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Report to the Committee on Armed Services, House of Representatives

May 2024

NUCLEAR NONPROLIFERATION

Efforts Are Underway to Address Factors Affecting the International Atomic Energy Agency's Safeguards Program

GAO-24-106296

GAO Highlights

Highlights of GAO-24-106296, a report to the Committee on Armed Services, House of Representatives

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Why GAO Did This Study

IAEA plays a crucial role in supporting nuclear nonproliferation and facilitating peaceful uses of nuclear energy through its safeguards program. In 2022, IAEA operated this program in 188 countries with which it had safeguards agreements (countries do not have to be IAEA members to have a safeguards agreement with IAEA). The U.S., which led the establishment of IAEA—a United Nations-affiliated organization—in the 1950s, provides financial and other assistance to the agency to improve safeguards.

The House report accompanying the fiscal year 2021 National Defense Authorization Act included a provision for GAO to review IAEA's safeguards program and U.S. support for it. This report examines (1) how the U.S. and other member countries support IAEA safeguards, and (2) what key factors IAEA officials and stakeholders have identified that could affect IAEA's implementation of safeguards and the efforts being taken to address these factors.

GAO reviewed IAEA and U.S. agency documentation for 2021 and 2022, and interviewed U.S. State Department and DOE officials to identify U.S. and other member country contributions that support safeguards. Data from 2022 were the most recent at the time of our review. To identify factors that could affect safeguards implementation, GAO reviewed IAEA documentation and interviewed IAEA officials at its headquarters in Vienna, Austria. GAO also interviewed stakeholders—including U.S. and seven other member country officials and U.S. national laboratory representatives—and conducted a literature review.

View GAO-24-106296. For more information, contact Allison Bawden at (202) 512-3841 or bawdena@gao.gov.

What GAO Found

To verify that civilian nuclear material and activities are not being used for nuclear weapons, the International Atomic Energy Agency (IAEA) uses safeguards—technical measures and activities such as inspections and environmental sampling at nuclear facilities. The U.S. and other IAEA member countries support IAEA's safeguards program in several ways. First, all 178 member countries contribute to its regular budget, which funds the safeguards program and other programs. Second, the U.S. and 22 other countries plus the European Commission have established support programs that provide additional voluntary cash and in-kind assistance to the safeguards program. Third, the U.S. Department of Energy (DOE) supports domestic activities that indirectly support the safeguards program, such as technology research and development conducted at DOE national laboratories that IAEA could adopt.

U.S. Contributions to the International Atomic Energy Agency (IAEA), 2022

U.S. contribution to IAEA's regular budget	$105 million[a]
U.S. support program for IAEA safeguards	$31 million in cash and in-kind assistance for more than 100 specific requests for safeguards assistance, such as providing technical experts
U.S. activities that indirectly supported IAEA's safeguards program	More than $103 million, such as for safeguards-related technology research

Source: GAO analysis of Department of State and Department of Energy information. | GAO-24-106296

[a]The total IAEA regular budget was approximately $418 million in 2022. Of this total, IAEA allocated approximately $161 million to its safeguards program.

GAO identified a range of factors that could affect safeguards implementation and efforts IAEA and member countries are taking to address these factors. These factors include:

- **Resource constraints.** According to IAEA officials, IAEA aims to limit the growth of its regular budget. The safeguards program has had to rely on voluntary cash contributions from member countries to meet safeguards needs. Inflationary pressures have also reduced IAEA purchasing power. IAEA is expanding its resource base by encouraging more countries to establish support programs and has added three support programs since 2021.
- **Anticipated growth of nuclear power.** IAEA officials and several stakeholders identified the continued growth of nuclear power worldwide as a factor that is expected to increase demands on IAEA's resources. IAEA is taking steps to improve efficiency, such as increasing the use of remote monitoring of nuclear facilities.
- **New types of nuclear facilities.** The emergence of new types of nuclear facilities—such as advanced nuclear reactors—may require new and more resource-intensive safeguards approaches. IAEA officials and stakeholders said that the development of unique safeguards approaches for these new facility types could be complex, costly, and time-consuming. IAEA and member countries are working with developers of new nuclear facilities to ensure safeguards can be implemented effectively.

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Abbreviations List

AP	Additional Protocol
ARISE	Advanced Reactor International Safeguards Engagement
COMPASS	Comprehensive Capacity Building Initiative for SSACs and SRAs
D&IS Programme	Development and Implementation Support Programme for Nuclear Verification
DNN R&D	Office of Defense Nuclear Nonproliferation Research and Development
U.S. DOE	U.S. Department of Energy
IAEA	International Atomic Energy Agency
INSEP	International Nuclear Safeguards Engagement Program
JCPOA	Joint Comprehensive Plan of Action
MSSP	member state support program
NNSA	National Nuclear Security Administration
NPT	The Treaty on the Nonproliferation of Nuclear Weapons
POTAS	Program of Technical Assistance to IAEA Safeguards
R&D	research and development
RMP	Enhancing Capabilities for Nuclear Verification—Resource Mobilization Priorities
SQP	small quantities protocol
SRA	state or regional authority responsible for safeguards implementation
SSAC	state or regional system of accounting for and control of nuclear material
SSN	nuclear-powered attack submarine
State	U.S. Department of State
USSP	U.S. Support Program

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May 21, 2024

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

For over 60 years, the International Atomic Energy Agency (IAEA) has played a crucial role in advancing nuclear nonproliferation goals shared by the U.S. and the broader international community through its nuclear safeguards program.[1] IAEA implements safeguards through activities such as information analysis, inspections, and environmental sampling that enable the agency to verify that a country is living up to its international commitment not to use nuclear material for nuclear weapons purposes.[2] The IAEA Department of Safeguards is responsible for implementing safeguards worldwide, and in 2022 implemented safeguards at more than 1,300 nuclear facilities and locations in 188 countries.

The Treaty on the Nonproliferation of Nuclear Weapons (NPT), which came into force in 1970, requires nonnuclear weapon states—countries that had not manufactured and detonated a nuclear weapon before

[1]IAEA is an autonomous international organization affiliated with the United Nations and based in Vienna, Austria. The agency was founded with the dual mission of (1) promoting the peaceful uses of nuclear energy by transferring nuclear science and technology through its nuclear science and applications and technical cooperation programs, and (2) verifying, through its safeguards program, that nuclear material subject to safeguards is not diverted to nuclear weapons or other proscribed purposes. IAEA has 178 member countries and implements safeguards in some countries that are not members but have safeguards agreements.

[2]IAEA defines safeguards as a set of legal instruments, technical measures, and administrative procedures implemented by IAEA in accordance with safeguards agreements and their protocols. These agreements are concluded between IAEA and states or groups of states, in some cases together with a regional authority responsible for safeguards implementation, to verify that nuclear material, nuclear facilities, or other items subject to safeguards are not acquired or used for proscribed purposes. Nuclear materials that can potentially be used to construct a nuclear weapon are highly enriched uranium (uranium enriched to 20 percent or greater in the isotope uranium-235); uranium-233; and separated plutonium containing the isotope plutonium-239 (unless the plutonium contains greater than 80 percent of the isotope plutonium-238). Low enriched uranium contains less than 20 percent and greater than 0.7 percent uranium-235. Most commercial nuclear reactor fuel is enriched to between 3 percent and 5 percent uranium-235.

January 1, 1967—to agree not to manufacture or acquire nuclear weapons. The NPT also requires these countries to subject all nuclear material to IAEA safeguards.[3] As of January 2024, the United Nations Office of Disarmament Affairs reports that there are 191 parties to the treaty.[4] These parties are composed of 186 nonnuclear weapon states and five nuclear weapon states—China, France, Russia, the United Kingdom, and the U.S.

We have previously reported on the challenges facing IAEA's safeguards program. For example, in May 2013, we reported on the challenges IAEA faced in implementing safeguards generally, and found that IAEA had not clearly defined how it would implement a novel safeguards concept known as the state-level concept.[5] We also found that the agency had not quantified the resource requirements for implementing this concept.[6] In June 2016, we reported on technical, financial, and other challenges facing IAEA in its effort to use its existing safeguards authorities to verify and monitor Iran's nuclear-related commitments under the Joint Comprehensive Plan of Action.[7]

The House report accompanying the National Defense Authorization Act for Fiscal Year 2021 included a provision for GAO to review IAEA's

[3]Under Article III of the NPT, each nonnuclear weapon state party agrees, among other things, to accept IAEA safeguards on all source or special fissionable material with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices within the territory of such state, under its jurisdiction, or carried out under its control anywhere.

[4]A party to the NPT is a state that participates in the treaty. Not all parties to the NPT are members of IAEA or have safeguards agreements with IAEA.

[5]GAO, *Nuclear Nonproliferation: IAEA Has Made Progress in Implementing Critical Programs but Continues to Face Challenges*, GAO-13-139 (Washington, D.C.: May 16, 2013). The state-level concept is intended to optimize the agency's use of resources by scoping planned safeguards activities in a country based on its potential pathways to a nuclear weapon, instead of planning activities based on the nature and quantity of nuclear material and the types of facilities within a country.

[6]GAO-13-139. In August, 2016 we closed related recommendations from this report as implemented after determining that (1) IAEA had clearly defined the state-level concept and (2) the U.S. Department of State had identified areas where U.S. support for IAEA was needed to further develop and implement the concept.

[7]GAO, *Iran Nuclear Agreement: The International Atomic Energy Agency's Authorities, Resources, and Challenges*, GAO-16-565 (Washington, D.C.: June 9, 2016). This report did not contain any recommendations.

safeguards program and its support from the U.S.[8] This report examines (1) how the U.S. and other IAEA member countries support IAEA safeguards and (2) key factors IAEA officials and stakeholders have identified that could affect IAEA's implementation of safeguards and the efforts IAEA and member countries are undertaking to address the identified factors.

To address these objectives, we reviewed documents from IAEA, including the agency's most recent biennial "Program and Budget" documents, 2021 and 2022 annual reports for the safeguards program and for IAEA as a whole, and other relevant IAEA documents. We interviewed officials from the four U.S. agencies that coordinate safeguards support to IAEA: the Department of State, the Department of Energy (DOE), the Department of Defense, and the Nuclear Regulatory Commission. We reviewed documents from these agencies, including from the National Nuclear Security Administration (NNSA), a separately organized agency within DOE, and from U.S. national laboratories involved in supporting nuclear safeguards. To identify financial support for safeguards from the U.S. and other member countries, we reviewed IAEA documents and information provided by State, NNSA, and U.S. national laboratories. We confirmed the reliability of the information presented in this report with agency officials. In addition, through coordination with the U.S. Mission to International Organizations in Vienna, we interviewed officials at IAEA headquarters in Vienna, Austria, including those responsible for implementing safeguards.

We also interviewed a nongeneralizeable sample of 29 relevant stakeholders: individuals we selected based on their status as (a) U.S. and non-U.S. government officials working in nuclear safeguards policy; (b) representatives from DOE national laboratories and sites involved in developing technologies that could support IAEA safeguards or who are actively involved in helping manage U.S. support of IAEA; and (c) other knowledgeable individuals with insights into IAEA and safeguards, such as former IAEA officials.[9] For example, we interviewed officials from

[8]H.R. Rep. No. 116-442, at 310 (2020) (accompanying H.R. 6395, William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, enacted as Pub. L. No. 116-283) (2021).

[9]Throughout this report, we will say "several" when referring to a point made by five or more stakeholders and "some" when referring to a point made by three to four stakeholders. If fewer than three stakeholders made a given point, we will cite the specific number. Factors we identified based on interviews we conducted are not generalizable to stakeholders we did not interview for our report.

seven IAEA member countries who were available to meet with us in Vienna. Officials from these countries met with us in response to our request to the U.S. Mission to International Organizations in Vienna to arrange meetings with officials from IAEA member countries holding a diversity of views on IAEA safeguards, including those that have voluntarily contributed support to the safeguards program.

To capture U.S. stakeholder perspectives, we interviewed officials from the Department of State and NNSA, and representatives from eight DOE national laboratories and sites.[10] We also interviewed officials from the Department of Defense and the Nuclear Regulatory Commission, as well as other knowledgeable individuals with insights into IAEA and safeguards.

Based on reviews of key documents and interviews with IAEA officials and stakeholders, we identified five broad categories of factors that may affect safeguards implementation. We then conducted additional analysis and coded the content of these documents and interviews into our five broad categories. To supplement our review of IAEA documents and our interviews, a GAO librarian conducted a structured literature search to identify relevant studies or journal articles for literature published between 2017 and 2022. We used professional judgment to identify a selection of 34 studies for further review based on their relevance to our objectives. We used those reviews to corroborate the categories we developed, inform our general understanding, and identify illustrative examples.

