysis on the contract competition estimated that the agency could save approximately \$76.1 million over 10 years by reducing available fees under the newly competed contract.⁴⁹ NNSA officials stated that NNSA estimated these cost savings by comparing the maximum contractor fees that the new contractor could earn over the potential 10-year life of the contract with the maximum contractor fees that the previous contractor would have earned for the same period of work.⁵⁰ Using NNSA documentation of these fees paid to date, we estimated that NNSA has saved approximately \$35.1 million due to lower overall contractor fees during the

⁴⁹National Nuclear Security Administration, *Cost-Benefit Analysis*.

⁵⁰Specifically, NNSA estimated approximately \$76.1 million in potential cost savings by adding up the difference between the three fees Triad would be paid based on Triad's fee rate versus fees paid to the prior contractor, Los Alamos National Security, LLC, based on its fee rate: (1) fixed fees (approximately \$216 million less to Triad), (2) award fees (approximately \$168 million more to Triad), and (3) Strategic Partnership Project (SPP) fees (approximately \$27 million less to Triad), according to NNSA's calculations. As explained previously, SPPs are a mechanism by which the contractor may perform work for non-DOE entities—including other federal agencies—or allow non-DOE entities to use DOE facilities for work that is not directly funded by DOE appropriations. NNSA officials stated that the non-DOE entities sponsoring such work pay all costs and fees associated with SPPs. NNSA's cost estimate assumed that all SPPs would be sponsored by federal entities, and thus, according to NNSA officials, NNSA considered any associated savings in SPP fees to be savings to the federal government as a whole, if not to NNSA specifically.

period of performance under our review (fiscal years 2019 through 2021).⁵¹

NNSA officials stated that the agency will continue to realize savings due to lower contractor fees resulting from Triad's lower overall contractor fee rate compared to the previous contractor's fee rate.⁵² Further, NNSA officials stated that its contract with Triad represents a shift in how contractor fees are distributed: by decreasing the percentage of fees that are fixed, and increasing the percentage of fees that are tied to contractor performance (i.e., at-risk award fees).⁵³ NNSA officials said this shift increases contractor accountability by tying more fee to performance.

We reported in January 2020 that NNSA's cost-benefit report for competing the LANL contract did not provide details on the limitations that could affect its cost savings estimate.⁵⁴ The following are examples of

⁵¹As discussed further in our report, NNSA's estimate included two assumptions that affected our estimate of cost savings achieved to date: the contractor would receive optimal performance ratings (and thus 100 percent of its performance-based award fee), and all SPP fees would go towards projects sponsored by federal entities. With regard to award fees, though it is common for contractors to receive performance ratings below 100 percent, NNSA did not want to consider lower award fees resulting from suboptimal performance as a "savings" to the government, and thus estimated potential savings assuming optimal contractor performance, according to officials. During the period of performance under our review (fiscal years 2019 through 2021), NNSA's performance ratings for Triad ranged from 66.3 to 88 percent, according to NNSA's award fee determinations. (We previously reported on DOE's and NNSA's contractor performance ratings for fiscal years 2006 through 2016 and found that for that period contractors earned a median of 94 percent of available award and incentive fees. See [GAO-19-5](#).) Our cost savings estimate, therefore, reflects the difference between what NNSA would have paid the two contractors in award fees based on Triad's actual performance ratings. With regard to SPP fees, about 91 percent of these fees were paid by federal sponsors during the period of performance under our review, according to NNSA documentation. Therefore, our estimate of actual cost savings to the federal government reflects approximately 91 percent of the overall cost savings from SPP fees. See appendix I for further details on our estimate of actual cost savings.

⁵²NNSA's estimated cost savings were very modest in light of the contract cost. Specifically, the approximate \$76.1 million that NNSA anticipated saving over the potential 10-year contract represents about 0.3 percent of the total cost of the potential 10-year life of the contract (approximately \$24 billion).

⁵³According to NNSA's cost savings calculations and NNSA officials, under the previous contractor, NNSA agreed to pay 2 percent in fixed fees and up to 0.5 percent in at-risk award fees. In its contract with Triad, NNSA agreed to pay 1 percent in fixed fees and up to 1.275 percent in at-risk award fees. To establish contractor fees for the current LANL contract, NNSA applied Triad's agreed-upon fee rates to the estimated management and operating costs for the laboratory over the potential 10-year contract.

⁵⁴[GAO-20-292R](#).

such limitations, which make it difficult to assess the extent to which NNSA can expect to achieve the approximate \$76.1 million it estimated saving over the potential 10-year life of the contract.

