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Report to Congressional Committees

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NATIONAL NUCLEAR SECURITY ADMINISTRATION

Improvements Needed for Managing Recapitalization of Fusion Facilities

GAO-25-107204

GAO Highlights

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GAO-25-107204 September 2025

A report to congressional committees.

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What GAO Found

The National Nuclear Security Administration's (NNSA) January 2023 recapitalization plan for the three Inertial Confinement Fusion (ICF) program facilities—National Ignition Facility (NIF), Z Pulsed Power Facility (Z), and Omega Laser Facility—contained sufficient information for decision-makers on sustaining the facilities in the near-term. However, NNSA's plans for facility upgrades in the mid-term have evolved.

For the near-term, the plan outlined 110 discrete sustainment activities to be completed among the three facilities within 6 to 8 years at a total estimated cost of $492 million. These activities could help the facilities continue to support stockpile stewardship experiments with a reduced risk of catastrophic failure.

Example of a Sustainment Activity at the National Ignition Facility, Laser Amplifier to be Refurbished

Source: Lawrence Livermore National Laboratory; National Nuclear Security Administration information. | GAO-25-107204

For the mid-term, NNSA plans to upgrade NIF at an estimated cost of $470 million to $1 billion. For Z, NNSA's planned approach for upgrades is no longer current; officials said they are exploring an additional upgrade option. NNSA has not documented the options under consideration, but such a step would help decision-makers, including Congress, understand the potential options, estimated costs, and relevance to mission needs. At Omega, no upgrades are planned.

GAO found the ICF program has not developed and used performance measures, such as scope, cost, and time frame baselines, to evaluate progress of the near-term sustainment activities. NNSA has generally managed the facilities' sustainment as an annual activity rather than as a multi-year surge of work. Without developing and using such measures, NNSA management and decision-makers have incomplete information on whether NNSA is achieving its recapitalization objective to ensure the ICF facilities continue to operate at their originally designed performance levels.

Why GAO Did This Study

NNSA relies on three facilities to conduct the ICF Program's high energy density experiments in support of nuclear stockpile stewardship and modernization: NIF, Z, and Omega. These facilities are aging and need recapitalizing to maintain experimental operations and continue supporting mission needs. In January 2023, NNSA submitted to Congress a recapiltalization plan for the three facilities.

A Senate report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2024 includes a provision for GAO to assess NNSA's plan for the facilities.

This report examines the extent to which NNSA (1) included sufficient information in the plan to support decision-making for sustaining and upgrading the three facilities in the near- and mid-term and (2) has made progress on near-term sustainment efforts included in the plan.

GAO reviewed the recapitalization plan, conducted site visits to the three facilities, and interviewed agency officials and site representatives to observe the current conditions and ongoing sustainment and upgrade activities. GAO also collected information on NNSA's approach to following program management requirements and guidance.

What GAO Recommends

GAO is making two recommendations: that NNSA (1) document the options under consideration for upgrades to Z and (2) develop and use performance measures, consistent with NNSA's program management guidance, to evaluate the progress of sustainment activities for all three ICF facilities against a baseline. NNSA concurred with both recommendations and stated it would take action to address them.

Contents

Abbreviations

CD	critical decision
DOE	Department of Energy
HED	High Energy Density
ICF	Inertial Confinement Fusion
NIF	National Ignition Facility
NNSA	National Nuclear Security Administration
OMEGA EP	OMEGA Extended Performance laser
Z	Z Pulsed Power Facility

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Report to Congressional Committees

Maintaining and enhancing the performance, reliability, security, and safety of the U.S. nuclear stockpile is the responsibility of the National Nuclear Security Administration (NNSA)—a separately organized agency within the Department of Energy (DOE). Since 1992, the U.S. has observed a unilateral moratorium on nuclear explosive testing while continuing to maintain and modernize the nuclear stockpile.[1] In place of nuclear explosive testing, NNSA has relied on data from a network of experimental and testing facilities and complex computer models to better understand and assess the performance of the nation's current nuclear stockpile, support programs to modernize the stockpile, and advance the research and development capabilities necessary to meet the needs for a future deterrent.

In support of this science-based stockpile stewardship and modernization mission, NNSA's Inertial Confinement Fusion (ICF) Program is responsible for managing the nation's three high energy density (HED) experimental facilities: (1) the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California, (2) the Omega Laser Facility at the University of Rochester in New York, and (3) the Z Pulsed Power Facility (Z) at Sandia National Laboratories in New Mexico. HED experiments focus on creating states of matter with the high energies and densities typically found during the detonation of a nuclear weapon. Since most of the energy in a nuclear weapon is generated by matter in HED conditions, collecting data on and modeling the behavior of matter in that environment is critical for understanding and predicting the performance of nuclear weapon components. Achieving those environments is only possible at facilities specifically designed to create them.

According to agency documents, NNSA has historically prioritized conducting HED experiments over maintaining the three facilities—which can require a pause in experimental work—because the data from these experiments support multiple NNSA programs, including several ongoing weapons modernization efforts. Agency documents state that now these facilities are aging and need recapitalizing to restore operational

[1]A nuclear explosive test is the detonation of a nuclear weapon in a controlled environment, such as underground, to check its operation and measure its capabilities.

performance specifications and support the mission need. For example, NIF was designed and built beginning in the mid-1990s, and the buildings that support operations there are more than 20 years old, with some buildings approaching 50 years of age. The Z Pulsed Power Facility's infrastructure dates to the 1980s. According to agency documents, the demand for these facilities is projected to grow over the coming years due to NNSA's ongoing efforts to modernize the current nuclear stockpile and efforts to plan for a future deterrent.

In a 2021 congressionally directed review of the ICF program, the independent JASON Defense Advisory Group recommended that NNSA develop a plan to recapitalize the ICF facilities and begin planning for a next generation capability.[2] Following the JASON review, congressional committees directed NNSA to develop a plan to sustain and upgrade the three ICF facilities to include information on the scope, costs, and time frames needed to carry out this work to meet NNSA missions.[3]

NNSA submitted a plan to recapitalize the ICF facilities to the committees in January 2023.[4] The plan proposes near-term sustainment activities to be completed within 6 to 8 years to support NNSA's stockpile stewardship mission. It also proposes potential upgrades in the mid-term to improve the facilities' capabilities as well as technology development to inform

[2]JASON, *Contributions of the ICF Program to Stockpile Stewardship: Executive Summary*, (McLean, VA: April 2021). The JASON's mission is to contribute to national security and public benefit by working on problems of importance to the U.S. government. The group is organized and supported by the MITRE Corporation—a not-for-profit research and development organization.

[3]S. Rept. No. 117-39, at 370 (2021) (accompanying S. 2792, a bill for the National Defense Authorization Act for Fiscal Year 2022); H. Rept. No. 117-98, at 162 (2021) (accompanying H.R. 4549, a bill for the Energy and Water Development and Related Agencies Appropriations, 2022). Senate Report 117-39 directed NNSA to develop the recapitalization plan and include the following elements: (1) the current operations and maintenance status of each of the three major ICF facilities, (2) current and future challenges of operating and maintaining the three major facilities, (3) the required resources and scope of work needed to recapitalize and upgrade the three major facilities to meet NNSA missions for at least the next decade, and (4) the long-term costs to maintain each of the three major facilities in a condition necessary to meet mission requirements. The report also directed NNSA to address recommendations from a 2021 JASON report in the recapitalization plan. House Report 117-98 directed NNSA to develop a strategic plan for recapitalizing, upgrading, and maintaining ICF facilities and include cost estimates and a reasonable time frame for implementation.

[4]National Nuclear Security Administration, *Inertial Confinement Fusion 10-Year Facility and Infrastructure Plan* (Washington, D.C.: Jan. 2023).

future capabilities.[5] Finally, the plan describes early concepts for next generation capabilities, which are considered too preliminary to have cost or schedule estimates.

A Senate report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2024 includes a provision for us to assess the ICF recapitalization plan.[6] Our report examines the extent to which NNSA (1) included sufficient information in the recapitalization plan to support decision-making for sustaining and upgrading the three facilities in the near- and mid-term and (2) has made progress on the near-term sustainment efforts included in the plan.