We conducted this performance audit from October 2022 to May 2024 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

IAEA Structure

IAEA's policy-making bodies include the Board of Governors, which consists of 35 member countries, including the U.S. as a de facto

[10]We interviewed representatives from Brookhaven National Laboratory, Idaho National Laboratory, Los Alamos National Laboratory, New Brunswick National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, and the Y-12 National Security Complex.

permanent member; and the General Conference, which consists of all 178 member countries of IAEA.[11,12] The agency's staff, led by the Director General, is referred to as the Secretariat and is organized into six departments that implement programs approved by the Board of Governors and the General Conference.[13]

IAEA's Department of Safeguards is composed of several divisions that are responsible for ensuring safeguards implementation in different geographical areas. Inspectors and analysts in these divisions work to verify that nuclear material is not diverted to the manufacture of nuclear weapons, including by conducting inspections at nuclear facilities worldwide covered by IAEA safeguards. The Department of Safeguards also has other divisions that perform safeguards-related functions and activities, such as divisions that perform analytical services, conduct planning, and provide technical and scientific services to support safeguards equipment.

IAEA Funding

IAEA funds its programs primarily through (1) its regular budget, for which all member countries are assessed an annual contribution, and (2) extrabudgetary contributions, which are voluntary.[14] IAEA's regular budget is composed of annually assessed contributions from all 178 member countries. The annual contribution for each member country to IAEA's regular budget is based on an assessment of that country's

[11]While there are 191 parties to the NPT, not all are IAEA member states. IAEA membership is not a prerequisite for a state being a party to the NPT, nor is being a party to the NPT a requirement for membership in the agency. IAEA may implement safeguards in member and non-member states that are party to the NPT. For example, IAEA implements safeguards in India, Israel, and Pakistan, which are not parties to the NPT. We note that IAEA uses the term "state" without expressing "any opinion whatsoever … concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers."

[12]Throughout this report, we use the term "countries" to refer to what IAEA calls "states." We do this to distinguish our discussions of the types of parties to the NPT—referred to as nuclear weapon and nonnuclear weapon states—from our discussions of the places where IAEA applies safeguards.

[13]The six departments are the Department of Safeguards, the Department of Nuclear Safety and Security, the Department of Nuclear Energy, the Department of Nuclear Sciences and Applications, the Department of Management, and the Department of Technical Cooperation.

[14]In addition, IAEA has a Technical Cooperation Fund—generally supported through other voluntary annual contributions of member countries— that supports IAEA's Technical Cooperation program. That program makes nuclear technology available to IAEA member countries to help them address their development priorities such as those to address health, nutrition, and agriculture.

"capacity to pay." This amount is calculated using a country's share of gross national income and then further adjusted based on debt burden and population. The IAEA regular budget supports IAEA's six major program areas, including safeguards. IAEA's regular budget was $417.9 million in 2022. In addition to IAEA's regular budget, in 2022 IAEA received $118.5 million in voluntary cash contributions from a small number of member countries, including the U.S.

Safeguards Legal Framework

IAEA derives its authority to establish and administer safeguards from its statute,[15] the NPT and other regional nonproliferation treaties, bilateral commitments between countries, and project agreements with countries. Article III of the NPT binds each of the treaty's nonnuclear weapon state parties to enter into an agreement with IAEA that applies safeguards to all source and special fissionable material. The purpose of the agreements is to prevent diversion of nuclear material from peaceful uses to nuclear weapons or other nuclear explosive devices within the state's territory, under its jurisdiction, or carried out anywhere under its control.[16]

The safeguards agreements that countries conclude with IAEA come in several different forms and provide the legal basis for IAEA to conduct its verification activities. Safeguards agreements may allow IAEA to make determinations—or "conclusions"—about the safeguards status of nuclear material in a country. In 2022, IAEA was able to make conclusions for 188 countries that had safeguards agreements in force.[17]

Most countries have negotiated an agreement with IAEA known as a comprehensive safeguards agreement, which covers all of a country's nuclear activities and serves as the basis for the agency's safeguards activities. Most countries with a comprehensive safeguards agreement have also brought into force an Additional Protocol to their agreement,

[15]Statute of the International Atomic Energy Agency, July 29, 1957, 276 U.N.T.S. 3.

[16]Source material includes natural uranium, depleted uranium, and thorium. Special fissionable material includes plutonium-239, uranium-233, and uranium enriched in the isotopes uranium-235 or uranium-233.

[17]These countries do not include North Korea, where IAEA did not implement safeguards and, therefore, could not draw any conclusion. The total of 188 countries does not include Taiwan but does include Palestine.

which requires providing IAEA a broader range of information on, and access to, the country's nuclear and nuclear-related activities.[18]

IAEA developed the Additional Protocol to obtain additional information about and access to countries' nuclear and nuclear-related activities, due in part to IAEA's response to the discovery in 1991 of a clandestine nuclear weapons program in Iraq. The Additional Protocol gives the agency's inspectors access to an expanded range of locations—beyond those under comprehensive safeguards agreements—including those where the agency seeks to assure the absence of undeclared nuclear material and activities. Undeclared nuclear material and activities are those a country has not declared and placed under safeguards but should have under its comprehensive safeguards agreement or Additional Protocol. For countries with comprehensive safeguards agreements but without Additional Protocols in force, IAEA may be able to conclude that declared nuclear material remained in peaceful activities for a given year but would not be able to come to what it refers to as the "broader conclusion" that all nuclear material remained in peaceful activities for a given year.[19]

For countries with a comprehensive safeguards agreement and an Additional Protocol, IAEA may be able to come to the "broader conclusion." Specifically, this means that IAEA found (1) no indication of the diversion of declared nuclear material from peaceful nuclear activities, (2) no indication of undeclared production or processing of nuclear

[18]In lieu of comprehensive safeguards agreements, the five NPT nuclear weapon states have other safeguards agreements in force with IAEA, called voluntary offer agreements, in which IAEA safeguards are implemented with regard to declared nuclear material in selected facilities in all five countries. The five NPT nuclear weapon states also have Additional Protocols in force. In addition, IAEA has item-specific safeguards agreements in place with countries not party to the NPT—India, Israel, and Pakistan—that require IAEA to implement safeguards for nuclear material, facilities, and other items specified in the relevant safeguards agreements.

[19]Of the 46 countries that had a comprehensive safeguards agreement but without an Additional Protocol in force in 2022, IAEA concluded that declared nuclear material remained in peaceful activities for all 46.

material at declared facilities and locations outside facilities, and (3) no indication of undeclared nuclear material or activities.[20]

For countries that have a comprehensive safeguards agreement and small amounts of nuclear material, another safeguards protocol—the small quantities protocol—may apply. The small quantities protocol suspends certain safeguards measures as long as a country meets specific eligibility requirements.[21] A small quantities protocol also requires that the country not have any nuclear facilities.

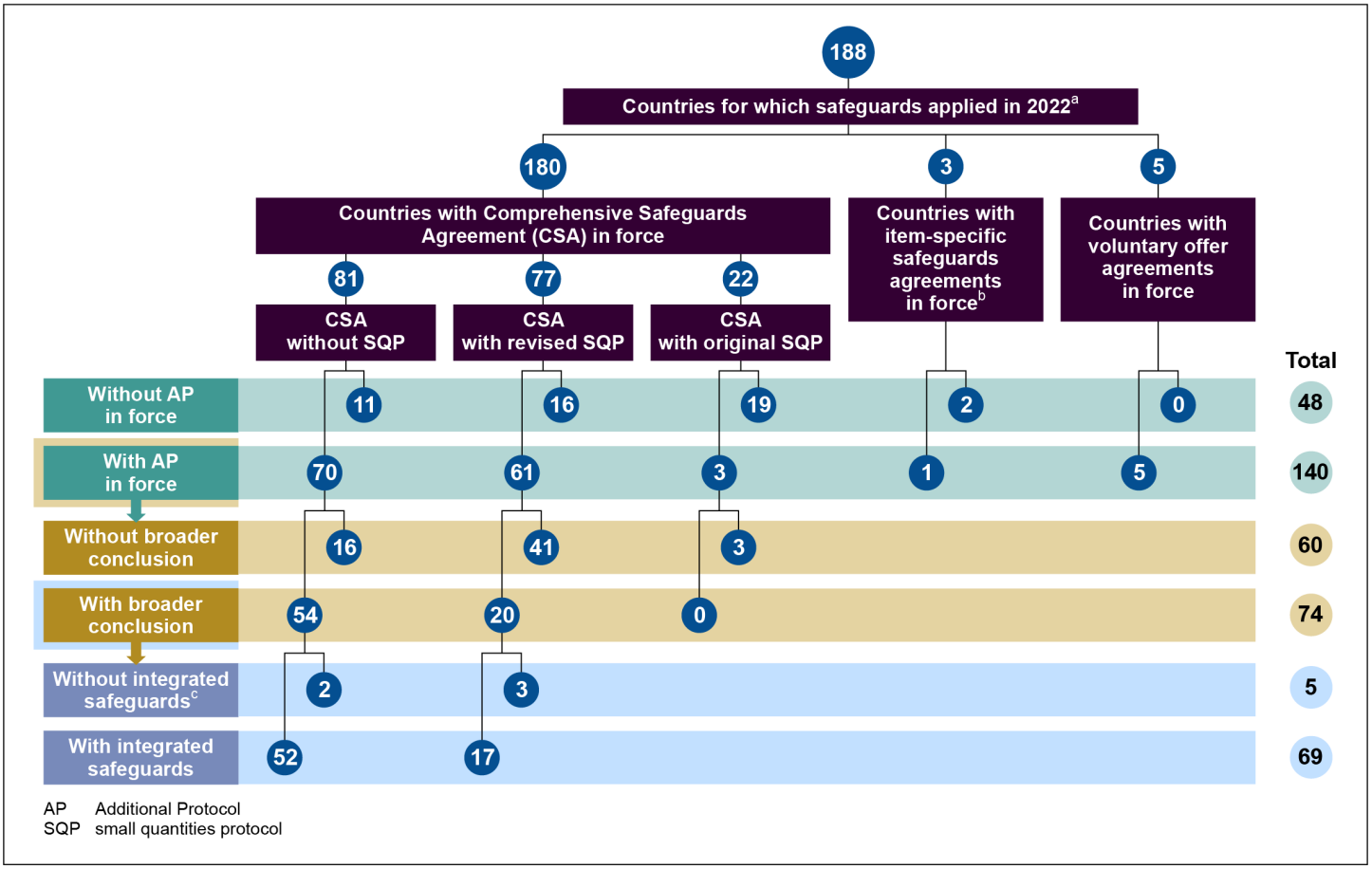
In 2005, the small quantities protocol was revised to allow IAEA to have a greater ability to reach a credible safeguards conclusion. As of the end of 2022, of 99 countries that had a comprehensive safeguards agreement with a small quantities protocol, 77 of those had accepted the revised small quantities protocol. Those countries that have accepted the revised small quantities protocol must provide an initial report on nuclear material to IAEA and allow IAEA to perform ad hoc verification activities in the country, which they were not required to do under the original version. According to IAEA's annual report, for countries with a small quantities protocol and that have not accepted the revised protocol, IAEA has a limited ability to draw a credible safeguards conclusion.

See figure 1 for information on the numbers of countries with different types and combinations of IAEA safeguards agreements in force as of 2022 (the latest information available at the time of our review).

[20]Not all countries with a comprehensive safeguards agreement and an Additional Protocol receive a broader conclusion each year. Of the 134 countries that had both a comprehensive safeguards agreement and an Additional Protocol in force in 2022, IAEA drew the broader conclusion that all nuclear material remained in peaceful activities for 74 countries. For the remaining 60 countries, evaluations regarding the absence of undeclared nuclear material and activities for each of these states remained ongoing. On this basis, IAEA concluded that, for these countries, declared nuclear material remained in peaceful activities.

[21]Under the small quantities protocol, the reference to small quantities of nuclear material means, among other things, that the country can have up to 1 kilogram of special fissionable material, 10 metric tons of natural uranium and depleted uranium with an enrichment level above 0.5 percent, 20 metric tons of natural uranium and depleted uranium with an enrichment level of 0.5 percent or below, and 20 metric tons of thorium.

Figure 1: International Atomic Energy Agency (IAEA) Safeguards Agreements in 2022



Source: GAO adaptation of a figure in IAEA's *Safeguards Implementation Report for 2022.* | GAO-24-106296

Note: Countries have different types and combinations of IAEA safeguards agreements in force that provide the legal basis for IAEA to conduct its verification activities and that may allow IAEA to make a conclusion that a country's nuclear material remained in peaceful uses.

[a]The 188 countries do not include North Korea, where IAEA did not implement safeguards in 2022. The total also does not include Taiwan but does include Palestine.

[b]As of January 2024, three countries that have not signed the Treaty on the Nonproliferation of Nuclear Weapons—India, Israel, and Pakistan—had what are called item-specific safeguards agreements in force that require the application of safeguards to nuclear material, facilities, and other items specified in the relevant safeguards agreement.

[c]Integrated safeguards are an optimized combination of safeguards measures available for countries that have received a broader conclusion from IAEA—that not only has all declared nuclear material remained in peaceful activities, but also that there are no indications of undeclared nuclear activities—based on a safeguards approach developed specifically for that country.

