United States Government Accountability Office

GAO

Report to the Ranking Member, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives

January 2008

# NUCLEAR SECURITY

# Action May Be Needed to Reassess the Security of NRC-Licensed Research Reactors

Accountability ★ Integrity ★ Reliability

GAO-08-403

# NUCLEAR SECURITY

## Action May Be Needed to Reassess the Security of NRC-Licensed Research Reactors

GAO Accountability·Integrity·Reliability

# Highlights

Highlights of GAO-08-403, a report to the Ranking Member, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives

### Why GAO Did This Study

There are 37 research reactors in the United States, mostly located on college campuses. Of these, 33 reactors are licensed and regulated by the Nuclear Regulatory Commission (NRC). Four are operated by the Department of Energy (DOE) and are located at three national laboratories. Although less powerful than commercial nuclear power reactors, research reactors may still be attractive targets for terrorists. As requested, GAO examined the (1) basis on which DOE and NRC established the security and emergency response requirements for DOE and NRC-licensed research reactors and (2) progress that the National Nuclear Security Administration (NNSA) has made in converting U.S. research reactors that use highly enriched uranium (HEU) to low enriched uranium (LEU) fuel.

This report summarizes the findings of GAO's classified report on the security of research reactors (GAO-08-156C).

### What GAO Recommends

GAO recommends that NRC reassess the consequences of terrorist attacks on NRC-licensed research reactors using assumptions that better reflect a fuller range of expert opinion on reactor security.

NNSA and DOE generally agreed with the report. NRC disagreed with the report in several areas. GAO continues to believe that given the uncertainty associated with NRC's security assessment, it is important that NRC reassess the consequences of a terrorist attack on research reactors.

To view the full product, including the scope and methodology, click on GAO-08-403. For more information, contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

### What GAO Found

DOE developed the security and emergency response requirements for its research reactors using its Design Basis Threat—a process that establishes a baseline threat for which minimum security measures should be developed. These research reactors benefit from the greater security required for the national laboratories where they are located, which store weapons-usable nuclear materials. DOE also has concluded that the consequences of an attack at some of its research reactors could be severe, causing radioactivity to be dispersed over many square miles and requiring the evacuation of nearby areas. As a result, all facilities where DOE reactors are located have extensive plans and procedures for responding to security incidents.

NRC based its security and emergency response requirements largely on the regulations it had in place before September 2001. NRC decided that the security assessment it conducted between 2003 and 2006 showed that these requirements were sufficient. While it was conducting this assessment, NRC worked with licensees to improve security when weaknesses were detected. However, GAO found that NRC's assessment contains questionable assumptions that create uncertainty about whether the assessment reflects the full range of security risks and potential consequences of attacks on research reactors. For example, Sandia National Laboratories (SNL)—a contractor NRC used to assist in performing its assessment— found that some NRC-licensed research reactors may not be prepared for certain types of attacks. However, NRC disagreed with SNL's finding. In 2006, NRC concluded that the consequences of attacks would result in minimal radiological exposure to the public. In addition, NRC assumed that terrorists would use certain tactics in attacking a reactor but did not fully consider alternative attack scenarios that could be more damaging. Finally, NRC assumed that a small part of a reactor could be damaged in an attack, resulting in the release of only a small amount of radioactivity. However, according to experts at Idaho National Laboratories and the Department of Homeland Security, it is possible that a larger part of a reactor could be damaged, which could result in the release of larger amounts of radioactivity.

NNSA has made progress in changing from HEU to LEU fuel in U.S. research reactors but may face difficulty in converting some of the remaining research reactors. Since 1978, NNSA has converted eight currently operating U.S. research reactors, including two in 2006. In addition, NNSA plans to convert 10 more U.S. research reactors by September 2014—five of which are scheduled for conversion by 2009. However, NNSA faces difficulties in converting the remaining five reactors because these reactors cannot operate with the currently available LEU fuel. NNSA is now developing a new LEU fuel that will allow the remaining five reactors to operate. However, according to NNSA, developing this fuel has been problematic, as early efforts experienced failures during testing. NNSA officials acknowledged that further setbacks are likely to delay plans to convert these research reactors.

# Contents

**Abbreviations**

| | |
|---|---|
| CFR | Code of Federal Regulations |
| DBT | Design Basis Threat |
| DHS | Department of Homeland Security |
| DOE | Department of Energy |
| HEU | highly enriched uranium |
| INL | Idaho National Laboratory |
| kW | kilowatt |
| LANL | Los Alamos National Laboratory |
| LEU | low-enriched uranium |
| MW | megawatt |
| NNSA | National Nuclear Security Administration |
| NRC | Nuclear Regulatory Commission |
| ORNL | Oak Ridge National Laboratory |
| RERTR | Reduced Enrichment for Research and Test Reactors |
| SNL | Sandia National Laboratories |
| SWAT | Special Weapons and Tactics |

United States Government Accountability Office
Washington, DC 20548

January 31, 2008

The Honorable Christopher Shays
Ranking Member
Subcommittee on National Security and Foreign Affairs
Committee on Oversight and Government Reform
House of Representatives

Dear Mr. Shays:

Nuclear research reactors located throughout the United States play an important role in education, medicine, industry, national security, and basic scientific research. Currently, 37 research reactors operate in the United States. Of these reactors, 33 are licensed and regulated by the Nuclear Regulatory Commission (NRC) and 4 are operated by the Department of Energy (DOE). The DOE research reactors are located at three national laboratories: Oak Ridge National Laboratory (ORNL), Sandia National Laboratories (SNL), and Idaho National Laboratory (INL). Research reactors are less powerful than commercial nuclear power reactors, ranging in size from less than 1 megawatt (MW) to 250 MW, compared with the 3,000 MW found for a typical commercial nuclear power reactor.

Although research reactors are less powerful than commercial nuclear power reactors, they may nevertheless be targets for terrorists determined to steal reactor fuel for use in a nuclear weapon or radiological dispersal device (dirty bomb) or to sabotage a reactor in order to disperse radioactive material into the atmosphere over neighboring communities. For example, unlike commercial nuclear power reactors, several research reactors use highly enriched uranium (HEU) fuel instead of low-enriched uranium (LEU) fuel, which make them a target because HEU is a key component in the construction of some nuclear weapons.[1] Furthermore, most NRC-licensed research reactors are located on university campuses; and while they have security systems in place, they are also accessible to students for educational purposes.

[1]HEU is uranium enriched in the isotope uranium-235 to 20 percent or greater. LEU is uranium that is enriched to less than 20 percent in the isotope uranium-235.

Through a series of orders, manuals, and directives, DOE has established security requirements for all of its facilities, including those that maintain nuclear materials. The key component of the security requirements is the Design Basis Threat (DBT) document. The DBT identifies the size and capability of terrorist forces and the potential consequences of terrorist attacks. From this document, DOE developed the security objectives and policies and the security measures necessary to protect nuclear weapons, nuclear weapons components, special nuclear material, national laboratories, and other critical DOE assets against the attacking force described in the DBT.

While NRC maintains a DBT for the commercial power reactors it licenses, it does not have a DBT for NRC-licensed research reactors. However, NRC has assessed threat scenarios to NRC-licensed research reactors and has identified as potential threats the theft of fuel for use in a nuclear weapon, dirty bomb, radiological exposure device, and sabotage to disperse radioactive material. In addressing these threats, NRC must ensure that its security requirements are consistent with section 104(c) of the Atomic Energy Act of 1954. Section 104(c) directs NRC to impose only "such minimum amount of regulation" of a research reactor licensee as NRC finds will permit it to fulfill its obligations to promote the common defense and security and protect public health and safety of the public, and will permit the conduct of widespread and diverse research and development. Security requirements for NRC-licensed research reactors are based on a graded approach; that is, research reactors possessing larger quantities of nuclear material or using material potentially more attractive to adversaries are generally required to have more security measures in place.

Both DOE and NRC require reactor operators or licensees to develop and implement emergency response plans to prepare for accidents and possible terrorist attacks. Among other things, these plans are to address the coordination of activities by emergency first responders, including police, fire, medical, and hazardous materials personnel. These plans may also include guidelines for when and how areas near a research reactor should be evacuated.

Following the events of September 11, 2001, NRC assessed the security of NRC-licensed research reactors in order to determine whether additional security measures were warranted.[2] Unlike a DBT, the assessment did not prescribe specific security standards. Instead, the security assessment analyzed the effectiveness of security at individual NRC-licensed research reactors and the potential consequences of terrorist attacks. NRC contracted with SNL for this assessment because, according to NRC officials, SNL has considerable expertise in assessing the security of nuclear facilities.[3] To determine the types of threats that needed to be taken into account during the security assessment, NRC and SNL used a threat assessment developed by NRC from current intelligence information that identified the potential threats to NRC-licensed research reactors.

Beyond these efforts to secure research reactors and plan for emergencies, the United States has had a policy since 1978 of reducing and, to the extent possible, replacing the use of HEU fuel in research reactors with LEU fuel. While HEU is a key component in the construction of nuclear weapons, LEU is poorly suited for this use. Accordingly, replacing HEU with LEU reduces the risk that terrorists will gain access to the material needed to construct a nuclear weapon. To support this policy, DOE initiated the Reduced Enrichment for Research and Test Reactors (RERTR) program, or reactor conversion program, to develop the technology to reduce and eventually eliminate the use of HEU in research reactors worldwide.[4] The National Nuclear Security Administration (NNSA), a separately organized agency within DOE, oversees the reactor conversion program.

In response to your request concerning the security of U.S. research reactors, we examined (1) the basis on which DOE and NRC established the security and emergency response requirements for DOE and NRC-licensed research reactors and (2) the progress NNSA has made in its ongoing efforts to convert U.S. research reactors that use HEU fuel to LEU fuel. In October 2007, we reported to you on the results of our work in a classified report.[5] Subsequently, you asked us to provide you with an

[2]NRC, *Security Assessment of NRC-Licensed Research and Test Reactor*, NRC, (April 2006). In this report, we refer to this assessment as the NRC security assessment. This assessment is controlled as Safeguards Information (SGI) by NRC.

[3]Other agencies, such as the Department of Homeland Security and DOE, have relied on SNL for their expertise on security issues as well.

[4]In this report, we refer to the RERTR program as the reactor conversion program.

[5]GAO, *Research Reactor Security*, GAO-08-156C (Washington DC.: Oct. 12, 2007).

unclassified version of our report. This report summarizes the results of our classified report.