Variable award fees based on contractor performance. NNSA's cost savings estimate assumed that the contractor would receive 100 percent of its potential award fee based on performance, according to officials. However, NNSA officials stated that while they encourage high contractor performance, in reality, the agency rarely awards 100 percent of the award fee. If NNSA's performance assessments continue to be less than 100 percent (as they have been to date), then NNSA will pay the contractor less in award fees, which could affect the total amount of savings NNSA can expect to achieve solely as a result of the change in fee structure under the Triad contract.

Strategic Partnership Projects. NNSA officials stated that NNSA's estimate assumed that all cost savings resulting from lower Strategic Partnership Project (SPP) fees under Triad versus the prior contractor represent a savings to the federal government as a whole. However, some portion of SPP fees may go towards projects with nonfederal sponsors—as they have to date, according to NNSA documentation—which can affect the proportion of future cost savings NNSA will be able to claim as a savings to the federal government.

Option years. NNSA's estimate was based on a potential 10-year contract, according to the agency's 2019 cost-benefit report. However, the Triad contract states that the last 5 years of the contract are option years that are awarded at NNSA's discretion based on contractor performance. If NNSA decides not to award any of the option years, or award fewer than all 5, the agency will not realize the savings it anticipated in the last 5 years of the Triad contract, which were approximately \$40 million, according to our review of NNSA's calculations.⁵⁵

Cost of contract transition. NNSA's estimate did not take into account the cost of the contract transition (\$12.4 million), which the agency would not have incurred had it stayed with the prior contractor. Taking into account the cost of the contract transition, NNSA's actual cost savings

⁵⁵NNSA officials stated that if they did not award some or all of the option years to Triad, the agency would have to procure a new M&O contractor for LANL, which would come with a different set of potential costs and savings.

over the 10-year contract would be less than its approximate \$76.1 million estimate.

We recommended in March 2015 that the NNSA Administrator take steps to ensure that future reports to Congress describing the costs and benefits of competing its M&O contracts under the requirements of NDAs reflect DOE's information quality guidelines;⁵⁶ federal cost accounting standards; and GAO's best practices guidance, including cost estimating best practices.⁵⁷ In our January 2020 report on NNSA's cost-benefit analysis on competing the M&O contract for LANL, we found that NNSA did not fully address the limitations and uncertainties that could affect its approximate \$76.1 million cost savings estimate.⁵⁸ At that time, we reiterated that NNSA would enhance the usefulness of its future cost and benefit reports to Congress by providing clear and complete information on all required reporting elements, including the limitations and uncertainties that could affect cost savings. While NNSA stated that cost savings were not a main driver for competing the contract for LANL, we continue to believe that by providing clear and complete information on all reporting elements, such as fully addressing the limitations of its cost savings estimate, NNSA can aid DOE and congressional decision makers in monitoring the government's realization of such costs and benefits going forward.

⁵⁶GAO, *National Nuclear Security Administration: Reports on the Benefits and Costs of Competing Management and Operating Contracts Need to Be Clearer and More Complete*, [GAO-15-331](#) (Washington, D.C.: Mar. 23, 2015).

⁵⁷For our March 2015 report, we reviewed the following federal guides and standards: Department of Energy, *Final Report Implementing Office of Management and Budget Information Dissemination Quality Guidelines*, 67 Fed. Reg. 62446 (Oct. 7, 2002); GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: Mar. 2, 2009); and Federal Accounting Standards Advisory Board, *Statement of Federal Financial Accounting Standards No. 4: Managerial Cost Accounting Standards and Concepts* (Washington, D.C.: July 31, 1995).

⁵⁸[GAO-20-292R](#).

NNSA and Its Contractor Report Progress in Achieving Workforce Stability and Increased Small Business Participation, but Challenges Remain

Workforce Stability Progress and Challenges

NNSA officials and Triad representatives, as well as NNSA performance evaluation reports and DOE assessments we reviewed point to progress both in maintaining workforce stability and increasing small business participation at LANL. However, officials and representatives also acknowledged continued challenges, and they stated that an accurate assessment of Triad's performance in these areas will require more time.

NNSA officials stated that Triad's efforts in the areas of recruiting and retention have shown promise in addressing LANL's workforce stability. As stated previously, NNSA anticipated achieving workforce stability for 5 to 10 years under the new contract for LANL, according to NNSA's 2019 cost-benefit report. While officials stated that NNSA does not set specific workforce stability goals for Triad, NNSA officials and contractor performance evaluations described various Triad efforts that have focused on and demonstrated success in recruiting and retaining employees, despite some challenges.⁵⁹ Specifically,

Recruiting. Triad has grown the LANL workforce by roughly 1,600 employees from fiscal years 2019 through 2021,⁶⁰ according to Triad employee headcount data.⁶¹ NNSA's recent performance evaluation reports discuss workforce efforts that suggest Triad is successfully hiring staff. For example, NNSA's fiscal year 2021 performance evaluation report stated that Triad supported hiring events specific to the plutonium pit production mission that resulted in the hiring of 400 employees for that mission. According to NNSA's fiscal year 2019 performance evaluation report, Triad efforts have also targeted hiring for hard-to-fill positions. For example, Triad representatives stated that the contractor has partnered with several universities to train and recruit additional criticality safety staff to address a staffing shortage in LANL's criticality safety division.