Safeguards Activities

IAEA implements safeguards through a range of activities and techniques to help ensure that all nuclear material is where it was declared to be and to verify that there was no misuse of the facility, no diversion of declared nuclear material, and no undeclared nuclear material or activities. Inspectors and analysts in IAEA's Department of Safeguards collaborate to verify that the quantities of nuclear material that nonnuclear weapon states have formally declared to the agency are correct and complete. For example, to verify nondiversion of nuclear material, IAEA inspectors count items (e.g., containers of uranium or plutonium), measure attributes of these items (e.g., the weight and enrichment ratio of uranium in a storage cylinder), and compare their findings with records and declared amounts.

Inspectors typically verify the declared nuclear material inventory by reviewing a facility's nuclear material accounting documentation and through other means, such as visual observation and radiation detection and measurement. These measures are complemented by use of containment and surveillance techniques over declared material,[22] such as installation of cameras at a facility and application of seals and other identifying and tamper-indicating devices.[23] Visual observation allows inspectors to observe the processes within a location and the equipment it contains, and to check the consistency of observations with declarations. Inspection activities are supported by off-site safeguards activities, such as analysis of the environmental samples collected during inspections,[24] remote monitoring of declared material,[25] analysis of commercial satellite imagery, and analysis of open-source documents, such as technical journals.

IAEA plans its inspections—including their frequency—based on the safeguards agreements with a given country, its nuclear material, and the

[22]Containment refers to structures or equipment that prevent undetected access to nuclear material. Surveillance involves the observation and collection of information about nuclear material and activities at a nuclear facility.

[23]Seals are designed to make tampering more difficult or reduce the probability that tampering could take place without detectable physical evidence. Tampering is interference to defeat the integrity of safeguards equipment.

[24]IAEA inspectors collect environmental samples from nuclear facilities and other locations, and IAEA's Network of Analytical Laboratories analyzes these samples to verify that their isotopic signatures match the declared activities of the location and to detect traces, if any, of undeclared nuclear material.

[25]Remote monitoring or remote data transmission refers to IAEA's capability to securely receive data at IAEA offices from unattended safeguards systems, such as surveillance cameras, at nuclear facilities.

nature of its fuel cycle and facilities to be safeguarded. IAEA plans its supporting safeguards activities—such as analysis of satellite imagery before inspections, Additional Protocol declarations, and information obtained during inspections (such as environmental samples)—in proportion to the frequency of inspections.

The U.S. and Other Member Countries Support IAEA Safeguards through a Variety of Mechanisms

IAEA's safeguards program receives voluntary extrabudgetary support from member countries through a variety of mechanisms outside of the regular IAEA budget. Specifically, many member countries have established voluntary support programs through which a country can provide direct financial contributions to IAEA safeguards, as discussed above, as well as in-kind assistance through goods and services paid for by the member country. The U.S. provides the largest share of extrabudgetary support to the safeguards program. In addition, the U.S. supports IAEA safeguards indirectly by funding research and development at U.S. national laboratories and supporting other activities.

Many Member Countries Have Support Programs and Other Mechanisms to Contribute to IAEA Safeguards beyond Its Regular Budget

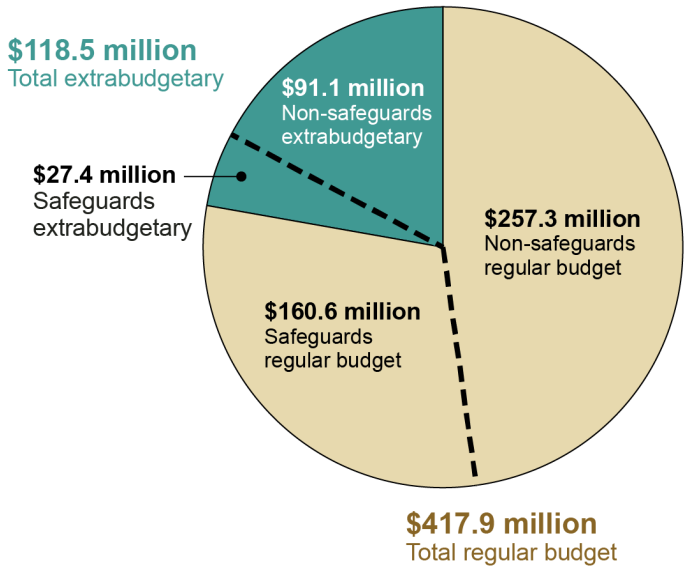
In 2022, IAEA allocated $160.6 million to the safeguards program from its overall regular budget of $417.9 million. However, according to IAEA documentation and officials we interviewed, the agency relies on extrabudgetary cash contributions to carry out activities which are unfunded by the regular budget.

Extrabudgetary contributions supporting IAEA's safeguards program generally come from IAEA member countries that have established voluntary programs with the agency, referred to as member state support programs (MSSP).[26] As of January 2024, 23 countries and the European Commission had established MSSPs to provide technical, financial, and other support to IAEA. Safeguards extrabudgetary support is generally provided through MSSPs to address a specific need that IAEA's safeguards program has requested be filled. Extrabudgetary contributions to IAEA can be in two forms: (1) direct financial contributions, referred to as cash, and (2) in-kind assistance, which consists of goods or services offered to IAEA with the costs borne by the member country.

[26]The U.S. established the first MSSP in 1977 to provide a research and development (R&D) capacity to the agency to meet safeguards deficiencies and needs. IAEA has traditionally had limited involvement in R&D because member countries believe that the agency is an implementation organization, not a research organization. The creation of MSSPs resulted from IAEA's acknowledgement that (1) new equipment and techniques would need to be developed to meet safeguards deficiencies, and that (2) member countries should conduct R&D rather than the agency developing its own R&D capacity.

In 2022, IAEA received a total of $118.5 million from member countries in extrabudgetary contributions in the form of cash for all IAEA programs. Of these extrabudgetary cash contributions, the safeguards program received $27.4 million. Figure 2 illustrates the allocation of IAEA regular budget and extrabudgetary contributions to safeguards in 2022.

Figure 2: International Atomic Energy Agency's (IAEA) 2022 Budget



Source: IAEA 2022 Annual Report. | GAO-24-106296

Note: This figure does not include estimates of member countries' in-kind contributions, as, according to IAEA, only some member countries provide cost estimates of in-kind contributions; IAEA therefore cannot identify in-kind contributions for all countries. Extrabudgetary funds are voluntary contributions outside the regular budget provided by some member countries. This figure also does not include voluntary contributions that member countries make to IAEA's Technical Cooperation Fund that supports IAEA's Technical Cooperation program. That program makes nuclear technology available to IAEA member countries to help them address their developmental priorities in a range of areas, such as health, nutrition, and agriculture.

The safeguards program may use extrabudgetary cash contributions in several ways, including paying temporary non-inspector staff salaries, improving information technology systems, and providing training, among other things. For example, in 2022, extrabudgetary cash contributions from member countries paid the salaries of 35 cost-free experts[27] and 24

[27]A cost-free expert is an individual who has a specialized skill that is not readily available among IAEA staff or who cannot be financed under the IAEA regular budget. These positions are fully or partially paid for by a member country and can last between 1 and 7 years depending on the specific arrangement.

junior professional officers.[28] These experts and officers were involved in initiatives across the safeguards program, including nuclear fuel cycle analysis, safeguards training, and data evaluation.

Not all MSSPs have a cash component to their extrabudgetary contributions; some member countries provide in-kind contributions only, and some provide both. In-kind contributions from MSSPs can take a variety of forms, including the development of safeguards techniques and technology, sample analysis, and provision of supplies. For example, Australia's support program supplies in-kind support through two laboratories that conduct environmental sample analysis for IAEA. Similarly, Germany's support program trains IAEA inspectors to conduct inspections at uranium enrichment facilities. While IAEA tracks the types and numbers of in-kind efforts from each MSSP, we were unable to estimate the total monetary value of MSSP in-kind contributions because, according to U.S. officials, the agency does not track the value of member country in-kind contributions.

Whether cash or in-kind, IAEA centrally coordinates member countries' extrabudgetary support through publications that identify safeguards priorities. Every 2 years, IAEA's safeguards program identifies its priority objectives in a plan known as the Development and Implementation Support Programme for Nuclear Verification (D&IS Programme). The D&IS Programme links to higher level IAEA planning documents, including to the five focus areas under the Department of Safeguards' Strategic Plan,[29] and to the department's Enhancing Capabilities for Nuclear Verification—Resource Mobilization Priorities (RMP) document. The RMP specifies a prioritized set of needed safeguards capabilities—aligned under the five focus areas in the Strategic Plan—for which the department is seeking external support. The D&IS Programme operationalizes the RMP by identifying a series of discrete "safeguards-relevant development and implementation plans" to develop and sustain the needed capabilities identified in the RMP.

[28]The purpose of the junior professional officer program is to assist IAEA in its activities and to provide an opportunity for young professionals wishing to pursue an international career to acquire on-the-job professional experience. The junior professional officer works as a junior IAEA staff member under the guidance of a senior staff member in either a scientific, technical, or administrative field. The duration of these positions is usually 2 years, and the positions are fully funded by a MSSP.

[29]The five focus areas include core activities, technical capabilities, management, stakeholders and partnerships, and people and knowledge.

Each of the plans in the D&IS Programme lists output goals, planned activities, and support needed from MSSPs to achieve a plan's objective.[30] The safeguards program makes specific requests for support—which it refers to as tasks—to member countries. These requests are aligned with the objectives of the D&IS plans. For example, in line with the 2020 objective to improve real-time monitoring capabilities, IAEA asked for assistance to assess advanced passive tag technology for applicability to nuclear facility surveillance. These tags use ultra-high frequency or ultra-wide band radio waves to track objects over extended distances with high precision and may eliminate the need for inspectors to expose themselves to hazardous environments.

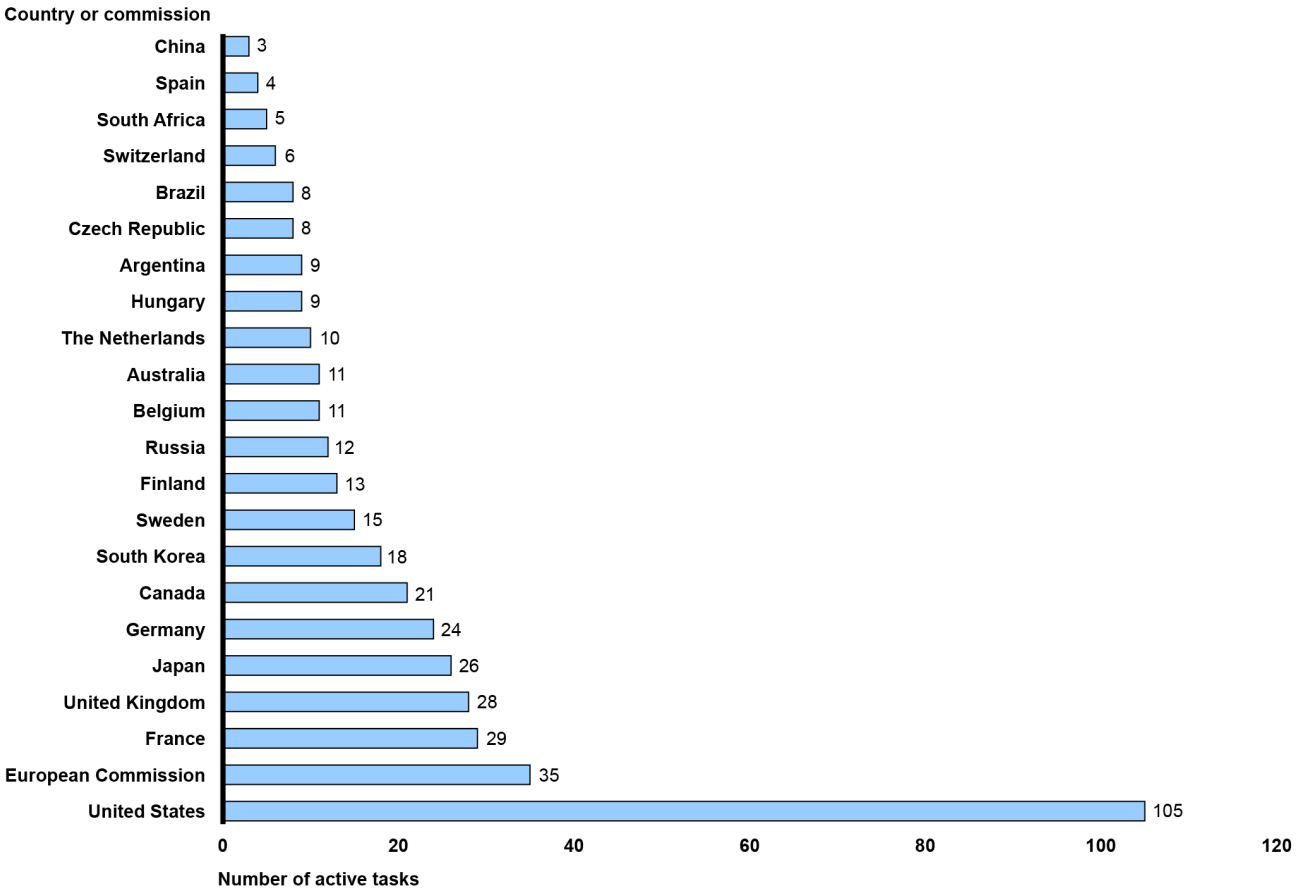
IAEA makes task requests to MSSPs based on IAEA officials' understanding of the interests, priorities, and available resources within each member country with an MSSP. According to national laboratory representatives, IAEA may request which MSSP or MSSPs it prefers to fulfill a task, and in the case of U.S. national laboratories, it may identify a preferred national laboratory.