To address these objectives, we reviewed relevant DOE and NRC policy, planning, and analysis documents, including DOE's DBT and NRC's threat assessment document. Both of these documents establish a baseline threat for which minimum security measures should be developed. We also reviewed inspection oversight manuals, security plans, emergency plans, and the relevant provisions of the *Code of Federal Regulations*. For both DOE and NRC-licensed research reactors, we reviewed NRC, SNL, Los Alamos National Laboratory, and INL reports and studies to assess the potential consequences of an attack on research reactors. In addition, at our request—an INL reactor vulnerability expert whose expertise includes evaluating and modeling the effects of radiological sabotage—analyzed the consequences of a radiological sabotage attack against a research reactor with characteristics similar to some mid-powered NRC-licensed reactors. Prior to performing the analysis, the INL expert and GAO discussed and agreed on the assumptions that would be used in the analysis. GAO's Chief Technologist reviewed the INL expert's analysis and found it met sufficiency, competency, and relevancy standards for GAO sources. Additionally, we interviewed a Department of Homeland Security (DHS) expert regarding some of the key inputs used in the INL expert's analysis. We also discussed the INL expert's analysis with INL management, who stated that the analysis was technically accurate and that its reactor vulnerability expert had done good work in preparing it.

We also visited research reactor sites, including all four DOE-operated research reactors and 10 of the 33 NRC-licensed research reactors. To select these reactors, we used a nonprobability (or judgmental) sample based on reactor size in terms of power and geographic location. Accordingly, we were able to review a variety of security measures in place for reactors of different power levels, including some of the most powerful, and for reactors at locations with varying relative population densities. At both DOE and NRC-licensed research reactors, we examined security systems and interviewed officials, including directors of reactor operations, campus security, and local police and fire officials. A GAO special agent specializing in security systems participated in the visits to two DOE and five NRC-licensed research reactors. Furthermore, we interviewed officials representing DOE's Offices of Health, Safety and Security, University Programs, Security Policy, and Security Evaluations; the NNSA office that implements the reactor conversion program; and several offices within NRC, including its Research and Test Reactors Branch, Office of Nuclear Security and Incident Response, Division of Security Policy, and Reactor Security Branch. Finally, we interviewed INL and SNL scientists and officials, as well as several security and reactor experts at universities and nongovernmental organizations, who have conducted studies or are considered experts on the potential effects of attacks on research reactors to obtain differing perspectives about research reactor security. We conducted the work for the classified report between May 2006 and July 2007 in accordance with generally accepted government auditing standards and we conducted our work for the unclassified report between October 2007 and January 2008. 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.

## Results in Brief

DOE protects its four research reactors by using the security and emergency requirements developed for its DBT and by relying on the reactors' location at national laboratories that require heightened security because these laboratories store weapons-usable nuclear material or conduct nuclear weapons-related activities. DOE's DBT requires its research reactors to be protected in a graded manner—that is, a reactor possessing more dangerous material must be safeguarded more securely than those that have less dangerous material. In addition, DOE requires that all personnel with routine access to DOE reactors have a federal security clearance. This is an important measure to help address the so-called "insider threat"—the possibility that someone inside a facility, such as a reactor employee, would assist terrorists in an attack. Despite extensive security features at DOE research reactors, we did find a security weakness. We discovered that the Web site for one DOE research reactor contained information about its refueling schedule. According to security experts, reactors are more vulnerable during refueling because large doors that are normally tightly secured must be opened to deliver fuel. After we brought this matter to DOE's attention, DOE removed the information from its Web site. Finally, DOE has concluded that the consequences of an attack at some of its research reactors could be severe, causing radiation to be dispersed over many square miles and requiring the evacuation of nearby areas. As a result, all facilities where DOE reactors are located have established extensive plans and procedures for safety and security incidents. For example, DOE facilities where research reactors are located have emergency response plans that call for evacuating areas surrounding the facility for up to 300-square miles in the event of a potentially hazardous radiological release.

NRC's security and emergency response requirements are largely based on the regulations it had in place before September 11, 2001. NRC decided to retain its requirements after conducting a security assessment between 2003 and 2006 and determining that these requirements were sufficient. NRC worked with individual licensees to improve security when weaknesses were detected. However, we found that NRC's assessment contains analyses and assumptions about reactor security and terrorist capabilities that are questionable—creating uncertainty about whether NRC's assessment reflects the full range of security risks and potential consequences of an attack on a research reactor. We reached this conclusion for three reasons. First, SNL—which NRC had contracted with to assist in performing its security assessment—found that some NRC-licensed research reactors may not be prepared for certain types of terrorist attacks. For example, SNL's analysis of several reactors found that in certain scenarios where a small group of well-trained terrorists attacked a reactor, the terrorists could be successful. However, NRC disagreed with SNL's finding and believed it would be far more difficult for terrorists to successfully attack a research reactor. In the end, NRC concluded in 2006 that the radiological consequences of attacks would result in minimal radiological exposure to the public. Therefore, NRC decided that it did not need to strengthen the security requirements. Second, based on its threat assessment, NRC assumed that terrorists would use certain weapons and tactics in attacking a reactor but did not fully consider alternative attack scenarios that could be more damaging if carried out successfully. According to an SNL expert, attacking a research reactor using an alternative approach would be a difficult and sophisticated task that would likely require specific knowledge of reactors and sabotage techniques. Nonetheless, this expert stated that such an attack was possible and identified detailed information needed for such an attack. Finally, NRC assumed that a small portion of a research reactor could be damaged in a terrorist attack, resulting in the release of only a small amount of radioactivity into the atmosphere. However, according to experts at INL and DHS, it is possible that a larger portion of a research reactor could be damaged in a terrorist attack, which could result in the release of a larger amount of radioactivity.

We also identified potential shortcomings with NRC's current security and emergency response requirements and measures that may require immediate attention. For example, at one research reactor we visited, the reactor could be accessed and potentially damaged in an attack. In addition, at the time of our review, NRC did not have a background check requirement for research reactor staff who had unescorted access to the reactor, which created a potential security weakness. However, in response to the requirements in the Energy Policy Act of 2005, NRC issued an order to research reactor licensees in May 2007, requiring that all staff with unescorted access to reactors be fingerprinted and undergo a Federal Bureau of Investigation criminal background check. Concerning emergency response requirements, all the NRC-licensed research reactors we visited had emergency plans for responding to terrorist attacks and agreements with local law enforcement and other first responders for responding to emergencies. However, NRC does not require that these plans include evacuation plans for areas surrounding its licensed reactors, even though most research reactors are located on college campuses or near populated areas where the consequences of an attack could be more severe than NRC estimates. Furthermore, NRC's requirements for emergency response plans do not call for first responders to reactor security alarms to be armed. At most NRC-licensed research reactors we visited, the designated first responders would be armed, but at a few they would not. At these reactors, unarmed campus police—not local law enforcement agencies—are the designated first responders when alarms are set off.

Regarding NNSA's reactor conversion program, NNSA has made progress in converting U.S. research reactors from using HEU fuel to using LEU fuel, but it faces challenges in converting some of the remaining research reactors. NNSA has converted 8 currently operating U.S. research reactors since 1978, including 2 in 2006. In addition, NNSA plans to convert 10 more U.S. research reactors by September 2014. Of these 10, 5 are on schedule to be converted by 2009. However, NNSA faces challenges in converting the remaining 5 reactors because these reactors cannot operate with the LEU fuel that is currently available. NNSA is now developing a new LEU fuel that will allow the remaining five reactors to operate, but according to an NNSA official, this fuel must be developed by 2011 if NNSA is to meet its conversion schedule goal of 2014. Development of this fuel, however, has been problematic. Early efforts to develop the fuel experienced failures during testing, which caused NNSA to push back anticipated completion dates. NNSA and national laboratory officials acknowledged that the fuel development schedule is optimistic and that further technical setbacks would likely delay NNSA's plans to convert research reactors. Furthermore, NNSA's cost estimate for the conversion of the remaining DOE and NRC-licensed research reactors may be uncertain because fuel development is not yet complete, and the projected completion dates for the reactors' conversions hinge on the timely and successful development of the new fuel.

In our October 2007 classified report, we made recommendations to the Chairman of NRC to reassess the consequences of terrorist attacks on NRC-licensed research reactors using assumptions that better reflect a fuller range of expert opinion on the security of reactors and the capabilities of potential terrorist forces. If NRC finds that the consequences of an attack are more severe than previously estimated, we also recommended that the Chairman of NRC (1) ensure that the security requirements for research reactors are commensurate with the consequences of attacks, (2) reexamine emergency response requirements to address whether evacuation plans should be included, and (3) require that first responders to alarms at research reactors be armed.

We provided DOE, NNSA, and NRC with draft copies of our classified report for their review and comment. As discussed in our classified report, NNSA, whose comments also reflected DOE's views, generally agreed with the report and provided minor technical comments, which we incorporated as appropriate. NRC did not agree with the report and criticized our report in several areas. For example, NRC stated that we misrepresented its use of the SNL security assessment and that we incorrectly stated that the NRC had dismissed the findings in SNL's assessment. We believe we have accurately described NRC's position on the work done by SNL. Specifically, NRC has reiterated its disagreement with the SNL analysis in writing on several occasions. When NRC provided us with copies of SNL's security assessment, it also provided a disclaimer stating that NRC "does not support many of the assumptions and/or information contained in these reports and…the reports cannot be used independently to develop any conclusions regarding the security or protective measures for the facilities contained in the reports." Furthermore, according to a 2005 statement from an NRC Commissioner concerning SNL's work, "because the Sandia security assessment reports contain scenarios and assumptions that are not supported by the Commission, the reports should not be released to anyone outside the agency nor should they be shared with licensees or stakeholders." NRC's specific comments and our response are discussed at the end of this letter. (NRC comments on our classified report contained information that was classified. However, in December 2007, NRC provided an unclassified version of its comments to us, which we have included in appendix I along with our response to its comments.)

## Background

Table 1 lists the 37 research reactors operating in the United States. Of the 33 reactors that NRC licenses and regulates, 27 are located on university campuses. In contrast, all DOE research reactors are located in relatively isolated locations and at facilities where public access is restricted because weapons-usable nuclear materials associated with DOE's nuclear weapons programs are also stored on site.