⁵⁹NNSA officials stated that while NNSA does not prescribe workforce stability goals, it would consider Triad's ability to stabilize LANL's workforce within a broader assessment of Triad's capacity to execute LANL's mission.

⁶⁰According to Triad representatives, Triad's headcount data includes both full- and part-time career employees and employees hired on a 1-10 year term appointment. Students, postdocs, and craft employees are not included.

⁶¹As previously stated, LANL is undergoing an expansion of the laboratory's nuclear weapons missions, which will require the laboratory to add roughly 1,700 full-time staff from fiscal years 2019 through 2026 to support LANL's plutonium missions alone, according to LANL documentation.

According to a 2021 DOE report, Triad has hired and qualified a sufficient number of staff to meet staffing targets related to criticality safety for future increased plutonium pit production rates after fiscal year 2023.⁶²

Retention. According to Triad data, for the majority of calendar year 2019, LANL's annualized voluntary attrition rate was above 7.5 percent—the threshold at which Triad considers that the attrition rate needs to be improved.⁶³ Triad documentation stated that voluntary attrition during this time was affected by the contract transition. LANL's voluntary attrition remained below 7.5 percent for all of calendar year 2020 and the majority of calendar year 2021.⁶⁴

NNSA's performance evaluation reports have highlighted Triad's use of incentive programs as a promising tool for retaining critical talent. NNSA officials stated that the Triad Incentive Compensation Program has been key to retaining essential employees and establishing a comprehensive compensation package, in particular.⁶⁵ This program provides certain eligible laboratory executives, managers, and professionals an annual lump-sum payment linked directly to Triad's annual performance ratings. According to Triad documentation, the program seeks to recognize these employees for achieving significant performance goals and exhibiting

⁶²Department of Energy Office of Enterprise Assessments, *Assessment of the Triad National Security, LLC Nuclear Criticality Safety Program*.

⁶³According to our review of Triad's attrition calculation, Triad's voluntary attrition rate is an annualized attrition rate, which is updated each month and covers attrition in the previous 12 months. Specifically, Triad takes the sum of voluntary terminations (i.e., voluntary attrition) during the prior 12-month period and divides it by the year-start employee population for a given month. See appendix I for further details on Triad's voluntary attrition metric.

⁶⁴Triad representatives stated that LANL has an aging workforce and provided data showing that retirements made up roughly half of voluntary terminations from calendar years 2019 through 2021. NNSA officials and Triad documents also noted that voluntary attrition in calendar year 2021 was affected by voluntary terminations of employees who did not want to comply with Triad's COVID-19 vaccination mandate, which went into effect on October 15, 2021. Triad data show that voluntary attrition was above 7.5 percent in October through December 2021. According to NNSA officials and Triad representatives, Triad implemented a vaccine mandate for all LANL employees before the federal government mandated vaccination for all federal employees in order to meet mission requirements amid rising COVID-19 case rates in northern New Mexico.

⁶⁵NNSA officials stated that the Triad Incentive Compensation Program was introduced in fiscal year 2019 as a pilot compensation program. It is currently approved through fiscal year 2022.

desired behaviors related to NNSA's performance expectations, including those related to safety.

Triad also developed additional incentive programs to attract and retain talent for specific, in-demand positions, such as

- a retention incentive for technicians who work in LANL's hazardous plutonium facilities and who meet specific assignment, training, and other criteria; and
- lump-sum payments and promotional pay increases based on analysts' completion of LANL's nuclear criticality safety programs in the criticality safety division, which was understaffed at the time of the contract transition, according to Triad representatives.

Challenges. While NNSA performance evaluations and NNSA officials stated that Triad's initiatives discussed above suggest greater workforce stability for LANL, officials also acknowledged several challenges to attracting and retaining new talent. For example, NNSA officials stated that Triad has already depleted the local talent pool in northern New Mexico. Triad is targeting other geographic areas for recruitment, such as the city of Albuquerque. However, it is also competing with large technology companies moving into such areas that can offer high salaries and that do not require staff to commute long distances, according to NNSA officials. DOE's Human Reliability Program also places unique requirements on certain employees, including that LANL staff with access to certain materials, nuclear explosive devices, facilities, and programs meet high standards for reliability and physical and mental suitability. NNSA officials also said that having to maintain security clearances and be subject to random drug testing can deter some potential employees.