IAEA maintains a database that tracks requests it is making to MSSPs. This database also allows MSSPs to respond to IAEA's requests so there is visibility into which MSSPs are performing the work for IAEA. In 2022, IAEA tracked 410 unique task requests to the 22 MSSPs that existed at the time.[31] The number of tasks per MSSP ranged from three tasks accepted by China, to 105 accepted by the U.S. (see fig. 3). U.S. funding supported 26 percent of all IAEA safeguards-related task requests made in 2022 (the most recent data available at the time of our review).

[30]For example, a plan in the 2022–2023 D&IS Programme to develop replacement surveillance equipment for safeguards inspections identifies a desired outcome of improving real-time monitoring and flow measurement capabilities of nuclear material at nuclear facilities. That outcome specifies a desired technology development output, identifies planned activities, and links to specific safeguards priorities under the RMP.

[31]The United Arab Emirates and Norway established MSSPs in 2023 and are not included in this count.

Figure 3: International Atomic Energy Agency (IAEA) Active Support Tasks by Country, as of 2022



Source: GAO analysis of IAEA information. | GAO-24-106296

The U.S. Contributes to IAEA Safeguards beyond the Agency's Regular Budget

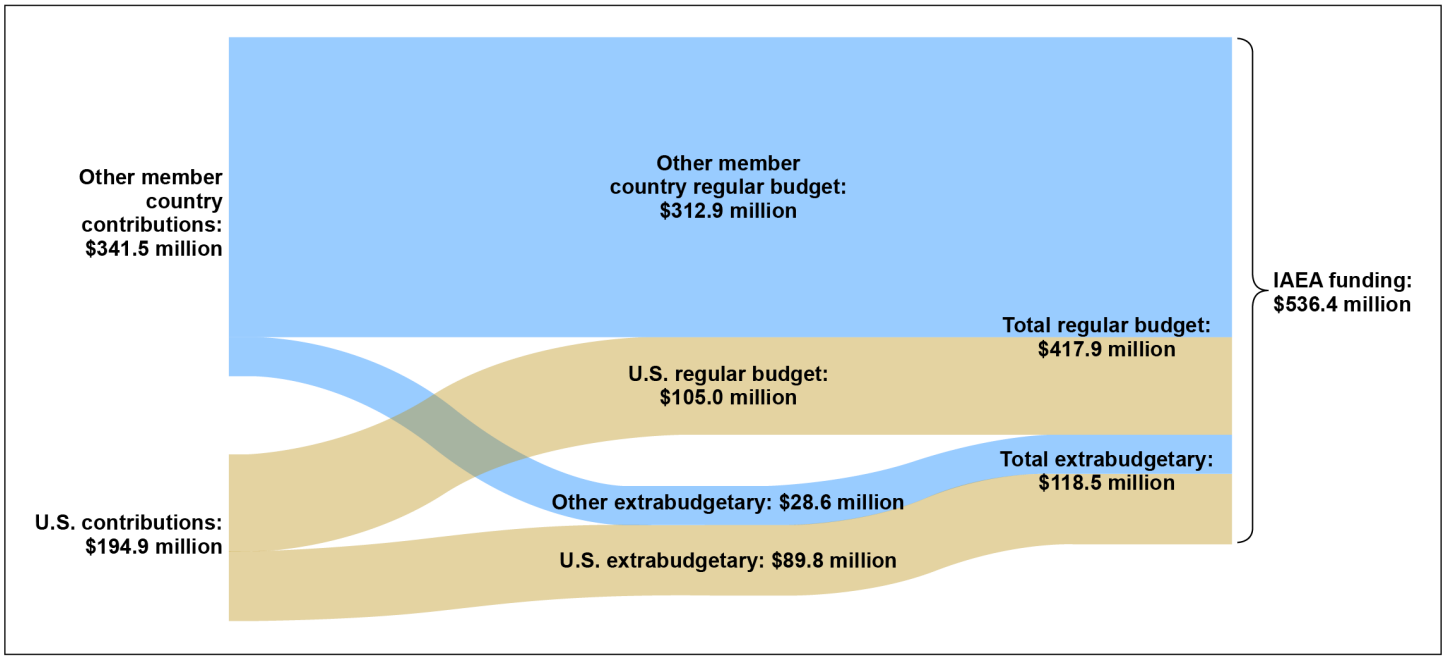
In 2022, according to Department of State information, the U.S. provided a total of $211.5 million to IAEA in combined regular budget and extrabudgetary contributions. The U.S. contributed $105 million to IAEA's regular budget in 2022, making the U.S. the largest contributor to the IAEA regular budget.[32] Additionally, to support activities across the agency, the U.S. provided $106.4 million in voluntary extrabudgetary contributions in 2022, including $89.8 million in cash and $16.6 million in in-kind contributions. In total, U.S. regular budget and cash contributions

[32]The U.S. contributed $101.6 million to IAEA's regular budget in fiscal year 2023, according to State Department information.

to IAEA accounted for about 36 percent of the agency's overall budget in 2022.[33]

Figure 4 illustrates the size of U.S. and all other member countries' contributions to IAEA's regular budget and extrabudgetary cash contributions.

Figure 4: U.S. and Other Member Countries' Regular Budget and Cash Contributions to the International Atomic Energy Agency (IAEA) in 2022



Source: IAEA 2022 Annual Report and Department of State pledge letter to IAEA for 2022. | GAO-24-106296

Note: In addition to the $194.9 million in regular budget and extrabudgetary cash contributions, the U.S. provided IAEA with $16.6 million in in-kind contributions in 2022. According to IAEA, not all member countries provide cost estimates for their in-kind contributions to the agency. We have therefore excluded in-kind contributions from this figure. This figure does not include voluntary contributions from member states to IAEA's Technical Cooperation Fund. Figures do not sum due to rounding.

Of the $106.4 million in total U.S. extrabudgetary contributions to IAEA in 2022, $30.7 million was allotted to IAEA's safeguards program. Of this $30.7 million, $17.6 million was in cash and $13.1 million in in-kind

[33]According to IAEA, not all member countries provide cost estimates for their in-kind contributions to the agency. We have therefore excluded in-kind contributions from this calculation.

support. The Program of Technical Assistance to IAEA Safeguards (POTAS) is the largest category of U.S. extrabudgetary funding allotted to safeguards, and it is used to address formal task requests from IAEA for the provision of staff or technical assistance to address IAEA safeguards needs. According to national laboratory representatives, POTAS technical assistance supports a wide range of activities, from the development of new tools and technologies at DOE national laboratories to the procurement of commercial off-the-shelf equipment.[34]

Together with POTAS, four additional U.S. programs provide extrabudgetary support to IAEA. These programs include

- the High Priority Safeguards Project, which addresses urgent and often unforeseen high priority safeguards needs;
- Environmental Sample Analysis, which pays for analysis conducted at U.S. laboratories of environmental samples collected by IAEA inspectors;[35]
- Excess Fissile Material, which covers IAEA expenses for implementation of safeguards in the U.S. at DOE sites;
- and the Ukraine Assistance Fund, which was initiated in 2022 to support IAEA's ongoing nuclear safeguards activities in Ukraine.

See table 1 for a summary of U.S. extrabudgetary contributions.

[34]POTAS tasks are organized into one of seven categories: measurements methods and techniques; training; system studies; information processing; containment, surveillance and monitoring systems; safeguards evaluation and administrative support; and special tasks.

[35]IAEA maintains a Network of Analytical Laboratories that supports the safeguards program. These laboratories have different roles, including laboratories that supply reference materials; those which supply analysis of environmental samples; and those which supply analysis of nuclear material samples. The Network's member facilities in the U.S. include the Air Force Technical Applications Center, and DOE's Lawrence Livermore, Los Alamos, New Brunswick, Oak Ridge, Pacific Northwest, and Savannah River National Laboratories.

Table 1: U.S. Extrabudgetary Contributions to International Atomic Energy Agency (IAEA) Safeguards in 2022

Dollars in millions

Programs	2022 cash	2022 in-kind	Total
Program of Technical Assistance to IAEA Safeguards	$13.5	$4.6	**$18.1**
High Priority Safeguards Projects	1.35	4.0	**$5.35**
Environmental Sample Analysis	0	4.5	**$4.5**
Excess Fissile Material	0.75	0	**$0.75**
Ukraine Assistance Fund	2	0	**$2**
Total	**$17.6**	**$13.1**	**$30.7**

Source: Department of State pledge letter to IAEA for 2022 and other State information. | GAO-24-106296

The U.S. Support Program (USSP) coordinates most of these cash and in-kind contributions through POTAS. Two groups coordinate activities under the USSP: the Subgroup on Safeguards Technical Support, and the International Safeguards Project Office. The Subgroup on Safeguards Technical Support is an interagency committee chaired by the Department of Energy and includes other representatives from State, the Department of Defense, and the Nuclear Regulatory Commission. The Subgroup is responsible for the oversight, direction, and coordination of the USSP, including acceptance of task requests from IAEA and approval of funding. The International Safeguards Project Office, located at DOE's Brookhaven National Laboratory, provides administrative and technical support to the Subgroup in its administration of USSP tasks. According to national laboratory representatives, the Subgroup and the International Safeguards Project Office participate in a deliberative agency process to evaluate, approve, and monitor IAEA task requests.

The U.S. Provides Indirect Support to IAEA Safeguards

In addition to the funding and in-kind support provided by the U.S. to IAEA through regular and extrabudgetary contributions, NNSA implements several categories of activities that indirectly support IAEA's safeguards program. This support includes (1) research and development (R&D) in support of safeguards, (2) international safeguards outreach, and (3) engagement with the nuclear industry. NNSA officials reported that the agency allotted $103.4 million to such indirect activities in fiscal year 2022.[36] This support does not involve the direct transfer of cash or in-kind support to IAEA. Instead, it may assist IAEA through domestically

[36]In fiscal year 2023, NNSA allotted $89.8 million to activities that indirectly supported IAEA's safeguards program.

led safeguards-related programs and projects, such as development of potentially promising technologies or tools at a U.S. national laboratory that could meet a future safeguards need.

Research and Development in Support of Safeguards

Separate from the formal task-driven approach discussed above, NNSA conducts safeguards-related R&D on its own initiative. NNSA's safeguards-related R&D is led by two offices within its Office of Defense Nuclear Nonproliferation: the Office of Defense Nuclear Nonproliferation Research and Development (DNN R&D) and the Office of Nonproliferation and Arms Control.[37]

DNN R&D supports international nuclear safeguards by developing tools and systems that improve the effectiveness and efficiency of safeguards, including containment, surveillance, and non-destructive and destructive analysis.[38] For example, DNN R&D is developing unique color-changing materials that can be used for passive tamper indication on containment seals. In fiscal year 2022, DNN R&D allotted approximately $9.9 million to support safeguards R&D.[39]

The Office of Nonproliferation and Arms Control supports R&D technologies and approaches at higher levels of maturity, with the goal of demonstrating suitable tools and techniques that could meet current or future IAEA safeguards needs. Specifically, this office focuses on developing technologies and approaches to improve the efficiency of safeguards and enhance the capabilities of inspectors. In addition, the office is involved in developing concepts and approaches for implementing safeguards for new nuclear facilities and fuel cycles. For example, the office supported work at Oak Ridge National Laboratory to develop radiation shielding for memory cards to improve the function of IAEA cameras installed in nuclear facilities. In fiscal year 2022, the Office

[37]The Office of Defense Nuclear Nonproliferation works globally to prevent state and non-state actors from developing nuclear weapons or acquiring weapons-usable nuclear or radiological materials, equipment, technology, and expertise.

[38]Non-destructive and destructive assays are measurements which determine the type and quantity of nuclear material in a sample. Destructive analysis requires the destruction of a sample—such as dissolution in acid—to determine its composition. Non-destructive analysis techniques measure the radiation emitted by a sample to determine its composition without destroying the sample.

[39]This total includes $7.9 million for safeguards and approximately $2 million of data science and artificial intelligence development that is relevant to safeguards.

of Nonproliferation and Arms Control allotted $25.9 million to safeguards R&D at U.S. national laboratories.

In addition to the R&D supported by DNN R&D and the Office of Nonproliferation and Arms Control, DOE national laboratories, plants, and sites also self-initiate some safeguards R&D. For the purposes of this report, we refer to these self-initiated projects as "directed R&D programs."[40] According to national laboratory representatives, safeguards-related R&D projects may be supported by all three sources at various points during the technology maturation process. That is, an R&D project might begin as a directed R&D program at a laboratory, plant, or site, then receive support from the DNN R&D program, and then be further developed with support from the Office of Nonproliferation and Arms Control.