**Table 1: Location, Fuel Type, and Power Level of Operating U.S. Research Reactors**

| Reactors | Location | Fuel type | Power level[a] |
|---|---|---|---|
| **DOE—4** | | | |
| Advanced Test Reactor | INL, Idaho | HEU | 250 Megawatt (MW) |
| High Flux Isotope Reactor | ORNL, Tennessee | HEU | 85 MW |
| Annular Core Research Reactor | SNL, New Mexico | HEU | 4 MW |
| Neutron Radiography Reactor | INL, Idaho | HEU | 250 kilowatt (kW) |
| **NRC—33** | | | |
| National Institute of Standards and Technology | Gaithersburg, Maryland | HEU | 20 MW |
| University of Missouri, Columbia | Columbia, Missouri | HEU | 10 MW |
| Massachusetts Institute of Technology | Cambridge, Massachusetts | HEU | 5 MW |
| University of California, Davis | Sacramento, California | LEU | 2 MW |
| Rhode Island Nuclear Science Center | Narragansett, Rhode Island | LEU | 2 MW |
| Armed Forces Radiobiology Research Institute | Bethesda, Maryland | LEU | 1 MW |
| University of Massachusetts, Lowell | Lowell, Massachusetts | LEU | 1 MW |
| North Carolina State University | Raleigh, North Carolina | LEU | 1 MW |
| Oregon State University | Corvallis, Oregon | HEU | 1 MW |
| Pennsylvania State University | University Park, Pennsylvania | LEU | 1 MW |
| University of Texas | Austin, Texas | LEU | 1 MW |
| Texas A&M University | College Station, Texas | LEU | 1 MW |
| U.S. Geological Survey | Denver, Colorado | LEU | 1 MW |
| Washington State University | Pullman, Washington | HEU | 1 MW |
| University of Wisconsin | Madison, Wisconsin | HEU | 1 MW |
| Ohio State University | Columbus, Ohio | LEU | 500 kW |
| Dow Chemical Company | Midland, Michigan | LEU | 300 kW |
| Aerotest Operations, Inc. | San Ramon, California | LEU | 250 kW |
| University of California, Irvine | Irvine, California | LEU | 250 kW |
| Kansas State University | Manhattan, Kansas | LEU | 250 kW |
| University of Maryland | College Park, Maryland | LEU | 250 kW |
| Reed College | Portland, Oregon | LEU | 250 kW |
| Missouri University of Science and Technology | Rolla, Missouri | LEU | 200 kW |
| University of Arizona | Tucson, Arizona | LEU | 100 kW |
| University of Florida | Gainesville, Florida | LEU | 100 kW |
| General Electric Company | Sunol, California | HEU | 100 kW |
| University of Utah | Salt Lake City, Utah | LEU | 100 kW |
| Worcester Polytechnic Institute | Worcester, Massachusetts | LEU | 10 kW |

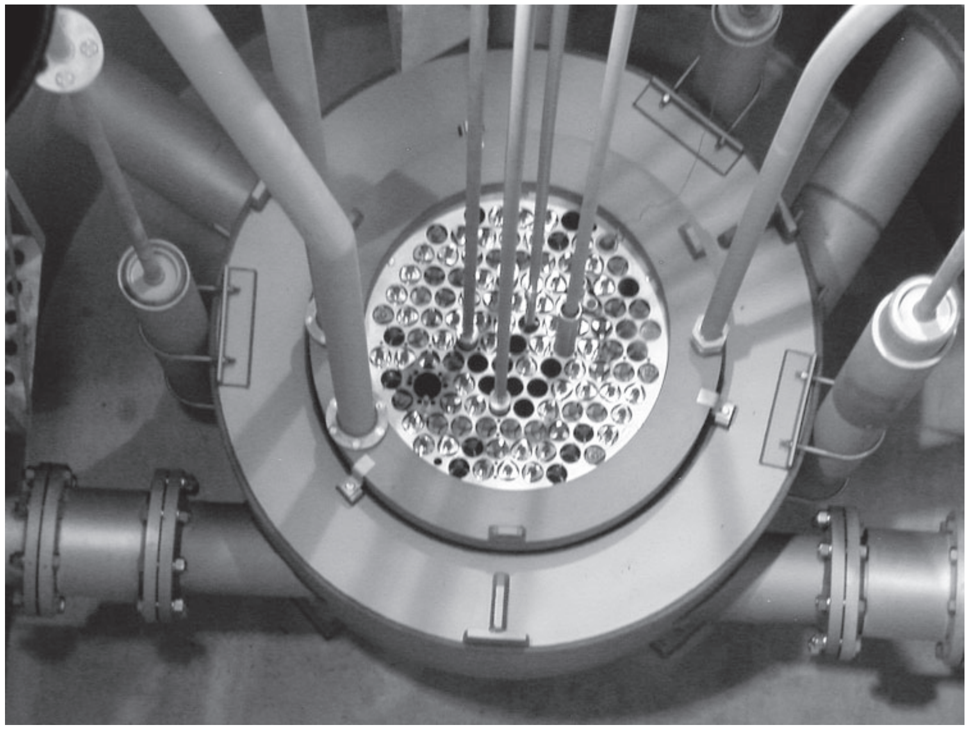
| Reactors | Location | Fuel type | Power level[a] |
|---|---|---|---|
| Purdue University | West Lafayette, Indiana | HEU | 1 kW |
| Rennselaer Polytechnic Institute | Schenectady, New York | LEU | .10 kW |
| Idaho State University | Pocatello, Idaho | LEU | .005 kW |
| University of New Mexico | Albuquerque, New Mexico | LEU | .005 kW |
| Texas A&M University | College Station, Texas | LEU | .005 kW |

Source: DOE and NRC.

[a]One megawatt is 1,000 kilowatts. On average, 1 kilowatt is the amount of power that is needed to operate a typical U.S. household for 1 hour.

Several factors may make research reactors a target for terrorists. For example, most U.S. research reactors are located on university campuses; while these research reactors have security systems in place, none are protected with the kind of security or armed security forces that protect nuclear power reactors. Furthermore, once inside the reactor building, terrorists may gain access to the reactor. Figure 1 shows the inside of a research reactor. In addition, while power reactors use LEU fuel, several research reactors still use HEU fuel in order to produce the appropriate conditions in the reactor for conducting a wide variety of research. HEU is attractive to terrorists looking to construct a crude nuclear weapon. NRC's Office of Nuclear Reactor Regulation has oversight responsibility for all NRC-licensed research reactors. DOE's Office of Nuclear Energy, Science, and Technology's Radiological Facilities Management program is charged with maintaining DOE research reactors in a secure manner.

Figure 1: Inside of a Research Reactor



Source: Photo provided by an NRC-licensed research reactor.

To enforce safety, security, and emergency planning requirements, both DOE and NRC conduct routine inspections to ensure compliance with DOE orders, manuals, and directives and with NRC regulations. DOE's Office of Independent Oversight and Performance Assurance—which independently assesses the effectiveness of DOE policies and programs in safeguards and security and emergency management for DOE facilities—routinely inspects DOE facilities for compliance with DOE safeguards and security requirements. NRC-licensed research reactors are licensed and routinely inspected by inspectors representing NRC's Research and Test Reactor Section. The requirements for the physical protection of NRC-licensed research reactors are set out in NRC regulations and primarily focus on preventing the theft and diversion of fuel.[6] In addition to the specific requirements established in the regulations, NRC may require—depending on the individual facility and site conditions—any additional

[6] 10 C.F.R. part 73.

measures it deems necessary to protect against radiological sabotage at research reactors that it licenses to operate above 2 MW of power.[7] Commensurate with the security requirements, security related inspection activity is based on a graded approach, where security measures are based on the type and quantity of nuclear material on site. For example, research reactors licensed to possess more than 5 kilograms of HEU are inspected at least annually, while reactors that are licensed to possess less than 1 kilogram of HEU are inspected at least triennially.

NRC used its security assessment of NRC-licensed research reactors to determine whether additional security measures were warranted. NRC's assessment considered an analysis of security at reactors, as well as the consequences of attacks. The security assessment also included site-specific assessments of NRC-licensed research reactors to determine the vulnerability of structures, security operations, and physical protection systems, as well as access control systems at research reactors. Using varying numbers of adversaries and capabilities, NRC assessed threat scenarios, which included theft of fuel for use in a nuclear weapon or dirty bomb and sabotage attacks designed to disperse radioactive material. NRC used the number of immediate fatalities caused by radiological release resulting from an attack at a research reactor as its criterion to measure consequences and assessed the adequacy of the security at NRC-licensed reactors. If NRC discovered that there was potential to affect public health, it was to identify countermeasures to mitigate or prevent the consequences, while considering the cost-effectiveness of these countermeasures.

As a complement to DOE and NRC security efforts, NNSA's Reactor Conversion Program has a goal of reducing or eliminating the use of HEU at research reactors. To support this goal, NRC promulgated a rule in 1986 requiring all NRC-licensed research reactors to convert to LEU if feasible and if DOE provided adequate funding. In addition, under the 2005 North American Security and Prosperity Partnership, the United States, Mexico, and Canada agreed to convert civil HEU reactors on the North American continent to LEU fuel, where such LEU fuel is available. Since 2004, NNSA has overseen the fuel conversion of U.S. research reactors. To achieve NNSA's goal, in 2005, NNSA's reactor conversion program partnered with the DOE Office of Nuclear Energy University Reactors Program to accelerate the conversion of U.S. research reactors by providing funding to enable research reactors where LEU is available to convert as rapidly as

[7] 10 C.F.R. § 73.60(f).

possible. INL is the technical lead for the reactor conversion program's fuel development effort.

## DOE Used Its DBT to Develop Security and Emergency Response Requirements for Its Reactors, Which Also Benefit from National Laboratories' Enhanced Security

To protect its four research reactors, DOE uses the security and emergency requirements developed from its DBT and counts on the security afforded by the reactors' locations at certain national laboratories that require heightened security. Furthermore, DOE has concluded that consequences from an attack at some of its research reactors could be severe and has therefore established extensive plans and procedures for safety and security incidents.

### DOE Research Reactors Are Protected by Requirements of the DBT and Their Location at National Laboratories

DOE's research reactors benefit from the greater security required for the national laboratories where the research reactors are located. The laboratories are engaged in nuclear weapon activities or store special nuclear material and therefore are to meet the requirements for DOE's 2003 DBT. This DBT was developed to support DOE policies for preventing unauthorized access, theft, or sabotage of nuclear weapons and all special nuclear material under DOE's jurisdiction. More specifically, following the DBT, DOE requires its research reactors to be protected in a graded manner; that is, a reactor possessing more dangerous nuclear material must be safeguarded more securely than those that have less dangerous material. For example, SNL and INL—the locations of DOE's Annular Core Research Reactor and its Neutron Radiography Reactor, respectively—store weapons-usable nuclear materials and therefore have robust security features and specially dedicated, heavily armed guard forces. The other two DOE reactors—the Advanced Test Reactor and High Flux Isotope Reactor—located at INL and ORNL, respectively, have extensive security features, including perimeter barbed-wire fences and armed security guards at all times. In addition, DOE requires that all personnel with routine access to DOE reactors have a federal security clearance. Among other things, this requirement helps to reduce the possibility of an insider threat.