Triad is seeking to address these workforce challenges by (1) allowing hundreds of positions to work remotely, (2) establishing regional commuter pools, and (3) leasing office space in other locations to provide staff with localized worksites, according to NNSA officials.

It is too early to tell whether Triad's efforts will provide workforce stability throughout the potential 10-year contract. As stated above, Triad data show that LANL's workforce grew by roughly 1,600 employees from fiscal years 2019 through 2021. Triad data also show that LANL's voluntary attrition remained below Triad's 7.5 percent threshold for all of calendar year 2020 and the majority of calendar year 2021. Such data suggest that Triad has been successful thus far in growing LANL's workforce and retaining employees. It is nonetheless difficult to assess any workforce

Small Business Participation Progress and Challenges

trends with only 3 years of contractor data. Moreover, neither NNSA nor Triad assess workforce stability in aggregate for the entire laboratory, but rather, workforce needs are established and monitored at the program level, according to NNSA officials and Triad representatives.⁶⁶ Aggregate data on hiring and attrition can, therefore, only provide a rough picture of current workforce stability at LANL.

Triad has made several efforts to improve small business participation and relationships, according to NNSA officials. As we reported in 2020, NNSA anticipated increased small business participation under the new contract.⁶⁷ NNSA officials said that in 2021, Triad implemented internal training for procurement specialists. It also launched a new electronic repository of subcontractors to increase engagement with the small business community and get more small businesses registered in its procurement system. Triad has also hosted monthly supplier forums, and it created specific subcontractor outreach positions to assist small businesses with preparing bids and to answer technical questions about the process, according to NNSA officials.⁶⁸

Triad has consistently met its total small business participation goal, but it has not consistently met goals in specific socioeconomic categories, such as women-owned or veteran-owned small businesses, according to Triad data.⁶⁹ According to NNSA officials, Triad's contract included ambitious small business goals. For example, by fiscal year 2023, Triad's goal is to

⁶⁶According to Triad representatives, workforce planning goals for specific program areas may include hiring new staff, but they may also use other means to meet their missions, such as subcontracting. Representatives stated that Triad has improved the ability to plan for and track these workforce needs by linking its workforce planning process to LANL's financial system. Under the previous contractor, program areas established their staffing needs but did not have information on whether those positions could be funded. The new system provides better, real-time financial data to program managers so they can develop more practicable workforce planning goals, according to representatives.

⁶⁷[GAO-20-292R](#).

⁶⁸Triad's subcontractor representative positions are intended to ease the company's relationships with small businesses, according to NNSA officials. In its fiscal year 2020 performance evaluation report, NNSA raised an issue with the timeliness of Triad's payments to some small businesses. According to officials, Triad subsequently addressed the issue, and it has been working through the backlog of legacy claim payments and shortening the time frame in which it pays small businesses.