NNSA has demonstrated various tools and technologies to IAEA that have been developed under these R&D projects, such as a system that enables real-time, wireless transfer of surveillance images from IAEA cameras through reinforced concrete walls at nuclear facilities. According to national laboratory representatives, if IAEA's safeguards program determines that an NNSA-developed technology or tool could be applicable to a current safeguards challenge or has potential to address an emerging challenge, IAEA could create a task request to the USSP to further develop the technology. For example, in response to a 2007 IAEA proposal for the development of an unattended verification system for cylinders containing uranium for enrichment, Pacific Northwest National Laboratory and Los Alamos National Laboratory developed novel analysis methods using funds from laboratory-directed R&D programs and the Office of Nonproliferation and Arms Control. After seeing the results of these analysis methods, in 2013 IAEA made a formal task request to the USSP requesting the development of a prototype system. The Pacific Northwest National Laboratory delivered this prototype—known as the Unattended Cylinder Verification Station—to IAEA in February 2022.

International Safeguards Outreach

NNSA sponsors outreach to other countries through its International Nuclear Safeguards Engagement Program (INSEP). According to NNSA,

[40]To foster scientific excellence, contractors managing and operating certain DOE facilities use a portion of their annual budgets to conduct self-initiated R&D projects selected at the discretion of the facility's director. For the purposes of this report, directed R&D programs include laboratory-directed research and development programs, plant-directed research and development programs, and site-directed research and development programs.

the purpose of the INSEP program is to promote nuclear nonproliferation through three primary efforts: (1) promoting implementation of safeguards agreements by countries; (2) strengthening countries' capacity to meet IAEA obligations; and (3) transferring safeguards technologies to other countries that could help them implement their own safeguards more effectively and efficiently. For example, the Oak Ridge National Laboratory hosts training for IAEA member countries in which participants learn about legal obligations of IAEA safeguards agreements, gain hands-on experience with certain safeguards technologies and techniques, and learn what to expect when IAEA performs in-field verification.

According to national laboratory representatives, INSEP plays a vital role in strengthening the IAEA safeguards system through the breadth and depth of its global capacity building activities. These activities augment and complement IAEA's own efforts in this area. According to an IAEA official, INSEP and IAEA officials meet quarterly to coordinate efforts and avoid duplication. According to NNSA, over the past 4 years the INSEP program has engaged with over 100 countries and multiple regional and international organizations. In fiscal year 2022, NNSA allotted $14.1 million for international outreach under INSEP.

Engagement with Nuclear Industry

NNSA sponsors safeguards-related engagement with the advanced reactor community in the U.S. through the Advanced Reactor International Safeguards Engagement (ARISE) program.[41] According to NNSA documentation and national laboratory representatives, advanced reactor developers in the U.S. are seeking to export future reactors to countries interested in developing nuclear power to meet their energy needs or mitigate climate change. ARISE documentation notes that 10 to 12 countries are expected to newly employ nuclear power by 2035, of which several are considering advanced reactor designs. NNSA started the ARISE program in 2021 to educate potential suppliers of advanced reactors about safeguards-related requirements and objectives, and to ensure new reactor designs can be safeguarded.

According to stakeholders we interviewed, because the U.S. is not subject to the same safeguards requirements as nonnuclear weapon states, U.S.-based advanced reactor developers may be less familiar with

[41]Advanced reactors are nuclear reactors that differ from the large light-water reactors in use at U.S. nuclear power plants, which use ordinary water as their moderator and coolant. Advanced reactors include small modular reactors based on current nuclear technology, and newer types of reactors, including those that could use different coolant systems or different forms of nuclear fuel, such as molten salt fuel.

IAEA safeguards. Moreover, documentation we reviewed noted that current safeguards approaches were developed predominantly for large light-water reactors and may not be directly applicable to advanced reactor designs.

For these reasons, the ARISE program seeks to educate the U.S. advanced reactor community about IAEA safeguards. It works with U.S. advanced reactor developers to integrate safeguards considerations into the early design of advanced reactors that could be exported. According to documentation we reviewed and national laboratory representatives we interviewed, NNSA's engagement through the ARISE program can help mitigate the possibility that an advanced reactor developer would need to make potentially costly retrofits or design changes to accommodate IAEA safeguards. For example, the program may work with nuclear industry vendors to incorporate features into reactor designs—such as designing reactors to include sufficient space to accommodate IAEA cameras and other containment and surveillance equipment—to allow for easier implementation of safeguards in the completed facility. NNSA officials reported allotting $3.2 million for the ARISE program in fiscal year 2022.

IAEA, with Member Country Support, Is Making Efforts to Address a Range of Factors That May Affect Safeguards Implementation

According to IAEA documents and interviews with IAEA officials and stakeholders, a range of factors could affect the effective and efficient implementation of IAEA safeguards.[42] These factors include (1) IAEA resource constraints, (2) the global growth of nuclear power and nuclear facilities, (3) new types of nuclear facilities, (4) challenging environments, and (5) other political and economic factors specific to individual countries, such as countries with limited capacity to support safeguards. IAEA, with member country support, is making efforts to address these factors.

IAEA Is Taking Steps with Member Countries to Address Resource Constraints

IAEA officials and several stakeholders told us that certain resource constraints—such as limited budgetary growth and inflationary pressure—are factors that could affect safeguards implementation. IAEA is taking steps to continue to implement safeguards, including working with member countries to expand its resource base and broaden implementation of the state-level concept.

[42]The 2023 and prior meetings of the IAEA General Conference have passed resolutions stressing the importance of strengthening the effectiveness and improving the efficiency of safeguards.

IAEA has identified its limited safeguards budget as a fundamental, recurring challenge to safeguards implementation. IAEA officials told us that allocations from IAEA's regular budget to the safeguards program are often not sufficient to meet all planned safeguards program activities and needs. They instead have relied on extrabudgetary contributions from certain member countries to support the safeguards program, including extrabudgetary contributions from the U.S. IAEA officials told us that they believe the safeguards program will continue to rely on such extrabudgetary contributions. These resource limitations are a result of several factors, including:

- **IAEA's zero-real-growth policy for its regular budget.** IAEA officials and some stakeholders told us that the agency's reliance on extrabudgetary support for safeguards is driven in part by a long-standing zero-real-growth policy for IAEA's regular budget.[43] Under this policy, the IAEA regular budget generally does not grow except for allowances for inflation.[44] Specifically, IAEA's biennial budgets include a mechanism—referred to as price adjustment—to allow for growth in the regular budget by a certain percentage each year to account for inflation. For instance, IAEA's biennial budget for 2022 and 2023 contained an inflationary price adjustment factor of 1.7 percent for each year when it was published in July 2021.
- **Reduced IAEA purchasing power due to inflationary pressures.** IAEA officials told us that, especially in 2022, greater-than-expected inflationary pressures had eroded the purchasing power of IAEA's regular budget. Specifically, IAEA officials said that by October 2022, the agency had experienced an 11 percent loss in purchasing power compared to July 2021 due to worldwide economic inflation. Other related factors, including the war in Ukraine, have also increased some costs to IAEA. For example, in 2022 the electricity costs for operating IAEA's Safeguards Analytical Laboratory in Seibersdorf, Austria, more than doubled from the previous year, according to IAEA

[43]In 1985, the United Nations imposed a policy of "zero-real-growth" in an effort to stem the upward growth of budgets and to improve the efficiency of the United Nations system across the board.

[44]While IAEA has had a zero-real-growth policy since the 1980s, increases to the regular budget have occasionally been approved. For example, in 2003 IAEA approved a budget that included a real budget increase of 10 percent over multiple years, and the 2010 budget included a 2.7 percent regular budget increase.

officials we interviewed.[45] They said this cost increase was due, in part, to reduced energy supplies from Russia as a consequence of the war in Ukraine.

Because of these inflationary pressures, in 2022 the IAEA Director General requested a revised price adjustment factor for 2023. IAEA estimated that an increase in the price adjustment to 9.9 percent was needed to maintain the zero-real-growth budget for 2023 that was initially presented and approved in 2021. In a special session in January 2023, the General Conference approved an increase in the price adjustment to 4.9 percent for the IAEA regular budget for 2023, about half of what was requested.

- **IAEA limits on the use of extrabudgetary contributions.** According to IAEA officials, IAEA cannot use extrabudgetary funds to support all safeguards program costs. Specifically, according to IAEA officials and documentation, operational safeguards activities including in-field verification activities (inspections) and salaries for inspectors are funded exclusively out of the regular budget. Extrabudgetary funds cannot be used for these purposes because such contributions are voluntary and not guaranteed, and therefore they cannot be relied on for funding core functions such as safeguards inspections and salaries.

According to IAEA officials, IAEA's zero-real-growth policy and recent inflationary pressures are challenging for the safeguards program because of IAEA's policy against the use of extrabudgetary funding for safeguards inspector salaries. As a result, the number of available safeguards inspectors is limited by the size of the zero-real-growth regular budget.

To help ensure continued implementation of safeguards amid limited budgetary growth and inflationary pressures, IAEA is taking steps to expand its safeguards resource base. IAEA's efforts to expand its resource base include encouraging additional member countries to establish support programs and entering into nontraditional partnerships with nongovernmental entities. For example, three member countries established new support programs—Switzerland in November 2021, the

[45]IAEA's Safeguards Analytical Laboratory includes two labs that support safeguards: a Nuclear Material Laboratory that is responsible for destructive analysis and non-destructive assay of nuclear material samples, and an Environmental Sample Laboratory that processes and analyzes environmental samples for safeguards purposes. The Safeguards Analytical Laboratory also supports safeguards through the supply of sampling equipment and training of IAEA inspectors.

United Arab Emirates in March 2023, and Norway in September 2023. These were the first new member state support programs since 2013.

In 2021, IAEA started to expand support by signing agreements with "non-traditional" entities such as civil society organizations, foundations, academia, and the private sector. Since 2021, IAEA has signed agreements with seven non-traditional entities.[46] According to IAEA, partnerships with these entities can leverage their expertise to support the advancement of verification and monitoring techniques, address emerging safeguards challenges, and help countries build their capacity to comply with safeguards agreements. We did not determine whether any of these entities provided direct financial support to IAEA or if their contributions were only in-kind.

In addition to expanding its resource base, IAEA is working to broaden implementation—and acceptance—of the state-level concept for safeguards. The state-level concept is intended to optimize the agency's use of resources by scoping planned safeguards activities in a country based on its potential pathways to a nuclear weapon. IAEA views the state-level concept as a key tool for maximizing the effectiveness of safeguards implementation given budget and other resource constraints. As we reported in 2013, the state-level concept is an effort to shift the planning of safeguards activities in a given country from a narrow facilities-based approach to a state-as-a-whole approach.[47] Traditional

[46]These non-traditional entities include the Center for Energy and Security Studies (Russia); Rosatom Technical Academy (Russia); the European Safeguards Research and Development Association (Italy); the Institute of Nuclear Materials Management (U.S.); the Stimson Center (U.S.); the Open Nuclear Network Programme of One Earth Future (Austria); and the Verification Research, Training and Information Centre (United Kingdom).

[47]See GAO-13-139.

safeguards approaches had been based on the nature and quantity of nuclear material and the types of facilities within a given country.[48]

Officials from two member countries told us that state-level approaches enable IAEA to prioritize safeguards activities and make safeguards implementation more efficient. However, some countries have raised concerns about the state-level concept and how it may be implemented. For example, officials we interviewed from one member country expressed concerns about the potentially subjective way in which IAEA officials could assess state-specific factors in a given country in the development of a state-level safeguards approach. In addition, they did not believe there were clear, quantifiable criteria under the state-level concept, and they did not believe these concerns had been addressed satisfactorily by IAEA officials. Officials of another member country noted that providing IAEA with all of the information needed to address nuclear material and activities in the state as a whole can be a burden for some countries, particularly those having a small number of officials who work on safeguards issues.

IAEA officials told us that the state-level concept represents a shift in how safeguards are implemented, and they acknowledged the concerns of some countries about the concept. However, IAEA officials said that they believed the concept is being implemented in a nondiscriminatory manner, and that steps are being taken to further improve implementation. For instance, IAEA officials told us that—based on the technical objectives derived from an acquisition path analysis—the Department of Safeguards develops performance targets designed to differentiate between countries on a nondiscriminatory basis in how safeguards will be applied to meet those objectives. IAEA officials told us that the mix of safeguards activities and measures, and the scope of their intensity and frequency, are based on those targets.

[48]IAEA implements "state-level safeguards" based on the state-level concept, which entails development of a customized state-level safeguards approach to implement IAEA safeguards for an individual country. Under this approach, IAEA considers a broad range of information about a country's nuclear capabilities and tailors its safeguards activities in each country accordingly. IAEA develops state-level safeguards approaches for countries using a structured, technical method to analyze the plausible paths by which nuclear material suitable for use in a nuclear weapon or other nuclear weapon could be acquired. Specifically, to develop a state-level approach, IAEA conducts an "acquisition path analysis" or a diversion path analysis and considers six "state-specific factors." IAEA then establishes technical objectives associated with the steps along a path to guide the planning, conduct, and evaluation of safeguards activities for that country.

State officials noted that the perspectives of some member countries critical of the state-level concept are often politically motivated, and these officials expressed full confidence in IAEA's ability to draw independent, objective conclusions using impartial and technically credible evaluation methods and all relevant information.