We also found that DOE is engaged in efforts to improve security at the reactor sites. For example, at the SNL and INL sites the locations of the Annular Core Research Reactor and Neutron Radiography Reactor, respectively, DOE recently made several security upgrades, including installing new surveillance systems with thermal imaging cameras; these cameras enable surveillance of the surrounding territory for up to several miles, regardless of light and weather conditions. Despite extensive security features at DOE research reactors, we did find a security weakness and some research reactor vulnerabilities. Specifically, we discovered that the Web site for one DOE research reactor contained information about its refueling schedule. According to security experts, reactors are more vulnerable during refueling because large doors that are normally tightly secured must be opened to deliver fuel. After we brought this weakness to DOE's attention, the department removed the information. Concerning vulnerabilities, at two DOE research reactors, we discovered key features at the reactor facilities that were vulnerable to attack, as DOE officials acknowledged. In both cases, the reactor operators store large amounts of spent reactor fuel in pools that are easily accessible to anyone inside the reactor facility. According to national laboratory officials at both of these facilities, this fuel is dangerous because if it is damaged during a terrorist attack, it could cause a large radiological release into the area surrounding the research reactor. During visits to both facilities, the reactor operators said that an attack on their spent fuel concerned them just as much as an attack on the actual reactor because of the potential for release of radiological material into the atmosphere. These operators said that the spent fuel needs to be removed for disposal; DOE plans to remove most of this spent fuel by 2012.

## DOE Has Established Extensive Plans and Procedures for Safety and Security Incidents

DOE has concluded that the consequences of an attack at some of its research reactors could be severe, possibly causing radiation to be dispersed over many square miles and requiring the evacuation of nearby areas. As a result, all facilities where DOE reactors are located have established extensive plans and procedures for responding to reactor emergencies, as DOE policies require. For example, ORNL—the location of the High Flux Isotope Reactor—has a laboratory shift superintendent on duty at all times to classify potential events and coordinate preplanned responses geared to the nature of the event. According to ORNL officials, emergencies can lead to the mobilization of significant numbers of security personnel trained to respond to emergencies at the reactor. This mobilization could include the activation of the mutual assistance agreement between ORNL and the neighboring Y-12 National Security Complex to deploy Y-12's off-duty security forces to ORNL in the event of a terrorist attack. DOE policies also require DOE research reactor operators, with DOE and laboratory officials, to assess the worst-case consequences of accidents or terrorist attacks at their research reactors and develop emergency response plans that call for evacuating areas up to 300-square miles surrounding the reactor in the event of a potentially hazardous radiological release into the atmosphere. Decisions to evacuate are made based on the amount of radiation to which people could be exposed, as determined by their proximity to the reactor and the amount of radioactivity released. Furthermore, in worst-case scenarios, DOE reactor facility emergency plans include multijurisdictional plans outlining the immediate coordination of regional and federal emergency response assets.

## Security and Emergency Response Requirements for NRC-Licensed Research Reactors Are Based on Questionable Assumptions, Meaning That Reactors May Not Be Adequately Protected

NRC decided to largely retain the security and emergency response regulations it had in place before September 11, 2001. NRC decided to retain these requirements after conducting a security assessment between 2003 and 2006 and determining that these requirements were sufficient. However, we found that NRC's security assessment used questionable analysis and assumptions that may not fully reflect the consequences of a terrorist sabotage attack. According to experts at INL and DHS, the consequences of a terrorist attack on a research reactor could be more than what NRC estimates. Consequently, even though a number of NRC-licensed research reactors have recently improved security, NRC's security and emergency response requirements may need immediate strengthening to protect against the consequences of an attack.

### NRC's Security Assessment May Not Adequately Reflect the Potential Consequences of a Terrorist Attack on Its Licensed Research Reactors

Between 2003 and 2006, NRC conducted a security assessment of NRC-licensed research reactors to determine whether existing security and emergency response requirements were sufficient to protect against an attack. NRC first conducted a screening analysis to assess the significance of the consequences of a sabotage attack at each of the 33 NRC-licensed research reactors and established a minimum radiological dose that an attack would have to produce before further assessment was warranted. Eventually, NRC concluded that the potential effects of terrorists sabotaging these 33 reactors were minimal and that the security and emergency response regulations for research reactor licensees did not need strengthening.

In conducting this assessment, NRC established a minimum radiological dosage as the criterion to determine if a full security assessment was necessary. During its initial phase of this assessment, NRC determined that most of the reactors would experience minimal consequences from sabotage and therefore present a low radiological risk to public health and safety. For the remaining reactors, NRC conducted a further detailed security assessment. NRC concluded that the potential effects of an attack at these reactors were also minimal and that the security and emergency response regulations for research reactors did not need strengthening.

NRC's security assessment also included SNL's evaluation of the security of NRC-licensed research reactors; however, NRC disagreed with several of SNL's findings. NRC contracted with SNL to help perform its security assessment, and as part of this work, SNL estimated the probabilities that terrorists could successfully carry out an attack on NRC-licensed reactors. SNL found that some NRC-licensed research reactors may not be prepared for certain types of terrorist attacks. For example, SNL's analysis of several reactors found that under certain scenarios involving a small group of well-trained terrorists, an attack on a reactor could be successful. NRC, however, believed that SNL's assumptions about terrorists' capabilities were excessive and that SNL did not give enough credit to the capabilities of first responders. Ultimately, NRC disagreed with SNL about the security of research reactors. In its final analysis, NRC concluded that, because the radiological consequences of an attack would be minimal, no changes in the security and emergency response regulations for NRC-licensed research reactors were necessary.

However, NRC's security assessment may contain important shortcomings. As a result, NRC may not have a sound basis for determining the adequacy of security and emergency response requirements for its licensed research reactors. Based on our analysis and an analysis conducted by an INL reactor vulnerability expert at our request, we concluded that NRC's security assessment used questionable assumptions and analyses about research reactor security and the potential consequences of an attack on NRC-licensed research reactors. Specifically, NRC made the following assumptions that we have reason to question:

- NRC assumed that terrorists would use certain weapons and tactics in attacking a reactor but did not fully consider alternative attack scenarios which could be more damaging if carried out successfully. According to an SNL expert, attacking a research reactor using this alternative approach would be a difficult and sophisticated task, which would likely require specific knowledge of reactors and sabotage techniques. Nonetheless, this expert stated that such an attack was possible and identified detailed information for carrying it out. Moreover, the attack scenarios that NRC did not fully consider could lead to more significant consequences than NRC estimates, according to an INL reactor vulnerability expert.

- NRC assumed that only a small portion of a research reactor could be damaged in a terrorist attack, resulting in the release of only a small amount of radioactivity into the atmosphere. However, according to experts at INL and DHS, it is possible that a larger portion of a research reactor could be damaged in a terrorist attack. If this occurred, these experts also noted that an attack could result in a release of a larger amount of radioactivity into the atmosphere over neighboring communities.

- NRC assumed that insiders with access to the reactor would only participate to a limited degree. However, in similar security assessments for DOE facilities, DOE assumes that insiders would fully participate in an attack, and it has designed its defenses on the assumption of full participation. Fully participating insiders could both provide information, such as details of the facility layout and operating schedule, as well as participate in an attack by performing key functions, such as opening doors or disabling alarm systems. NRC officials acknowledge that if its assessment had assumed fully participating insiders, then the results of its assessment may have turned out differently.

Furthermore, according to a reactor vulnerability expert at INL, the consequences of a terrorist attack could be significant. Specifically, this expert stated that terrorist attackers using different weapons and tactics than NRC assumed in attack scenarios may be able to damage a larger portion of a research reactor. In addition, at our request, this INL reactor vulnerability expert conducted an analysis of the consequences of a terrorist attack.[8] This analysis confirmed his views that an attack at a research reactor could release a large amount of radioactivity, which would be damaging to neighboring communities. In fact, the analysis concluded:

> "It is clear that an event as described in this report could have significant consequences. The consequences of a successful sabotage attack in addition to the direct dose could be significant radioactive material release and subsequent contamination of areas that have high socio-economic impact. It is important that the risk from these reactors be well characterized and the emergency preparedness for such an event be included [in] the planning process."

Because most NRC-licensed research reactors are located on college campuses or in urban areas, the release of large amounts of radiation could affect a substantial portion of the population.

---

[8]INL, *Evaluation of a Psuedo TRIGA Reactor for Radiological Sabotage*, INL/EXT-07-12348 (April 2007).

We discussed the INL reactor vulnerability expert's analysis with INL's Deputy Associate Laboratory Director for National and Homeland Security Directorate, who stated that the analysis was technically accurate and that their reactor vulnerability expert had done good work in preparing it. However, he cautioned us that the analysis represented the efforts of only one of INL's reactor vulnerability experts. In his view, a more comprehensive analysis of the vulnerability and the consequences of a terrorist attack on a research reactor is warranted. Such a study should include experts from a variety of technical areas, including national intelligence sources, and involve more than one laboratory. These experts would determine the most appropriate assumptions that should be used in the analysis. For example, according to the Deputy Associate Laboratory Director, one important part of such an analysis would be examining the physical nature of damaging a research reactor. This could be done through modeling and actual experiments. Once this is determined, it would inform other aspects of a reactor vulnerability analysis and result in a more comprehensive understanding of the potential consequences of a terrorist attack.

We shared the results of INL's reactor vulnerability expert's analysis with NRC, who disagreed with several of the basic assumptions and findings concerning the consequences of an attack on a research reactor. NRC's reasons for its disagreement, and our analysis of these reasons, are discussed in detail in the classified version of this report.

## Despite Recent Security Improvements, NRC's Security and Emergency Response Requirements May Not Sufficiently Address the Potential Consequences of an Attack

NRC maintains an active oversight program of all research reactor licensees, which includes routine safety and security inspections. Between 2001 and 2006, NRC worked with its licensees to make immediate security improvements to research reactors where needed. As a result of continuing oversight activities, when NRC found additional security measures were necessary to ensure public health and safety, NRC requested that licensees implement additional security measures. NRC verified improved security through inspections and issued letters formally binding the licensees to maintain security enhancements.

During our visits to NRC-licensed research reactors, we found the following improvements to security:

- improved access controls to key areas inside reactor facilities,
- augmented surveillance of activities within controlled access areas, and
- improved alarm and communication systems.

For example, one NRC research reactor licensee installed antitruck bomb barriers, including concrete and steel reinforced poles and a steel cable gate, which are not required for the category of reactor at this particular facility. In fact, we discovered that several of NRC's research reactor licensees have made security improvements that exceed NRC's security requirements. Similarly, to address the potential truck bomb threat, several other NRC research reactor licensees have placed jersey barriers near exterior parts of reactor buildings. Figure 2 shows a research reactor building surrounded with jersey barriers. Some NRC-licensed research reactors have added jersey barriers, installed new steel-hardened doors, and improved camera surveillance systems. Still another licensee installed a new alarm system that is hardwired to the closest police station, which monitors reactor alarms at all times.