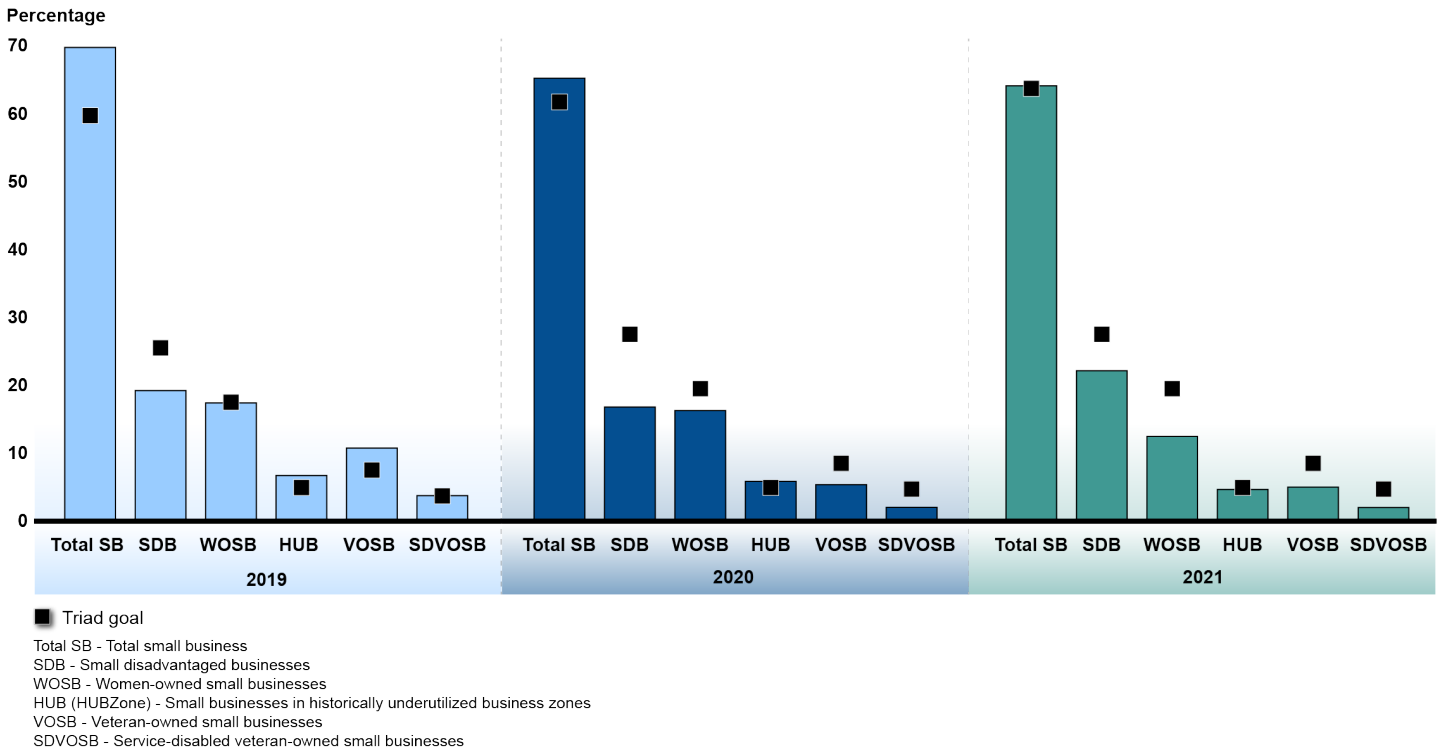
⁶⁹According to officials, NNSA assesses the extent to which Triad is meeting the small business goals to which it agreed in its contract as part of NNSA's broader assessment of Triad's capacity to execute LANL's mission.

spend 67.7 percent of subcontracted dollars with small businesses—approximately 17 percent more than LANL’s average total small business participation rate of 57.7 percent from fiscal years 2015 through 2017. According to Triad data, Triad has exceeded its total small business participation goal each year from fiscal years 2019 through 2021. However, the amount by which Triad has exceeded its goal has been narrowing. Further, Triad has not consistently met its goals for specific small business socioeconomic subcategories (see fig. 2).⁷⁰

⁷⁰NNSA officials stated that Triad is generally taking a broad approach to engaging with small businesses, rather than targeting its initiatives to address specific socioeconomic small business categories. One exception is Triad’s partnership with small businesses in Española, New Mexico, and on tribal lands, which are both qualified HUBZones. The HUBZone program is a U.S. Small Business Administration program for small businesses that operate and employ people in historically underutilized business zones, or “HUBZones,” among other criteria.

Figure 2: NNSA’s Contractor’s Small Business Participation Goals and Performance, Fiscal Years 2019–2021

According to National Nuclear Security Administration (NNSA) officials, it is too early to tell whether the small business initiatives introduced by its management and operating contractor for Los Alamos National Laboratory, Triad National Security, LLC, will effectively increase small business participation going forward.



Source: GAO analysis of Triad data. | GAO-22-105412

Note: Small business participation is defined as the percent of total subcontracting dollars spent with small businesses. NNSA officials stated that an individual small business may be represented in multiple socioeconomic subcategories (i.e., a small business may be a women-owned and a veteran-owned small business), and all small businesses in the socioeconomic subcategories are also represented in the total small business category. NNSA officials stated that small businesses are responsible for reporting whether they qualify as a small business in a socioeconomic subcategory according to U.S. Small Business Administration eligibility criteria.

NNSA officials stated that Triad may face challenges in achieving its small business goals going forward due to LANL’s isolated geography and specific subcontracting needs. For example, NNSA officials stated that a large portion of LANL’s subcontracting budget goes to construction, but it can be especially difficult to find small architecture and construction firms able or willing to operate in LANL’s remote location. Officials also stated that LANL can have very unique product needs for small items like software, which can be difficult for small businesses to fulfill. Further, Triad documentation states that LANL’s expanding mission has rapidly

increased the laboratory's procurement volume and changed the types of goods and services being procured in recent years, which has taxed the small business capabilities of New Mexico. As a result, Triad renegotiated its total small business goal for fiscal year 2022 from 65.7 percent to 64.5 percent, according to NNSA documentation. NNSA officials stated that while Triad's small business efforts appear promising thus far, it is too early to tell whether they will effectively increase small business participation going forward.