For objective one, we compared the plan to the elements outlined in the congressional direction.[7] We also reviewed facility-specific sustainment plans, developed by site representatives, that contained details on sustainment activities for each facility that NNSA summarized in its recapitalization plan.[8] We interviewed NNSA officials from the ICF program office, and representatives from the two national laboratories and the University of Rochester, where these facilities are located, to examine the extent of any changes in the sustainment or upgrade approach since the agency issued its plan to congressional committees in January 2023. We did not evaluate the quality of the cost estimates reported on in NNSA's recapitalization plan as they were intended to provide Congress with preliminary, general information on the magnitude of the sustainment investment.

For objective two, we reviewed NNSA-provided information on ongoing sustainment activities, including the most recent ICF Facility Operations

[5]The NNSA plan did not define the mid-term time frame. According to information in the plan, the mid-term upgrades could overlap with the time frame during which NNSA carries out sustainment activities. Upgrade-related activities provide new or enhanced capabilities, while sustainment activities ensure capabilities continue at their designed level.

[6]S. Rept. No. 118-58, at 385 (2023) (accompanying S. 2226, a bill for the National Defense Authorization Act for Fiscal Year 2024).

[7]See National Nuclear Security Administration, *Inertial Confinement Fusion 10-Year Facility and Infrastructure Plan*, S. Rept. No. 117-39, and H. Rept. No. 117-98.

[8]Lawrence Livermore National Laboratory, *National Ignition Facility Sustainment Plan*, LLNL-AR-826802 (Livermore, CA: Sept. 2021); University of Rochester Laboratory for Laser Energetics, *OMEGA Sustainment Plan*, DOE/NA/3856-1642 (Rochester, NY: Oct. 2021); and Sandia National Laboratories, *Sustaining the Z Facility—Z and ZBL—Z Sustainment Plan*, SAND2021-2254 O (Albuquerque, NM: Feb. 2021).

program plan, facility-specific sustainment plans, and monthly progress reports to gather status data. We compared that to information in the recapitalization plan. We compared the status data of the sustainment activities NNSA provided us to information presented in these published reports and internal reporting documents. Based on our analysis, we determined that this information was reliable for our purposes of reporting on NNSA's progress on the near-term sustainment efforts.

For both objectives, we conducted site visits to each facility to observe the current conditions of the facilities and ongoing sustainment activities and discussed upgrade plans. Further, we collected information from the ICF federal program managers on their approach to following NNSA's program management requirements described in NNSA's Office of Defense Program's Program Execution Instruction (Program Execution Instruction).[9] The Program Execution Instruction provides requirements for federal program managers who oversee programs, such as the ICF program, as well as guidance on methods and activities to meet these requirements. For example, the Program Execution Instruction provides guidance on establishing and using performance measures to evaluate program performance in meeting scope, cost, and schedule objectives. We also compared NNSA's performance management approaches for the ICF recapitalization effort with the Program Execution Instruction's direction by analyzing program management information in program plans, facility-specific plans, and progress reports.

We conducted this performance audit from December 2023 to September 2025 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.

[9]Department of Energy and National Nuclear Security Administration, *Defense Programs Program Execution Instruction: NA-10 Program Management Tools and Processes Revision 4* (Nov. 15, 2013; updated Dec. 2024).

Background

Approaches to Inertial Confinement Fusion and Overview of NNSA's Facilities

NNSA achieves HED conditions in a laboratory environment through the use of inertial confinement fusion (ICF). ICF uses high-power lasers or electrical pulses to compress a small capsule of fusion fuel under extreme temperatures and pressures for a short time. Under these temperatures and pressures, the nuclei in the fuel (typically hydrogen isotopes of deuterium and tritium) undergo a fusion reaction—the hydrogen nuclei form together into a helium nucleus and release energy.[10] This released energy further heats the fuel, creating HED conditions. The three ICF facilities in NNSA's program use different, unique approaches to conduct HED experiments in support of the ICF program goals.

Below we describe each facility, the ICF approach they use to conduct HED experiments, and their current operations.

National Ignition Facility. NIF is located at Lawrence Livermore National Laboratory in Livermore, California. Construction on the facility began in 1997. It became operational in 2009. NIF uses an approach known as laser indirect drive to conduct ICF experiments. Using this approach, NIF's 192 lasers are focused to strike a gold cylinder called a hohlraum. The lasers vaporize the hohlraum and create a bath of x-rays that compresses a target capsule—inside the hohlraum—made up of frozen deuterium-tritium fuel. NIF's lasers deliver 2.2 megajoules of energy to the hohlraum, and it takes about one hundred times more energy to deliver it to the target.[11] NIF is the most powerful of the three ICF facilities, and the most energetic laser facility in the world.[12] NIF is the first facility in

[10]Isotopes are varieties of a given chemical element with the same number of protons but different numbers of neutrons. Hydrogen is the simplest element. Most naturally occurring hydrogen, or protium, has one proton and no neutrons. Deuterium is an isotope of hydrogen that has one proton and one neutron. Tritium is an isotope of hydrogen with one proton and two neutrons. Protons and neutrons are particles found in the nuclei of an atom. Protons are positively charged, and neutrons do not have an electrical charge. Helium is an element with two protons and two neutrons.

[11]A joule is unit of measurement for work or energy. One kilojoule is equal to 1,000 joules, and one megajoule is equal to 1 million joules. The average U.S. home in 2021 consumed about 38,000 megajoules of energy in a year according to the U.S. Energy Information Administration.

[12]The term "energetic" refers to the measure of photons in a laser's pulse. The NIF laser contains more photons in its pulse than any other laser.

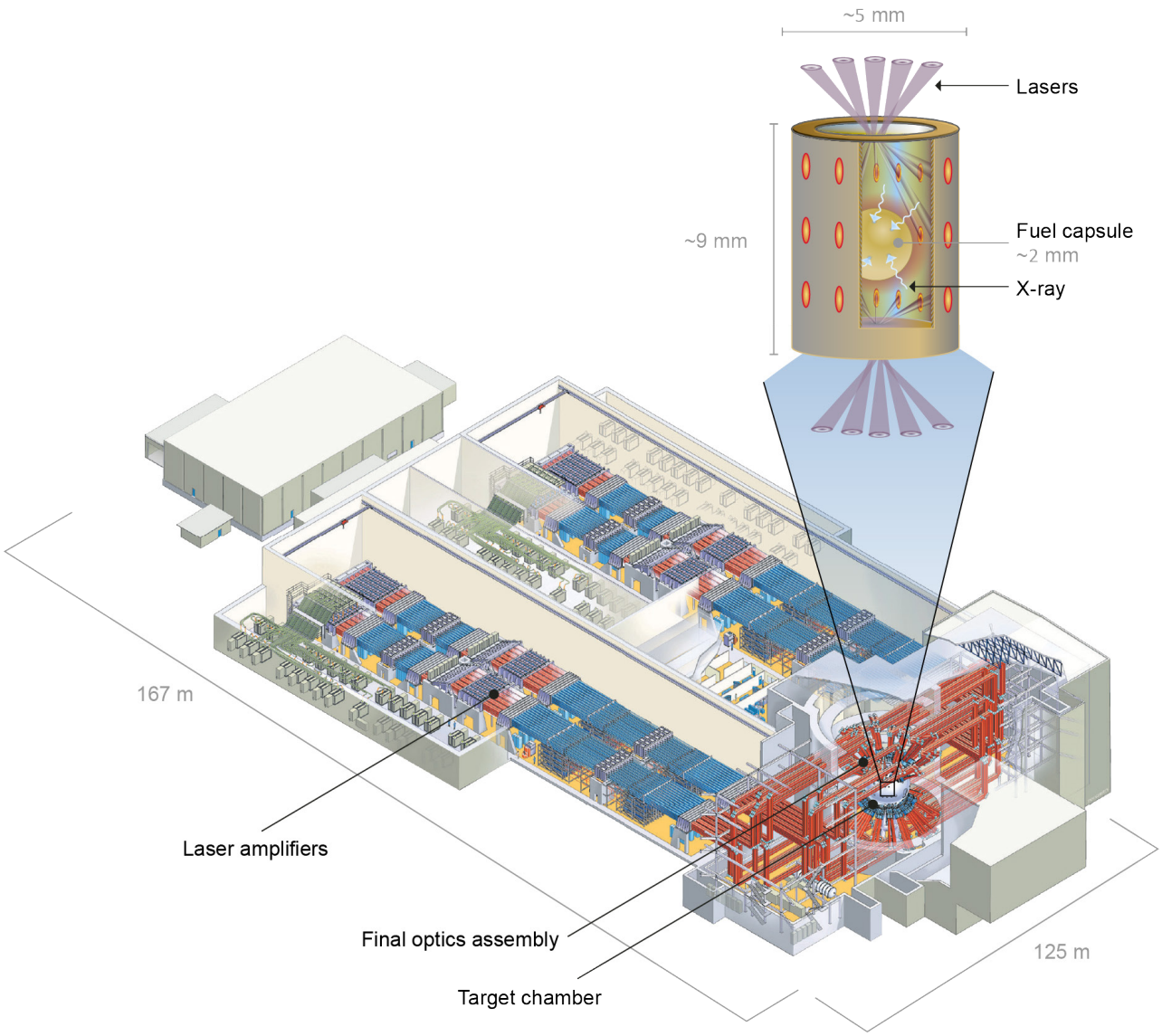
the world to achieve ignition, where the system creates more fusion energy than the lasers used to drive the reaction.[13]