In addition, IAEA officials told us that they had been taking steps to further improve state-level safeguards approaches and address concerns. For example, the agency initiated a state-level approach "improvement project" in 2019 to further refine methodologies for acquisition path analysis and the development of performance targets. In addition, IAEA's Safeguards Implementation Report for 2022 notes that the agency has developed lessons learned from the state-level approach implementation process to, among other things, improve consistency in the development of approaches for countries with both a comprehensive safeguards agreement and Additional Protocol in force.

IAEA officials further told us that they engage with and report to countries on the development of the state-level concept and state-level approaches. For example, in response to member country requests, in 2018 the IAEA Director General provided the IAEA Board of Governors with a report on the experiences gained and lessons learned in the implementation of state-level safeguards approaches. IAEA officials told us that the agency plans to provide member countries with a comprehensive report on developments related to the implementation of the state-level concept and expects to complete this report in 2024.

Some member countries have supported the agency's effort to build support for the state-level concept, including by addressing the subjectivity concerns of skeptical countries. For example, a U.S. national laboratory helped develop a software tool that used technical, objective performance targets for planning safeguards activities under the state-level concept, thereby minimizing the potential for human bias.

IAEA and Member Countries Are Working to Increase Efficiency as Global Nuclear Power Expansion May Strain Safeguards Resources

IAEA officials and several stakeholders identified the continued growth of nuclear power worldwide as a factor that is expected to increase demands on IAEA's resources. According to IAEA, at the end of 2022, there were 438 operational nuclear power reactors in 32 countries worldwide. IAEA's recent annual reports provide details on current and forecasted growth in nuclear power, including

- 12 new nuclear power reactors added to the electrical grid over 2021 and 2022;

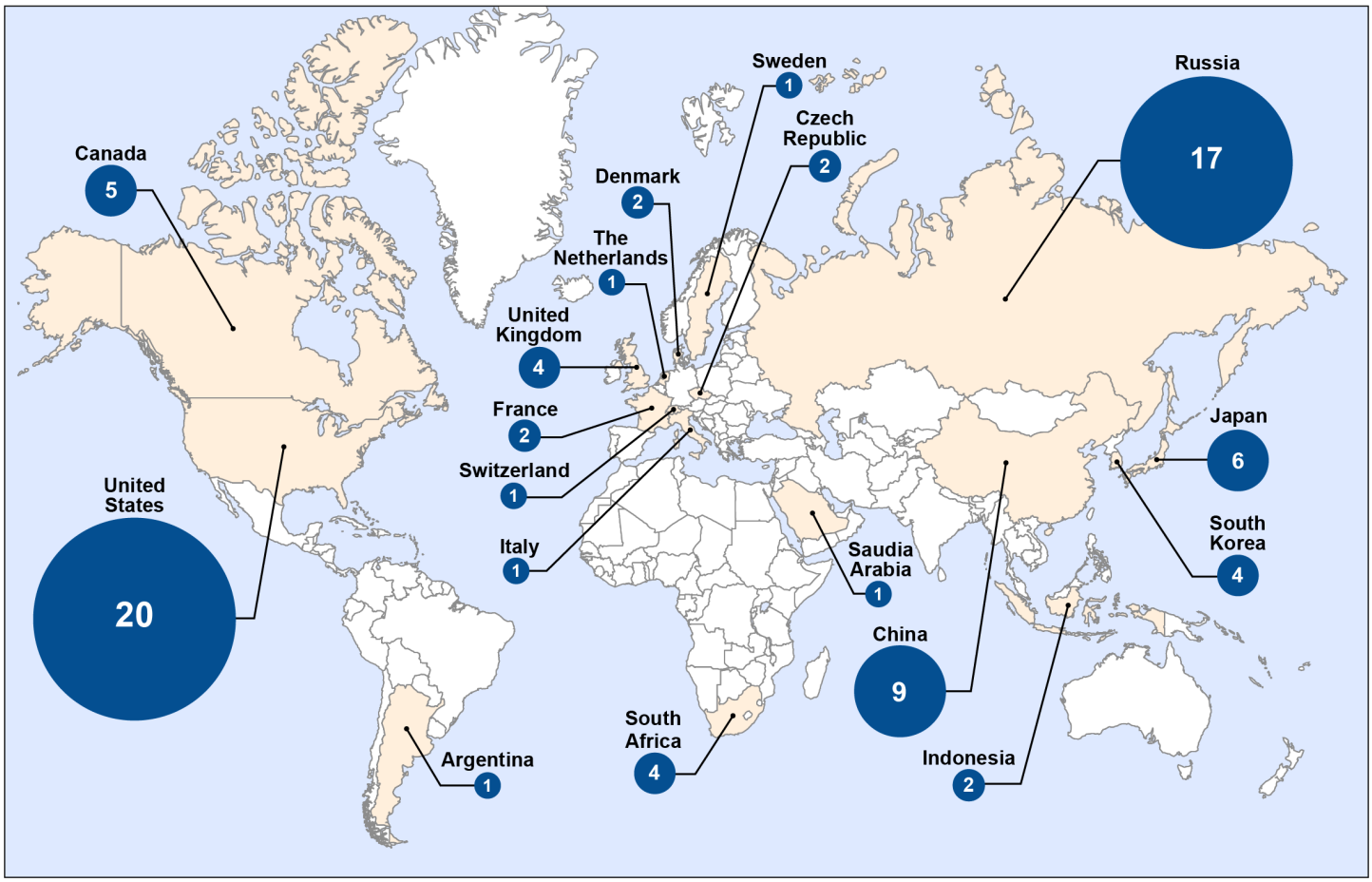
- 58 nuclear power reactors under construction at the end of 2022; and
- 26 countries considering, planning, or actively working to include nuclear power in their energy mix in 2022.

In addition, according to NNSA, 10 to 12 countries are planning operations of their first nuclear power plant by 2035, which could represent an increase of more than a third in the number of countries operating nuclear reactors as of 2022.

Some of this growth in nuclear power may be in the form of large, conventional light-water reactors, but IAEA also anticipates significant global growth in nuclear power via deployment of small modular reactors.[49] As of 2022, only two small modular reactors were operating. However, according to IAEA, there are more than 80 designs being developed across 50 vendors and 18 countries (see fig. 5). Further, at least 17 countries that do not currently have nuclear power reactors are participating in the development of small modular reactors.

[49]Small modular reactors are nuclear reactors with a power capacity of up to 300-megawatt, and whose components and systems can be factory-built and then transported to sites for installation as demand arises.

Figure 5: Number of Small Modular Reactor Designs under Development by Country, as of 2022



Sources: GAO analysis of the International Atomic Energy Agency's *Small Modular Reactors: A new nuclear energy paradigm*; Map Resources (map). | GAO-24-106296

In addition to the growth in nuclear power increasing the safeguards burden, according to IAEA documentation, IAEA must continue to safeguard nuclear facilities that are being decommissioned. For example, in 2021 and 2022, 15 nuclear power reactors were retired but will still be subject to IAEA safeguards until their decommissioning. Further, the spent fuel associated with these facilities will be subject to safeguards indefinitely.

As nuclear power expands worldwide and other demands are placed on the IAEA safeguards program, IAEA inspectors and the resources necessary to support them will come under additional pressure. For example, expansion of nuclear power would require IAEA to implement a

safeguards approach and conduct inspections for each new facility, including development of safeguards approaches for each of a potentially broad range of small modular reactor designs. Additionally, according to some stakeholders, as the use of small modular reactors expands and these reactors are operated in remote regions or small islands, the frequency of inspections and time that staff must take to conduct inspections could increase, which could further burden safeguards program resources.

Other developments in the nuclear fuel cycles of some countries could also strain IAEA safeguards resources. For example, since the 1980s, Japan has been developing a large facility at Rokkasho for reprocessing spent nuclear fuel from its nuclear power plants.[50] In addition, at the same location, Japan is building a facility to make fuel for nuclear power plants out of the uranium and plutonium that has been reprocessed.[51] According to IAEA officials, these new facilities will be a considerable burden on safeguards resources as they will require additional inspectors and a permanent inspector presence. Specifically, IAEA will likely require three additional inspectors conducting safeguards activities at the fuel fabrication facility at all times. This would translate into IAEA needing a total of eight to nine new inspectors to support this work. For comparison, the IAEA operations division responsible for that region currently employs approximately 80 inspectors.

To address increasing demands on its resources driven by anticipated global growth in nuclear power, IAEA's safeguards program is taking steps to increase efficiency in its implementation of safeguards, and some member countries are assisting these efforts. For example, according to IAEA officials, IAEA is moving toward increasing remote data transmission from unattended safeguards systems at nuclear facilities to reduce the effort of inspectors. As of the end of 2022, IAEA was receiving safeguards data collected by 1,782 unattended sources—such as surveillance systems, active seals, and other systems—from 159 facilities

[50]Reprocessing refers generally to the processes used to separate spent nuclear reactor fuel into nuclear material that may be recycled for use in new fuel and material that would be discarded as waste. There are no commercial reprocessing facilities currently operating in the U.S., but there are commercial facilities operating in other countries.

[51]Japan's mixed oxide facility will fabricate nuclear fuel out of reprocessed plutonium and uranium. Japan will use this nuclear fuel to power some of its nuclear power plants.

in 32 countries.[52] The amount of data received from these systems in 2022 was more than triple the amount of data received in 2016.

The U.S. and other member countries are assisting in the development of technology to facilitate remote data transmission. For example, an effort by multiple U.S. laboratories resulted in a system for remotely verifying cylinders containing uranium at uranium enrichment plants. As of 2022, IAEA was testing a prototype of this system, known as the Unattended Cylinder Verification Station. These stations would be situated at key locations of enrichment facilities, and would have technologies to identify cylinders containing uranium, assess the composition of the uranium inside, and transmit related data to IAEA, without the need for an IAEA inspector.

IAEA and Member Countries Are Identifying Approaches and Technologies to Address Challenges Posed by New Types of Nuclear Facilities

Our review identified the emergence of new types of nuclear facilities as a factor that may require new and potentially more resource-intensive safeguards approaches. IAEA officials and several stakeholders said that each new reactor and facility type will require development of unique safeguards approaches that could be complex or time-consuming to implement and further stress safeguards program resources. They also told us that new nuclear facility types could create additional technical challenges in detecting potential nuclear material diversions or undeclared nuclear material and activities. For instance, IAEA officials said that new types of facilities could present challenges to IAEA because they may require new ways of accounting for and measuring material to ensure safeguards.

Examples of some new, more challenging facilities for safeguards include:

- **Molten salt reactors.** In molten salt reactors, the nuclear fuel is mixed with a salt coolant and flows continuously through the reactor. This fuel form would make it more difficult to account for all the nuclear material in the reactor as compared with traditional light-water reactors. With light-water reactors, IAEA can count the fuel rods and use radiation detection to ensure the rods have not been exchanged or diverted. According to two stakeholders, some molten fuel reactor

[52]According to IAEA, active seals are reusable seals with an internal, battery-powered electronic circuit that continuously monitors the integrity of the sealing loop—such as a fiberoptic cable—and tracks when the seal is opened and closed. The seal identity and the integrity of the data from the seal are maintained via strong cryptographic means. The seal can be verified in the field and monitored remotely.

designs present new difficulties for material accounting because they need to have a technical solution to monitor a continuous flow of fuel through the reactor, rather than counting a known number of fuel rods. IAEA and member countries will therefore need to develop new approaches to safeguarding molten fuel, such as using meters to monitor the continuous flow of fuel.

- **Pyroprocessing facilities.** Pyroprocessing is a reprocessing technique that differs from existing, mature reprocessing technologies.[53] Traditional reprocessing, such as at the Rokkasho reprocessing facility, uses an aqueous process in which the spent nuclear fuel is dissolved in acid and the reusable plutonium and uranium are recovered. In traditional reprocessing using aqueous techniques, reservoirs—sometimes referred to as accountability tanks—can be sampled to confirm the composition of the reprocessed material, such as recovered uranium or plutonium.[54] This reservoir of dissolved material and acid can be sampled during the aqueous reprocessing. Because of the relatively homogeneous composition of the reservoir, the sample could provide an indicator of whether the process has been modified to divert material.

  By contrast, pyroprocessing melts the spent nuclear fuel in a bath of molten salt, heated to hundreds of degrees Celsius, and separates the reusable products through electrical separation. According to a 2007 study from Pacific Northwest National Laboratory and a journal article we identified in our literature review, the nature of pyroprocessing makes it difficult to account for loss of nuclear material during reprocessing.[55] For example, because pyroprocessing converts material in a hot, highly radioactive, and corrosive environment, it is more difficult to sample. In addition, pyroprocessing facilities do not have accountability tanks for sampling and the

[53]According to an NNSA report, a key disadvantage of reprocessing is that it separates out plutonium in the spent nuclear fuel, which can be used in a nuclear weapon. NNSA, *Draft Nonproliferation Impact Assessment for the Global Nuclear Energy Partnership Programmatic Alternatives* (Washington, D.C.: December 2008).

[54]Until the mid-1970s, the U.S. reprocessed spent nuclear fuel but reverted to using nuclear fuel a single time in a power reactor, primarily to discourage other countries from pursuing reprocessing because of concerns over nuclear proliferation.