Agency Comments

We provided a draft of this report to DOE and NNSA for review and comment. DOE and NNSA provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, and the Administrator of NNSA. In addition, this report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or bawden@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 III.



Allison Bawden
Director, Natural Resources and Environment

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Appendix I: Objectives, Scope, and Methodology

In this review, we examined (1) what steps the new contractor has taken to improve safety performance at Los Alamos National Laboratory (LANL), and how the National Nuclear Security Administration (NNSA) and other organizations have assessed these steps to date; and (2) the extent to which anticipated cost savings and other benefits on which we reported in 2020 have been realized to date under the current contract.¹

To address the first objective, we reviewed Department of Energy (DOE) regulations and other documentation related to safety performance requirements and expectations. Among other things, this documentation included (1) NNSA's contract with the current LANL management and operating (M&O) contractor, Triad National Security, LLC; and (2) DOE and NNSA directives for the safe management of nuclear facilities, such as DOE's Facility Safety Order (DOE Order 420.1C) and NNSA's corporate performance evaluation policy for M&O contractors (NNSA Policy Letter 540.3, or NAP 540.3).²

We then identified key safety areas of concern that contributed to NNSA's decision to re-compete its contract for LANL in 2018 and informed NNSA's safety performance assessment approach with Triad to date. We asked officials at NNSA's Los Alamos Field Office for their perspectives on key safety performance issues faced under the prior contractor and on which issues officials have focused with regard to safety oversight since the beginning of NNSA's contract with Triad. We identified key safety issues that emerged in these interviews; other interviews we conducted with officials from NNSA's Office of Safety (NA-51), DOE's Office of Enterprise Assessments (DOE-EA), and other federal offices; and NNSA performance evaluation reports, DOE-EA reports, and other assessments that we reviewed. For reporting purposes, we grouped the issues discussed in these sources into four thematic categories: (1) safety issues management (to include, for example, problems associated with event reporting, extent-of-condition analysis, corrective action development, and corrective action effectiveness evaluation), (2) safety control documentation (to include, for example, problems with hazard and control documentation, such as safety basis, criticality safety, and natural hazard documentation), (3) conduct of operations (to include, for example,

¹GAO, *National Nuclear Security Administration Contracting: Review of the NNSA Report on the Los Alamos National Laboratory Contract Competition*, [GAO-20-292R](#) (Washington, D.C.: Jan. 30, 2020).

²NNSA's corporate performance evaluation policy was previously called NAP 4-C. NNSA renumbered the policy as NAP 540.3 in 2019.

problems associated with operational discipline and process deviations), and (4) safety culture (to include, for example, problems around leadership tone, incentive structures, and unwritten rules).

We then reviewed documents describing Triad's actions related to safety—such as Triad's year-end summaries of integrated safety management efforts and documentation of safety improvement initiatives—and NNSA's assessments of these actions, including NNSA's year-end performance evaluation reports and documented performance input from other NNSA organizations. We also reviewed assessments of Triad's safety performance produced by other organizations, including DOE-EA and the Defense Nuclear Facilities Safety Board. We also interviewed officials from DOE's Office of Environment, Health, Safety & Security, DOE-EA, NA-51, and NNSA's Los Alamos Field Office, as well as Triad representatives.

To address the second objective, we reviewed documents and data, and we interviewed officials. Specifically, to determine the extent to which NNSA has achieved anticipated cost savings under the current contract, we reviewed NNSA documents on contractor fees and cost savings, including NNSA's contract with Triad, NNSA's cost savings calculations, and award fee determination letters. We also interviewed NNSA officials to better understand NNSA's cost savings estimation methodology, including how the agency estimated contractor fees, calculated the potential savings in fees for each year of the contract, and any assumptions associated with the calculations identified by officials.

NNSA's anticipated cost savings—approximately \$76.1 million over a potential 10-year contract period, according to NNSA's 2019 cost-benefit report on the contract competition—were based on the difference in the maximum contractor fees that NNSA agreed to pay Triad versus the fees NNSA would have paid the previous contractor for the same period of work.³ To arrive at this estimate, NNSA added up the difference between the three fees paid to Triad based on Triad's fee rate versus the fees paid to the prior contractor, Los Alamos National Security, based on its fee

³National Nuclear Security Administration, *Cost-Benefit Analysis for Competition of Management and Operating Contracts* (Washington, D.C.: April 2019).

rate: (1) fixed fees, (2) award fees based on contractor performance,⁴ and (3) Strategic Partnership Project (SPP) fees.⁵