NIF operates 365 days per year and had an average shot rate of 337 shots per year from fiscal year 2020 through 2024. A "shot" is an instance when researchers fire the laser or pulsed power system and release energy into the experimental target chamber. Shot performance is a key operations metric that NNSA and site representatives monitor. According to NNSA documents, facility aging at NIF has begun to affect performance and increases the risk of stoppage or slowdown in operations. For example, officials told us they had planned for 380 shots in fiscal year 2023, but due to aging infrastructure and increases in unplanned facility downtime, were only able to carry out 311 shots for that year.

Figure 1 depicts a diagram of the NIF facility with scale information to compare the size of the facility to the size of the fuel capsule, or target.

[13]The term "achieve ignition" means when a nuclear fusion reaction produces more energy in the fusion target than the energy used to initiate the nuclear reaction. A December 2022 experiment at NIF "achieved ignition" when 2.05 megajoules of laser energy generated 3.15 megajoules of fusion energy. NIF has subsequently "achieved ignition" multiple times since the first successful demonstration in 2022. As of May 2025, the highest fusion yield generated on NIF was approximately 8.6 megajoules, according to NNSA.

Figure 1: Layout, Key Components, and Technology at National Ignition Facility, Lawrence Livermore National Laboratory



Sources: Lawrence Livermore National Laboratory; National Nuclear Security Administration (facility) and GAO (detail). | GAO-25-107204

Note: The technology presented in figure 1 is laser indirect drive, which is used for inertial confinement fusion experiments at the National Ignition Facility.

Omega Laser Facility. The Omega facility, composed of the OMEGA laser and the OMEGA Extended Performance (OMEGA EP) laser, is located at the University of Rochester Laboratory for Laser Energetics in

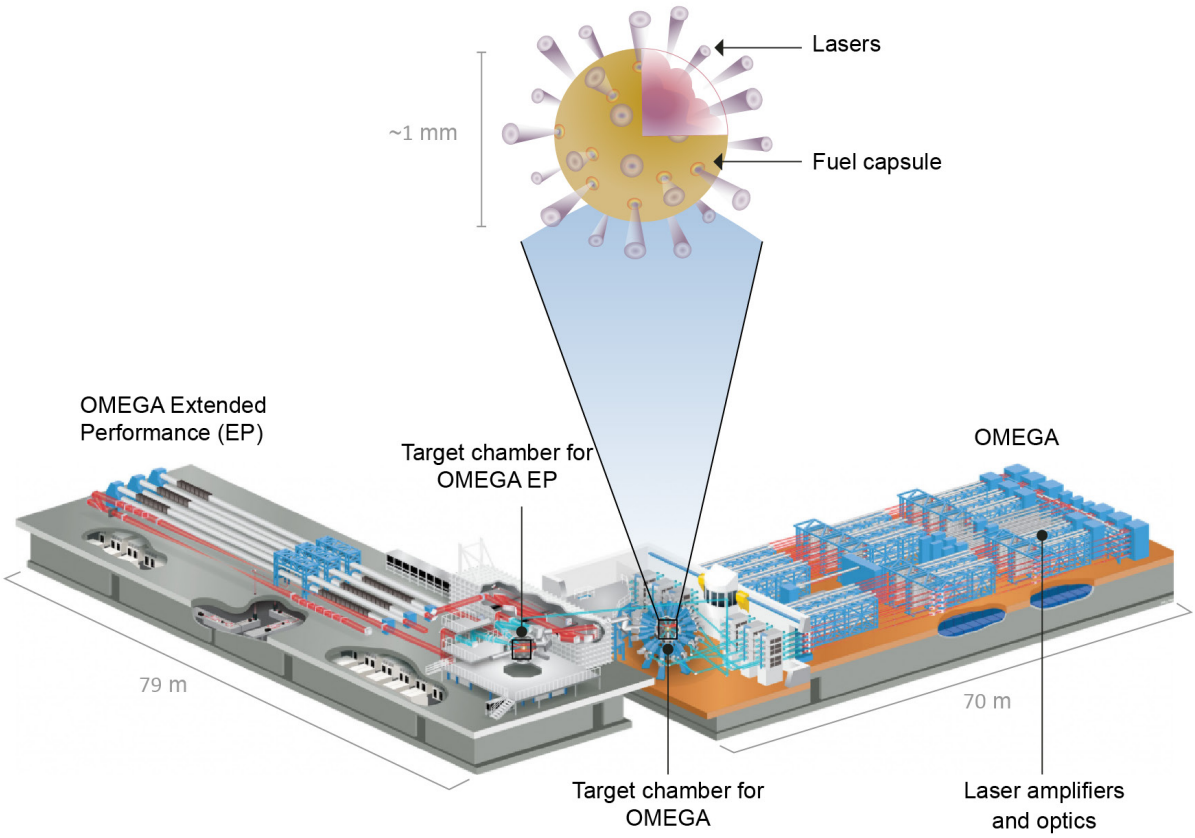
Rochester, New York. Operational since 1995, the OMEGA laser consists of 60 individual lasers that direct up to 40 kilojoules of energy to a target less than 1 mm in diameter. The OMEGA EP laser became operational in 2008 and consists of four beams with various configurable pulse lengths and individual energies up to 5 kilojoules.

The Omega facility uses laser direct drive, where laser beams are focused directly on the target, a deuterium-tritium fuel capsule, to compress it and thereby trigger the fusion reaction. The lasers cause the surface of the fuel capsule to vaporize away outward, causing a powerful recoil that compresses the capsule inward. In a direct drive ICF experiment, the energy of the lasers is transferred directly into compressing the capsule with minimal energy loss.

According to NNSA, Omega is a smaller facility, operating at lower laser energy, and requiring significantly lower precision in experimental setup aspects, including target alignment and beam pointing. Unlike NIF, the Omega facility also operates below the damage threshold for the laser glass, meaning it does not expect to damage the optics during normal operations and has lower shot-to-shot maintenance needs. The combination of a lower required precision in experimental setup and operating below the damage threshold allows the OMEGA laser to conduct significantly more experiments, with an average of about 2,000 shots per year between fiscal years 2020 and 2024. The Omega facility executes more experiments per year than NIF or Z.

Figure 2 depicts a diagram of the Omega Laser Facility, with scale information to compare the size of the facility to the size of the fuel capsule, or target.

Figure 2: Layout, Key Components, and Technology at Omega Laser Facility, University of Rochester Laboratory for Laser Energetics



Sources: University of Rochester Laboratory for Laser Energetics; National Nuclear Security Administration (facility) and GAO (detail). | GAO-25-107204

Note: The technology presented in figure 2 is laser direct drive, which is used for inertial confinement fusion experiments at the Omega Laser Facility.

Z Pulsed Power Facility. Z is located at Sandia National Laboratories in Albuquerque, New Mexico. The facility began as the Particle Beam Fusion Accelerator 2 in 1985 and was transformed into the Z Pulsed Power Facility in 1996. Its most recent refurbishment was completed in 2006.