[55]Pacific Northwest National Laboratory, *Advanced Safeguards Approaches for New Reprocessing Facilities* (Richland, WA: June 2007) and Seung Min Woo, Sunil S. Chirayath, and Matthew Fuhrmann, “Nuclear fuel reprocessing: Can pyro-processing reduce nuclear proliferation risk?”, *Energy Policy*, vol. 144 (2020). https://doi.org/10.1016/j.enpol.2020.111601. The Energy Policy journal is an international peer-reviewed journal.

material is typically not homogenous, which makes it harder to obtain a representative sample to detect material diversion. IAEA would therefore need to develop new accounting techniques to verify that nuclear material at these facilities is appropriately safeguarded.

- **Geologic repositories.** In the future, after spent nuclear fuel is removed from a reactor and cooled in an interim storage location, it could be permanently disposed of in a geologic repository underground. However, geologic repositories could present additional safeguard challenges for IAEA. For example, spent fuel placed deep underground in a repository may be inaccessible for inspection by IAEA. This could require alternative techniques, such as underground mapping via ground-penetrating radar, to monitor the waste and detect any potential diversion of spent fuel from the repository.

IAEA is working with member countries and developers of new nuclear facilities to ensure that safeguards can be implemented effectively in new facility types. These efforts include evaluating safeguards concepts, investigating prospective safeguards technologies and equipment, and identifying safeguards measures and potential efficiencies through design modification early in the design stages of a facility. In addition, U.S. national laboratories are conducting research and development and providing training on methods for safeguarding potential new types of facilities, such as advanced reactors and pyroprocessing facilities.

Other member countries support IAEA by making certain facilities in their countries available to IAEA for safeguards development and training. For example, IAEA is working with Finland to develop safeguards approaches for a geological repository, using the repository that Finland is building as a test bed for potential safeguards approaches.

In addition, IAEA and certain member countries are working with designers of nuclear reactors and other facilities to encourage “safeguards by design” approaches, under which safeguards requirements and objectives are integrated into the design process of a nuclear facility, from initial planning through design, construction, operation, and decommissioning. For instance, as discussed above, NNSA’s ARISE program engages with U.S. advanced reactor vendors to encourage integration of safeguards consideration into the designs of such reactors. In addition, NNSA has developed facility-specific safeguards by design guidance documents for reactor designers and operators.

IAEA Is Taking or Developing Steps to Implement Safeguards in Challenging Environments

According to IAEA officials and stakeholders we interviewed, a broad factor that could affect future safeguards implementation is the existence of environments where IAEA may be challenged in conducting safeguards-related work. These environments include pandemics and natural disasters, armed conflict zones, and countries that are pursuing use of nuclear material for nonprohibited military purposes, such as naval nuclear propulsion.

Pandemics and Natural Disasters

IAEA officials told us that global pandemics (such as COVID-19) and regional environmental disasters (such as the 2011 earthquake and tsunami that led to the Fukushima nuclear power plant accident) could create disruption and access problems that complicate timely facility inspections by IAEA and pose other safeguards implementation challenges. For example, according to one study, following the Fukushima accident, structural damage and radiation prevented Japanese operators and the IAEA from accessing some of the facilities.[56] IAEA created a task force with Japanese authorities which developed an approach for monitoring and implementing safeguards at the facility.[57]

IAEA has taken steps to continue safeguards implementation, or developed approaches for doing so, in these challenging environments, with U.S. and other member country support. For example, during the COVID-19 pandemic, the agency mitigated the effects of the pandemic on safeguards activities by chartering flights for inspectors.

Zones of Armed Conflict

IAEA officials and some stakeholders identified the existence of nuclear facilities subject to safeguards in conflict areas as an inherent challenge to IAEA in its ability to access and implement safeguards at such facilities. They told us that a notable example is the challenge IAEA has faced in conducting its safeguards mission—as well as nuclear safety and security activities—in Ukraine since Russia's February 2022 invasion of the country.

For example, IAEA reported that, when the agency was ultimately able to conduct in-field verification activities at one nuclear site in Ukraine in November 2022, it was not possible to access one facility to verify nuclear

[56]Chen Kane, *Safeguards and Verification in Inaccessible Territories*, (James Martin Center for Nonproliferation Studies: October 2018).

[57]After the incident, only half of the eight buildings on site were accessible. As of the end of 2021, IAEA reported that the safeguards situation at the site had stabilized and 87 percent of the nuclear material at the site had been reverified. However, three of the six reactors contained some nuclear material that was still inaccessible to verification.

material because a 5-ton shield could not be lifted due to insufficient power, a result of heavy shelling.[58] In addition, as small modular reactors and nuclear facilities are deployed to more countries in more regions around the world, the likelihood increases that IAEA will have to implement safeguards at nuclear facilities in other conflict areas.

To help facilitate IAEA's safeguards efforts in Ukraine, member countries have supported IAEA through additional extrabudgetary contributions, such as funding for IAEA inspector charter flights to and from Ukraine, and deliveries of safety equipment.[59] IAEA reported that in 2022, agency staff conducted 24 safeguards-related missions to Ukraine, using alternative means, such as travelling by car or on a member country-supported charter flight. IAEA inspectors were able to conduct sufficient in-field activities to conclude that declared nuclear material remained in peaceful activities for Ukraine for 2022, but were not able to make the broader conclusion that all nuclear material remained in peaceful activities for Ukraine for 2022.[60]

In addition, according to documentation we reviewed, IAEA's use of unattended monitoring systems may be able to allow continued implementation of some safeguards in environments affected by pandemics, natural disasters, or conflict. For example, according to IAEA's Nuclear Safety, Security, and Safeguards in Ukraine report for February 2022 to February 2023, IAEA used unattended monitoring systems, including cameras, in Ukraine to ensure that declared nuclear material under IAEA safeguards was not removed, with the data

[58]IAEA, *Nuclear Safety, Security, and Safeguards in Ukraine: February 2022 - February 2023* (Vienna, Austria: Feb. 23, 2023).

[59]IAEA reported that, in 2022, despite the ongoing conflict in Ukraine, IAEA conducted nine in-person missions to nuclear power plants. According to IAEA, by January 2023, IAEA had established a permanent physical presence at all five nuclear power plants in Ukraine.

[60]According to IAEA's Safeguards Implementation Report for 2022, IAEA was not able to draw a broader conclusion for Ukraine because circumstances prevented the agency from verifying certain nuclear material previously declared by Ukraine, and therefore it could not conclude that all nuclear material remained in peaceful activities. However, on the basis of IAEA's evaluation of available safeguards-relevant information, IAEA did not find indications that would give rise to a proliferation concern.

transmitted in real time to IAEA headquarters and analyzed by safeguards inspectors.[61]

Naval Nuclear Propulsion Programs

According to IAEA officials and several stakeholders we interviewed, an emerging challenge for IAEA will be some member countries' pursuit of naval nuclear propulsion programs. This will require development of new arrangements between the countries and IAEA regarding the nuclear material associated with those programs and development of appropriate safeguards approaches to verify nondiversion of material from those programs.

In September 2021, Australia, the United Kingdom, and the U.S. announced the creation of a new security partnership, referred to as AUKUS. Under this partnership, Australia would acquire conventionally armed nuclear-powered submarines and nuclear propulsion systems (reactors) from the U.S. and U.K. in the future, and the parties would also pursue other forms of security cooperation.[62] The submarine reactors would be based on U.S. and U.K. technology and use highly enriched uranium fuel—material that could be used in a nuclear weapon if subject to further chemical processing.

In March 2023, IAEA's Director General issued a statement that Australia's comprehensive safeguards agreement allows Australia to use nuclear material in a non-proscribed military nuclear activity, such as nuclear propulsion, provided that Australia makes an arrangement with

[61]According to IAEA, the use of remote data transmission also played a role in maintaining continuous knowledge of nuclear material at Ukrainian nuclear facilities.

[62]The proposed first major initiative under AUKUS, referred to as Pillar 1, would consist of several elements under which (1) the U.S. and U.K. rotationally deploy up to five nuclear-powered attack submarines (SSN) in the Pacific with regular visits to a port in Western Australia, (2) the U.S. sells three to five Virginia-class SSNs to Australia, and (3) Australia and the U.K. construct a new class of attack submarine—designated SSN-AUKUS—utilizing technology provided by either the U.S. or the U.K. Under a second pillar of the partnership, the U.S., Australia, and the U.K. are pursuing a range of cooperative activities to develop advanced security capabilities in other areas, such as artificial intelligence, hypersonic capabilities, and electronic warfare.

the agency.[63] Nuclear material for the submarine reactors under the AUKUS partnership would not be produced in Australia, but would be in "welded power units"—sealed reactors—transferred from either the U.S. or U.K. to Australia. The AUKUS parties have said that they will work closely with IAEA to ensure compliance with their IAEA agreements.

In addition, Brazil has had a long-standing interest in developing a conventionally armed, nuclear-powered submarine. Brazil has stated that, unlike the submarine transfer under AUKUS, development of its naval nuclear propulsion program would be fully indigenous, with the nuclear reactor and low-enriched uranium fuel being designed, developed, built, and assembled in Brazil. Brazil's safeguards agreement allows for the use of safeguarded nuclear material for nuclear propulsion, including submarines and prototypes, with the application of special procedures.[64] In May 2022, Brazil initiated discussions with IAEA over the special procedures it has proposed to apply for nuclear material in its naval propulsion program.

However, according to IAEA officials, IAEA has limited experience in creating such arrangements for naval nuclear propulsion programs. To

[63]Australia's comprehensive safeguards agreements—INFCIRC/217—includes a provision entitled "Non-application of safeguards to nuclear material to be used in non-peaceful activities." That provision contains the procedures to be followed in the event that Australia wishes to exercise its discretion to use nuclear material required to be safeguarded under the agreement in a nuclear activity which does not require the application of safeguards. IAEA officials told us that this provision is not unique to Australia's safeguards agreement, but applies to all countries having safeguards agreements with the Agency.

[64]The legal framework for the application of safeguards in Brazil is INFCIRC/435—Agreement of 13 December 1991 between the Republic of Argentina, the Federative Republic of Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials and the International Atomic Energy Agency for the Application of Safeguards—referred to informally as the Quadripartite Agreement. It contains a provision—Article 13—allowing use of safeguarded materials for naval nuclear propulsion if certain procedures are applied. The Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials is a binational organization set up to administer and apply a common system of nuclear material accounting and control in both countries, to ensure materials are not diverted to nuclear weapons.

date, no country has entered into such an arrangement with IAEA.[65] In fact, the special arrangement requirements under the safeguards agreements do not provide detail on the special arrangements required for nuclear materials in non-proscribed military activity. Two stakeholders told us that developing the arrangement for nuclear material under the AUKUS partnership, in particular, could be complicated by the classified nature of the U.S. and U.K. submarine reactor and fuel characteristics, which could make information sharing between the parties and IAEA difficult.

IAEA officials also acknowledged that Brazil's domestic naval nuclear propulsion program and the AUKUS agreement represent challenges to IAEA's implementation of safeguards. They added that the technical objectives for and tools to be applied for safeguarding materials in both cases are still in development and will take time. IAEA officials told us that it is important for the agency to take a deliberative approach to the design of the special arrangements for either program, because it could set a precedent for future agreements with other countries.[66]

The agency is working regularly with Brazil and the AUKUS partners and taking preliminary steps to develop safeguards approaches for nuclear material in those planned programs, according to IAEA officials we interviewed and IAEA documents we reviewed. For instance, since Brazil's May 2022 communication of its proposed special procedures for nuclear material in its naval nuclear propulsion program, IAEA has held technical meetings in Brazil to further discuss the proposal. IAEA officials have also visited facilities and laboratories that are planned to receive, process, produce, and handle nuclear material for the Brazilian program. Regarding AUKUS, in May 2023, IAEA conducted a technical visit to a naval base in Australia that will be used for the maintenance of nuclear submarines. IAEA also conducted a "design information verification" at the planned location for Australia's future submarine construction. IAEA and Australia also held initial discussions on ways to facilitate possible

[65]According to IAEA, the agency created a nuclear propulsion arrangement with Canada in the 1980s, but it was never presented to IAEA's board because Canada abandoned the effort. As a nuclear weapon state, the U.S. is not obligated to accept safeguards, and while it has volunteered to accept certain safeguards, its agreement does not limit U.S. naval nuclear propulsion, nor does it require the U.S. to enter into any special arrangement with IAEA before doing so. Australia and Brazil are both nonnuclear weapon states.

[66]For example, Iran has previously stated its intention to develop nuclear-powered submarines.

verification and monitoring activities, including voluntary transparency measures.

IAEA and Member Countries Are Conducting Outreach to Address Country-Specific Factors Affecting Safeguards Implementation

IAEA officials and several stakeholders identified a range of factors specific to individual countries that may affect IAEA's ability to implement safeguards. These factors include political tensions between IAEA member countries, insufficient national capacity of some countries to adequately support safeguards, resistance to adopting protocols to IAEA safeguards agreements, and limited cooperation by some countries in supporting IAEA safeguards.