**Figure 2: Research Reactor Building Surrounded by Jersey Barriers**

Source: GAO.

Despite such improvements, we identified potential shortcomings with current security and emergency response requirements and measures. These requirements and measures may require immediate attention if NRC's assessment of the consequences of an attack on its licensed reactors is deficient. For example:

- At two research reactors we visited, we found features of the reactor that if damaged during an attack could make the reactor more at risk for radiological releases.

- According to an SNL security analysis of NRC-licensed research reactors, a number of reactors could be attacked and sabotaged by well-trained terrorists. If an NRC-licensed research reactor were attacked, the local police would have to assess the threat and determine the appropriate response before the attackers have completed the tasks needed to sabotage the reactor.

- At still another research reactor, we found an unlocked and unalarmed access leading directly into the reactor room. In this case, the licensee is relying on another security measure that might be overcome. However, this measure could be compromised. In our view, it is both sensible and inexpensive to put a lock and an alarm trigger on this access to the reactor room, rather than depend on having one element of the security system function flawlessly.

In response to the Energy Policy Act of 2005, NRC has begun to address a potential security weakness we identified during our review. Specifically, we found that NRC did not require research reactor licensees to conduct extensive background checks on their staff with access to reactors. However, starting in 2006, NRC began requiring research reactor licensees to fingerprint staff with access to sensitive security information and subject them to a criminal history background check by the Federal Bureau of Investigation. Furthermore, in May 2007, NRC ordered research reactor licensees to subject all staff with unescorted access to reactors to this check.

All of the NRC-licensed research reactors that we visited have detailed and coordinated emergency plans for responding to terrorist attacks, including the deployment of police, Special Weapons and Tactics (SWAT), fire, ambulance, and hazardous material personnel to the reactor facility. In addition, most NRC-licensed research reactors licensees we visited have agreements with local law enforcement and other first responders for responses to emergencies. For example, the research reactor at the Massachusetts Institute of Technology has memorandums of understanding with the city of Cambridge Police Department, Fire Department, Emergency Management Department, and Massachusetts General Hospital outlining cooperation in case of emergencies. However, we found weaknesses in two key areas of NRC emergency response plan requirements—evacuation planning and first response:

***Few Reactors Have Evacuation Planning***. Evacuation planning is important because most NRC-licensed reactors are located in highly populated areas, with other buildings located near the reactor facility. For example, one NRC-licensed research reactor is located within 100 yards of a day-care facility, 300 yards of a university dormitory, and one-half mile of a stadium that holds more than 90,000 fans on game days during football season. NRC regulations for emergency plans require licensees to establish plans for coping with emergencies, but NRC does not require that these plans include evacuation plans for areas surrounding its licensed reactors. Instead, these requirements only require licensees to establish limited emergency planning zones, which vary in size depending on the size of the reactor. The acceptable emergency planning zone for reactors that NRC licenses to operate at 2 MW or less—that is, 30 of the 33 NRC-licensed research reactors—is limited to the grounds of the reactor facility; there are no evacuation plans for the areas surrounding the reactor. Two other NRC-licensed research reactors—at the Massachusetts Institute of Technology and the University of Missouri, Columbia—must establish an emergency planning zone with possible evacuation of 100 meters surrounding the research reactor; the 20 MW National Institute of Standards and Technology reactor must establish an emergency planning zone of 400 meters.

***Some First Responders Are Not Armed***. NRC regulations on emergency response require that licensees ensure that a watchman or off-site response force will respond to unauthorized entrance or activity at research reactors, but regulations do not require first responders for emergencies at research reactors to be armed. At most NRC-licensed reactors we visited, the designated first responders are armed. At a few reactors, however, unarmed campus police—not local law enforcement agencies—would be the first responders when alarms are set off. Such plans are likely to delay an armed police response. According to SNL security experts, the lack of a timely armed response increases the risk that a terrorist attack will be successful.

## NNSA Has Made Progress in Converting U.S. Research Reactors from HEU to LEU Fuel, but It Faces Challenges in Converting Some Remaining Research Reactors

NNSA has converted 8 currently operating U.S. research reactors from HEU to LEU fuel and has plans to convert 10 remaining reactors by 2014. However, NNSA will confront challenges in converting 5 of these 10 remaining research reactors because they cannot be converted with fuel that is currently available. According to NNSA and national laboratory officials, the schedule for fuel development is optimistic and further technical setbacks in fuel development would likely delay their research reactor conversion plans.

### NNSA Has Converted 8 Currently Operating U.S. Research Reactors and Has Plans to Convert 10 Remaining Reactors

Since 1978, when the reactor conversion program started, DOE has converted a total of 8 currently operating U.S. research reactors from HEU to LEU fuel. In 2004, we reported on the progress of the reactor conversion program and recommended, among other things, that NNSA place a higher priority on converting these reactors.[9] In response to our recommendation, in 2006, NNSA converted 2 more operating U.S. research reactors from HEU to LEU fuel. NNSA plans to convert an additional 10 U.S. research reactors by 2014, including 5 that can convert with currently available fuel and 5 that cannot convert with currently available fuel. The 2 NRC-licensed research reactors that converted in 2006 were reactors at the University of Florida and Texas A&M University, which were converted at a cost of about $3 million and $7 million, respectively. These recent conversions represent the first U.S. conversions since 2000 and are part of NNSA's expanded effort to convert research reactors worldwide.

NNSA plans to convert the remaining 5 U.S. research reactors that can convert with currently available fuel by September 2009 at an estimated cost of $37 million (see table 2).

[9]GAO, *Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors*, GAO-04-807 (Washington, D.C.: July 30, 2004).

**Table 2: U.S. Research Reactors Using HEU Fuel That NNSA Plans to Covert to Currently Available LEU Fuel by 2009**

| Reactor | Anticipated conversion date |
|---|---|
| Purdue University | 2007 |
| Oregon State University | 2008 |
| Washington State University | 2008 |
| University of Wisconsin | 2009 |
| Neutron Radiography Reactor—DOE | 2009 |

Source: NNSA.

## NNSA Faces Challenges in Converting 5 of the 10 Remaining Reactors

NNSA has set a target date of 2014 for converting the five remaining HEU research reactors that cannot convert with currently available fuel. NNSA is now developing a new fuel that will allow the remaining five reactors to convert; according to an NNSA official, this new fuel must be developed by 2011 if NNSA is to meet its 2014 conversion schedule goal. We believe that the conversion schedule may be optimistic because developing this fuel has been problematic. For example, early efforts to develop the fuel experienced failures during testing that caused NNSA to push back anticipated completion dates from 2008 to 2010, and NNSA has since delayed the completion of the fuel until 2011. Argonne National Laboratory officials working on the fuel development effort at that time characterized the failures during testing as the worst they had ever experienced. According to NNSA officials and INL fuel development scientists, more recent attempts to develop new LEU fuel appear promising. In addition, a series of recent successful tests of the new fuel, including fuel fabrication and testing at the Advanced Test Reactor are indicative of the potential to successfully develop the new LEU fuel. However, NNSA and national laboratory officials acknowledged that the fuel development schedule is optimistic and that further technical setback would likely delay DOE's research reactor conversion plans. NNSA estimates that an additional $46 million will be needed to actually convert reactors once the fuel is available. This estimate is uncertain. If any further technical difficulties are experienced in the process of developing the new fuel, additional funding will be required for further fuel improvements, and the estimated conversion date will not be met. Table 3 outlines the schedule for converting the five research reactors that cannot convert with currently available fuel.

**Table 3: Anticipated Conversion Dates for Five U.S. Research Reactors Using HEU Fuel That Cannot Convert with Currently Available LEU Fuel**

| Reactor | Anticipated conversion date |
|---|---|
| University of Missouri, Columbia | 2012 |
| Massachusetts Institute of Technology | 2012 |
| National Institute of Standards and Technology | 2012 |
| Advanced Test Reactor—DOE | 2013 |
| High Flux Isotope Reactor—DOE | 2014 |

Source: NNSA.

## Conclusions

The NRC-licensed nuclear research reactors located throughout the United States play an important role in education and basic scientific research. However, because most of these reactors are located on university campuses, they face unique challenges in both remaining accessible for educational purposes and providing enough security to protect neighboring communities from the potentially significant impacts of a terrorist attack. Understanding the consequences of a terrorist attack on these research reactors is critical to determining the level of security needed to protect them. To understand the consequences of an attack, NRC conducted a security assessment of its licensed reactors and concluded that the consequences would be minimal—having almost no effect on nearby areas. However, NRC's security assessment may underestimate the potential consequences of an attack because it used assumptions and analyses about reactor security and terrorist capabilities that we believe are questionable. Additionally, NRC's conclusions are not supported by the findings of SNL, an INL reactor vulnerability expert, and a DHS expert. SNL found that a group of well-trained terrorists could gain access to a number of NRC-licensed research reactors. Moreover, INL and DHS experts believe that it is possible that a meaningful portion of a research reactor could be damaged in an attack. Such an attack could result in a radioactive release that is greater than NRC estimates in their assessment. Without an analysis that better reflects the full range of expert opinion on the security of reactors and the capabilities of potential terrorist forces, NRC will not have fully considered the risks posed by research reactors. NRC will also lack assurance that it has established security and emergency response plan requirements commensurate with the risks posed by attacks on its licensed research reactors.

## Recommendations for Executive Action

To better understand and prepare for the potential consequences of a terrorist attack on NRC-licensed research reactors, we recommended in our October 2007 classified report that the Chairman of NRC reassess the consequences of terrorist attacks on NRC-licensed research reactors using assumptions that better reflect a fuller range of outside expert opinion on the security of reactors and the capabilities of potential terrorist forces.

If NRC finds that the consequences of an attack on a research reactor are more severe than previously estimated, we recommended that the Chairman of NRC take the following three actions:

- ensure that the security requirements for research reactors are commensurate with the consequences of attacks,
- reexamine emergency response requirements to address whether evacuation plans should be included, and
- require that first responders to alarms at research reactors be armed.

## Agency Comments and Our Evaluation

We provided DOE, NNSA, and NRC with draft copies of our classified report for their review and comment. As discussed in our classified report, NNSA, whose comments also reflected DOE's views, generally agreed with the report and provided minor technical comments, which we incorporated as appropriate in this unclassified report as well. NRC did not agree with the report and stated that the report provides an unbalanced assessment of its effort to enhance security at research reactors since September 11, 2001. NRC summarized its views in a separate unclassified letter which we have included in appendix I, along with our comments.