The Z facility uses powerful electrical pulses, and a technique called a z-pinch to achieve an inertial confinement fusion reaction. At Z, pulsed electrical energy turns a cylindrical deuterium-tritium fuel capsule into a

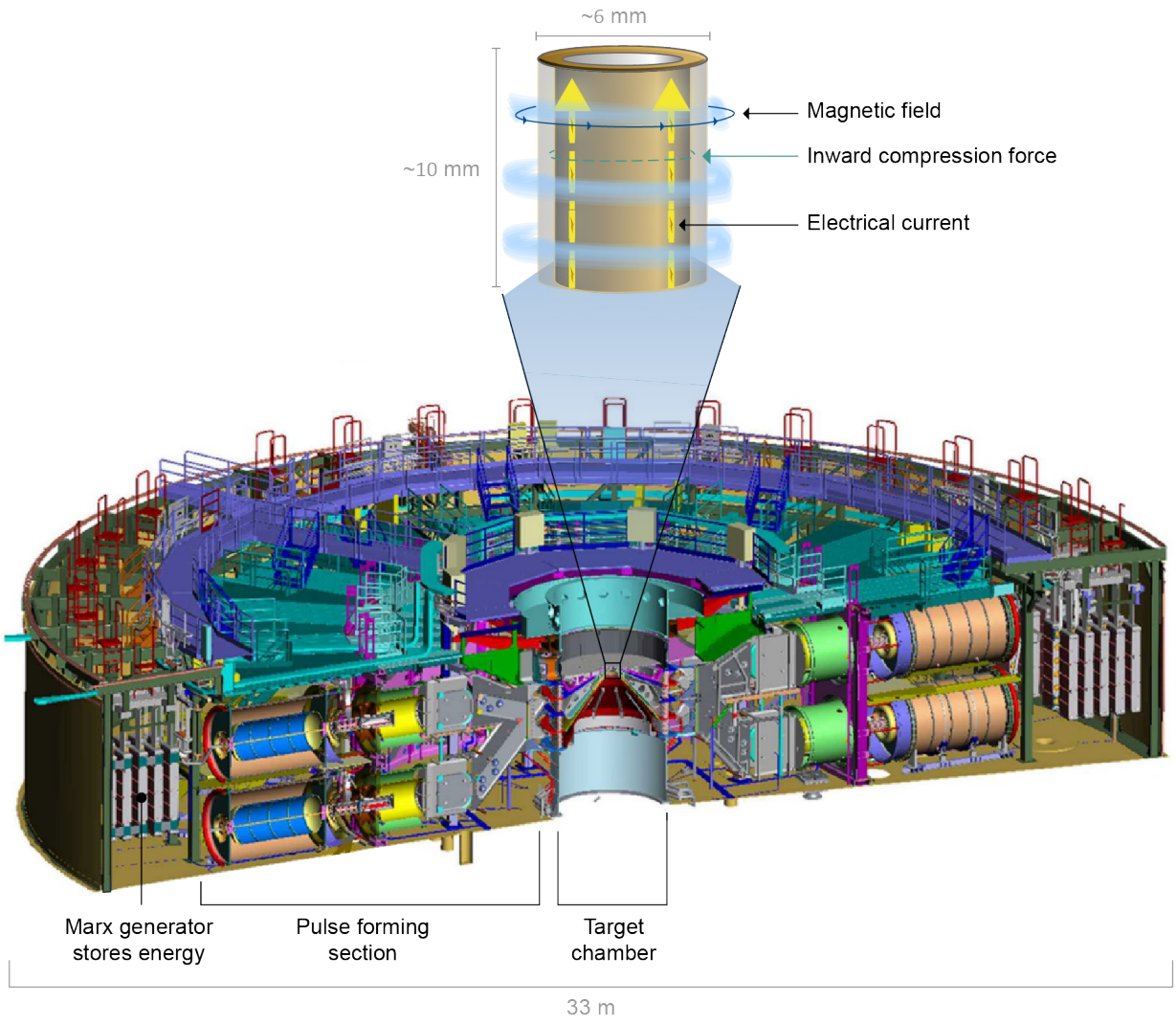
highly energized plasma.[14] By running a current through the plasma, the resulting magnetic field compresses the fuel inward—an approach known as magnetic direct drive. A strong enough current will create enough compression to cause a fusion reaction. The magnetic direct drive approach allows Z to compress larger targets over a longer time scale than either NIF or Omega. This means Z is useful in different experiments for testing material samples at larger sizes than NIF or Omega. Delivering approximately 2 megajoules of energy on target, Z is the most powerful pulsed-powered machine in the world.

According to NNSA, Z's annual shot rate average has fluctuated. For example, from fiscal years 2020 and 2024 Z's shot rate was around 130 shots per year. NNSA officials told us that during this period, there were significant deviations due to aging infrastructure and major events, which have increased downtime at the facility. However, during fiscal year 2023 and 2024, the shot rate has been closer to about 150 shots per year for the period.

Figure 3 depicts a diagram of the Z Pulsed Power facility and the size of its target load or sample.

[14]Plasma is a state of matter, similar to solids, liquids, and gases, that consists of a superheated gas with enough energy to strip electrons from atoms, creating a mix of ions and free electrons.

Figure 3: Layout, Key Components, and Technology at Z Pulsed Power Facility, Sandia National Laboratories



Sources: Sandia National Laboratories; National Nuclear Security Administration (facility) and GAO (detail). | GAO-25-107204

Note: The technology presented in figure 3 is magnetic direct drive, which is used for inertial confinement fusion experiments at the Z Pulsed Power Facility.

According to NNSA documents, the long-term goal of the ICF program is to generate high fusion yield in the laboratory. Such a capability would close significant gaps in the ability of NNSA scientists to experimentally investigate the physics of nuclear weapons at their operating conditions. NNSA documents define a high-fusion yield facility as capable of generating ICF yields greater than 200 megajoules. According to NNSA

documents, none of the current facilities can achieve this high yield. Moreover, to inform development of a next generation HED capability, NNSA documents outline that both technology development and mid-term upgrades to the ICF facilities will be needed.

Key Roles and Responsibilities for ICF Program, Part of NNSA's Office of Defense Programs

NNSA's ICF program, including the planned near-term recapitalization effort, is part of the Office of Experimental Sciences within the Office of Research, Development, Test, and Engineering in NNSA's Office of Defense Programs. The ICF program consists of the following three subprograms:

- High Energy Density and Ignition Science for Stockpile Applications focuses on planning and carrying out experiments at the ICF facilities;
- ICF Diagnostics and Instrumentation focuses on improving technologies for collecting data from experiments; and
- Facility Operations focuses on supporting the operations and maintenance of the three facilities. The ICF recapitalization effort is managed under the Facility Operations subprogram.[15]

Federal program managers within NNSA's ICF program are responsible for managing and overseeing the technical scope, cost, and schedule for programs in accordance with NNSA and DOE policy, directives, and instructions. Specific responsibilities include (1) program planning and budgeting, (2) authorizing and overseeing work, (3) evaluating performance against established milestones and other requirements or criteria, and (4) communicating complete and current program information to stakeholders and decision-makers. At NIF and Z, NNSA's management and operating contractors for Lawrence Livermore and Sandia National Laboratories manage day-to-day site operations of the ICF facilities, including managing the facilities and infrastructure of each site. At

[15]The ICF's Facility Operations subprogram distinguishes it from other infrastructure for Office of Defense Programs activities, many of which are allocated operations and maintenance funds from NNSA's Office of Infrastructure.

Omega, site operations are the responsibility of the University of Rochester's Laboratory for Laser Energetics.[16]

NNSA's Plan Contained Sufficient Information on Activities to Sustain Capabilities in the Near-Term, and Plans for Mid-term Facility Upgrades Have Evolved

NNSA's recapitalization plan contained sufficient information for decision-makers on the scope, costs, and time frames to sustain capabilities in the near-term. NNSA's plans for facility upgrades in the mid-term to NIF and Z have evolved beyond what was described in the 2023 recapitalization plan. NNSA does not currently have plans to upgrade Omega because NNSA expects the facility to operate through the 2040s with its current sustainment plans.