To determine the extent to which NNSA has realized these anticipated cost savings during the period of performance under our review (fiscal years 2019 through 2021), we identified the total amount of fees paid to Triad for each of the three fee types and compared this to the fees that would have been paid to the prior contractor based on its fee rates. We then added up the difference in the fees between Triad and the prior contractor for each of the three fee types (about \$58.4 million less paid to Triad in fixed fees, about \$36.1 million more paid to Triad in award fees, and about \$12.8 million less paid to Triad in SPP fees) to arrive at an estimate of approximately \$35.1 million in actual cost savings to date. Our estimate of cost savings reflects the fixed fees established in NNSA's contract with Triad (for fixed fees), NNSA's actual performance ratings for Triad according to NNSA award fee determination letters (for award fees),⁶ and NNSA documentation on actual SPP fees paid in fiscal years 2019 through 2021 (for SPP fees).⁷ We also reviewed NNSA's

⁴NNSA's estimate of cost savings assumed that both contractors would receive performance ratings of 100 percent, and thus, the maximum available award fee. This assumption results in a conservative estimate of savings because if a contractor does not receive performance ratings of 100 percent, NNSA will retain part of the contractor's award fee. According to NNSA officials, though it is common for contractors to receive performance ratings below 100 percent, NNSA did not want to consider lower award fees resulting from suboptimal performance as a "savings" to the government, and thus estimated potential savings assuming optimal contractor performance.

⁵As explained previously, SPPs are a mechanism by which the contractor may perform work for non-DOE entities—including other federal agencies—or allow non-DOE entities to use DOE facilities for work that is not directly funded by DOE appropriations. NNSA officials stated that the non-DOE entities sponsoring such work pay all costs and fees associated with SPPs. NNSA's cost estimate assumed that all SPPs would be sponsored by federal entities, and thus, according to NNSA officials, NNSA considered any associated savings in SPP fees to be savings to the federal government as a whole, if not to NNSA specifically.

⁶According to NNSA's award fee determination letters, Triad's performance ratings for fiscal years 2019, 2020, and 2021 were 66.3, 88, and 87.3 percent, respectively. NNSA applies these percentages to Triad's maximum available award fee to determine the contractor's actual award fee. We applied the same percentages to the prior contractor's maximum available award fee to determine what NNSA would have paid the prior contractor for the same level of performance.

⁷According to NNSA documentation on SPP fees paid from fiscal years 2019 through 2021, about 91 percent of SPP fees were paid by federal sponsors. Therefore, our estimate of actual cost savings resulting from the difference in SPP fees under the two contractors reflects approximately 91 percent of the overall cost savings from SPP fees.

calculations and documentation, and we interviewed officials to identify examples of limitations—such as uncertainties and cost exclusions described in our 2009 Cost Estimating and Assessment Guide—that NNSA did not identify as part of its cost savings estimate.⁸

To determine the extent to which workforce stability and small business participation benefits have been achieved in the first 3 years of the contract, we first reviewed NNSA's contract with Triad to identify any workforce or small business participation goals. For workforce goals, we found that while NNSA did not set specific workforce stability goals in the contract, Triad representatives stated that recruiting and retaining employees are key aspects of workforce stability that have been the focus of several workforce initiatives. For small business participation, the contract includes annual goals for the percentage of subcontracted dollars Triad has agreed to obligate to small businesses.

To report on Triad's performance in these areas, we reviewed two sets of Triad data. First, we reviewed data on LANL employee headcounts and monthly voluntary terminations from fiscal years 2019 through 2021, including Triad's calculation of the annualized voluntary attrition rate during this period. According to Triad representatives, Triad calculates the annualized voluntary attrition rate each month by taking the sum of voluntarily terminations (i.e., voluntary attrition) during the prior 12-month period and dividing it by the year-start population for that month. This results in an estimate of monthly attrition that takes into account attrition that has occurred over the prior 12 months. Using Triad's data on monthly voluntary terminations and employee population, we calculated voluntary attrition for each individual month, not taking into account attrition over the prior 12 months. We compared our calculation of attrition to Triad's calculation and found that our calculation resulted in greater month-to-month variation.⁹ We report Triad's rate because we could compare it to

⁸Our 2009 cost estimating and assessment guide states that credible cost estimates should identify uncertainties and recognize excluded costs. Such uncertainties can include economic uncertainties, such as multiyear savings assumptions, or cost estimation uncertainties, such as overoptimism in contractor capabilities. The guide also states that excluded costs should be disclosed and given a rationale. GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: Mar. 2, 2009).

⁹According to a Triad representative, employees tend to terminate their employment at the end of the week, which can cause months that have 5 weeks in them to appear to have voluntary attrition that is arbitrarily high. Triad's annualized voluntary attrition metric is less sensitive to such effects on the attrition rate because it smooths out attrition over a 12-month period.

their associated targets for voluntary attrition. Further, given that LANL's workforce has grown during the period of our review, Triad's method of calculating annualized attrition using the year-start population (as opposed to year-end) results in a more conservative estimate of attrition. According to Triad representatives, the employee headcount and voluntary attrition data do not include postdocs, student employees, or craft workers. Second, we reviewed Triad data on the percentage of subcontracted dollars that LANL has obligated to small businesses from fiscal years 2019 through 2021.