NRC criticized our report in four areas. First, NRC stated that the draft report misrepresented the effort it has made following September 11, 2001, to assess and enhance the security of research reactors; it also asserted that we compared security requirements for NRC-licensed research reactors with DOE operated reactors and that the comparison is incomplete and inaccurate. Second, NRC stated that we misrepresented its use of the SNL security assessment and that we incorrectly stated that NRC had dismissed the findings in SNL's assessment. Third, NRC asserted that our report misrepresented or excluded key facts. Finally, NRC believes that our assumptions concerning terrorist attack scenarios lack a sound technical basis.

First, we disagree with NRC's assertion that our report misrepresents the Commission's efforts since September 11, 2001, to assess and enhance the security of research reactors. We accurately describe NRC's active oversight actions, including routine inspections for safety and security. Furthermore, we give NRC credit for working with research reactor licensees to make, and to verify, many security improvements that NRC identified as necessary. We also discuss the many security features and improvements at NRC-licensed research reactors that we visited and note that several of the licensees have made security improvements that exceed NRC's security requirements. Furthermore, contrary to NRC's comments, our report does not compare security requirements for NRC-licensed and DOE operated research reactors or actual security conditions at the reactors. Rather, our report discusses our findings on security requirements and their implementation at NRC-licensed and DOE operated research reactors.

Second, we disagree with NRC's assertion that our report misrepresents NRC's use of the SNL security assessment and that NRC dismissed SNL's security assessment. Our report did not state that NRC "dismissed" the security assessment; instead, it accurately states that NRC "disagreed" with SNL about the security of research reactors. Furthermore, NRC itself has reiterated this disagreement with the SNL analysis in writing on several occasions. Specifically, when NRC provided us with copies of SNL's security assessment, it also provided a disclaimer stating that NRC "does not support many of the assumptions and/or information contained in these reports and…the reports cannot be used independently to develop any conclusions regarding the security or protective measures for the facilities contained in the reports." In addition, a 2005 statement by an NRC Commissioner concerning SNL's work further supports our point that NRC disagreed with the SNL analysis. This Commissioner states, "because the Sandia security assessment reports contain scenarios and assumptions that are not supported by the Commission, the reports should not be released to anyone outside the agency nor should they be shared with licensees or stakeholders." Continuing, this Commissioner states that SNL's security reports "if taken out of context, could prove to be an enormous burden on NRC and our licensees and could result in a tremendous amount of time spent explaining why we think the Sandia analyses are deeply flawed."

Third, we disagree with NRC's assertion that our report misrepresents or excludes key facts. In particular, NRC states that INL and SNL refute our characterization of key facts gathered from INL, federal agencies, and SNL to support our recommendations. With regard to INL, we did receive a letter from INL in June 2007 requesting that we not include or refer in any fashion to any INL technical judgments contained in the INL report. Later that month, we spoke with INL management about the reason for this request. As we state in our report, according to INL's Deputy Associate

Laboratory Director for National and Homeland Security Directorate,[10] INL believes that a more comprehensive analysis of the vulnerability and consequences of attacks on research reactors is warranted. Nonetheless, this official stated that the INL analysis was technically accurate and INL's vulnerability expert had done good work in preparing it. As a result of this discussion, we deleted from the report much of the specific details of this analysis, such as the specific estimates of radiological consequences, and instead provided only a short summary of the key findings of the analysis. Our report includes a statement from the INL analysis stating that a terrorist attack could produce "significant consequences" and have "high socio-economic impact" because INL officials emphasized this point during communications with us after we received INL's June 2007 letter. Furthermore, in its comments, NRC states that INL requested that we exclude from our report references to information we obtained from verbal communications with INL experts. INL never asked us to exclude discussions we had during our visit to INL and subsequent discussions with INL officials. INL would have no basis to make such a request because representatives of INL management arranged our meetings with INL experts to gather the information and data needed to complete our work.

With respect to SNL, in neither of two sets of written comments did SNL dispute our primary conclusion regarding its work for NRC—that some NRC-licensed research reactors may not be prepared for certain types of terrorist attacks—nor did SNL disagree with our main report recommendation. We received initial comments from SNL in July 2007 on an early version of our classified draft report. At that time, we revised our draft to acknowledge one of SNL's key points—namely, that damaging a research reactor is a difficult and sophisticated task. However, we did not include further details of these initial comments because they were inconsistent with the information SNL had provided during extensive discussions over 2 days in November 2006. For example, in its July 2007 written comments, SNL provided information that demonstrated why this task is so difficult. However, during discussions with SNL's expert, he noted that damaging a reactor was possible and provided us with very detailed steps of how to do so. These steps addressed many of the very limitations discussed in the July 2007 comments from SNL. Furthermore, a key finding of our report is that NRC disagreed with the SNL finding that some NRC-licensed research reactors may not be prepared for certain

[10] INL's June 2007 letter to GAO asked us to contact this INL official—the Deputy Associate Laboratory Director, National Homeland Security Directorate—if we needed any additional information regarding INL's request.

types of terrorist attacks. In its July 2007 comments, SNL did not address our characterization of the work it did for NRC. Finally, in subsequent comments provided in September 2007 as part of DOE's technical comments, SNL expanded upon its earlier comments regarding the difficulty of sabotaging a research reactor which we had already acknowledged in the report. In discussing this point, SNL stated that further study was needed on the extent to which terrorists could damage a research reactor. Regardless of the details of the work performed by INL and SNL, which we believe raise key concerns, one thing remains clear: there is need for further study to better understand the risks and consequences of an attack on a research reactor by well trained terrorists.

Finally, NRC asserted that our assumptions regarding terrorist attack scenarios lack a sound technical basis. We disagree. Specifically, we note the following:

- The findings in our report do not rely on assumptions but, instead, are based on the evidence we collected from experts at NRC, DOE, INL, SNL, DHS, and other sources. This evidence demonstrates that there is uncertainty about some aspects of NRC's security assessment. However, NRC's comments suggest that no such uncertainty exists, even though in some cases NRC used assumptions in its security assessment that it had difficulty defending. For example, NRC officials did not fully consider an alternative attack scenario that could be more damaging if carried out successfully because, according to NRC officials, the supervisor of the staff doing the assessment was an engineer who instructed the staff that such scenarios were unlikely, if not impossible. During discussions on this point, an NRC official acknowledged that if the alternative attack scenario had been fully assessed, NRC's security assessment might have demonstrated more significant consequences.

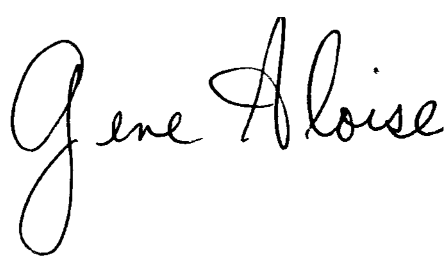
- NRC states that we incorrectly assumed that terrorists could use certain tactics in attacking research reactors since there is a lack of intelligence information that terrorists have demonstrated these capabilities. We disagree. The events of September 11, 2001, and the threats faced by our armed forces in Iraq demonstrate that terrorists are capable of innovating how they conduct attacks. Consequently, we believe that, in conducting its security assessment, NRC should have considered a fuller range of threats, including both the threats that have occurred and the possibility of emerging threats.

- NRC also disagreed with our characterization of (1) what portion of a reactor could be damaged in a terrorist attack and (2) the extent of the radiation released from such an attack. However, experts at INL and DHS provided our evidence on these points. As previously discussed, according to an INL vulnerability expert, a well-executed terrorist attack could damage a significant portion of a research reactor and release a larger amount of radioactivity into the neighboring communities than NRC estimates. On this point, INL's Deputy Associate Laboratory Director for National and Homeland Security Directorate told us that additional analysis and study is warranted in order to gain a more comprehensive understanding of both how much of a reactor could be damaged in an attack and what the resulting radiological consequences would be.

As agreed with your office, unless you publicly release the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will then send copies of this report to the appropriate congressional committees; the Secretary of Energy; the Administrator of NNSA; the Chairman of NRC; and the Director, Office of Management and Budget. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at www.gao.gov.

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

Sincerely yours,



Gene Aloise
Director, Natural Resources
and Environment

# Appendix I: Comments from the Nuclear Regulatory Commission

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

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

December 17, 2007

Mr. Gene Aloise, Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Aloise:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am providing an unclassified version of the NRC's comments on the U.S. Government Accountability Office's (GAO's) classified draft report about the security of research and test reactors. A detailed and classified version of these comments was provided by letter dated September 4, 2007. We ask that this unclassified version of our comments be included, in its entirety, in the unclassified public version of GAO's final report.

The NRC is pleased to be afforded this opportunity to comment on this draft report. Unfortunately, we found that this report provides an unbalanced assessment of the efforts of the NRC and Research and Test Reactor (RTR) licensees to enhance security after September 11, 2001. Additionally, this report lacks sound technical bases and credible intelligence information in support of GAO's recommendations and the NRC strongly encourages GAO to make substantial changes to the report.

Safe and secure RTRs are a part of campus landscapes around the country, providing education and training to the next generation of scientists and engineers. Currently, there are 32 operating NRC-licensed RTRs in the United States. These RTRs support a wide variety of scientific programs including biology, chemistry, physics, and medicine. A number of scientific and medical advancements can be attributed to RTRs, including improved cancer treatment therapies that have increased survival rates, and evidence that resulted in the now widely accepted asteroid impact theory on the extinction of the dinosaurs.[1] For perspective, the majority of NRC-licensed RTRs are less than 1 Megawatt-thermal (MWt), and range in size from 5 Watts – about the size of a standard nightlight in a child's bedroom – up to 20 MWt. In comparison, the typical operating nuclear power plant in the United States is rated to 3000 MWt and can power over 1 million homes.

**GAO Misrepresents NRC Actions to Enhance Security**

See comment 1

GAO's report misrepresents the considerable efforts made by the NRC following September 11, 2001, to assess and enhance the security of RTRs. Security measures for RTRs are based on a "graded" approach that is derived from the requirements of Section 104.c. of the Atomic

[1] National Research Council. (1988). *University Research Reactors in the United States – Their Role and Value.* Washington, D.C.: National Academy Press.

-2-

Energy Act of 1954, as amended, which directs the NRC to impose the minimum amount of regulation necessary to protect the public health and safety and the common defense and security. In general, RTRs that possess larger quantities of nuclear material or material that is potentially more attractive to adversaries have enhanced security measures in place. In the remaining months of 2001, after September 11$^{th}$, the NRC issued advisories with recommended security precautions based on on-site evaluations. From 2002 to 2004, the NRC established additional security measures at RTRs in a prioritized manner. During this time RTRs implemented compensatory measures, which included site-specific background investigations of personnel with access to the reactors. All RTR licensees have committed to incorporate these additional security measures into their security plans or procedures. The NRC ensures that the compensatory measures remain in place through our regulatory processes, which include Confirmatory Action Letters and on-site inspections. Additionally, background checks of all individuals with unescorted access to the NRC-licensed RTRs found no issues. Furthermore, the NRC requested and received, in the Energy Policy Act of 2005, the authority to require Federal Bureau of Investigations (FBI) identification and criminal history records checks, based on fingerprints, of any person with access to Safeguards Information or unescorted access to RTRs. In September 2006 and April 2007, respectively, the NRC implemented this authority through Orders to all RTRs.