Plan Contained Sufficient Information for Decision-Makers on the Scope, Costs, and Time Frames to Sustain Capabilities

In accordance with congressional direction, NNSA's recapitalization plan needed to include information on the activities, costs, and timelines related to sustaining the current facilities. NNSA's plan contained sufficient information for decision-makers relating to these three elements. It provided a general scope of activities to address the highest priority sustainment issues at all three facilities and the estimated cost and time frame to complete the planned activities in the near-term (the next 6 to 8 years). NNSA also included information on the activities' anticipated impact on facility operations. Specifically, the plan identified 110 discrete activities for ensuring that the ICF facilities' capabilities support the needs of stockpile stewardship and modernization through the facilities' projected design lifetimes. NNSA's 2023 plan estimated the overall cost to complete the planned sustainment activities will be about $492 million and recommended that the work be completed within 6 to 8 years (see table 1).

[16]DOE and the Laboratory for Laser Energetics of the University of Rochester have a Cooperative Agreement for research in ICF and HED physics at the Omega Laser Facility. This agreement usually lasts for 5 years, and the most recent renewal period was from fiscal year 2024 through 2028. This agreement also allows for cost sharing between DOE and the Laboratory for Laser Energetics. In fiscal year 2024, the Omega Laser Facility received $99.4 million in federal funding from the NNSA, with $60.8 million directly supporting facility operations and maintenance. The Omega Laser Facility also receives funding from the University of Rochester to support capital investments as well as from Empire State Development, an umbrella organization for economic development financing for the State of New York.

Table 1: Number and Estimated Cost of Sustainment Activities Outlined in the 2023 Recapitalization Plan for the National Nuclear Security Administration's Inertial Confinement Fusion Facilities

Dollars in millions

Inertial Confinement Fusion Facility	Number of sustainment activities identified	Estimated cost
National Ignition Facility (Lawrence Livermore)	26	$302 million
Omega Laser Facility (University of Rochester)	44	$72 million
Z Pulsed Power Facility (Sandia)	40	$118 million
Total	**110**	**$492 million**

Source: GAO analysis of National Nuclear Security Administration information. | GAO-25-107204

Note: The 2023 recapitalization plan identified a time frame of 6 to 8 years to complete the sustainment activities.

NNSA officials told us that the $492 million estimated cost reflected the total of the three facilities' estimates of the procurement and labor costs to complete each sustainment activity. According to these officials, the amount reported was intended to provide Congress general information on the magnitude of the sustainment investment. The 6- to 8-year time frame was recommended to reduce the facility down-time and impact to ongoing experiments. However, according to officials, the plan did not specify start and end dates for every sustainment activity as these would depend on the annual funding for the ICF program.

Regarding the identified sustainment activities, each facility identified sustainment activities that would address the highest priority issues at each site. The identified activities were also intended to ensure that each facility could continue operating at its originally designed performance levels and continue delivering data to meet the needs of the U.S. nuclear stockpile. According to the plan and NNSA officials, the facilities prioritized activities using a common risk assessment approach that considered the estimated probability of a component or system failing and the consequence to operations should the component or system fail. According to the plan, all sustainment activities identified involved technologies that are at a high technology readiness level.[17] The activities

[17]A technology readiness level is a metric used for describing technology maturity. It is a measure used by many U.S. government agencies to assess maturity of evolving technologies prior to incorporating that technology into a system or subsystem.

identified in the plan encompassed a number of areas related to facility operations, consisting of:

- driver systems which produce the energy needed to induce the compression, such as NIF laser amplifiers or Z's capacitor banks;
- experimental systems, such as the Omega target viewing system required to position the targets and align the Omega lasers; and
- support system infrastructure, such as the tools and equipment used for designing and fabricating the targets for ICF experiments conducted at Z.

Below are examples of the sustainment activities the plan included for each facility and the operational impacts NNSA anticipates.

National Ignition Facility. NNSA identified 26 activities in the recapitalization plan to sustain NIF's capabilities with a total estimated cost of $302 million.

Among the 26 sustainment activities is one to refurbish NIF's laser amplifiers. NIF's laser amplifiers increase the energy of the initial laser pulse, producing a stronger beam that can be delivered to the target. It takes several stages of amplification to reach the final energy directed onto the target. However, according to the plan, after a decade of use, the laser amplifiers are experiencing increasing levels of particle contaminants and are impacting the facility's ability to carry out experiments at the highest power and energy levels. Most significantly, the sealant used to hold together a component of the laser amplifiers has degraded from the light exposure leaving particles on the glass (see fig. 4). These particles reduce the transmission of the laser beams and, ultimately, the energy directed at the target. To mitigate debris from the degrading sealant, NNSA plans to remove and clean the laser amplifier components. NNSA reported that refurbishing the laser amplifiers and replacing other degraded components to address amplifier performance would cost $42.9 million.

Figure 4: Photo of National Ignition Facility Laser Amplifier, Lawrence Livermore National Laboratory

Sources: Lawrence Livermore National Laboratory; National Nuclear Security Administration information. | GAO-25-107204

NNSA stated in the plan that some of the sustainment activities cannot be completed during NIF's regular maintenance and downtime periods.[18] To minimize impacts to NIF operations, the plan proposed an extended maintenance period of 8 months divided into 2-week downtime periods every 2 months for the last 2 years of the sustainment effort. The plan also proposed an additional extended 10-week period for activities that require a longer contiguous period. This extended downtime would be used to carry out the most intensive sustainment projects, such as amplifier refurbishment, replacement of large optical components, and other major undertakings requiring prolonged access to the interior of the target chamber.[19] The plan stated that there would be a 13 to 26 percent reduction in the NIF shot rate during the last 2 years of the effort. We

[18]Currently, NIF plans for 6 cumulative weeks of maintenance each calendar year.

[19]These activities include the removal of important hardware components, such as the Polar Diagnostic Instrument Manipulator used to insert diagnostic instruments into the NIF target chamber to within a few centimeters of an experiment. Since it was first deployed during the commissioning of NIF, the manipulator has had significant reliability issues with four times the amount of unavailability and repair hours of all other positioners, according to NNSA documents. As a result, a substantial number of lost shot days and data have been caused by problems with the manipulator, according to NNSA documents.

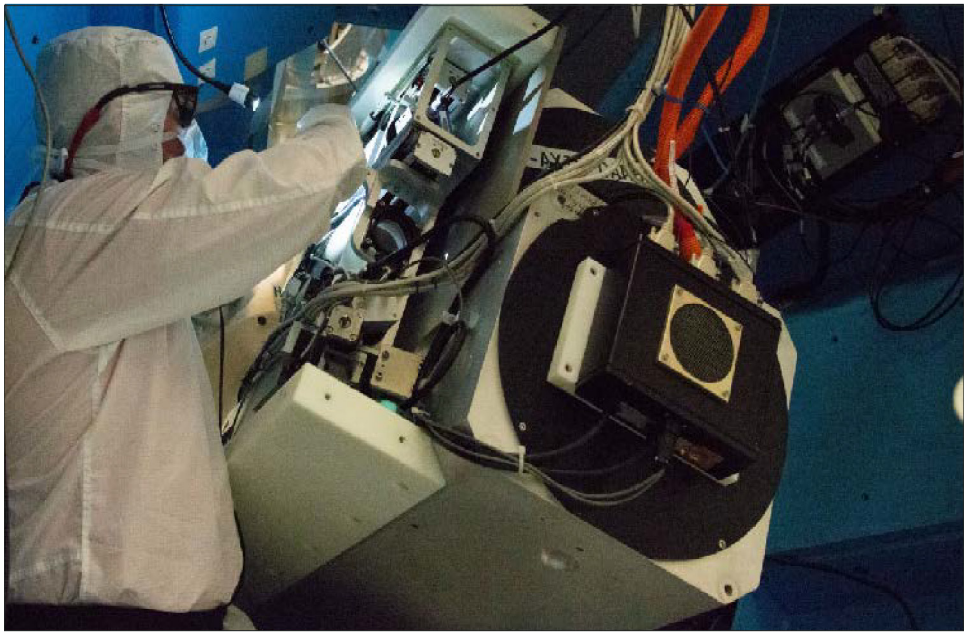
determined that this would equate to an anticipated reduction of approximately 44 to 88 shot days per year.

Omega Laser Facility. NNSA identified 44 activities in the recapitalization plan to sustain Omega's capabilities, with a total estimated cost of $72 million.