Political Tensions between Member Countries

Several stakeholders told us that tensions between certain countries or groups of countries over broader political or international relations issues could affect IAEA's safeguards budget or the perceived legitimacy of IAEA safeguards activities or the agency itself.

For example, an official from one member country told us that overarching disagreements between countries on elements of the broader nuclear nonproliferation legal framework undermine international support for IAEA safeguards. Specifically, the discontent among nonnuclear weapon states who are dissatisfied with the pace of disarmament progress by the nuclear weapon states under the NPT has led to the fraying of support for that treaty. Because adoption of safeguards by nonnuclear weapon states is driven by the NPT, this dissatisfaction has eroded support for IAEA's safeguards program, according to this official.

Officials of another member country echoed similar concerns that the political dynamic within IAEA is shifting, as political tensions in other forums—such as the UN Security Council and the UN General Assembly—are spilling over into and undermining negotiations at IAEA and making it more difficult to find consensus on technical safeguards-related issues. These officials believed that the breakdown in the long-standing, consensus-driven "spirit of Vienna" could affect IAEA messaging on safeguards and safeguards funding. For example, according to these officials, some member countries have turned to politicizing U.S. extrabudgetary support to safeguards, trying to portray the funding as a political lever over the agency. In contrast, IAEA and U.S. officials describe U.S. extrabudgetary support as enabling the safeguards program to meet IAEA's unfunded priorities.

State officials told us that they believed there has been some erosion in consensus over safeguards issues, based in part on the factors discussed above. However, they believed that such concerns were

overstated, and that there was no ongoing or imminent breakdown of the "spirit of Vienna" surrounding IAEA safeguards matters.

Other member countries we interviewed noted that extrabudgetary contributions to IAEA's safeguards program tend to come from a small number of highly developed member countries via their MSSPs. According to the officials we interviewed, these contributions create a perception that the funding may lead to new or additional safeguards activities beyond those agreed to by all member countries under IAEA's Program and Budget and that are supported through regular budget funding. According to officials, this perception can create suspicion and resentment among member countries that have not established their own MSSPs, and who therefore have limited visibility into IAEA's safeguards activities being supported by the extrabudgetary contributions. State officials told us that member countries without support programs that hold such perceptions or suspicions could create their own MSSPs, which could involve financial contributions. This would give them greater visibility into extrabudgetary-supported safeguards activities. DOE officials further noted that member countries with questions about extrabudgetary-supported safeguards activities could also review the IAEA's D&IS Programme and request any clarification directly from the Secretariat.

In another example, some stakeholders have said that the announcement of the AUKUS partnership triggered a backlash from China—which is opposed to the partnership—against the IAEA Secretariat and leadership for what they described as China's perception that the agency had a duty to object to the deal but failed to strenuously do so.[67] State officials told us that China's objection should not be "taken at face value" because China has no basis to expect that IAEA would object to something that is explicitly envisioned under safeguards agreements. IAEA officials and stakeholders did not identify solutions or actions that could be taken to directly resolve the political tensions between countries that play out over IAEA's resources and roles.

National Capacity of Some Countries to Support Safeguards

Under a comprehensive safeguards agreement with IAEA, a country is required to establish and maintain a state system of accounting for and control of nuclear material (SSAC). IAEA takes into account the technical

[67]According to an official from one member country we interviewed, China has protested the agreement in IAEA forums, raised nonproliferation concerns about the agreement, and, notably, its former ambassador to IAEA opined that the lack of IAEA objection to the agreement raised questions about the agency's legitimacy.

effectiveness of the SSAC in its verification activities in the country. SSACs are managed by a country or regional authority responsible for safeguards implementation, referred to by IAEA as an SRA.[68]

According to IAEA officials, the capacity of some countries to fulfill their safeguards obligations may be affected by limitations in their SSAC or SRA, such as underdeveloped regulations, laws, and domestic accounting and reporting systems. Similarly, one study we reviewed found that prospective importers of nuclear power reactors have significantly lower governance capabilities—such as stable regulatory environments—than the major suppliers of nuclear power plants, and this could challenge associated safeguards.[69]

To help increase the capacity of these countries to implement safeguards, IAEA conducts outreach through interactive webinars, in-person training courses, and other activities, sometimes with support from member countries. For example, IAEA has continued to implement a training program for countries—the Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS)—to improve the quality of their required safeguards reporting to IAEA on their declared nuclear material and activities. Member countries support the program through extrabudgetary support. Further, some countries have undertaken complementary training efforts, such as through NNSA's INSEP program, which IAEA officials said has been instrumental in managing challenges associated with the small quantities protocol.

Resistance of Some Countries to Adopting Protocols to IAEA Safeguards Agreements

According to IAEA officials and some stakeholders, some countries are resistant to adopting certain protocols to their safeguards agreements with IAEA. Specifically, the agency has had the most difficulty persuading countries to adopt two protocols:

- **Additional Protocol.** IAEA has advocated for universalization of the Additional Protocol, which it says is an important tool for the agency's

[68]The term "state or regional authority responsible for safeguards implementation (SRA)" was introduced by IAEA in 2012 to denote the authority established at the national or regional level to ensure and facilitate the implementation of IAEA safeguards in a country or countries of a region.

[69]Viet Phuong Nguyen and Man-Sung Yim, "Nonproliferation and Security Implications of the Evolving Civil Nuclear Export Market", *Sustainability*, vol. 11, no. 7 (2019) https://doi.org/10.3390/su11071830.

detection of potential undeclared nuclear material or activities.[70] The U.S. and certain other member countries have advocated for countries that have not yet done so to conclude an Additional Protocol to their safeguards agreement with IAEA. While the majority of countries have concluded an Additional Protocol to their comprehensive safeguards agreement, according to an IAEA official, some countries have been resistant due to political reasons, a lack of capacity, or a lack of interest.

IAEA, with member country support, conducts outreach to explain the Additional Protocol and its benefits to officials from these countries. For example, IAEA conducts workshops, virtual events, and consultations with member countries. As a result of this outreach, since 2012, the agency has increased the number of countries with an Additional Protocol from 122 to 140 countries (as of 2022).

- **Revised small quantities protocol.** For countries with a small quantities protocol, IAEA has been encouraging them to adopt a revised small quantities protocol (or to rescind their original agreement). According to IAEA's annual report, for the 22 countries as of 2022 with a small quantities protocol based on the original standard text, IAEA's ability to draw a credible and sound annual safeguards conclusion is significantly affected.[71] The adoption of revised protocols increases the agency's ability to detect undeclared nuclear material or activities.

  According to an IAEA official, there is no active political resistance to the revised small quantities protocol on the part of those countries that have not yet concluded such an agreement with the agency. Instead, this official told us that reluctance is usually related to a country's limited capacity to fulfill safeguards commitments or a country's focus on addressing domestic priorities ahead of adopting a revised small quantities protocol.

  To address these challenges, the IAEA Director General has reached out directly to encourage these countries to adopt a revised protocol, and IAEA holds bilateral consultations with these countries to facilitate adoption of revised protocols. IAEA officials also said that the U.S.

[70]The Additional Protocol requires a country to provide IAEA with a broader range of information on its nuclear and nuclear-related activities and gives the agency's inspectors access to an expanded range of locations, including those where the agency seeks to assure the absence of undeclared nuclear material and activities.

[71]This is because the original text of the small quantities protocol (1) did not require the country to provide IAEA with an initial report on the country's nuclear material and (2) suspended IAEA's right to conduct ad hoc verification activities in the country.

INSEP program has been helpful in addressing implementation and capacity challenges with countries with small quantities protocols.

Resistance to or Limited Cooperation from Certain Countries in Safeguards Implementation

Documents we reviewed and some stakeholders we interviewed noted that IAEA continues to face limited cooperation from some countries in implementing IAEA safeguards. There are certain unique country factors that are not within IAEA's power to address—such as a country's refusal to participate in safeguards implementation. Some documents and stakeholders identified certain countries that refused to participate in safeguards implementation or had limited cooperation with IAEA on safeguards issues, including:

- **North Korea.** In 1992, North Korea completed a comprehensive safeguards agreement with IAEA and provided its initial declaration of nuclear materials and facilities in the country. According to IAEA, shortly thereafter, inconsistencies emerged about North Korea's declarations. Since that time, numerous concerns have been raised about North Korea's nuclear program, including a uranium enrichment program that was not declared to IAEA. North Korea announced its withdrawal from the NPT in 2003, and in 2009 North Korea informed IAEA it was terminating all cooperation with IAEA.[72] IAEA has not conducted safeguards activities in North Korea since then.

  IAEA has reported that without access to locations in North Korea, it cannot confirm the operational status or design of North Korean nuclear-related facilities, or the nature and purpose of the activities at those locations. Because IAEA is not able to conduct safeguards activities in North Korea, its knowledge of the North Korean nuclear program remains limited. Consequently, IAEA has not been able to verify the "correctness and completeness" of North Korea's 1992 declarations of its nuclear materials and facilities under its safeguards agreement.

  In 2017, IAEA formed a team within the safeguards program to, among other things, enhance the monitoring of North Korea's nuclear facilities and maintain verification approaches and technologies in case North Korea agreed to allow safeguards activities in the country once again. Currently IAEA's team monitors the development of North

[72]Despite its announced withdrawal, North Korea is still counted as a party to the treaty by the United Nations Office for Disarmament Affairs. According to the Office, the other parties to the treaty continue to express divergent views regarding the status of North Korea under the NPT.

Korea's nuclear program and evaluates available safeguards-relevant information, including open-source imagery and satellite information.[73]

- **Iran.** As noted in IAEA's 2022 Safeguards Implementation Report, the agency's verification and monitoring activities in Iran related to the Joint Comprehensive Plan of Action (JCPOA) were seriously affected by Iran's decision to remove all of IAEA's JCPOA-related surveillance and monitoring equipment in June 2022.[74] Despite IAEA's continued efforts, the report noted that Iran has not yet clarified and resolved outstanding safeguards issues, including those related to nuclear material particles at undeclared locations in Iran.
- **Syria.** In 2008, IAEA was provided with information alleging that an installation at the Dair Alzour site in Syria, destroyed by Israel in September 2007, had been a nuclear reactor that was not yet operational and into which no nuclear material had been introduced. Information subsequently provided to the agency indicated that there were three other locations in Syria that were functionally related to the Dair Alzour site. In 2011, IAEA concluded it was very likely that the building destroyed at the Dair Alzour site was a nuclear reactor which should have been declared to the agency. IAEA was unable to provide an assessment of the nature or operational status of the other three locations. IAEA's Board of Governors in 2011 found that Syria's undeclared construction of a nuclear reactor at Dair Alzour and failure to provide design information for the facility constituted non-compliance by Syria with its obligations under its safeguards agreement.

  Since that time, Syria has not responded to IAEA requests to cooperate with the agency to resolve outstanding issues related to the Dair Alzour site and the three other locations. In an August 2023

[73]While not able to conduct safeguards in North Korea currently, IAEA's safeguards program spent approximately $1.5 million in 2022 related to ensuring its readiness to conduct verification there. IAEA officials said that if North Korea opened its extensive nuclear facilities to IAEA safeguards, that would create a large demand for additional inspections.

[74]In July 2015, multilateral talks with Iran culminated in an agreement—the Joint Comprehensive Plan of Action (JCPOA)—in which the U.S., France, Germany, the United Kingdom, Russia, and China, with the High Representative of the European Union for Foreign Affairs and Security Policy, agreed to reciprocal commitments with Iran. The JCPOA details Iran's commitments related to its nuclear facilities, equipment, materials, and activities, among other things. On July 20, 2015, the United Nations Security Council endorsed the JCPOA and requested that IAEA verify and monitor these commitments. In June 2016, we reported on issues facing IAEA in this verification and monitoring effort. See: GAO, *Iran Nuclear Agreement: The International Atomic Energy Agency's Authorities, Resources, and Challenges*, GAO-16-565 (Washington, D.C.: June 9, 2016).

report to the Board of Governors, the IAEA Director General stated that no new information had come to light to affect IAEA's assessment that the building destroyed at the Dair Alzour site was very likely a nuclear reactor that Syria should have declared to the agency. The report also noted that IAEA remained unable to provide any assessment concerning the nature or operational status of the three other sites.

Agency Comments

We provided a draft of this report to NNSA, State, the Department of Defense, and the Nuclear Regulatory Commission for review and comment. NNSA provided technical comments on the report, which we incorporated, as appropriate. State, the Department of Defense, and the Nuclear Regulatory Commission had no comments on the report. We also provided IAEA with a detailed summary of facts contained in the draft report. IAEA provided technical comments on the summary of facts.

We are sending copies of this report to the appropriate congressional committees, the Administrator of NNSA, the Secretary of State, the Secretary of Defense, the Chairman of the Nuclear Regulatory Commission, and other interested parties. This report will also be available at no charge on GAO's 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 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 I.

Allison Bawden
Director, Natural Resources and Environment

Appendix I: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, William Hoehn (Assistant Director), David Messman (Analyst in Charge), Karl Antonsson, William Bauder, Alisa Beyninson, Antoinette Capaccio, Cindy Gilbert, Gwen Kirby, and Dan Royer made key contributions to this report.

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