We determined these workforce and small business data to be reliable for the purposes of (1) reporting on Triad's progress to date in increasing workforce stability and small business participation, and (2) corroborating NNSA officials' perspectives on Triad's progress in these areas. We made this determination based on interviews with NNSA officials and Triad representatives who manage the data, reviews of related documentation, and comparing the data to source documents.

We also reviewed NNSA's annual performance evaluation reports to identify instances where NNSA discussed Triad's workforce and small business performance within the context of NNSA's broader performance goals for the laboratory. Lastly, we interviewed officials from NNSA's Los Alamos Field Office to understand their perspectives on Triad's efforts and challenges increasing workforce stability and small business participation at LANL.

Appendix II: Safety Performance Assessments for Los Alamos National Laboratory, Fiscal Years 2019–2021

The National Nuclear Security Administration (NNSA) has evaluated the performance of Triad National Security, LLC, the management and operating contractor for Los Alamos National Laboratory, for 3 of up to 10 possible years under the current contract. NNSA’s performance evaluation reports summarize NNSA’s assessment of Triad’s performance in several areas, and they include positive examples of safety performance (accomplishments) as well as examples of challenges (issues). Table 1 provides abridged excerpts related to safety performance from NNSA’s evaluations from fiscal years 2019 through 2021.

Table 1: Safety Performance Accomplishments and Issues in National Nuclear Security Administration (NNSA) Performance Evaluations of the Los Alamos National Laboratory (LANL) Contractor, Fiscal Years 2019–2021

Fiscal year	Accomplishments	Issues
2019	<ul style="list-style-type: none"> High level of responsiveness to safety basis document reviews Assessments completed of all outstanding criticality safety evaluations for LANL’s Plutonium Facility-4 (PF-4) operations Strong safety culture tone set by leadership Better communication of safety incidents More robust risk trending and analysis tools 	<ul style="list-style-type: none"> Weaknesses in conduct of operations, procedural violations, and deviations in criticality safety processes Many significant repeat events, including serious injuries Problems categorizing issues, which impeded the ability to observe trends Inconsistent quality of safety basis documentation
2020	<ul style="list-style-type: none"> Exceptional transition to COVID-19 posture, while expanding PF-4 operations Increased operational rigor and additional management presence Reduction in criticality incident reporting Improved quality and timeliness of safety basis documentation New incentive compensation program that is aligned with NNSA priorities New tools to improve issues management Improved trends in alarm response, which demonstrates effective corrective action implementation 	<ul style="list-style-type: none"> Lack of consistent identification of legacy issues before they manifest in unnecessary incidents, which shows that corrective actions are not fully effective Efforts to improve contractor assurance systems, but time needed to validate efforts’ effectiveness

**Appendix II: Safety Performance Assessments
for Los Alamos National Laboratory, Fiscal
Years 2019–2021**

Fiscal year	Accomplishments	Issues
2021	<ul style="list-style-type: none"> Working sessions to address emerging issues in infrastructure, production, and conduct of operations led by leadership Safety basis products of good quality Significantly reduced hazardous energy events Some improvement in ability to respond to and recover from events Excellent leadership during the COVID-19 pandemic 	<ul style="list-style-type: none"> Lapses in disciplined operations, which affected mission, due to not following approved procedures, lack of effective line management engagement, and normalizing adverse conditions Significant events such as the vault water bath overflow event at PF-4, which demonstrate corrective action management is not effective Inconsistent approach to managing and reporting abnormal events, which increases risk for repeat events, compliance violations, and releases of hazardous energy Lack of consistency across the laboratory to report and categorize abnormal events. Minimal improvement despite actions taken to address these issues Ongoing conduct of operations weaknesses in some areas

Source: GAO summary of NNSA contractor performance evaluation reports. | GAO-22-105412

Note: We selected safety-related excerpts from NNSA's performance evaluation reports and then abridged the excerpts using simplified, nontechnical language, where possible.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, Jonathan Gill (Assistant Director), David Wishard (Analyst-in-Charge), Taylor Bailey, Mark Braza, Juana Collymore, Wil Gerard, Ryan Gottschall, William Horowitz, Chaya Johnson, Jennifer Leotta, Marya Link, Jamie Meuwissen, Donna Morgan, Robert Sanchez, Jasmine Scott, Sara Sullivan, and Tatiana Winger made key contributions to this report.

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