Among the 44 sustainment activities is one to update the target viewing system interface (see fig.5). The target viewing system is required to position the targets and align the lasers for every shot taken. The target viewing systems used at Omega were deployed in 2005 and 2008 with an interface that was compatible with the technology used at the time. At nearly 20 years old, the interface for the target viewing system used at the facility is now obsolete. Moreover, the manufacturer is unable to guarantee its ability to repair the site's existing cameras that use the obsolete technology, which are typically damaged at the rate of one to two per year. As no replacement cameras exist, alternatives will require that Laboratory for Laser Energetics facility managers make some changes to the target viewing system's control system and software.

To ensure continued use of the target viewing system, NNSA proposed to adapt the current system for future camera technology and address known deficiencies in the existing equipment. NNSA reported in the plan that this project would cost $506,000.

Figure 5: Photo of Omega Laser Facility Target Viewing System, University of Rochester Laboratory for Laser Energetics



Sources: University of Rochester Laboratory for Laser Energetics; National Nuclear Security Administration information. | GAO-25-107204

Like NIF, NNSA reported that the sustainment activities identified for Omega in the plan could not be accomplished during the regular maintenance and downtime periods.[20] NNSA proposed to augment the Omega maintenance period with an additional 4- to 6-week period per year during a 5-year surge to complete larger sustainment activities. The plan stated that there would be an 11 to 17 percent reduction in the Omega shot rate during this period, which we estimated to be a reduction of approximately 22 to 33 shot days per year.

Z Pulsed Power Facility. NNSA identified 40 activities in the recapitalization plan to sustain Z's capabilities, with a total estimated cost of $118 million.

[20]Currently, the Omega Laser Facility plans 1 week per quarter of maintenance downtime for a total of 4 weeks a year for the OMEGA-60 laser, and 2 weeks per quarter for a total of 8 weeks per calendar year for OMEGA Extended Performance laser.

Among the 40 sustainment activities is one to replace Z's Marx Bank capacitors (see fig.6). The Z machine contains over 2,000 Marx Bank capacitors, which store and release energy for its pulsed power delivery system. According to the plan, the capacitors were certified in 2007 for a lifetime of 3,000 shots. NNSA projects that Z will reach its 3,000th shot by 2028. The failure rate has increased over the past 5 years and will likely increase as the capacitors reach their end of life.

To ensure that the Z machine will continue to operate after 2028, NNSA plans to replace all the Marx Bank capacitors. Only one supplier can currently produce these capacitors and NNSA plans to negotiate a contract with this supplier to begin in late fiscal year 2025 so the supplier can begin to deliver replacement capacitors in 2028. NNSA reported this project would cost $34.3 million.

Figure 6: Photo of the Marx Bank Capacitors at Z Pulsed Power Facility, Sandia National Laboratories

Sources: Sandia National Laboratories; National Nuclear Security Administration information. | GAO-25-107204

NNSA reported in the plan that Z anticipated minimal disruptions related to executing sustainment work because the additional sustainment work would coincide with regular and routine maintenance activities.[21] As a

[21]Currently, Z plans for a 2- to 3-week maintenance period each calendar year.

result, NNSA did not anticipate a reduction of the shot rate below 150 shots per year to complete the sustainment scope.

Plans for Mid-term Facility Upgrades Have Evolved

NNSA's recapitalization plan provided scope, cost, and time frame details, as called for in the congressional direction, on proposed upgrades for the mid-term that were current at the time the report was published in 2023. NNSA is moving forward with a variation of an approach detailed in the plan to upgrade NIF. In addition, NNSA's approach for Z upgrades as outlined in the plan are no longer current as officials said they continue to explore an additional upgrade option. According to NNSA officials, the plan did not describe upgrades for the Omega facility because none are currently planned.

National Ignition Facility

According to officials, NNSA is moving forward with a variation of an approach to upgrade NIF as detailed in the plan. The upgrade project, now called the Enhanced Yield Capability project, aims to increase NIF's laser energy from 2.2 megajoules to 2.6 megajoules by leveraging existing facility infrastructure. According to agency documents, when NIF was first constructed in 2009, the facility was built with space to install up to seven amplifiers per beamline, although only five amplifiers were installed. The project will install two additional amplifiers into the two empty amplifier locations at each of the 192 beamlines and replace optical components needed to support the higher energy operations. According to NNSA, the agency expects that this upgrade may increase NIF fusion yield up to 40 megajoules.

According to NNSA documents and officials, the agency plans to manage the project following DOE's project management requirements for capital asset acquisition projects, which require, among other things, that projects go through critical decision (CD) milestones.[22] According to NNSA officials, DOE's Deputy Secretary approved the initial milestone, CD-0, in September 2024 to approve the mission need for the project and begin the conceptual design phase.

According to NNSA officials, the estimated cost of the upgrade project continues to evolve as it progresses through the DOE project management process. In the 2023 recapitalization plan, NNSA reported that the NIF upgrade options under consideration at the time could cost $200 million to $300 million. NNSA officials told us that the estimated cost

[22]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Change 7) (Washington, D.C.: June 21, 2023).

range developed in support of the CD-0 milestone was between $470 million to $1 billion with an estimated project completion date range of fiscal year 2031 to fiscal year 2035. Consistent with DOE capital asset acquisition projects, NNSA officials said that this estimate will be refined again after additional planning and design work is completed to support the CD-2 milestone (approval of the performance baseline.) At that point, the estimate will then serve as the project's baseline cost. NNSA plans to request funding to start the project in the President's fiscal year 2026 budget request to Congress, according to the officials.

Z Pulsed Power Facility

We found that NNSA's approach to Z upgrades outlined in the 2023 recapitalization plan is no longer current and has evolved beyond what was described in the plan. In the 2023 plan, NNSA outlined a portfolio of proposed upgrades aimed at supporting Z operations through 2035 at an estimated cost of $37.5 million. These activities, referred to in the plan as Z Facility Core Capability Investments, included research and development projects to increase energy storage in the Marx generators, increase power efficiency in the magnetically insulated transmission lines, and improve pulsed power electrical components.[23] According to NNSA, these upgrades would improve Z's operational performance and enable the facility to perform higher energy experiments not currently accessible on Z.[24] As of May 2025, ICF federal program managers said NNSA still intends to undertake these upgrade activities in the mid-term.

ICF federal program managers told us that the program is also exploring an additional upgrade option for Z to meet mission needs. Officials told us that they were considering an upgrade that would involve a major overhaul of Z. Under this other approach, NNSA would replace all of Z's major pulsed power components, increasing the facility's power and energy by 50 percent to ensure that Z could be used to meet NNSA needs into the 2040s. A preliminary cost estimate for this upgrade

[23]Magnetically insulated transmission lines are made up of five uniquely designed and fabricated components that are produced from complex fabrication and manufacturing processes. These components can take between 18 and 24 months to procure. The lines play a critical role in delivering the energy pulse to the target area for an ICF experiment.

[24]In the recapitalization plan, NNSA also proposed developing a pulsed power demonstration module and estimated this project to cost about $14 million. NNSA requested funding for the technology maturation efforts related to the Z Core Capability Investments and the Pulsed Power Demonstration Module in fiscal year 2025 under the Advanced Diagnostics subprogram. ICF officials told us that NNSA is not moving forward with a proposed plan to develop a next generation pulsed power testbed that it described in the plan because the driver technology for a next generation HED capability has not yet been defined.

concept ranged from $300 million to $500 million based on an analysis of historical costs from a large overhaul of Z completed in 2006, according to the officials.[25] As of May 2025, officials told us that this approach, termed the ZX initiative, was only in the early planning stages and that currently no funding or priority was associated with it.

We found that NNSA continues to explore another option for Z upgrades, in part, because the agency's planning for a next generation HED capability has evolved since NNSA issued the 2023 recapitalization plan. Specifically, the recapitalization plan described a concept for a new, next generation pulsed power capability to replace Z and provide a next generation HED capability for the ICF program.[26] However, NNSA officials told us during our audit work that the agency has decided to move away from planning specifically for a next generation pulsed power capability. Instead, the agency will evaluate both laser and pulsed power driver technologies for such a capability to carry out high yield ICF experiments. Furthermore, NNSA officials told us that the evolution in planning for the next generation HED capability could require Z to operate longer, into the 2040s or even potentially until 2050. The January 2023 plan stated that Z would need to operate through at least 2035.