See comment 2

GAO's report misrepresents NRC's use of Sandia National Laboratories' (SNL) security assessments. GAO asserted that the NRC dismissed SNL's reports because we did not agree with its results. That is untrue. As we previously discussed with GAO's staff, the NRC's research and test reactor technical staff carefully reviewed SNL's reports and determined that, while some of its assumptions and methodologies were unrealistically conservative, the reports were useful. In fact, the NRC's experts used input from SNL's reports in the development of a comprehensive decision-making framework which applied a risk-informed methodology in the evaluation of potential security enhancements. In 2006, after applying this framework to RTRs, the NRC determined that additional security enhancements were unnecessary due to the minimal risk these facilities pose to public health and safety. The NRC staff repeatedly cautioned GAO that SNL's modeling and assumptions used in the reports had limitations and that SNL's results alone did not provide a risk-informed basis for making regulatory decisions. GAO's report does not reflect NRC's caution and instead presents elements of the SNL reports out of their proper context.

See comment 3

GAO's comparison of security requirements for NRC-licensed and DOE-operated RTRs provides an incomplete and inaccurate representation of their safety and security. It should be noted that of the Department of Energy's (DOE) four RTRs, two are significantly larger than any NRC-licensed RTR. Furthermore, DOE's security requirements are based on the weapons-grade nuclear material handled and stored elsewhere on the site and not the RTRs themselves. Requirements such as Federal security clearances and protection against Design Basis Threats, while reasonable for a DOE facility where access is restricted due to the presence of significant quantities of highly classified and controlled strategic nuclear material, are inappropriate for a low-power, NRC-licensed RTR.

See comment 4

-3-

**Experts Question Key Facts in GAO's Report**

The NRC has determined that GAO's report misrepresents or excludes key facts. GAO's recommendations appear to be based predominantly on a pre-decisional sample document[2] demonstrating Idaho National Laboratory's (INL) capabilities and on opinions from Federal agencies and other labs, such as SNL. However, the NRC is aware that both INL and SNL provided written comments to GAO prior to the completion of the draft report refuting GAO's characterization of some of their work and key facts in the report.

After reviewing GAO's Statement of Facts, INL provided written comments regarding GAO's representation of work INL performed for GAO. INL's June 13, 2007, letter[3] to GAO's lead reviewer clearly stated that, "INL formally requests that the GAO not include or refer to in any fashion any INL technical judgments contained in the INL pre-decisional sample document." INL further explained that the document was prepared as a demonstration of the lab's capabilities and had not been reviewed either externally or internally by experts. Furthermore, INL stated that the report had not been reviewed for the, "reality of the scenarios and the engineering credibility of the attack systems and the example reactor conditions with recognized authorities." Since GAO issued its draft report for comment, NRC has confirmed INL's position on verbal communications, which GAO refers to in its draft report. "In line with INL's position of the proposal we provided to GAO, that it not be included or referred to in their report, our position is the same for verbal information exchanged with the GAO. Those conversations were conducted in order to define information to scope our proposal to GAO, not to provide technical information or facts."[4] Therefore, INL finds that inclusion and reference to the sample pre-decisional INL report in GAO's report detracts from its technical credibility, and INL indicates that its pre-decisional, sample document and associated verbal communications are not to be included or referred to in GAO's report.

Similarly, SNL, after reviewing GAO's Statement of Facts, provided written comments regarding GAO's characterization of SNL experts. SNL's comments to GAO fundamentally challenged the information used by GAO to claim that the NRC had not appropriately considered terrorist capabilities. SNL noted that GAO's Statement of Facts contained no mention of Sandia's views regarding the viability or practicality of the assumed terrorist scenarios. SNL further stated in its comments that despite providing GAO with a subject matter expert who refuted GAO's assumptions, GAO failed to acknowledge key scientific facts that challenged the basis for using the GAO-identified terrorist capabilities. Despite SNL's comments to the contrary, GAO's report represents these presumed terrorist capabilities as credible threats and a basis to challenge NRC's security requirements for RTRs.

Not only did GAO misrepresent the experts cited in its report, it also failed to acknowledge those experts' formal dissenting views. A fundamental principle of good decision-making is the consideration and inclusion of all relevant facts and information, even those that contradict one's conclusions. The NRC does not understand how GAO can exclude formal comments from national laboratories that it claims are experts and still conclude that it's characterization of RTR

[2] Schrader, Bradley J. Ph.D., PE, CHP. (April 2007): "Evaluation of a Pseudo TRIGA reactor for Radiological Sabotage." (This document is OUO).
[3] Letter from Hill, David J. INL Deputy Laboratory Director, Science and Technology, to Ruedel, Peter, GAO: "INL Response Regarding GAO Use of INL Evaluation of Research Reactors," 13 June 2007.
[4] Email from Landon, Chad J., INL, to Mendonca, Marvin, NRC: "Re: Info." August 15, 2007.

-4-

security is credible and balanced. INL's written comments are provided as Enclosure 1, to this letter.

**GAO's Assumptions Lack a Sound Technical Basis**

See comment 5

GAO's report assumes that a highly unlikely combination of events could damage an RTR and release radioactivity to the environment. GAO does not provide credible intelligence information or supporting technical bases for their postulated terrorist scenarios. Despite many meetings between the NRC and GAO staff where the NRC pointed out the significant limitations, challenges, and realisms that would make the scenarios highly unlikely, GAO's report continues to characterize them as credible without providing any supporting technical basis or analysis.

GAO's report assumes that terrorists could employ highly sophisticated methods and skills to cause significant damage to an RTR. GAO's report however, provides no supporting intelligence information that terrorists have demonstrated this capability. The NRC maintains an expert and dedicated team of threat assessment specialists with over 150 years of combined experience working in the intelligence community. This team applied NRC's rigorous threat assessment process, which GAO commended as "logical and well-defined,"[5] in determining credible terrorist capabilities. The NRC continually reviews intelligence information and when appropriate revises its assessment of credible terrorist capabilities.

See comment 4

See comment 6

In addition to the lack of credible intelligence information, GAO did not provide a sound technical basis to demonstrate that an RTR could be damaged as GAO assumes. As stated previously, GAO's own experts, SNL, challenged GAO's assumptions regarding the viability or practicality of GAO's postulated methods to damage an RTR. SNL provided a series of detailed scientific facts that support the view that GAO's postulation is highly unlikely. Further questioning the technical bases of GAO's scenario, Los Alamos National Laboratory (LANL) conducted a classified engineering and safety analysis, published as a classified report in 1990, that specifically analyzed methods similar to those postulated by GAO. LANL's analysis concluded that RTRs are resistant to the postulated attack due to their design and materials of construction. Additionally, LANL's classified analysis determined that the accomplishment of such scenarios would encounter significant challenges. During the course of NRC's security assessments performed since September 11, 2001, we found that law enforcement response provides a high degree of confidence that responders would successfully thwart the attack scenarios assumed by GAO. Additionally, the scientific work of LANL found that even if an adversary were successful in overcoming these restraints, the upper limit on the radioactivity released would be far less than the assumptions made by GAO. The conclusions reached in 1990 remain valid in the post-9/11 environment because the scientific principles they are based on have not changed.

GAO's evaluation and assumptions ignore the physical realities of RTR design and construction and the likely effects of the postulated scenarios on the terrorists that would prevent an attack from being successful in damaging an RTR. NRC and SNL staff reviewed GAO's scenarios and concluded that considerable resources and time would be necessary, if it would be possible at all. LANL's classified engineering and safety analysis reached the same conclusions as the

[5] Government Accountability Office. (March 2006). *Nuclear Power Plants: Efforts Made to Upgrade Security, but the Nuclear Regulatory Commission's Design Basis Threat Process Should Be Improved.* (Publication No. GAO-06-388).

NRC staff, which has over 220 combined years of experience regulating, operating, and managing RTRs.

GAO also assumed that upon damaging an RTR, a large, direct release of radiation would occur. NRC and LANL analyses have already shown that the probability of causing sufficient damage to an RTR such that a large release would occur is extremely low. In addition, the design and construction features present real world barriers to the release of radioactivity to the environment. These features were conveniently ignored in the GAO evaluation. Although questioned in the report, GAO does not provide any supporting technical basis to challenge the adequacy of the existing RTR emergency plans.

The NRC believes that the inaccuracies, misrepresentation, and unsupported assumptions discussed above undermine the credibility of the evidence presented in the draft report, which thus does not support a sound technical basis for its conclusions and recommendations. The NRC strongly encourages GAO to make substantial changes to the report in order to enhance its accuracy and thereby provide a convincing and fair presentation of the physical security of NRC-licensed RTRs.

Again, thank you for the opportunity to comment on this report. Should you have any questions about these comments, please contact Ms. Melinda Malloy, at (301) 415-1785, of my staff.

Sincerely,

Luis A. Reyes
Executive Director
for Operations

Enclosure:
INL Response Regarding GAO Use of
INL Evaluation of Research Reactors

Idaho National Laboratory

June 13, 2007

CCN 210055

Mr. Peter E. Ruedel
Government Accounting Office
441 G Street NW
Washington, DC 200548

SUBJECT: INL Response Regarding GAO Use of INL Evaluation of Research Reactors

References:
1 Draft GAO Report - (OUO/SGI) Draft, Statement of Facts DOE and NRC Research Reactors
2 INL Pre-Decisional, Sample Document (OUO), Evaluation of a Pseudo TRIGA reactor for Radiological Sabotage, Bradley J. Schrader, Ph.D., PE, CHP, April 2007.

Dear Mr. Ruedel:

See comment 4

In response to the request, June 7, 2007 from the Government Accounting Office (GAO) to provide review comments related to the draft GAO report (reference 1), the INL formally requests that the GAO not include or refer to in any fashion any INL technical judgments contained in the INL pre-decisional sample document (reference 2).

The referenced INL document was prepared as a sample document demonstrating the INL's capability; it was not intended to be a formal deliverable in response to a Work-for-Others agreement with the GAO. As you know, no such work-for-others agreement ever existed. Further and more importantly, the reference 2 document has not been peer-reviewed pursuant to the normal INL technical report review processes. For this type of document, the INL typically would have this report reviewed by internal and external experts, prior to release as a formal report. Specifically for this document, the INL would have established the reality of the scenarios and the engineering credibility of the attack systems and the example reactor conditions with recognized authorities. Neither this peer review or the referenced research methodologies were performed. Again, the reference 2 document was provided to GAO as nothing more than a sample of the INL's research capabilities.