Although NNSA is considering other mid-term options to upgrade Z, officials told us they have not yet documented these options in the program plan and have not yet completed an analysis of alternatives study that would identify and compare options under consideration. At the time of our audit, officials told us that the program was focused on prioritizing near-term sustainment needs. Further, they stated, as noted above, that the ZX initiative was only in early conceptual planning and had not been presented to NNSA leadership.

[25]According to agency documents, the 2006 upgrade primarily focused on replacing pulsed power components installed in 1996. At the time, the Z Pulsed Power Facility had been built largely as a short-term proof-of-principle demonstration of the potential of the Z-pinch approach for fusion research and was rapidly reaching obsolescence. When the refurbished Z Pulsed Power Facility was recommissioned in 2007, the output power and energy was twice that of when the facility was commissioned in 1996.

[26]NNSA also reported on the concept for a next generation pulsed power facility in the fiscal year 2024 Stockpile Stewardship Plan in November 2023. Department of Energy, *Fiscal Year 2024 Stockpile Stewardship and Management Plan* (Washington, D.C.: Nov. 2023). However, NNSA's Enterprise Blueprint released in October 2024 documented the need for a next generation high-yield high energy density capability without identifying the technology or location for a future capability. National Nuclear Security Administration, *Enterprise Blueprint* (Oct. 2024).

According to NNSA's Program Execution Instruction, the program plan can be used to document and communicate the options and approach when in the process of analyzing a decision. The Program Execution Instruction also provides guidance to federal program managers on various methods, such as analysis of alternatives, to analyze and make decisions.[27]

It is early in the process and information will continue to become available as NNSA conducts additional analysis. However, the plan for Z, as presented to Congress in 2023, has been overtaken by events. Documenting the options under consideration for Z upgrades including their potential scopes, estimated costs, and relevance to meeting mission needs in the annually updated program plan or other document, could help the ICF program ensure that decision-makers, including NNSA leadership and Congress, are better positioned to understand what is needed to upgrade the Z facility.

Near-Term Sustainment Activities Are Ongoing but NNSA Has Not Evaluated Progress Against a Baseline

NNSA has sustainment activities ongoing at each site, with others yet to begin. However, NNSA has not established measures to evaluate progress in completing all the sustainment work against a scope, cost, and schedule baseline.

NNSA Tracks Progress of Ongoing Sustainment Activities

NNSA officials have reported that many of the planned near-term sustainment activities discussed earlier are ongoing. Site representatives at each of the three facilities track day-to-day progress of sustainment activities and report that information to NNSA's ICF program office, according to NNSA officials. ICF federal program managers corroborate their understanding of this information at weekly meetings with site representatives and in monthly progress reports. Also, ICF federal program managers collect this information at the end of each fiscal year

[27]For example, according to the *Program Execution Instruction*, an analysis of alternatives is appropriate when criteria can be established which distinguish potential alternatives, especially when it is unclear if or how all alternatives meet the identified requirements, or when there is a significant difference among the alternatives in terms of risk to the activity. Department of Energy and National Nuclear Security Administration, *Program Execution Instruction.*

and report it in annual program plans. Specifically, we found the following progress reporting activities.

- The sustainment managers at each facility track progress on sustainment activities and submit monthly progress reports to the ICF federal program managers. These progress reports include details on all the active sustainment activities that month such as phase of activity, status, expected completion date, cost, risk, and description.
- The ICF federal program managers discuss ongoing work and emerging issues needing management attention and resolution during weekly meetings with site representatives at each facility. Additionally, ICF federal program managers meet monthly with site representatives to walk through monthly progress reports and discuss project management issues or improvements.

  According to the ICF federal program managers, they confirm completion of sustainment activities and adherence to project scope at quarterly and at the end of fiscal year milestone reporting periods.

ICF program and facility-specific sustainment plans include milestone information for each facility by fiscal year, and the milestone information varies by site. For example, in the fiscal year 2024 program plan for the Facility Operations subprogram, NIF milestones include four related to sustainment activities, Z had three milestones, and Omega had one.

Our analysis of the site-specific monthly progress reports shows the following progress made on sustainment work as of March 2025:

- National Ignition Facility. At NIF, approximately 52 percent of the sustainment activities were ongoing, with the remaining 48 percent not started. No activities were complete, but NNSA officials said this was on track with their expectations as NIF sustainment activities are multi-year projects.
- Omega Laser Facility. At Omega, approximately 7 percent of sustainment activities were completed, with 50 percent of activities ongoing. Eleven percent of some activities had started but were paused, while the remaining 31 percent had not started.[28]

[28]Due to rounding, the total sustainment activity progress percentages for the Omega Laser Facility do not add up to 100 percent.

- Z Pulsed Power Facility. At Z, approximately 16 percent of sustainment activities were completed, with the remaining work split with 42 percent of activities ongoing and 42 percent not started.

NNSA Has Not Evaluated Facility Progress Against Near-Term Sustainment Scope, Cost, and Time Frame Baselines

Neither NNSA's fiscal year 2024 program plan for the Facility Operations subprogram nor NNSA's facility-level tracking of sustainment activities provide an evaluation of the extent to which NNSA has met the near-term scope, cost, and time frame goals outlined in the recapitalization plan. According to the Program Execution Instruction, programs, such as the ICF program, are required to track performance-based management measures against milestones and cost and schedule baselines.[29] NNSA officials told us they consider the recapitalization plan to be the baseline for the sustainment effort.

NNSA tracks some performance information on sustainment, including information on scope, cost, and time frames. But this information does not assess progress made on the overall effort compared to the baseline as set forth in the 2023 recapitalization plan.

Scope. NNSA officials told us that the near-term sustainment activities' scope at the three facilities has largely remained the same, but that since the recapitalization plan, NNSA has restructured the organization of the work scope.[30] However, with the revised breakdown of sustainment activities, we were unable, during our analysis, to fully reconcile the completion of facility-specific sustainment activities with the recapitalization plan. For example, a crosswalk, provided by NNSA officials, between facility-specific sustainment tracking numbers to the recapitalization plan was needed to fully ensure the scope described in the plan is covered.

Cost. NNSA reports on annual funding spent on sustainment activities at each facility in the program plans. That is, NNSA tracks the costs incurred

[29]A baseline is a quantitative definition of cost, schedule, and technical performance that serves as a standard of measurement for an effort. This is the established plan against which the status of the work is measured, assessed, and controlled.

[30]Individual activities in the recapitalization plan have, in some cases, been broken down into multiple projects. Also, there were cases in which activities were removed after NNSA reassessed their scope and found they did not meet the definition of sustainment, or that NNSA had inadvertently omitted activities from the recapitalization plan. Therefore, the total number of sustainment activities NNSA now tracks shifted from 110 to 138. We relied on written and testimonial information from NNSA to collect status numbers and did not independently validate this information.

for discrete ongoing activities in each facility's monthly reports. Additionally, in fiscal year 2023 when the sustainment work started, NNSA established a facility sustainment budget line to assist in tracking and measuring annual sustainment spending within the ICF program's operations budget. However, this information does not provide any insight into whether an activity's actual cost is consistent with the plan estimate. For example, it does not include information on whether ongoing sustainment activities are costing more or less than anticipated or whether the total funding directed toward the sustainment work is at, below, or exceeding the $492 million proposed in the plan.

Time frame. The monthly progress reports the facilities submit to the ICF federal program managers identify the phase or status and expected completion date for discrete sustainment activities. However, these reports do not provide details needed to assess the overall progress on the sustainment effort to determine whether near-term sustainment objectives will be met in a time frame that supports programs' experimental needs.

NNSA officials and site representatives told us in November 2024 that the time frames for completing the overall sustainment scope have shifted. The sustainment work began in fiscal year 2023 and, in the recapitalization plan, NNSA proposed completion of the work within 6 to 8 years. Instead, NNSA officials said they now anticipate the sustainment effort may be completed by fiscal year 2033.[31] In the immediate term, ICF facilities have not experienced a significant impact to their operations. However, the ICF program managers told us they have communicated to NNSA decision-makers that the delays increase the risk that ICF facilities could suffer hardware failures. Such failures would result in unplanned downtime reducing the number of experiments the facilities could execute to support NNSA's stockpile stewardship and modernization missions.

NNSA has not evaluated the extent to which facilities have met planned sustainment scope, cost, and time frame goals because NNSA has not established performance measures to do so in its published program plan. The Program Execution Instruction requires that programs, such as the ICF program, track performance measures against milestones, costs, and schedule baselines to assess the progress of work and provides

[31]This estimation was based on projected fiscal year 2025 funding levels requested in the President's budget request. As of March 2025, federal agencies are operating under a continuing resolution which generally holds funding to fiscal year 2024 levels.

guidance on methods for establishing and using such measures.[32] Specifically, the Program Execution Instruction states that measures have the following characteristics: (1) measurable, reliable, and consistent; (2) simple and unambiguous; (3) verifiable and effective; and (4) drive effective decisions and process improvement.

We found that NNSA has not established such baseline measures because it generally manages sustainment under the ICF program's facilities and operations budget as an annual operations activity. By contrast, the sustainment effort described in the recapitalization plan represents a multi-year surge of sustainment work scope that NNSA and the three facilities reported is necessary to complete in a certain amount of time to maintain the facilities' performance and continue to support national nuclear security mission needs.

Without developing and using performance measures to evaluate actual progress in completing the overall ICF near-term sustainment effort against scope, cost, and schedule baselines, NNSA management and decision-makers—including Congress—have incomplete information on whether NNSA is achieving its recapitalization objective to ensure the ICF facilities continue to operate at their originally designed performance levels.

Conclusions

NNSA's ICF recapitalization plan described general scope, costs, and time frames for sustaining operations of the ICF facilities and continuing HED experiments in support of stockpile and modernization mission needs in the near-term. However, NNSA's plans for facility upgrades in the mid-term to improve their performance and access more HED environments continues to evolve. In particular, NNSA continues to explore mid and long-term options to upgrade Z. The agency has not determined the type of next generation HED capability to support the mission in the long-term and thus NNSA is uncertain how long Z may need to operate. It is early in the process and information will continue to become available as NNSA conducts additional analysis. By documenting

[32]The ICF program falls into the category of "standard management" in the *Program Execution Instruction*. The *Program Execution Instruction* uses four program management categories, in order of increasing rigor: standard management, enhanced management B, enhanced management A, and capital acquisition management. According to the *Program Execution Instruction*, federal program managers can tailor their approach in addressing program management requirements by exercising professional judgment to determine the degree of controls, verification, and documentation needed to meet requirements. Department of Energy and National Nuclear Security Administration, *Program Execution Instruction.*

options under consideration for Z upgrades in program plans, the ICF program would ensure decision-makers, including NNSA leadership and Congress are well-positioned to understand the range of options that may be available to upgrade the Z including their potential scopes, estimated costs, and relevance to meeting HED and national security mission needs.

The ICF federal program managers and site representatives track the progress of ongoing sustainment activities. However, the program does not evaluate the extent to which the scope, cost, and time frame goals outlined in the recapitalization plan have been met because NNSA has not established performance measures. By developing and using performance measures to evaluate progress in completing this surge of sustainment work against the scope, cost, and time frame baseline, decision-makers—including Congress—can determine whether the sustainment activities are achieving their intended purpose.

Recommendations for Executive Action

We are making the following two recommendations to NNSA:

The Administrator for the National Nuclear Security Administration should ensure that the ICF program documents the options under consideration for upgrades to the Z Pulsed Power Facility, including potential scopes, estimated costs, and relevance to meeting mission needs, in the program plan or other document. (Recommendation 1)

The Administrator for the National Nuclear Security Administration should ensure that the ICF program develops and uses performance measures, consistent with NNSA's program management guidance, to evaluate the progress of sustainment activities at all three ICF facilities against scope, cost, and schedule baselines and report on the progress in the program plan and progress reports. (Recommendation 2)

Agency Comments

We provided NNSA with a draft of this report for review and comment. In its comments, reproduced in Appendix I, NNSA concurred with our recommendations. NNSA stated that the ICF program will document the options under consideration for a potential Z upgrade and develop performance measures to better track and report on the overall progress of the sustainment effort. NNSA also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary Energy, the NNSA Administrator, and other interested parties. In addition, the 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 BawdenA@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 key contributions to this report are listed in appendix II.

//SIGNED//

Allison Bawden
Director, Natural Resources and Environment

List of Committees

The Honorable Roger Wicker
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable John Kennedy
Chair
The Honorable Patty Murray
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Chuck Fleischmann
Chairman
The Honorable Marcy Kaptur
Ranking Member
Subcommittee on Energy and Water Development, and Related Agencies
Committee on Appropriations
House of Representatives

Appendix I: Comments from the Department of Energy

Department of Energy
Under Secretary for Nuclear Security
Administrator, National Nuclear Security Administration
Washington, DC 20585

July 30, 2025

Ms. Allison B. Bawden
Director, Natural Resources
and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Ms. Bawden:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report, *National Nuclear Security Administration: Improvements Needed for Managing Recapitalization of Fusion Facilities* (GAO-25-107204). The Department of Energy's National Nuclear Security Administration (NNSA) appreciates GAO's observations on the recapitalization plan for NNSA's three Inertial Confinement Fusion (ICF) program facilities.

NNSA is pleased that GAO's analysis indicated that NNSA's January 2023 plan to recapitalize ICF program facilities contains sufficient information about the scope, cost, and timelines for near-term sustainment capabilities, consistent with congressional direction. As the report notes, while the information about the scope, cost, and timelines for mid-term upgrades were current at the time the plan was published, NNSA's plans for the Z Pulsed Power Facility are evolving and NNSA agrees it would be beneficial to document the options under consideration as they become more clear. NNSA also appreciates GAO's observations on using performance measures to better gauge progress for near-term sustainment activities and agrees it would be helpful to better track and report on overall progress.

The enclosed Management Decision outlines the specific actions planned to address the two recommendations in the report. NNSA subject matter experts have provided technical and general comments under separate cover for your consideration to enhance the clarity and accuracy of the report. If you have any questions, please contact Mr. George Webb, Acting Director, Audits and Internal Affairs, at (301) 903-3436.

Sincerely,

Teresa M. Robbins
Acting Under Secretary for Nuclear Security
and Administrator, NNSA

Enclosure

Enclosure

NATIONAL NUCLEAR SECURITY ADMINISTRATION
Management Decision

National Nuclear Security Administration: Improvements Needed for Managing Recapitalization of Fusion Facilities (GAO-25-107204)

The Government Accountability Office (GAO) recommends the Department of Energy's National Nuclear Security Administration (NNSA):

Recommendation 1: Ensure that the Inertial Confinement Fusion (ICF) program documents options under consideration for upgrades to the Z pulsed power facility, including potential scopes, estimated costs, and relevance to meeting mission needs, in the program plan or other document.

Management Response: Concur. The ICF Program is conducting pre-conceptual planning for a potential Z facility upgrade. The NNSA laboratories held a workshop to explore mission needs and documented their findings. Based on these findings, the ICF Program is evaluating potential scope for upgrading the facility and determining the appropriate pathway. Once completed, potential scope and preliminary cost estimates will be documented. The estimated date for completing these actions is March 31, 2027.

Recommendation 2: Ensure that the ICF program develops and uses performance measures, consistent with NNSA's program management guidance, to evaluate the progress of sustainment activities at all three ICF facilities against scope, cost, and schedule baselines and report on the progress in the program plan and progress reports.

Management Response: Concur. The ICF Program is developing performance measures to ensure collection of consistent, up-to-date data on each facility's sustainment progress for evaluating actual against planned scope, cost, and schedule. The estimated date for completing this action is December 31, 2026. The use of these performance measures to report on the progress of sustainment activities will continue through the completion of all sustainment activities.

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Allison Bawden, Director, bawdena@gao.gov

Staff Acknowledgments

In addition to the contact named above, Brian M. Friedman (Assistant Director), Emily Pinto (Analyst in Charge), Owen Baron, William Bauder, PhD, Antoinette Capaccio, Mae Jones, Krinjal Mathur, Sara Sullivan, Andrew Stavisky, and Mario Tiberie made significant contributions to this report.