Because this referenced document has not undergone the standaru peer review processes, the INL would not use this document as the basis for any action; and we suggest that any use by GAO of the contents of this pre-decisional document or references to its contents will detract from the technical credibility of the GAO report.

P.O. Box 1625 • 2525 North Fremont Ave. • Idaho Falls, Idaho 83415 • 208-526-0111 • www.inl.gov

Mr. Peter E. Ruedel
June 13, 2007
CCN 210055
Page 2

If you need additional information regarding resolution of this request, the INL point of contact is Mr. Lynn Goldman (208-526-0010), Deputy Associate Laboratory Director, National and Homeland Security Directorate.

Sincerely,

David J. Hill, Deputy Laboratory Director
Science & Technology

SDH:rlo

cc: R. L. Green, DOE-ID, MS 1170
J. J. Grossenbacher, INL, MS 3695
W. D. Lewis, DOE-ID, MS 1240
V. C. Pearson, DOE-ID, MS 1170
K. R. Tuuri, DOE-ID, MS 1170

The following are GAO comments on the Nuclear Regulatory Commission's (NRC) letter dated December 17, 2007.

## GAO Comments

1. We disagree. We accurately describe NRC's oversight actions taken since September 2001, including its process of performing routine inspections for safety and security. Furthermore, we give NRC credit for working with research reactor licensees to make, and to verify, many security improvements that NRC identified as necessary. We also discuss the many security features and improvements at NRC-licensed research reactors that we visited including security improvements that exceed NRC's security requirements.

2. Our report does not misrepresent NRC's use of Sandia National Laboratories' (SNL) security assessment and did not state that NRC "dismissed" the security assessment. Instead, our report accurately states that NRC "disagreed" with SNL about the security of research reactors. On this point, NRC has reiterated its disagreement with the SNL analysis in writing several times. Specifically, when NRC provided us with copies of SNL's security assessment, it also provided a disclaimer stating that NRC "does not support many of the assumptions and/or information contained in these reports and…the reports cannot be used independently to develop any conclusions regarding the security or protective measures for the facilities contained in the reports." Furthermore, a 2005 statement from an NRC Commissioner concerning SNL's work further supports our point that NRC disagreed with the SNL analysis. According to this Commissioner, "because the Sandia security assessment reports contain scenarios and assumptions that are not supported by the Commission, the reports should not be released to anyone outside the agency nor should they be shared with licensees or stakeholders." He further states that SNL's security reports "if taken out of context, could prove to be an enormous burden on NRC and our licensees and could result in a tremendous amount of time spent explaining why we think the Sandia analyses are deeply flawed."

3. Contrary to NRC's comments, our report does not compare security requirements for NRC-licensed and Department of Energy (DOE) operated research reactors or actual security conditions at the reactors. In fact, we reported on DOE and NRC security issues in separate sections of the report. We did, however, compare one assumption regarding how each agency considered the role of insiders who may provide assistance to an attacking force. In our view, this was an important comparison to make because, in its assessment, NRC

assumed that insiders with access to the reactor would only participate to a limited degree in an attack on a reactor. However, in similar security assessments for DOE facilities, DOE assumed that insiders would fully participate in an attack, and it has designed its defenses on the assumption of full participation. In discussing this point with NRC officials, they acknowledged that if NRC's assessment had assumed fully participating insiders, then the results of its assessment may have turned out differently.

4. Our report did not misrepresent or exclude key facts provided to us by Idaho National Laboratory (INL) and SNL. With regard to INL, we did receive a letter from INL in June 2007 requesting that we not include or refer in any fashion to any INL technical judgments contained in the INL report, and we subsequently spoke with INL management about the reason for this request. As our report states, according to INL's Deputy Associate Laboratory Director for National and Homeland Security Directorate,[1] INL believes that a more comprehensive analysis of the vulnerability and consequences of attacks on research reactors is warranted. Nonetheless, this official stated that the INL analysis was technically accurate and INL's vulnerability expert had done good work in preparing it. As a result of this discussion, we deleted from the report many of the specific details of this analysis, such as the specific estimates of radiological consequences, and instead provided only a short summary of the key findings in the analysis. As we pointed out in our report, the INL analysis stated that a terrorist attack could produce "significant consequences" and have "high socio-economic impact." We retained this statement because INL officials emphasized this point during communications with us after we received INL's June 2007 letter. Furthermore, although NRC states that INL asked us to exclude references to information we obtained from verbal communications with INL experts, INL never made such a request to us. INL would have no basis to make such a request because representatives of INL management arranged our meetings with INL experts to gather the information and data needed to complete our work.

   With respect to SNL, in neither of two sets of written comments did SNL dispute our primary conclusion regarding its work for NRC—that some NRC-licensed research reactors may not be prepared for certain types of terrorist attacks—nor did SNL disagree with our main report

[1] INL's June 2007 letter to GAO asked us to contact this INL official—the Deputy Associate Laboratory Director, National Homeland Security Directorate—if we needed any additional information regarding INL's request.

recommendation. We received initial comments from SNL in July 2007 on an early version of our classified draft report and revised our draft to acknowledge one of SNL's key points—namely, that damaging a research reactor is a difficult and sophisticated task. However, we did not include further details of the SNL comments because they were inconsistent with the information we received during extensive discussions with SNL experts during 2 days in November 2006. For example, in its July 2007 written comments, SNL provided information that demonstrated why this task is so difficult. However, during discussions with SNL's expert, he noted that damaging a reactor was possible and provided us with very detailed steps of how to do so. These steps addressed many of the very limitations discussed in the July 2007 comments from SNL. Furthermore, as we also reported, NRC disagreed with the SNL finding that some NRC-licensed research reactors may not be prepared for certain types of terrorist attacks. In its July 2007 comments, SNL did not address our characterization of the work it did for NRC. Finally, in subsequent comments provided in September 2007 as part of DOE's technical comments, SNL provided more detailed information on the difficultly of sabotaging a research reactor. Our report includes SNL's view that attacking a research reactor would be a difficult task that would likely require specific knowledge of reactors and sabotage techniques. Nonetheless, SNL's comments also acknowledge the need for further study on the extent to which terrorists could damage a research reactor. Regardless of the details of the work performed by INL and SNL, which we believe raise key concerns, one thing remains clear: there is need for further study to better understand the risks and consequences of an attack on a research reactor by well trained terrorists.

5. We disagree with NRC's assertion that our assumptions regarding terrorist attack scenarios lack a sound technical basis. Specifically, we note the following:

- The findings in our report do not rely on assumptions but instead are based on the evidence we collected from experts at NRC, DOE, INL, SNL, DHS, and other sources. This evidence demonstrates uncertainty about some aspects of NRC's security assessment. In contrast, NRC's comments suggest that no such uncertainty exists, even though in some cases NRC used assumptions in its security assessment that it had difficulty defending. For example, NRC officials did not fully consider an alternative attack scenario that could be more damaging if carried out successfully because, according to NRC officials, the supervisor of the staff doing the assessment instructed the staff that such scenarios were unlikely, if not impossible. An NRC official acknowledged that if the alternative attack scenario had been fully assessed, NRC's security assessment might have demonstrated more significant consequences.

- We disagree with NRC's statement that we incorrectly assumed that terrorists could use certain tactics in attacking research reactors, since there is a lack of intelligence information that terrorists have demonstrated these capabilities. NRC's security assessment did not address certain tactics that were raised as a concern in its own intelligence documents. Furthermore, as the events of September 11, 2001, and the threats faced by our armed forces in Iraq have shown, terrorists are capable of innovating how they conduct attacks. Consequently, we believe that, in conducting its security assessment, NRC should have considered a fuller range of threats, including both the threats that have occurred and the possibility of emerging threats.

- We stand by the evidence provided by INL and DHS experts regarding the portion of a reactor that could be damaged in a terrorist attack and the extent of the radiation that could be released from such an attack. As previously discussed, according to an INL vulnerability expert, a well-executed terrorist attack could damage a significant portion of a research reactor and lead to the release of a larger amount of radioactivity into the neighboring communities than NRC estimates. On this point, INL's Deputy Associate Laboratory Director for National and Homeland Security Directorate told us that more analysis and study is warranted to gain a more comprehensive understanding of both how much of a reactor could be damaged in an attack and what the resulting radiological consequences would be.

6. This comment refers to a classified report Los Alamos National Laboratory (LANL) issued in 1989. That report discussed the potential and limitations to a certain type of terrorist attack on research reactors that is discussed more fully in our classified report. The scenario addressed in the LANL report was similar to the type of attack identified in the INL analysis. (The LANL report was discussed in our classified report. Because the LANL report is classified, we are not including the details of the LANL report in this report.) However, we note that the LANL report was completed more than 15 years ago at a time when the United States faced different and less severe potential threats. In our view, the LANL study, when combined with the views of INL and DHS experts, demonstrates that there is some uncertainty within the community of reactor experts on the consequences of certain types of attacks on research reactors. This uncertainty provides

the basis for our recommendation that NRC reconsider its security assessment.

# Appendix II: GAO Contact and Staff Acknowledgments

## GAO Contact

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

## Staff Acknowledgments

In addition to the contact named above, John Delicath, Doreen S. Feldman, Eugene Gray, Keith Rhodes, Ray Rodriguez, Peter Ruedel, Rebecca Shea, Carol Herrnstadt Shulman, Ned Woodward, and Franklyn Yao made key contributions to this report.

## GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

## Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's Web site (www.gao.gov). Each weekday, GAO posts newly released reports, testimony, and correspondence on its Web site. To have GAO e-mail you a list of newly posted products every afternoon, go to www.gao.gov and select "E-mail Updates."

### Order by Mail or Phone

The first copy of each printed report is free. Additional copies are $2 each. A check or money order should be made out to the Superintendent of Documents. GAO also accepts VISA and Mastercard. Orders for 100 or more copies mailed to a single address are discounted 25 percent. Orders should be sent to:

U.S. Government Accountability Office
441 G Street NW, Room LM
Washington, DC 20548

| | | |
|---|---|---|
| To order by Phone: | Voice: | (202) 512-6000 |
| | TDD: | (202) 512-2537 |
| | Fax: | (202) 512-6061 |

## To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Web site: www.gao.gov/fraudnet/fraudnet.htm
E-mail: fraudnet@gao.gov
Automated answering system: (800) 424-5454 or (202) 512-7470

## Congressional Relations

Gloria Jarmon, Managing Director, jarmong@gao.gov, (202) 512-4400
U.S. Government Accountability Office, 441 G Street NW, Room 7125
Washington, DC 20548

## Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548